
**UPDATE TO RISK ASSESSMENT REPORT
FOR THE FORMER PACIFIC DRY DOCK
AND REPAIR COMPANY YARD I SITE
IN OAKLAND, CALIFORNIA**

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July 6, 1998

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1.0 EXECUTIVE SUMMARY

In 1996, Crowley Marine Services, Inc. prepared and submitted to the Alameda County Health Care Services Agency ("Alameda County"), a Risk Assessment Report on the former Pacific Dry Dock and Repair Company Yard I. The Port of Oakland reviewed and commented at length on that Report. Alameda County also reviewed the Risk Assessment and asked that Crowley conduct certain further investigation work at the Site. This Update to the Risk Assessment Report describes and presents the results of that further effort. The additional work confirms the results of the earlier sampling conducted under regulatory oversight since 1989. Furthermore, the recently-collected data confirm that potential risks posed to a commercial/industrial worker (excess cancer risk of $7.1E-07$ and hazard index of 0.00042) are well within the range of risks computed in the original risk assessment and, in fact, are below levels of regulatory concern (typically $1.0E-05$ for excess cancer risks and a hazard index of 1.0 for noncancer health effects). Based on these findings, the former Pacific Dry Dock Yard I Site constitutes a low risk soil and groundwater site based on the criteria set forth in the Water Board guidance (SWRCB, 1996; RWQCB-San Francisco Bay Region, 1996), and Crowley hereby requests regulatory closure of this Site.

2.0 INTRODUCTION

This is an update to the Risk Assessment (RA) Report (Risk-Based Decisions, July 7, 1997) previously submitted by Crowley Marine Services ("Crowley") which evaluated the human health and environmental significance of metals, petroleum hydrocarbon constituents, and chlorinated solvents in soils and groundwater at the former Pacific Dry Dock and Repair Company Yard I (the "Site") located at 1441 Embarcadero, Oakland, California. The earlier RA showed that the chemicals remaining in soils and groundwater at the Site did not present carcinogenic or non-carcinogenic risks to future workers above levels of regulatory concern under an onsite commercial/industrial worker exposure scenario. Furthermore, the RA also showed that, using health-protective assumptions, the residual chemicals did not present a threat to the environment.

Crowley has performed extensive investigations at Yard I under the supervision of Alameda County and the California Regional Water Quality Control Board San Francisco Bay Region (RWQCB). A series of phased investigation programs were conducted at Yard I between 1989 and 1997. Aerial photographs, site observations and Site histories were used to select areas for the initial environmental investigations. Many of the initial soil and water samples collected from the Site were tested for broad ranges of priority pollutants such as chlorinated and aromatic volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), Title 22 metals (metals), and petroleum hydrocarbons. The initial soil and groundwater and surface water test results were used to focus areas for additional investigation and testing. The phased investigation approach that was used is consistent with the current ASTM standards for environmental investigations. The phased investigations

had targeted areas likely to be of environmental concern. Analyses were based on substances expected to be used or produced within each target area.

In response to discussions between Crowley and Alameda County, with input from the Port of Oakland ("Port"), Crowley agreed to conduct additional sampling of this Site to confirm the earlier Site characterization data. ~~The additional sampling was conducted in accordance with the Sampling Work Plan for the Former Pacific Dry Dock and Repair Company Yards I and II (Risk-Based Decisions, November 14, 1997) which was approved by Alameda County with some modifications (Alameda County, January 21, 1998).~~ A meeting was held with Mr. Barney Chan and Ms. Madhula Logan of the Alameda County and representatives of Crowley at the Site on January 30, 1998 to review the *Sampling Work Plan*. At this meeting, three groundwater samples were requested by the Agency and agreed to by Crowley. ~~Modifications to the Work Plan were confirmed in a letter from Crowley to Mr. Chan (February 3, 1998).~~ The data collected reflects this agreed-upon sampling program.

3.0 DATA COLLECTION AND EVALUATION

The Site is currently a vacant property bounded by the Brooklyn Basin and the Oakland Inner Harbor on the south and west, the Embarcadero Freeway on the north, and an industrial property to the east.

A considerable amount of soil and water sampling has been conducted at the Site since 1989. In accordance with Alameda County and RWQCB requirements, remediation of certain targeted areas at the Yard was also completed as previously reported to these agencies.

3.1 Overview of Sampling Strategy

A brief overview of the rationale underlying the Sampling Plan and interpretation of the data obtained is provided to place the current data in context. As stated in the Plan, the objectives of the sampling were to:

1. Acquire additional data about the shallow soils at the Site to ensure estimation of representative chemical concentrations.
2. Evaluate isolated areas on the Site believed to have some potential for chemical concentrations to exceed human health based regulatory thresholds.
3. Further evaluate potential risks, if any, posed by the Site.

To accomplish these objectives, the Work Plan combined randomized, representative sampling with targeted, judgmental sampling. This work was accomplished by clearly delineating the targeted regions and by specifying different approaches to finding sample locations in the targeted areas. Samples were collected from surficial soils (0.5 to 1.5 feet bgs) and from deeper soils, typically one

foot above the water table. Currently, the depth to groundwater at this Site is at about 2.5 to 6 feet bgs.

To yield results representative of extreme conditions, many samples were "focused" or "targeted" in areas believed to have a higher likelihood of exhibiting significant contamination ("strata"). The portion of the Site remaining after all targeted strata were sampled was still of considerable size. ~~Sample locations within this larger area of the Site, outside the targeted areas, were selected at random so that their results could be used for valid statistical inferences about conditions across the Site.~~

Measurements of targeted samples do not represent average conditions; they only reflect the targeted areas, which typically are small. The data from the targeted samples were compared to the EPA Region 9 industrial soil Preliminary Remediation Goals (PRGs) at the $1.0E-06$ risk threshold (one in one million excess risk), or for noncarcinogens at a hazard index of 1.0 (EPA, Region 9 PRG, May 1, 1998). Where the chemical concentration in any targeted sample exceeded its PRG, further evaluation of the targeted area was conducted.

Measurements of the random samples were statistically combined to estimate the average and variability of chemicals of concern throughout the Site. The procedure recommended by the EPA is to calculate a 95% upper confidence limit (UCL) of the mean. The 95% level means that repeated use of the UCL procedure is expected to overestimate the true mean 95 out of every 100 times it is applied.

Targeted and random samples were obtained at many locations and then composited into small groups before analysis to increase the spatial sampling intensity, thereby increasing the chance of identifying any localized high concentration. Only samples for which the same set of analyses was required were

composited. Analysis for volatile organic compounds (VOCs), including benzene, toluene, ethylbenzene and xylenes (BTEX) analyses were performed on the original, uncomposited samples.

Samples were systematically named to indicate:

1. (Test) Group: Numbers correspond to the different collections of analytical tests that were performed.
2. Composite: Within each group, for a given horizon, samples were composited. All those to be composited were assigned to a compositing group, designated by small latin letters a, b, c, *etc.*
3. Identifier: Within a compositing group, individual samples were identified by sequential whole numbers beginning with 1.
4. Horizon: "S" for shallow, "D" for deeper - near the water table.

The naming convention is of the form <group><composite>.<identifier><horizon>, with a period separating the first two from the second two. Thus, for example, the deep samples from composite b in group 1 at Yard I have been designated 1b.1D, 1b.2D, and 1b.3D (see Table 3.2). The samples contributing to a composite are called its "aliquots." For example, samples 1b.1D, 1b.2D, and 1b.3D are the designated aliquots for composite 1b(D).

3.2 Analytical Results

Figure 1 shows the locations of the target and random samples and the samples collected as part of the earlier Site investigations. This Figure illustrates the extent of characterization performed.

Table 1 shows the analytical results for metals in shallow and deep samples from target [T] and random [R] samples. As shown in the Table, all the metals were either within the range of background concentrations reported for California soils or below the corresponding EPA Region 9 PRG. In fact, all four of the metals quantitatively evaluated in the original RA -- copper, lead, mercury and zinc -- were found to be at or below levels detected in earlier investigations. For example, the 95% UCL of copper was 307 mg/kg whereas now it is 89.69 mg/kg; for lead the 95% UCL was 185 mg/kg, now it is 76 mg/kg; for zinc the 95% UCL was 244 whereas now it is 135 mg/kg; for mercury, the 95% UCL was 1.56, now it is 0.80 mg/kg. The distribution of these metals in Site soils is shown in Figures 2-1 and 2-2 (zinc), Figures 2-3 and 2-4 (copper), Figures 2-5 and 2-6 (lead), and Figures 2-7 and 2-8 (mercury).

Table 2 shows the data for carcinogenic and non-carcinogenic polynuclear aromatic hydrocarbons (PNAs) and semi-volatile organic compounds (SVOCs) in the composite soil samples. Table 3 shows the concentrations of these same chemicals in the discrete aliquots that made up the composites, as described in the Sampling Work Plan.

An examination of the data from the random samples in Table 2 shows that only sample 1d S had detectable levels of the carcinogenic PNAs, although none of these detections were above the corresponding PRG. Analysis of the discrete aliquots (1d.1S, 1d.2S and 1d.3S) that make up the composite 1d S in Table 3 show all non-

detects for the carcinogenic and non-carcinogenic PNAs although the detection limits on some of the carcinogenic PNAs are higher than in the composite sample.

For the composite target samples, as shown in Table 2, only target sample 7a.S had a detection of 3.3 mg/kg benzo(a)pyrene, above its PRG of 0.36 mg/kg. Analysis of the discrete aliquots (7a.1S and 7a.2S), shown in Table 3, shows that the discrete aliquot 7a.2S had a benzo(a)pyrene concentration of 2.5 mg/kg while 7a.1S was non-detect for this (and all the PNAs). Table 3 also shows that discrete sample 9a.2S had a benzo(a)pyrene concentration of 1.2 mg/kg, above its PRG, even though the other discrete aliquot, 9a.1S, was non-detect and the original composite target sample 9a.S (Table 2) had a detection of 0.3 mg/kg for benzo(a)pyrene. Figures 3-1 through 3-14 show the spatial pattern of distribution of each of the seven potentially carcinogenic PNAs.

Figures 3-15 and 3-16 show the distribution of naphthalene, as a surrogate of the noncarcinogenic PNAs.

Four groundwater samples were also collected at the request of Alameda County. One sample GW1 was obtained from MW-1. The locations of the other three grab groundwater samples and GW1 are shown in Figure 1. GW1, GW3, and GW4 were analyzed for VOCs, PNAs and dissolved metals. GW2 was analyzed for VOCs and dissolved metals. Apart from some detections of dissolved metals close to their limits of detection, no organic compounds were detected (Supplemental Site Investigation Sampling and Analysis Results, Pacific Dry Dock Yards I and II, The Gauntlett Group, July 1998).

4.0 EXPOSURE ASSESSMENT

The Site was used as an industrial facility and the original RA assumed future land use would remain industrial, although re-development of the Yard as a public park was qualitatively considered. Thus, the exposure assessment quantitatively evaluates direct worker exposure to chemicals in soils. Calculations and input parameters used for estimating intake rates, through direct contact with soils, were obtained from the EPA (EPA, 1989 and 1994).

Intake (or exposure) was calculated as either the Average Daily Dose (ADD) or the Lifetime Average Daily Dose (LADD). The ADD was used in the evaluation of noncarcinogenic health effects, while the LADD was used to evaluate carcinogenic effects. For direct exposure to chemicals in soils, the equation used is written as:

$$\text{Intake} = \frac{(Cs) (Ir) (FI) (EF) (ED)}{(BW) (AT) (365)}$$

Where:

Intake	=	ADD or LADD (mg/kg/day)
Cs	=	Concentration of Chemical in Soil (mg/m ³)
Ir	=	Soil ingestion rate (50 mg/day)
FI	=	Fraction of contaminated soil surface (0.10)
EF	=	Exposure Frequency (250 days/year)
ED	=	Exposure Duration (25 years)
BW	=	Body Weight (70 kg)
AT	=	Averaging Time (70 years)
365	=	Conversion Factor (days/year)

The parameters selected to quantify chemical intake (noted in parentheses above) represent default 95% upper bound estimates recommended by the USEPA (1989).

The only site-specific parameter was the conservative estimate that approximately 10% of the surface soils at the Site contained chemical concentrations above background. In fact, as can be seen from the Figures, the chemicals of potential concern, PNAs, were detected in a small fraction of the potential worker exposure domain represented by the Site as a whole. Thus, assuming that as much as 10 percent of the Site area is impacted is a health-protective assumption.

5.0 RISK CHARACTERIZATION

5.1 Carcinogenic Health Risks

The following calculation was used to obtain numerical estimates of lifetime cancer risks for humans:

$$\text{Risk} = \text{Intake (or Exposure)} * \text{SF}$$

Where:

Risk	=	Potential excess cancer risk adjusted for a 70-year lifetime (unitless)
Intake	=	Chemical intake (LADD) (mg/kg/day)
SF	=	Slope factor (mg/kg/day) ⁻¹

Risks to commercial/industrial workers are typically regulated by the RWQCB and the DTSC at the 1.0E-05 (one in 100,000 excess cancers) level.

5.2 Noncarcinogenic Human Health Effects

Health hazards associated with exposure to noncarcinogenic compounds were evaluated using Reference Doses (RfDs) and calculating hazard quotients. The hazard quotient is the ratio of the intake rate to the RfD (developed by the EPA), as follows:

$$\text{HQ} = \text{Intake/RfD}$$

Where:

HQ	=	Hazard Quotient
Intake	=	Chemical intake (ADD) (mg/kg/day)
RfD	=	Reference dose (mg/kg/day)

Hazard quotients were summed for all noncarcinogenic chemicals to calculate a total hazard index. The EPA has set a hazard index of 1.0 as the threshold for noncancer health effects (EPA, 1989).

5.3 Results of the Human Health Evaluation

Table 4 shows the exposures and risks (carcinogenic and noncarcinogenic) from direct worker contact via ingestion of PCBs and benzene in soils/fill. This potential exposure resulted in an excess cancer risk of $7.1E-07$. In spite of the conservative assumptions made in quantifying potential risks, this excess cancer risk is approximately 14 times lower than the risk ($1.0E-05$) considered acceptable by the RWQCB, DTSC and the EPA for commercial/industrial workers.

For noncancer health effects, the hazard index was 0.00042, more than 2,000 times lower than the regulatory threshold of 1.0 (Table 4).

The potential health effects to onsite workers from direct contact with lead in fill/soils at the Site was evaluated using the Department of Toxic Substances Control's (DTSC's) LeadSpread Model. As shown in Table 5, default exposure assumptions recommended by the DTSC were used. The results show that the 95th percentile of blood lead in a potentially exposed worker would be $3.6 \mu\text{g/L}$, well below the regulatory level of concern of $10 \mu\text{g/L}$. The same Table shows that, for an industrial worker exposure scenario, the 95% UCL of the Preliminary Remedial Goal (PRG-95) for lead in soil would be $6,306.5 \mu\text{g/g}$ (or mg/kg), a level 83 times higher than the 95% UCL for lead in soils at the Site.

6.0 CONCLUSIONS

The additional sampling of the Site affirms the results of the earlier phases of sampling conducted since 1989. Furthermore, the additional sampling data confirm that potential risks posed to a commercial/industrial worker (excess cancer risk of $7.1E-07$ and hazard index of 0.00042) are of the same order as the range of risks computed in the original risk assessment and, in fact, are below levels of regulatory concern (typically $1.0E-05$ for excess cancer risks and a hazard index of 1.0 for noncancer health effects). Based on these findings, the former Pacific Dry Dock Yard I Site constitutes a low risk soil and groundwater site based on the criteria set forth in the Water Board guidance (SWRCB, 1996; RWQCB-San Francisco Bay Region, 1996) and regulatory closure of this Site is requested.

