APRIL, 1993

DRAFT
WORK PLAN
ON-SITE GROUNDWATER
INTERIM REMEDIAL MEASURE EXPANSION
GROUNDWATER OPERABLE UNIT GW-2
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

DAMES & MOORE

APRIL 1993
00173-076-8453

SAC57.022

DAMES & MOORE

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April 23, 1993

Mr. Val W. Siebal, Ombudsman
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California Environmental Protection Agency
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Attention: Mr. James L. Tjosvold, P.E.

Re: Work Plan
On-Site Groundwater Interim
Remedial Measure Expansion
Groundwater Operable Unit GW-2
Union Pacific Railroad Yard
Sacramento, California
Project No. 00173-076-044

Dear Mr. Tjosvold:

Union Pacific Railroad Company (UPRR) has requested that Dames & Moore transmit the above-referenced document. Presented in the Work Plan is UPRR's proposed approach for expansion of the current groundwater interim remedial measure (IRM) at the UPRR Yard in Sacramento, California to include groundwater operable unit GW-2.

Please provide us with your comments on the work plan, and if you have questions or require clarification, please contact either of the undersigned at (916) 387-8800.

Sincerely,

DAMES & MOORE

Timothy K. Parker, R.G.
Project Manager

Jim Brake, R.G.
Project Geologist

Enclosure

cc: Distribution List

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1.0 INTRODUCTION

This Work Plan contains the technical rationale and proposed approach for expanding the on-site groundwater interim remedial measure (IRM) at the Union Pacific Railroad (UPRR) Sacramento Yard (the site) to include Groundwater Operable Unit 2 (GW-2). UPRR's approach for design and implementation of an on-site groundwater IRM was provided in the On-Site Groundwater IRM Work Plan (Dames & Moore, 1992c). The on-site groundwater IRM addresses minimizing off-site migration and decreasing the mass of contaminants in the on-site portion of Groundwater Operable Unit GW-1 (GW-1). The Work Plan was approved by the California Department of Toxic Substances Control in written correspondence dated December 31, 1992. The on-site groundwater IRM is currently under construction (approximately 90 percent complete as of the date of this document), and start-up is planned to occur during the second week of April 1993, pending weather conditions.

The proposed expansion addresses collection and treatment of contaminated groundwater present in the first hydrostratigraphic zone contained within the site boundary. The proposed expansion does not constitute the final remedial measure, but is an interim step to address impacts to groundwater in GW-2 until a full-scale remediation system is designed and installed.

The extent of groundwater impacts in the first hydrostratigraphic zone has been evaluated on- and off-site by the completion of 66 soil borings, many of which were cored continuously, and 42 of which were completed as groundwater monitoring wells; conducting quarterly groundwater monitoring for aromatic and chlorinated volatile organic compounds (VOCs) and selected metals since 1989; conducting cone penetration tests (CPT) and groundwater sampling using the Hydropunch™ (HP) at approximately 100 locations; and by conducting an aquifer pumping test. GW-2 originates on-site near groundwater monitoring well MW-5, and extends a distance of approximately 1,200 feet to the southeast (Dames & Moore, 1991c).

The objectives in implementing the expansion are as follows:

- Limit off-site migration of on-site contaminants in the first hydrostratigraphic zone;

- Decrease the mass of contaminants within GW-2; and

- Provide data on the effects of long-term pumping of the first hydrostratigraphic zone including:

  ° First hydrostratigraphic zone response;
  ° Water quality variation; and
  ° Groundwater treatment system operation and discharge.

These data will be utilized in developing the final groundwater remedial measure.

The Work Plan is organized into 7 sections. Section 2.0 presents the rationale for selection of extraction well location and flow rate. Analytical calculations were used to evaluate the pumping rates and well locations needed to produce an adequate hydraulic barrier (i.e., capture zone) to minimize migration of constituents off-site. The capture zone analysis focused on using one well to produce the desired results.

Section 3.0 discusses estimated extracted groundwater quality, the effect of the addition of extracted water from GW-2 on treatment system influent quality, and projected total contaminant mass increases. A table is included which provides existing (GW-1) and projected (addition of GW-2) influent groundwater quality and mass-loading.

