APPENDIX B – TABLES

Table 1. Stauffer Chemical Company Site, Former Ponds/Dredged Material Piles Designations

Pond/Pile	Location	Sample Point	Date	Description
39	Northeast property	SB-02SZ	January 1988	Subsurface: saturated zone
		39-1C	December 1989	Composite depths
		SC-L7-01	April 1989	Surface soil
		SC-L7-02	April 1989	Surface soil
		SC-L7-03	April 1989	Subsurface: 3 feet
42	Western portion of the main production area	SB-12SZ	January 1988	Subsurface: saturated zone
		SC-L5-01	April 1989	Surface soil
		SC-L5-02	April 1989	Surface soil
		SC-L5-03	April 1989	Subsurface: 3 feet
		42-1C	December 1989	Composite depths
		SS68	September 1990	Surface soil
44A	Main production area; near power house and slag pits	44A-1C	December-1989	Composite depths
44B	Main production area; near power house and slag pits	44B-1C	December 1989	Composite depths
45	Main production area; near power house and slag pits	45-1C	December 1989	Composite depths
46A	Southern portion of the main production area	46A-2-5C	December 1989	Composite depths
46B	Southern portion of the main production area	46B-3-3C	December 1989	Composite depths
47	Southern portion of the main production area	47-3-1C	December 1989	Composite depths

Table 1. Stauffer Chemical Company Site, Former Ponds/Dredged Material Piles Designations (continued)

Pond/Pile	Location	Sample Point	Date	Description
48	Southern portion of the main production area	48-6-9C	December 1989	Composite depths
		PM93-2	March 1993	Surface soil
49A	Southern portion of the main production area	SC-SS-04	January 1988	Surface soil
		SC-L1-01	April 1989	Surface soil
		SC-L1-02	April 1989	Surface soil
		SC-L1-03	April 1989	Subsurface: 3 feet
		SC-L3-01	April 1989	Surface soil
		SC-L3-02	April 1989	Surface soil
		SC-L3-03	April 1989	Subsurface: 3 feet
		49A-6-23C	December 1989	Composite depths
		PM93-1 (two samples)	March 1993	Surface soil
49B	Southern portion of the main production area	SC-L2-01	April 1989	Surface soil
		SC-L2-02	April 1989	Surface soil
		SC-L2-03	April 1989	Subsurface: 3 feet
		49B-9-21C	December 1989	Composite depths
49C	Southern portion of the main production area	SC-SS-03	January 1988	Surface soil
		49C-9-13C	December 1989	Composite depths

Table 1. Stauffer Chemical Company Site, Former Ponds/Dredged Material Piles Designations (continued)

Pond/Pile	Location	Sample Point	Date	Description
49D	Southern portion of the main production area	49D-7-11C (two samples)	December 1989	Composite depths
		SS69	September 1990	Surface soil
49E	Southern portion of the main production area	SC-L4-01	April 1989	Surface soil
		SC-L4-02	April 1989	Surface soil
		SC-L4-03	April 1989	Subsurface: 3 feet
		49E-8-10C	December 1989	Composite depths
50	Southern portion of the main production area	This area was covered over by growth at the time of sampling (December 1989). Elemental phosphorus was found in borings during a preliminary investigation. No other samples were collected from this area.		
51	Southern portion of the main production area	SC-L6-01	April 1989	Surface soil
		SC-L6-02	April 1989	Surface soil
		SC-L6-03	April 1989	Subsurface: 3 feet
		51-4-5C	December 1989	Composite depths
		PM93-3	March 1993	Surface soil
52	Northeast portion of the slag storage area	52-1C	December 1989	Composite depths
Pile 1	Dredged material from pond 39; northeast property	SC-SS-02	January 1988	Surface composite

Table 1. Stauffer Chemical Company Site, Former Ponds/Dredged Material Piles Designations (continued)

Pond/Pile	Location	Sample Point	Date	Description
Pile 2	Dredged pond materials from ponds 49A, 49B, 49C, and 51 in the southern portion of the main production area	SB-08A	January 1988	Subsurface: 4 feet
		SB-08B	January 1988	Subsurface: 10 feet
		SB-08C	January 1988	Subsurface: 15 feet
		SC-P2-01	April 1989	Surface soil
		SC-P2-02	April 1989	Surface soil
		SC-P2-03	April 1989	Subsurface: 8 feet
Pile 3	Dredged material from pond 42; western portion of the main production area	SC-P3-01	April 1989	Surface soil
		SC-P3-02	April 1989	Surface soil
		SC-P3-03	April 1989	Subsurface: 5 feet
Pile 4	Area of a former pile of dredged pond material in southeast property; nearest to pond 49C	SS93-17	March 1993	Surface soil

Table 2. On-Site Soil Sampling Summary Data, Pond Soils

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppm)	Source	
Volatile Organic Compounds (VOCs)								
2-Butanone	0.007 J	0.007 J	SS69 surface	Sept-90	1/7	22,000	RBC-N	0
Acetone	0.009 J,B	0.31	PM93-2 surface	Mar-93	4/7	20,000	child-RMEG	0
Methylene chloride	0.005 J	0.027	PM93-2 surface	Mar-93	5/7	90	CREG	0
Toluene	0.005	0.005	SS68 surface	Sept-90	1/8	1,000	child-I-EMEG	0
Trichloroethylene	0.003 J	0.003 J	SS69 surface	Sept-90	1/7	2	CREG	0
Semivolatile Organic Compounds (SVOCs)								
Anthracene	0.66 J	0.66 J	PM93-2 surface	Mar-93	1/7	20,000	child-RMEG	0
Benzo[a]anthracene	0.073 J	2.8 J	PM93-2 surface	Mar-93	2/8	0.87	RBC-C	1
Benzo[a]pyrene	0.11 J	0.15 J	SC-SS-03 surface composite and SS69 surface	Jan-88 and Sept-90	3/8	0.1	CREG	3
Benzo[b]fluoranthene	0.15 J	5.2	PM93-2 surface	Mar-93	5/8	0.87	RBC-C	1

Table 2. On-Site Soil Sampling Summary Data, Pond Soils (continued)

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppm)	Source	
Benzo[g,h,i]perylene	0.09 J	1.5 J	PM93-2 surface	Mar-93	4/7	20,000	child-RMEG, anthracene	0
Benzo[k]fluoranthene	0.052 J	1.1 J	PM93-2 surface	Mar-93	4/8	8.7	RBC-C	0
bis(2-Ethylhexyl) phthalate	0.3 J,B	2.2 J	PM93-2 surface	Mar-93	3/7	50	CREG	0
Chrysene	0.061 J	4.8	PM93-2 surface	Mar-93	4/8	87	RBC-C	0
di-n-Butyl phthalate	0.078 J,B	0.67 J,B	PM93-2 surface	Mar-93	5/7	5,000	child-RMEG	0
Fluoranthene	0.036 J	3.9	PM93-2 surface	Mar-93	4/8	2,000	child-RMEG	0
Indeno[1,2,3-cd] pyrene	0.11 J	1.8 J	PM93-2 surface	Mar-93	4/7	0.87	RBC-C	1
Phenanthrene	0.036 J	2 J	PM93-2 surface	Mar-93	3/7	2,000	child-RMEG, fluoranthene	0
Pyrene	0.1 J	3.3	PM93-2 surface	Mar-93	2/7	2,000	child-RMEG	0
Pesticides/Polychlorinated Biphenyls								
Arochlor 1248	3.1	3.1	SS69 surface	Sept-90	1/7	1	child-EMEG, arochlor 1254	1

Table 2. On-Site Soil Sampling Summary Data, Pond Soils (continued)

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppm)	Source	
Inorganics-Metals								
Aluminum (Al)	180	7,600	SC-SS-03 surface composite	Jan-88	42/42	100,000	child-I-EMEG	0
Antimony (Sb)	20.8	52	PM93-3 surface	Mar-93	10/15	20	child-RMEG	10
Arsenic (As)	4.2	340 J,N	SB12-SZ saturated zone	Jan-88	48/59	0.5	CREG	48
Barium (Ba)	2	140	SB12-SZ saturated zone	Jan-88	40/42	4,000	child-RMEG	0
Beryllium (Be)	0.71 X	2	PM93-1 surface	Mar-93	9/15	50	child-C-EMEG	0
Cadmium (Cd)	0.99	66 J	SB-02SZ saturated zone	Jan-88	54/59	10	child-C-EMEG	47
Calcium (Ca)	1,430	440,000 J	SC-SS-03 surface composite	Jan-88	42/42	NA	NA	NA
Chromium (Cr)	1.7	226	PM93-2 surface	Mar-93	58/59	200	child-RMEG Cr^{6+}	1
Cobalt (Co)	1.3 X	4.7	SS68 surface	Sept-90	5/15	500	child-I-EMEG	0
Copper (Cu)	1.8	1,040	PM93-2 surface	Mar-93	26/42	3,100	RBC-N	0