Table 1
Soil Sample Results
Metals
Pacific Dry Dock Yard I
Oakland, California

Analyte ¹ (mg/kg) ²	Sample Identification														Background			Regulatory Level		
	1a.S	1a.D	1b.S	1b.D	1c.S	1c.D	1d.S	1d.D	4a.S	4a.D	6a.S	6a.D	7a.1S	8a.S	Mean	S.D.	95%UCL	Mean	95%UCL	EPA Region 9
	R	R	R	R	R	R	R	R	T	T	T	T	T	T						Industrial PRG ³
Antimony	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	3.7	<2	<2	<2	1.00	0.00	1.00			750
Arsenic	<1	1.9	1.2	1.5	7.6	3.4	2.8	2.8	2.9	2.5	3	3	<1	<1	2.71	2.19	4.18	6.60	19.10	3
Barium	74	160	59	450	69	96	140	140	190	94	83	160	43	81	148.50	127.51	233.93			100,000
Beryllium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.61	<0.5	0.25	0.00	0.25			3400
Cadmium	1.9	2.6	1.8	1.4	2.8	2.1	2	1.8	2.5	1.4	1.1	1.3	1.3	1.8	2.05	0.45	2.35			930
Chromium	55	11	31	24	12	14	12	26	18	21	15	25	19	57	23.13	14.95	33.14	118.00	99.60	450
Cobalt	10	6.6	6.6	7.3	5.9	5.6	6.1	7.9	8	5.7	4	4.1	3.8	11	7.00	1.42	7.95	13.30		29,000
Copper	35	41	23	32	83	140	47	98	32	26	140	460	9.8	20	62.38	40.77	89.69	49.00	69.40	70,000
Lead	7.6	7.5	16	54	60	48	67	130	14	43	140	84	7.5	12	48.76	40.63	75.99	29.00	16.10	1,000
Mercury	0.48	0.55	0.94	0.94	0.92	0.41	0.31	0.45	0.34	1.5	2.1	1	0.37	0.2	0.63	0.26	0.80	0.15	0.40	560
Molybdenum	<1	<1	<1	2.4	<1	<1	<1	<1	<1	<1	<1	<1	2.6	<1	0.74	0.67	1.19			9,400
Nickel	120	25	48	35	17	18	27	42	24	33	62	22	28	140	41.50	33.56	63.98			37,000
Selenium	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	1.00	0.00	1.00			9,400
Silver	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.50	0.00	0.50			9,400
Thallium	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.56	0.18	0.68			150
Vanadium	25	26	22	26	22	24	19	25	32	17	15	28	18	22	23.63	2.45	25.26	125.00		13,000
Zinc	55	80	49	66	160	140	120	160	74	60	93	290	30	43	103.75	46.71	135.04	78.00	106.10	100,000

Notes

1. Title 22 California Code of Regulations metals
2. mg/kg = miligrams per kilogram
3. Industrial preliminary remediation goal listed (Environmental Protection Agency, Region 9, May 1, 1998)
4. NP = not published
5. Background Mean and 95% UCL: Protocol for Determining Background Concentration of Metals in Soil. Lawrence Berkeley National laboratory (1995).
Elements in North American Soils. Dragun, J. and Chiasson, A. (1991)
6. Mean, S.D, and UCL calculated for random samples (R) only

Table 2
Composite Soil Sample Results
PNAs and SVOCs
Pacific Dry Dock Yard I
Oakland, California

Analyte ¹ (mg/kg) ²	Sample Identification															Regulatory Level			
	1a.S	1a.D	1b.S	1b.D	1c.S	1c.D	1d.S	1d.D	4a.S	4a.D	6a.S	6a.D	7a.S	8a.S	9a.S	Mean	S.D.	95%UCL	EPA Region 9
	R	R	R	R	R	R	R	R	T	T	T	T	T	T	T				Industrial PRG ³
Naphthalene	0.15	<0.10	<0.10	<0.10	<0.10	<0.10	0.14	<1.0	<0.10	<0.10	0.48	<0.10	0.15	<0.10	<0.10	0.13	0.16	0.23	190
Acenaphthene	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	1	<1.0	<0.10	<0.10	0.13	<0.10	<0.10	<0.10	<0.10	0.23	0.35	0.46	2,800
Fluorene	0.13	<0.10	<0.10	<0.10	<0.10	<0.10	0.98	1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.1	0.30	0.43	0.58	2,200
Phenanthrene	0.17	<0.10	<0.10	<0.10	<0.10	<0.10	5.3	<1.0	<0.10	<0.10	0.72	<0.10	0.52	<0.10	0.57	0.78	1.83	2.01	NP ⁴
Anthracene	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.46	<1.0	<0.10	<0.10	<0.10	<0.10	0.11	<0.10	0.16	0.16	0.20	0.29	220,000
Fluoranthene	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	2.8	<1.0	<0.10	<0.10	0.76	<0.10	1.1	<0.10	0.65	0.45	0.96	1.09	37,000
Pyrene	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	1.6	<1.0	<0.10	<0.10	0.4	<0.10	6.5	<0.10	0.46	0.30	0.55	0.67	26,000
Benzo(a)anthracene	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.55	<1.0	<0.10	<0.10	0.2	<0.10	1.7	<0.10	0.26	0.17	0.22	0.32	3.6
Chrysene	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.42	<1.0	<0.10	<0.10	0.24	<0.10	2	<0.10	0.3	0.15	0.19	0.28	360
Benzo(b)fluoranthene	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.24	<1.0	<0.10	<0.10	0.21	<0.10	1	<0.10	0.22	0.13	0.16	0.24	3.6
Benzo(k)fluoranthene	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<2.0	<0.20	<0.20	<0.20	<0.20	1.8	<0.20	<0.20	0.21	0.32	0.43	36
Benzo(a)pyrene	<0.035	<0.035	<0.035	<0.035	0.08	<0.035	0.24	<0.35	<0.035	<0.035	0.2	<0.050	3.3	<0.035	0.3	0.07	0.09	0.13	0.36
Indeno(1,2,3-cd)pyrene	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<2.0	<0.20	<0.20	<0.20	<0.20	1.4	<0.20	<0.20	0.21	0.32	0.43	3.6
Dibenzo(ah)anthracene	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<2.0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.21	0.32	0.43	0.36
Benzo(ghi)perylene	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<2.0	<0.20	<0.20	<0.20	<0.20	2	<0.20	<0.20	0.21	0.32	0.43	NP
2-Methylnaphthalene	NA ⁵	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.17	<0.10	NA	NA	NA				NP
Dibenzofuran	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.12	<0.10	NA	NA	NA				3,200

- Notes
1. Only the constituents listed were detected. All other constituents were not detected.
 2. mg/kg = milligrams per kilogram
 3. Industrial preliminary remediation goal listed (Environmental Protection Agency, Region 9, May 1, 1998)
 4. NP = not published
 5. NA = not analyzed
 6. Mean, S.D, and UCL calculated for random samples (R) only

Table 3
Discrete Soil Sample Results
PNAs and SVOCs
Pacific Dry Dock Yard I
Oakland, California

Analyte ¹ (mg/kg) ²	Sample Identification										Regulatory Level		
	1d.1S	1d.2S	1d.3S	6a.1S	6a.2S	7a.1S	7a.2S	9a.1S	9a.2S	Mean	S.D.	95%UCL	EPA Region 9 Industrial PRG ³
	R	R	R	T	T	T	T	T	T				
Naphthalene	<2.5	<2.5	<0.10	<2.5	2.4	<0.10	<2.5	<0.10	<1.0	0.85	0.69	2.02	190
Acenaphthene	<2.5	<2.5	<0.10	<2.5	0.51	<0.10	<2.5	<0.10	<1.0	0.85	0.69	2.02	2,800
Fluorene	<2.5	<2.5	<0.10	<2.5	<0.50	<0.10	<2.5	<0.10	<1.0	0.85	0.69	2.02	2,200
Phenanthrene	<2.5	<2.5	<0.10	<2.5	2.7	<0.10	5.8	<0.10	1.9	0.85	0.69	2.02	NP ⁴
Anthracene	<2.5	<2.5	<0.10	<2.5	<0.50	<0.10	<2.5	<0.10	<1.0	0.85	0.69	2.02	220,000
Fluoranthene	<2.5	<2.5	<0.10	<2.5	1.4	<0.10	7	<0.10	2.1	0.85	0.69	2.02	37,000
Pyrene	<2.5	<2.5	<0.10	<2.5	0.64	<0.10	3.3	<0.10	1.3	0.85	0.69	2.02	26,000
Benzo(a)anthracene	<2.5	<2.5	<0.10	<2.5	<0.50	<0.10	2.6	<0.10	<1.0	0.85	0.69	2.02	3.6
Chrysene	<2.5	<2.5	<0.10	<2.5	<0.50	<0.10	3.4	<0.10	1.3	0.85	0.69	2.02	360
Benzo(b)fluoranthene	<2.5	<2.5	<0.10	<2.5	<0.50	<0.10	<2.5	<0.10	1.5	0.85	0.69	2.02	3.6
Benzo(k)fluoranthene	<5.0	<5.0	<0.20	<5.0	<1.0	<0.20	<5.0	<0.20	<2.0	1.70	1.39	4.04	36
Benzo(a)pyrene	<0.88	<0.88	<0.035	<1.2	<0.25	<0.035	2.5	<0.035	1.2	0.30	0.24	0.71	0.36
Indeno(1,2,3-cd)pyrene	<5.0	<5.0	<0.20	<5.0	<0.20	<0.20	<5.0	<0.20	<2.0	1.70	1.39	4.04	3.6
Dibenzo(ah)anthracene	<5.0	<5.0	<0.20	<5.0	<0.20	<0.20	<5.0	<0.20	<2.0	1.70	1.39	4.04	0.36
Benzo(ghi)perylene	<5.0	<5.0	<0.20	<5.0	<0.20	<0.20	<5.0	<0.20	<2.0	0.92	1.38	3.24	NP
2-Methylnaphthalene	NA ⁵	NA	NA	<2.5	0.67	NA	NA	NA	NA				NP
Dibenzofuran	NA	NA	NA	<2.5	0.6	NA	NA	NA	NA				3,200

Notes

1. Only the constituents listed were detected. All other constituents were not detected.
2. mg/kg = milligrams per kilogram
3. Industrial preliminary remediation goal listed (Environmental Protection Agency, Region 9, May 1, 1998)
4. NP = not published
5. NA = not analyzed
6. Mean, S.D, and UCL calculated for random samples (R) only

Table 4
 Excess Cancer Risks (ECR) and Noncarcinogenic Health Hazards for Onsite Workers Via
 Direct Contact with Soils
 Pacific Dry Dock Yard I
 Oakland, California

Chemical	Cs (mg/kg)	Ir (mg/d)	FI	EF (d/yr)	ED (yr)	CF (d/yr)	AT (yr)	BW (kg)	LADD (mg/kg/d)	SF mg/kg/d-1	ECR
Carcinogens											
Benzo(a)anthracene	2.02E+00	50	0.1	250	25	365	70	70	3.5E-08	7.30E-01	2.6E-08
Chrysene	2.02E+00	50	0.1	250	25	365	70	70	3.5E-08	7.30E-03	2.6E-10
Benzo(b)fluoranthene	2.02E+00	50	0.1	250	25	365	70	70	3.5E-08	7.30E-01	2.6E-08
Benzo(k)fluoranthene	4.04E+00	50	0.1	250	25	365	70	70	7.1E-08	7.30E-02	5.1E-09
Benzo(a)pyrene	7.11E-01	50	0.1	250	25	365	70	70	1.2E-08	7.30E+00	9.1E-08
Indeno(1,2,3-cd)pyrene	4.04E+00	50	0.1	250	25	365	70	70	7.1E-08	7.30E-01	5.1E-08
Dibenzo(ah)anthracene	4.04E+00	50	0.1	250	25	365	70	70	7.1E-08	7.30E+00	5.1E-07
Total ECR:											7.1E-07

Chemical	Cs (mg/kg)	Ir (mg/d)	FI	EF (d/yr)	ED (yr)	CF (d/yr)	AT (yr)	BW (kg)	ADD (mg/kg/d)	RfD mg/kg	HQ
Noncarcinogenic Effects											
Copper	8.97E+01	50	0.1	250	25	365	25	70	4.4E-06	3.70E-02	1.19E-04
Mercury	8.00E-01	50	0.1	250	25	365	25	70	3.9E-08	3.00E-04	1.30E-04
Zinc	1.35E+02	50	0.1	250	25	365	25	70	6.6E-06	5.00E-02	1.32E-04
Naphthalene	2.02E+00	50	0.1	250	25	365	25	70	9.9E-08	2.00E-02	4.94E-06
Acenaphthene	2.02E+00	50	0.1	250	25	365	25	70	9.9E-08	6.00E-02	1.65E-06
Fluorene	2.02E+00	50	0.1	250	25	365	25	70	9.9E-08	4.00E-02	2.47E-06
Anthracene	2.02E+00	50	0.1	250	25	365	25	70	9.9E-08	3.00E-01	3.29E-07
Fluoranthene	2.02E+00	50	0.1	250	25	365	25	70	9.9E-08	4.00E-02	2.47E-06
Pyrene	2.02E+00	50	0.1	250	25	365	25	70	9.9E-08	3.00E-02	3.29E-06
Dibenzofuran	2.02E+00	50	0.1	250	25	365	25	70	9.9E-08	4.00E-03	2.47E-05
Hazard Index:											0.00042

Table 5
Lead Risk Assessment
Pacific Dry Dock Repair Company Yard I
Oakland, California

INPUT		OUTPUT							
MEDIUM	LEVEL	percentiles					PRG-99	PRG-95	
		50th	90th	95th	98th	99th	(ug/g)	(ug/g)	
LEAD IN AIR (ug/m ³)	0.15								
LEAD IN SOIL (ug/g)	76.0	BLOOD Pb, ADULT (ug/dl)	2.0	3.2	3.6	4.2	4.6	3417.3	5102.9
LEAD IN WATER (ug/l)	15	BLOOD Pb, CHILD (ug/dl)	3.6	5.7	6.5	7.5	8.2	264.7	558.5
PLANT UPTAKE? 1=YES 0=	0	BLOOD Pb, PICA CHILD (ug/dl)	7.6	11.9	13.5	15.6	17.1	19.5	41.1
(ug/m ³)	50	BLOOD Pb, INDUSTRIAL (ug/dl)	1.9	3.0	3.4	4.0	4.4	4262.5	6306.5

EXPOSURE PARAMETERS

units	residential		industrial	
	adults	children	children with pica	adults

General

Days per week	days/wk	7	7	7	5
---------------	---------	---	---	---	---

Dermal Contact

Skin area	cm ²	3700	2800	2800	5800
Soil adherence	mg/cm ²	0.5	0.5	0.5	0.5
Route-specific constant	(ug/dl)/(ug/day)	0.00011	0.00011	0.00011	0.00011

Soil ingestion

Soil ingestion	mg/day	25	55	790	25
Route-specific constant	(ug/dl)/(ug/day)	0.0176	0.0704	0.0704	0.0176

Inhalation

Breathing rate	m ³ /day	20	10	10	20
Route-specific constant	(ug/dl)/(ug/day)	0.082	0.192	0.192	0.082

Water ingestion

Water ingestion	l/day	1.4	0.4	0.4	1.4
Route-specific constant	(ug/dl)/(ug/day)	0.04	0.16	0.16	0.04

