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ENVIRONMENTAL PROTECTION
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February 6, 1995

Project No. 1233

Ms. Eva Chu
Hazardous Materials Specialist
Alameda County
Environmental Health Department
Environmental Protection Division
1131 Harbor Bay Parkway, #250
Alameda, CA 94502-6577

Ed Leonhardt x 232

RE: ADDENDUM TO RISK BASED CORRECTIVE ACTIONS ANALYSIS
Montgomery Ward Auto Service Center and
Enea Properties Sites
Dublin, California

Dear Ms. Chu:

This letter is an addendum to the Environmental Audit, Inc. (EAI) report titled "Risk Based Corrective Actions Analysis, Montgomery Ward Auto Service Center and Enea Properties Sites, Dublin, California," dated October 14, 1994 (see EAI, 1994). This addendum addresses your comments regarding the risk based corrective actions (RBCA) in EAI, 1994 as stated in your letter dated January 11, 1995 and our verbal communications.

1.0 REVISED EMISSIONS CALCULATIONS

Regarding the miscalculations on page 12 of the EAI, 1994 document, Attachment A contains the revised calculations for benzene emissions into outdoor air. The revised calculations indicate that the maximum allowable benzene concentration in ground water that would result in a 1×10^{-5} cancer risk level is 23.01 mg/l. If a cancer risk of 1×10^{-6} is used, the maximum allowable benzene concentration in ground water is 2.30 mg/l.

Tables 1 and 2 contain analytical data from monitoring activities completed at the Montgomery Ward Auto Service Center site (Montgomery Ward) and the Enea Properties Site (Enea Properties), respectively, through the fourth quarter 1994. These data show that only on two occasions has the benzene concentration in ground water exceeded its calculated maximum allowable concentration of 2.30 mg/l in ground water using a very conservative risk of 1×10^{-6} (see Table 1, July 24, 1992 data for wells B-5 and B-10; and Table 2). In fact, the data in Tables 1 and 2 clearly show that for the past two years (1993 and 1994) none of the benzene concentrations in ground water have exceeded the calculated maximum allowable concentration of benzene based on a risk of 1×10^{-6} in ground water for problematic benzene emissions into outdoor air.

For emissions into outdoor air from non-carcinogens, including toluene, ethylbenzene, and xylenes (TEX), the calculations in Attachment A show that the maximum allowable TEX concentrations in ground water that would result in a hazard quotient of greater than 1.0 are 2,426 mg/l, 5,813 mg/l, and 46,697 mg/l, respectively. The allowable concentration of these constituents are orders of magnitude greater than the concentrations of these constituents in ground water (see Tables 1 and 2).

Total petroleum hydrocarbons (TPH) emissions to outdoor air were also calculated. Attachment A contains the calculations. These calculations used a cancer slope factor of 0.0017 $(mg/kg\text{-}day)^{-1}$ which was developed for gasoline by the U.S. EPA (see Michelsen and Boyce, 1993). It was assumed that the "gasoline vapors" demonstrate some of the same characteristics as benzene for purposes of calculations including the diffusion coefficient in air and water, and Henry's Law constant. This is a conservative assumption since benzene is one of the more volatile components of gasoline. Further, such factors have not been developed for gasoline but for specific constituents of gasoline. The calculations show that the maximum allowable concentration of gasoline in ground water based on a risk 1×10^{-6} for emissions into outdoor air is 39.2 mg/l.

2.0 SURFACE WATER

As stated in Sections 4.0 and 5.4 of the EAI, 1994 document, the nearest surface water body down-gradient of the Montgomery Ward and Enea Properties is Dublin Creek. Dublin Creek is located approximately 1,500 feet south of the Montgomery Ward Site (see Figure 1). Dublin Creek is an intermittent stream with an average flow of less than two cubic feet per second (Steven J. Ellis, Zone 7 of the Alameda County Flood Control and Water Conservation District, personal communication, September 1994). Dublin Creek appears to be a recharge source for the shallow ground water table (Richard Daniels, Alameda County Flood Control District, personal communication, 1994).

It is estimated that the Dublin Creek is approximately 1,100 feet east from the down-gradient edge of the dissolved benzene plume, based on Figure 1 which shows the maximum interpreted extent of the dissolved benzene plume whose plume axis is elongated in a east-west direction

3.0 MANMADE SUBSURFACE CONDUITS

A cross section along Dublin Boulevard showing the sewer line invert elevation and the historical high ground water elevations was constructed based on information from quarterly ground water monitoring activities conducted by EAI since April 1992 (see Figures 2 and 3; see Table 3). Figure 3 shows that, based on these data, high ground water has not intersected the sewer line invert. These data support the statement made by EAI in EAI, 1994 document that "possibly the sewer line is not a preferential conduit for transport of the dissolved contaminants" since the high historical ground water elevation data did not intercept the sewer line invert adjacent to the Montgomery Ward site.

4.0 CALCULATIONS FOR EMISSIONS INTO AN ENCLOSED AIR SPACE

4.1 Calculations for Gasoline Vapors in Enclosed Air Space

The following emission calculations were completed to determine the risk based screening level (RBSL) for gasoline vapors into an enclosed air space. The calculations were performed for the closest buildings to the Montgomery Ward property, i.e., the Enea Plaza buildings. The calculations assumed that gasoline vapors migrated into the buildings through cracks in the foundation. It was assumed that the "gasoline vapors" demonstrate some of the same characteristics as benzene for purposes of calculations including the diffusion coefficient in air and water, and Henry's Law constant. This is a conservative assumption since benzene is one of the more volatile components of gasoline. Further, such factors have not been developed for gasoline but for specific constituents of gasoline. Default factors developed by ASTM were used in the calculation of indoor air concentrations, except where site specific data are available. The following equations and assumptions were used:

$$\text{RBSL (mg/l-H20)} = \frac{\text{RBSLair (ug/m}^3\text{-air) x } 10^{-3}\text{ mg/ug}}{\text{VFwesp}}$$

Where:

RBSLwater	= RBSL - ground water (mg/l-H20)
RBSLair	= RBSL - air (ug/m^3-air)
VFwesp	= Volatilization factor calculated below (mg/m^3-air)/(mg/l-H20)

$$\text{RBSLair} = \frac{\text{TR x BW x ATc x 365 days/year x } 10^3\text{ ug/mg}}{\text{SFi x IRair EF x ED}}$$

$= 84.16$ ug/m^3-air

Where:

TR	= Target excess lifetime cancer risk (1 x 10^{-5})
BW	= Adult body weight (70 kg)
ATc	= Averaging time for carcinogens (70 years)
SFi	= Cancer slope factor [0.0017 (mg/kg-day)$^{-1}$ for gasoline vapors] which is the U.S. EPA derived toxicity factor for gasoline (see Michelsen and Boyce, 1993).
IRair	= Inhalation rate (20 m^3/day)
EF	= Exposure frequency (250 days/year)
ED	= Exposure duration (25 years)

$$\text{VFwesp} = \frac{\text{H(Dws/Lgw)/(ERxLb) x 10-3 l/m}^3}{1 + [\text{Dws/Lgw)/(ERxLb)}] + [(\text{Dws/Lgw)/(Dcrack/Lcrack)}^n]}$$

= Volatilization factor [6.78 x 10^{-3} (mg/m^3-air)/(mg/l-H20)]

Where:

H	= Henry's Law Constant [0.22 (l-H20)/(l-air)]
Lgw	= Depth to groundwater (305 cm)
ER	= Enclosed-space air exchange rate (0.0028 1/sec) The air exchange rate was modified from the ASTM document since the default value (0.00014 1/sec or 0.5 exchanges per hour) assumed

that vapors were migrating into a small basement without a ventilation system. The buildings on the Enea Property consist of commercial buildings with forced air ventilation systems. It is assumed herein that the air exchange rate in a building with a forced air ventilation system is 10 exchanges per hour or 0.0028 1/sec.

Lb = Enclosed-space volume infiltration area ratio (1010 cm). The default assumption of 300 cm was increased by the ratio of the total square footage of the basement used in the default assumptions by the square footage of the commercial buildings (estimated to be about 5,000 square feet).

Lcrack = Enclosed space foundation (15 cm).

n = Areal fraction of cracks in foundations (0.01)

Dws = See calculation below

Dcrack = See calculation below

Ds = $\mathbf{Dair(Oas^{3.33})/(Ot^{3.33}) + Dwat(1/H)(Ows^{3.33}/Ot^{3.33})}$
= Effective diffusion coefficient in soil (0.0263 cm2/sec)

Where:

Dair = Diffusion coefficient in air (0.093 cm2/sec)
Oas = Volumetric air content in vadose zone soils (0.26)
Ot = Total soil porosity (0.38)
Dwat = Diffusion coefficient in water (1.1 x 10^{-5} cm2/sec)
H = Henry's law constant (0.22 l water/l air)
Ows = Volumetric water content in vadose soils (0.12)

Dcrack = $\mathbf{Dair(Oacrack^{3.33}/Ot^{3.33}) + Dwat(1/H)(Owcrack^{3.33}/Ot^{3.33})}$
= Diffusion coefficient through capillary fringe (0.0263 cm2/sec)

Where:

Dair = Diffusion coefficient in air (0.093 cm2/sec)
Oacrack = Volumetric air content in foundation cracks (0.26)
Ot = Total soil porosity (0.38)
Dwat = Diffusion coefficient in water (1.1 x 10^{-5} cm2/sec)
H = Henry's law constant (0.22 l water/l air)
Owcrack = Volumetric water content in foundation (0.12)

Dcap = $\mathbf{Dair(Ocap^{3.33}/Ot^{3.33}) + Dwat(1/H)Owcap^{3.33}/Ot^{3.33}}$
= Diffusion coefficient thru capillary fringe (0.093 cm^2/sec)

Where:

Dair = Diffusion coefficient in air (0.093 cm^2/s)
Oacap = Volumetric air content in capillary fringe soils (0.38 cm^3-air/cm^3-soil)
Ot = Total soil porosity (0.38 cm^3-air/cm^3-soil)
Dwat = Diffusion coefficient in water (1.1 x 10-5 cm^2/s)
Owcap = Volumetric water content in capillary fringe soils (0.342 cm^3-H2O/cm^3-soil)
H = Henry's Law Constant [0.22 (l-H20)/(l-air)]

Dws = $\mathbf{(hcap + hv)[hcap/Dcap + hv/Ds]^{-1}}$

= Effective diffusion coefficient (0.0266 cm2/s).

Where:

hcap	= thickness of capillary fringe (5 cm)
hv	= thickness of vadose zone (295 cm)
Dcap	= effective diffusion coefficient through capillary fringe (0.093 cm^2/sec) (calculated above)
Ds	= effective diffusion coefficient in soil based on vapor-phase concentration (0.0263 cm2/sec calculated above).