Section 4.0 presents information on the expansion design. A figure is included that depicts the planned layout of the expansion. Conceptually, the proposed expansion consists of extracting groundwater from one new well and treating extracted groundwater using the on-site treatment system.

Permitting requirements, implementation and schedule are discussed in Section 5.0. The planned start-up date for implementation of the expansion is the first week of June 1993. Section 6.0 proposes monitoring requirements during start-up and operation, and Section 7.0 includes a list of references used to prepare this Work Plan.

2.0 EXTRACTION WELL FIELD

A capture zone analysis was performed to select the location of an extraction well capable of capturing impacted groundwater on-site in the first hydrostratigraphic zone. The capture zone analysis focuses on using one well to produce the hydraulic barrier necessary to capture the on-site portion of GW-2 (see Figure 1). The approach used to design the extraction well field is based upon a set of analytical equations developed by Javandel and Tsang (1986). The capture zone width at the location of an extraction well (Y_w) is defined by the equation:

$$Y_w = \frac{Q}{2Ti}$$

where i is the hydraulic gradient, Q is the pumping rate, and T is the transmissivity of the hydrostratigraphic zone. The capture zone width upgradient of the extraction well will have a maximum value (Y_{max}) defined by the equation:

$$Y_{max} = \frac{Q}{Ti}$$

or

$$Y_{max} = 2 \times Y_w .$$

The stagnation point is the farthest point downgradient which is within the capture zone. The distance to the stagnation point from the extraction well (X_s) is defined by the equation:

$$X_s = \frac{Q}{2\pi Ti}$$

or

$$X_s = \frac{Y_w}{\pi} .$$

Parameters used to calculate capture zone and their sources are summarized in Table 1.

The hydraulic gradient in the GW-2 area is based upon groundwater contour maps prepared for the site (Dames & Moore, 1993a and 1993b). In GW-2, the hydraulic gradient is approximately 2 feet per 700 feet, or 0.0029.

The transmissivity of the first hydrostratigraphic zone is based upon several sets of data. These include the aquifer pumping test, boring logs for monitoring wells in GW-2, and slug test results from the same wells (Dames & Moore, 1991c and 1992b). These data indicate that the transmissivity of the first hydrostratigraphic zone ranges between approximately 266 to 356 square feet per day in GW-2.

The pumping rate is based upon site hydrostratigraphic information and the Theis equation (Lohman, 1972). The Theis equation can relate pumping rate in a well to the transmissivity and the desired drawdown. The Theis equation was developed for confined aquifers. The first hydrostratigraphic zone in GW-2 is considered to be unconfined to semi-confined. Therefore, the Theis equation is not directly applicable, but it can be used to provide a preliminary estimate of the expected pumping rate. The actual pumping rate may be lower. The Theis equation indicates that the maximum pumping rate will be approximately 7.8 gallons per minute, or 1,500 cubic feet per day.

Based on the information described above (see Table 1), the calculated GW-2 capture zone lateral dimension ranges are:

- Y_w = 580 to 970 feet;
- Y_{max} = 1,160 to 1,940 feet; and
- X_s = 185 to 310 feet.

Given these capture zone parameters, existing monitoring wells MW-25 and MW-26 are located in a position that will meet the objectives stated in Section 1.0. Slug-test results indicate that the pumping rate may be higher in MW-25 than in MW-26. Therefore, MW-25 will be used as the extraction well for the GW-2 IRM. Details regarding the suitability of MW-25 for extraction are discussed in Section 4.1.

3.0 INFLUENT QUALITY

Chemicals of concern in groundwater are primarily VOCs and nickel. Table 2 lists these contaminants of concern and their expected concentrations. The chemical concentrations of the extracted water were developed using quarterly monitoring results. The highest concentrations measured to date within any of the wells located within GW-2 is assumed to represent the quality of groundwater pumped from the proposed extraction well. The highest concentrations measured to date are assumed to represent the worst-case scenario. For the purposes of this evaluation, it is assumed that total flow from GW-2 will be 10 gpm. This will allow the GW-2 system to be easily expanded, if necessary, without additional permitting.

