FIRST QUARTER 1994
MONITORING REPORT
FOR
WORTHLEY DRIVE PARCEL
SAN LORENZO, CALIFORNIA

LOWNEY ASSOCIATES
Environmental / Geotechnical / Engineering Services

LOWNEY ASSOCIATES
Environmental/Geotechnical/Engineering Services

1969-1994
25
YEARS OF EXCELLENCE

August 29, 1994
719-3A, MV081806

Mr. Anthony Varni
P.O. Box 778
Hayward, California 94543

RE: FIRST QUARTER 1994 GROUND WATER MONITORING WORTHLEY DRIVE PARCEL SAN LORENZO, CALIFORNIA

Dear Mr. Varni:

In accordance with your request, we have performed additional ground water monitoring at the above referenced site. The scope of work was performed per our agreement with you dated January 18, 1994. In addition, this report responds to the Alameda County Department of Environmental Health letter dated April 27, 1994.

We refer you to the text of the report for details regarding our investigation. If you have any questions, please call.

Very truly yours,

LOWNEY ASSOCIATES

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Environmental Engineer

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FIRST QUARTER 1994 GROUND WATER MONITORING

For

WORTHLEY DRIVE PARCEL
San Lorenzo, California

To

ANTHONY VARNI
P.O. Box 778
Hayward, California 94543

August 1994

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FIRST QUARTER 1994 GROUND WATER MONITORING
FOR
WORTHLEY DRIVE PARCEL
SAN LORENZO, CALIFORNIA

1.0 INTRODUCTION

1.1 Purpose

We are pleased to present this report summarizing the first quarter 1994 ground water monitoring at 16525 Worthley Drive, San Lorenzo, California (Figure 1). The purpose of this investigation was to continue an on-going ground water quality evaluation at the site, near the vicinity of the former fuel storage tanks, by collecting and analyzing ground water samples from monitoring well MW-2 and extraction well RW-1. In addition, this report addresses the comments received from the Alameda County Department of Environmental Health (ACDEH) regarding the April 1, 1994 work plan. Review of other areas of the property was not part of this scope of work.

1.2 Background

The site reportedly was developed in the late 1960s as an aircraft engine maintenance facility, which operated there until 1981. We understand that two underground gasoline fuel storage tanks (USTs) were used by this facility and were removed from the site in 1987.

Following the removal of the USTs, two soil borings and one monitoring well reportedly were drilled within the former tank excavation (Converse Environmental Consultants 1987). Analysis of composite soil samples collected from the borings detected total petroleum hydrocarbons (TPH) as gasoline at concentrations up to 40 parts per million (ppm). Analysis of the ground water sample reportedly collected from the monitoring well detected TPH as gasoline at 44,000 parts per billion (ppb). This well is presumed to have been destroyed during subsequent overexcavation activities.

In 1987, Exceltech installed six ground water monitoring wells at the site to evaluate soil and ground water quality. The wells were sampled in July and November 1987 (Exceltech 1987).

Monitoring wells MW-2 and MW-3 were installed adjacent to the former tank excavation (Figure 2). Results of the ground water collected from MW-3 revealed 260 ppb TPH as gasoline and low concentrations of toluene and xylenes (1.0 ppb and 2.1 ppb, respectively). Ground water collected and analyzed from MW-2 revealed 110 ppb TPH as gasoline and low concentrations of benzene, toluene, and xylene (1.2 ppb, 1.9 ppb, and 2.0 ppb, respectively).

Analysis of soil samples collected from MW-3 detected TPH as gasoline at 13 ppm and 4.1 ppm and benzene at 0.14 ppm and 0.15 ppm at the 10- and 15-foot depths, respectively. Analysis of soil collected from MW-2 at depths of 10 and 15 feet revealed TPH as gasoline at 8.4 ppm and 10 ppm, respectively and benzene at up to 0.34 ppm.

Monitoring wells MW-1 and MW-4 were located approximately cross-gradient from the fuel tank area, and MW-5 and MW-6 were located approximately up-gradient from the former fuel tank area. Analysis of ground water from these four wells typically did not detect gasoline range hydrocarbons or BTEX compounds. Analysis of soil samples from these crossand up-gradient wells detected only low levels of TPH as gasoline (up to 28 ppm) and xylene (up to 3.6 ppm).

In 1988, a soil vapor survey (SVS) was conducted at the site to further evaluate the extent of fuel impact to the on-site soil (Exceltech 1990). Results of the SVS reportedly detected two areas with elevated volatile fuel hydrocarbons near the location of monitoring well MW-3. These areas were reportedly excavated in November 1988 (Exceltech 1990). Monitoring well MW-3 was damaged during the excavation and was subsequently destroyed.

In November 1989, a ground water monitoring well, MW-7, and a ground water recovery well, RW-1, were installed up-gradient and adjacent to the former underground storage tank area, respectively (Figure 2). Analysis of ground water samples collected from RW-1 detected TPH as gasoline at 1,300 ppb, and benzene, ethylbenzene, toluene, and xylene at concentrations of 150 ppb, 15 ppb, 100 ppb, and 170 ppb, respectively (Exceltech 1990). Analytical results indicated no detectable levels of petroleum hydrocarbons in the ground water collected from MW-7.

In January 1991, a ground water extraction and treatment system was installed at the site. The system extracted ground water from RW-1 at a limited rate of approximately 0.1 gallon per minute (gpm) and treated the water with activated carbon beds prior to discharge. Laboratory analyses of influent samples collected from the treatment system indicates that petroleum hydrocarbon concentrations have decreased or remained generally consistent over the past several years. Since its installation in November 1989, extraction well RW-1 appears to have been sampled/analyzed 31 times. Fourteen of 31 sampling events did not detect TPH as gasoline above the laboratory detection limit. Analytical results for the remaining 17 events revealed concentrations typically ranging from 57 ppb to 480 ppb; higher levels were only detected in three sampling events.

Quarterly sampling of ground water from well MW-2, located near the former USTs, has historically detected only low levels of TPH as gasoline and BTEX compounds. From 1987 to 1994 concentrations of TPH as gasoline have typically ranged between 57 ppb and 870 ppb. Higher concentrations were only detected during two sampling events. Petroleum hydrocarbons typically have not been detected in the other on-site monitoring wells.

Per the request of the ACDEH, monitoring well MW-8 was installed on-site to further evaluate ground water quality (Exceltech 1991). Monitoring well MW-8 is located approximately 100 feet southwest of the former UST excavation. One composite soil sample and the ground water sample collected from MW-8 reportedly did not contain petroleum hydrocarbons above the laboratory detection limit. As approved by the ACDEH in a letter dated March 25, 1991 (Exceltech 1991), sample collection was suspended from wells MW-1, MW-4, MW-5, MW-6, and MW-7 because concentrations of TPH were not detected above the laboratory detection limit for a period of over one year.

A summary of previous sampling results from monitoring well MW-2 and extraction well RW-1 is presented in Table 1.

1.3 Scope of Work

The scope of work performed during this supplemental ground water quality investigation included the following:

- Purging and sampling of ground water from monitoring well MW-2 and the on-site extraction well RW-1 located near the former fuel tank area.
- Laboratory analysis of the ground water samples for TPH as gasoline and BTEX.
- Preparation of this report which also addresses comments from the ACDEH regarding our work plan.

2.0 SITE INVESTIGATION

2.1 Ground Water Flow

Based on ground water elevations measured by others (Resna 1992 and 1993), the regional ground water flow direction has fluctuated between south-southwest and south-southeast, generally towards the San Francisco Bay. Ground water level measured on April 8, 1994 from monitoring well MW-2 showed the depth to ground water to be 7.26 feet below the ground surface, which appears to be generally consistent with past measurements.

2.2 Ground Water Quality

Ground water from two of eight on-site monitoring wells was sampled and analyzed for TPH as gasoline and BTEX. A discussion of well sampling protocol is presented in Appendix A.

The laboratory analytical results for this sampling event and the previous investigations are presented in Table 1. Laboratory analytical data is presented in Appendix B.

TABLE 1. Ground Water Sampling Results
(concentrations in ppb)

Well	Date	TPHg	Benzene	Toluene	Ethyl-benzene	Total Xylenes
MW-2	07/14/87	110	1.2	1.9	--	2
	11/24/87	3,600	82	47	--	13
	02/29/88	800	ND	ND	--	ND
	05/25/88	250	ND	ND	--	ND
	08/10/88	260	ND	ND	--	ND
	11/29/88	870	9.	ND	1	1
	02/07/89	710	16	ND	ND	ND
	05/12/89	260	2.8	0.76	1.3	3
	08/04/89	360	ND	ND	ND	0.48
	11/14/89	85	ND	3.5	0.36	2.5
	02/22/90	120	ND	ND	1.5	0.55
	05/17/90	240	ND	ND	ND	ND
	08/17/90	130	ND	2.9	1.2	0.68
	11/06/90	170	0.37	1.2	2	1.5
	02/01/91	57	ND	ND	ND	0.73
	05/01/91	220	1.5	0.42	0.43	0.54
	08/08/91	710	4.1	0.84	ND	0.71
	11/15/91	630	2.3	ND	3.1	0.86
	02/12/92	580	5.9	1.2	0.52	ND
	05/21/92	790	26	5.4	ND	ND
	11/13/92	230	ND	ND	ND	ND
	02/24/93	400	17	ND	ND	ND
	05/28/93	110	<0.50	<0.50	<0.50	<0.50
	08/20/93	1,000	<0.50	0.75	1.1	5.4
	11/30/93	590	<0.50	<0.50	3.8	2.3
	04/08/94	480	5.2	<0.50	<0.50	<0.50
RW-1	11/28/89	3,200	<50	<100	<100	<100
	01/09/90	1,300	150	15	100	170
	01/16/91	78	17.0	2.7	7.7	1.3
	04/20/91	<30	<0.30	<0.30	<0.30	<0.30
	05/01/91	160	40	0.79	14	6.1
	05/24/91	<30	<0.30	<0.30	<0.30	<0.30
	06/14/91	57	12	<0.30	4.3	0.84
	07/03/91	<30	<0.30	<0.30	<0.30	<0.30
	07/22/91	18	<0.30	2.7	0.4	<0.30
	08/08/91	89	41	0.31	4.6	0.73
	11/15/91	140	41	<0.30	1.3	0.44
	12/18/91	<50	12	<0.50	0.78	<0.50

continued

TABLE 1. Ground Water Sampling Results
(concentrations in ppb)
(continued)