Table 2. On-Site Soil Sampling Summary Data, Pond Soils (continued)

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppm)	Source	
Iron (Fe)	24	12,000	SC-SS-02 surface composite	Jan-88	42/42	23,000	RBC-N	0
Lead (Pb)	1.6	900	PM93-2 surface	Mar-93	59/59	400	EPA AL	2
Magnesium (Mg)	39	14,000	SB-08C 15 feet/ dredge	Jan-88	40/42	NA	NA	NA
Manganese (Mn)	2.4	160	SB-08B 10 feet/ dredge	Jan-88	40/42	3,000	child-RMEG	0
Mercury (Hg)	0.095	2.2	PM93-2 surface	Mar-93	35/42	20	child-RMEG, $HgCl_2$	0
Nickel (Ni)	2.7	43	SC-SS-02 surface composite	Jan-88	27/42	1,000	child-RMEG	0
Potassium (K)	174	4,820	PM93-3 surface	Mar-93	32/42	NA	NA	NA
Selenium (Se)	6.6	39 J, N	SC-SS-03 surface composite	Jan-88	30/42	300	child-C-EMEG	0
Silver (Ag)	2.8	19.3	PM93-2 surface	Mar-93	31/42	300	child-RMEG	0
Sodium (Na)	25.7	14,100	PM93-3 surface	Mar-93	30/42	NA	NA	NA
Thallium (Tl)	2.9 J	37	SC-P2-03 surface composite/ dredge	Apr-89	32/42	4	child-RMEG	31

Table 2. On-Site Soil Sampling Summary Data, Pond Soils (continued)

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppm)	Source	
Vanadium (V)	2.4	110	SC-SS-02 surface composite	Jan-88	39/42	200	child-I-EMEG	0
Zinc (Zn)	4.2	1,200 J	SC-SS-03, SC-SS-04 surface composites	Jan-88	41/42	20,000	child-C-EMEG	0
Inorganics-Other								
Chloride	47.2	1,190	51-4-5C composite depths	Dec-89	10/19	NA	NA	NA
Cyanide	0.86	12.6	45-1C composite depths	Dec-89	9/44	1,000	child-RMEG	0
Fluoride	5	410,000 J	SB-02SZ saturated zone	Jan-88	32/32	3,000	child-RMEG, FNa	4
Phosphorus (Total)	343	121,000	SS69 surface	Sept-90	27/27	NA	NA	NA

Table 2. On-Site Soil Sampling Summary Data, Pond Soils (continued)

Radiologic Parameters	Minimum (Bq/kg)	Confidence	Maximum (Bq/kg)	Confidence	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
								Value (Bq/kg)	Source	
Radium-226	14.8	±3.7	1,258	±111	44A-1C, 45-1C composite depths	Dec-89	30/32	5.4	NCRP screening limit (residential)	30

Sources:
NUS 1989 (one sampling point analyzed for VOCs and SVOCs, eight sampling points analyzed for metals and other inorganics).
NUS 1991 (27 sampling points analyzed for metals, 12 sampling points analyzed for other inorganics).
PBS&J 1990 (three samples analyzed for radium-226).
Weston 1990a (17 samples analyzed for metals and other inorganics, 29 samples analyzed for radium-226).
Weston 1990c (two sampling points analyzed for VOCs, SVOCs, pesticides, metals and other inorganics).
Weston 1993 (five samples analyzed for VOCs, SVOCs, pesticides, metals, and other inorganics).

Key:

B	detected in the associated laboratory blank and in the sample	N	presumptive evidence of presence of material
Bq/kg	Becquerel per kilogram	NCRP	National Council on Radiation Protection and Measurements
CRDL	contract-required detection limit	NA	not available
CREG	cancer risk evaluation guide	ppm	parts per million
C-EMEG	chronic environmental media evaluation guide (ATSDR)	RBC-C	risk-based concentration, for cancer effects
EPA AL	U.S. Environmental Protection Agency action level	RBC-N	risk-based concentration, for noncancer effects
I-EMEG	intermediate environmental media evaluation guide (ATSDR)	RMEG	reference dose media evaluation guide
J	estimated quantity below the quantitation limit	X	result is less than the CRDL, but greater than or equal to the instrument detection limit

Table 3. On-Site Soil Sampling Summary Data, Slag

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppm)	Source	
Volatile Organic Compounds (VOCs)								
No VOCs were detected in the on-site slag sample.								
Semivolatile Organic Compounds (SVOCs)								
Benzo[a]anthracene	0.12 J	0.12 J	SS93-14	Mar-93	1/1	0.87	RBC-C	0
Benzo[a]pyrene	0.11 J	0.11 J	SS93-14	Mar-93	1/1	0.1	CREG	1
Benzo[b]fluoranthene	0.17 J	0.17 J	SS93-14	Mar-93	1/1	0.87	RBC-C	0
Benzo[g,h,i]perylene	0.16 J	0.16 J	SS93-14	Mar-93	1/1	20,000	child-RMEG, anthracene	0
Benzo[k]fluoranthene	0.042 J	0.042 J	SS93-14	Mar-93	1/1	8.7	RBC-C	0
Chrysene	0.1 J	0.1 J	SS93-14	Mar-93	1/1	87	RBC-C	0
di-n-Butyl phthalate	0.19 J, B	0.19 J, B	SS93-14	Mar-93	1/1	5,000	child-RMEG	0
Fluoranthene	0.11 J	0.11 J	SS93-14	Mar-93	1/1	2,000	child-RMEG	0
Indeno[1,2,3-cd]pyrene	0.11 J	0.11 J	SS93-14	Mar-93	1/1	0.87	RBC-C	0
Phenanthrene	0.067 J	0.067 J	SS93-14	Mar-93	1/1	2,000	child-RMEG, fluoranthene	0
Pyrene	0.12 J	0.12 J	SS93-14	Mar-93	1/1	2,000	child-RMEG	0
Pesticides/Polychlorinated Biphenyls (PCBs)								
alpha-Chlordane	0.0015 J	0.0015 J	SS93-14	Mar-93	1/1	2	CREG	0
Dieldrin	0.0051	0.0051	SS93-14	Mar-93	1/1	0.04	CREG	0
gamma-Chlordane	0.0062	0.0062	SS93-14	Mar-93	1/1	2	CREG	0

Table 3. On-Site Soil Sampling Summary Data, Slag (continued)

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppm)	Source	
p,p-DDT	0.0073	0.0073	SS93-14	Mar-93	1/1	2	CREG	0
Inorganics-Metals								
Aluminum (Al)	2,000	12,000	“Stauffer slag pile”	Jul-98	5/5	100,000	child-I-EMEG	0
Antimony (Sb)	0.0197	0.0197	“Stauffer slag pile”	Jul-98	1/5	20	child-RMEG	0
Arsenic (As)	0.00463	4.2	SS93-14	Mar-93	2/11	0.5	CREG	1
Barium (Ba)	32.8	108	“Stauffer slag pile”	Jul-98	2/2	4,000	child-RMEG	0
Beryllium (Be)	0.25 X	1.99	“Stauffer slag pile”	Jul-98	3/5	50	child-C-EMEG	0
Cadmium (Cd)	0.157	4.8	SS7	Dec-89	6/11	10	child-C-EMEG	0
Calcium (Ca)	49,500	49,500	SS93-14	Mar-93	1/1	NA	NA	NA
Chromium (Cr)	3.6	122	SS6	Dec-89	11/11	200	child-RMEG, Cr^{6+}	0
Cobalt (Co)	0.957	2.7 X	SS93-14	Mar-93	2/2	500	child-I-EMEG	0
Copper (Cu)	3.16	23.4	SS93-14	Mar-93	3/5	3,100	RBC-N	0
Iron (Fe)	3,130	10,600	SS93-14	Mar-93	2/2	23,000	RBC-N	0
Lead (Pb)	0.52	121	SS93-14	Mar-93	8/11	400	EPA AL	0
Magnesium (Mg)	394 X	394 X	SS93-14	Mar-93	1/1	NA	NA	NA

Table 3. On-Site Soil Sampling Summary Data, Slag (continued)