RBSLw **= RBSLair x (0.001 mg/ug)/VFwesp**
= 84.164 x 0.001/ 0.006784
= 12.4 mg/l

Based on these calculations the maximum gasoline (assumed to be TPH in this case) that could be present in ground water and result in a cancer risk less than 1 x 10^{-5} is 12.4 mg/l or 12,406 ug/l.

4.2 Calculations for Benzene in Enclosed Air Space

The same assumptions as described for the calculations of gasoline vapors in enclosed air space were used to calculate the allowable concentration of benzene in ground water that would result in a 1 x 10^{-5} cancer risk with the exception that the cancer potency slope for benzene was used (see Attachment B).

Based on these calculations the maximum benzene that could be present in groundwater and result in a cancer risk less than 1 x 10^{-5} is 0.727 mg/l or 727 ug/l (see Attachment B).

4.3 Calculations for Xylene in Enclosed Air Space

The same assumptions as described for the calculations of gasoline vapors in enclosed air space were used to calculate the allowable concentration of xylene in ground water that would result in a hazard index of 1 with the exception that the RBSL in air was calculated as follows:

$$RBSLair = \frac{THQ \times RFDi \times BW \times ATn \times 365\ days/year \times 10^3\ ug/mg}{IRair \times EF \times ED}$$
$$= 10220\ ug/m^3\text{-air}$$

Where:

THQ	= Target hazard quotient (1)
RFDi	= Inhalation chronic reference dose (2 mg/kg-day^{-1})
BW	= Adult body weight (70 kg)
ATn	= Averaging time for non-carcinogens (70 years)
IRair	= Inhalation rate (20 m^3/day)
EF	= Exposure frequency (250 days/year)
ED	= Exposure duration (25 years)

In addition, the chemical specific values for Henry's law constant and the diffusion coefficients for xylene were used.

Based on these calculations the maximum xylene concentration that could be present in groundwater and result in a hazard index of less than 1 is 1,476 mg/l or 1,476,119 ug/l (see Attachment B).

4.4 Calculations for Toluene in Enclosed Air Space

The same assumptions as described for the calculations of xylene in enclosed air space were used to calculate the allowable concentration of toluene in ground water that would result in a hazard index of 1 with the exception that the chemical specific values including Henry's law constant and the diffusion coefficients for xylene were used.

Based on these calculations, the maximum toluene concentration that could be present in groundwater and result in a hazard index of less than 1 is 76.7 mg/l or 76,705 ug/l (see Attachment B).

4.5 Calculations for Ethylbenzene in Enclosed Air Space

The same assumptions as described for the calculations of xylene in enclosed air space were used to calculate the allowable concentration of ethylbenzene in ground water that would result in a hazard index of 1 with the exception that the chemical specific values including Henry's law constant and the diffusion coefficients for ethylbenzene were used.

Based on these calculations, the maximum ethylbenzene concentration that could be present in groundwater and result in a hazard index of less than 1 is 183.76 mg/l or 183,764 ug/l (see Attachment B).

5.0 RISK BASED CLEANUP LEVELS FOR TPH

In this report and in the EAI, 1994 document, EAI has addressed BTEX issues as they relate to the RBCA analysis. These analyses show that the concentrations of BTEX in ground water at the Enea Properties site do not exceed the risk based clean up levels established for any of these constituents. These analyses, however, do not take into account the affects of total petroleum hydrocarbons (TPH) in ground water. TPH risk is usually quantified indirectly by use of a single surrogate (such as benzo(a)pyrene, n-hexane, or pyrene) or a combination of surrogates (for gasoline surrogate combinations such as benzo(a)pyrene, benzene, and n-hexane, or benzene, benzo(a)pyrene, n-hexane, pyrene, and toluene). Indirect quantification is necessary since the composition of the original petroleum product varies significantly, depending on composition of the source, weathering of the product over time, and differential movement of the petroleum product components in the environment.

EAI in its RBCA calculations for TPH has used different methods for determining the TPH RBCL in ground water. One method uses the U.S. EPA derived toxicity factor for gasoline of 0.0017 (mg/kg-day^{-1}) (see Michelsen and Boyce, 1993). Another is to use the U.S. EPA derived reference dose for gasoline of 0.02 mg/kg-day^{-1} (see Michelsen and Boyce, 1993). The last method used is based on computing the RBCL for several non-carcinogenic compounds reported to be in gasoline (i.e., TEX, cyclohexane, n-butane, pentane, and so forth, which constitute the major fractions of gasoline), adjust each compound's RBCL based on the average weight percent that these compounds are present in gasoline, and summing the weighted RBCL for each compound. Use of the last method is appropriate since this gasoline is comprised of many compounds, and since RBCLs have already been established for BTEX (see EAI, 1994).

5.1 TPH RBCL using U.S. EPA Toxicity Factor for Gasoline

Recently, the U.S. EPA has developed toxicity factors for certain original petroleum product mixtures (e.g., gasoline has a toxicity factor of 0.0017 mg/kg-day) (Michelsen and Boyce, 1993). Use of the toxicity factor developed for specific petroleum products are advantageous since they can account for the toxicity of all components of the mixture and any additive or other affects. However, because the composition of the original petroleum product may become substantially altered after release into the environment, toxicity factors based on the original products may not be directly applicable to the environmental setting at a site, particularly where significant weathering has occurred. Additionally, the composition of petroleum products is highly variable due to differences in source petroleum composition and refining methods.

The dissolved gasoline (as TPH) in the ground water on the Enea Properties site is weathered. EAI bases this statement on the ratio of benzene to TPH in ground water samples obtained from the wells on the Enea Properties. These samples usually contain a ratio of less than 1% benzene to TPH by weight. Typically, unweathered gasoline contains 1% to 3% benzene by weight in gasoline. Further, the gasoline dissolved in the ground water is probably chemically different than the gasoline mixture used by the U.S. EPA in deriving the gasoline cancer slope factor. "Weathered" gasoline is expected to contain fewer volatile organic compounds (VOCs) than fresh gasoline so that little exposure to VOCs including gasoline vapors is expected. As such, the RBCL derived for TPH from the calculations are very conservative and may not be directly applicable at the Montgomery Ward and Enea Properties sites.

Due to the fact that there is limited exposure to ground water containing TPH through dermal, inhalation, and ingestion exposure pathways (see EAI, 1994), a risk factor of 1×10^{-5} was used. Based on this risk factor and the toxicity factor (cancer slope) of 0.0017 for gasoline (see above), the RBCL is calculated as follows:

$$RBCLx\ (mg/L) = \frac{TR \times BW \times ATc \times 365\ (days/yr)}{SFo \times IRw \times EF \times ED}$$

Where:

TR = target excess individual lifetime cancer risk (unitless)
BW = adult body weight (kg)
ATc = averaging time for carcinogens (yr)
SFo = oral cancer slope factor ((mg/kg-day)-1)
IRw = daily water ingestion rate (liters/day)
EF = exposure frequency (days/yr)
ED = exposure duration (yr)

Since the local immediate land use is commercial/industrial, the following defaults were used in the calculations:

BW = 70 kg
ATc = for commercial/industrial is 70 yr
SFo = for gasoline = 0.0017 kg-day/mg
IRw = 1 liter/day

EF = 250 days/yr for commercial/industrial use
ED = 25 years for commercial/industrial use

The RBCL for TPH is therefore 1.68 mg/l.

Review of data in Table 2 shows that of the wells at the site the only one well (Enea well MW-1) contains concentrations of dissolved TPH higher than 1.68 mg/l or 1,680 ug/l. Recent data show that Enea well MW-1 contains approximately 4.4 mg/l (4,400 ug/l) (see Table 2). Although this one well contains dissolved TPH concentrations in excess of the calculated RBCL of 1.68 mg/l for TPH, one must be aware that this value was derived using an unweathered gasoline which probably has a dissimilar composition to the dissolved gasoline presently in ground water at this time. Therefore, strict adherence to the TPH RBCL of 1.68 mg/l based on the 0.0017 cancer slope factor for gasoline is probably not realistic.

5.2 TPH RBCL Using Reference Dose for Gasoline

The U.S. EPA also has determined a reference dose value for gasoline of 0.2 $(mg/kg\text{-}day)^{-1}$. This value is used in the following equation for non-carcinogens:

$$RBCL(mg/l\text{-}H20) = \frac{THQ \times RfDo \times BW \times ATn \times 365\ day/yr}{IRw \times EF \times ED}$$

where:

THQ = target hazard quotient for individual constituents (unitless) = 1
RfDo = oral chronic reference dose (mg/kg-day) (0.02 $mg/kg\text{-}day^{-1}$)
BW = adult body weight (kg) (70 kg)
ATn = averaging time for carcinogens (yr) (70 years)
IRw = daily water ingestion rate (liters/day) (1 liter/day)
EF = exposure frequency (days/yr) (250 days/yr)
ED = exposure duration (yr) (25 years)

The above values are based on commercial/industrial use (see EAI, 1994). The resultant risk based clean-up level is then calculated at 57 mg/l using the given gasoline reference dose value.

5.3 TPH RBCL using Major Non-Carcinogenic Compounds in Gasoline

A RBCL for TPH was derived using the data contained in the Table 4 for non-carcinogens and the following equation:

$$TPH\ RBCL = (Wt\%X_1)(X_{1RBCL1}) + (Wt\%X_2)(X_{2RBCL2}) + (Wt\%X_3)(X_{3RBCL3}) + (Wt\%X_i)(X_{iRBCLi}) + \ldots$$

where X_i = Compound
Wt% = average weight percent of compound X_i in gasoline
X_{iRBCLi} = risk based cleanup level of compound X_i

Use of this equation takes into account the major constituents in gasoline. These are TEX, n-hexane, napthalene, cyclohexane, n-pentane, and so forth. The resulting RBCL for TPH using this method is approximately 21.9 mg/l (see Table 4).

6.0 SUMMARY OF RBSL AND RBCLs

Table 5 contains the calculated RBSL and RBCL for BTEX and TPH, and compares these to the highest concentrations detected in the last four quarters of ground water monitoring conducted at the Montgomery Ward and Enea Properties sites.

6.1 Enea Properties

The data in Table 5 show that the concentrations detected in ground water at the Enea Properties site have not exceeded any of the RBCLs calculated herein or in EAI, 1994, except for TPH as calculated using a cancer slope value of 0.0017 $(mg/kg\text{-}day)^{-1}$ (see Section 5.1). As stated in Section 5.1, the use of this cancer slope is probably not applicable since the gasoline product used to derive the toxicity value is dissimilar in composition and condition (unweathered) to the gasoline material at the site. Based on the above, it appears that the alternative calculations provide a more reasonable TPH RBCL of 21.9 to 57 mg/l (see Table 5).

