



3480 Buskirk Avenue
Pleasant Hill, CA 94523-4342
P.O. Box 8045
Walnut Creek, CA 94596-1220
(510) 937-9010
FAX (510) 937-9026

CONFIDENTIAL
95 SEP 13 PM 1:31

September 12, 1995

① What about soil to indoor?

Ms. Madhulla Logan
Department of Environmental Health
Environmental Protection Division
1131 Harbor Bay Parkway, #250
Alameda, CA 94502-6577

②

Subject: Response to County Comments on Risk Assessment Dated August 3, 1995
Former E-Z Serve Station #100877 Located at 525 West A Street Hayward, CA

Dear Ms. Logan:

This letter responds to each of the four issues raised in your letter of August 3, 1995.

1. As per guidelines published by the Environmental Protection Agency (EPA) and the Department of Toxic Substances Control (DTSC), the age (duration) and body weight of a child is taken to be 6 years and 15 kilograms, respectively. ✓

The values of 6 years for exposure duration and 15 kilograms for body weight for the child were inserted into the risk equations. The updated files are included as Attachment A. There was no significant change in the risk results.

2. The sampling data should be analyzed to determine if it follows a log normal or a normal distribution. This is important as the calculation for the 95% UCL of the average is different for both. Also if it happens to be log normal, then the non-detects would be calculated as detection limit/log of 2. This is given in the EPA reference "Supplemental Guidance to RAGS: Calculating the Concentration Term".

A statistical analysis of the data was conducted (see Attachment B) and the data was determined to follow a normal distribution. A coefficient-of-variation was conducted and the data were also plotted. No changes to the risk calculations were necessary.

3. Is the reasonable maximum exposure the same as the 95% UCL of the average.

The reasonable maximum exposure concentration is the 95% UCL of the average concentration.

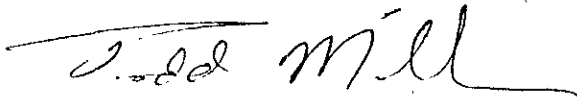
Ms. Madhulla Logan
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4. Provide more detailed information on models used for the indoor air volatilization pathway and the consumption of homegrown produce pathway. Give appropriate references for models, and the source/reference from which the exposure values were obtained. Also, include a rationale as to why a particular value was chose. Eg: a value of 0.002 was used for the soil organic carbon coefficient but no source reference or rationale has been given for using this value. If it is a site specific measured value, then please describe the procedure used for measurement.

More detail has been provided regarding references for models and sources of values on Tables 6-3, 6-4 and 6-12. Please refer to individual tables in Attachment A and the list of references in Attachment C.

If you have any questions please call me at (510) 210-2278.

Sincerely,



Todd Miller
Project Manager

002 - site

Enclosures
TD:lkg

cc: Mr. Brian Cobb
Mr. John Reeves

ATTACHMENT A
UPDATED RISK CALCULATIONS

Table 6-1 Summary of Risks
Former E-Z Serve Station #100877
525 West A Street, Hayward, California

Exposure Pathway	Risk	Hazard Index
Current Risk		
Inhalation of Indoor Air Through Crack in Foundation	2E-06	0.0003
Total	2E-06	0.0003
Future Risk		
Ingestion of Soil	2E-08	0.00003
Dermal Contact with Soil	1E-06	0.0003
Inhalation of Soil	1E-06	0.0002
Total	4E-06	0.0008
Hypothetical Groundwater Use		
Ingestion of Groundwater	2E-03	0.5
Dermal Contact with Groundwater While Bathing	4E-04	0.08
Inhalation of Groundwater While Bathing	1E-02	2
Ingestion of Homegrown Produce Via Irrigation	8E-07	0.001
Total	1E-02	2

**Table 6-2 Inhalation of Indoor Air Through a Crack in the Foundation
Former E-Z Serve Station #100877
525 West A Street, Hayward, California**

Calculation of Cancer Risk for Adults

Compound	Ciac mg/m ³	IR m ³ /day	EF days/year	ED yr	BW kg	AT days	Intake mg/kg/day	Inhalation Slope Factor (mg/kg/day) ⁻¹	Cancer Risk
Benzene	1.48E-04	20	365	30	70	25550	1.82E-05	1.00E-01	2E-06
Toluene	1.86E-05	20	365	30	70	25550	2.28E-06	-	-
Ethylbenzene	2.28E-05	20	365	30	70	25550	2.79E-06	-	-
Xylenes	1.02E-04	20	365	30	70	25550	1.25E-05	-	-
Total Individual Excess Cancer Risk									2E-06

Calculation of Hazard Quotient for Children

Compound	Ciac mg/m ³	IR m ³ /day	EF days/year	ED yr	BW kg	AT days	Intake mg/kg/day	Inhalation RfD mg/kg/day	Hazard Quotient
Benzene	1.48E-04	15	365	6	15	2190	1.48E-04	-	-
Toluene	1.86E-05	15	365	6	15	2190	1.86E-05	0.1	0.0002
Ethylbenzene	2.28E-05	15	365	6	15	2190	2.28E-05	0.3	0.00008
Xylenes	1.02E-04	15	365	6	15	2190	1.02E-04	-	-
Hazrd Index									0.0003

$$\text{Chronic Daily Intake} = (\text{Ciac} \times \text{IR} \times \text{EF} \times \text{ED}) / (\text{BW} \times \text{AT})$$

Where

Ciac = Concentration in air

IR = Inhalation rate

EF = Exposure frequency

ED = Exposure duration

BW = Body weight

AT = Averaging time

Cancer Risk = Intake x Slope Factor

Hazard Quotient = Intake / Reference Dose

**Table 6-3 Calculation of Indoor Air Concentration
Based on Chemical Concentrations in Groundwater and Soil
Former E-Z Serve Station #100877
525 West A Street, Hayward, California**

Parameter	Benzene	Toluene	Ethylbenzene	Xylenes
Pa, unitless	0.35	0.35	0.35	0.35
Pt, unitless	0.5	0.5	0.5	0.5
Do, cm ² /sec	0.08195	0.07367	0.06274	0.06742
Ds, cm ² /sec	0.0099	0.0089	0.0076	0.0082
T, K ¹	288	288	288	288
R, (atm x m ³)/(mole x K)	8.20E-05	8.20E-05	8.20E-05	8.20E-05
Cw, mg/L	1.879	0.143	0.599	1.716
H, (atm x m ³)/mole	5.59E-03	6.37E-03	6.43E-03	7.04E-03
Csg, mg/cm ³ (from GW)	4.45E-04	3.86E-05	1.63E-04	5.11E-04
Cs, mg/Kg	0.370	0.104	0.151	0.311
H'	0.24	0.27	0.27	0.30
B	1.8	1.8	1.8	1.8
Kd	0.039	0.14	0.52	0.11
Ow	0.1	0.1	0.1	0.1
Oa	0.22	0.22	0.22	0.22
Csg, mg/cm ³ (from soil)	7.08E-04	1.22E-04	6.78E-05	4.52E-04
total Csg, mg/cm ²	1.15E-03	1.61E-04	2.31E-04	9.64E-04
Ca, mg/cm ³	0	0	0	0
L, cm	488	488	488	488
J, mg/(cm ² x sec)	2.35E-08	2.94E-09	3.60E-09	1.61E-08
A, cm ²	790	790	790	790
VR, sec	3600	3600	3600	3600
V, m ³	450	450	450	450
IAC, mg/m ³	1.48E-04	1.86E-05	2.28E-05	1.02E-04

¹for Newark, from "Climatological Data Annual Summary, California 1993", V97 N13, NOAA

**Table 6-4 Calculation of Indoor Air Concentration Based on Chemical Concentration in Groundwater and Soil
Former E-Z Serve Station #100877
525 West A Street, Hayward, California**

$IAC = (J \times A \times VR) / V$

- IAC = Indoor air concentration, mg/m³
- J = Flux rate, mg/cm² x sec
- A = Area of exposed soil, cm²
- VR = Indoor air residence time, sec
- V = Indoor volume, m³

A = 790 cm² of exposed soil
0.5 cm crack along one side of a 2000 ft² home *where!*

VR = 3600 sec (one change per hour)

*used
databank
model*

V = 4.5E+02 m³
2000 ft² home with 8 ft ceilings built on a concrete slab
2000 ft² x 8 ft x 2.83E+04 cm³/ft³ x 10-6 m³/cm³ = 4.5E+02 m³

Flux at Soil Surface (Karimi, et al, 1987)

$J = (Ds(Ca - Csg)) / L$

- J = Vapor flux, mg/(cm² x sec)
- Ds = Effective vapor phase diffusion coefficient, cm²/sec
- L = Depth to groundwater, cm
- Ca = Concentration of vapor at surface, set = 0
- Csg = Concentration of vapor in soil gas, mg/cm³

Csg is estimated from concentrations in water (Cw) and soil (Cs)