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppm)	Source	
Manganese (Mn)	145	471	"Stauffer slag pile"	Jul-98	2/2	3,000	child-RMEG	0
Mercury (Hg)	0.0248	0.0248	"Stauffer slag pile"	Jul-98	1/5	20	child-RMEG, $HgCl_2$	0
Nickel (Ni)	14.8	40	Slag/7-7"	Sept-97	3/5	1,000	child-RMEG	0
Potassium (K)	278 X	278 X	SS93-14	Mar-93	1/1	NA	NA	NA
Selenium (Se)	0.33 X	0.414	"Stauffer slag pile"	Jul-98	2/5	300	child-C-EMEG	0
Silver (Ag)	0.00141	0.00141	"Stauffer slag pile"	Jul-98	1/5	300	child-RMEG	0
Sodium (Na)	582 X	582 X	SS93-14	Mar-93	1/1	NA	NA	NA
Thallium (Tl)	0.47	0.57 X	SS93-14	Mar-93	2/5	4	child-RMEG	0
Vanadium (V)	28.7	29.6	SS93-14	Mar-93	2/2	200	child-I-EMEG	0
Zinc (Zn)	6.7	186	SS93-14	Mar-93	4/5	20,000	child-C-EMEG	0
Inorganics-Other								
Cyanide	2	6.5	SS54	Apr-90	7/10	1,000	child-RMEG	0
Fluoride	30	1,920	SS54	Apr-90	11/11	3,000	child-RMEG, FNa	0
Phosphorus (Total)	1,610	48,500	SS6	Dec-89	10/10	NA	NA	NA

Table 3. On-Site Soil Sampling Summary Data, Slag (continued)

Radiologic Parameters	Minimum (Bq/kg)	Confidence	Maximum (Bq/kg)	Confidence	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
								Value (Bq/kg)	Source	
Gross alpha	9,990	±655	9,990	±655	Slag/2–6"	Sept-97	1/1	NA	NA	NA
Gross beta	4,590	±264	4,590	±264	Slag/2–6"	Sept-97	1/1	NA	NA	NA
Radium-226	777	±74	2,730	NA	SS48	Mar-90	12/12	5.4	NCRP screening limit (residential)	12

Sources:
PBS&J 1990 (one sampling point analyzed for radium-226).
Parsons 1997 (three sampling points analyzed for metals, other inorganics, and radionuclides).
EPA 1999a (one sampling point analyzed for metals, other inorganics, and radium-226).
Weston 1990a (six sampling points analyzed for metals and other inorganics; seven samples analyzed for radium-226).
Weston 1993 (one sampling point analyzed for VOCs, SVOCs, pesticides, PCBs, metals, and other inorganics).

Key:

B	detected in the associated laboratory blank and in the sample
Bq/kg	Becquerel per kilogram
CRDL	contract-required detection limit
CREG	cancer risk evaluation guide
C-EMEG	chronic environmental media evaluation guide (Agency for Toxic Substances and Disease Registry)
EPA AL	U.S. Environmental Protection Agency action level
I-EMEG	intermediate environmental media evaluation guide (Agency for Toxic Substances and Disease Registry)
J	estimated quantity below the quantitation limit
NA	not available
ppm	parts per million
RBC-C	risk-based concentration, for cancer effects
RBC-N	risk-based concentration, for noncancer effects
RMEG	reference dose media evaluation guide
X	result is less than the CRDL, but greater than or equal to the instrument detection limit

Table 4. On-Site Soil Sampling Data, Surface Soil

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppm)	Source	
Volatile Organic Compounds (VOCs)								
1,1,1-Trichloroethane	0.003 J	0.003 J	SS64	Apr-90	1/21	22,000	RBC-N	0
Acetone	0.005 J,B	0.66 E,B	SS66	Apr-90	11/21	20,000	child-RMEG	0
Bromoform	0.002 J	0.002 J	SS37C	Dec-89	1/21	90	CREG	0
Carbon disulfide	0.003 J	0.15	SS64 & SS66	Apr-90	7/22	5,000	child-RMEG	0
Chloroform	0.001 J	0.002 J	SS63 & SS65	Apr-90	3/22	100	CREG	0
Chloromethane	0.001 J	0.003 J	SS65	Apr-90	2/21	49	RBC-C	0
Ethylbenzene	0.001 J	0.001 J	SS38C	Dec-89	1/21	5,000	child-RMEG	0
Methylene chloride	0.005 B	0.48 E,B	SS64	Apr-90	17/21	90	CREG	0
Tetrachloroethylene	0.001 J	0.007	SS64 & SS66	Apr-90	9/21	500	child-RMEG	0
Toluene	0.002 J	0.041	SS66	Apr-90	9/22	1,000	child-I-EMEG	0
Semivolatile Organic Compounds (SVOCs)								
1,2-Dichlorobenzene	0.012 T,C	0.012 T,C	SS37C	Dec-89	1/23	5,000	child-RMEG	0
1,3-Dichlorobenzene	0.0056 T,C	0.0056 T,C	SS37C	Dec-89	1/23	2,300	RBC-N	0
1,4-Dichlorobenzene	0.0069 T,C	0.0069 T,C	SS37C	Dec-89	1/23	20,000	child-I-EMEG	0
2-Methylnaphthalene	0.045 J	0.077 J	SS93-10	Mar-93	3/23	2,000	RBC-N	0
2,4-Dichlorophenol	0.057 J	1.2	SS34C	Dec-89	3/23	200	child-I-EMEG	0
2,4,5-Trichlorophenol	0.17 J	0.17 J	SS34C	Dec-89	1/23	5,000	child-RMEG	0
2,4,6-Trichlorophenol	0.29 J	0.29 J	SS34C	Dec-89	1/23	60	CREG	0
Acenaphthylene	0.11 J	0.77	SS93-1	Mar-93	3/23	4,700	RBC-N	0

Table 4. On-Site Soil Sampling Data, Surface Soil (continued)

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppm)	Source	
Anthracene	0.008 J	1.0	SS93-1	Mar-93	5/23	20,000	child-RMEG	0
Benzo[a]anthracene	0.056 J	2.9	SS93-10	Mar-93	10/24	0.87	RBC-C	4
Benzo[a]pyrene	0.025 J	2.7	SS65	Apr-90	11/24	0.1	CREG	6
Benzo[b]fluoranthene	0.051 J	4.3	SS93-1	Mar-93	13/24	0.87	RBC-C	4
Benzo[g,h,i]perylene	0.045 J	3.5	SS65	Apr-90	10/23	20,000	child-RMEG, anthracene	0
Benzo[k]fluoranthene	0.034 J	2.6	SS65	Apr-90	11/24	8.7	RBC-C	0
Benzoic acid	0.14 J,B	0.51 J,B	SS36C	Dec-89	8/16	200,000	child-RMEG	0
bis(2-Ethylhexyl) phthalate	0.043 J,B	1.0 J,B	SS65	Apr-90	9/23	50	CREG	0
Carbazole	0.084 J	0.57	SS93-10	Mar-93	3/7	32	RBC-C	0
Chrysene	0.042 J	2.8	SS65	Apr-90	13/24	87	RBC-C	0
di-n-Butyl phthalate	0.054 J	0.24 J,B	SS93-13	Mar-93	13/23	5,000	child-RMEG	0
Dibenzo[a,h] anthracene	0.1 J	0.34 J	SS93-1	Mar-93	3/23	0.087	RBC-C	3
Dibenzofuran	0.038 J	0.067 J	SS93-10	Mar-93	2/23	310	RBC-N	0
Fluoranthene	0.055 J	3.3	SS93-10	Mar-93	12/24	2,000	child-RMEG	0
Fluorene	0.066 J	0.075 J	SS93-1	Mar-93	2/23	2,000	child-RMEG	0
Indeno[1,2,3-cd] pyrene	0.060 J	3.1	SS65	Apr-90	10/23	0.87	RBC-C	3
Isophorone	0.24 J	0.33 J	SS66	Apr-90	2/23	700	CREG	0
Naphthalene	0.048 J	0.049 J	SS93-10	Mar-93	2/23	1,000	child-I-EMEG child-RMEG	0

Table 4. On-Site Soil Sampling Data, Surface Soil (continued)