Table 2 shows the assumed concentration of the extracted water for GW-1, GW-2, and also projects the combined influent concentrations into the existing treatment system. Based on the concentrations in Table 2, the influent organic constituent concentrations would actually drop in most cases with the addition of water from GW-2, since the concentration of most organic contaminants is much lower in GW-2 than in GW-1. However, since the total flow of the influent increases from 40 gpm to 50 gpm, the total mass of contaminants increases by about 10 percent (from 0.166 lbs/day to 0.176 lbs/day).

Table 2 indicates the nickel concentration may increase as a result of adding an additional flow stream from GW-2. However, as noted above, the highest nickel concentration measured to date (910 μg/L) within wells located in GW-2 (See Table 2) was assumed to represent the influent water quality to the treatment system. It is anticipated that the nickel concentration present in extracted groundwater from GW-2 will be significantly lower than estimated. A purpose for the proposed IRM is to verify the presence or absence of nickel in extracted groundwater.

The implications for the change in flow and concentrations on permitting requirements is discussed in more detail in Section 5.0.

4.0 SYSTEM DESIGN

The expansion includes the addition of one extraction well (MW-25), and lateral piping extending to the existing on-site treatment system. Design details, including proposed extraction well and pump specifications, pipes, type of instrumentation, pipe material, valving, and controls, will be described in subsequent engineering design documents prepared in order to obtain permits and ensure the system is properly constructed; however, the conceptual design of the expansion is presented below. The existing, on-site groundwater IRM consists of a low-profile air stripper with off-gas treatment using vapor phase carbon, and discharge of treated groundwater to the sanitary sewer.

4.1 GROUNDWATER EXTRACTION WELL

Existing monitoring well MW-25 will be used as the GW-2 extraction well. MW-25 is constructed of four-inch-diameter Schedule 40 PVC casing. It has a stainless steel, continuous, wire-wrapped screen with a slot size of 0.02 inches. The well is screened from 26 to 41 feet below ground surface (bgs). The sand pack extends from 24 to 41.5 feet bgs. Considering the expected drawdown and pumping rate during extraction, MW-25 is adequately constructed to function as an IRM extraction well.

The extraction well will be equipped with a three or four-inch submersible pump. The pump will be designed to provide a flow of up to 15 gpm against the expected hydraulic head, estimated to be 50 to 60 feet. The extraction well will include low-level switches to control groundwater levels and prevent dewatering of the well and potential pump damage. The groundwater extraction pump will be operated from the central control panel located at the treatment system, which will have start-up and shut-down switches for the pump.

4.2 TREATMENT SYSTEM COMPONENTS

Extracted groundwater will be pumped to the existing treatment system located south of MW-4 through piping buried in a trench located near the fence on the east side of the site (Figure 2). Influent water will be piped from the extraction well (MW-25) to an influent holding tank that is located adjacent to the air stripper. The influent holding tank also receives groundwater extracted from wells MW-4 and YMW-32. Water will be pumped from the influent holding tank through a bag filter, used to remove any sediment or particles, and into the low profile air stripper. Off-gas from the air stripper will be routed through vapor phase carbon units to remove groundwater contaminants present in the vapor phase, prior to exiting to the atmosphere.

4.3 EFFLUENT (TREATED GROUNDWATER) DISCHARGE

The shallow tray air stripper is designed with an effluent holding tank which is the base of the air stripper system. Treated effluent water will exit the air stripper holding tank and is pumped by the effluent discharge pump through 4-inch underground piping to the discharge point in an existing 114-inch sewer line located approximately 2,000 feet to the north.