Well	Date	TPHg	Benzene	Toluene	Ethyl-benzene	Total Xylenes
RW-1	02/12/92	260	78	.073	6.6	8.2
(cont.)	03/06/92	480	81	1.2	21	21
	04/02/92	300	52	1.2	13	15
	05/21/92	57	20	ND	1.7	0.85
	06/30/92	<50	7.7	<0.50	<0.50	<0.50
	07/17/92	79	7.4	<0.50	1.2	1.4
	09/01/92	<50	4.2	<0.50	<0.50	<0.50
	11/13/92	ND	ND	ND	ND	ND
	01/08/93	ND	8	ND	0.78	0.59
	01/29/93	64	22	ND	4.8	3.7
	03/18/93	2,400	330	3.3	51	17
	04/22/93	<50	13	<0.50	1.5	<0.50
	05/28/93	<50	0.76	<0.50	<0.50	<0.50
	08/20/93	57	16	<0.50	0.70	1.92
	09/15/93	<50	1.5	<0.50	<0.50	<0.50
	10/08/93	<50	<0.50	<0.50	0.50	<0.50
	10/26/93	<50	<0.50	<0.50	0.50	<0.50
	12/16/93	<50	0.73	2.6	1.1	<0.50
	04/08/94	130	15	1.4	1.9	1.9

– no data obtained
ND not detected

3.0 ADDITIONAL SITE INFORMATION

Based on our review of available boring logs for the on-site wells, asphaltic concrete and baserock generally cover the site's surface. This cap is underlain by interbedded clayey silt to silt (Stratum A) to a depth of approximately 9 to 15 feet below ground surface (bgs). Generally, underlying Stratum A is sandy clay with thin saturated silt to sand layers (Stratum B) that extends to a depth of approximately 14 to 24 feet bgs. The sandy clay confines the underlying water-bearing zone (Stratum C). The shallow water-bearing zone generally underlies Stratum B, except in boring MW-8 where it underlies Stratum A, to a depth of approximately 17 to 27 feet bgs. This stratum consists of saturated clayey sand, silt, and sand. The water-bearing zone is underlain by clay (Stratum D). Stratum D was detected in two of eight borings immediately beneath the water-bearing zone to the maximum depth explored of 26.5 feet. Boring logs are presented in Appendix C.

4.0 RESPONSE TO ACDEH LETTER

In response to the April 1, 1994 work plan, the ACDEH, in their letter dated April 27, 1994, requested additional information regarding site history and for the discontinuation of the ground water extraction system.

Based on boring logs from previous on-site investigations, soil underlying the site consists mainly of low permeable silt and clay. The low rate of ground water extraction by the treatment system (0.1 gpm) also indicates that the shallow water-bearing zone consists of low permeable materials. Therefore, due to the low rate of extraction and the presence of low-permeable silts and clays, the potential for significant off-site migration of impacted ground water and impact to the adjacent canal is low, in our opinion.

Even if a direct migration pathway were to exist between the water-bearing zone underlying the site and the adjacent canal, published data indicates that the threat to the aquatic environment would likely be insignificant. For BTEX compounds, the median tolerance limit (TL_m) values, for various bacteria, algae, protozoa, crustacean, and fish are typically in the range of 5 ppm to over 100 ppm (Verschueren 1983). Ground water analyses during the April 1994 sampling event and prior sampling events show concentrations of BTEX well below the TL_m values. Copies of supporting published data are presented in Appendix D.

In addition, if BTEX compounds are released to surface water, they will likely be volatilized; the estimated half-life for volatilization of benzene from a river 1 meter deep flowing 1 meter/second (m/s) with a wind velocity of 3 m/s is estimated to be 2.7 hours at 20°C (Howard 1990).

Thus, the low part per billion concentrations of BTEX compounds present in ground water underlying the site do not pose a significant threat to the adjacent canal, in our opinion.

Review of ground water sampling data collected from the site since 1987 (Table 1) indicates that petroleum fuel hydrocarbons have generally decreased or remained consistent. Based on our experience at numerous sites for which long-term monitoring data is available, some fluctuation in the detected concentrations is considered normal, especially where fine grained sediments are predominant.

The concentrations detected in the November 1987 and March 1993 sampling events are questionable, in our opinion, since the prior and later results were low to non-detect concentrations. These results may have been due to laboratory or sample handling/collection errors and are not viewed as being representative of site conditions.

Ground water clean up standards are typically established based on beneficial uses of the impacted water body. Maximum Contaminant Levels (MCLs) have been established for compounds perceived by the EPA and State of California to present a significant health concern. Regulations to protect water bodies utilized as drinking water sources typically rely on MCLs, although MCLs have been used as cleanup levels in some cases regardless of whether the ground water is utilized as a drinking water source or not. The state has established MCLs which are typically more strict than federal MCLs.

MCLs have been established for benzene, toluene, ethylbenzene, and xylenes. No federal or state MCLs have been established for gasoline or diesel, however, since these are general analytical parameters rather than specific chemical compounds. Depending on the site location and overseeing regulatory agency, up to 500 ppb of total petroleum hydrocarbons present in the ground water may be allowed depending on taste and odor thresholds. Based upon our experience with various regulatory agencies, case closure may be considered if the levels of petroleum fuel compounds do not exceed the levels presented in Table 2. Based on the April 1994 sampling event, only benzene currently exceeds these standards.

TABLE 2. Typical Ground Water Cleanup Standards Compared to Minimum/Maximum Concentrations

Petroleum Hydrocarbon Compound	Typical Clean Up Standard (ppb)	April 1993 to April 1994 RW-1 (ppb)	April 1993 to April 1994 MW-2 (ppb)
Diesel Range Hydrocarbons	500	--	--
Gasoline Range Hydrocarbons	500	<50-130	100-1,000
Benzene	1.0 (MCL)	<0.50-1.6	<0.50-5.2
Toluene	1,000 (MCL)	<0.50-2.6	<0.50-0.75
Ethylbenzene	680 (MCL)	<0.50-1.9	<0.50-3.8
Xylenes	1,750 (MCL)	<0.50-1.9	<0.50-5.4

MCL - Maximum Contaminate Level established for drinking water

Based on our review of boring logs for the existing ground water monitoring wells, the on-site wells appear to have slotted casing extending throughout the thickness of the water-bearing zone. The water-bearing zone at the site consists of sandy clay, silt, and sand confined by low permeability clay. Because the ground water is under pressure, stabilized ground water levels within the wells have risen to a higher elevation as compared to the elevation at which ground water was first encountered. In our opinion, the on-site monitoring wells appear to have been properly screened at the time of well installation.

5.0 CONCLUSIONS

Four ground water monitoring wells and one ground water extraction well are currently present at the site; three ground water monitoring wells are located off-site. Historic sampling of each of these wells indicates that petroleum impacted ground water is localized near the former UST excavation. ~~The Alternative Points of Compliance (APC)~~ NAT policy of the CRWQCB allows impacted ground water to exist on-site within a shallow water-bearing zone without cleanup.

The APC policy recognizes that achieving low ppb drinking water standards (or non-detect levels) using existing pump and treat technology to remediate fine grained, low yielding shallow water-bearing zones is not practical, and accepts adequate source removal and monitoring as an appropriate management strategy.

As discussed below, the APC policy lists four main criteria which should be evaluated and addressed.

- First, the ground water must be in low yielding, fine grained sediments. This is demonstrated by the attached boring logs and the low rate of ground water extraction from well RW-1.

- Second, adequate source removal is undertaken to limit future migration of chemicals to the ground water. The source of the petroleum hydrocarbons present in ground water at the site was the former underground fuel storage tanks which have been removed from the site. In addition, the former fuel tank area was over-excavated to remove petroleum impacted soil, reducing the potential for continued impact to the ground water.

  Analysis of soil samples collected from borings drilled within and directly adjacent to the former tank excavation has detected only low concentrations of TPH as gasoline (up to 40 ppm).

- Third, best available clean up technologies are inappropriate or not cost-effective. As recognized by the CRWQCB and as shown through the past decade of experience at Bay Area sites, existing pump and treat technology is not a cost-effective method of achieving low ppb drinking water standards when applied to shallow, low yielding, fine grained aquifers.

  The results achieved through the on-site application of ground water extraction further support this finding. During the past several years of ground water extraction, no significant reduction in the already low petroleum hydrocarbons levels can be directly attributed to the remedial efforts. In our opinion, the concentration decreases which appear to have occurred are likely due to natural degradation. The low yield (0.1 gpm) of the existing extraction well does not provide an effective capture zone and further expenditures for continued operation including permitting and effluent monitoring are not warranted. The minimal benefits, if any, associated with continued operation of the extraction well do not justify the expense.

- Fourth, an acceptable plan is submitted for continued management of the site. Due to the low petroleum hydrocarbon concentrations present in ground water at the site and the lack of a significant threat to the adjacent canal, on-going ground water sampling to monitor the anticipated natural degradation of remaining contaminants is a reasonable and practical approach, in our opinion.

We recommend sending a copy of this report to the ACDEH and the California Regional Water Quality Control Board.

6.0 LIMITATIONS

Soil deposits and rock formations may vary in type, strength, and many other important properties across any geologic area. The study that we have made assumes that the data obtained in the field and laboratory are reasonably representative of field conditions and that the subsurface conditions are reasonably susceptible to interpolation and extra-pollution between sampling locations.