6.2 Montgomery Ward Site including Off-Site Wells (MW-100, MW-101, and MW-102)

Table 5 shows that none of the TPH and BTEX concentrations in ground water from the 1994 quarterly monitoring data exceeded the maximum allowable concentrations in ground water as determined by calculations for emissions into outdoor air.

Table 5 also shows that the maximum concentrations in ground water for emissions into enclosed space were exceeded for TPH and benzene at one well on the Montgomery Ward site. Review of the quarterly monitoring data for the Montgomery Ward site shows that this occurred in only one sampling event (January 13, 1994) and in only one well (well B-10) (see Table 1). Well B-10 is located adjacent to Dublin Boulevard and is approximately 55 feet away from the Montgomery Ward building (see Figure 5). Wells B-5, B-10, B-15, and B-16 are closer than well B-10 to the Montgomery Ward building, and these wells did not contain problematic TPH and BTEX concentrations in ground water with respect to emissions into enclosed space (see Table 1 and Table 5). Therefore, the data from well B-10 are not representative for the entire site and should not be considered as representing the concentrations in ground water for calculating emissions into enclosed space. The concentrations detected during the January 13, 1994 sampling event of well B-10, however, do not exceed the maximum allowable concentrations into outdoor air space.

In respect to TPH and BTEX RBCLs at the Montgomery Ward site, only the dissolved benzene concentrations in ground water exceed those established by this RBCA analysis. Ground water extraction activities, however, have been on-going at the site and have reduced the concentrations of dissolved contaminants in the ground water (see EAI, 1994).

7.0 CONCLUSIONS

The revised calculations, information, and analyses presented in this addendum together with the data and conclusions contained in the EAI, 1994 document indicate that the TPH and BTEX concentrations detected in ground water off-site and down-gradient of the Montgomery Ward site do not exceed their calculated RBCL and RBSL values.

For the Montgomery Ward site, the 1994 monitoring data show that only benzene has been detected in ground water in excess of its calculated RBCL. However, the on-going ground water extraction activities at the site appear to be effective in reducing the concentration of TPH and BTEX in the ground water at the site. The analyses presented for emissions into outdoor air and enclosed air space also show that the TPH and BTEX concentrations in ground water are not problematic.

8.0 LIMITATION

Our professional services have been performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable environmental consultants in this or similar localities. No other warranty, expressed or implied, is made as to the professional advice contained in this report.

Please call if you have any questions or need additional information.

Sincerely,

ENVIRONMENTAL AUDIT, INC.

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attachments

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REFERENCES CITED

Environmental Audit, Inc., (EAI, 1994), "Risk Based Corrective Actions Analysis, Montgomery Ward and Enea Properties Sites, Dublin, California," dated October 14, 1994.

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TABLES

TABLE 1

ANALYTICAL TESTING RESULTS FOR GROUND WATER SAMPLES

Montgomery Ward Site

Parts per billion (ppb)

Well B-5

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
04-16-92	4400	670	160	280	320	ND
07-24-92	31000	5400	2600	2200	5800	ND
10-22-92	9100	1100	190	520	740	ND
01-15-93	2300	530	160	300	470	7.9
04-15-93	4900	600	160	470	390	ND
07-14-93	8800	590	210	840	1100	9.9
10-14-93	4500	530	46	490	350	ND
01-13-94	120	15	1.9	12	11	ND
04-04-94	5700	450	39	350	400	ND
07-05-94	2200	69	13	150	95	ND
10-03-94	4700	190	38	510	570	ND

Well B-10

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
04-16-92	7300	1400	640	880	1100	ND
07-24-92	27000	3800	1600	2000	4000	ND
10-22-92	16000	2300	340	1100	1200	ND
01-15-93	10000	1400	310	730	1100	13
04-15-93	8100	580	270	810	580	19
07-14-93	6400	840	120	750	800	7.1
10-14-93	100000	720	120	930	1100	ND
01-13-94	18000	990	180	1300	2400	ND
04-04-94	12000	370	96	900	1800	ND
07-05-94	7800	170	50	550	810	ND
10-03-94	6300	120	33	480	630	ND

Well B-12

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
04-16-92	12000	1300	1100	510	1200	ND
07-24-92	12000	1000	630	520	1000	ND
10-22-92	11000	370	230	400	940	ND
01-15-93	120	2.8	ND	1.6	3.6	11
04-15-93	7100	730	240	350	570	ND
07-14-93	4500	540	97	380	610	ND
10-14-93	11000	710	170	650	1600	ND
01-13-94	6000	330	100	330	620	24
04-04-94	8700	350	58	350	660	ND
07-05-94	8800	250	340	370	920	ND
10-03-94	1300	63	42	110	140	ND

TABLE 1

ANALYTICAL TESTING RESULTS
FOR GROUND WATER SAMPLES
Montgomery Ward Site

Parts per billion (ppb)

Well B-15

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
04-16-92	65	4.4	2.4	6.1	2.8	ND
07-24-92	ND	3.6	1.5	3.1	1.6	ND
10-22-92	ND	1.7	0.89	0.78	0.88	ND
01-15-93	ND	ND	ND	ND	ND	13
04-15-93	ND	2.8	ND	3.0	1.5	ND
07-14-93	ND	ND	ND	0.57	0.74	7.8
10-14-93	ND	0.96	2.6	1.3	3.6	25
01-13-94	ND	ND	0.92	0.70	2	ND
04-04-94	ND	ND	ND	0.56	1	ND
07-05-94	ND	ND	ND	ND	ND	ND
10-03-94	ND	ND	ND	ND	ND	ND

Well B-16

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
04-16-92	1300	390	1.7	35	9.3	ND
07-24-92	1600	120	5.7	120	410	ND
10-22-92	1000	76	ND	55	130	ND
01-15-93	160	6.5	0.86	2.3	2.6	5.5
04-15-93	300	65	ND	13	2	ND
07-14-93	170	5.9	ND	4.6	12	ND
10-14-93	390	11	2.4	16	45	21
01-13-94	350	8.7	0.62	25	68	ND
04-04-94	550	8.7	ND	35	81	ND
07-05-94	850	14	5.6	52	130	ND
10-03-94	210	5.3	ND	26	5.8	ND

Well MW-100

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
05-13-93	13000	83	ND	960	820	NA
07-14-93	13000	32	ND	1400	790	8
10-14-93	7500	48	16	900	520	0.022
01-13-94	7000	51	ND	590	330	ND
04-04-94	9800	69	ND	540	410	ND
07-05-94	5900	31	8.7	190	190	ND
10-03-94	3900	ND	ND	220	200	ND

TABLE 1

ANALYTICAL TESTING RESULTS
FOR GROUND WATER SAMPLES

Montgomery Ward Site

Parts per billion (ppb)

Well MW-101

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
05-13-93	ND	ND	ND	ND	ND	NA
07-14-93	ND	ND	ND	ND	ND	11
10-14-93	ND	0.65	0.89	ND	1.1	ND
01-13-94	ND	ND	ND	ND	ND	28
04-04-94	ND	ND	ND	ND	ND	ND
07-05-94	ND	ND	ND	ND	ND	ND
10-03-94	ND	ND	ND	ND	ND	ND

Well MW-102

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
05-13-93	3600	17	ND	130	63	NA
07-14-93	1500	13	ND	64	4.9	ND
10-14-93	24000	9.6	5.2	60	60	ND
01-13-94	2000	22	ND	26	55	ND
04-04-94	2100	16	2.5	15	35	ND
07-05-94	1300	7	2.9	10	23	ND
10-03-94	620	5.1	ND	5.2	11	ND

5-13-93

Hydropunch ID	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
HP-1	ND	ND	ND	ND	ND	ND
HP-2	ND	ND	ND	ND	ND	ND
HP-3	5700	12	ND	180	50	ND
HP-4	680	6.6	ND	4.1	15	ND
HP-5	ND	ND	ND	ND	ND	ND
HP-6	ND	ND	ND	ND	ND	ND
HP-7	ND	ND	ND	ND	ND	ND
HP-8	ND	ND	ND	ND	ND	ND

ND Not Detected
NA Not Analyzed

K:\1233\ANAL-MW.DOC

TABLE 2

ANALYTICAL TESTING RESULTS
FOR GROUND WATER SAMPLES

Enea Plaza Sites

Parts per billion (ppb)

Well MW-1

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
10-14-93	5700	76	19	160	460	ND
04-04-94	7000	27	ND	260	49	ND
07-05-94	5100	23	ND	260	50	ND
10-03-94	4400	8.1	ND	170	50	ND

Well MW-2

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
10-14-93	ND	ND	ND	1.1	0.71	21
04-04-94	ND	ND	ND	ND	ND	21
07-05-94	ND	ND	ND	ND	ND	ND
10-03-94	590	1.1	ND	22	6.5	ND

Well MW-3

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
10-14-93	2600	26	30	100	130	ND
04-04-94	2600	13	3.4	90	140	ND
07-05-94	3400	15	5	31	48	ND
10-03-94	1400	6.3	ND	31	36	ND

Well MW-4

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
04-04-94	ND	ND	ND	ND	ND	23
07-05-94	ND	ND	0.5	ND	0.62	ND
10-03-94	ND	ND	ND	ND	ND	ND

8-11-93

Hydropunch ID	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	TPH-D
HP-1	98	1.4	ND	ND	ND	51
HP-2	260	0.87	0.64	ND	0.63	69
HP-3	ND	ND	ND	ND	ND	ND
HP-4	ND	ND	ND	ND	0.52	ND
HP-5	ND	ND	ND	ND	ND	81
HP-6 (blank)	ND	ND	ND	ND	ND	140

Note: ENEA samples HP-1 through HP-6 were also analyzed for VOCs using EPA Method 8240. No VOCs were detected.