Food ingestion

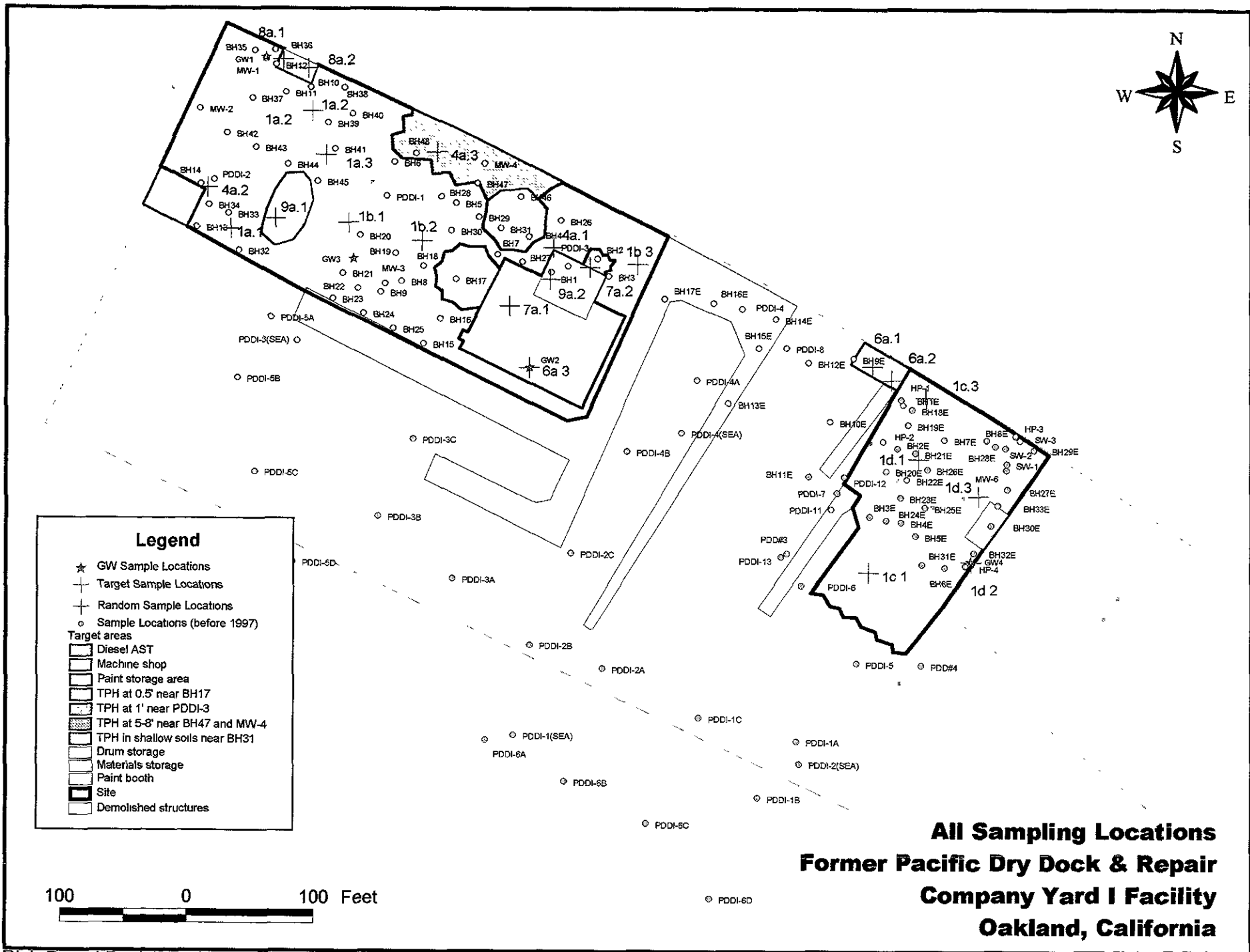
Food ingestion	kg/day	2.2	1.3	1.3	2.2
Route-specific constant	(ug/dl)/(ug/day)	0.04	0.16	0.16	0.04
Dietary concentration	ug/kg	10.0	10.0	10.0	10.0
Lead in produce	ug/kg	10.0	10.0	10.0	

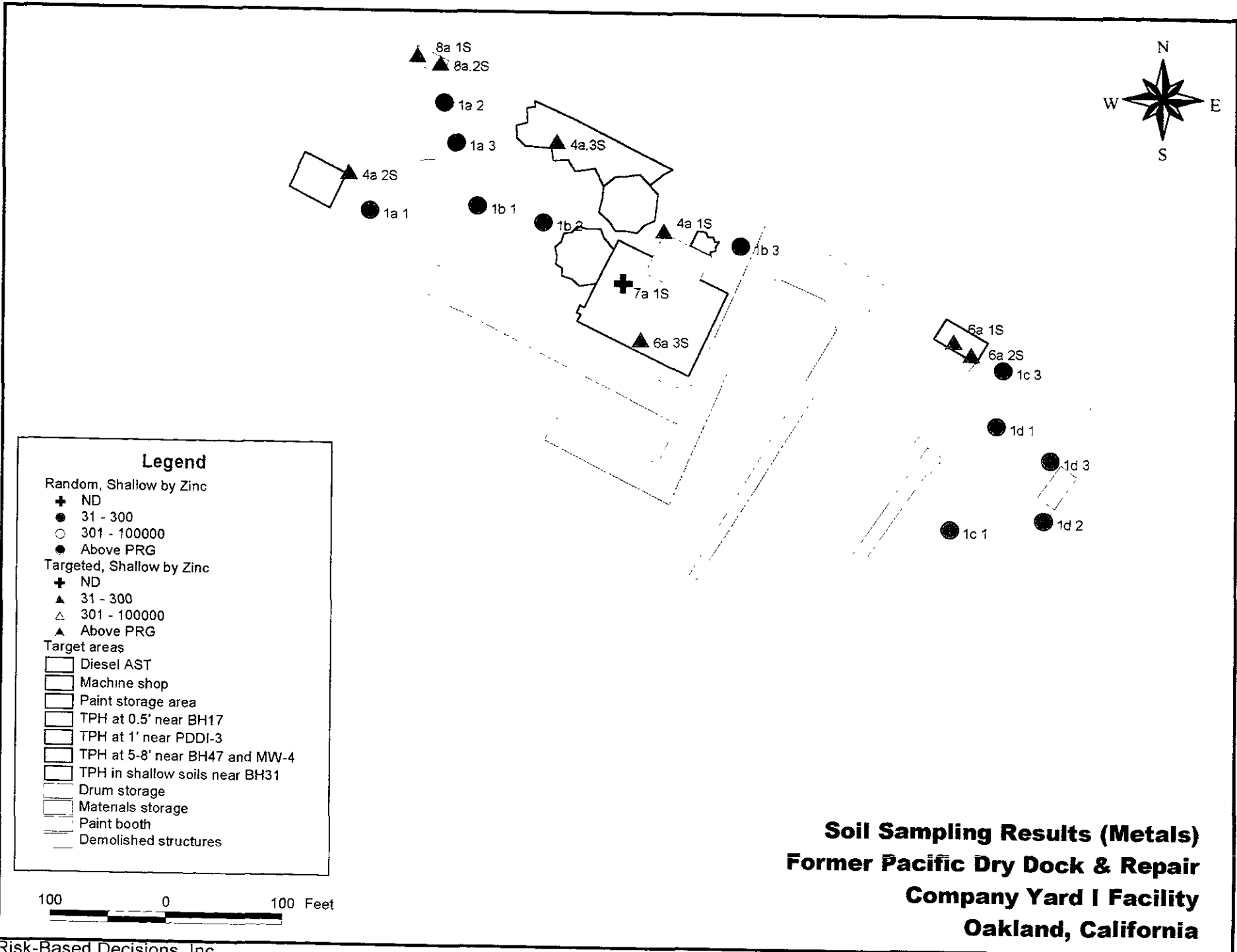
PATHWAYS, ADULTS

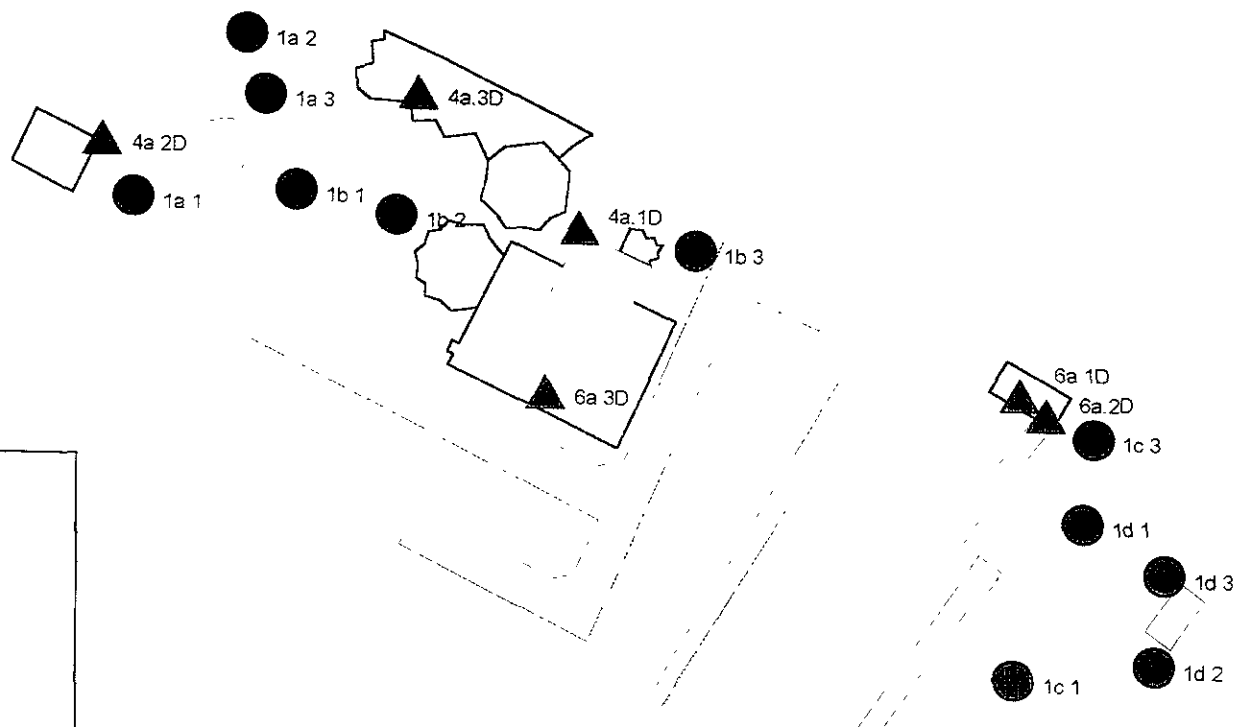
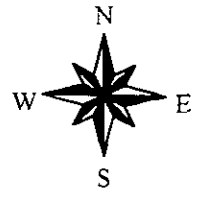
Pathway	Residential		Industrial		concentration in medium
	Blood Pb ug/dl	percent of total	Blood Pb ug/dl	percent of total	
SOIL CONTACT:	0.01	1%	0.02	1%	76 ug/g
SOIL INGESTION:	0.03	2%	0.02	1%	76 ug/g
INHALATION:	0.25	12%	0.18	9%	0.15 ug/m ³
WATER INGESTION:	0.84	42%	0.84	43%	15 ug/l
FOOD INGESTION:	0.88	44%	0.88	45%	10.0 ug Pb/kg diet

PATHWAYS, CHILDREN

Pathway	Typical		with pica		concentration in medium
	Blood Pb ug/dl	percent of total	Blood Pb ug/dl	percent of total	
SOIL CONTACT:	0.01	0%	0.01	0%	76 ug/g
SOIL INGESTION:	0.29	8%	4.23	58%	76 ug/g
INHALATION:	0.30	8%	0.30	4%	0.15 ug/m ³
WATER INGESTION:	0.96	26%	0.96	13%	15 ug/l
FOOD INGESTION:	2.08	57%	2.08	27%	10.0 ug Pb/kg diet







Legend

Random, Deep by Zinc

- ND
- 31 - 300
- 301 - 100000
- Above PRG

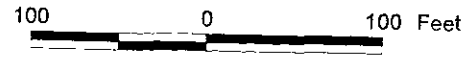
Targeted, Deep by Zinc

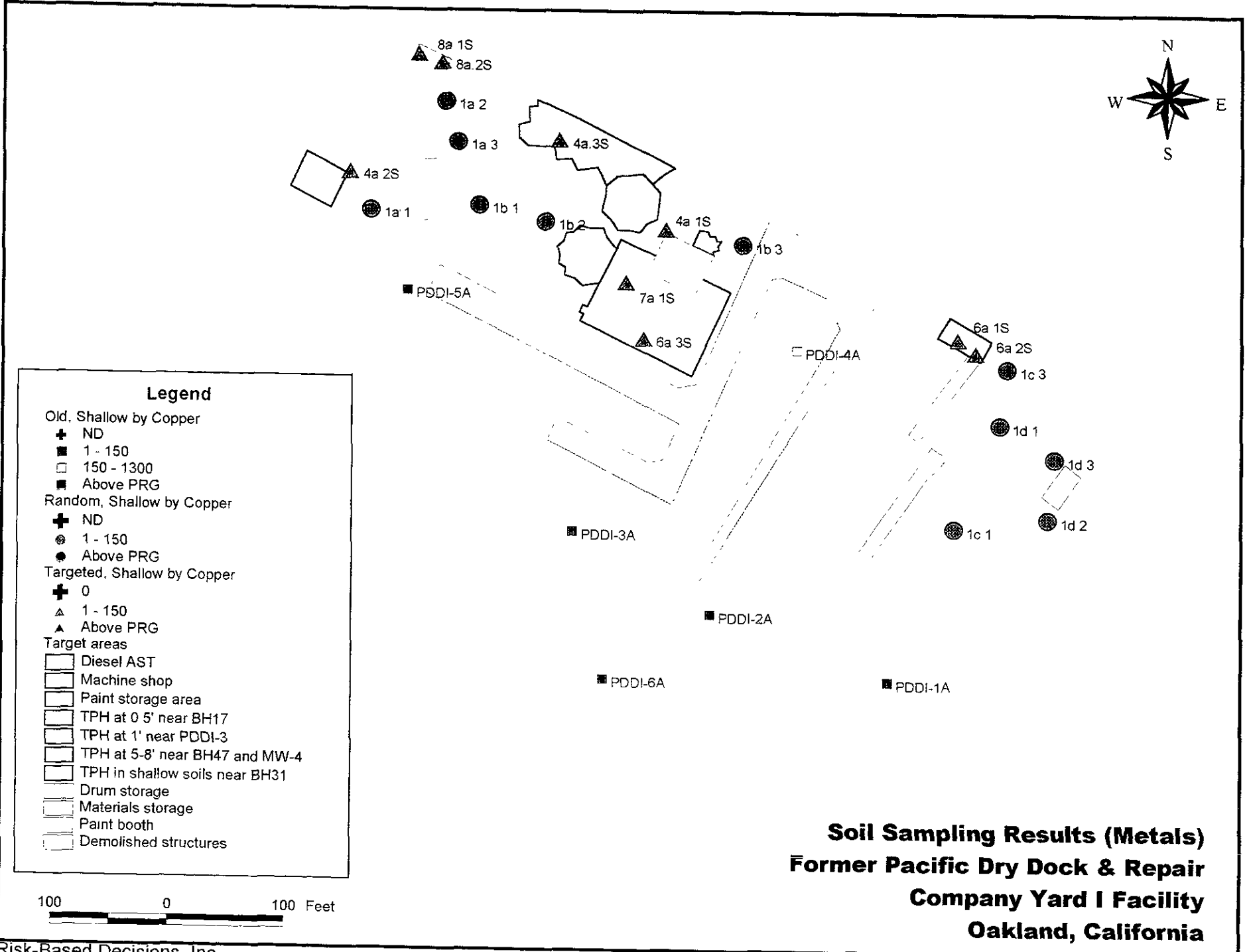
- ND
- 31 - 300
- 301 - 100000
- Above PRG