The accuracy and reliability of geo- or hydrochemical studies are a reflection of the number and type of samples taken and the extent of the analysis conducted, and is thus inherently limited and dependent on the resources expended. Our sampling and analytical plan was designed using accepted environmental engineering principles and our judgment for the performance of a reconnaissance soil and ground water quality investigation, and was based on the degree of investigation desired by you. It is possible to obtain a greater degree of certainty, if desired, by implementing a more rigorous sampling program or installation of additional monitoring wells.

This report was prepared for the sole use of Mr. Anthony Varni in evaluating the environmental setting and ground water quality at the referenced site at the time of this study. We make no warranty, expressed or implied, except that our services have been performed in accordance with hydrogeological and environmental engineering principles generally accepted at this time and location. The hydrochemical and other data presented in this report can change over time and are applicable only to the time this study was performed.

* * * * * * * * *

REFERENCES

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_________, 1987, Summary of Environmental Engineering Services 16525 Worthley Drive San Lorenzo, California; May 15, 1987.

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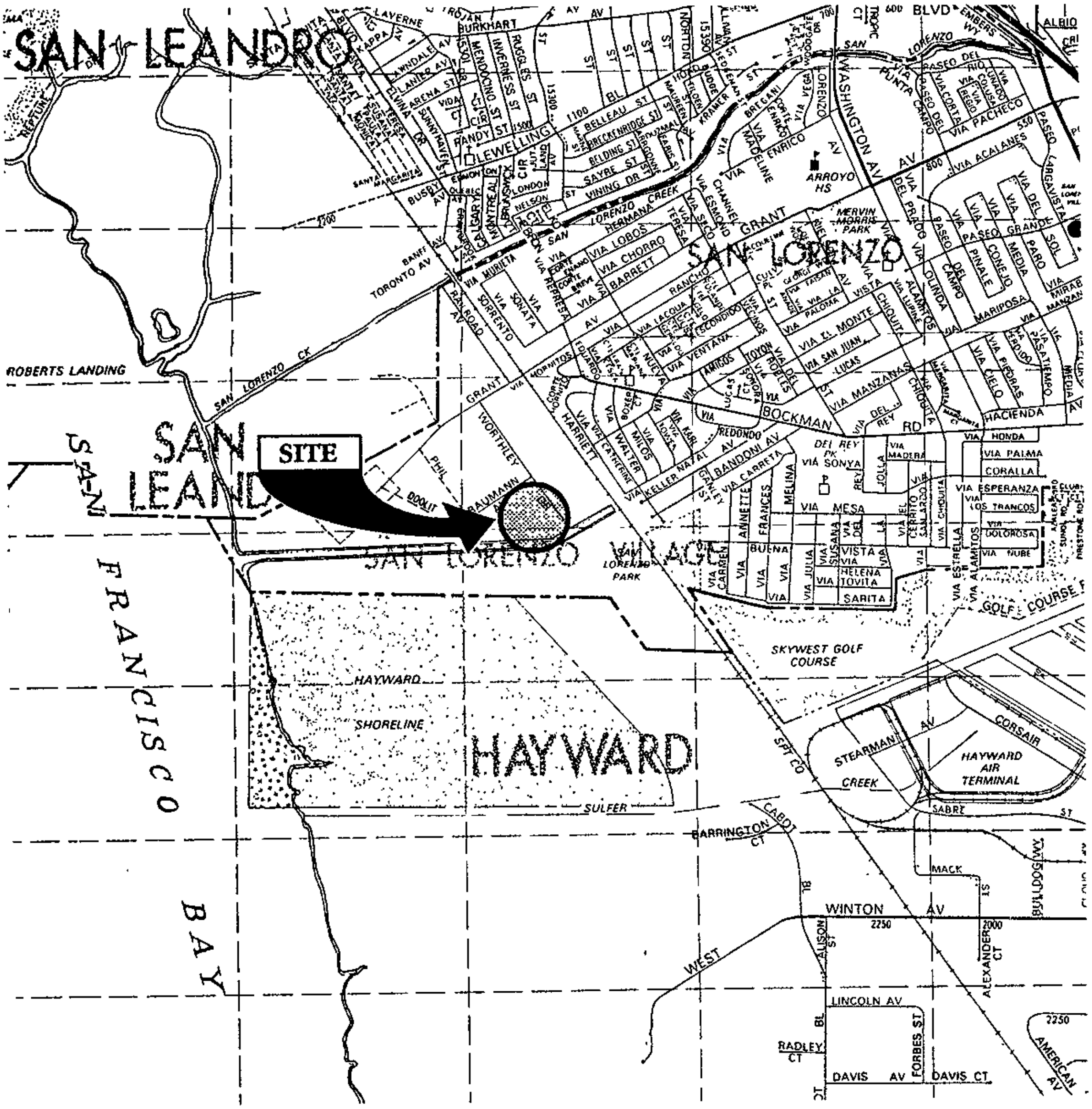
_________, 1991, Monitoring well MW-8 Installation and May Quarterly Groundwater Monitoring Report for Crown Metal Manufacturing at Pacific International Steel Facility 16525 Worthley Drive San Lorenzo, California; May 1991.



719-3A, 5/25 BB*EB

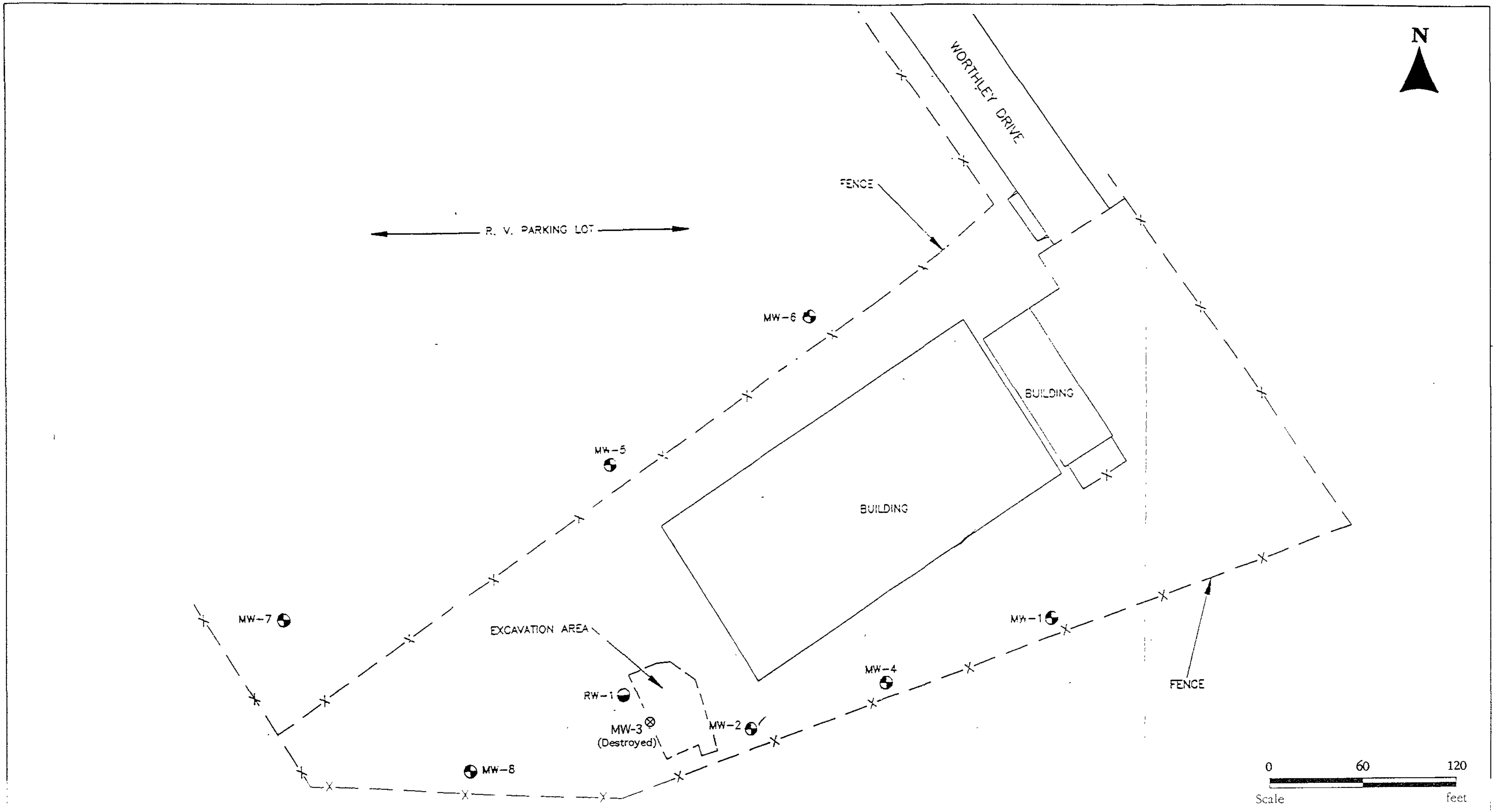
VICINITY MAP

PACIFIC INTERNATIONAL STEEL
San Lorenzo, California

LOWNEYASSOCIATES
Environmental/Geotechnical/Engineering Services

FIGURE 1

719-3A, August 1994



LEGEND

- Approximate location of ground water monitoring well by Resna (1993)
- Approximate location of ground water recovery well by Resna (1993)

Base by Resna, dated 8/93

SITE PLAN

PACIFIC INTERNATIONAL STEEL
San Lorenzo, California

LOWNEY ASSOCIATES
Environmental / Geotechnical / Engineering Services

FIGURE 2
719-3A, August 1994

719-3A, 5/25 BB'EB

APPENDIX A

GROUND WATER SAMPLING

Prior to ground water sampling, the static water level was measured using an electronic water level measurement device. A submersible Grundfos pump was then used to purge a minimum of three well casing volumes of water from each well. After each well volume, pH, conductivity, and temperature were recorded. The pH and conductivity generally stabilize after three to ten well volumes. If, after the third well volume, the pH and conductivity did not stabilize, additional well volumes were removed until these measurements did stabilize. All well developing and sampling equipment was cleaned with an aqueous tri-sodium phosphate solution and distilled water or steam cleaned prior to entering the well.