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppm)	Source	
Phenanthrene	0.036 J	1.5	SS93-10	Mar-93	9/23	2,000	child-RMEG, fluoranthene	0
Phenol	0.006 T,J	0.01 T,J	SS64	Apr-90	2/23	30,000	child-RMEG	0
Pyrene	0.040 J	3.1	SS93-10	Mar-93	13/23	2,000	child-RMEG	0
Pesticides/Polychlorinated Biphenyls (PCBs)								
Arochlor-1254	0.21 J	0.21 J	SS65	Apr-90	1/28	1	child-C-EMEG	0
Arochlor-1260	0.076 J	0.076 J	SS64	Apr-90	1/28	0.32	RBC-C	0
Dieldrin	0.02	0.027	SS93-9A	Mar-93	2/28	0.04	CREG	0
pp-DDE	0.009	0.021	SS93-9A	Mar-93	2/28	2	CREG	0
pp-DDT	0.0038 J,B	0.013	SS51C	Apr-90	6/28	2	CREG	0
Inorganics-Metals								
Aluminum (Al)	67.4	6,810	SS93-8	Mar-93	23/23	100,000	child-I-EMEG	0
Antimony (Sb)	0.91 B	48.9	SS93-6	Mar-93	10/21	20	child-RMEG	4
Arsenic (As)	0.39 J	140	NE-1–6"	Sept-97	32/91	0.5	CREG	30
Barium (Ba)	2.4 X	80.9	SS93-3	Mar-93	14/15	4,000	child-RMEG	0
Beryllium (Be)	0.05 B	1.6	SS93-8	Mar-93	30/39	50	child-C-EMEG	0
Cadmium (Cd)	0.82 X	59	NE-1–6"	Sept-97	45/73	10	child-C-EMEG	7
Calcium (Ca)	36 X	377,000	SS93-8	Mar-93	16/17	NA	NA	NA
Chromium (Cr)	0.58 B	163	SS93-3	Mar-93	64/75	200	child-RMEG	0
Cobalt (Co)	1.1	33.3	SS93-5	Mar-93	10/15	500	child-I-EMEG	0

Table 4. On-Site Soil Sampling Data, Surface Soil (continued)

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppm)	Source	
Copper (Cu)	0.34 B	65.5	SS93-5	Mar-93	19/21	3,100	RBC-N	0
Iron (Fe)	250	44,800	SS93-3	Mar-93	17/17	23,000	RBC-N	2
Lead (Pb)	0.7	324	SS93-8	Mar-93	75/75	400	EPA AL	0
Magnesium (Mg)	34	3,910	SS93-21	Jul-93	15/15	NA	NA	NA
Manganese (Mn)	0.59 X	292	SS93-3	Mar-93	17/17	3,000	child-RMEG	0
Mercury (Hg)	0.066	0.67	NE-1–6"	Sept-97	5/21	20	child-RMEG, $HgCl_2$	0
Nickel (Ni)	0.91 B	115	SS93-5	Mar-93	19/21	1,000	child-RMEG	0
Potassium (K)	161 X	1,740	SS93-6	Mar-93	12/15	NA	NA	NA
Selenium (Se)	0.32	32.5	SS93-8	Mar-93	13/21	300	child-C-EMEG	0
Silver (Ag)	1.2 X	9.7	SS93-8	Mar-93	5/21	300	child-RMEG	0
Sodium (Na)	19.6 X	15,500	SS93-21	Jul-93	14/15	NA	NA	NA
Thallium (Tl)	0.37 X	15	NE-1–6"	Sept-97	9/21	4	child-RMEG	4
Vanadium (V)	1.4 X	252	SS93-5	Mar-93	15/15	200	child-I-EMEG	1
Zinc (Zn)	0.9 B	519	SS93-8	Mar-93	20/21	20,000	child-C-EMEG	0
Inorganics-Other								
Chloride	47.3	224	SS16	Dec-89	3/52	NA	NA	NA
Cyanide	0.57	3.0	SS1	Dec-89	4/73	1,000	child-RMEG	0
Fluoride	3.1	4,230	SS17	Dec-89	75/77	3,000	child-C-EMEG, FNa	1

Table 4. On-Site Soil Sampling Data, Surface Soil (continued)

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppm)	Source	
Phosphorus (total)	50	84,800	SS10	Dec-89	76/76	NA	NA	NA

Radiologic Parameters	Minimum (Bq/kg)	Confidence	Maximum (Bq/kg)	Confidence	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
								Value (Bq/kg)	Source	
Gross alpha	77.0 J	±21.4	29,800	540	NE-1–6"	Sept-97	6/7	NA	NA	NA
Gross beta	67.0 J	±26.2	17,800	233	NE-1–6"	Sept-97	6/7	NA	NA	NA
Polonium-210	7,522	NA	7,522	NA	SS93-21	Mar-93	1/1	210	NCRP screening limit (residential)	1
Radium-226	12.6 J	±3.62	1,813	±185	SS29	Dec-89	39/39	5.4	NCRP screening limit (residential)	39
Radon-222	110	NA	110	NA	SS93-21	Mar-93	1/1	NA	NA	NA

Sources: NUS 1989 (one sampling point analyzed for VOCs and SVOCs, metals, and other inorganics).
NUS 1991 (two sampling points analyzed for metals).
PBS&J 1990 (six sampling points analyzed for radium-226).
Parsons 1997 (six sampling points analyzed for metals, other inorganics, and radionuclides).
Parsons 1999 (18 samples analyzed for metals).
Weston 1990a (16 samples analyzed for VOCs, SVOCs, and pesticides/PCBs; 52 samples analyzed for metals and other inorganics; 23 samples analyzed for radium-226).
Weston 1990c (three samples analyzed for radionuclides).
Weston 1993 (7 samples analyzed for VOCs and SVOCs; 12 samples analyzed for pesticides/PCBs; 14 samples analyzed for metals; 18 samples analyzed for other inorganics; 1 sampling point analyzed for radionuclides).

On-site surface soil samples are those samples *not* taken from former ponds, dredge pond material, slag (from slag pits and storage area), or roads.

Table 4. On-Site Soil Sampling Data, Surface Soil (continued)

Key:

B	detected in the associated laboratory blank and in the sample
Bq/kg	Becquerel per kilogram
C	response factor from daily standard
CRDL	contract-required detection limit
CREG	cancer risk evaluation guide
C-EMEG	chronic environmental media evaluation guide (Agency for Toxic Substances and Disease Registry)
E	compound was detected beyond the calibration range and was subsequently analyzed at dilution
I-EMEG	intermediate environmental media evaluation guide (Agency for Toxic Substances and Disease Registry)
J	estimated quantity below the quantitation limit
NA	not available
NCRP	National Council on Radiation Protection and Measurements
ppm	parts per million
RBC-C	risk-based concentration, for cancer effects
RBC-N	risk-based concentration, for noncancer effects
RMEG	reference dose media evaluation guide
T	compound tentatively identified by laboratory during analysis
X	result is less than the CRDL, but greater than or equal to the instrument detection limit

Table 5. On-Site Soil Sampling Summary Data, Surface Soil Contaminants of Potential Concern

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Mean Detected (ppm)	Median Detected (ppm)	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppm)	Source	
Inorganics-Metals								
Arsenic (As)	0.39 J	140	20	5.0	32/91	0.5	CREG	30
Cadmium (Cd)	0.82 X	59	8.0	2.3	45/73	10	child-C-EMEG	7
Thallium (Tl)	0.37 X	15	6.4	2.8	9/21	4	child-RMEG	4
Inorganics-Other								
Fluoride	3.1	4,230	474	206	75/77	3,000	child-C-EMEG, FNa	1
Phosphorus (Total)	50	84,800	24,600	16,900	76/76	NA	NA	NA

Sources: NUS 1989 (one sampling point analyzed for metals and other inorganics).
NUS 1991 (two sampling points analyzed for metals).
Parsons 1997 (six sampling points analyzed for metals and other inorganics).
Parsons 1999 (18 samples analyzed for metals).
Weston 1990a (52 samples analyzed for metals and other inorganics).
Weston 1993 (14 samples analyzed for metals and 18 samples analyzed for other inorganics).

On-site surface soil samples are those samples *not* taken from former ponds, dredge pond material, slag (from slag pits and storage area), or roads.