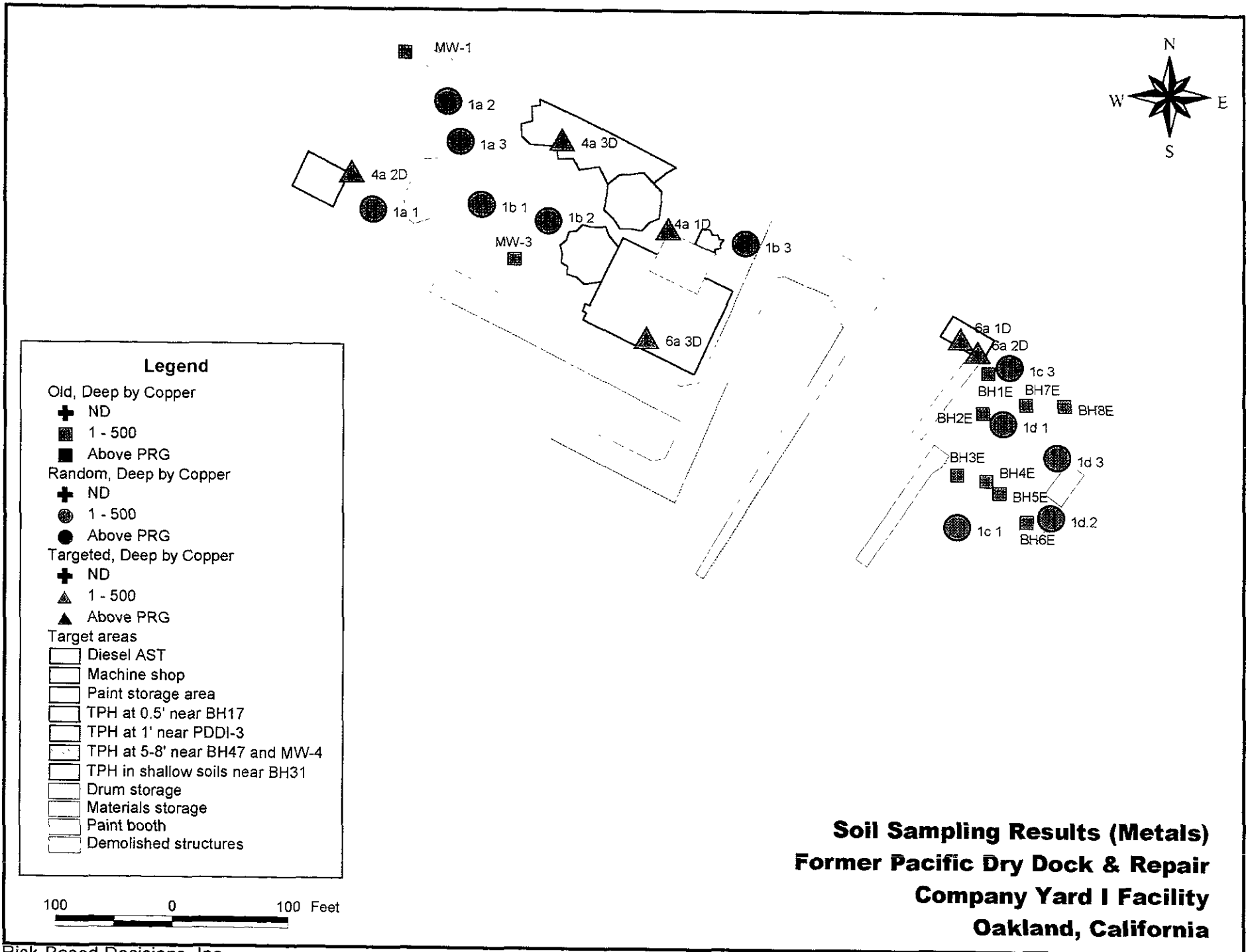
Target areas

- Diesel AST
- Machine shop
- Paint storage area
- TPH at 0.5' near BH17
- TPH at 1' near PDDI-3
- TPH at 5-8' near BH47 and MW-4
- TPH in shallow soils near BH31
- Drum storage
- Materials storage
- Paint booth
- Demolished structures

**Soil Sampling Results (Metals)
Former Pacific Dry Dock & Repair
Company Yard I Facility
Oakland, California**





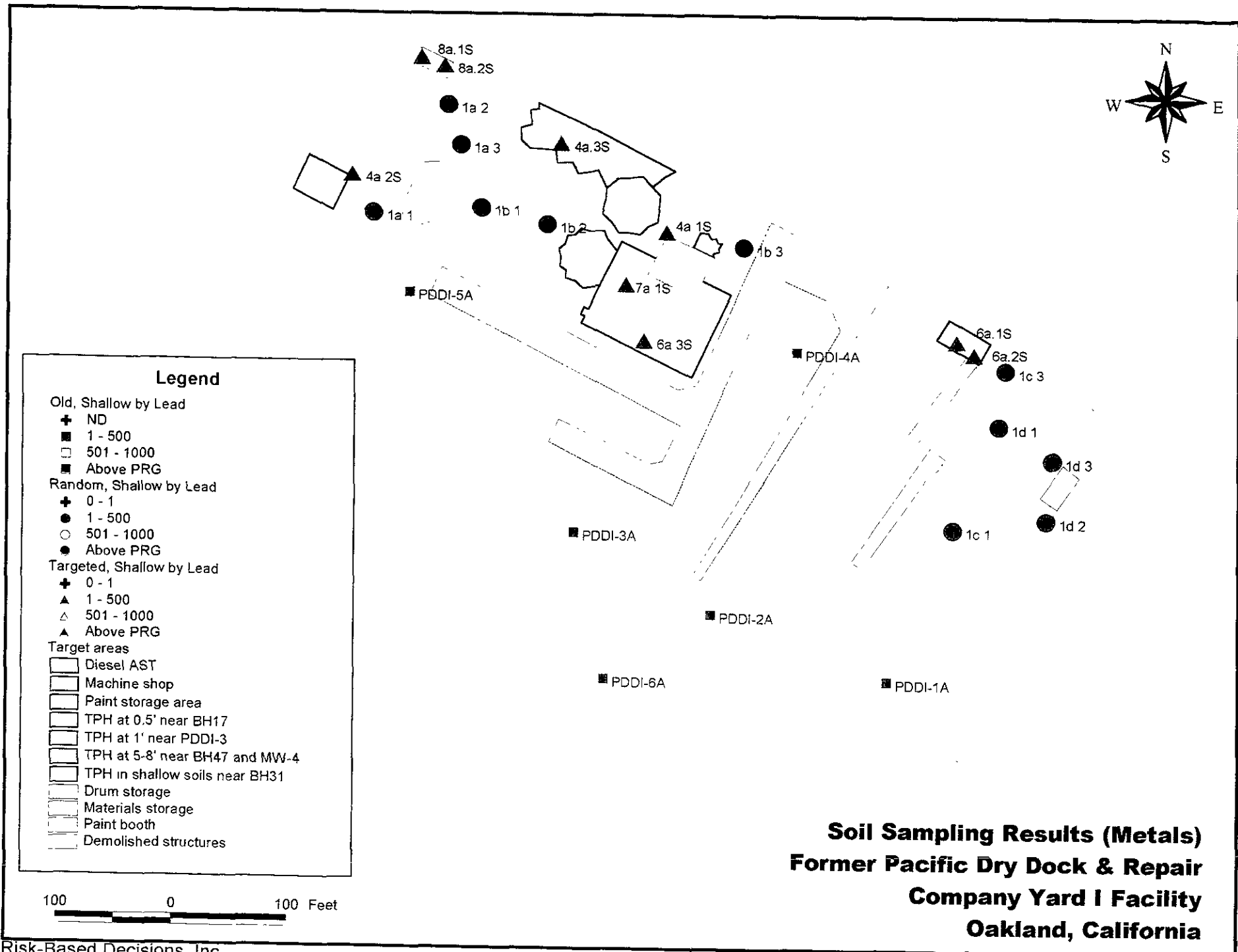


Legend

- Old, Deep by Copper
 - ND
 - 1 - 500
 - Above PRG
- Random, Deep by Copper
 - ND
 - 1 - 500
 - Above PRG
- Targeted, Deep by Copper
 - ND
 - 1 - 500
 - Above PRG
- Target areas
 - Diesel AST
 - Machine shop
 - Paint storage area
 - TPH at 0.5' near BH17
 - TPH at 1' near PDDI-3
 - TPH at 5-8' near BH47 and MW-4
 - TPH in shallow soils near BH31
 - Drum storage
 - Materials storage
 - Paint booth
 - Demolished structures

**Soil Sampling Results (Metals)
Former Pacific Dry Dock & Repair
Company Yard I Facility
Oakland, California**

100 0 100 Feet



Legend

Old, Shallow by Lead

- + ND
- 1 - 500
- 501 - 1000
- Above PRG

Random, Shallow by Lead

- + 0 - 1
- 1 - 500
- 501 - 1000
- Above PRG

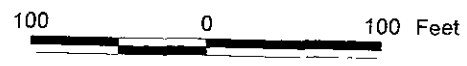
Targeted, Shallow by Lead

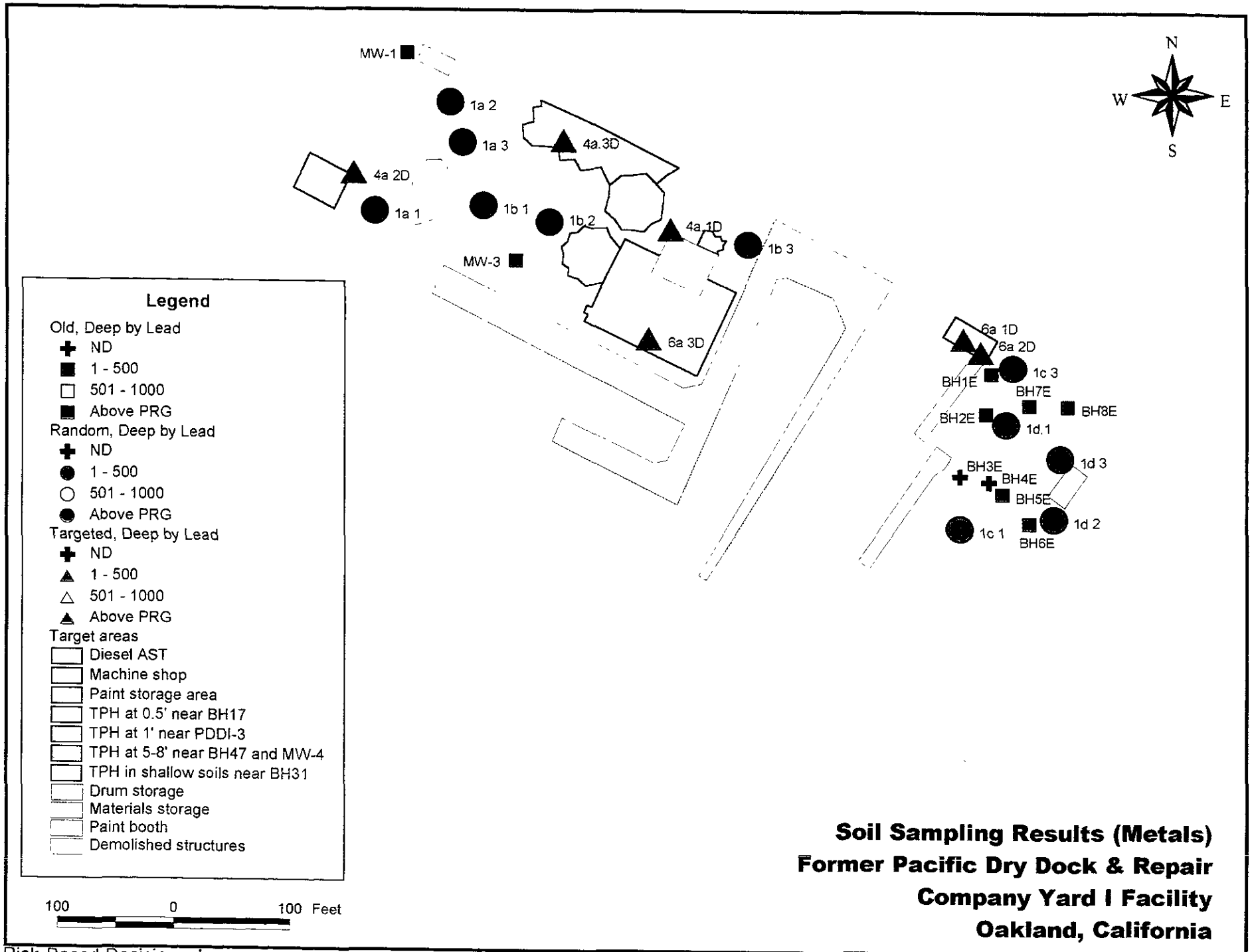
- + 0 - 1
- ▲ 1 - 500
- △ 501 - 1000
- ▲ Above PRG