Soil Gas Concentration from groundwater (EPA 1988)

$Csg = (H \times Cw) / (R \times T \times 1000)$

- H = Henry's Law Constant, (atm x m³)/mole
- Cw = Concentration in groundwater, mg/L
- R = Gas constant (8.2E-05 atm x m³/(mole x K))
- T = Mean annual air temperature, K

*low
vapor
solubility is
not taken
into effect*

Soil Gas Concentration from soil (TNRCC)

$Csg = (Cs \times H' \times B) / (Kd \times B + Ow + Oa \times H')$

- Csg = Soil Vapor Concentration, mg/L (mg/L x 1E-03L/cm³ = mg/cm³)
- Cs = Bulk soil concentration, mg/kg
- H' = Henry's Law Constant, unitless, H/R x T, H x 42.29
- R = Gas constant, 0.0000821 atm-m³/mole-K
- T = Absolute temperature, 273K + C, at 15 C
- B = Dry soil bulk density, 1.8 kg/L
- Kd = Soil water aprtition coefficient, Koc x Foc
- Koc = Oragnic carbon partition coefficient
- Foc = Soil organic carbon fraction, 0.00047
- Ow = Water content, 0.1

- Oa = Air fill soil porosity, O-Ow *0.2 - 0.1 = 0.1*
- O = total soil porosity, 1 - B/Pb, where Pb = particle density, 2.65 kg/L

Total Soil Gas Concentration = that from groundwater + that from soil

Effective Diffusion Coefficient (Karimi, et al, 1987)

$Ds = Do(Pa^{3.33} / Pt^2)$

- Do = Vapor phase diffusion coefficient at 10 C, cm²/sec
- Pt = Total porosity, unitless, 0.5
- Pa = Air filled porosity, unitless, 0.35

0.35

*328 ft
1600 x 3
2.54 cm*

**Table 6-5 Ingestion of Soil
Former E-Z Serve Station #100877
525 West A Street, Hayward, California**

Calculation of Cancer Risk for Adults

Compound	Cs mg/kg	IR mg/day	CF kg/mg	FI -	EF days/year	ED yr	BW kg	AT days	Intake mg/kg/day	Oral Slope Factor (mg/kg/day) ⁻¹	Cancer Risk
Benzene	0.370	100	1E-06	1	365	30	70	25550	2.27E-07	1.00E-01	2E-08
Toluene	0.104	100	1E-06	1	365	30	70	25550	6.37E-08	-	-
Ethylbenzene	0.151	100	1E-06	1	365	30	70	25550	9.24E-08	-	-
Xylenes	0.311	100	1E-06	1	365	30	70	25550	1.90E-07	-	-
Total Individual Excess Cancer Risk											2E-08

Calculation of Hazard Index for Children

Compound	Cs mg/kg	IR mg/day	CF kg/mg	FI -	EF days/year	ED yr	BW kg	AT days	Intake mg/kg/day	Oral Reference Dose mg/kg/day	Hazard Quotient
Benzene	0.370	200	1E-06	1	365	6	15	2190	4.93E-06	-	-
Toluene	0.104	200	1E-06	1	365	6	15	2190	1.39E-06	0.2	0.00001
Ethylbenzene	0.151	200	1E-06	1	365	6	15	2190	2.01E-06	0.1	0.00002
Xylenes	0.311	200	1E-06	1	365	6	15	2190	4.15E-06	2	0.00002
Hazard Index											0.00003

Chronic Daily Intake = (Cs x IR x CF x FI x EF x ED)/(BW x AT)

- Where
- Cs = Concentration in soil
 - IR = Ingestion rate
 - CF = Conversion factor
 - FI = Fraction ingested, assume 100%
 - EF = Exposure frequency
 - ED = Exposure duration
 - BW = Body weight
 - AT = Averaging time

Cancer Risk = Intake x Slope Factor
Hazard Quotient = Intake / Reference Dose

effective or not (total effect points)

**Table 6-6 Dermal Contact with Soil
Former E-Z Serve Station #100877
525 West A Street, Hayward, California**

Calculation of Cancer Risk for Adults

Compound	Cs mg/kg	SA cm ²	AF mg/cm ²	CF kg/mg	ABS -	EF days/year	ED yr	BW kg	AT days	Intake mg/kg/day	Oral Slope Factor (mg/kg/day) ⁻¹	Cancer Risk
Benzene	0.370	3120	1.45	1.00E-06	1	365	30	70	25550	1.02E-05	1.00E-01	1E-06
Toluene	0.104	3120	1.45	1.00E-06	1	365	30	70	25550	2.88E-06	-	-
Ethylbenzene	0.151	3120	1.45	1.00E-06	1	365	30	70	25550	4.18E-06	-	-
Xylenes	0.311	3120	1.45	1.00E-06	1	365	30	70	25550	8.61E-06	-	-
Total Individual Excess Cancer Risk												1E-06

Calculation of Hazard Index for Children

Compound	Cs mg/kg	SA cm ²	AF mg/cm ²	CF kg/mg	ABS -	EF days/year	ED yr	BW kg	AT days	Intake mg/kg/day	Oral RfD mg/kg/day	Hazard Quotient
Benzene	0.370	1580	1.45	1.00E-06	1	365	6	15	2190	5.65E-05	-	-
Toluene	0.104	1580	1.45	1.00E-06	1	365	6	15	2190	1.59E-05	0.2	0.0001
Ethylbenzene	0.151	1580	1.45	1.00E-06	1	365	6	15	2190	2.31E-05	0.1	0.0002
Xylenes	0.311	1580	1.45	1.00E-06	1	365	6	15	2190	4.75E-05	2	0.0002
Total Hazard Index												0.0003

Chronic Daily Intake = (Cs x SA x AF x ABS x ED x EF x CF)/(BW x AT)

Where

- Cs = Chemical concentration in water
- SA = Skin surface area available for contact, hands and arms
- AF = Adherence Factor, 1.45 potting soil, 2.77 kaolin clay
- ABS = Absorption Factor
- EF = Exposure frequency
- ED = Exposure duration
- CF = Conversion factor
- BW = Body weight
- AT = Averaging time

Cancer Risk = Intake x Slope Factor

Hazard Quotient = Intake / Reference Dose

**Table 6-7 Inhalation of Soil
Former E-Z Serve Station #100877
525 West A Street, Hayward, California**

Calculation of Cancer Risk for Adults

Compound	Cs mg/Kg	IR m ³ /day	EF days/yr	ED yr	VF m ³ /kg	PEF m ³ /kg	BW kg	AT days	Intake mg/kg/day	Inhalation Slope Factor (mg/kg/day) ⁻¹	Cancer Risk
Benzene	0.370	20	365	30	3536	4.63E+09	70	25550	1.28E-05	1.00E-01	1E-06
Toluene	0.104	20	365	30	6705	4.63E+09	70	25550	1.90E-06	-	-
Ethylbenzene	0.151	20	365	30	13892	4.63E+09	70	25550	1.33E-06	-	-
Xylenes	0.311	20	365	30	5954	4.63E+09	70	25550	6.40E-06	-	-
Total Individual Excess Cancer Risk											1E-06

Calculation of Hazard Index for Children

Compound	Cs mg/Kg	IR m ³ /day	EF days/yr	ED yr	VF m ³ /kg	PEF m ³ /kg	BW kg	AT days	Intake mg/kg/day	Inhalation Reference Dose mg/kg/day	Hazard Quotient
Benzene	0.370	15	365	6	3536	4.63E+09	15	2190	1.05E-04	-	-
Toluene	0.104	15	365	6	6705	4.63E+09	15	2190	1.55E-05	0.1	0.0002
Ethylbenzene	0.151	15	365	6	13892	4.63E+09	15	2190	1.09E-05	0.3	0.00004
Xylenes	0.311	15	365	6	5954	4.63E+09	15	2190	5.22E-05	-	-
Hazard Index											0.0002

Chronic Daily Intake = (Cs x IR x EF x ED (1/VF + 1/PEF))/(BW x AT)

Where

- Cs = Concentration in soil
- IR = Ingestion rate
- EF = Exposure frequency
- ED = Exposure duration
- VF = Volatilization factor
- PEF = Particulate emission factor
- BW = Body weight
- AT = Averaging time

**Table 6-8 Calculation of the Volatilization Factor (VF)
Former E-Z Serve Station #100877
525 West A Street, Hayward, California**