ND Not Detected, NA Not Analyzed

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TABLE 3
GROUND WATER ELEVATIONS
Montgomery Ward Auto Service Center
Enea Properties
Dublin, California

Date Measured	Elevation of top surface of PVC well casing (feet MSL)	Measured depth to ground water (feet bgs)	Measured depth to Product	Product Thickness	Ground water elevation (feet MSL)
B-5					
	340.05				
04/16/92		10.62	-	0.00	329.43
07/24/92		11.91	-	0.00	328.14
10/22/92		12.97	-	0.00	327.08
01/15/93		12.97	-	0.00	327.08
04/15/93		09.75	-	0.00	330.30
05/14/93		10.07	-	0.00	329.98
07/14/93		10.80	-	0.00	329.25
10/14/93		12.08	-	0.00	327.97
01/13/94		12.23	-	0.00	327.82
04/04/94		11.30	-	0.00	328.75
07/05/94		12.37	-	0.00	327.68
10/03/94		13.04	-	0.00	327.01
B-10					
	339.70				
04/16/92		10.32	-	0.00	329.38
07/24/92		11.69	-	0.00	328.01
10/22/92		12.67	-	0.00	327.03
01/15/93		09.48	-	0.00	330.22
04/15/93		09.49	-	0.00	330.21
05/14/93		09.87	-	0.00	329.83
07/14/93		10.64	-	0.00	329.06
10/14/93		11.80	-	0.00	327.90
01/13/94		11.94	-	0.00	327.76
04/04/94		11.00	-	0.00	328.70
07/05/94		12.08	-	0.00	327.62
10/04/94		12.69	-	0.00	327.01
B-12					
	339.10				
04/16/92		09.95	-	0.00	329.15
07/24/92		11.57	-	0.00	327.53
10/22/92		12.82	-	0.00	326.28
01/15/93		08.66	-	0.00	330.44
04/15/93		08.70	-	0.00	330.40
05/14/93		09.32	-	0.00	329.78
07/14/93		09.95	-	0.00	329.15
10/14/93		10.94	-	0.00	328.16
01/13/94		11.28	-	0.00	327.82

TABLE 3
GROUND WATER ELEVATIONS

Montgomery Ward Auto Service Center
Enea Properties
Dublin, California

Date Measured	Elevation of top surface of PVC well casing (feet MSL)	Measured depth to ground water (feet bgs)	Measured depth to Product	Product Thickness	Ground water elevation (feet MSL)
04/04/94		10.32	-	0.00	328.78
07/05/94		19.25	-	0.00	319.85
10/04/94		19.27	-	0.00	319.83
B-15					
	340.62				
04/16/92		11.09	-	0.00	329.53
07/24/92		12.33	-	0.00	328.29
10/22/92		13.25	-	0.00	327.37
01/15/93		10.22	-	0.00	330.40
04/15/93		10.26	-	0.00	330.36
05/14/93		10.64	-	0.00	329.98
07/14/93		11.35	-	0.00	329.27
10/14/93		12.41	-	0.00	328.21
01/13/94		12.59	-	0.00	328.03
04/04/94		11.74	-	0.00	328.88
07/05/94		12.86	-	0.00	327.76
10/04/94		13.35	-	0.00	327.27
B-16					
	339.82				
04/16/92		10.63	-	0.00	329.19
07/24/92		11.90	-	0.00	327.92
10/22/92		12.88	-	0.00	326.94
01/15/93		09.79	-	0.00	330.03
04/15/93		09.83	-	0.00	329.99
05/14/93		10.20	-	0.00	329.62
07/14/93		10.92	-	0.00	328.90
10/14/93		11.99	-	0.00	327.83
01/13/94		12.16	-	0.00	327.66
04/04/94		11.28	-	0.00	328.54
07/05/94		12.28	-	0.00	327.54
10/04/94		12.89	-	0.00	326.93
MW-100					
	339.61				
05/14/93		10.34	-	0.00	329.27
07/14/93		11.00	-	0.00	328.61
10/14/93		12.12	-	0.00	327.49
01/13/94		12.25	-	0.00	327.36
04/04/94		11.36	-	0.00	328.25

TABLE 3

GROUND WATER ELEVATIONS

Montgomery Ward Auto Service Center
Enea Properties
Dublin, California

Date Measured	Elevation of top surface of PVC well casing (feet MSL)	Measured depth to ground water (feet bgs)	Measured depth to Product	Product Thickness	Ground water elevation (feet MSL)
07/05/94		12.22	-	0.00	327.39
10/04/94		12.88	-	0.00	326.73
MW-101					
	338.54				
05/14/93		09.91	-	0.00	328.63
07/14/93		10.38	-	0.00	328.16
10/14/93		11.30	-	0.00	327.24
01/13/94		11.21	-	0.00	327.33
04/04/94		10.69	-	0.00	327.85
07/05/94		11.39	-	0.00	327.15
10/04/94		11.98	-	0.00	326.56
MW-102					
	339.23				
05/14/93		09.60	-	0.00	329.63
07/14/93		10.31	-	0.00	328.92
10/14/93		11.57	-	0.00	327.66
01/13/94		11.71	-	0.00	327.52
04/04/94		10.83	-	0.00	328.40
07/05/94		11.65	-	0.00	327.96
10/04/94		12.36	-	0.00	326.87
ENEA MW-1					
	335.84				
10/14/93		09.05	-	0.00	326.79
01/13/94		NM	-	0.00	NM
04/04/94		08.36	-	0.00	327.48
07/05/94		09.04	-	0.00	326.80
10/04/94		09.66	-	0.00	326.18
ENEA MW-2					
	335.61				
10/14/93		08.90	-	0.00	326.71
01/13/94		NM	-	0.00	NM
04/04/94		08.05	-	0.00	327.56
07/05/94		08.84	-	0.00	326.77
10/04/94		09.59	-	0.00	326.02

TABLE 3

GROUND WATER ELEVATIONS

Montgomery Ward Auto Service Center
Enea Properties
Dublin, California

Date Measured	Elevation of top surface of PVC well casing (feet MSL)	Measured depth to ground water (feet bgs)	Measured depth to Product	Product Thickness	Ground water elevation (feet MSL)
ENEA MW-3					
	336.93				
10/14/93		09.89	-	0.00	327.84
01/13/94		NM	-	0.00	NM
04/04/94		09.19	-	0.00	327.74
07/05/94		09.92	-	0.00	327.01
10/04/94		10.56	-	0.00	326.37
ENEA MW-4					
	335.76				
10/14/93		NI	-	0.00	NI
01/13/94		NM	-	0.00	NM
04/04/94		08.55	-	0.00	327.21
07/05/94		09.15	-	0.00	326.61
10/04/94		09.77	-	0.00	325.99
ENEA EW-1					
	336.08				
10/14/93		NI	-	0.00	NI
01/13/94		NM	-	0.00	NM
04/04/94		08.62	-	0.00	327.46
07/05/94		09.28	-	0.00	326.80
10/04/94		09.89	-	0.00	326.19

NOTES:

NI	Not installed, NM - Not measured
MSL	Mean Sea Level
bgs	below ground surface

Depth to water is as measured from the cut notch at the top side of each PVC well casing.

The elevations of all wells were surveyed in October 1993 to City of Dublin Benchmark No. DUB-680 (elevation=331.60 MSL), located along Dublin Boulevard, 0.60 miles easterly from San Ramon Road.

All depth to water measurements were converted to MSL elevations using well casing elevation datum surveyed on 10/14/93.

Wells B-5, B-12, B-15, B-16, MW-100, MW-101 and MW-102 are owned by Montgomery Ward and are associated with 7575 Dublin Blvd.

Wells MW-1, MW-2, MW-3, MW-4 and EW-1 are owned by Enea Properties and are located at Amador Plaza Road and Dublin Boulevard.

DTP:1233:ELEV.XLS

TABLE 4

DATA AND WEIGHTED AVERAGE TPH RBCL

Compound	R_fD_o ①	THQ ②	SF_o ③	Weight % in Gasoline ④	Weight % Avg	RBCL⑤ (mg/L)	Wt Avg. RBCL (mg/L)
n-hexane	0.06	1	-	0.24-3.5	1.9	17	3.2
toluene	0.2	1	-	2.73-21.8	12.2	57	6.95
cyclohexane	ND⑦	ND	-	0.26 ⑧	0.26	NC⑨	-
n-butane	ND	ND	-	3.93-4.7	4.3	NC	-
pentane	ND	ND	-	5.73-10.92	8.3	NC	-
ethylbenzene	0.1	1	-	0.36-2.86	1.6	10	0.16
mixed xylenes	2.0	1	-	3.22-8.31	5.8	200	11.6
napthalene	0.004	1	-	0.09-0.49	0.29	1.1	0.0032
						SUM OF WT. AVG. RBCL	21.9

① R_fD_o- Oral chronic reference dose $(mg/kg\text{-}day)^{-1}$
② THQ- Target hazard quotient for individual constituents
③ Sf_o- Cancer slop factor
④ Source: Heath, J.S., et al, 1993 (see References cited)
⑤ See Section 5.2 for explanation
⑥ See Section 5.2 for explanation
⑦ ND- No data
⑧ Source: USEPA, Air Emissions Species Manual, Volume I Volatile Organic Compounds Species Profile, 2nd Ed., EPA-450/2-90-001A, January 1990.
⑨ NC- Not computed due to lack of information regarding R_fD_o for this compound.

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TABLE 5

COMPARISON OF CALCULATED MAXIMUM GROUND WATER CONCENTRATIONS BASED ON EMISSIONS TO OUTDOOR AIR, EMISSIONS INTO ENCLOSED SPACE, AND RISK BASED CLEAN UP LEVELS TO 1994 GROUND WATER MONITORING DATA FOR MONTGOMERY WARD AND ENEA PROPERTIES SITES

		TPH (mg/L)	Benzene (mg/L)	Toluene (mg/L)	Ethylbenzene (mg/L)	Xylenes (mg/L)
Ground Water Monitoring Data	Montgomery Ward site including off-site wells (MW-100, MW-101 and MW-102)	18 ①	0.990 ①	0.340	1.30	2.40
	Enea Properties wells	7	0.0277	0.030	0.260	0.140
Calculated Values	Maximum ground water concentrations based on emissions to outdoor air	39.2	2.08	2,426	5,813	46,697
	Maximum ground water concentrations based on emissions into enclosed space	12.4	0.727	76.7	183	1,476
	RBCL	21.9 to 57	0.098	20	10	200

① Data from well B-10 based on ground water samples obtained on January 13, 1994. Although these concentrations are higher than the maximum allowable concentrations for TPH and benzene in ground water based on emissions to enclosed space, these data are not representative for the entire Montgomery Ward site (see Section 6.2 for detailed explanation)