Key:

ppm	parts per million
CRDL	contract-required detection limit
CREG	cancer risk evaluation guide
C-EMEG	chronic environmental media evaluation guide (Agency for Toxic Substances and Disease Registry)
J	estimated quantity below the quantitation limit
NA	not available
RMEG	reference dose media evaluation guide
X	result is less than the CRDL, but greater than or equal to the instrument detection limit

Table 6. Stauffer Chemical Company Site, Monitoring Well Identifications (1985 to 2002)

Semiannual Sampling (NUS 1989, SMC 2002)	**Expanded Site Investigation (NUS 1989)**	**Final Listing Site Inspection (NUS 1991)**	**Remedial Investigation (Weston 1993)**		**(Parsons 1999)**	**Description**	
January 1987 through February 2002	***January 1988***	***April 1989***	***March/ April 1993***	***July 1993***	***1998 and 1999***	***Location***	***Approximate Depth (feet)***
M-1	SC-MW-04ES	SC-MW-04ES	MW-4ES	—	—	Downgradient of slag disposal area	16
M-2	SC-MW-08ES	SC-MW-08ES	MW-8ES	—	MW-8ES	Downgradient of lagoons/calcium fluoride storage areas	17
M-3	SC-MW-06ES	SC-MW-06ES	MW-6ES	—	—	Downgradient of lagoons/calcium fluoride storage areas	15
M-4	SC-MW-05ES	SC-MW-05ES	MW-5ES	—	—	Downgradient of lagoon no. 1	16
M-5	SC-MW-02ES	SC-MW-02ES	MW-2ES	—	—	Downgradient of calcium fluoride deposit	15
M-6	SC-MW-03ES	SC-MW-03ES	—	—	—	Downgradient of calcium fluoride deposit	15
M-7	SC-MW-07ES	SC-MW-07ES	MW-7ES	MW-7ES	MW-7ES	Background	18
—	SC-MW-01S	SC-MW-01S	MW-1S	MW-1S	MW-1S	Background	32
—	SC-MW-01F	SC-MW-01F	MW-1F	—	—	Background	50
—	SC-MW-02F	SC-MW-02F	MW-2F	—	—	Downgradient of lagoons/drum burial areas	50
—	SC-MW-03F	SC-MW-03F	MW-3F	—	—	Along east property line	50
—	SC-MW-04F	SC-MW-04F	MW-4F	—	—	South of Anclote River	50
—	SC-MW-07S	SC-MW-07S	MW-7S	—	—	Downgradient of lagoons/calcium fluoride storage areas	32
—	SC-MW-09S	SC-MW-09S	MW-9S	—	MW-9S	Downgradient of buried drum area (no. 3)	32
—	SC-MW-10S	SC-MW-10S	MW-10S	—	—	Along east property line	32

Table 6. Stauffer Chemical Company Site, Monitoring Well Identifications (1985 to 2002) (continued)

Semiannual Sampling (NUS 1989, SMC 2002)	**Expanded Site Investigation (NUS 1989)**	**Final Listing Site Inspection (NUS 1991)**	**Remedial Investigation (Weston 1993)**		**(Parsons 1999)**	**Description**	
January 1987 through February 2002	***January 1988***	***April 1989***	***March/ April 1993***	***July 1993***	***1998 and 1999***	***Location***	***Approximate Depth (feet)***
—	SC-MW-11S	SC-MW-11S	MW-11S	—	—	South of Anclote River	32
—	SC-TW-01	—	—	—	—	Background; northeast corner of the site	IBWT
—	SC-TW-03	—	—	—	—	South of Anclote Road and slag disposal area	IBWT
—	SC-TW-06	—	—	—	—	Old disposal pond near lagoon system	IBWT
—	SC-TW-07	—	—	—	—	Immediately southwest of buried drum area no. 1	IBWT
—	SC-TW-08	—	—	—	—	Downgradient of calcium fluoride storage area no. 3	IBWT
—	SC-TW-09	—	—	—	—	Southwest of drum disposal area no. 3	IBWT
—	SC-TW-11	—	—	—	—	Downgradient/west of facility complex	IBWT
—	SC-TW-13	—	—	—	—	Along east property boundary	IBWT
—	SC-TW-14	—	—	—	—	Along east property boundary	IBWT
—	SC-TW-16	—	—	—	—	Anclote River dredge disposal area	IBWT
—	—	—	MW93-1	—	—	Downgradient from former slag processing area	11
—	—	—	MW93-2	—	—	Just west of Anclote Road (to characterize possible upgradient/off-site sources)	16

Table 6. Stauffer Chemical Company Site, Monitoring Well Identifications (1985 to 2002) (continued)

Semiannual Sampling (NUS 1989, SMC 2002)	**Expanded Site Investigation (NUS 1989)**	**Final Listing Site Inspection (NUS 1991)**	**Remedial Investigation (Weston 1993)**		**(Parsons 1999)**	**Description**	
January 1987 through February 2002	***January 1988***	***April 1989***	***March/ April 1993***	***July 1993***	***1998 and 1999***	***Location***	***Approximate Depth (feet)***
—	—	—	MW93-3	—	—	South of pond 42	16
—	—	—	MW93-4	—	—	Central portion of site (to characterize impact of main process area)	20
—	—	—	MW93-5	—	MW93-5	North of pond 42	15
—	—	—	WP93-1	—	—	Temporary well point installed radially around MW-93-4	S
—	—	—	WP93-2	—	—	Temporary well point installed radially around MW-93-4	S
—	—	—	WP93-3	—	—	Temporary well point installed radially around MW-93-4	S
—	—	—	WP93-4	—	—	Temporary well point installed radially around MW-93-4	S
—	—	—	WP93-5	—	—	Temporary well point installed radially around MW-93-4	S
—	—	—	—	WP93-6	—	Piezometer installed to evaluate water table elevation near MW93-1	12
—	—	—	—	WP93-7	—	Piezometer installed to evaluate water table elevation near MW93-1	7
—	—	—	—	WP93-8	—	Piezometer installed to evaluate water table elevation near MW93-1	13
—	—	—	—	—	MW-98-1	North of site and north of Anclote Road at Sweetbriar Drive	S

Table 6. Stauffer Chemical Company Site, Monitoring Well Identifications (1985 to 2002) (continued)

Semiannual Sampling (NUS 1989, SMC 2002)	**Expanded Site Investigation (NUS 1989)**	**Final Listing Site Inspection (NUS 1991)**	**Remedial Investigation (Weston 1993)**		**(Parsons 1999)**	**Description**	
January 1987 through February 2002	***January 1988***	***April 1989***	***March/ April 1993***	***July 1993***	***1998 and 1999***	***Location***	***Approximate Depth (feet)***
—	—	—	—	—	MW-98-2	Downgradient along western boundary of site	S
—	—	—	—	—	MW-98-3	Downgradient along western boundary of site	S
—	—	—	—	—	MW-98-4	Downgradient along western boundary of site	S

Key

IBWT	immediately below water table
MW	monitoring well
S	shallow
SI	site inspection
TW	temporary well

Table 7. On-Site Groundwater Monitoring Summary Data, Surficial Aquifer

Chemical	Minimum Detected (ppb)	Maximum Detected (ppb)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppb)	Source	
Volatile Organic Compounds (VOCs)								
Carbon Disulfide	4 J	4 J	MW-8ES	Jan-88	1/4	1,000	child-RMEG	0
Chloroform	6	6	MW-9S	Jan-88	1/5	6	CREG	0
1,1-Dichloroethane	2 J	2 J	MW-8ES	Jan-88	1/5	800	RBC-N	0
Trichloroethylene	14	14	MW-1S	Mar-93	1/7	0.09	CREG	1
Semivolatile Organic Compounds (SVOCs)								
Di-n-Octyl Phthalate	0.80 J	1 J	MW93-3	Mar-93	2/7	730	RBC-N	0
4-Methylphenol	1 J	1 J	MW93-1	Mar-93	1/7	180	RBC-N	0
Pesticides/Polychlorinated Biphenyls								
Methoxychlor	0.009 J,P	0.009 J,P	MW93-3	Mar-93	1/8	40	LTHA, MCL, MCLG	0
Inorganics-Metals								
Aluminum (Al)	19.8 B	290,000	MW-11S	Jan-88	286/379	37,000	RBC-N	13
Antimony (Sb)	2	210	MW-8ES	Oct-88	63/370	4	child-RMEG	41
Arsenic (As)	1	980	MW93-3	Mar-93	199/382	0.02	CREG	199
Barium (Ba)	1	550	MW93-3	Mar-93	158/370	700	child-RMEG	0
Beryllium (Be)	0.11 B	11	MW-11S	Jan-88	14/83	20	child-RMEG	0
Boron (B)	25	3,200	MW-7ES	Jul-92	204/284	600	LTHA	44
Cadmium (Cd)	0.00	150	MW93-3	Mar-93	33/95	5	child-RMEG, LTHA	11
Calcium (Ca)	5,800	2,300,000	MW-3ES	Jan-88	95/95	NA	NA	–

Table 7. On-Site Groundwater Monitoring Summary Data, Surficial Aquifer (continued)