Compound	LS	V	DH	A	ps	o	T	Di	Dei	E	H	foc	Koc	Kd	Kas	VF
Benzene	45	2.25	2	20,250,000	2.65	1.58E-03	7.90E+08	0.08195	0.0580	0.35	5.59E-03	0.02	83	1.66	0.138	3,536
Toluene	45	2.25	2	20,250,000	2.65	4.57E-04	7.90E+08	0.07367	0.0521	0.35	6.37E-03	0.02	300	6.00	0.044	6,705
Ethylbenzene	45	2.25	2	20,250,000	2.65	1.08E-04	7.90E+08	0.06274	0.0444	0.35	6.43E-03	0.02	1100	22.00	0.012	13,892
Xylenes	45	2.25	2	20,250,000	2.65	5.76E-04	7.90E+08	0.06742	0.0477	0.35	7.04E-03	0.02	240	4.80	0.060	5,954

$$VF = ((LS \times V \times DH) / A) \times ((3.14 \times o \times T)^{1/2} / (2 \times Dei \times E \times Kas \times 10^{-3}))$$

Where

LS = Length of side of contaminated area, m, 45m →

V = Wind speed in mining zone, m/s, 2.25 m/s

DH = Diffusion height, m, 2m

A = Area of contamination, cm², 20,250,000 cm²

o =

T = Exposure interval, s, 7.90E+08 s

Dei = Effective diffusivity, cm²/s

E = True soil porosity, 0.35

Kas = Soil-air partition coefficient, g-soil/cm³-air

$$o = (Dei \times E) / (E + (ps) \times (1-E)/Kas)$$

Where

ps = True soil density or particle density, g/cm³, 2.65 g/cm³

$$Dei = Di \times (E^{0.33})$$

Where

Di = Diffusivity in air

$$Kas = (H/Kd) \times 41$$

Where

H = Henry's Law Constant, atm-m³/mol

Kd = Soil-water partition coefficient, cm³/g

$$Kd = Koc \times foc$$

Where

Koc = Organic carbon partition coefficient, cm³/g

foc = fraction organic carbon content of soil, 0.02

**Table 6-9 Ingestion of Groundwater
Former E-Z Serve Station #100877
525 West A Street, Hayward, California**

Calculation of Cancer Risk for Adults

Compound	Cw mg/L	IR L/day	EF days/year	ED yr	BW kg	AT days	Intake mg/kg/day	Oral Slope Factor (mg/kg/day) ⁻¹	Cancer Risk
Benzene	1.88	2	365	30	70	25550	2.30E-02	1.00E-01	2E-03
Toluene	0.14	2	365	30	70	25550	1.75E-03	-	-
Ethylbenzene	0.60	2	365	30	70	25550	7.34E-03	-	-
Xylenes	1.72	2	365	30	70	25550	2.10E-02	-	-
Total Individual Excess Cancer Risk									2E-03

Calculation of Hazard Index for Children

Compound	Cw mg/L	IR L/day	EF days/year	ED yr	BW kg	AT days	Intake mg/kg/day	Oral Reference Dose mg/kg/day	Hazard Quotient
Benzene	1.88	1	365	6	15	2190	1.25E-01	-	-
Toluene	0.14	1	365	6	15	2190	9.54E-03	0.2	0.05
Ethylbenzene	0.60	1	365	6	15	2190	3.99E-02	0.1	0.40
Xylenes	1.72	1	365	6	15	2190	1.14E-01	2	0.06
Hazard Index									0.50

Chronic Daily Intake = (Cw x IR x EF x ED)/(BW x AT)

Where

Cw = Concentration in water

IR = Ingestion rate

EF = Exposure frequency

ED = Exposure duration

BW = Body weight

AT = Averaging time

Cancer Risk = Intake x Slope Factor

Hazard Quotient = Intake / Reference Dose

**Table 6-10 Dermal Contact with Groundwater while Bathing
Former E-Z Serve Station #100877
525 West A Street, Hayward, California**

Calculation of Cancer Risk for Adults

Compound	Cw mg/L	SA cm ²	PC cm/hour	CF 1L/1000 cm ³	ET hr/day	EF days/year	ED yr	BW kg	AT days	Intake mg/kg/day	Oral Slope Factor (mg/kg/day) ⁻¹	Cancer Risk
Benzene	1.88	18150	0.1	0.001	0.2	365	30	70	25550	4.18E-03	1.00E-01	4E-04
Toluene	0.14	18150	0.1	0.001	0.2	365	30	70	25550	3.18E-04	-	-
Ethylbenzene	0.60	18150	0.1	0.001	0.2	365	30	70	25550	1.33E-03	-	-
Xylenes	1.72	18150	0.1	0.001	0.2	365	30	70	25550	3.81E-03	-	-
Total Individual Excess Cancer Risk												4E-04

Calculation of Hazard Index for Children

Compound	Cw mg/L	SA cm ²	PC cm/hour	CF 1L/1000 cm ³	ET hr/day	EF days/year	ED yr	BW kg	AT days	Intake mg/kg/day	Oral RfD mg/kg/day	Hazard Quotient
Benzene	1.88	8223	0.1	0.001	0.2	365	6	15	2190	2.06E-02	-	-
Toluene	0.14	8223	0.1	0.001	0.2	365	6	15	2190	1.57E-03	0.2	0.008
Ethylbenzene	0.60	8223	0.1	0.001	0.2	365	6	15	2190	6.57E-03	0.1	0.07
Xylenes	1.72	8223	0.1	0.001	0.2	365	6	15	2190	1.88E-02	2	0.009
Total Hazard Index												0.08

$$\text{Chronic Daily Intake} = (\text{Cw} \times \text{SA} \times \text{PC} \times \text{ED} \times \text{ET} \times \text{EF} \times \text{CF}) / (\text{BW} \times \text{AT})$$

Where

- Cw = Chemical concentration in water
- SA = Skin surface area available for contact
- PC = Permeability coefficient
- ET = Exposure time
- EF = Exposure frequency
- ED = Exposure duration
- CF = Conversion factor
- BW = Body weight
- AT = Averaging time

- Cancer Risk = Intake x Slope Factor
- Hazard Quotient = Intake / Reference Dose

**Table 6-11 Inhalation of Groundwater While Bathing
Former E-Z Serve Station #100877
525 West A Street, Hayward, California**

Calculation of Cancer Risk for Adults

Compound	Cw mg/L	K L/m ³	IR m ³ /day	EF days/year	ED yr	BW kg	AT days	Intake mg/kg/day	Inhalation Slope Factor (mg/kg/day) ⁻¹	Cancer Risk
Benzene	1.88	0.50	20	365	30	70	25550	1.15E-01	1.00E-01	1E-02
Toluene	0.14	0.50	20	365	30	70	25550	8.76E-03	-	-
Ethylbenzene	0.60	0.50	20	365	30	70	25550	3.67E-02	-	-
Xylenes	1.72	0.50	20	365	30	70	25550	1.05E-01	-	-
Total Individual Excess Cancer Risk										1E-02

Calculation of Hazard Quotient for Children

Compound	Cw mg/L	K L/m ³	IR m ³ /day	EF days/year	ED yr	BW kg	AT days	Intake mg/kg/day	Inhalation RfD mg/kg/day	Hazard Quotient
Benzene	1.88	0.50	15	365	6	15	2190	9.40E-01	-	-
Toluene	0.14	0.50	15	365	6	15	2190	7.16E-02	0.1	0.72
Ethylbenzene	0.60	0.50	15	365	6	15	2190	3.00E-01	0.3	1.00
Xylenes	1.72	0.50	15	365	6	15	2190	8.58E-01	-	-
Hazard Index										1.71

Chronic Daily Intake = (Cw x K x IR x EF x ED)/(BW x AT)

Where

Cw = Concentration in water

K = Volatilization factor

IR = Inhalation rate

EF = Exposure frequency

ED = Exposure duration

BW = Body weight

AT = Averaging time

Cancer Risk = Intake x Slope Factor

Hazard Quotient = Intake / Reference Dose

**Table 6-12 Ingestion of Homegrown Produce Via Irrigation
Former E-Z Serve Station #100877
525 West A Street, Hayward, California**

Input Parameters

Compound	Ksp	log Ksp	Kd	log Kow	log Koc	Foc
Benzene	2.30	0.36	0.04	2.12	1.92	0.00047
Toluene	1.02	0.01	0.14	2.73	2.48	0.00047
Ethylbenzene	0.59	-0.23	0.52	3.15	3.04	0.00047
Xylenes	0.51	-0.30	0.11	3.26	2.38	0.00047

Calculation of Cancer Risk for Adults

Compound	Cw mg/L	Cs mg/kg	Cp mg/kg	IR ¹ kg/day	GI -	L ² -	EF days/yr	ED yr	BW kg	AT days	Chronic Daily Intake mg/kg/day	Oral Slope Factor (mg/kg/day) ⁻¹	Cancer Risk
Benzene	1.88	3.67E-02	1.69E-02	2.50E-01	1	0.30	365	30	70	25550	7.78E-06	1.00E-01	8E-07
Toluene	0.14	1.02E-02	2.08E-03	2.50E-01	1	0.30	365	30	70	25550	9.55E-07	-	-
Ethylbenzene	0.60	1.54E-01	1.81E-02	2.50E-01	1	0.30	365	30	70	25550	8.30E-06	-	-
Xylenes	1.72	9.67E-02	9.78E-03	2.50E-01	1	0.30	365	30	70	25550	4.49E-06	-	-
Total Individual Excess Cancer Risk													8E-07