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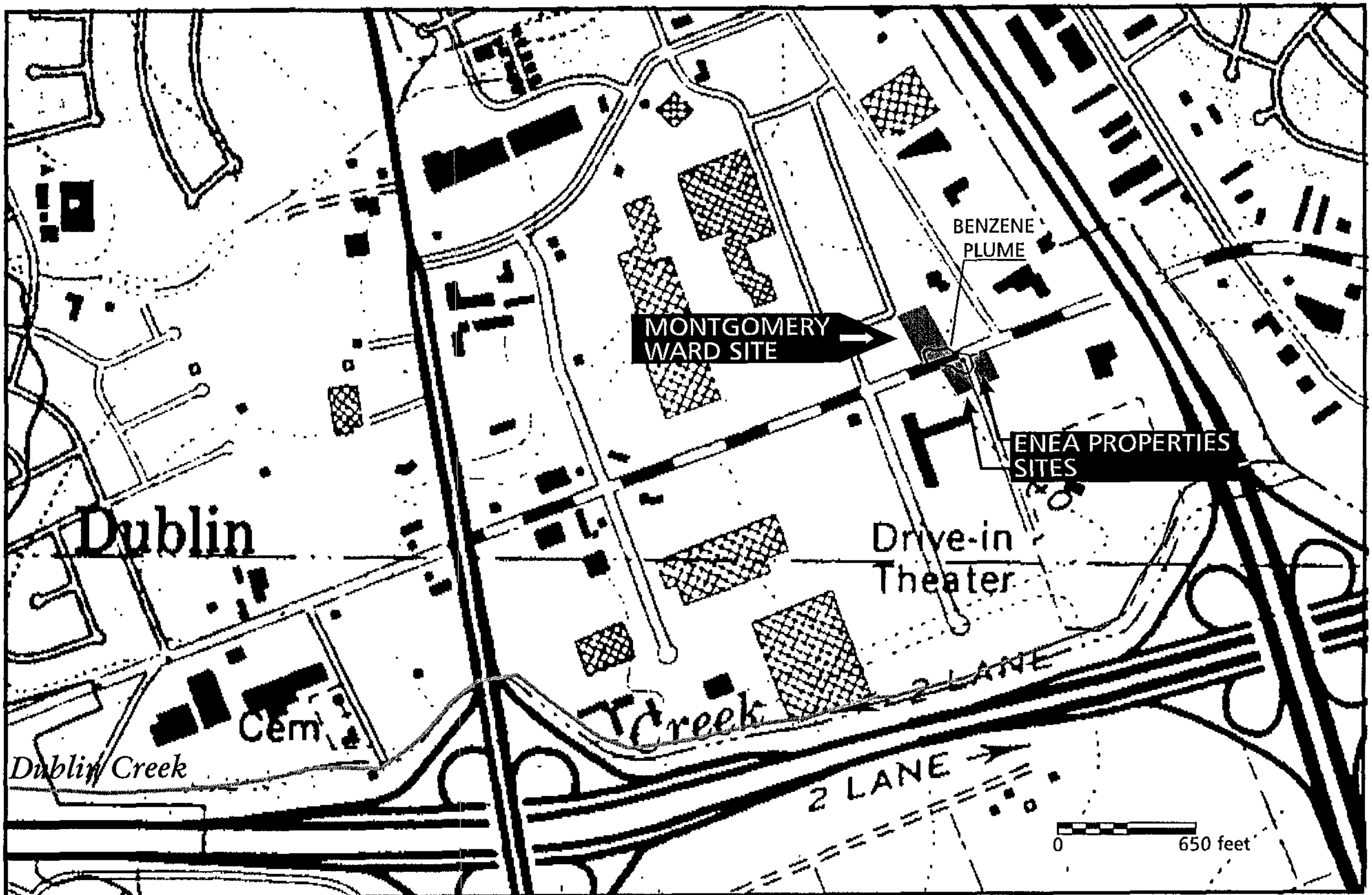
FIGURES



ENVIRONMENTAL AUDIT, INC.®

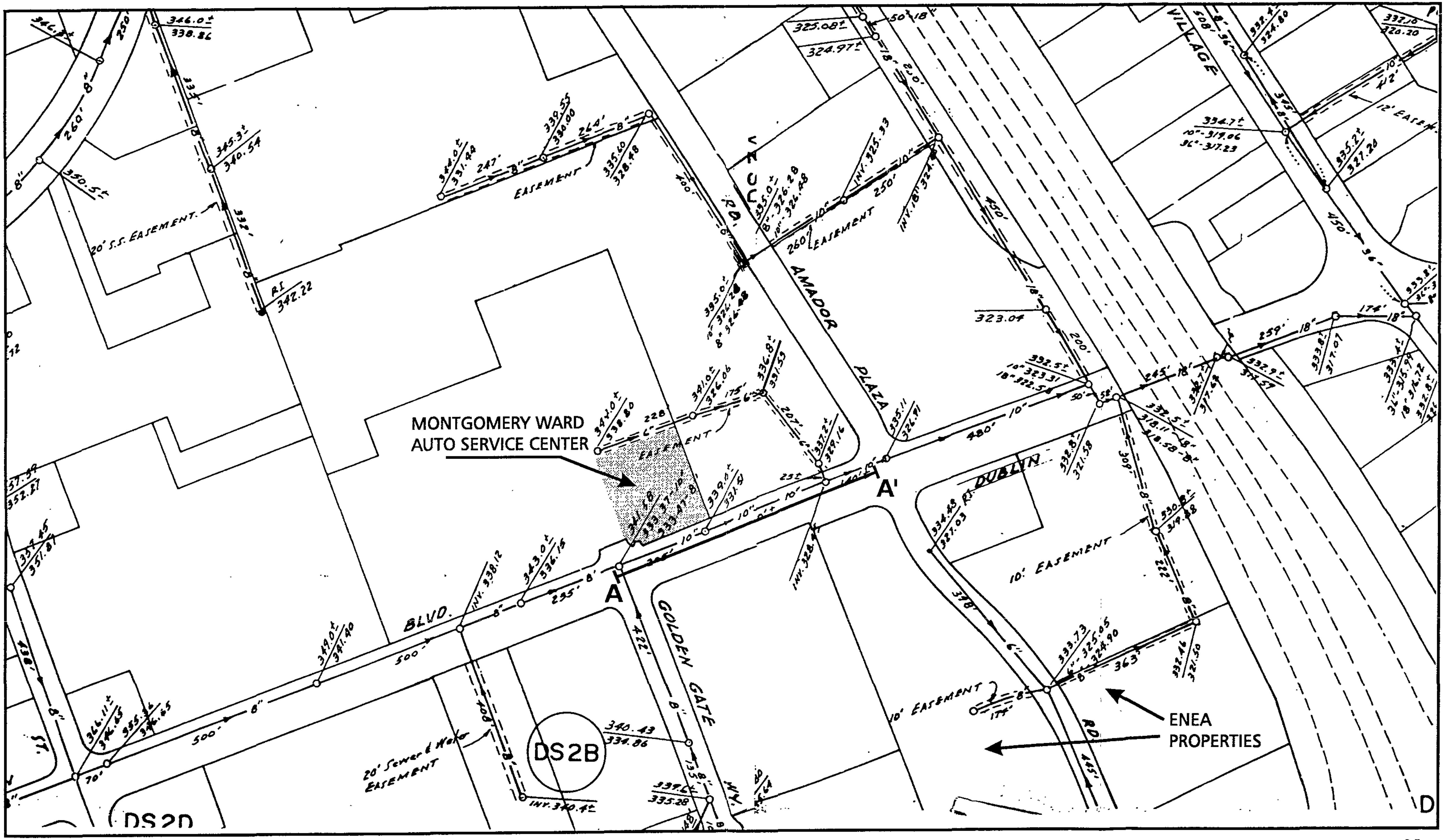
LOCATION MAP SHOWING DUBLIN CREEK IN RELATION TO BENZENE PLUME

SOURCE: USGS TOPOGRAPHIC 7.5 MINUTE SERIES
DUBLIN, CALIFORNIA QUADRANGLE

NOTE: BENZENE PLUME BASED ON FIGURE NO. 9 (EAI, 1994)

Figure 1

Project No. 1233
K:1233 CREEK CDR



Environmental Audit, Inc.

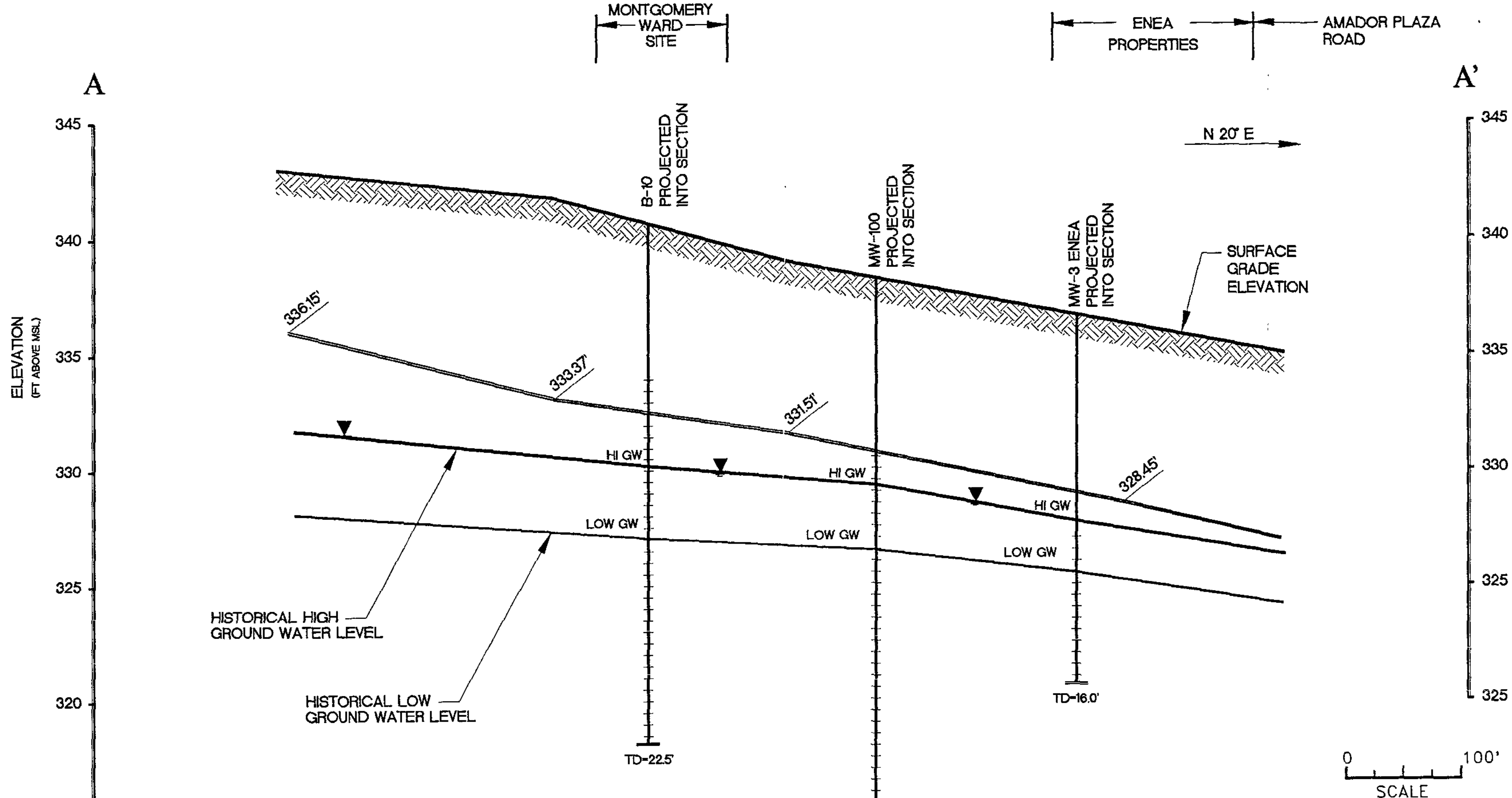
SEWER LINE AND CROSS SECTION
LOCATION MAP
Montgomery Ward Auto Service Center
Dublin, California