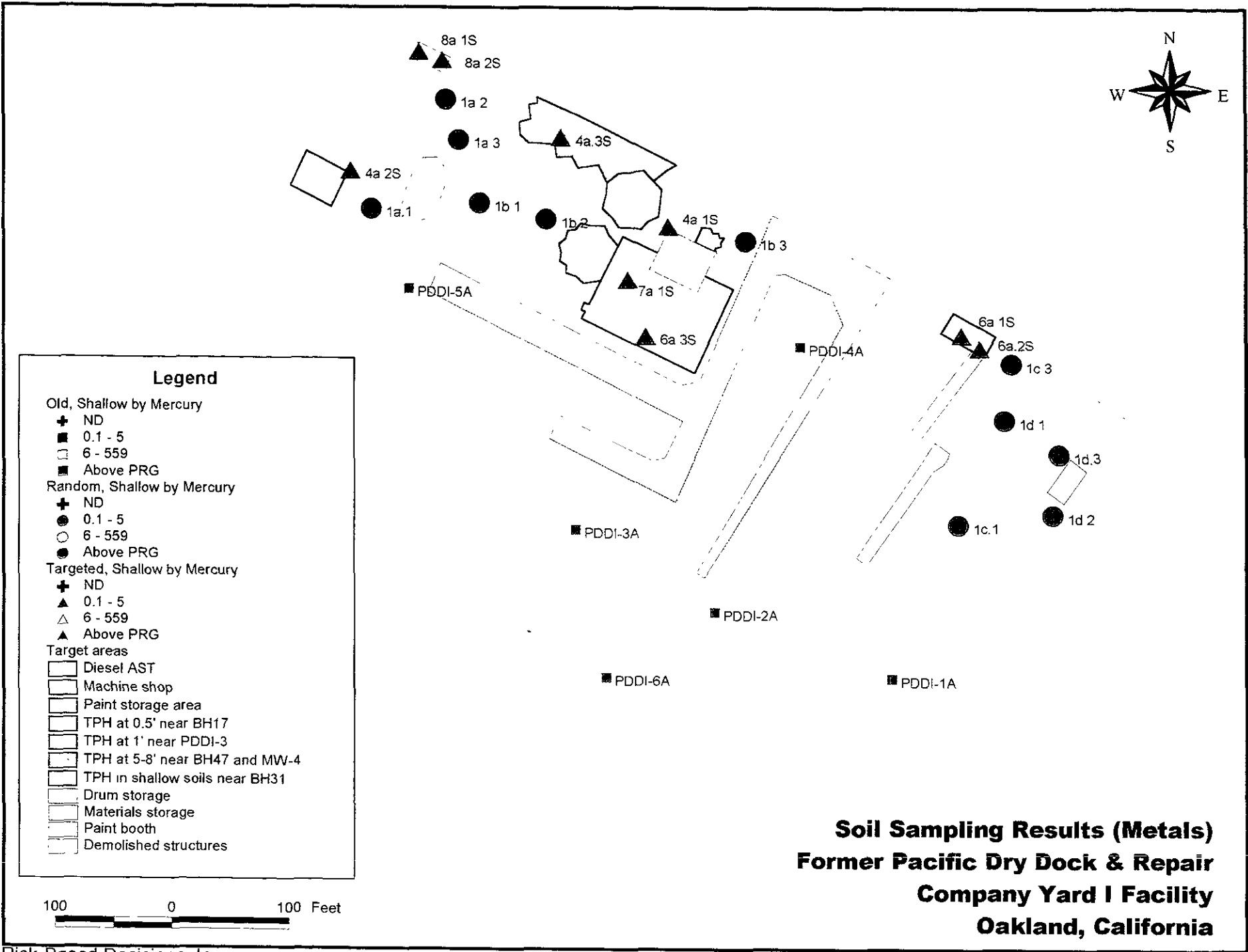
Target areas

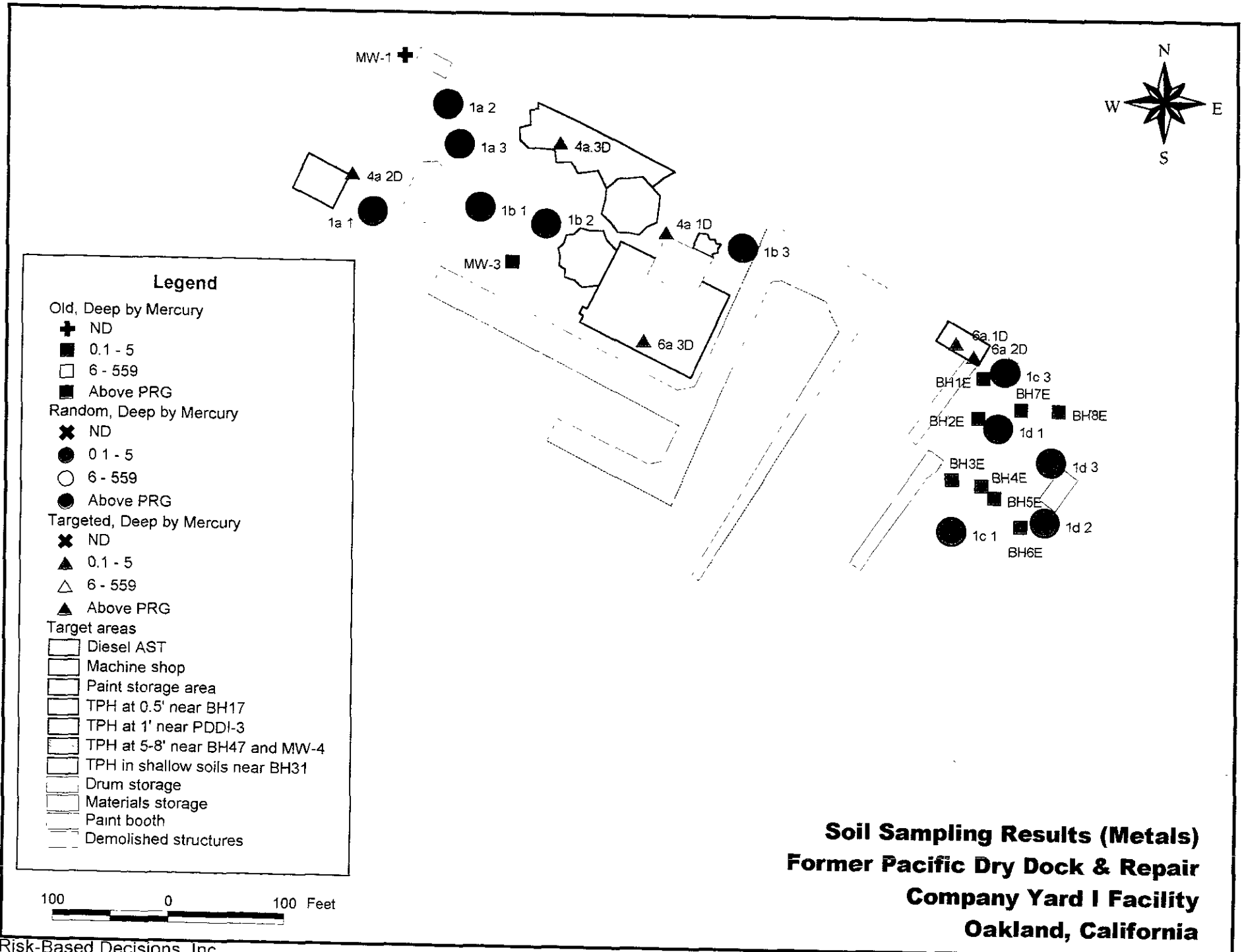
- Diesel AST
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- TPH in shallow soils near BH31
- Drum storage
- Materials storage
- Paint booth
- Demolished structures

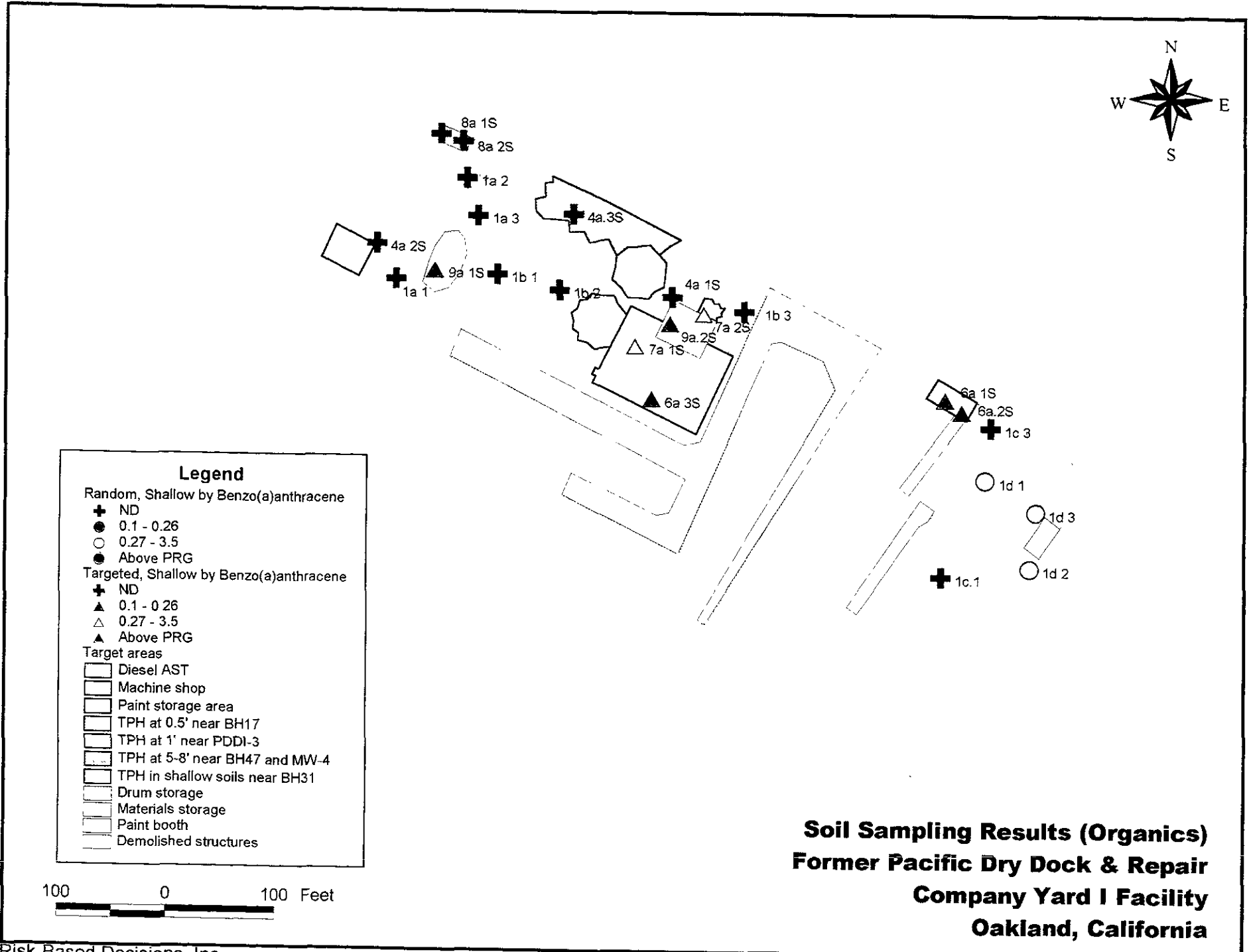
**Soil Sampling Results (Metals)
Former Pacific Dry Dock & Repair
Company Yard I Facility
Oakland, California**

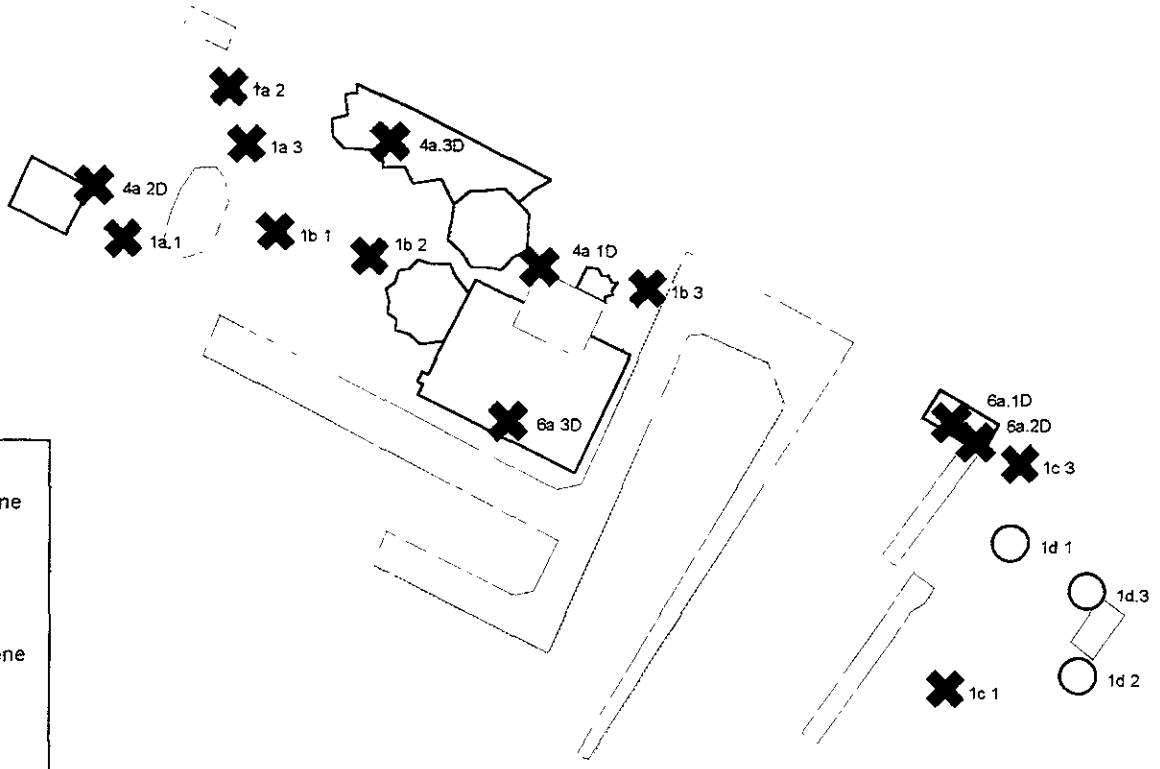
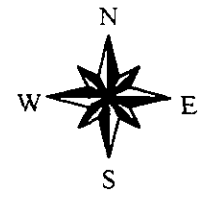












Legend

Random, Deep by Benzo(a)anthracene

- ✕ ND
- 0.1 - 0.26
- 0.27 - 3.5
- Above PRG

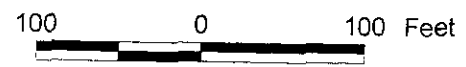
Targeted, Deep by Benzo(a)anthracene

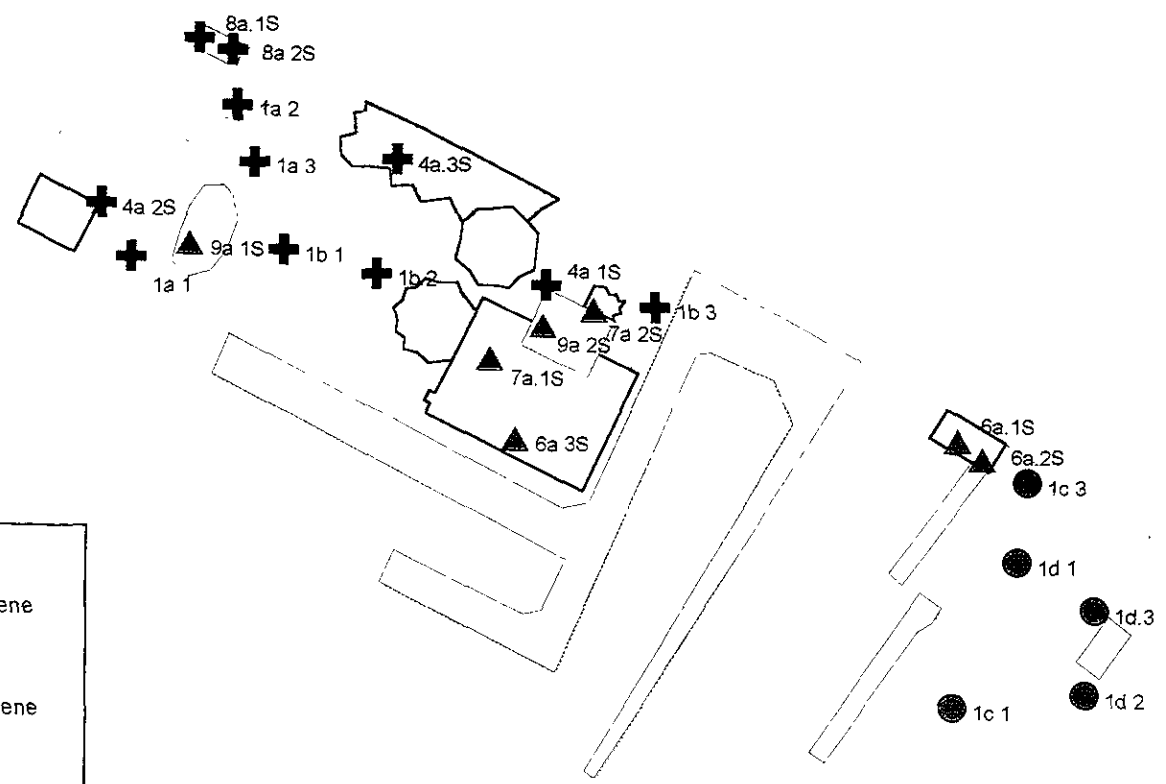
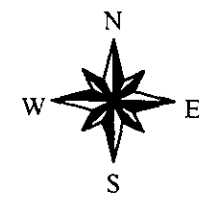
- ✕ ND
- ▲ 0.1 - 0.26
- △ 0.27 - 3.5
- ▲ Above PRG

Target areas

- Diesel AST
- Machine shop
- Paint storage area
- TPH at 0.5' near BH17
- TPH at 1' near PDDI-3
- TPH at 5-8' near BH47 and MW-4
- TPH in shallow soils near BH31
- Drum storage
- Materials storage
- Paint booth
- Demolished structures