Calculation of Hazard Index for Children

Compound	Cw mg/L	Cs mg/kg	Cp mg/kg	IR ¹ kg/day	GI -	L ² -	EF days/yr	ED yr	BW kg	AT days	Chronic Daily Intake mg/kg/day	Oral Reference Dose (mg/kg/day)	Hazard Quotient
Benzene	1.88	3.67E-02	1.69E-02	2.50E-01	1	0.30	365	6	15	2190	8.47E-05	-	-
Toluene	0.14	1.02E-02	2.08E-03	2.50E-01	1	0.30	365	6	15	2190	1.04E-05	0.2	0.00005
Ethylbenzene	0.60	1.54E-01	1.81E-02	2.50E-01	1	0.30	365	6	15	2190	9.03E-05	0.1	0.0009
Xylenes	1.72	9.67E-02	9.78E-03	2.50E-01	1	0.30	365	6	15	2190	4.89E-05	2	0.00002
Hazard Index													0.001

Concentration in surface soil, Cs = Cw x Kd x 0.5 (Based on steady-state conditions)

where:

Cw = Concentration in water

Kd = Soil to water partition coefficient

0.5 =

Concentration in plants, Cp = 0.2 x Ksp x Cs (McKone, 1988)

where:

Cs = Concentration in soil

Ksp = Soil to plant partition coefficient

0.2 =

Chronic Daily Intake = (Cp x IR x GI x L x ED x EF) / (BW x AT)

where:

Cp = Concentration in plant

IR = Ingestion rate

GI = Gastrointestinal absorption factor

L = Fraction of plant homegrown

BW = Body weight

ED = Exposure duration

EF = Exposure frequency

AT = Averaging time

Cancer Risk = Chronic Daily Intake x Slope Factor

Hazard Quotient = Chronic Daily Intake / Reference Dose

Parameter	Reference
Ksp	
log Ksp	1.588-0.578*logKow (Travis, 1988)
Kd	Koc*Foc
log Kow	Superfund Public Health Evaluation Manual, October 1986
log Koc	Superfund Public Health Evaluation Manual, October 1986
Foc	Based on data collected from a State Superfund Site in the Bay Area

¹CAPCOA, 1993. The value for vine crops was chosen for the ingestion rate as it is more conservative than the value for root or leafy crops when combined with the interception fraction for vine crops.

²EPA 1989. Exposure Factors Handbook, EPA/600/8-89/043, May 1989, Value for worst case scenario.

where:

Kow = octanol:water partition coefficient

Koc = organic:carbon partition coefficient

foc = fraction organic carbon in soil

Ksp = soil:plant partition coefficient

**ATTACHMENT B
STATISTICAL ANALYSIS**



STATISTICAL ANALYSIS OF GROUND-WATER MONITORING DATA AT RCRA FACILITIES

INTERIM FINAL GUIDANCE

**OFFICE OF SOLID WASTE
WASTE MANAGEMENT DIVISION
U.S. ENVIRONMENTAL PROTECTION AGENCY
401 M STREET, S.W.
WASHINGTON, D.C. 20460**

4.2 CHECKING DISTRIBUTIONAL ASSUMPTIONS

The purpose of this section is to provide users with methods to check the distributional assumptions of the statistical procedures recommended for ground-water monitoring. It is emphasized that one need not do an extensive study of the distribution of the data unless a nonparametric method of analysis is used to evaluate the data. If the owner or operator wishes to transform the data in lieu of using a nonparametric method, it must first be shown that the untransformed data are inappropriate for a normal theory test. Similarly, if the owner or operator wishes to use nonparametric methods, he or she must demonstrate that the data do violate normality assumptions.

EPA has adopted this approach because most of the statistical procedures that meet the criteria set forth in the regulations are robust with respect to departures from many of the normal distributional assumptions. That is, only extreme violations of assumptions will result in an incorrect outcome of a statistical test. Moreover, it is only in situations where it is unclear whether contamination is present that departures from assumptions will alter the outcome of a statistical test. EPA therefore believes that it is protective of the environment to adopt the approach of not requiring testing of assumptions of a normal distribution on a wide scale.

It should be noted that the normal distributional assumptions for statistical procedures apply to the errors of the observations. Application of the distributional tests to the observations themselves may lead to the conclusion that the distribution does not fit the observations. In some cases this lack of fit may be due to differences in means for the different wells or some other cause. The tests for distributional assumptions are best applied to the residuals from a statistical analysis. A residual is the difference between the original observation and the value predicted by a model. For example, in analysis of variance, the predicted values are the group means and the residual is the difference between each observation and its group mean.

If the conclusion from testing the assumptions is that the assumptions are not adequately met, then a transformation of the data may be used or a nonparametric statistical procedure selected. Many types of concentration data have been reported in the literature to be adequately described by a log-normal distribution. That is, the natural logarithm of the original observations has been found to follow the normal distribution. Consequently, if the normal distributional assumptions are found to be violated for the original data, a transformation by taking the natural logarithm of each observation is suggested. This assumes that the data are all positive. If the log transformation does not adequately normalize the data or stabilize the variance, one should use a nonparametric procedure or seek the consultation of a professional statistician to determine an appropriate statistical procedure.

The following sections present four selected approaches to check for normality. The first option refers to literature citation, the other three are statistical procedures. The choice is left to the user. The availability of statistical software and the user's familiarity with it will be a factor in the choice of a method. The coefficient of variation method, for example, requires only the computation of the mean and standard deviation of the data.

Plotting on probability paper can be done by hand but becomes tedious with many data sets. However, the commercial Statistical Analysis System (SAS) software package provides a computerized version of a probability plot in its PROC UNIVARIATE procedure. SYSTAT, a package for PCs also has a probability plot procedure. The chi-squared test is not readily available through commercial software but can be programmed on a PC (for example in LOTUS 1-2-3) or in any other (statistical) software language with which the user is familiar. The amount of data available will also influence the choice. All tests of distributional assumptions require a fairly large sample size to detect moderate to small deviations from normality. The chi-squared test requires a minimum of 20 samples for a reasonable test.

Other statistical procedures are available for checking distributional assumptions. The more advanced user is referred to the Kolmogorov-Smirnov test (see, for example, Lindgren, 1976) which is used to test the hypothesis that data come from a specific (that is, completely specified) distribution. The normal distribution assumption can thus be tested for. A minimum sample size of 50 is recommended for using this test.

A modification to the Kolmogorov-Smirnov test has been developed by Lilliefors who uses the sample mean and standard deviation from the data as the parameters of the distribution (Lilliefors, 1967). Again, a sample size of at least 50 is recommended.

Another alternative to testing for normality is provided by the rather involved Shapiro-Wilk's test. The interested user is referred to the relevant article in *Biometrika* by Shapiro and Wilk (1965).

4.2.1 Literature Citation

PURPOSE

An owner or operator may wish to consult literature to determine what type of distribution the ground-water monitoring data for a specific constituent are likely to follow. In cases where insufficient data prevents the use of a quantitative method for checking distributional assumptions, this approach may be necessary and make it easier to determine whether there is statistically significant evidence of contamination.

PROCEDURE

One simple way to select a procedure based on a specific statistical distribution, is by citing a relevant published reference. The owner or operator may find papers that discuss data resulting from sampling ground water and conclude that such data for a particular constituent follow a specified distribution. Citing such a reference may be sufficient justification for using a method based on that distribution, provided that the data do not show evidence that the assumptions are violated.

To justify the use of a literature citation, the owner or operator needs to make sure that the reference cited considers the distribution of data for the specific compound being monitored. In addition, he or she must evaluate

the similarity of their site to the site that was discussed in the literature, especially similar hydrogeologic and potential contaminant characteristics. However, because many of the compounds may not be studied in the literature, extrapolations to compounds with similar chemical characteristics and to sites with similar hydrogeologic conditions are also acceptable. Basically, the owner or operator needs to provide some reason or justification for choosing a particular distribution.

4.2.2 Coefficient-of-Variation Test

Many statistical procedures assume that the data are normally distributed. The concentration of a hazardous constituent in ground water is inherently nonnegative, while the normal distribution allows for negative values. However, if the mean of the normal distribution is sufficiently above zero, the distribution places very little probability on negative observations and is still a valid approximation.

One simple check that can rule out use of the normal distribution is to calculate the coefficient of variation of the data. The use of this method was required by the former Part 264 Subpart F regulations pursuant to Section 264.97(h)(1). Because most owners and operators as well as Regional personnel are already familiar with this procedure, it will probably be used frequently. The coefficient of variation, CV, is the standard deviation of the observations, divided by their mean. If the normal distribution is to be a valid model, there should be very little probability of negative values. The number of standard deviations by which the mean exceeds zero determines the probability of negative values. For example, if the mean exceeds zero by one standard deviation, the normal distribution will have less than 0.159 probability of a negative observation.