The projected quality of treated groundwater exiting the air stripper is provided in Table 3. As indicated on the table, approximately 90 percent of the organic constituents are assumed to be removed by air stripping. (Actual air stripping model results indicate the removal efficiency is significantly higher than 90 percent.) It should be noted that air stripping is not effective in removing nickel. The maximum projected nickel concentration is approximately 400 $\mu g/L$. However, when treated groundwater is combined with wastewater present in the 114-inch sanitary sewer, the nickel concentrations should be diluted to approximately 5 $\mu g/L$. In addition, expected nickel concentrations of 400 $\mu g/L$ are projected maximum or worst-case scenario. One purpose of the IRM system is to monitor nickel concentrations present in extracted groundwater.

4.4 AIR DISCHARGE

Air discharge from the air stripper will be treated by an off-gas treatment system. The VOCs transferred to the air phase are removed by two granular activated carbon filters in series. The air flow rate through the current stripper off-gas treatment system will not change as a result of the additional flow from GW-2. The existing stripper moves 600 cubic feet per minute (cfm) of atmosphere air through two shallow-tray units to "strip" VOCs from the extracted groundwater.

With the addition of extracted groundwater from GW-2, total flow into the treatment system will be a maximum of 50 gpm, as discussed in Section 3.0. Assuming 100 percent removal efficiency (and assuming all TPH-gasoline is removed by the air stripper), mass loading to the vapor-phase carbon units increases from 0.166 lbs/day to 0.176 lbs/day. Assuming a 90-percent removal efficiency for the carbon units, mass loading to air would increase from 0.0166 lbs/day to 0.0176 lbs/day, or an increase of 0.0010 lbs/day. Table 4 shows the expected mass loading of the off-gas leaving the carbon canisters assuming 100-percent removal efficiency for the stripper and 90-percent removal efficiency for the vapor-phase carbon units.

5.0 PERMITTING

Permits that may need to be obtained or amended for the expansion of the IRM are listed below:

- Building Permit;
- Air Discharge Permit; and
- Water Discharge Permit.

The building permit would be obtained by the construction contractor from the City of Sacramento and is required for trenching, piping, and wiring.

An air discharge Permit to Construct has been obtained from the Sacramento Metropolitan Air Quality Management District (SMAQMD) for system construction and start-up. A permit to operate the air stripping system will be issued by SMAQMD once the start-up sampling and analysis results have been received and approved by SMAQMD. The permit to operate will need to be reviewed and possibly revised, as the water flow and the mass loading to air may increase slightly as a result of pumping from GW-2 (see Table 4).

The water discharge permits include an Industrial Sewer Use Permit and a Memorandum of Understanding (MOU). The existing Industrial Sewer Use Permit from the Sacramento Regional County Sanitation District allows for a monthly discharge of 1.73 million gallons (40 gallons per minute). Additional flow would result in assessment of additional fees in accordance with the ordinance in effect on the date that the monthly reports indicate that the flow was increased. There are also effluent limitations required by the permit, but these are not expected to be exceeded as a result of additional flow from GW-2 (see Table 3).

The MOU with the City of Sacramento (City), Department of Public Works, Flood Control and Sewers was finalized March 30, 1993 and describes discharge, monitoring, and reporting requirements for discharge to the City's combined storm/sanitary sewer system. The MOU is for discharge of treated water from GW-1 only. Additional discharge of treated water from GW-2 may require documentation of regulatory approval by the DTSC and documentation of expected effluent concentrations out of the treatment system and into the sewer line (see Table 3).

6.0 SYSTEM START-UP, MONITORING, AND REPORTING

Aquifer response and capture zone development will be evaluated based on water level measurements taken from monitoring wells in both the first and second hydrostratigraphic zones. Water levels will be measured in the wells listed in Table 5 on a schedule that will vary over time. Water levels will be measured frequently during start-up and initial operation and then less frequently over time. The reduction and movement of groundwater contaminants in the first hydrostratigraphic zone will be evaluated using groundwater samples collected directly from the extraction well effluent.

Water quality samples will also be collected more frequently during start-up and then less frequently as operation continues. Samples from the wells will be analyzed for chlorinated solvents (EPA Method 601) and nickel (EPA Method 200.7). Table 5 shows a proposed schedule for monitoring during start-up. The schedule calls for frequent monitoring during the first week of operation, and less frequent monitoring as operation continues. Monitoring during regular operation (after start-up) would occur monthly. Planned monitoring activities will occur with those that would be conducted for regular operation of the IRM.