**Soil Sampling Results (Organics)
Former Pacific Dry Dock & Repair
Company Yard I Facility
Oakland, California**





Legend

Random, Shallow by Benzo(a)pyrene

- + ND
- 0.035 - 0.35
- Above PRG

Targeted, Shallow by Benzo(a)pyrene

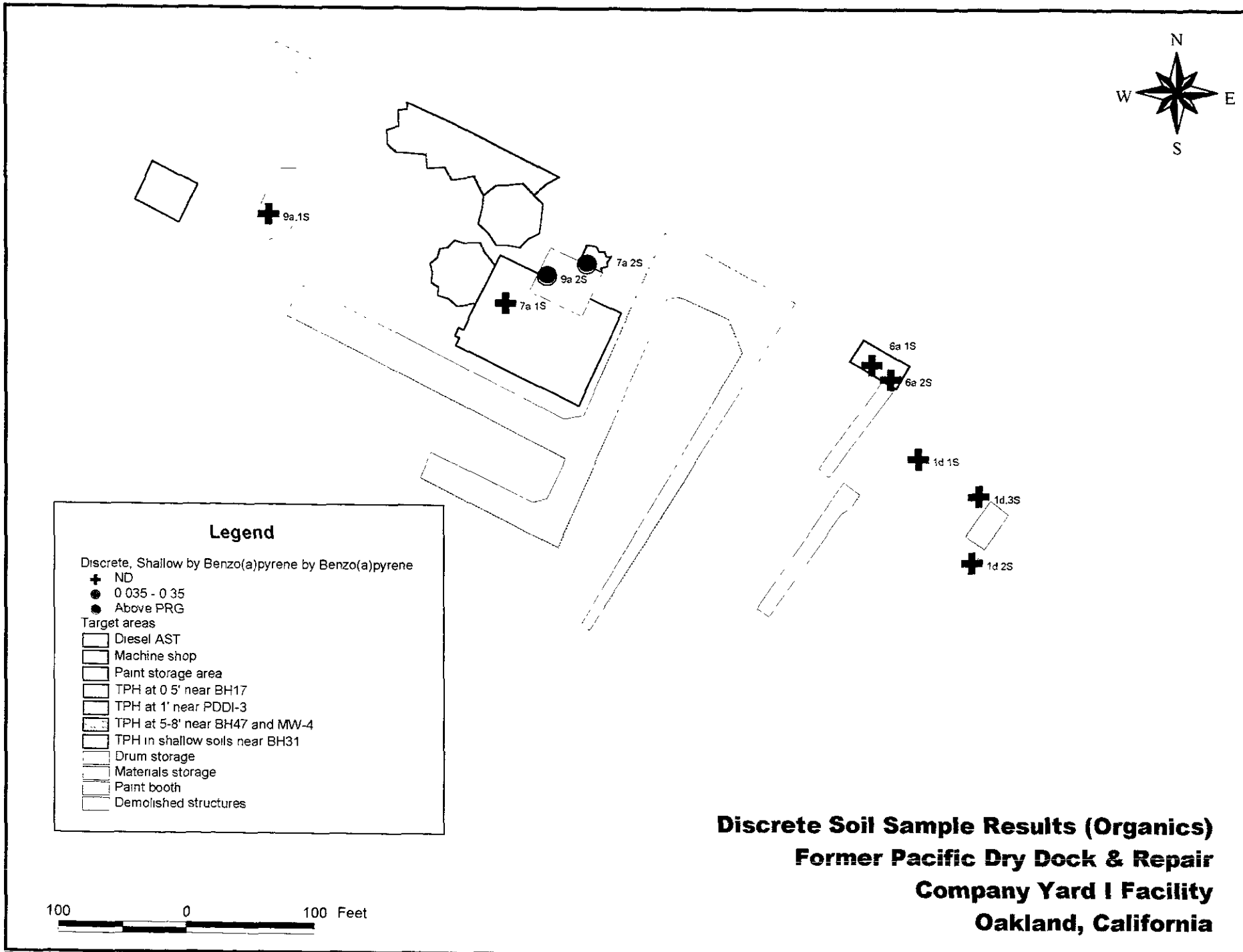
- + ND
- ▲ 0.035 - 0.35
- ▲ Above PRG

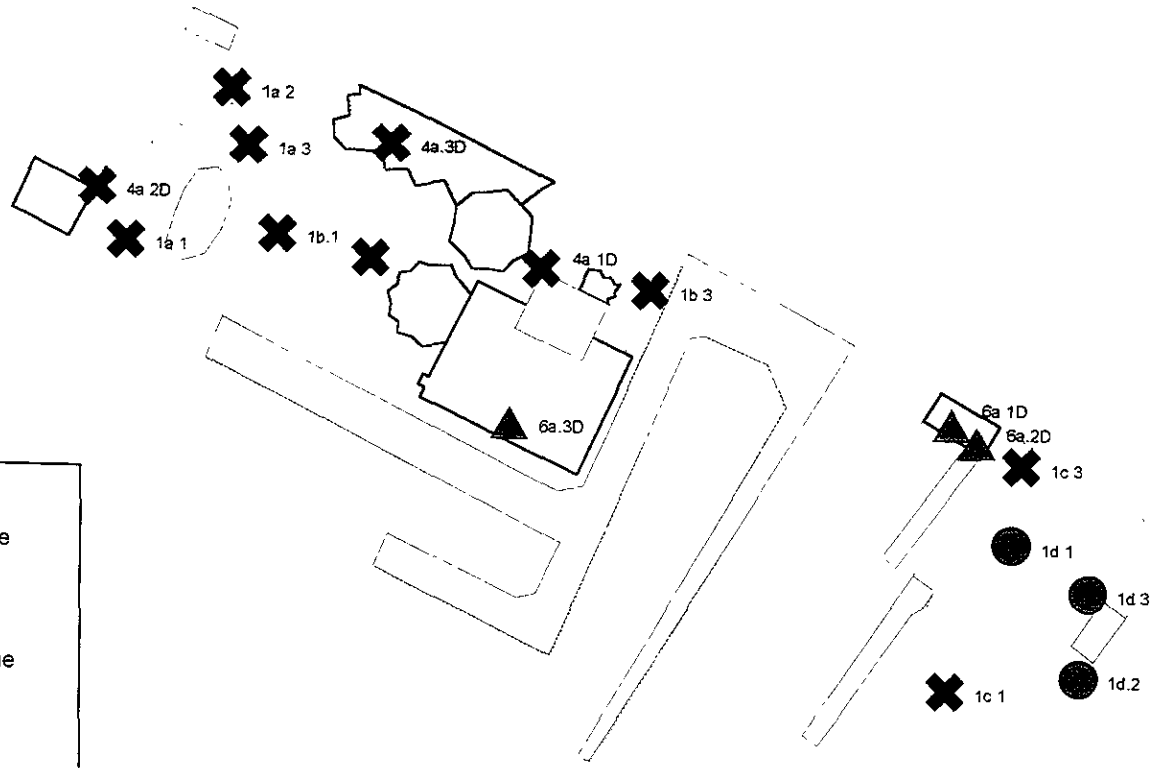
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**Soil Sampling Results (Organics)
Former Pacific Dry Dock & Repair
Company Yard I Facility
Oakland, California**







Legend

Random, Deep by Benzo(a)pyrene

- ✕ ND
- 0.035 - 0.35
- Above PRG

Targeted, Deep by Benzo(a)pyrene

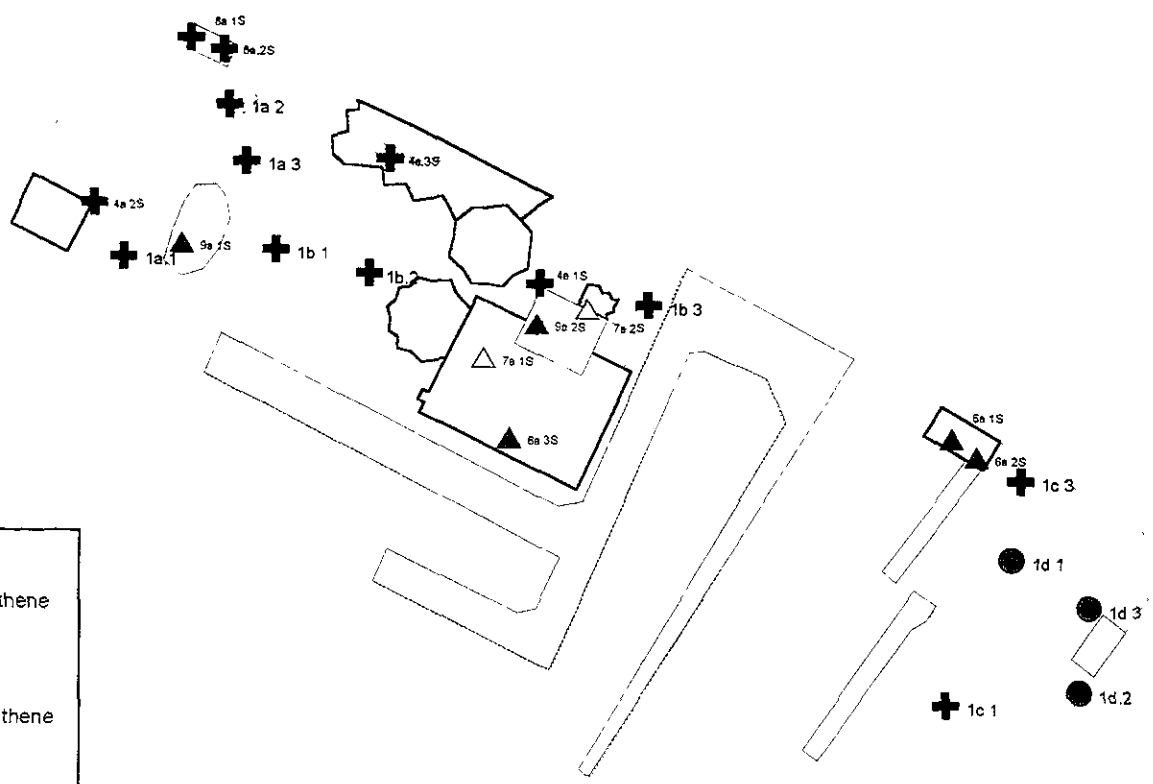
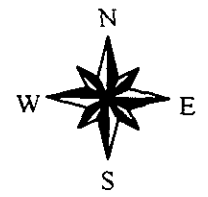
- ✕ ND
- ▲ 0.035 - 0.35
- ▲ Above PRG

Target areas

- Diesel AST
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- Paint booth
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**Soil Sampling Results (Organics)
Former Pacific Dry Dock & Repair
Company Yard I Facility
Oakland, California**



Legend

Random, Shallow by Benzo(b)fluoranthene

- + ND
- 0.1 - 0.26
- 0.26 - 3.5
- Above PRG

Targeted, Shallow by Benzo(b)fluoranthene

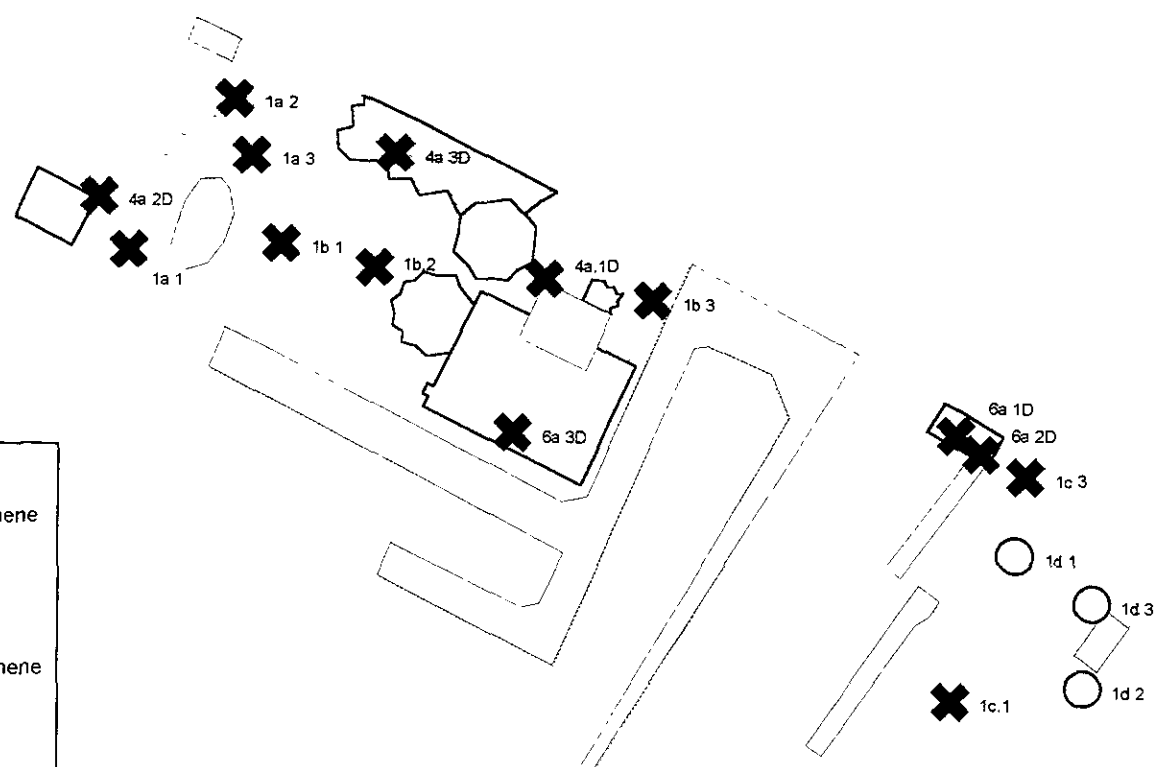
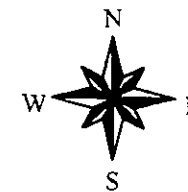
- + ND
- ▲ 0.1 - 0.35
- △ 0.35 - 3.5
- ▲ Above PRG

Target areas

- Diesel AST
- Machine shop
- Paint storage area
- TPH at 0.5' near BH17
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- Drum storage
- Materials storage
- Paint booth
- Demolished structures



**Soil Sampling Results (Organics)
Former Pacific Dry Dock & Repair
Company Yard I Facility
Oakland, California**



Legend

Random, Deep by Benzo(b)fluoranthene

- ✕ ND
- 0.1 - 0.35
- 0.35 - 3.5
- Above PRG

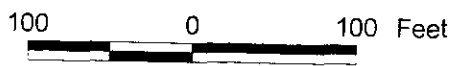
Targeted, Deep by Benzo(b)fluoranthene

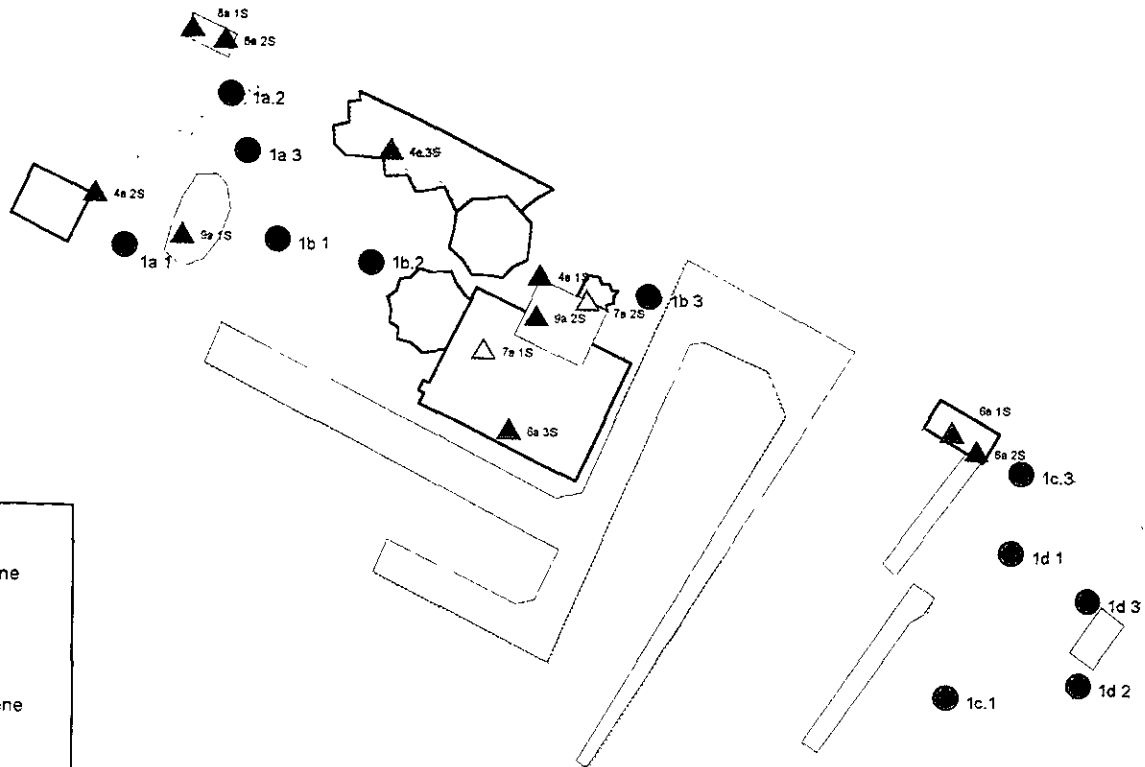
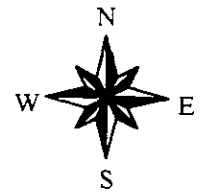
- ✕ ND
- ▲ 0.1 - 0.35
- △ 0.35 - 3.5
- ▲ Above PRG

Target areas

- ▭ Diesel AST
- ▭ Machine shop
- ▭ Paint storage area
- ▭ TPH at 0.5' near BH17
- ▭ TPH at 1' near PDDI-3
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- ▭ Drum storage
- ▭ Materials storage
- ▭ Paint booth
- ▭ Demolished structures