Figure 2

SOURCE: DUBLIN-SAN RAMON SERVICES DISTRICT

Project No. 1233

K:1233:SEWER.CDR



LEGEND:

336.15' — LOCATION OF SEWER PIPE WITH INVERT ELEVATION

TD-28.0 — LOCATION OF WELL SCREEN INTERVAL

NOTE:

ELEVATION OF SEWER PIPE AND SURFACE IS BASED ON DATA FOUND IN FIG. 14 (EAI RBCA DOCUMENT, 1994)

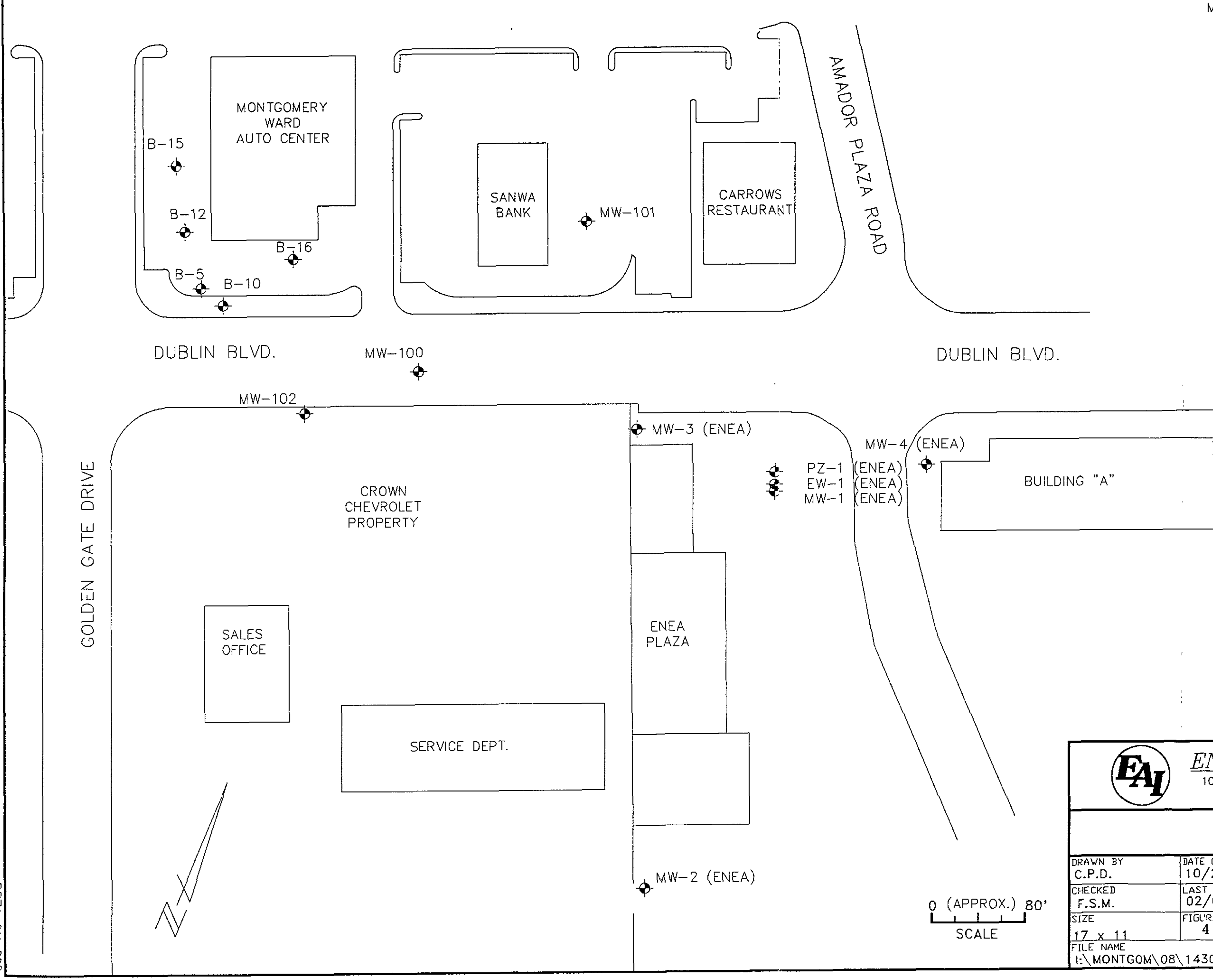
HISTORICAL HI AND LOW GROUND WATER ELEVATIONS BASED ON (EAI, 1994)

Job No. 1571

ENVIRONMENTAL AUDIT, INC.
1000-A ORTEGA WAY • PLACENTIA, CA 92670-7125
714/632-8521 • FAX: 714/632-6754

SECTION A-A'

DRAWN BY	DATE CREATED	
M.C.	01/30/95	MONTGOMERY WARD
CHECKED	LAST REV	AUTO SERVICE CENTER
	01/30/95	7575 DUBLIN BOULEVARD
SIZE	FIGURE	DUBLIN, CALIFORNIA
17 x 11	3	
FILE NAME		
I:\MONTGOM\08\14308025		



EXPLANATION:

MW-1 327.52 GROUND WATER MONITORING WELL LOCATION/GROUND WATER ELEVATION IN FEET MEAN SEA LEVEL

GROUND WATER ELEVATION CONTOUR (DASHED WHERE APPROXIMATE) CONTOUR INTERVAL = 0.10 FEET

- All wells surveyed to the city of Dublin Benchmark No DUB-680 (elevation = 331.60 feet MSL)
- Wells MW-1, MW-2, MW-3, PZ-1 & EW-1 belong to ENEA Properties.
- NM – Not Measured

ENVIRONMENTAL AUDIT, INC.
1000-A ORTEGA WAY • PLACENTIA, CA 92670-7125
714/632-8521 • FAX: 714/632-6754

SITE PLAN

DRAWN BY	DATE CREATED	
C.P.D.	10/29/93	MONTGOMERY WARD AUTO SERVICE CENTER 7575 DUBLIN BOULEVARD DUBLIN, CALIFORNIA
CHECKED F.S.M.	LAST REV 02/03/94	
SIZE 17 x 11	FIGURE 4	
FILE NAME I:\MONTGOM\08\14308001		

ATTACHMENT A

MONTGOMERY WARDS – DUBLIN
HEALTH RISK ASSESSMENT
Benzene Impacts – Outdoor Air Concentrations

RBSL(air) = (TR)(BW)(ATc)(365)(1000)/(SFi*IR*EF*ED)

RBSL(air)	4.933793	(ug/m3)

TR	0.00001	
BW	70	kg
ATc	70	years
SFi	0.029	(mg/kg–day)–1
IRair	20	m3/day
EF	250	days/year
ED	25	years

RBSL(water) = RBSL(air)*0.001/VFwamb

RBSL	23.0062	mg/l–H2O
	23006.2	ug/l–H2O

RBSL(a)	4.933793	(ug/m3)
VFwamb	0.000214	(mg/m3)(mg/l)

VFwamb = H x 1000 l/m3/[1+(Uair*oair*Lgw/(W*Dws)]

VFwamb	0.000214	(mg/m3)(mg/l)

H	0.22	l water/l air
Uair	894	cm/s
oair	244	cm
Lgw	305	cm
W	2438	cm
Dws	0.026602	cm2/sec

Ds = Dair (Oas^3.33/Ot^3.33) + Dwat(1/H)(Ows^3.33/Ot^3.33)

Ds	0.026283	(cm2/sec)
Dair	0.093	cm2/s
Oas	0.26	
Ot	0.38	
Dwat	0.000011	cm2/s
H	0.22	l water/l air
Ows	0.12	

Dcap = Dair (Oacap^3.33/Ot^3.33) + Dwat(1/H)(Owcap^3.33/Ot^3.33)

Dcap	0.093035	cm2/sec
Dair	0.093	cm2/sec
Ocap	0.38	
Ot	0.38	
Dwat	0.000011	cm2/s
H	0.22	l water/l air
Owcap	0.342	

Dws = (Hcap + Hv)(Hcap/Dcap + Hv/Ds)^–1

Dws	0.026602	cm2/s
Hcap	5	cm
Hv	295	cm
Dcap	0.093035	cm2/s
Ds	0.026283	

1st Term	300
2nd Term	0.000089

1233TB9

MONTGOMERY WARDS – DUBLIN
HEALTH RISK ASSESSMENT
Benzene Impacts – Outdoor Air Concentrations

RBSL(air) = (TR)(BW)(ATc)(365)(1000)/(SFi*IR*EF*ED)

RBSL(air)	0.493379	(ug/m3)

TR	1.0E–06	
BW	70	kg
ATc	70	years
SFi	0.029	(mg/kg–day)–1
IRair	20	m3/day
EF	250	days/year
ED	25	years

RBSL(water) = RBSL(air)*0.001/VFwamb

RBSL	2.30062	mg/l–H2O
	2300.62	ug/l–H2O

RBSL(a)	0.493379	(ug/m3)
VFwamb	0.000214	(mg/m3)(mg/l)

VFwamb = H x 1000 l/m3/[1+(Uair*oair*Lgw/(W*Dws)]

VFwamb	0.000214	(mg/m3)(mg/l)

H	0.22	l water/l air
Uair	894	cm/s
oair	244	cm
Lgw	305	cm
W	2438	cm
Dws	0.026602	cm2/sec

Ds = Dair (Oas^3.33/Ot^3.33) + Dwat(1/H)(Ows^3.33/Ot^3.33)

Ds	0.026283	(cm2/sec)
Dair	0.093	cm2/s
Oas	0.26	
Ot	0.38	
Dwat	0.000011	cm2/s
H	0.22	l water/l air
Ows	0.12	

Dcap = Dair (Oacap^3.33/Ot^3.33) + Dwat(1/H)(Owcap^3.33/Ot^3.33)

Dcap	0.093035	cm2/sec
Dair	0.093	cm2/sec
Ocap	0.38	
Ot	0.38	
Dwat	0.000011	cm2/s
H	0.22	l water/l air
Owcap	0.342	