Consequently, one can calculate the standard deviation of the observations, calculate the mean, and form the ratio of the standard deviation divided by the mean. If this ratio exceeds 1.00, there is evidence that the data are not normal and the normal distribution should not be used for those data. (There are other possibilities for nonnormality, but this is a simple check that can rule out obviously nonnormal data.)

PURPOSE

This test is a simple check for evidence of gross nonnormality in the ground-water monitoring data.

PROCEDURE

To apply the coefficient-of-variation check for normality proceed as follows.

Step 1. Calculate the sample mean, \bar{X} , of n observations X_i , $i=1, \dots, n$:

$$\bar{X} = \left(\sum_{i=1}^n X_i \right) / n$$

Step 2. Calculate the sample standard deviation, S .*

$$S = \left[\sum_{j=1}^n (X_j - \bar{X})^2 / (n - 1) \right]^{1/2}$$

Step 3. Divide the sample standard deviation by the sample mean. This ratio is the CV.

$$CV = S/\bar{X}.$$

Step 4. Determine if the result of Step 3 exceeds 1.00. If so, this is evidence that the normal distribution does not fit the data adequately.

EXAMPLE

Table 4-1 is an example data set of chlordane concentrations in 24 water samples from a fictitious site. The data are presented in order from least to greatest.

Applying the procedure steps to the data of Table 4-1, we have:

Step 1. $\bar{X} = 1.52$

Step 2. $S = 1.56$

Step 3. $CV = 1.56/1.52 = 1.03$

Step 4. Because the result of Step 3 was 1.03, which exceeds 1.00, we conclude that there is evidence that the data do not adequately follow the normal distribution. As will be discussed in other sections one would then either transform the data, use a nonparametric procedure, or seek professional guidance.

* Throughout this document we use S^2 to denote the unbiased estimate of the population variance σ^2 . We refer to this unbiased estimate of the population variance as the sample variance. The formula given in Step 2 above for S , the square root of the unbiased estimate of the population variance, is used as the sample estimate of the standard deviation and is referred to as the "sample standard deviation." Any computation of the sample standard deviation or the sample variance, unless explicitly noted otherwise, refers to these formulas. It should be noted that this estimate of the standard deviation is not unbiased in that its expected value is not equal to the population standard deviation. However, all of the statistical procedures have been developed using the formulas as we define them here.

TABLE 4-1. EXAMPLE DATA FOR COEFFICIENT-
OF-VARIATION TEST

Chlordane concentration (ppm)	
	0.04
	0.18
	0.18
	0.25
	0.29
	0.38
	0.50
	0.50
	0.60
Dissolved phase	0.93
	0.97
	1.10
	1.16
	1.29
	1.37
	1.38
	1.45
	1.46
	2.58
	2.69
	2.80
Immiscible phase	3.33
	4.50
	6.60

NOTE. The owner or operator may choose to use parametric tests since 1.03 is so close to the limit but should use a transformation or a nonparametric test if he or she believes that the parametric test results would be incorrect due to the departure from normality.

4.2.3 Plotting on Probability Paper

PURPOSE

Probability paper is a visual aid and diagnostic tool in determining whether a small set of data follows a normal distribution. Also, approximate estimates of the mean and standard deviation of the distribution can be read from the plot.

PROCEDURE

Let X be the variable; $X_1, X_2, \dots, X_1, \dots, X_n$ the set of n observations. The values of X can be raw data, residuals, or transformed data.

Step 1. Rearrange the observations in ascending order:

$$X(1), X(2), \dots, X(n).$$

Step 2. Compute the cumulative frequency for each distinct value $X(i)$ as $(i/(n+1)) \times 100\%$. The divisor of $(n+1)$ is a plotting convention to avoid cumulative frequencies of 100% which would be at infinity on the probability paper.

If a value of X occurs more than once, then the corresponding value of i increases appropriately. For example, if $X(2) = X(3)$, then the cumulative frequency for $X(1)$ is $100 \times 1/(n+1)$, but the cumulative frequency for $X(2)$ or $X(3)$ is $100 \times (1+2)/(n+1)$.

Step 3. Plot the distinct pairs $[X(i), (i/(n+1)) \times 100]$ values on probability paper (this paper is commercially available) using an appropriate scale for X on the horizontal axis. The vertical axis for the cumulative frequencies is already scaled from 0.01 to 99.99%.

If the points fall roughly on a straight line (the line can be drawn with a ruler), then one can conclude that the underlying distribution is approximately normal. Also, an estimate of the mean and standard deviation can be made from the plot. The horizontal line drawn through 50% cuts the plotted line at the mean of the X values. The horizontal line going through 84% cuts the line at a value corresponding to the mean plus one standard deviation. By subtraction, one obtains the standard deviation.

REFERENCE

Dixon, W. J., and F. J. Massey, Jr. *Introduction to Statistical Analysis*. McGraw-Hill, Fourth Edition, 1983.

EXAMPLE

Table 4-2 lists 22 distinct chlordane concentration values (X) along with their frequencies. These are the same values as those listed in Table 4-1. There is a total of $n=24$ observations.

Step 1. Sort the values of X in ascending order (column 1).

Step 2. Compute $[100 \times (i/25)]$, column 4, for each distinct value of X , based on the values of i (column 2).

Step 3. Plot the pairs $[X_i, 100 \times (i/25)]$ on probability paper (Figure 4-2).

INTERPRETATION

The points in Figure 4-2 do not fall on a straight line; therefore, the hypothesis of an underlying normal distribution is rejected. However, the

MIKECV.XLS

Parameter		TPHg ¹	Benzene	Toluene	Ethylbenze	Xylenes
MW-1	34456	7200	2100	29	490	520
MW-1	34516	13000	3700	150	550	12000
MW-1	34597	10000	3100	75	440	870
MW-1	34673	8700	3700	87	520	950
MW-1	34773	290	56	2	12	47
MW-1A	34516	12000	1100	3.321928	920	1100
Mean		8531.667	2292.667	57.72032	488.6667	2581.167
Std. Dev.		4558.028	1488.302	57.55036	289.9563	4629.632
CV.		53.42482	64.91576	99.70555	59.33622	179.362
MW-2	34456	18000	3800	260	1100	3500
MW-2	34516	18000	3700	510	870	2600
MW-2	34597	19000	4500	300	1200	4000
MW-2	34674	22000	4700	340	1400	4500
MW-2	34773	29000	5600	350	1900	6300
Mean		21200	4460	352	1294	4180
Std. Dev.		4658.326	770.0649	95.23655	388.8187	1377.316
CV.		21.97324	17.26603	27.05584	30.04781	32.95015
MW-3	34456	4200	680	48	310	540
MW-3	34516	4600	600	63	240	470
MW-3	34597	8200	2200	130	670	930
MW-3	34674	4000	640	34	290	480
MW-3	34773	4300	980	47	370	780
Mean		5060	1020	64.4	376	640
Std. Dev.		1768.615	676.4614	38.0828	170.8215	205.061
CV.		34.95287	66.31974	59.13479	45.43126	32.04078
MW-4	34456	10000	2200	440	470	1200
MW-4	34516	8200	2000	370	350	930
MW-4	34597	7200	2000	360	380	1000
MW-4	34674	9000	2300	400	440	1100
MW-4	34773	15000	4400	600	770	2660
Mean		9880	2580	434	482	1378
Std. Dev.		3041.71	1025.671	97.87747	167.8392	723.8923
CV.		30.78654	39.75467	22.55241	34.82141	52.53209
MW-5	34456	8000	1300	29	440	770
MW-5	34516	10000	1700	97	600	1400
MW-5 (Avg)	34597	8850	1650	55	660	1500
MW-5	34673	10000	1800	166.0964	620	1400
MW-5	34773	5300	1100	11	180	320
Mean		8430	1510	71.61928	500	1078
Std. Dev.		1942.164	296.6479	61.92215	197.4842	513.5368
CV.		23.03872	19.64556	86.46016	39.49684	47.63792
MW-6	34456	5300	930	54	610	240
MW-6	34516	10000	1500	160	850	690
MW-6	34597	11000	2000	140	1200	760
MW-6	34674	8600	1300	87	980	610
MW-6	34773	9800	1600	110	1000	1000
Mean		8940	1466	110.2	928	660
Std. Dev.		2206.354	393.4209	42.02618	217.4167	276.315
CV.		24.67958	26.83635	38.13628	23.42852	41.86591
MW-7	34456	5700	630	13	660	400