**Soil Sampling Results (Organics)
Former Pacific Dry Dock & Repair
Company Yard I Facility
Oakland, California**





Legend

Random, Shallow by Benzo(k)fluoranthene

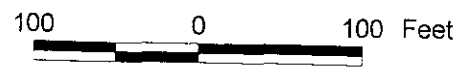
- + ND
- 0.1 - 0.35
- 0.36 - 3.5
- 3.6 - 35
- Above PRG

Targeted, Shallow by Benzo(k)fluoranthene

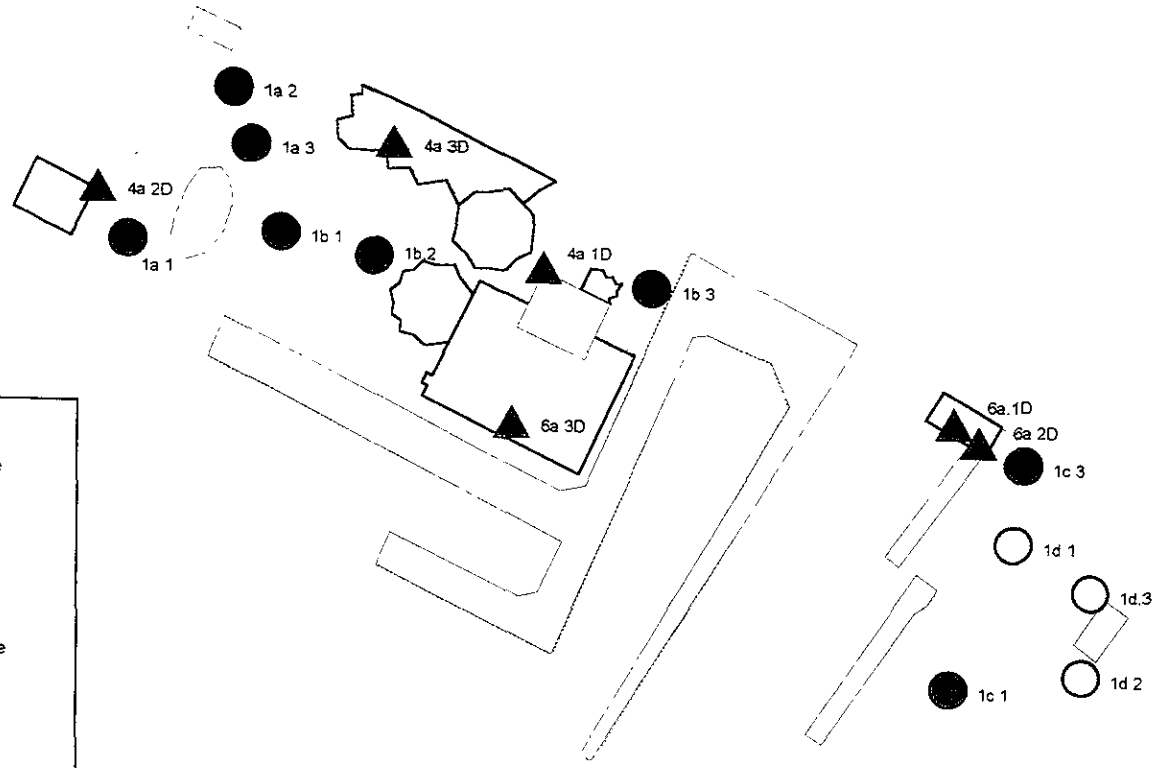
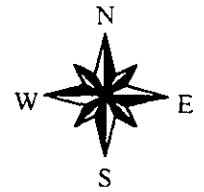
- + ND
- ▲ 0.1 - 0.35
- △ 0.36 - 3.5
- △ 3.6 - 35
- ▲ Above PRG

Target areas

- ▭ Diesel AST
- ▭ Machine shop
- ▭ Paint storage area
- ▭ TPH at 0.5' near BH17
- ▭ TPH at 1' near PDDI-3
- ▭ TPH at 5-8' near BH47 and MW-4
- ▭ TPH in shallow soils near BH31
- ▭ Drum storage
- ▭ Materials storage
- ▭ Paint booth
- ▭ Demolished structures



**Soil Sampling Results (Organics)
Former Pacific Dry Dock & Repair
Company Yard I Facility
Oakland, California**



Legend

Random, Deep by Benzo(k)fluoranthene

- ✕ ND
- 0.1 - 0.35
- 0.36 - 3.5
- 3.6 - 35
- Above PRG

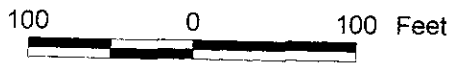
Targeted, Deep by Benzo(k)fluoranthene

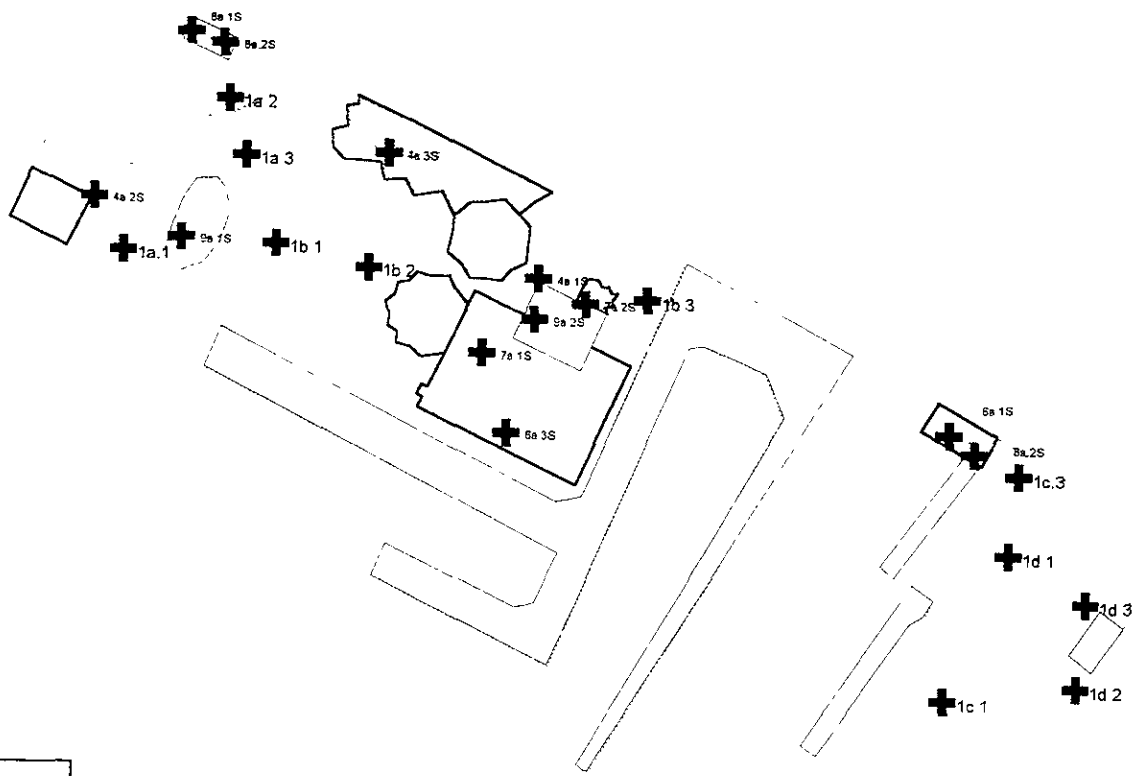
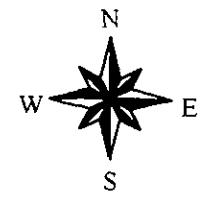
- ✕ ND
- ▲ 0.1 - 0.35
- △ 0.36 - 3.5
- △ 3.6 - 35
- ▲ Above PRG

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**Soil Sampling Results (Organics)
Former Pacific Dry Dock & Repair
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Oakland, California**





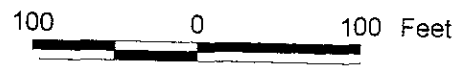
Legend

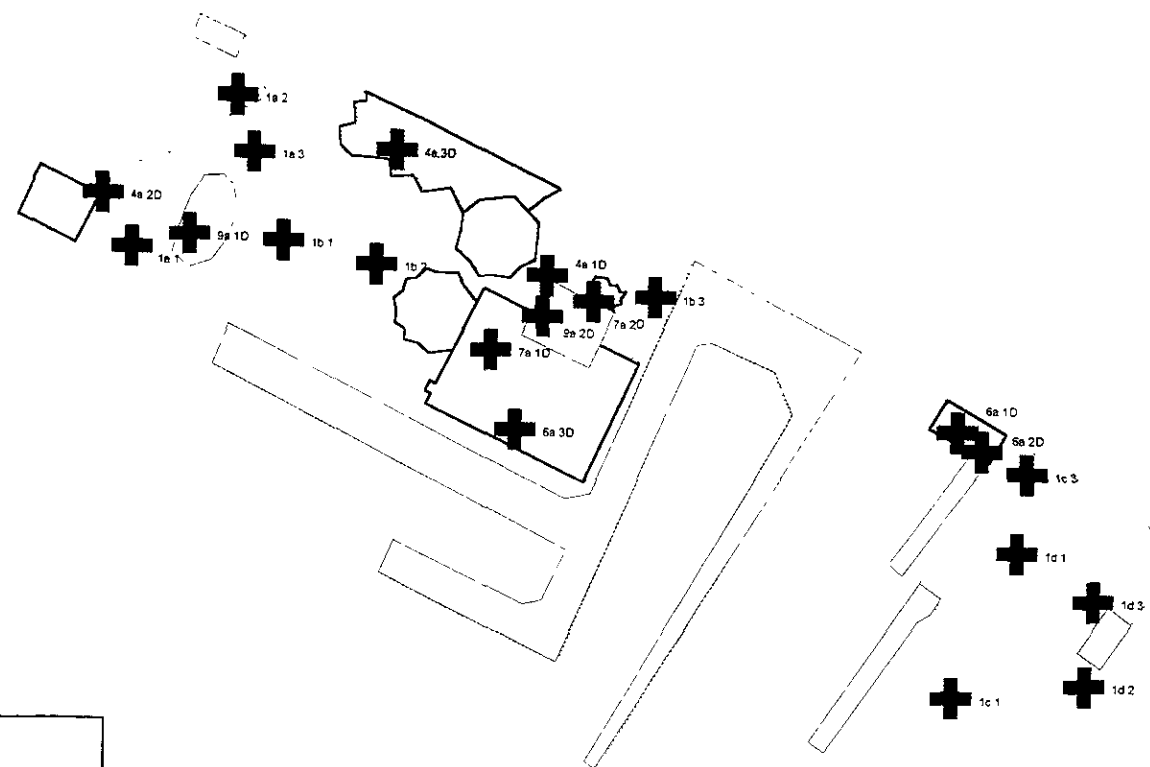
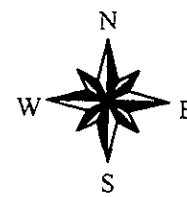
- ✦ ND Random, Shallow by Dibenzo(ah)anthracen
- ✦ ND Targeted, Shallow by Dibenzo(ah)anthracen

Target areas

- ▭ Diesel AST
- ▭ Machine shop
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**Soil Sampling Results (Organics)
Former Pacific Dry Dock & Repair
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Oakland, California**





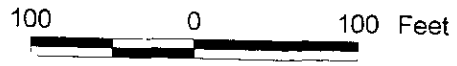
Legend

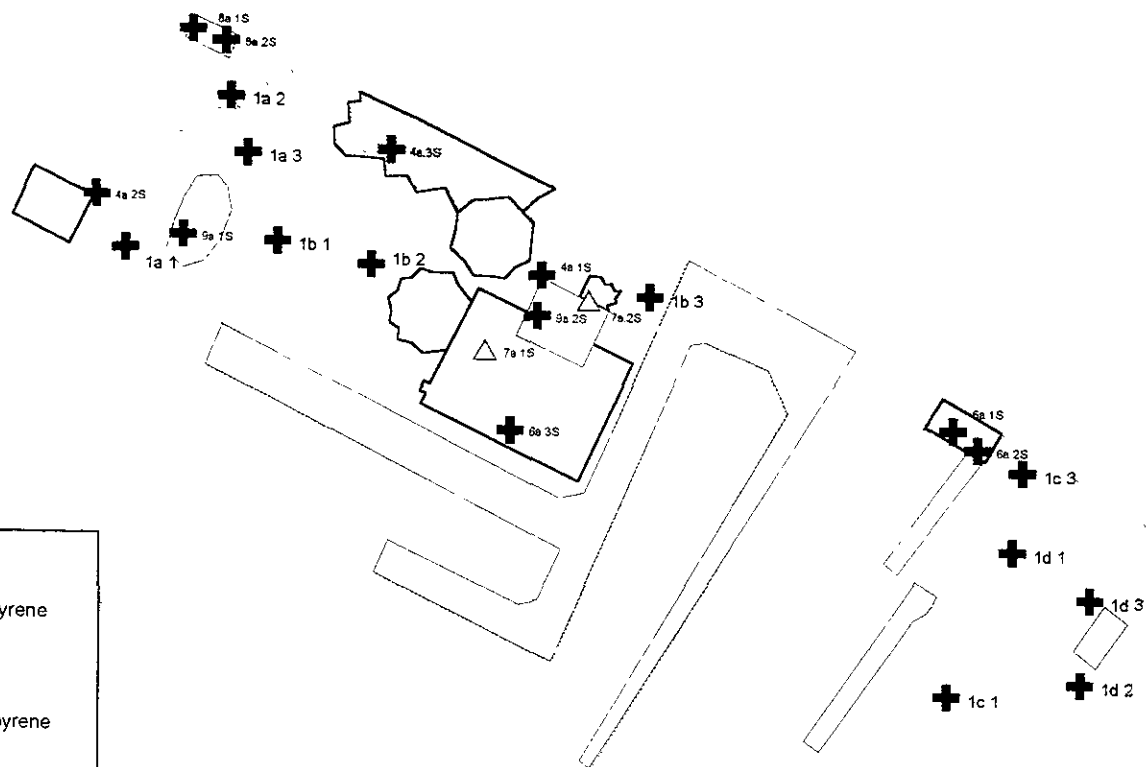
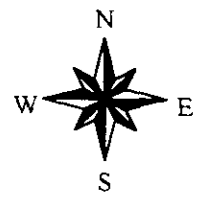
- ⊕ ND Random, Deep by Dibenzo(ah)anthracen
- ⊕ ND Targeted, Deep by Dibenzo(ah)anthracen

Target areas

- ☐ Diesel AST
- ☐ Machine shop
- ☐ Paint storage area
- ☐ TPH at 0.5' near BH17
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- ☐ Materials storage
- ☐ Paint booth
- ☐ Demolished structures