The ground water samples were subsequently collected appropriate sample bottles, labeled, and immediately placed on ice until delivered to an analytical laboratory certified by the California Department of Health Services for chemical analysis of drinking water and hazardous waste. Carried along with the ground water samples was a chain of custody form that was maintained for all well samples.

Purged ground water was stored on-site in labeled 55-gallon drums.

LOWNEY ASSOCIATES RECORD OF WELL DEVELOPMENT/SAMPLING

Project Number 719-3A

Project Name Pacific International Steel

Field Geologist/Engineer (BB) / TMC

Well Number MW-2 Boring Diameter ________ (inches)

Well Total Depth (completed) 25.55 (feet) Casing Diameter 2" (inches)

Development Date ________ Method ________ Volume Produced ________ (liter/gal)

WELL VOLUME CONVERSION FACTORS

2-INCH CASING DIAMETER

VOL (GALLONS) = FEET OF WATER x 0.17
VOL (LITERS) = FEET OF WATER x 0.62

4-INCH CASING DIAMETER

VOL (GALLONS) = FEET OF WATER x 0.66
VOL (LITERS) = FEET OF WATER x 2.5

Sampling Date 4/8/94 Time ________ Method Hand Bail

Static Water Level Prior to Purging 7.26 (ft)
(Measured from top of casing)

Water Level After Recovery 7.3 (ft)

80 Percent Recharged Yes ☐ No ☐

Well Volume 3.10 (liter/gal)

Three Well Volumes 9.32 (liter/gal)

Total Produced 9.32 (liter/gal)

Number of Well Volumes 3

Production Time ________ (min)

Production Rate ________ (_ /min)

Well Volumes	pH	Conductivity µSx10	Temp °F
1	5.40	1820	62°
2	5.54	0080	61°
3	5.12	3600	62°
4			
5			
6			
7			
8			
9			
10			

Sample Description H_2O: 3 VOAs

Laboratory Sequoia Analytical

Deliver ☑ Pick-Up ☐ Date 4/8/94

Comments

LOVNEY ASSOCIATES RECORD OF WELL DEVELOPMENT/SAMPLING

Project Number 719-3A

Project Name Pacific International Steel

Field Geologist/Engineer (BB)/TMC

Well Number RW-1

Boring Diameter ________ (inches)

Well Total Depth (completed) ________ (feet)

Casing Diameter ________ (inches)

Development Date ________ Method ________ Volume Produced ________ (liter/gal)

WELL VOLUME CONVERSION FACTORS

2-INCH CASING DIAMETER

VOL (GALLONS) = FEET OF WATER x 0.17
VOL (LITERS) = FEET OF WATER x 0.62

4-INCH CASING DIAMETER

VOL (GALLONS) = FEET OF WATER x 0.66
VOL (LITERS) = FEET OF WATER x 2.5

Sampling Date 4/8/94 Time 9:45 Method Port of Extraction System

Static Water Level Prior to Purging ________ (ft)
(Measured from top of casing)

Water Level After Recovery ________ (ft)

80 Percent Recharged Yes ☐ No ☐

Well Volume ________ (liter/gal)

Three Well Volumes ________ (liter/gal)

Total Produced ________ (liter/gal)

Number of Well Volumes ________

Production Time ________ (min)

Production Rate ________ (_ /min)

Well Volumes	pH	Conductivity µSx10	Temp °F
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Sample Description 3 VOAs; H_2O

Laboratory Sequoia Analytical

Deliver ☑ Pick-Up ☐ Date 4/8/94

Comments

APPENDIX B

ANALYTICAL RESULTS

The refrigerated ground water samples and the chain of custody form were delivered to Sequoia Analytical Laboratory located in Redwood City, California. Ground water samples were analyzed for TPH as gasoline plus additional scans to detect BTEX (EPA Test Method 8015/8020). Attached are copies of these results and the chain of custody documentation. The laboratory is certified by the State of California as a Hazardous Waste Testing Laboratory and Approved Water and Wastewater Laboratory.

Sequoia Analytical

680 Chesapeake Drive, Redwood City, CA 94063, (415) 364-9600, FAX (415) 364-9233
1900 Bates Avenue, Suite L, Concord, CA 94520, (510) 686-9600, FAX (510) 686-9689
819 Striker Avenue, Suite 8, Sacramento, CA 95834, (916) 921-9600, FAX (916) 921-0100

Lowney Associates
405 Clyde Avenue
Mountain View, CA 94043
Attention: Peter Langtry

Client Project ID: 719-3A
Sample Matrix: Water
Analysis Method: EPA 5030/8015 Mod./8020
First Sample #: 4D56701

Sampled: Apr 8, 1994
Received: Apr 8, 1994
Reported: Apr 22, 1994

TOTAL PURGEABLE PETROLEUM HYDROCARBONS with BTEX DISTINCTION

Analyte	Reporting Limit μg/L	Sample I.D. 4D56701 MW-2	Sample I.D. 4D56702 RW-1
Purgeable Hydrocarbons	50	480	130
Benzene	0.50	5.2	15
Toluene	0.50	N.D.	1.4
Ethyl Benzene	0.50	N.D.	1.9
Total Xylenes	0.50	N.D.	1.9
Chromatogram Pattern:		Gas + <C8	Gas + Discrete Peak

APR 29

Quality Control Data

Report Limit Multiplication Factor:	1.0	1.0
Date Analyzed:	4/15/94	4/16/94
Instrument Identification:	GCHP-3	GCHP-17
Surrogate Recovery, %: (QC Limits = 70-130%)	99	98

Purgeable Hydrocarbons are quantitated against a fresh gasoline standard.
Analytes reported as N.D. were not detected above the stated reporting limit.

SEQUOIA ANALYTICAL

Andrea Fulcher
Project Manager

Sequoia Analytical

680 Chesapeake Drive, Redwood City, CA 94063, (415) 364-9600, FAX (415) 364-9233
1900 Bates Avenue, Suite L, Concord, CA 94520, (510) 686-9600, FAX (510) 686-9689
819 Striker Avenue, Suite 8, Sacramento, CA 95834, (916) 921-9600, FAX (916) 921-0100

Lowney Associates
405 Clyde Avenue
Mountain View, CA 94043
Attention: Peter Langtry

Client Project ID: 719-3A
Matrix: Liquid

QC Sample Group: 4D56701

Reported: Apr 22, 1994

QUALITY CONTROL DATA REPORT

ANALYTE	Benzene	Toluene	Ethyl Benzene	Xylenes
Method:	EPA 8020	EPA 8020	EPA 8020	EPA 8020
Analyst:	J. Minkel	J. Minkel	J. Minkel	J. Minkel
MS/MSD Batch#:	G4D73901	G4D73901	G4D73901	G4D73901
Date Prepared:	N/A	N/A	N/A	N/A
Date Analyzed:	4/15/94	4/15/94	4/15/94	4/15/94
Instrument I.D.#:	GCHP-3	GCHP-3	GCHP-3	GCHP-3
Conc. Spiked:	10 µg/L	10 µg/L	10 µg/L	30 µg/L
Matrix Spike % Recovery:	98	100	98	100
Matrix Spike Duplicate % Recovery:	99	100	99	100
Relative % Difference:	1.0	0.0	1.0	0.0

LOWNEY ASSOC.
APR 29 1994

LCS Batch#:	NOT APPLICABLE			
Date Prepared:				
Date Analyzed:				
Instrument I.D.#:				
LCS % Recovery:				
% Recovery Control Limits:	71-133	72-128	72-130	71-120

SEQUOIA ANALYTICAL

Andrea Fulcher
Project Manager

Please Note:
The LCS is a control sample of known, interferent free matrix that is analyzed using the same reagents, preparation, and analytical methods employed for the samples. The matrix spike is an aliquot of sample fortified with known quantities of specific compounds and subjected to the entire analytical procedure. If the recovery of analytes from the matrix spike does not fall within specified control limits due to matrix interference, the LCS recovery is to be used to validate the batch.

Sequoia Analytical
680 Chesapeake Drive, Redwood City, CA 94063, (415) 364-9600, FAX (415) 364-9233
1900 Bates Avenue, Suite L, Concord, CA 94520, (510) 686-9600, FAX (510) 686-9689
819 Striker Avenue, Suite 8, Sacramento, CA 95834, (916) 921-9600, FAX (916) 921-0100

Lowney Associates
405 Clyde Avenue
Mountain View, CA 94043
Attention: Peter Langtry

Client Project ID: 719-3A
Matrix: Liquid

QC Sample Group: 4D56702

Reported: Apr 22, 1994

QUALITY CONTROL DATA REPORT

ANALYTE	Benzene	Toluene	Ethyl Benzene	Xylenes
Method:	EPA 8020	EPA 8020	EPA 8020	EPA 8020
Analyst:	A. Maralit	A. Maralit	A. Maralit	A. Maralit
MS/MSD Batch#:	4D72104	4D72104	4D72104	4D72104
Date Prepared:	N/A	N/A	N/A	N/A
Date Analyzed:	4/16/94	4/16/94	4/16/94	4/16/94
Instrument I.D.#:	GCHP-17	GCHP-17	GCHP-17	GCHP-17
Conc. Spiked:	10 µg/L	10 µg/L	10 µg/L	30 µg/L
Matrix Spike % Recovery:	100	100	100	103
Matrix Spike Duplicate % Recovery:	100	100	100	103
Relative % Difference:	0.0	0.0	0.0	0.0

LOWNEY ASSOC.
APR 29 1994

LCS Batch#: NOT APPLICABLE

Date Prepared:
Date Analyzed:
Instrument I.D.#:

LCS % Recovery:

% Recovery Control Limits:	71-133	72-128	72-130	71-120

Please Note:
The LCS is a control sample of known, interferent free matrix that is analyzed using the same reagents, preparation, and analytical methods employed for the samples. The matrix spike is an aliquot of sample fortified with known quantities of specific compounds and subjected to the entire analytical procedure. If the recovery of analytes from the matrix spike does not fall within specified control limits due to matrix interference, the LCS recovery is to be used to validate the batch.