Operation and maintenance of the IRM expansion would include monitoring flow from the new extraction well and collecting samples for chlorinated hydrocarbons and nickel on a monthly basis. Data from the new well would be incorporated into the monthly reports produced for regular operation of the on-site IRM.

7.0 SCHEDULE

UPRR intends to initiate permitting and construction activities associated with the expansion of the on-site IRM immediately upon receipt of DTSC approval to proceed. Therefore, timely approval of this groundwater IRM expansion work plan is desirable. It is anticipated that the GW-2 expansion can be constructed and in operation within approximately one month of receiving DTSC notification to proceed. However, the schedule may be affected by the time it takes to obtain the necessary permit amendments.

8.0 REFERENCES

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TABLES

TABLE 1

CAPTURE ZONE PARAMETERS
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Groundwater Gradient[(a)]	Hydraulic Conductivity (ft/day)	Aquifer Thickness (ft)	Transmissivity (ft^2/day)	Flow rate[(e)]	Calculated Capture Zone Dimensions (ft)		
					Y_W	Y_{MAX}	X_S
0.0029	35[(b)]	12.7[(c)]	445	1,500	580	1,160	185
0.0029	—	—	266[(d)]	1,500	970	1,940	310

(a) Average gradient for groundwater in GW-2 calculated from groundwater contour maps for January 1992, May 1992, September 1992, November 1992, January 1993, and April 1993 (Dames & Moore, 1993a and 1993b).

(b) Based on average of falling head and rising head slug test results for MW-25 (Dames & Moore, 1991b).

(c) Saturated thickness of screened interval based on observed April 1993 groundwater levels and MW-25.

(d) Geometric mean of aquifer pumping test results for MW-11, MW-13, MW-14, MW-17, MW-18, MW-29, MW-30, and MW-33 (Dames & Moore, 1992b).

(e) Maximum pumping based on Theis Solution.

TABLE 2

ESTIMATED INFLUENT CONCENTRATIONS
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

	GW-1 Influent(1) (μg/L)	GW-2 Influent(2) (μg/L)	Combined Influent(3) (μg/L)	Mass Loading from GW-1(4) (lbs/day)	Mass Loading from GW-2(5) (lbs/day)	Total Mass Loading(3) (lbs/day)
1,1-DCE	161	39	137	0.077	0.005	0.082
1,1-DCA	15	12	14	0.007	0.001	0.008
1,2-DCA	4.4	3.1	4	0.002	0.000	0.002
1,1,1-TCA	11	26	14	0.005	0.003	0.008
TCE	11	1.1	9	0.005	0.000	0.005
PCE	0	0.7	0.14	0.000	0.000	0.000
Chloroform	0	6.2	1	0.000	0.001	0.001
Benzene	60	0	48	0.029	0.000	0.029
Toluene	3.3	1.4	3	0.002	0.000	0.002
Ethylbenzene	2.8	0	2	0.001	0.000	0.001
Xylene	4.7	0	4	0.002	0.000	0.002
TPH-gasoline	75	0	60	0.036	0.000	0.036
Nickel	200	910	342	0.096	0.109	0.205

(1) The method used to estimate GW-1 influent quality is described in the On-Site IRM Work Plan (Dames & Moore, 1992c).
(2) Concentrations based upon highest values measured to date during quarterly sampling.
(3) Assumes flow equals 50 gpm.
(4) Assumes flow equals 40 gpm.
(5) Assumes flow is 10 gpm.