**Soil Sampling Results (Organics)
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Oakland, California**





Legend

Random, Shallow by Indeno(1,2,3-cd)pyrene

- + ND
- 0.2 - 0.35
- 0.36 - 3.5
- Above PRG

Targeted, Shallow by Indeno(1,2,3-cd)pyrene

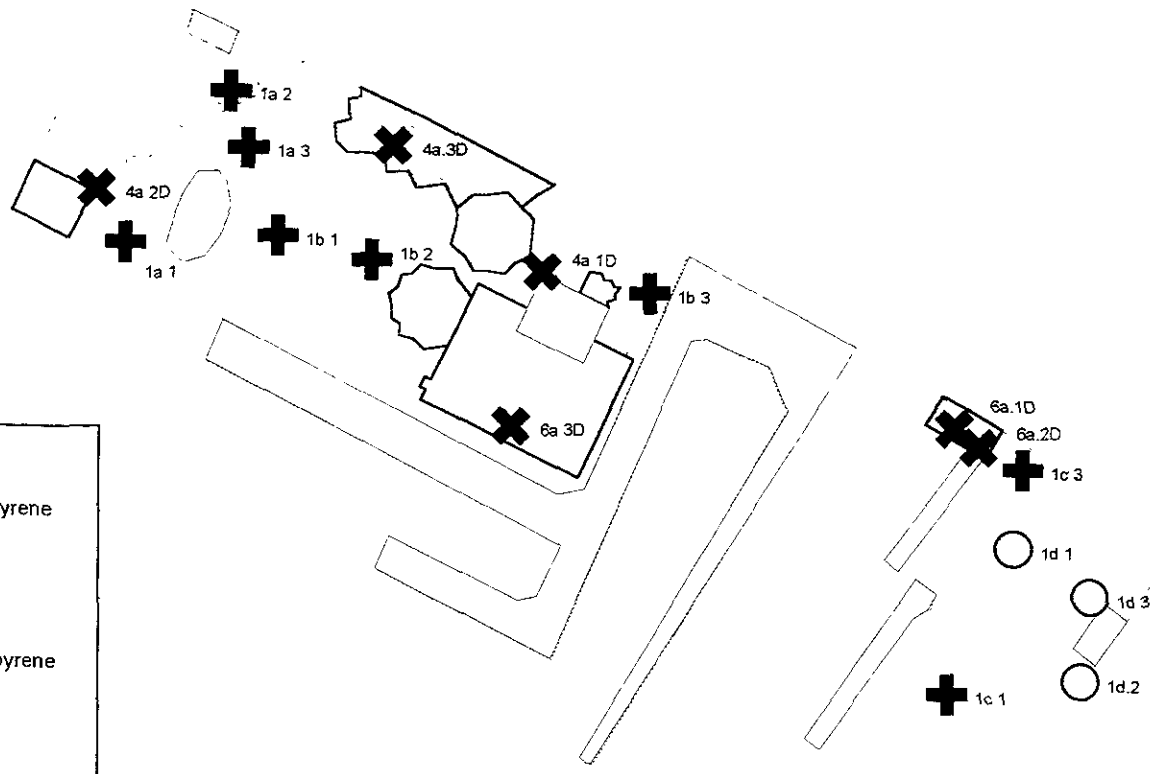
- + ND
- △ 0.2 - 0.35
- △ 0.36 - 3.5
- ▲ Above PRG

Target areas

- Diesel AST
- Machine shop
- Paint storage area
- TPH at 0.5' near BH17
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Soil Sampling Results (Organics)
Former Pacific Dry Dock & Repair
Company Yard I Facility
Oakland, California





Legend

Random, Deep by Indeno(1,2,3-cd)pyrene

- ⊕ ND
- 0.2 - 0.35
- 0.36 - 3.5
- Above PRG

Targeted, Deep by Indeno(1,2,3-cd)pyrene

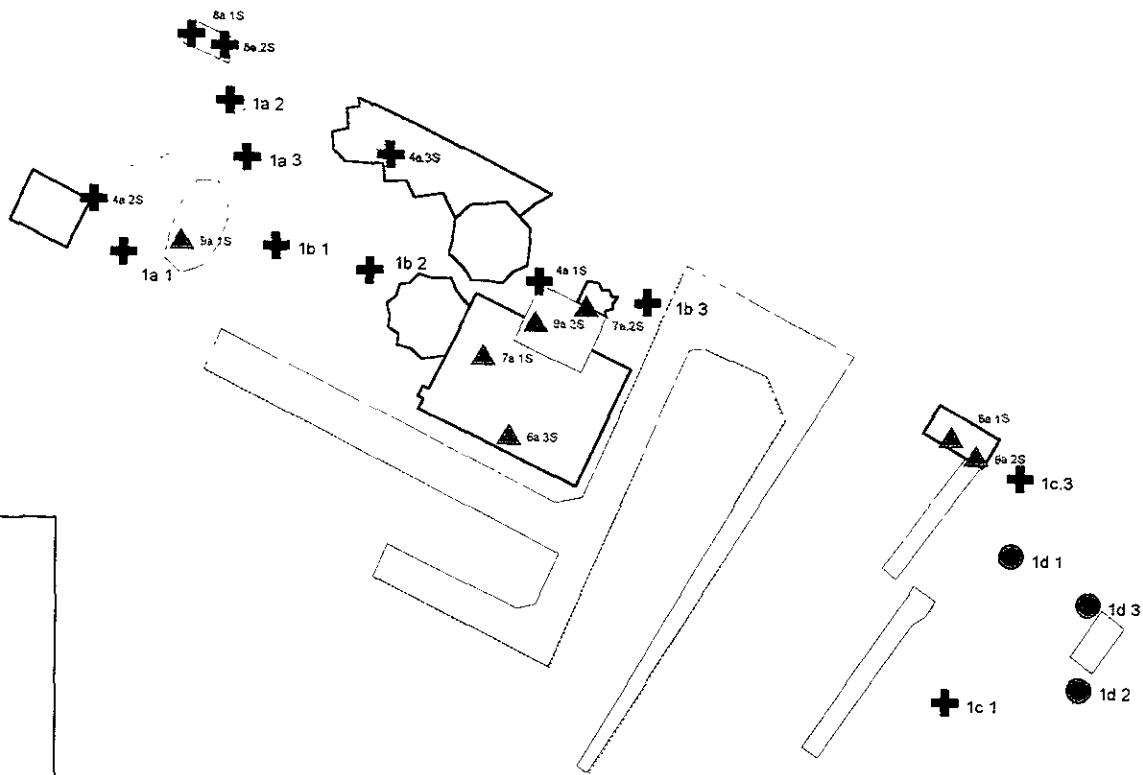
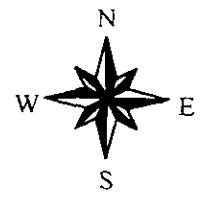
- ⊗ ND
- ▲ 0.2 - 0.35
- △ 0.36 - 3.5
- ▲ Above PRG

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**Soil Sampling Results (Organics)
Former Pacific Dry Dock & Repair
Company Yard I Facility
Oakland, California**





Legend

Random, Shallow by Chrysene

- + ND
- 0.1 - 35
- 36 - 359
- Above PRG

Targeted, Shallow by Chrysene

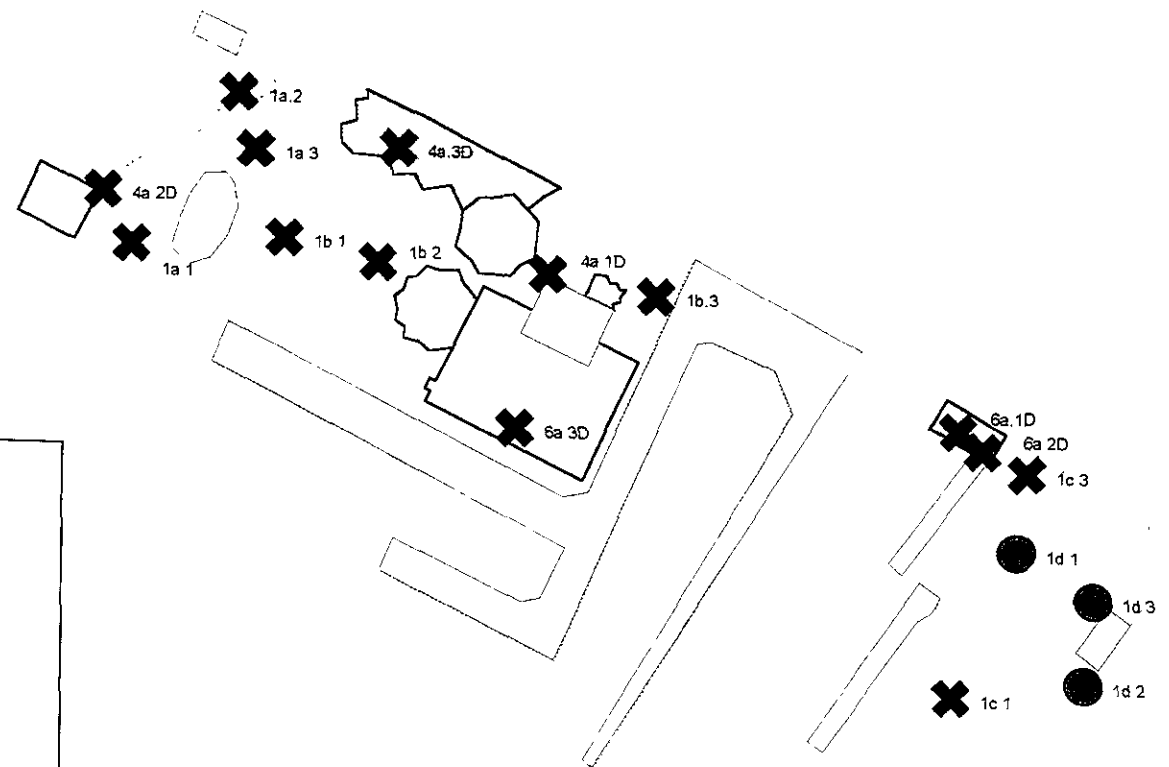
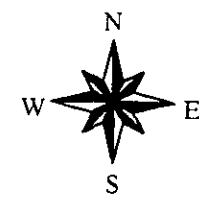
- + ND
- ▲ 0.1 - 35
- △ 36 - 359
- ▲ Above PRG

Target areas

- Diesel AST
- Machine shop
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**Soil Sampling Results (Organics)
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Legend

Random, Deep by Chrysene

- ✕ ND
- 0.1 - 35
- 36 - 359
- Above PRG

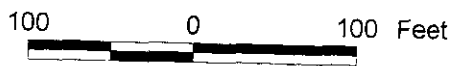
Targeted, Deep by Chrysene

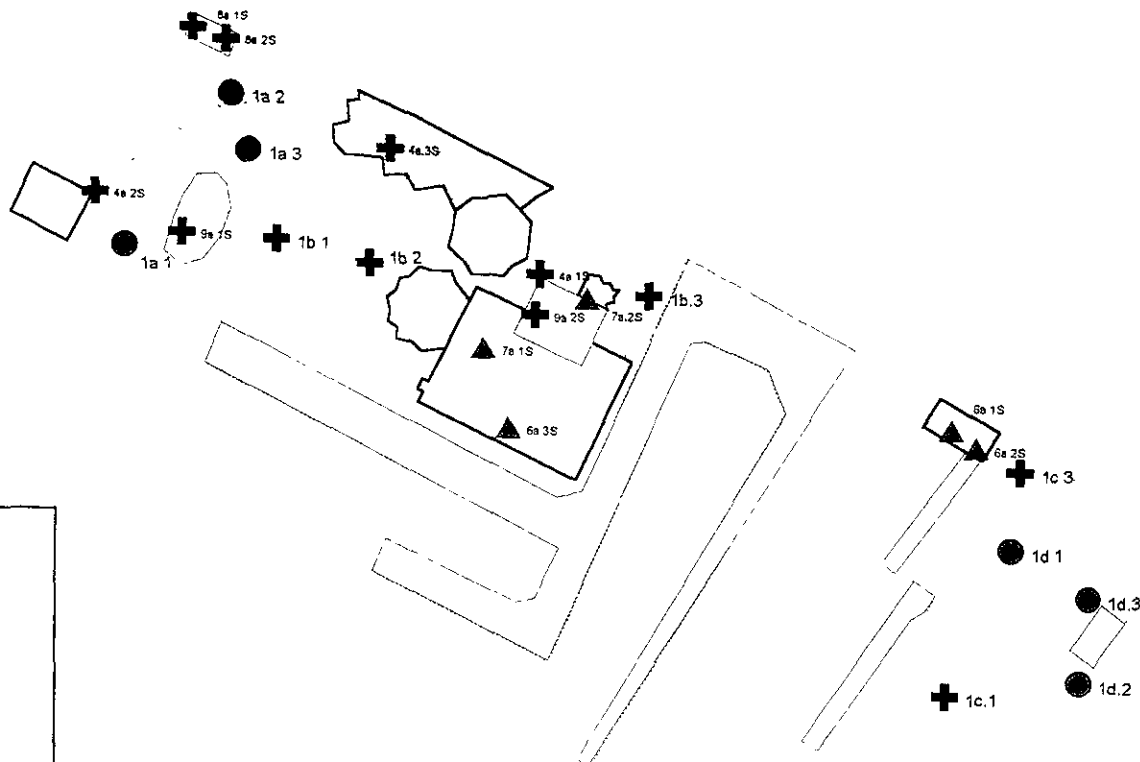
- ✕ ND
- ▲ 0.1 - 35
- △ 36 - 359
- ▲ Above PRG

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**Soil Sampling Results (Organics)
Former Pacific Dry Dock & Repair
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Legend

Random, Shallow by Naphthalene

- + ND
- 0.1 - 18
- 19 - 189
- Above PRG

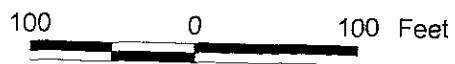
Targeted, Shallow by Naphthalene

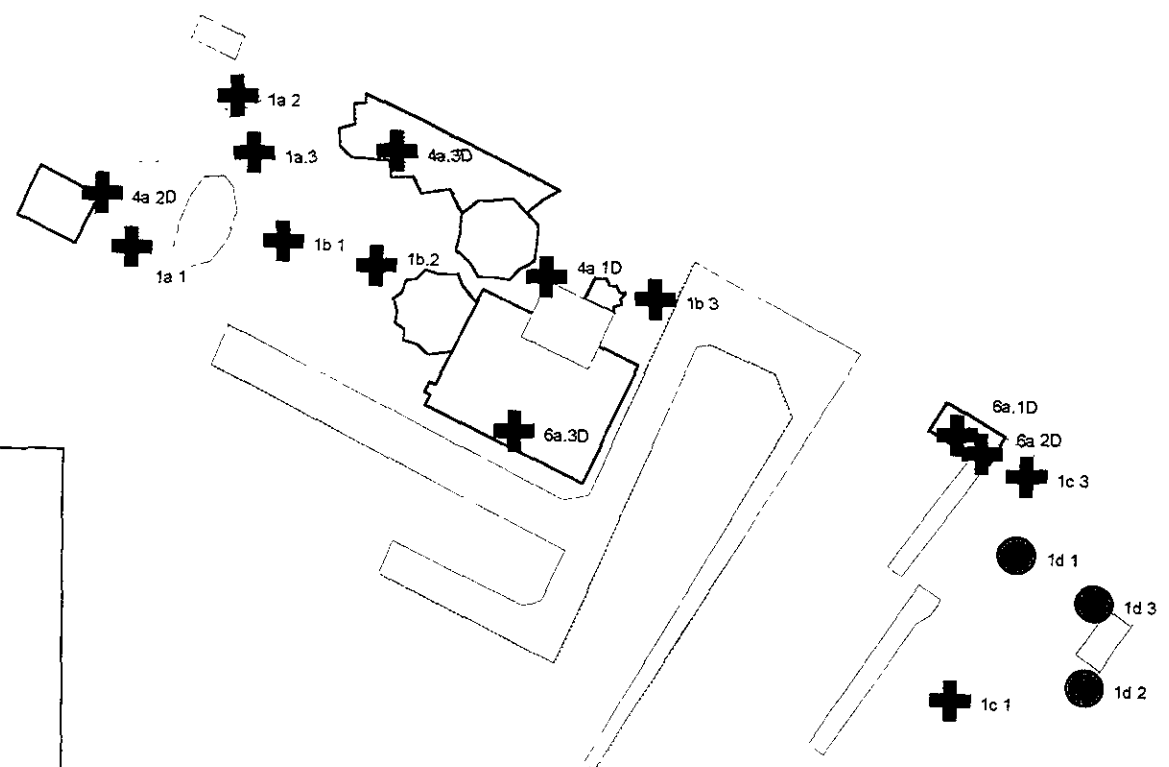
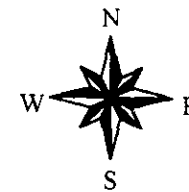
- + ND
- ▲ 0.1 - 18
- △ 19 - 189
- ▲ Above PRG

Target areas

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**Soil Sampling Results (Organics)
Former Pacific Dry Dock & Repair
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Legend

Random, Deep by Naphthalene

- + ND
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- △ 19 - 189
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**Soil Sampling Results (Organics)
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