SEQUOIA ANALYTICAL

Andrea Fulcher
Project Manager

LOWNEYASSOCIATES
CHAIN OF CUSTODY RECORD

9404567

JOB NO.	PROJECT NAME/LOCATION
719-3A	Pacific International Steel

SAMPLER (S): (Signature) Bridget A Baxter

NO. OF CONTAINERS

ANALYSIS REQUIRED: TPHG w/ BTEX

SHIP TO:
LOWNEY ASSOCIATES
405 Clyde Avenue
Mountain View, CA 94043
415-967-2365
415-967-2785 (FAX)

DATE	TIME	SAMPLE DESCRIPTION	NO. OF CONTAINERS	TPHG w/ BTEX							REMARKS
4/8/94		MW-2; H_2O	3	X							2wk TAT
-	-										2WK TAT
4/8/94		RW-1; H_2O	3	X							
← NOTHING FOLLOWS →											

Relinquished by: (Signature)	Date	Time	Received By: (Signature)
Bridget A Baxter	4/8/94	1:55	

Relinquished by: (Signature)	Date	Time	Received By: (Signature)

Laboratory of Record:	Date	Time	Received for Laboratory By: (Signature)	Date	Time	Remarks:
			[signature]	040894	1355	

APPENDIX C

BORING LOGS

PROJECT NAME: Crown Metal Mfg. BORING #: 1

PROJECT #: 1587G DATE DRILLED: 6/24/87

EXCELTECH

EXPLORATORY BORING LOG

LOGGED BY: MDH

DEPTH (ft.)	SAMPLE No.	BLOWS/FOOT 350 ft-lbs.	WATER LEVEL	UNIFIED SOIL CLASSIFICATION	SOIL DESCRIPTION	PRODUCT ODOR	OVA READING ppm	
1–4					Hard packed road surface			
5–9	1-01			ML	SILT, medium plasticity, low dry strength, slow dilatancy, low toughness, dark brown, no product odor, moist			
10–14	1-02			CL	CLAY, medium plasticity, low dry strength, slow dilatancy, medium toughness, tannish grey, no product odor, moist			
15–19	1-03		▽	CL	CLAY, w/15% fine subrounded sand, low plasticity, low dry strength, slow dilatancy, medium toughness, tannish brown, no product odor, wet			
20–24	1-04			CL	CLAY, w/15% fine subangular sand, low plasticity, medium dry strength, slow dilatancy, medium toughness, brown, no product odor, wet			
25–26	1-05			ML	SILT, low plasticity, low dry strength, no dilatancy, low toughness, tannish brown, no product odor, moist			
					TD 26.5'			

PROJECT NAME: Crown Metal Mfg.

PROJECT #: 1587G

DATE DRILLED: 6/24/87

LOGGED BY: MDH

EXCELTECH

EXPLORATORY BORING LOG

DEPTH (ft.)	SAMPLE No.	BLOWS/FOOT 350 ft-lbs.	WATER LEVEL	UNIFIED SOIL CLASSIFICATION	SOIL DESCRIPTION	PRODUCT ODOR	OVA READING ppm	
1–4					Hard-packed road surface, product odor			
5	2-01	3		CL	CLAY, medium plasticity, high dry strength, no dilatancy, medium toughness, dark grey, no product odor, moist, fill material			
10	2-02	4		CL	CLAY, medium plasticity, high dry strength, no dilatancy, medium toughness, light grey with brown streaks, no product odor, moist			
15	2-03	12	▽ (14)	CL	CLAY w/10% fine to coarse subrounded sand, medium plasticity, high dry strength, no dilatancy, medium toughness, brownish dark grey, no product odor, wet			
20	2-04	4		ML	SILT, medium plasticity, medium dry strength, slow dilatancy, low toughness, brown, no product odor, moist			
25	2-05	7						
					TD 26.5'			

EXCELTECH

PROJECT NAME: Crown Metal Mfg.

BORING #: 3

PROJECT #: 1587G

DATE DRILLED: 6/25/87

LOGGED BY: MDH

EXPLORATORY BORING LOG

DEPTH (ft.)	SAMPLE No.	BLOWS/FOOT 350 ft-lbs.	WATER LEVEL	UNIFIED SOIL CLASSIFICATION	SOIL DESCRIPTION	PRODUCT ODOR	OVA READING ppm	
1–4					Surfaced discolored, steam cleaning area			
5–9	3-01	3		CL	CLAY w/15% fine to coarse subrounded sand, medium plasticity, medium dry strength, no dilatancy, medium toughness, tannish grey, no product odor, moist			
10–14	3-02	8		CL	CLAY, medium plasticity, medium dry strength, no dilatancy, medium toughness, tannish grey, no product odor, moist			
15–19	3-03	15		SC	CLAYEY SAND, 50% fine to coarse, subrounded sand, 30%, fine subrounded sand, medium plasticity, medium dry strength, slow dilatancy, low toughness, brownish grey, no product odor, wet			
20–24	3-04	4		ML	SILT, medium plasticity, medium dry strength, no dilatancy, medium toughness, brown, no product odor, moist			
25–26	3-05	11						
					TD 26.5'			

PROJECT NAME: Crown Metal Mfg. BORING #: 4

PROJECT #: 1587G DATE DRILLED: 6/25/87

EXCELTECH

EXPLORATORY BORING LOG

LOGGED BY: MDH

DEPTH (ft.)	SAMPLE No.	BLOWS/FOOT 350 ft-lbs.	WATER LEVEL	UNIFIED SOIL CLASSIFICATION	SOIL DESCRIPTION	PRODUCT ODOR	OVA READING ppm	
1–4					Hard packed road surface			
5–9	4-01	3		CL	CLAY, medium plasticity, high dry strength, no dilatancy, medium toughness, dark grey, no product odor, moist			
10–14	4-02	5	▽ (at 14)	CL	CLAY, medium plasticity, high dry strength, no dilatancy, medium toughness, medium grey, no product odor, moist			
15–19	4-03	10		CL	CLAY w/10% fine to coarse subrounded sand, medium plasticity, high dry strength, no dilatancy, medium toughness, tannish brown, no product odor, wet			
20–24	4-04	9		CL	CLAY w/5% medium subrounded sand, medium plasticity, high dry strength, no dilatancy, medium toughness, medium grey, no product odor, moist			
25–26	4-05	9		ML	SILT, medium plasticity, medium dry strength, slow dilatancy, low toughness, grey no product odor, moist			
					TD 26.5'			

EXCELTECH

PROJECT NAME: Crown Metal Mfg.

BORING #: 5

PROJECT #: 1587

DATE DRILLED: 6/24/87

EXPLORATORY BORING LOG

LOGGED BY: MDH

DEPTH (ft.)	SAMPLE No.	BLOWS/FOOT 350 ft-lbs.	WATER LEVEL	UNIFIED SOIL CLASSIFICATION	SOIL DESCRIPTION	PRODUCT ODOR	OVA READING ppm	
1–4					Hard packed road surface			
5–9	5-01	3		CL	CLAY, medium plasticity, low dry strength, no dilatancy, low toughness, brown, no product odor, dry			
10–14	5-02	8	▽ (14)	CL	CLAY w/10% fine to coarse subrounded sand, medium plasticity, low dry strength, low dilatancy, medium toughness, tannish brown, no product odor, moist			
15–19	5-03	12		CL	CLAY w/20% medium to coarse subrounded sand, medium plasticity, low dry strength, low dilatancy, medium toughness, tan brown, no product odor, moist			
20–24	5-04	6		SP	POOR GRADED SAND, medium subangular sand, low plasticity, low dry strength, high dilatancy, low toughness, light brown, no product odor, wet			
25–26	5-05	15		CL	LEAN CLAY w/5% medium subrounded sand, medium plasticity, high dry strength, no dilatancy, medium toughness, grey, no product odor, moist			
					TD 26.5'			

PROJECT NAME: Crown Metal Mfg.

BORING #: 6

PROJECT #: 1587

DATE DRILLED: 6/26/87

EXCELTECH

EXPLORATORY BORING LOG

LOGGED BY: MDH

DEPTH (ft.)	SAMPLE No.	BLOWS/FOOT 350 ft-lbs.	WATER LEVEL	UNIFIED SOIL CLASSIFICATION	SOIL DESCRIPTION	PRODUCT ODOR	OVA READING ppm	
1–4					Hard packed road surface			
5	6-01	3		CL	CLAY w/15% fine to coarse sand, medium plasticity, medium dry strength, no dilatancy, medium toughness tannish grey, no product odor, moist			
10	6-02	4						
13			▽					
15	6-03	14		CL	LEAN CLAY, medium plasticity, medium dry strength, no dilatancy, medium toughness, tannish grey, no product odor, moist			
20	6-04	9		SC	CLAYEY SAND, 40% fine to coarse subrounded sand, 40% fine subrounded sand, medium plasticity, medium dry strength, slow dilatancy, low toughness, brownish grey, no product odor, wet			
25	6-05	17		CL	LEAN CLAY w/5% medium subrounded sand, medium plasticity, high dry strength, no dilatancy, medium toughness, grey, no product odor, moist			
26								
					TD 26.5'			

ensco environmental services, inc.

PROJECT NAME: Crown Metal Manufacturing (Pacific International Steel) San Lorenzo, California

PROJECT NUMBER: 1587-2G

BORING NO. MW-7

DATE DRILLED: 11/28/89

LOGGED BY: J.K.R.