TABLE 3
COMPARISON OF ESTIMATED EFFLUENT CONCENTRATIONS WITH CITY AND COUNTY DISCHARGE REQUIREMENTS
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Parameter	MCL (μg/l)	Influent Concentration (μg/l)	Effluent Concentration[1] (μg/l)	Concentration After Dilution[2] (μg/l)	Current Sanitation District Permit Limits[3]
1,1-DCE	6	136.6	13.7	ND	22
1,1-DCA	5	14.4	1.4	ND	22
1,2-DCA	0.5	4.1	ND	ND	180
1,1,1-TCA	200	14.0	1.4	ND	22
TCE	5	9.0	0.9	ND	26
PCE	5	ND[4]	ND	ND	--
CHLOROFORM	100	1.2	ND	ND	--
BENZENE	1	48.0	4.8	ND	37
TOLUENE	100	2.9	ND	ND	28
ETHYLBENZENE	680	2.2	ND	ND	142
XYLENE	1750	3.8	ND	ND	--
TPH	--	60.0	6.0	ND	--
Nickel	100	394	394	5	--

[1] Assuming a 90% removal efficiency.
[2] Concentration in 114 inch line assuming a dry weather flow of 4000 gpm.
[3] Monthly averages (--) indicates no limit was established.
[4] ND - Non detect assumed to be less than 0.5 μg/l.

TABLE 4
ESTIMATED AIR EMISSIONS
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Parameter	GW-1 Influent Concentration[1] (μg/l)	GW-2 Influent Concentration[2] (μg/l)	Final Influent Concentration[3] (μg/l)	Total Mass Loading To Air Stripper[3] (lbs/day)	Total Mass Air Emissions[4] (lbs/day)
1,1-DCE	161	39	137	0.082	0.0082
1,1-DCA	15	12	14	0.008	0.0008
1,2-DCA	4.4	3.1	4	0.002	0.0002
1,1,1-TCA	11	26	14	0.008	0.0008
TCE	11	1.1	9	0.005	0.0005
PCE	0	0.7	0.14	0.000	0.0000
CHLOROFORM	0	6.2	1	0.001	0.0001
BENZENE	60	0	48	0.029	0.0029
TOLUENE	3.3	1.4	3	0.002	0.0002
ETHYLBENZENE	2.8	0	2	0.001	0.0001
XYLENE	4.7	0	4	0.002	0.0002
TPH	75	0	60	0.036	0.0036

(1) The method used to estimate GW-1 influent quality is described in the On-Site IRM Work Plan (Dames & Moore, 1992c).
(2) Concentrations based upon highest values measured to data during quarterly sampling.
(3) Flow equals 40 gpm from GW-1, and 10 gpm from GW-2, total = 50 gpm.
(4) Assumes 100% mass transfer from the extracted groundwater to air, and 90% removal of organic parameters from the air by the vapor phase carbon units.

TABLE 5
START-UP MONITORING SCHEDULE
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

	DAYS AFTER START-UP																											
Well	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Extraction Well (MW-45)	L,Q	L	L,Q	L	L			L,Q				L,Q							L,Q							L,Q		
MW-25	L	L	L	L	L			L				L							L							L		
MW-26	L	L	L	L	L			L				L							L							L		
MW-27	L	L	L	L	L			L				L							L							L		

L = Water Level Measurement.
Q = Water Quality Measurement for VOCs, TPH Gasoline, and Nickel.

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Figures

EXPLANATION

Exploratory Holes		HP-2	Hydropunch Sample
●	April - May, 1990 Locations	⌖	Monitoring Well Location
▲	September - October, 1990	⌒	Boundary of Groundwater Operable Unit GW-1 and GW-2
■	February, 1991 Locations	— —	Fence Line
CPT-13	Cone Penetration Test	—·—	Property Boundary