Dws = (Hcap + Hv)(Hcap/Dcap + Hv/Ds)^–1

Dws	0.026602	cm2/s
Hcap	5	cm
Hv	295	cm
Dcap	0.093035	cm2/s
Ds	0.026283	

1st Term	300
2nd Term	0.000089

1233TB9

MONTGOMERY WARDS – DUBLIN
HEALTH RISK ASSESSMENT
Toluene Impacts – Outdoor Air Concentrations

RBSL(air) = (THQ)(RfD)(BW)(ATn)(365)(1000)/(IR*EF*ED)

RBSL(air)	562.1	(ug/m3)
THQ	1	
RfD	0.11	mg/kg–day
BW	70	kg
ATn	25	years
IRair	20	m3/day
EF	250	days/year
ED	25	years

RBSL(water) = RBSL(air)*0.001/VFwamb

RBSL	2426.58	mg/l–H2O
	2426580	ug/l–H2O
RBSL(a)	562.1	(ug/m3)
VFwamb	0.000232	(mg/m3)(mg/l)

VFwamb = H x 1000 l/m3/[1+(Uair*oair*Lgw/(W*Dws)]

VFwamb	0.000232	(mg/m3)(mg/l)
H	0.26	l water/l air
Uair	894	cm/s
oair	244	cm
Lgw	305	cm
W	2438	cm
Dws	0.024313	cm2/sec

Ds = Dair (Oas^3.33/Ot^3.33) + Dwat(1/H)(Ows^3.33/Ot^3.33)

Ds	0.024022	(cm2/sec)
Dair	0.085	cm2/s
Oas	0.26	
Ot	0.38	
Dwat	9.4E–06	cm2/s
H	0.26	l water/l air
Ows	0.12	

Dcap = Dair (Oacap^3.33/Ot^3.33) + Dwat(1/H)(Owcap^3.33/Ot^3.33)

Dcap	0.08503	cm2/sec
Dair	0.085	cm2/sec
Ocap	0.38	
Ot	0.38	
Dwat	0.000011	cm2/s
H	0.26	l water/l air
Owcap	0.342	

Dws = (Hcap + Hv)(Hcap/Dcap + Hv/Ds)^–1

Dws	0.024313	cm2/s
Hcap	5	cm
Hv	295	cm
Dcap	0.08503	cm2/s
Ds	0.024022	
1st Term	300	
2nd Term	0.000081	

1233TB10

MONTGOMERY WARDS – DUBLIN
HEALTH RISK ASSESSMENT
Ethyl benzene Impacts – Outdoor Air Concentrations

RBSL(air) = (THQ)(RfD)(BW)(ATn)(365)(1000)/(IR*EF*ED)

RBSL(air)	1481.9	(ug/m3)

THQ	1
RfD	0.29 mg/kg–day
BW	70 kg
ATn	25 years
IRair	20 m3/day
EF	250 days/year
ED	25 years

RBSL(water) = RBSL(air)*0.001/VFwamb

RBSL	5813.413 mg/l–H2O
	5813413 ug/l–H2O

RBSL(a)	1481.9	(ug/m3)
VFwamb	0.000255	(mg/m3)(mg/l)

VFwamb = H x 1000 l/m3/[1+(Uair*oair*Lgw/(W*Dws)]

VFwamb	0.000255	(mg/m3)(mg/l)

H	0.32 l water/l air
Uair	894 cm/s
oair	244 cm
Lgw	305 cm
W	2438 cm
Dws	0.021739 cm2/sec

Ds = Dair (Oas^3.33/Ot^3.33) + Dwat(1/H)(Ows^3.33/Ot^3.33)

Ds	0.021479 (cm2/sec)
Dair	0.076 cm2/s
Oas	0.26
Ot	0.38
Dwat	8.5E–06 cm2/s
H	0.32 l water/l air
Ows	0.12

Dcap = Dair (Oacap^3.33/Ot^3.33) + Dwat(1/H)(Owcap^3.33/Ot^3.33)

Dcap	0.076024 cm2/sec
Dair	0.076 cm2/sec
Ocap	0.38
Ot	0.38
Dwat	0.000011 cm2/s
H	0.32 l water/l air
Owcap	0.342

Dws = (Hcap + Hv)(Hcap/Dcap + Hv/Ds)^–1

Dws	0.021739 cm2/s
Hcap	5 cm
Hv	295 cm
Dcap	0.076024 cm2/s
Ds	0.021479

1st Term	300
2nd Term	0.000072

1233TB11

MONTGOMERY WARDS -- DUBLIN
HEALTH RISK ASSESSMENT
Xylene Impacts -- Outdoor Air Concentrations

RBSL(air) = (THQ)(RfD)(BW)(ATn)(365)(1000)/(IR*EF*ED)

RBSL(air)	10220	(ug/m3)

THQ	1	
RfD	2	mg/kg-day
BW	70	kg
ATn	25	years
IRair	20	m3/day
EF	250	days/year
ED	25	years

RBSL(water) = RBSL(air)*0.001/VFwamb

RBSL	46697.56	mg/l-H2O
	46697562	ug/l-H2O

RBSL(a)	10220	(ug/m3)
VFwamb	0.000219	(mg/m3)(mg/l)

VFwamb = H x 1000 l/m3/[1+(Uair*oair*Lgw/(W*Dws)]

VFwamb	0.000219	(mg/m3)(mg/l)

H	0.29	l water/l air
Uair	894	cm/s
oair	244	cm
Lgw	305	cm
W	2438	cm
Dws	0.020595	cm2/sec

Ds = Dair (Oas^3.33/Ot^3.33) + Dwat(1/H)(Ows^3.33/Ot^3.33)

Ds	0.020348	(cm2/sec)
Dair	0.072	cm2/s
Oas	0.26	
Ot	0.38	
Dwat	8.5E-06	cm2/s
H	0.29	l water/l air
Ows	0.12	

Dcap = Dair (Oacap^3.33/Ot^3.33) + Dwat(1/H)(Owcap^3.33/Ot^3.33)

Dcap	0.072027	cm2/sec
Dair	0.072	cm2/sec
Ocap	0.38	
Ot	0.38	
Dwat	0.000011	cm2/s
H	0.29	l water/l air
Owcap	0.342	

Dws = (Hcap + Hv)(Hcap/Dcap + Hv/Ds)^-1

Dws	0.020595	cm2/s
Hcap	5	cm
Hv	295	cm
Dcap	0.072027	cm2/s
Ds	0.020348	

1st Term	300
2nd Term	0.000069

1233TB12

HEALTH RISK ASSESSMENT
TPH Impacts—Outdoor Air Concentrations

RBSL(air) = (TR)(BW)(ATc)(365)(1000)/(SFi*IR*EF*ED)

RBSL(air)	8.416471	(ug/m3)

TR	1.0E−06
BW	70 kg
ATc	70 years
SFi	0.0017 (mg/kg−day)−1
IRair	20 m3/day
EF	250 days/year
ED	25 years

RBSL(water) = RBSL(air)*0.001/VFwamb

RBSL	39.24587 mg/l−H2O
	39245.87 ug/l−H2O

RBSL(a)	8.416471	(ug/m3)
VFwamb	0.000214	(mg/m3)(mg/l)

VFwamb = H x 1000 l/m3/[1+(Uair*oair*Lgw/(W*Dws)]

VFwamb	0.000214 (mg/m3)(mg/l)

H	0.22 l water/l air
Uair	894 cm/s
oair	244 cm
Lgw	305 cm
W	2438 cm
Dws	0.026602 cm2/sec

Ds = Dair (Oas^3.33/Ot^3.33) + Dwat(1/H)(Ows^3.33/Ot^3.33)

Ds	0.026283 (cm2/sec)
Dair	0.093 cm2/s
Oas	0.26
Ot	0.38
Dwat	0.000011 cm2/s
H	0.22 l water/l air
Ows	0.12

Dcap = Dair (Oacap^3.33/Ot^3.33) + Dwat(1/H)(Owcap^3.33/Ot^3.33)

Dcap	0.093035 cm2/sec
Dair	0.093 cm2/sec
Ocap	0.38
Ot	0.38
Dwat	0.000011 cm2/s
H	0.22 l water/l air
Owcap	0.342

Dws = (Hcap + Hv)(Hcap/Dcap + Hv/Ds)^−1

Dws	0.026602 cm2/s
Hcap	5 cm
Hv	295 cm
Dcap	0.093035 cm2/s
Ds	0.026283

1st Term	300
2nd Term	0.000089

1233tbc

ATTACHMENT B

MONTGOMERY WARDS – DUBLIN
HEALTH RISK ASSESSMENT
Benzene Impacts – Indoor air

RBSL(air) = (TR)(BW)(ATc)(365)(1000)/(SFi*IR*EF*ED)

RBSL(air)	4.933793	(ug/m3)

TR	0.00001	
BW	70	kg
ATc	70	years
SFi	0.029	(mg/kg–day)–1
IRair	20	m3/day
EF	250	days/year
ED	25	years

Ds = Dair (Oas^3.33/Ot^3.33) + Dwat(1/H)(Ows^3.33/Ot^3.33)

Ds	0.026283	(cm2/sec)
Dair	0.093	cm2/s
Oas	0.26	
Ot	0.38	
Dwat	0.000011	cm2/s
H	0.22	l water/l air
Ows	0.12	

Dcrack = Dair (Oacrack^3.33/Ot^3.33) + Dwat(1/H)(Owcrack^3.33/Ot^3.33)

Dcrack	0.026283	cm2/sec
Dair	0.093	cm2/sec
Oacrack	0.26	
Ot	0.38	
Dwat	0.000011	cm2/s
H	0.22	l water/l air
Owcrack	0.12	

Dcap = Dair (Oacap^3.33/Ot^3.33) + Dwat(1/H)(Owcap^3.33/Ot^3.33)

Dcap	0.093035	cm2/sec
Dair	0.093	cm2/sec
Ocap	0.38	
Ot	0.38	
Dwat	0.000011	cm2/s
H	0.22	l water/l air
Owcap	0.342	

Dws = (Hcap + Hv)(Hcap/Dcap + Hv/Ds)^–1

Dws	0.026602	cm2/s
Hcap	5	cm
Hv	295	cm
Dcap	0.093035	cm2/s
Ds	0.026283	
1st Term	300	
2nd Term	0.000089	

VFwesp = H(Dws/Lgw/(ER*Lb)/1+(Dws/Lgw/(ER*Lb) + Dws/Lgw/(Dcrack/Lcrack)^n x1000

VFwesp	0.006784	kg/m3
H	0.22	l water/l air
Dws	0.026602	
Lgw	305	
ER	0.0028	
Lb	1010	
Dcrack	0.026283	g/cm3
Lcrack	15	
n	0.01	
1st Term	0.006785	
2nd Term	0.000031	
3rd Term	0.000093	