Chemical	Minimum Detected (ppb)	Maximum Detected (ppb)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppb)	Source	
Chromium (Cr)	0.72 B	700	MW-11S	Jan-88	72/379	30	child-RMEG	28
Cobalt (Co)	3	47	MW-11S	Jan-88	7/83	730	RBC-N	0
Copper (Cu)	1	260	MW93-3	Mar-93	35/95	1,300	MCLG	0
Iron (Fe)	0.00	130,000	MW-11S	Jan-88	343/382	11,000	RBC-N	14
Lead (Pb)	1.1 X	680	MW93-3	Mar-93	29/82	15	EPA AL	10
Lithium (Li)	10	1,000	MW-5ES	Jul-90	50/284	730	RBC-N	2
Magnesium (Mg)	650	130,000	MW-8ES	Dec-98	91/95	NA	NA	–
Manganese (Mn)	1	1,700	MW-3ES	Jan-88	283/382	500	child-RMEG	3
Mercury (Hg)	0.02	5.9	MW93-3	Mar-93	13/55	2	LTHA (Inorganic Hg)	1
Nickel (Ni)	1	240	MW-11S	Jan-88	65/370	100	LTHA	3
Potassium (K)	302 B	480,000	MW-8ES	Jun-99	84/95	NA	NA	–
Selenium (Se)	1.4 X	140	MW93-3	Mar-93	14/83	50	child RMEG, LTHA	1
Silver (Ag)	4.3	6.3	MW93-3	Mar-93	2/43	50	child-RMEG	0
Sodium (Na)	2,100	690,000	MW-7S	Jan-88	95/95	NA	NA	–
Thallium (Tl)	3 JN	240	MW-9S	Mar-93	11/83	0.5	LTHA	11
Vanadium (V)	1 B	360	MW-11S	Jan-88	47/83	260	RBC-N	6
Zinc (Zn)	1.5 B	1,700	MW93-3	Mar-93	42/83	2,000	LTHA	0
Inorganics-Other								

Table 7. On-Site Groundwater Monitoring Summary Data, Surficial Aquifer (continued)

Chemical	Minimum Detected (ppb)	Maximum Detected (ppb)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppb)	Source	
Cyanide	2.2 B	160	MW-7ES	Jun-99	11/72	200	child-RMEG, LTHA	0
Fluoride	120	71,000 J	MW-3ES	Jan-88	348/358	4,000	MCL	139
Ortho-P	0.00	72,000	MW-8ES	Jul-96	237/273			
Phosphorus (Elemental)	0.17	0.43	MW-98-4	Sep-98	3/40			
Phosphorus (Total)	25	380,000	MW-8ES	Sep-98	73/75			
Sulfate (SO_4)	1,000	2,400,000	MW-7ES	Jul-92	267/274	250,000	NSDWRs	75

Radiologic Parameters	Minimum (pCi/L)	Confidence	Maximum (pCi/L)	Confidence	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
								Value (pCi/L)	Source	
Gross Alpha	-22.0000	±12.0	366.3	NA	MW93-3	Mar-93	270/363	15	MCL	41
Gross Beta	0.4000	±0.9	689.5	NA	MW93-3	Mar-93	321/362			
Polonium-210	-1	±6	314.9	NA	MW93-3	Mar-93	128/341			
Radium-226	-0.4000	±0.4	15.4	NA	MW-7S	Mar-93	228/341	5	MCL	7
Radon-222	-33.6	169.76 %	11,600.0	±300	MW-3ES	Jan-90	347/363	300	MCL	171

Sources: Flow 2001; NUS Corp 1989, 1991; Parsons 1999; SMC 2002; Weston 1993.

Table 7. On-Site Groundwater Monitoring Summary Data, Surficial Aquifer (continued)

Key:

B	Detected in the associated laboratory blank and in the sample
CREG	cancer risk evaluation guide
EPA AL	U.S. Environmental Protection Agency action level
J	estimated quantity below the quantitation limit
LTHA	lifetime health advisory (U.S. Environmental Protection Agency)
MCL	maximum contaminant level (U.S. Environmental Protection Agency)
MCLG	maximum contaminant level goal (U.S. Environmental Protection Agency)
NA	not available
NSDWRs	National Secondary Drinking Water Regulations (U.S. Environmental Protection Agency)
P	the percent difference between the results from the two gas chromatograph columns is > 25%; the lower of the two is reported
pCI/L	picocuries per liter
ppb	parts per billion
RBC-N	risk-based concentration, for noncancer effects
RMEG	reference dose media evaluation guide
X	result in less than the contract required detection limit, but greater than or equal to the instrument detection limit

Notes:

- Negative radiological readings represent samples in which the amount of radioactivity in the sample blank was larger than that in the sample.
- Stauffer Management Company duplicate samples collected during its routine groundwater monitoring program were counted as individual samples.

Table 8. On-Site Groundwater Monitoring Summary Data, Floridan Aquifer

Chemical	Minimum Detected (ppb)	Maximum Detected (ppb)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppb)	Source	
Volatile Organic Compounds (VOCs)								
Chloroform	1 J	1 J	MW-2F	Jan-88	1/3	6	CREG	0
Dibromochloromethane	1 J	1 J	MW-2F	Jan-88	1/3	0.13	RBC-C	1
1,1-Dichloroethane	1 J	1 J	MW-2F	Jan-88	1/3	800	RBC-N	0
Methylethyl Ketone	78 J,N	78 J,N	MW-1F	Jan-88	1/3	1900	RBC-N	0
Pesticides/Polychlorinated Biphenyls (PCBs)								
Methoxychlor	0.003 J,P	0.003 J,P	MW-2F	Mar-93	½	40	LTHA, MCL, MCLG	0
Inorganics-Metals								
Aluminum (Al)	34	74,000	MW-4F	Jan-88	8/8	37,000	RBC-N	1
Arsenic (As)	1.6	110 J,N	MW-4F	Jan-88	6/12	0.02	CREG	6
Barium (Ba)	10	340 J	MW-4F	Jan-88	8/8	700	child-RMEG	0
Beryllium (Be)	5	5	MW-4F	Jan-88	1/8	20	child-RMEG	0
Cadmium (Cd)	0.2	29	MW-3F	Jan-88	5/8	5	child-RMEG, LTHA	1
Calcium (Ca)	7,600	710,000	MW-4F	Jan-88	12/12	NA		
Chromium (Cr)	5.6	290	MW-4F	Jan-88	3/8	30	child-RMEG	1
Cobalt (Co)	35	35	MW-4F	Jan-88	1/8	730	RBC-N	0
Copper (Cu)	1.6	320	MW-3F	Jan-88	6/8	1,300	MCLG	0

Table 8. On-Site Groundwater Monitoring Summary Data, Floridan Aquifer (continued)

Chemical	Minimum Detected (ppb)	Maximum Detected (ppb)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppb)	Source	
Iron (Fe)	39	110,000	MW-4F	Jan-88	11/11	11,000	RBC-N	1
Lead (Pb)	1.6	9.6	MW-4F	Mar-93	2/8	15	EPA AL	0
Magnesium (Mg)	2,300 X	210,000	MW-4F	Jan-88	11/12	NA		
Manganese (Mn)	12	5,200	MW-4F	Jan-88	11/12	500	child-RMEG	1
Nickel (Ni)	12	200	MW-4F	Jan-88	3/8	100	LTHA	1
Potassium (K)	2,300	62,000	MW-2F	Apr-89	9/12	NA		
Sodium (Na)	11,900	690,000	MW-2F	Jan-88	12/12	NA		
Thallium (Tl)	2 J,N	2 J,N	MW-3F	Jan-88	1/8	0.5	LTHA	1
Vanadium (V)	4.1	320	MW-4F	Jan-88	5/8	260	RBC-N	1
Zinc (Zn)	12 X	210	MW-4F	Jan-88	5/8	2,000	LTHA	0
Inorganics-Other								
Fluoride	190	300	MW-2F	Mar-93	2/8	4,000	MCL	0
Phosphorus (Total)	93	27,000 J	MW-4F	Jan-88	5/7			

Table 8. On-Site Groundwater Monitoring Summary Data, Floridan Aquifer (continued)

Radiologic Parameters	Minimum (pCi/L)	Confidence	Maximum (pCi/L)	Confidence	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
								Value (pCi/L)	Source	
Gross Alpha	-3	±6	140	±30	MW-4F	Jan-88	8/8	15	MCL	2
Gross Beta	4	±1.5	113	±13	MW-4F	Jan-88	8/8			
Polonium-210	0.57	NA	1.7	NA	MW-4F	Mar-93	2/4			
Radium-226	0.66	NA	1.7	NA	MW-2F	Mar-93	3/4	5	MCL	0
Radon-222	10.3	NA	2,536	2.98 %	MW-1F	Jan-88	18/18	300	MCL	17

Sources: Flow 2001; NUS Corp 1989, 1991; Parsons 1999; SMC 2002; Weston 1993.

Key:

CREG	cancer risk evaluation guide
EPA AL	U.S. Environmental Protection Agency action level
J	estimated quantity below the quantitation limit
LTHA	lifetime health advisory (U.S. Environmental Protection Agency)
MCL	maximum contaminant level (U.S. Environmental Protection Agency)
MCLG	maximum contaminant level goal (U.S. Environmental Protection Agency)
N	presumptive evidence of presence of material
NSDWRs	National Secondary Drinking Water Regulations (U.S. Environmental Protection Agency)
P	the percent difference between the results from the two gas chromatograph columns is > 25%; the lower of the two is reported
ppb	parts per billion
RBC-C	risk-based concentration, for cancer effects
RBC-N	risk-based concentration, for noncancer effects
RMEG	reference dose media evaluation guide
X	result in less than the contract required detection limit, but greater than or equal to the instrument detection limit

Notes:

- Negative radiologic readings represent samples in which the amount of radioactivity in the sample blank was larger than that in the sample.