N

0 400

Scale in Feet

LOCATION OF GROUNDWATER OPERABLE UNITS

Union Pacific Railroad Yard
Sacramento, California

APRIL 1993

FIGURE 1

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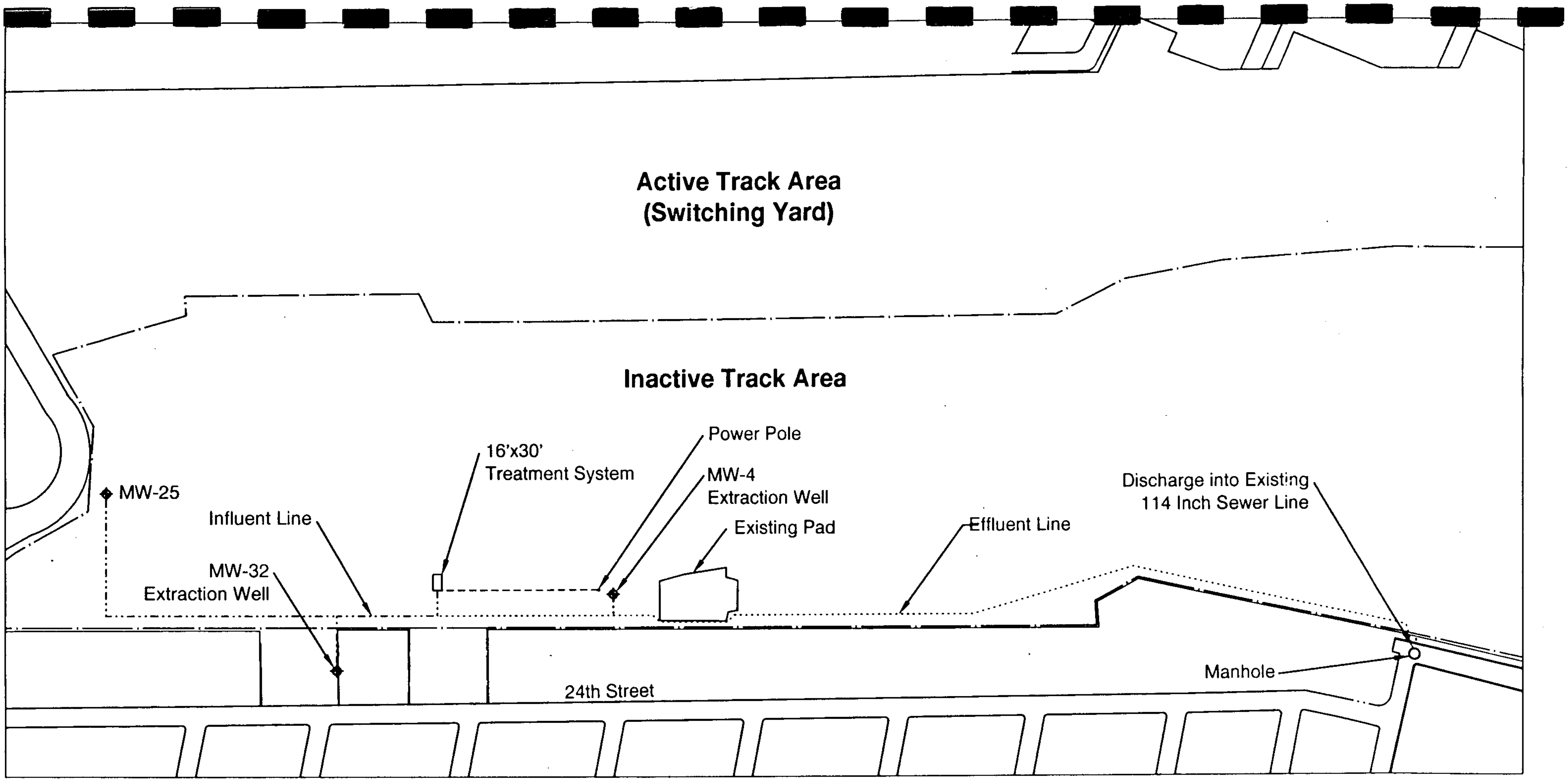
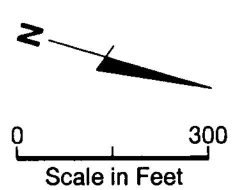


EXPLANATION

- Extraction Well
- Discharge Point
- Influent Line 2" Diameter
- Effluent Line 4" Diameter
- Power Line
- Fence Line
- Property Line



DAMES & MOORE

CURRENT SYSTEM LAYOUT PLAN
INTERIM REMEDIAL MEASURE
Union Pacific Railroad Yard
Sacramento, California
APRIL 1993

00173-072-044 SJR 2/16/93 DETAIL1

FIGURE 2