MIKECV.XLS

MW-7	34516	3100	180	99	160	520
MW-7	34597	6100	540	6	750	730
MW-7 (Avg)	34673	3800	295	33.21928	485	445
MW-7 (Avg)	34772	1450	310	4.5	28	317.5
Mean		4030	391	31.14386	416.6	482.5
Std. Dev.		1913.635	186.8288	39.62345	313.022	156.6046
CV.		47.48475	47.7823	127.2272	75.13731	32.45691
MW-8	34456	332.1928	3.321928	3	3.321928	7
MW-8	34516	300	18	48	19	37
MW-8	34597	332.1928	3.321928	3.321928	3.321928	3.321928
MW-8	34673	166.0964	1.660964	1.660964	1.660964	1.660964
MW-8	34772	166.0964	1.660964	1.660964	1.660964	1
Mean		259.3157	5.593157	11.52877	5.793157	9.996578
Std. Dev.		86.10609	6.985181	20.40214	7.429413	15.27364
CV.		33.20512	124.888	176.9672	128.2446	152.7887
MW-9	34456	17000	5400	270	1300	4700
MW-9	34516	10000	2100	120	450	1300
MW-9	34597	7500	2200	97	400	1200
MW-9	34673	10000	2700	130	530	1600
MW-9	34772	18000	5900	270	1200	3680
Mean		12500	3660	177.4	776	2496
Std. Dev.		4690.416	1839.293	85.37447	436.612	1594.704
CV.		37.52333	50.25392	48.12541	56.26443	63.89037
MW-10	34456	710	16	6	85	62
MW-10	34516	2000	52	43	120	210
MW-10	34597	2800	34	16	270	560
MW-10	34673	2700	30	13	260	430
MW-10	34772	1400	18	6	200	239
Mean		1922	30	16.8	187	300.2
Std. Dev.		883.6968	14.49138	15.28725	82.58329	195.5536
CV.		45.97798	48.30459	90.99553	44.16219	65.1411
MW-11	34740	7000	140	22	600	1000
MW-11	34772	6000	200	17	750	1276
Mean		6500	170	19.5	675	1138
Std. Dev.		707.1068	42.42641	3.535534	106.066	195.1615
CV.		10.87857	24.95671	18.13094	15.71348	17.14951
MW-12	34740	166.0964	1.660964	1.660964	1.660964	1.660964
MW-12	34772	166.0964	1.660964	1.660964	1.660964	0.9
Mean		166.0964	1.660964	1.660964	1.660964	1.280482
Std. Dev.		0	0	0	0	0.538083
CV.		0	0	0	0	42.0219
MW-13	34740	166.0964	1.660964	1.660964	1.660964	1.660964
MW-13	34772	166.0964	1.660964	1.660964	1.660964	1
Mean		166.0964	1.660964	1.660964	1.660964	1.330482
Std. Dev.		0	0	0	0	0.467372
CV.		0	0	0	0	35.12803
MW-14 (Avg)	34740	12000	45	20.60964	770	2200
MW-14	34772	1400	6	2	36	298
Mean		6700	25.5	11.30482	403	1249
Std. Dev.		7495.332	27.57716	13.159	519.0164	1344.917
CV.		111.8706	108.1457	116.4017	128.7882	107.6795

StatMost for Windows

Monday, August 21, 1995

4:28:00 PM

***** Statistics Report *****

	tph	Benzene	Toluene	Ethylbenzene
Sample size (N)	59	59	59	59
Num missings	0	0	0	0
Minimum	166.0964	1.6610	1.6610	1.6610
Maximum	29000.0000	5900.0000	600.0000	1900.0000
Std deviation	6264.3325	1645.1984	146.0244	423.5859
Variance	39241861.4180	2706677.6582	21323.1131	179425.0205
Std error	815.5466	214.1866	19.0108	55.1462
C.V.	84.1212	108.1323	127.4466	83.5235
Mean	7446.7960	1521.4680	114.5769	507.1459
Median	7200.0000	1100.0000	48.0000	450.0000
Kurtosis	1.3790	0.3075	1.7787	0.7839
Coeff kurtosis	4.3790	3.3075	4.7787	3.7839
Skewness	1.0614	1.0819	1.5781	0.8887
Coeff skewness	0.5307	0.5410	0.7891	0.4443

95.00% Confidence Interval:

lower limit	5814.3021	1092.7269	76.5227	396.7588
upper limit	9079.2899	1950.2090	152.6310	617.5330

Shewhart Statistics Report:

Variability:	84.1212	108.1323	127.4466	83.5235
s (Std Deviation):	6264.3325	1645.1984	146.0244	423.5859
UCL (Average + 3*s):	26239.7934	6457.0631	552.6499	1777.9036
Average + 2*s :	19975.4610	4811.8647	406.6256	1354.3177
Average + s :	13711.1285	3166.6663	260.6012	930.7318
Average :	7446.7960	1521.4680	114.5769	507.1459
Average - s :	1182.4635	-123.7304	-31.4475	83.5600
Average - 2*s :	-5081.8690	-1768.9288	-177.4719	-340.0259
LCL (Average - 3*s):	-11346.2014	-3414.1271	-323.4962	-763.6118
Maximum :	29000.0000	5900.0000	600.0000	1900.0000
Minimum :	166.0964	1.6610	1.6610	1.6610
Average + C(N)*s :	25984.3176	6389.9676	546.6947	1760.6287
Average - C(N)*s :	-11090.7256	-3347.0316	-317.5410	-746.3369

99.73% Confidence Interval:

upper limit	10003.1843	2192.8509	174.1674	680.0055
lower limit	4890.4077	850.0850	54.9863	334.2863

Xylenes

Sample size (N)	59
Num missings	0
Minimum	0.9000
Maximum	12000.0000
Std deviation	1934.6614
Variance	3742914.8435
Std error	251.8715
C.V.	149.4246
Mean	1294.7408
Median	760.0000
Kurtosis	16.1636
Coeff kurtosis	19.1636
Skewness	3.5451
Coeff skewness	1.7726

95.00% Confidence Interval:

lower limit	790.5652
upper limit	1798.9163

Shewhart Statistics Report:

Variability:	149.4246
--------------	----------

s (Std Deviation):	1934.6614
UCL (Average + 3*s):	7098.7250
Average + 2*s :	5164.0636
Average + s :	3229.4022
Average :	1294.7408
Average - s :	-639.9207
Average - 2*s :	-2574.5821
LCL (Average - 3*s):	-4509.2435
Maximum :	12000.0000
Minimum :	0.9000
Average + C(N)*s :	7019.8245
Average - C(N)*s :	-4430.3430

99.73% Confidence Interval:
 upper limit 2084.2496
 lower limit 505.2319

***** The End *****

StatMost for Windows

Monday, August 21, 1995

5:40:31 PM

***** Statistics Report *****

logbenzene logxylene

	logbenzene	logxylene
Sample size (N)	59	59
Num missings	0	0
Minimum	0.5074	-0.1054
Maximum	8.6827	9.3927
Std deviation	2.6520	2.3876
Variance	7.0330	5.7008
Std error	0.3453	0.3108
C.V.	45.8170	40.5271
Mean	5.7882	5.8915
Median	7.0031	6.6333
Kurtosis	-0.5274	1.2340
Coeff kurtosis	2.4726	4.2340
Skewness	-0.9250	-1.4356
Coeff skewness	-0.4625	-0.7178

95.00% Confidence Interval:

lower limit	5.0971	5.2692
upper limit	6.4793	6.5137

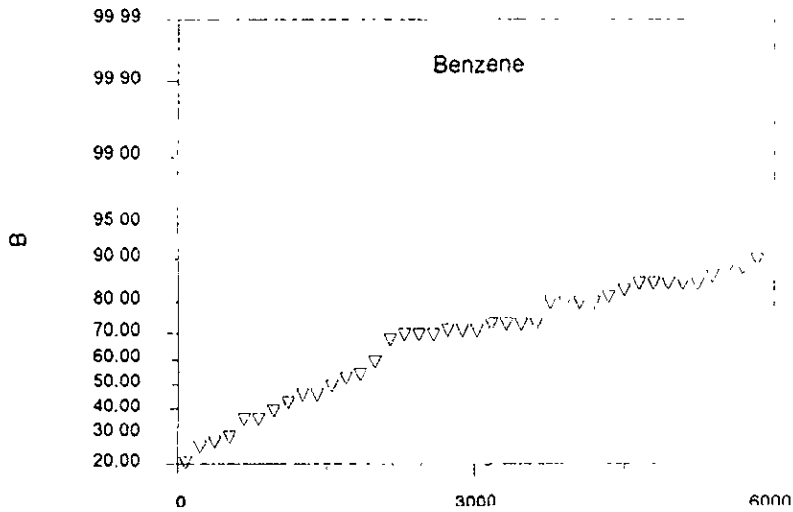
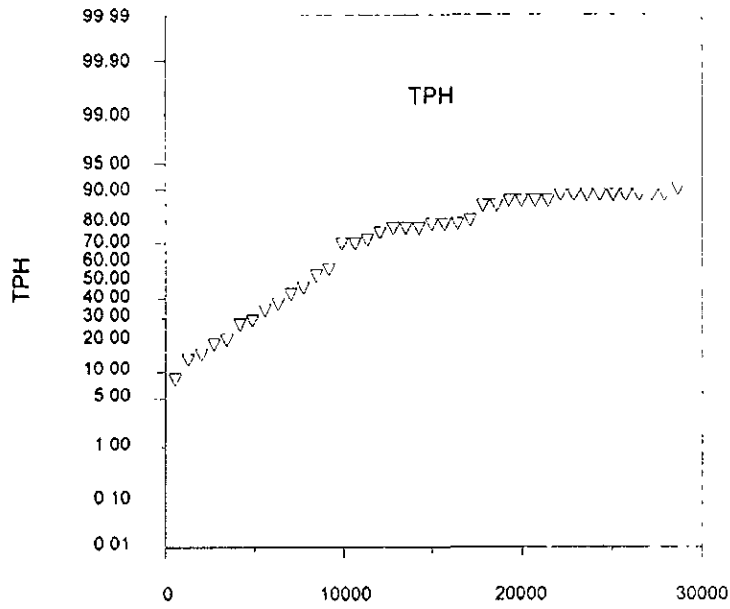
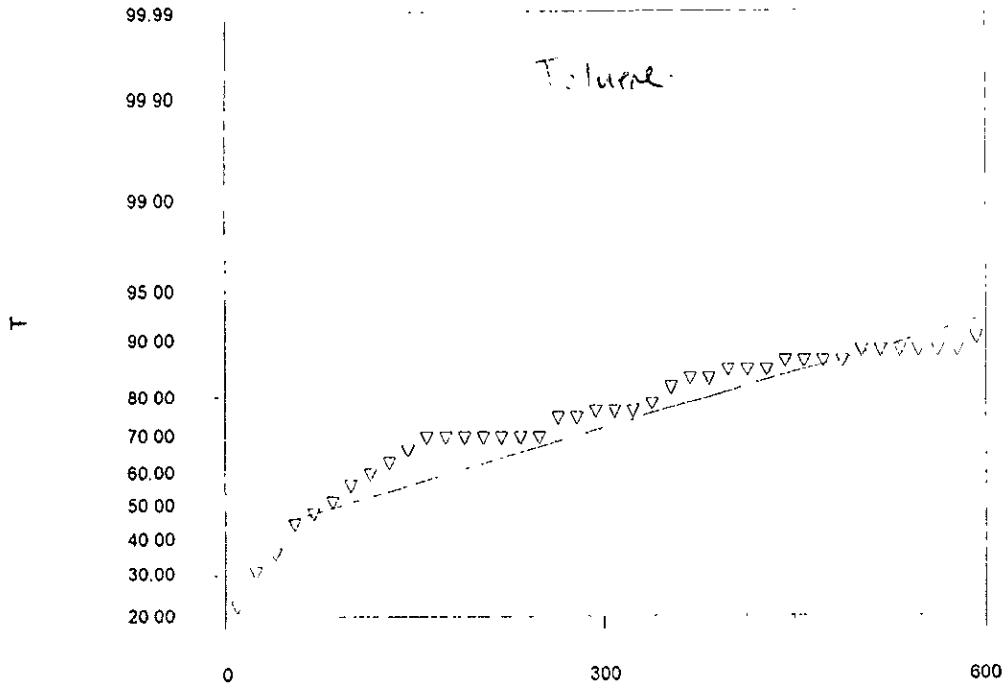
Shewhart Statistics Report:

Variability:	45.8170	40.5271
s (Std Deviation):	2.6520	2.3876
UCL (Average + 3*s):	13.7442	13.0544
Average + 2*s :	11.0922	10.6667
Average + s :	8.4402	8.2791
Average :	5.7882	5.8915
Average - s :	3.1362	3.5038
Average - 2*s :	0.4842	1.1162
LCL (Average - 3*s):	-2.1677	-1.2715
Maximum :	8.6827	9.3927
Minimum :	0.5074	-0.1054
Average + C(N)*s :	13.6360	12.9570
Average - C(N)*s :	-2.0596	-1.1741

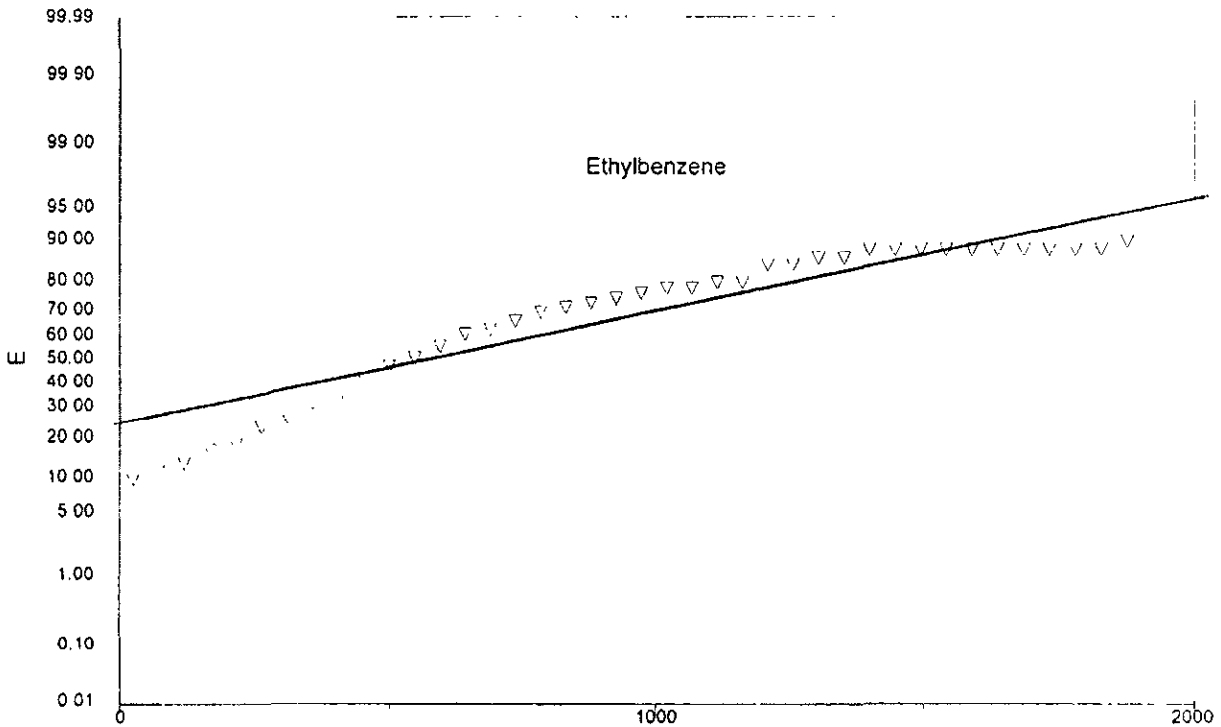
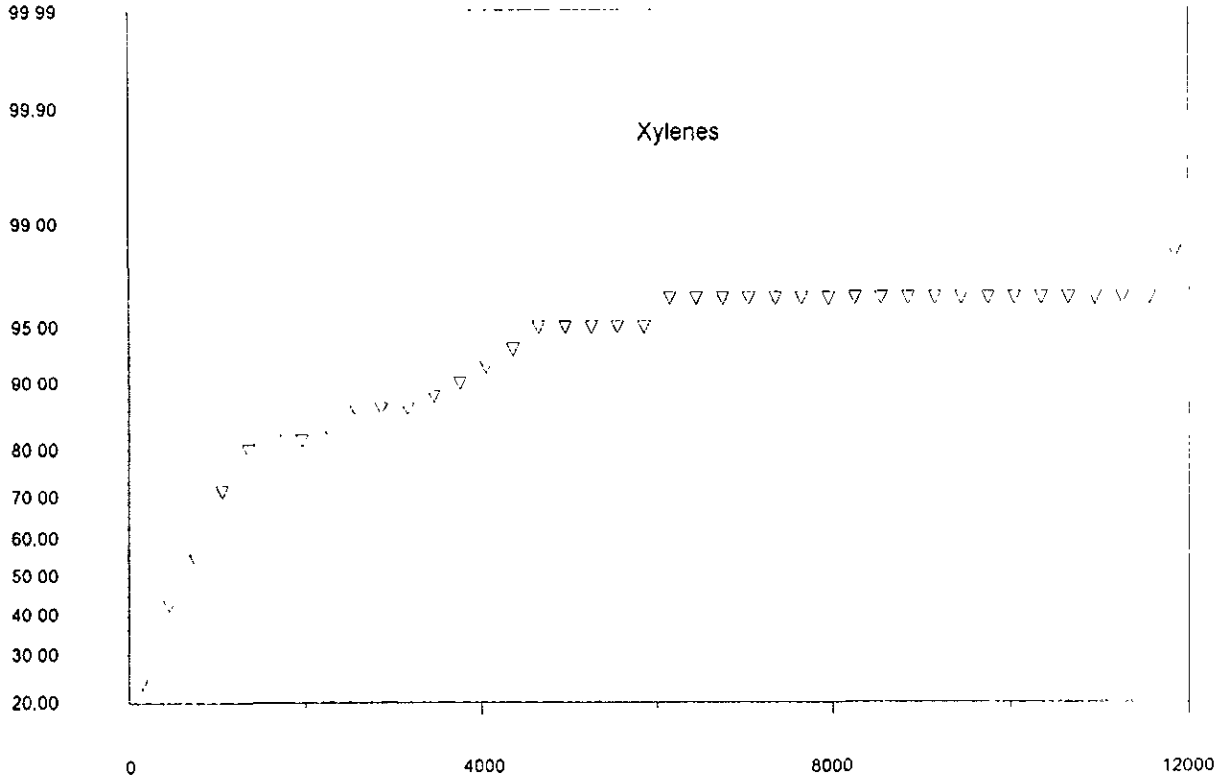
99.73% Confidence Interval:

upper limit	6.8705	6.8658
lower limit	4.7060	4.9171

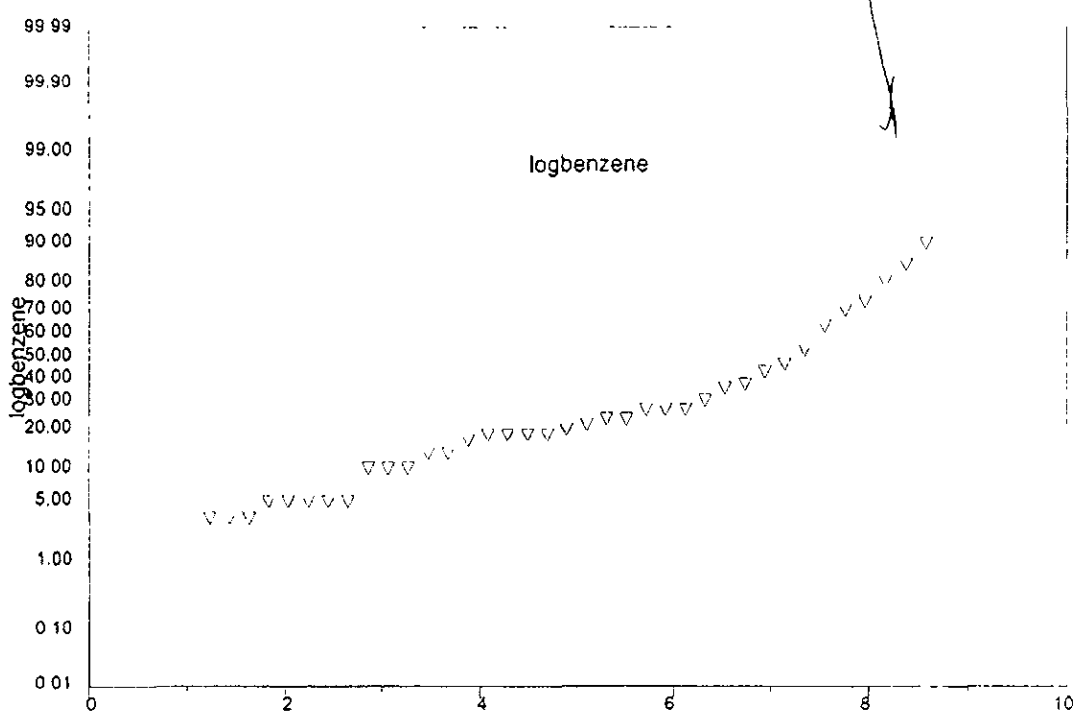
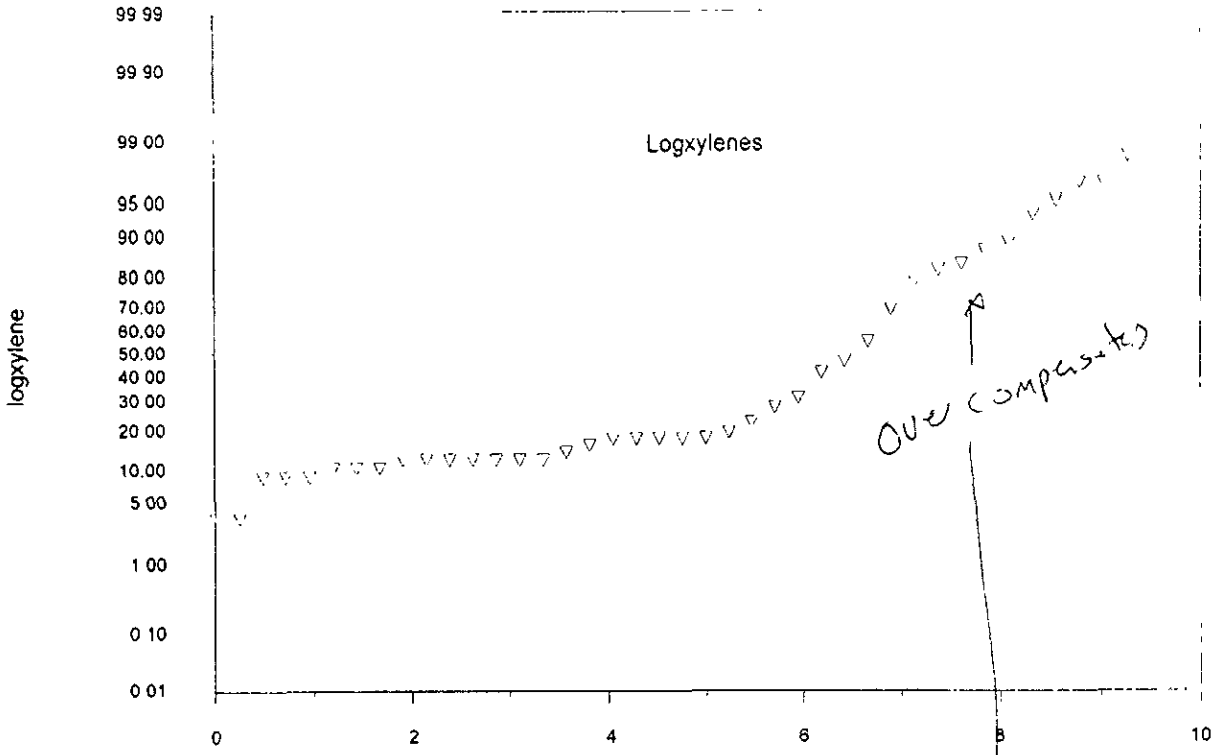
***** The End *****



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ATTACHMENT C
LIST OF REFERENCES

- Pa Cherry, J.A. and Freeze, R.A., 1979. Groundwater, Prentice-Hall, Inc. Englewood Cliffs, New Jersey.
- Based on soil type.
- Pt Cherry, J.A. and Freeze, R.A., 1979. Groundwater, Prentice-Hall, Inc. Englewood Cliffs, New Jersey.
- Based on soil type.
- Do Shen, Thomas T. "Estimating Hazardous Air Emissions from Disposal Sites" Pollution Engineering, August 1981.
- Based on 10 degrees celsius which were the closest to the mean annual air temperature of 15 degrees celsius.
- T Climatological Data Annual Summary, California 1993. V97N13 NOAA.
- Based on data for Newark; closest air station
- H SPHEM (Superfund Public Health Evaluation Manual), EPA/540/1-86/060, October 1986
- B TNRCC (Texas Natural Resource Conservation Commission) Leaking Storage Tank Program, Risk-Based Corrective Action for Leaking Storage Tank Sites, January 1994
- Default value, no site specific information
- Koc SPHEM (Superfund Public Health Evaluation Manual), EPA/540/1-86/060, October 1986
- Foc Based on site-specific data collected from a State Superfund Site in Palo Alto, California.
- Ow TNRCC (Texas Natural Resource Conservation Commission) Leaking Storage Tank Program, Risk-Based Corrective Action for Leaking Storage Tank Sites, January 1994
- Default value, no site specific information
- Pb TNRCC (Texas Natural Resource Conservation Commission) Leaking Storage Tank Program, Risk-Based Corrective Action for Leaking Storage Tank Sites, January 1994
- Default value, no site specific information
- L Site specific

- Cp McKone, T.E. 1988 "Conventional Weapons Demilitarization: A Health and Environmental Effects Data Base Assessment. Methods for Estimating Multi-Pathway Exposures to Environmental Contaminants. Final Report, Phase II. Lawrence Livermore National Laboratory, Livermore, California. UCRL-21064.
- Ksp Travis, C.C. and Arms, A.D., 1988. "Bioconcentration of Organics in Beef, Milk and Vegetation" Environ. Sci. Technol. 22, 271-274.