Table 9. Maximum Contaminant Levels Detected in Potable Water Wells (Wells 5, 12, 13, and 15) at Stauffer Chemical Company, Tarpon Springs, Florida, Before 1979 (When Use of These Wells Ceased)

Contaminant	Minimum Detected	Maximum Detected	Location of Maximum	Date of Maximum	Comparison Value (CV)	
					Value	*Source*
Fluoride	50 ppb	350 ppb	Well 5	6/11/74	4,000 ppb	MCL
Phosphorus	ND	2,240 ppb	Well 15	10/30/78	0.1 ppb[a]	LTHA
Sulfate	<5,000 ppb	80,000 ppb	Well 15	8/31/77	250,000 ppb	NSDWR
Iron	ND	600 ppb	Well 15	10/30/78	11,000 ppb	EPA RBC

Table 10. Maximum Contaminant Levels Detected in Backup Potable Water Wells (Wells 7, 10, and 14) at Stauffer Chemical Company, Tarpon Springs, Florida, Before 1979 (When Use of Potable Wells Ceased)

Contaminant	Minimum Detected	Maximum Detected	Location of Maximum	Date of Maximum	Comparison Value (CV)	
					Value	*Source*
Fluoride	100 ppb	1,340 ppb	Well 10	5/20/74	4,000 ppb	MCL
Phosphorus	60 ppb	2,020 ppb	Well 10	10/30/78	0.1 ppb*	LTHA
Sulfate	10,000 ppb	307,000 ppb	Well 10	3/30/77	250,000 ppb	NSDWR
Iron	<50 ppb	4,000 ppb	Well 14	3/30/77	11,000 ppb	EPA RBC

Key:

EPA	U.S. Environmental Protection Agency
LTHA	lifetime health advisory for drinking water (EPA)
MCL	maximum contaminant level (EPA)
ND	not detected
NSDWR	National Secondary Drinking Water Regulations (EPA)
ppb	parts per billion
RBC	risk-based concentration

Note:
*CV is for elemental (white) phosphorus.

Table 11. Off-Site Soil Monitoring Summary Data, Gulfside Elementary School Surface Soils

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppm)	Source	
Volatile Organic Compounds (VOCs)								
No GES samples were analyzed for VOCs.								
Semivolatile Organic Compounds (SVOCs)								
No GES samples were analyzed for SVOCs.								
Pesticides/Polychlorinated Biphenyls (PCBs)								
No GES samples were analyzed for pesticides/PCBs.								
Inorganics-Metals								
Aluminum (Al)	310	5,760	SC96-9	Feb-96	16/16	100,000	child-I-EMEG	0
Antimony (Sb)	1.7	13.2	SC93-1	Jul-93	3/14	20	child-RMEG	0
Arsenic (As)	0.13	0.6	SC93-1	Jul-93	9/14	0.5	CREG	1
Barium (Ba)	1.5	14.8	SC93-1	Jul-93	14/14	4,000	child-RMEG	0
Beryllium (Be)	0.16	0.16	SC93-1	Jul-93	2/14	50	child-C-EMEG	0
Cadmium (Cd)	0.59	0.59	SC93-1	Jul-93	1/14	10	child-C-EMEG	0
Calcium (Ca)	251	16,400	SC93-1	Jul-93	15/16	NA	NA	NA
Chromium (Cr)	0.83	23.9	SC93-1	Jul-93	16/16	200	child-RMEG	0
Cobalt (Co)	0.29	0.38	SC96-9	Feb-96	3/14	500	child-I-EMEG	0
Copper (Cu)	0.27	4.8	SC96-9	Feb-96	10/14	3,100	RBC-N	0
Iron (Fe)	220	1,430	SC93-1	Jul-93	16/16	23,000	RBC-N	0

Table 11. Off-Site Soil Monitoring Summary Data, Gulfside Elementary School Surface Soils (continued)

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppm)	Source	
Lead (Pb)	1.2	6.3	SC93-3	Jul-93	15/16	400	EPA AL	0
Magnesium (Mg)	19.6	634	SC93-1	Jul-93	14/14	NA	NA	NA
Manganese (Mn)	6.0	22.9	SC96-3	Feb-96	16/16	3,000	child-RMEG	0
Nickel (Ni)	1.1	4.2	SC93-3	Jul-93	13/14	1,000	child-RMEG	0
Potassium (K)	66.7	265	SC93-1	Jul-93	7/14	NA	NA	NA
Selenium (Se)	0.12	0.35	SC93-3	Jul-93	7/14	300	child-C-EMEG	0
Sodium (Na)	7.2	57.1	SC93-1	Jul-93	14/14	NA	NA	NA
Vanadium (V)	2.4	17.2	SC93-1	Jul-93	14/14	200	child-I-EMEG	0
Zinc (Zn)	1.2	16	SC96-8	Feb-96	14/14	20,000	child-C-EMEG	0
Inorganics-Other								
Cyanide	0.85	0.85	SC96-2	Feb-96	1/14	1,000	child-RMEG	0
Fluoride	2.4	14.3	SC93-1	Jul-93	4/14	3,000	child-C-EMEG, FNa	0
ortho-Phosphorus	6.9	7.3	S-2	Aug-97	2/14	NA	NA	NA
Phosphorus (Total)	5.4	1,100	SC93-1	Jul-93	27/28	NA	NA	NA

Table 11. Off-Site Soil Monitoring Summary Data, Gulfside Elementary School Surface Soils (continued)

Radiologic Parameters	Minimum (Bq/kg)	Confidence	Maximum (Bq/kg)	Confidence	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
								Value (Bq/kg)	Source	
Gross Alpha	27.4	± 201	740	NA	SC93-1	Jul-93	15/15	NA	NA	NA
Gross Beta	7.03	± 246	1,050	NA	SC93-1	Jul-93	15/15	NA	NA	NA
Polonium-210	10	± 7.0	107	NA	SC93-1	Jul-93	16/16	210	NCRP screening limit (residential)	0
Radium-226	15.5	NA	59.2	NA	SC93-1	Jul-93	15/15	5.4	NCRP screening limit (residential)	15
Radon-222	4.4	± 1.8	59	NA	SS93-1	Jul-93	15/15	NA	NA	NA

NOTE: One additional radiologic sampling was performed on roadways bordering GES on the east and northeast, as well as on the roofing material (EE&G 1997a). All parameters were below or within the ranges of the surface soil samples listed above. The concentrations of radium-266 found in both samples were above the comparison value.

Sources: EE&G 1997a (14 sampling points analyzed for other inorganics); NUS 1991 (two sampling points analyzed for metals); Weston 1993 (four sampling points analyzed for radionuclides, metals, and other inorganics); Weston 1996 (10 sampling points analyzed for metals and other inorganics, 12 sampling points analyzed for radionuclides.)

Key:		
	Bq/kg	Becquerel per kilogram
	CREG	cancer risk evaluation guide
	C-EMEG	chronic environmental media evaluation guide (Agency for Toxic Substances and Disease Registry)
	EPA AL	U.S. Environmental Protection Agency action level
	GES	Gulfside Elementary School
	I-EMEG	intermediate environmental media evaluation guide (Agency for Toxic Substances and Disease Registry)
	NA	not available
	NCRP	National Council on Radiation Protection and Measurements
	ppm	parts per million
	RBC-N	risk-based concentration, for noncancer effects
	RMEG	reference dose media evaluation guide