DEPTH (ft.)	SAMPLE No	BLOWS/FOOT	UNIFIED SOIL CLASSIFICATION	SOIL DESCRIPTION	WATER LEVEL
0–8	MW-7-1 (5)	11	CL	SILTY CLAY, greenish gray (5G 5/1) mottled with dark gray (N4/), 10-15% very fine sand, medium stiff, moderate plasticity, moist	▽ (approx. 7)
8–12	MW-7-2 (10)	5	CH	CLAY, dark gray (N4/), roots, stiff, high plasticity, moist	
12–16	MW-7-3 (15)	18	CL	SILTY CLAY, greenish gray (5GY 5/1), trace very fine sand, roots and rootholes, stiff, moderate plasticity, moist	
16				Bottom of Boring = 16 feet	

REVIEWED BY R.G./C.E.G.

EXPLORATORY BORING LOG

EXCELTECH

Project Name: Crown Metal Manufacturing, San Lorenzo, California

Boring No. MW-8

Date Drilled: 4/5/91

Project Number: 1587-2G

Logged By: BVT

Depth (ft.)	Sample No.	Blows/Foot	Unified Soil Classification	SOIL DESCRIPTION	Water Level	PID Reading (ppm)
0				FILL - SANDY GRAVEL: 7 inches		
1			CL	SILTY CLAY, mottled dark greenish gray (5G 4/1) with black (7.5YR N2/) 35 - 45% silt, trace very fine sand, 5 - 15% roots and plant matter, very stiff, moist		
6	8-1	18		Color grades to primarily dark greenish gray, decrease in organic matter (5 - 7%)		0
9			SM	SILTY SAND, light yellowish brown (2.5Y 6/4), 55 - 65% fine-medium sand, 30 - 40% silt, minor clay, loose, very moist to wet	▽	
11	8-2	3	CL	SILTY CLAY, dark gray (2.5 Y N4/), 15 - 25% silt, very soft, wet. At 11 feet, localized increase in sand content; 20 - 30%		0
13			ML	CLAYEY SILT, mottled dark grayish brown (2.5Y 4/2), dark yellowish brown (10YR 4/4) and light brownish gray (2.5Y 6/2), 20-30% clay, trace fine sand, 1 - 3% roots and rootholes, very stiff, moist		
16	8-3	20				0
16.5				Bottom of boring = 16.5 feet		

REVIEWED BY R.G./C.E.G.

EXPLORATORY BORING LOG

ensco environmental services, inc.

PROJECT NAME: Crown Metal Manufacturing (Pacific International Steel) San Lorenzo, California

BORING NO. RW-1

DATE DRILLED: 11/28/89

PROJECT NUMBER: 1587-2G

LOGGED BY: J.K.R.

DEPTH (ft.)	SAMPLE No	BLOWS/FOOT	UNIFIED SOIL CLASSIFICATION	SOIL DESCRIPTION	WATER LEVEL
0–0.5				FILL: reddish brown sandy gravel	
0.5–7.5	RW-1-1 (4–5)	11	ML	CLAYEY SILT, very dark gray (10YR 3/1), 30-40% clay, roots, stiff, moderate plasticity, moist	
7.5–12	(8.5–10)	3	CH	CLAY, greenish gray (5G 5/1), roots, soft, high plasticity, moist	
12–16.5	(13.5–15)	14	CL	SILTY CLAY, greenish gray (5GY 5/1), trace very fine sand, roots and rootholes, stiff, high plasticity, moist	▽ (~15)
16.5–20	(18.5–20)	8	ML	SANDY SILT, yellowish brown (10YR 5/4), 40-50% very fine sand, stiff, wet	
				Bottom of Boring = 20 feet	

REVIEWED BY R.G./C.E.G.

APPENDIX D

TOLERANCE LIMIT PUBLISHED DATA

–Water quality:
in river Maas at Eysden (Netherlands) in 1976: median: 0.1 μg/l; range: n.d. to 5.7 μg/l
Keizersveer (Netherlands) in 1976: median: 0.1 μg/l; range: n.d. to 1 μg/l (1368)
in lake Zürich (Switzerland): at surface: 28 ppt; at 30 m: 22 ppt
in Zürich area: spring water: 18 ppt; ground water: 45 ppt; tap water: 36 ppt (513)

–Aquatic reactions: evaporation:
Calculated half-life in water at 25°C and 1 m depth, based on evaporation rate of 0.144 m/hr: 4.81 hr;
based on evaporation rate of 0.137 m/hr: 5.03 hr (437)
soil adsorption: Freundlich constants for benzene sorption after 16 hr of incubation–concentrations 10–1000 ppb:

adsorbent	K	$1/n$	
Hastings silty clay loam	2.4	0.89	
Overton silty clay loam	1.8	0.94	
Al-saturated montmorillonite	30.9	1.08	
Ca-saturated montmorillonite	4.4	0.99	(1862)

–Waste water treatment:
A.S.: 33% theoretical oxidation of 500 ppm benzene by phenol acclimated activated sludge after 12 hr aeration (26)
A.C.: adsorbability: 0.08 g/g C, 95% reduction, infl.: 416 mg/l, effl.: 21 mg/l (32)
anaerobic lagoon: 13 lb/day/1,000 cu ft: infl.: 10 mg/l, effl.: 5 mg/l (37)
ion exchange: adsorption on Amberlite X AD-2: retention efficiency: 100%, infl.: 100 ppm, effl.: 0 ppm (40)
air stripping constant: $K = 1.71\ days^{-1}$ at 100 mg/l (82)
A.S., Sd, BOD, 14 d acclimation: 2% of ThOD after 5 days at 20°C
A.S., W, 14 d acclimation: 3% of ThOD after $\frac{1}{4}$ days at 20°C, feed: 50–200 mg/l (93)
air flotation after chemical addition: 78% removal (173)

A.C.: influent ppm	carbon dosage	effluent ppm	% reduction	
500	10X	27	95	
250	10X	23	91	
50	10X	20	60	(192)

–Sampling and analysis: photometry: min.full scale: 8.5×10^{-6} mole/l (53)

D. BIOLOGICAL EFFECTS:

–Toxicity threshold (cell multiplication inhibition test):

bacteria (*Pseudomonas putida*):	92 mg/l	(1900)
algae (*Microcystis aeruginosa*):	>1400 mg/l	(329)
green algae (*Scenedesmus quadricauda*):	>1400 mg/l	(1900)
protozoa (*Entosiphon sulcatum*):	>700 mg/l	(1900)
protozoa (*Uronema parduczi Chatton-Lwoff*):	486 mg/l	(1901)

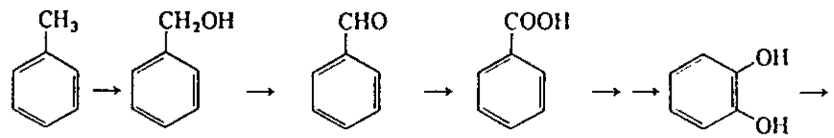
–Algae:
Chlorella vulgaris: 50% reduction of cell numbers vs controls, after 1 day incubation at 20°C: at 525 ppm (343)

inhibition of photosynthesis of a freshwater, non axenic unialgal culture o
Selenastrum capricornutum
at 10 mg/l: 95% carbon-14 fixation (vs. controls)
100 mg/l: 84% carbon-14 fixation (vs. controls)
1000 mg/l: 5% carbon-14 fixation (vs. controls) (1690
ciliate (*Tetrahymena pyriformis*): 24 hr LC_{100}: 12.8 mmole/l (1662

–Crustacean:
Grass shrimp (*Palaemonetes pugio*): 96 hr LC_{50}: 27 ppm (940
Crab larvae- stage 1 (*Cancer magister*): 96 hr LC_{50}: 108 ppm (941
Shrimp (*Crangon franciscorum*): 96 hr LC_{50}: 20 ppm (942
brine shrimp: TLm (24, 48 hr): 66–21 mg/l (41

–Fish:
minnows: min. lethal dose: 5–7 mg/l; 6 hr (226
bluegill sunfish: LD_{50}: 24–48 hr: 20 mg/l
LD_{100}: 24 hr: 34 mg/l; 2 hr: 60 mg/l (226
goldfish: LD_{50} (24 hr): 46 mg/l, modified ASTM D 1345 (27
fatheads: soft water: TLm (24, 96 hr): 35.5 to 33.5 mg/l
fatheads: hard water: TLm (24, 96 hr): 24.4 to 32 mg/l
bluegills: soft water: TLm (24, 96 hr): 22.5 mg/l
goldfish: soft water: TLm (24, 96 hr): 34.4 mg/l
guppies: soft water: TLm (24, 96 hr): 36.6 mg/l (5
mosquito fish: TLm (24, 96 hr): 395 mg/l
young Coho salmon: no significant mortalities up to 10 ppm after 96 hrs artificial sea water at 8°C
: mortality: 12/20 at 50 ppm after 24 up to hrs in artificial sea water at 8°C
: 30/30 at 100 ppm after 24 hrs in artificial s water at 8°C (31
Bass (*Morone saxatilis*): 96 hr LC_{50}: 5.8–10.9 ppm (94
Herring and anchovy larvae (*Clupea pallasi, Engraulis mordex*):
35–45 ppm caused delay in development of eggs and produces abnormal larva
10–35 ppm caused delay in development of larvae; decrease in feeding a growth, and increase in respiration (94
Chinook salmon (*Onchorhynchus tschawytsche*) 5–10 ppm: initial increase in
Striped bass (*Morone saxatilis*) respiration (94
pacific herring (*Clupea harengus pallasi*): BCF:
in eggs: 10.9
yolk-sac larvae: 6.9
feeding larvae: 3.9 (191
eel: infiltration ratio: flesh/water: 0.31; eel flesh 0.14 ng/g, water: 0.45 ng/g (41
eel (*Anguilla japonica*): BCF: 3.5; half-life: 0.5 days (192
guppy (*Poecilia reticulata*): 14 d, LC_{50}: 63 ppm (183
brown trout yearlings: 1 hr, LC_{50}: 12 mg/l (static bioassay) (9