RBSLw = RBSLair x 0.001/VFwesp

RBSLw	0.727239	mg/l
or	727.2387	ug/l

1233TB1

MONTGOMERY WARDS – DUBLIN
HEALTH RISK ASSESSMENT
Toluene Impacts – Indoor air

RBSL(air) = (THQ)(RFDi)(BW)(ATn)(365)(1000)/(IRair*EF*ED)

RBSL(air)	562.1	(ug/m3)

THQ	1	
RFDi	0.11	inhalation chronic reference dose (mg/kg-day)
BW	70	kg
ATn	25	years
IRair	20	m3/day
EF	250	days/year
ED	25	years

Ds = Dair (Oas ^ 3.33/Ot ^ 3.33) + Dwat(1/H)(Ows ^ 3.33/Ot ^ 3.33)

Ds	0.024022	(cm2/sec)
Dair	0.085	cm2/s
Oas	0.26	
Ot	0.38	
Dwat	9.4E-06	cm2/s
H	0.26	l water/l air
Ows	0.12	

Dcrack = Dair (Oacrack ^ 3.33/Ot ^ 3.33) + Dwat(1/H)(Owcrack ^ 3.33/Ot ^ 3.33)

Dcrack	0.024022	cm2/sec
Dair	0.085	cm2/sec
Oacrack	0.26	
Ot	0.38	
Dwat	9.4E-06	cm2/s
H	0.26	l water/l air
Owcrack	0.12	

Dcap = Dair (Oacap ^ 3.33/Ot ^ 3.33) + Dwat(1/H)(Owcap ^ 3.33/Ot ^ 3.33)

Dcap	0.085025	cm2/sec
Dair	0.085	cm2/sec
Ocap	0.38	
Ot	0.38	
Dwat	9.4E-06	cm2/s
H	0.26	l water/l air
Owcap	0.342	

Dws = (Hcap + Hv)(Hcap/Dcap + Hv/Ds) ^ -1

Dws	0.024313	cm2/s
Hcap	5	cm
Hv	295	cm
Dcap	0.085025	cm2/s
Ds	0.024022	
1st Term	300	
2nd Term	0.000081	

VFwesp = H(Dws/Lgw/(ER*Lb)/1+(Dws/Lgw/(ER*Lb) + Dws/Lgw/(Dcrack/Lcrack) ^ n x1000

VFwesp	0.007328	kg/m3
H	0.26	l water/l air
Dws	0.024313	
Lgw	305	
ER	0.0028	
Lb	1010	
Dcrack	0.024022	g/cm3
Lcrack	15	
n	0.01	
1st Term	0.007329	
2nd Term	0.000028	
3rd Term	0.000085	

RBSLw = RBSLair x 0.001/VFwesp

RBSLw	76.70599	mg/l
or	76705.99	ug/l

1233TB6

MONTGOMERY WARDS – DUBLIN
HEALTH RISK ASSESSMENT
Ethylbenzene Impacts – Indoor air

RBSL(air) = (THQ)(RFDi)(BW)(ATn)(365)(1000)/(IRair*EF*ED)

RBSL(air)	1481.9	(ug/m3)

THQ	1	
RFDi	0.29	inhalation chronic reference dose (mg/kg–day)
BW	70	kg
ATn	25	years
IRair	20	m3/day
EF	250	days/year
ED	25	years

Ds = Dair (Oas ^ 3.33/Ot ^ 3.33) + Dwat(1/H)(Ows ^ 3.33/Ot ^ 3.33)

Ds	0.021479	(cm2/sec)
Dair	0.076	cm2/s
Oas	0.26	
Ot	0.38	
Dwat	8.5E–06	cm2/s
H	0.32	l water/l air
Ows	0.12	

Dcrack = Dair (Oacrack ^ 3.33/Ot ^ 3.33) + Dwat(1/H)(Owcrack ^ 3.33/Ot ^ 3.33)

Dcrack	0.021479	cm2/sec
Dair	0.076	cm2/sec
Oacrack	0.26	
Ot	0.38	
Dwat	8.5E–06	cm2/s
H	0.32	l water/l air
Owcrack	0.12	

Dcap = Dair (Oacap ^ 3.33/Ot ^ 3.33) + Dwat(1/H)(Owcap ^ 3.33/Ot ^ 3.33)

Dcap	0.076019	cm2/sec
Dair	0.076	cm2/sec
Ocap	0.38	
Ot	0.38	
Dwat	8.5E–06	cm2/s
H	0.32	l water/l air
Owcap	0.342	

Dws = (Hcap + Hv)(Hcap/Dcap + Hv/Ds) ^ –1

Dws	0.021739	cm2/s
Hcap	5	cm
Hv	295	cm
Dcap	0.076019	cm2/s
Ds	0.021479	
1st Term	300	
2nd Term	0.000072	

VFwesp = H(Dws/Lgw/(ER*Lb)/1+(Dws/Lgw/(ER*Lb) + Dws/Lgw/(Dcrack/Lcrack) ^ n x1000

VFwesp	0.008064	kg/m3
H	0.32	l water/l air
Dws	0.021739	
Lgw	305	
ER	0.0028	
Lb	1010	
Dcrack	0.021479	g/cm3
Lcrack	15	
n	0.01	
1st Term	0.008065	
2nd Term	0.000025	
3rd Term	0.000076	

RBSLw = RBSLair x 0.001/VFwesp

RBSLw	183.7641	mg/l
or	183764.1	ug/l

1233TB7

MONTGOMERY WARDS -- DUBLIN
HEALTH RISK ASSESSMENT
Xylene Impacts -- Indoor air

RBSL(air) = (THQ)(RFDi)(BW)(ATn)(365)(1000)/(IRair*EF*ED)

RBSL(air)	10220	(ug/m3)

THQ	1	
RFDi	2	inhalation chronic reference dose (mg/kg-day)
BW	70	kg
ATn	25	years
IRair	20	m3/day
EF	250	days/year
ED	25	years

Ds = Dair (Oas^3.33/Ot^3.33) + Dwat(1/H)(Ows^3.33/Ot^3.33)

Ds	0.020348	(cm2/sec)
Dair	0.072	cm2/s
Oas	0.26	
Ot	0.38	
Dwat	8.5E-06	cm2/s
H	0.29	l water/l air
Ows	0.12	

Dcrack = Dair (Oacrack^3.33/Ot^3.33) + Dwat(1/H)(Owcrack^3.33/Ot^3.33)

Dcrack	0.020348	cm2/sec
Dair	0.072	cm2/sec
Oacrack	0.26	
Ot	0.38	
Dwat	8.5E-06	cm2/s
H	0.29	l water/l air
Owcrack	0.12	

Dcap = Dair (Oacap^3.33/Ot^3.33) + Dwat(1/H)(Owcap^3.33/Ot^3.33)

Dcap	0.072021	cm2/sec
Dair	0.072	cm2/sec
Ocap	0.38	
Ot	0.38	
Dwat	8.5E-06	cm2/s
H	0.29	l water/l air
Owcap	0.342	

Dws = (Hcap + Hv)(Hcap/Dcap + Hv/Ds)^-1

Dws	0.020595	cm2/s
Hcap	5	cm
Hv	295	cm
Dcap	0.072021	cm2/s
Ds	0.020348	
1st Term	300	
2nd Term	0.000069	

VFwesp = H(Dws/Lgw/(ER*Lb)/1+(Dws/Lgw/(ER*Lb) + Dws/Lgw/(Dcrack/Lcrack)^n x1000

VFwesp	0.006924	kg/m3
H	0.29	l water/l air
Dws	0.020595	
Lgw	305	
ER	0.0028	
Lb	1010	
Dcrack	0.020348	g/cm3
Lcrack	15	
n	0.01	
1st Term	0.006924	
2nd Term	0.000024	
3rd Term	0.000072	

RBSLw = RBSLair x 0.001/VFwesp

RBSLw	1476.119	mg/l
or	1476119	ug/l

1233TB5

MONTGOMERY WARDS – DUBLIN
HEALTH RISK ASSESSMENT
Gasoline Vapor Impacts/Revised assumptions

RBSL(air) = (TR)(BW)(ATc)(365)(1000)/(SFi*IR*EF*ED)

RBSL(air)	84.16471	(ug/m3)

TR	0.00001	
BW	70	kg
ATc	70	years
SFi	0.0017	(mg/kg–day)–1
IRair	20	m3/day
EF	250	days/year
ED	25	years

Ds = Dair (Oas ^ 3.33/Ot ^ 3.33) + Dwat(1/H)(Ows ^ 3.33/Ot ^ 3.33)

Ds	0.026283	(cm2/sec)
Dair	0.093	cm2/s
Oas	0.26	
Ot	0.38	
Dwat	0.000011	cm2/s
H	0.22	l water/l air
Ows	0.12	

Dcrack = Dair (Oacrack ^ 3.33/Ot ^ 3.33) + Dwat(1/H)(Owcrack ^ 3.33/Ot ^ 3.33)

Dcrack	0.026283	cm2/sec
Dair	0.093	cm2/sec
Oacrack	0.26	
Ot	0.38	
Dwat	0.000011	cm2/s
H	0.22	l water/l air
Owcrack	0.12	

Dcap = Dair (Oacap ^ 3.33/Ot ^ 3.33) + Dwat(1/H)(Owcap ^ 3.33/Ot ^ 3.33)

Dcap	0.093035	cm2/sec
Dair	0.093	cm2/sec
Ocap	0.38	
Ot	0.38	
Dwat	0.000011	cm2/s
H	0.22	l water/l air
Owcap	0.342	

Dws = (Hcap + Hv)(Hcap/Dcap + Hv/Ds) ^ –1

Dws	0.026602	cm2/s
Hcap	5	cm
Hv	295	cm
Dcap	0.093035	cm2/s
Ds	0.026283	cm2/sec

1st Term	300
2nd Term	0.000089

VFwesp = H(Dws/Lgw/(ER*Lb)/1+(Dws/Lgw/(ER*Lb) + Dws/Lgw/(Dcrack/Lcrack) ^ n x1000

VFwesp	0.006784	kg/m3
H	0.22	l water/l air
Dws	0.026602	cm2/sec
Lgw	305	cm
ER	0.0028	1/sec
Lb	1010	cm
Dcrack	0.026283	g/cm3
Lcrack	15	cm
n	0.01	

1st Term	0.006785
2nd Term	0.000031
3rd Term	0.000093

RBSLw = RBSLair x 0.001/VFwesp

RBSLw	12.40604	mg/l
or	12406.04	ug/l

1233TB4