–Amphibian:
mexican axolotl (3–4 w after hatching): 48 hr LC_{50}: 370 mg/l
clawed toad (3–4 w after hatching): 48 hr LC_{50}: 190 mg/l (18



Toluene → Benzyl alcohol → Benzaldehyde → Benzoic acid →→ Catechol →

initial steps in degradation by micro-organisms (1235)

–Impact on biodegradation processes:
inhibition of degradation of glucose by *Pseudomonas fluorescens* at: 30 mg/l
inhibition of degradation of glucose by *E. coli* at: 200 mg/l (293)

–Reduction of amenities:
T.O.C. = 1 mg/l (295)
approx. conc. causing adverse taste in fish: <0.25 mg/l (41)

–Water quality:
in river Maas at Eysden (Netherlands) in 1976: median: 0.1 μg/l; range: n.d.–2.1 μg/l
in river Maas at Keizersveer (Netherlands) in 1976: median: 0.1 μg/l; range: n.d.–0.7 μg/l (1368)

–Waste water treatment:
A.C.: adsorbability: 0.050 g/g C; 79.2% reduction, infl.: 317 mg/l, effl.: 66 mg/l (32)
sludge digestion is not affected yet at 440 mg/l; at 870 mg/l, gas production in the digester is reduced by 14.5% (30)
calculated half life time based on evaporative loss for a water depth of 1 m at 25°C: 5.18 hr (330)

–Sampling and analysis:
photometry: min. full scale: 5.7×10^{-6} mole/l (53)

D. BIOLOGICAL EFFECTS:

–Bacteria: *E. coli*: LD_0: 200 mg/l

–Toxicity threshold (cell multiplication inhibition test):

bacteria (*Pseudomonas putida*):	29 mg/l	(1900)
algae (*Microcystis aeruginosa*):	105 mg/l	(329)
green algae (*Scenedesmus quadricauda*):	>400 mg/l	(1900)
protozoa (*Entosiphon sulcatum*):	456 mg/l	(1900)
protozoa (*Uronema parduczi Chatton-Lwoff*):	>450 mg/l	(1901)

–Algae:
inhibition of photosynthesis of a freshwater, nonaxenic unialgal culture of *Selenastrum capricornutum*:
at 1% saturation: 91% carbon-14 fixation (vs. controls)
10% saturation: 96% carbon-14 fixation (vs. controls)
100% saturation: 3% carbon-14 fixation (vs. controls) (1690)
algae: kelp (*Macrocystis angustifolia*): 75% reduction in photosynthesis within 96 hr at 10 ppm
Scenedesmus: LD_0: 120 mg/l (946)

–Protozoa: ciliate (*Tetrahymena pyriformis*): 24 hr LC_{100}: 5.97 mmole/l (1662)

–Crustaceans:
marine isopod (*Cirolana borealis*): median effective time (ET_{50}) to narcotizatio[n] for different nominal concentrations of toluene in seawater:

conc. (ppm)	ET_{50} (hr)
0	–
0.0125	–
1.25	–
5.7	400
12.5	69
25	28
125	3

(bars indicate no visible effects on any individual during 4 days of exposure) (1443

grass shrimp (*Palaemonetes pugio*): 96 hr LC_{50}: 9.5 ppm (940
crab larvae–stage I (*Cancer magister*): 96 hr LC_{50}: 28 ppm (941
shrimp (*Crangon franciscorum*): 96 hr LC_{50}: 4.3 ppm (942
Daphnia: LD_0: 60 mg/l (30

–Fish:
goldfish: LD_{50}: (24 hr): 58 mg/l–modified ASTM D 1345 (277
fatheads: TLm (24–96 hr): 56–34 mg/l
bluegill: TLm (24–96 hr): 24,0 mg/l
goldfish: TLm (24–96 hr): 57.7 mg/l
guppies: TLm (24–96 hr): 63–59 mg/l (158
mosquito fish: TLm (24–96 hr): 1,340–1,280 mg/l in turbid Oklahoma (244
young Coho Salmon in artificial sea water at 8°C: no significant mortality up [t]o 10 ppm after 24 to 96 hrs
mortality:
9/10 at 50 ppm after 24 hrs, 10/10 at 50 ppm after 48 up to 96 hrs
28/30 at 100 ppm after 24 hrs, 30/30 after 48 up to 96 hrs (31

static test:	96 hr TLm (ppm) at 4°C	8°C	12°
pink salmon (*Oncorhynchus gorbuscha*)	6.41	7.63	8.[
shrimp (*Eualus* spp.)	21.4	20.2	14.[

the conc. of toluene in the test containers declined with time because of evapor[a]tion losses or biodegradation. Toluene declined to nondetectable levels after [ ] hr at 12°C; after 96 hr at 8°C, and to 25% of the initial conc. after 96 hr at 4° (139

goldfish: flow through bioassay:	96 hr TLm: 23 mg/l at 17–19°C	
	720 hr TLm: 15 mg/l at 17–19°C	(47
guppy (*Poecilia reticulata*):	14 d LC_{50}: 68 ppm	(183
bass (*Morone saxatilis*):	96 hr LC_{50}: 7.3 ppm	(94
goldfish (*Carassius auratus*):	96 hr LC_{50}: 22.8 ppm	(94

eel: infiltration ratio: flesh/water: 0.53; eel flesh: 1.17 ng/g; water: 2.22 ng/ (41

eel (*Anguilla japonica*): BCG: 13.2, 1/2 life period: 1.4 days (192

–Man: EIR: 5.3
severe toxic effects: 1,000 ppm = 3,830 mg/cu m, 60 min

*

BIOLOGICAL EFFECTS:

–Toxicity threshold (cell multiplication inhibition test):

bacteria (*Pseudomonas putida*):	12 mg/l	(1900)
algae (*Microcystis aeruginosa*):	33 mg/l	(329)
green algae (*Scenedesmus quadricauda*):	>160 mg/l	(1900)
protozoa (*Entosiphon sulcatum*):	140 mg/l	(1900)
protozoa (*Uronema parduczi Chatton-Lwoff*):	>110 mg/l	(1901)

–Fish:
fatheads: soft water: TLm (25–96 hr): 48.5 mg/l
fatheads: hard water: TLm (25–96 hr): 42.3 mg/l
bluegills: soft water: TLm (25–96 hr): 35.1–32.0 mg/l
goldfish: soft water: TLm (25–96 hr): 94.4 mg/l
guppies: soft water: TLm (25–96 hr): 97.1 mg/l (158)
young Coho salmon: in artificial sea water at 8°C, mortality:
30/30 at 50 ppm after 24 hrs
2/30 (not significant) at 10 ppm after 24 up to 96 hrs (317)

–Mammals:
ingestion: rat: single oral LD_{50}: in the range of 3500 mg/kg (1546)

ethylbutanoate *see* ethylbutyrate

2-ethyl-1-butanol (3-methylolpentane; pseudohexylalcohol)
$CH_3CH_2(C_2H_5)CHCH_2OH$

A. PROPERTIES: colorless liquid; m.w. 102.2, m.p. -50°C, b p. 150°C; v.p. 1.8 mm at 20°C; v.d. 3.54; sp.gr. 0.8328 at 20/20°C; solub. 4,300 mg/l at 20°C, 6,300 mg/l at 24°C;

B. AIR POLLUTION FACTORS: 1 mg/cu m = 0.24 ppm. 1 ppm = 4.17 mg/cu m
–Odor: characteristic: quality: musty, sweet
hedonic tone: neutral
T.O.C.: abs. perc. lim.: 0.07 ppm
50% recogn.: 0.77 ppm
100% recogn.: 0.77 ppm
O.I. 100% recogn.: 1,701 (19)

C. WATER POLLUTION FACTORS:
–Waste water treatment:
A.C.: adsorbability: 0.17 g/g C; 85.5% reduction, infl.: 1,000 mg/l, effl.: 145 mg/l (32)
–Reduction of amenities: T.O.C. = 0.2 mg/l (299)(894)

D. BIOLOGICAL EFFECTS:
–Mammalia: rat: single oral LD_{50}: 1.85 g/kg
inhalation: no deaths: sat. vap.: 8 hr (211)

ethylbutyrate (ethylbutanoate)
$CH_3CH_2CH_2COOC_2H_5$

A. PROPERTIES: colorless liquid; m.w. 116.16; m.p. -93°C; b.p. 121°C; v.p. 11.3 mm at 20°C; v.d. 4.00; sp.gr. 0.88 at 20/4°C; solub. 6,800 mg/l at 25°C

B. AIR POLLUTION FACTORS: 1 mg/cu m = 0.193 ppm, 1 ppm = 5.184 mg/cu m
–Odor: T.O.C.: 0.039 mg/cu m = 7.5 ppb (307)
detection: 0.28 mg/cu m (840)
recognition: 0.13–0.23 mg/cu m (610)
O.I. at 20°C = 1,982,000 (316)

C. WATER POLLUTION FACTORS:
–Odor threshold: detection: 0.001 mg/kg (889)
–Waste water treatment:
ion exchange: adsorption on Amberlite X AD-2: 100% retention, infl.: 100 ppm, effl.: nil

✱ D. BIOLOGICAL EFFECTS:

–Algae: *Chlorella vulgaris*: at 55 ppm: 50% reduction of cell numbers vs. controls after 1 day incubation at 20°C (343)

–Protozoa: threshold conc. of cell multiplication inhibition of the protozoan *Uronema parduczi Chatton-Lwoff*: >160 mg/l (1901)

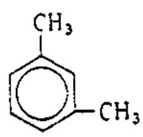
–Arthropods:
Daphnia magna: 24 hr TLm: 100–1,000 mg/l (n.s.i.) (26)
grass shrimp (*Palaemonetes pugio*): 96 hr LC_{50}: 7.4 ppm (n.s.i.) (940)
crab larvae–stage I (*Cancer magister*): 96 hr LC_{50}: 6 ppm (941)
shrimp (*Crangon franciscorum*): 96 hr LC_{50}: 1.3 ppm (942)

–Insects:
mayfly nymphs (*Ephemerella walkeri*): lowest observed avoidance conc.: >10 mg/l

–Fish: goldfish: LD_{50} (24 hr): 13 mg/l modified ASTM D 1345 (277)
n.s.i.: young Coho salmon: in artificial sea water at 8°C:
no significant mortality up to 10 ppm after 24 up to 96 hrs
mortality: 30/30 at 100 ppm after 24 hrs (317)
rainbow trout (*Salmo gairdneri*): lowest observed avoidance conc.: 0.01 mg/l (1621)
rainbow trout: 96 hr LC_{50} (S): 13.5 mg/l (n.s.i.) (1211)
eel (*Anguilla japonica*): BCF: 21.4, ½ life period: 2.0 days (1926)
eel: infiltration ratio: flesh/water: 0.46; eel flesh: 0.80 ng/g: water: 1.74 ng/g (412)
guppy (*Poecilia reticulata*): 7 d LC_{50}: 35 ppm (1833)
fathead minnows: static bioassay in Lake Superior Water at 18–22°C: LC_{50} (1; 24; 48; 72; 96 hr): 46; 42: 42; 42; 42 mg/l (n.s.i.)
goldfish (*Carassius auratus*): 96 hr LC_{50}: 16.9 ppm (n.s.i.) (943)
bass (*Morone saxatilis*): 96 hr LC_{50}: 11.0 ppm (943)

–Man: EIR: 2.3
severe toxic effects: 1.000 ppm = 4,410 mg/cu m, 60 min (n.s.i.)
symptoms of illness: 300 ppm = 1,323 mg/cu m, 60 min (n.s.i.)
unsatisfactory: 100 ppm = 441 mg/cu m, 60 min (n.s.i.) (185)

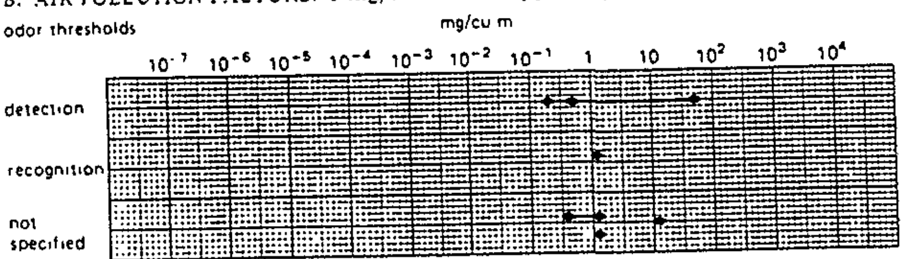
m-xylene (1,3-dimethylbenzene)



Manmade sources: in gasoline (high octane number): 12.03 wt % (387)

A. PROPERTIES: colorless liquid; m.w. 106.16; m.p. –48/–53°C; b.p. 139°C; v.p. 6 mm at 20°C, 11 mm at 30°C; v.d. 3.66; sp.gr. 0 864 at 20°C: sat. conc. 35 g/cu m at 20°C, 61 g/cu m at 30°C; log P_{oct} 3.20

B. AIR POLLUTION FACTORS: 1 mg/cu m = 0.23 ppm; 1 ppm = 4.41 mg/cu m



(307; 610; 642; 673; 727; 829)

O.I. at 20°C: 2100 (316)

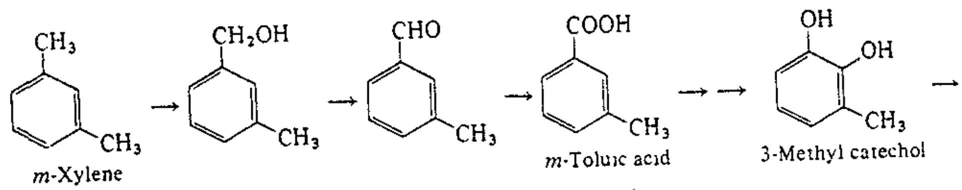
–Atmospheric reactions:
R.C.R.: 2.67 (49)
reactivity: HC cons.: ranking 1–3 (63)
NO ox.: ranking 0.9–1 (63)
estimated lifetime under photochemical smog conditions in S.E. England: 1.5 hr (1699; 1707)

–Ambient air quality:
Los Angeles 1966: glc's: avg.: 0.016 ppm ($n = 136$)
highest value: 0.061 ppm (1319)
glc's downtown Los Angeles, 1967: 10%ile: 4 ppb
avg.: 12 ppb
90%ile: 21 ppb (64)

–Manmade sources:
in exhaust of gasoline engines: 62-car survey: 1.9 vol.% (*m*+*p*-xylene) of total exhaust HC's (391)
engine variable study: 2.5 vol.% (*m*+*p*-xylene) of total exhaust HC's (393)
in exhaust of diesel engine: 1.9% of emitted HC's (*m*+*p*-xylene) (72)
in exhaust of reciprocating gasoline engine: 1.3% of emitted HC's
in exhaust of rotary gasoline engine: 5.6% of emitted HC's (*m*+*p*-xylene) (78)
–Sampling and analysis: photometry: min. full scale: 200 ppm (53)

C. WATER POLLUTION FACTORS:
–Oxidation parameters: BOD: 2.53 NEN 3235-5.4 (277)
COD: 2.63 NEN 3235-5.3 (277)

–Biodegradation:
incubation with natural flora in the groundwater–in presence of the other components of high-octane gasoline (100 μl/l)–*biodegradation*: 100% after 192 hr at 13°C (initial conc. 3.28 μl/l) (956)



initial steps in degradation by micro-organisms (1235)
–Reduction of amenities: T.O.C. in water: 1.0 ppm (325)
–Sampling and analysis: photometry: min. full. scale: 6.5×10^{-6} mole/l (53)

D. BIOLOGICAL EFFECTS:
–Protozoa:
ciliate (*Tetrahymena pyriformis*): 24 hr LC_{100}: 3.77 mmole/l (1662)
–Crustacean:
crab larvae–stage I (*Cancer magister*): 96 hr LC_{50}: 12 ppm (941)
shrimp (*Crangon franciscorum*): 96 hr LC_{50}: 3.7 ppm (942)
–Fish:
eel (*Anguilla japonica*): BCF: 23.6
half-life: 2.6 days (*m*+*p*-xylene) (1926)
eel: infiltration ratio: flesh/water: 0.47; eel flesh: 1.41 ng/g; water: 2.98 ng/g (412)
(1833)
guppy (*Poecilia reticulata*): 14 d LC_{50}: 38 ppm (942)
bass (*Morone saxatilis*): 96 hr LC_{50}: 9.2 ppm (277)
goldfish: 24 hr LD_{50}: 16 mg/l modified ASTM D 1345 (49)
–Man: EIR: 2.9

C. WATER POLLUTION FACTORS:

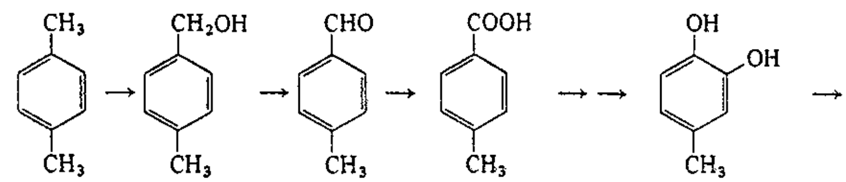
–BOD_5: 0 (26)
  1% of ThOD (220)
  1.40 NEN 3235-5.4 (277)
  2.35 adapted sew. NEN 3235-5.4 (277)

–COD: 2.56 NEN 3235-5.3 (277)
  13% of ThOD (220)

–$KMnO_4$ value: 0.102 (30)
  acid: 2% of ThOD; alkaline: 0% of ThOD

–ThOD: 3.125 (30)

–Biodegradation:
incubation with natural flora in the groundwater–in presence of the other components of high-octane gasoline (100 μl/l)–biodegradation: 100% after 192 hr at 13°C (initial conc. 1.03 μl/l) (956)
cooxidation to *p*-toluic acid by *Nocardia*–hexadecane as the growth substrate (956)



p-Xylene *p*-Toluic acid 4-Methyl catechol

initial steps in degradation by microorganisms (1235)

–Water quality:
in river Maas at Eysden (Netherlands) in 1976:
median: n.d.; range: n.d.–0.1 μg/l
in river Maas at Keizersveer (Netherlands) in 1976:
median: n.d.; range: n.d.–0.1 μg/l (1368)

–Reduction of amenities: T.O.C. in water: 0.53 ppm (325)

D. BIOLOGICAL EFFECTS:

–Protozoa:
ciliate (*Tetrahymena pyriformis*): 24 hr LC_{100}: 3.77 mmole/l (1662)

–Crustacean:
shrimp (*Crangon franciscorum*); 96 hr LC_{50}: 2.0 ppm (942)

–Fish:
guppy (*Poecilia reticulata*): 7 d LC_{50}: 35 ppm (1833)
bass (*Morone saxatilis*): 96 hr LC_{50}: 2.0 ppm (942)
fatheads: soft dilution water: TLm (24–96 hr): 28.8–26.7 mg/l (n.s.i.)
fatheads: hard dilution water: TLm (24–96 hr): 28.8 mg/l (n.s.i.)
bluegill: soft dilution water: TLm (24–96 hr): 24.0–20.9 mg/l (n.s.i.)
goldfish: soft dilution water: TLm (24–96 hr): 36.8 mg/l (n.s.i.)
guppies: soft dilution water: TLm (24–96 hr): 34.7 mg/l (n.s.i.) (158)
goldfish: LD_{50} (24 hr): 18 mg/l–modified ASTM D 1345 (277)

–Man: EIR: 2.5 (49)