Table 12. Private well sample locations and dates sampled

Map No.	Address	Well Type	Sampling Events (No.)	Year
1	1151 Savannah Avenue	Residential-potable	2	1999, 2000
2	1503 Savannah Avenue	Commercial-potable	3	1999, 2000
3	1502 Savannah Avenue	Commercial-potable	7	1997, 1999, 2000, 2001
4	822 Anclote Road	Commercial-potable	6	1990, 1997, 2000, 2001
5	1599 Rainville Road	Commercial-potable	6	1990, 1997, 1999, 2000, 2001
6	1456 Savannah Avenue	Commercial-potable	2	2000
7	1553 Savannah Avenue	Commercial-potable	7	1988, 1990, 1997, 2000, 2001
8	1525 Rainville Road	Commercial-potable	2	2000
9	1232 N. Florida Avenue	Residential-potable	2	2000, 2001
10	1222 N. Florida Avenue	Residential-potable	5	2000, 2001
11	1218 N. Florida Avenue	Residential-potable	1	2000
12	1210 N. Florida Avenue	Residential-potable	4	2000, 2001
13	1234 N. Florida Avenue	Residential-potable	2	2000
14	905 Riverside Drive	Residential-potable	6	2000, 2001
15	3020 Buff Boulevard	Residential-potable	3	1999, 2000, 2001
16	1328 Calvary Road	Residential-potable	2	2000, 2001
17	1421 Calvary Road	Residential-potable	1	2000
18	1132 Hickory Lane	Residential-potable	3	2000, 2001
19	1916 Geronimo Drive	Residential-potable	2	2000, 2001
20	1681 Wilmar Drive	Residential-potable	1	1999
21	1124 Hickory Lane	Residential-potable	1	1990
22	252 Jeru Boulevard	Residential-potable	3	2000, 2001
23	204 Jeru Boulevard	Residential-potable	3	2000, 2001
24	1771 Meyers Cove Drive	Irrigation	1	2001

Table 12. Private well sample locations and dates sampled (continued)

Map No.	Address	Well Type	Sampling Events (No.)	Year
25	1749 Meyers Cove Drive	Irrigation	1	2001
26	1727 Meyers Cove Drive	Irrigation	1	2001
27	800 Anclote Road	Commercial-potable	2	1990, 1997
28	1140 Anclote Road	Irrigation	1	1990
29	701 Anclote Road	Irrigation	1	1990
30	1253 N. Florida Avenue	Irrigation	1	1997
31	1202 Hickory Lane	Residential-potable	1	1997
32	2105 Wallace Boulevard	Residential-potable	1	1997
33	507 Anclote Road	Community public	1	1997
34	764 Chesapeake Drive	Irrigation	1	1997
35	1389 Rainville Road	Residential-potable	1	1997
36	374 Jeru Boulevard	Irrigation	1	1997
37	1138 Hickory Lane	Residential-potable	1	1988
38	2113 Cemetery Road	Residential-potable	1	1988

Table 13. Private Well Summary Data—Contaminants Detected at Levels Above Comparison Values, Residential Wells

Chemical	Minimum Detected (ppb)	Maximum Detected (ppb)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppb)	Source	
Semivolatile Organic Compounds (SVOCs)								
bis(2-Ethylhexyl)phthalate	3.1	7.6	S	Mar-00	3/12	3	CREG	3
Inorganics-Metals								
Arsenic (As)	0.65	24	NW	Mar-00	36/37	0.02	CREG	36
Calcium (Ca)	18,000	100,000	NW	Feb-97	6/6	NA		NA
Chromium (Cr)	1	44	NW	Jun-00	32/37	30	child RMEG	1
Lead (Pb)	0.12	270	S	Mar-01	24/38	15	EPA AL	4
Magnesium (Mg)	4,700	21,000	NW	Feb-97	6/6	NA		NA
Nickel (Ni)	0.62	120	NW	Mar-00	18/36	100	LTHA	1
Potassium (K)	1,100	2,200	NW	Jan-88	2/2	NA		NA
Sodium (Na)	9,100	510,000	NW	Jun-00	40/40	NA		NA
Thallium (Tl)	0.097	1.6	S	Mar-01	4/36	0.5	LTHA	1
Inorganic-Other								
Chloride (Cl)	25,400	420,000	NW	Feb-97	4/4	250,000	NSDWR	1

Radiologic Parameters	Minimum (pCi/L)	Confidence	Maximum (pCi/L)	Confidence	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
								Value (pCi/L)	Source	
Gross Alpha	0.00	±0.40	26.20	±5.00	S	Mar-00	27/36	15	MCL	1
Gross Beta	0.90	±0.20	10.10	±1.00	E	Apr-99	5/5	NA		NA

Sources: Flow 2001; Pinellas County Health Department 1990, 2002; FDOH 1997.

Key:

CREG	cancer risk evaluation guide
E	east of site
EPA AL	U.S. Environmental Protection Agency action level
LTHA	lifetime health advisory (U.S. Environmental Protection Agency)
MCL	maximum contaminant level (U.S. Environmental Protection Agency)
NA	not available
NSDWR	National Secondary Drinking Water Regulation (U.S. Environmental Protection Agency)
NW	northwest of site
pCi/L	picocuries per liter
ppb	parts per billion
RMEG	reference dose media evaluation guide
S	south of Anclote River

Table 14. Private Well Summary Data—Contaminants Detected at Levels Above Comparison Values, Commercial Wells

Chemical	Minimum Detected (ppb)	Maximum Detected (ppb)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppb)	Source	
Semivolatile Organic Compounds (SVOCs)								
bis(2-Ethylhexyl)phthalate	2	4.4	E	Mar-00	3/6	6	CREG	1
Inorganics-Metals								
Arsenic (As)	0.14	26	E	Mar-00	30/33	0.02	CREG	30
Calcium (Ca)	58,000	357,000	E	Jul-90	10/10	NA		NA
Iron (Fe)	20 I	18,000	E	Mar-00	28/35	11,000	RBC-N	1
Magnesium (Mg)	5,300	48,000	E	Feb-97	9/9	NA		NA
Nickel (Ni)	0.2	290	E	Mar-00	17/30	100	LTHA	1
Potassium (K)	2,300	2,300	E	Jan-88	1/1	NA		NA
Sodium (Na)	21,000	350,000	E	Feb-97	33/33	NA		NA
Thallium (Tl)	0.19	3.1	E	Mar-00	4/30	0.5	LTHA	2
Zinc (Zn)	50	3,700	E	Mar-01	23/33	2,000	LTHA	1
Inorganics-Other								
Chloride (Cl)	50,000	760,000	E	Feb-97	9/9	250,000	NSDWR	2
Sulfate (SO_4)	7,600	650,000	E	Jul-90	9/9	250,000	NSDWR	2

Radiologic Parameters	Minimum (pCi/L)	Confidence	Maximum (pCi/L)	Confidence	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
								Value (pCi/L)	Source	
Gross Alpha	0.00	±0.70	23.00	±6.00	E	Jan-88	19/22	15	MCL	1
Gross Beta	0.70	±0.20	13.00	±1.00	E	Apr-99	4/4	NA		NA
Radium-226	0.20	±0.10	8.60	±0.20	E[a]	Mar-00	21/21	5	MCL	1

Sources: Flow 2001; Pinellas County Health Department 1990, 2002; FDOH 1997.

Note: [a]At this location, radium-226 plus radium-228 was 10.20±0.50 pCi/L.

Key:

CREG	cancer risk evaluation guide
E	east of site
I	approximate value between the detection level and quantitation level
LTHA	lifetime health advisory (U.S. EPA)
MCL	maximum contaminant level (U.S. EPA)
NA	not available
NSDWR	National Secondary Drinking Water Regulation (U.S. EPA)
pCi/L	picocuries per liter
ppb	parts per billion
RBC-N	risk-based concentration, for noncancer effects

Table 15. Private Well Summary Data—Contaminants Detected at Levels Above Comparison Values, Irrigation Wells

Chemical	Minimum Detected (ppb)	Maximum Detected (ppb)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (CV)		Number Above CV
						Value (ppb)	Source	
Inorganics-Metals								
Arsenic (As)	1.1	4.4	E	Feb-97	6/8	0.02	CREG	6
Calcium (Ca)	50,000	95,000	NW	Jul-90	5/5	NA		NA
Magnesium (Mg)	21,000	44,000	S	Feb-97	5/5	NA		NA
Sodium (Na)	34,000	280,000	S	Feb-97	8/8	NA		NA
Zinc (Zn)	24	2,820	E	Jul-90	6/8	2,000	LTHA	1
Inorganics-Other								
Chloride (Cl)	265,000	580,000	S	Feb-97	5/5	250,000	NSDWR	5

Sources: Flow 2001; Pinellas County Health Department 1990, 2002; FDOH 1997.

Key:

E	east of site
CREG	cancer risk evaluation guide
LTHA	lifetime health advisory (U.S. Environmental Protection Agency)
NA	not available
NSDWR	National Secondary Drinking Water Regulation (U.S. Environmental Protection Agency)
ppb	parts per billion
NW	northwest of site
S	south of Anclote River

Table 16. Surface Water Summary Data, Anclote River, Upstream

Chemical	Minimum Detected (ppb)	Maximum Detected (ppb)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (ppb)	Comparison Value Source	Number Above CV
Inorganics-Metals								
Aluminum (Al)	40	600	upstream	Apr-89	3/50	37,000	RBC-N	0
Antimony (Sb)	9	850	upstream	Jan-89	5/50	4	child RMEG	5
Arsenic (As)	1.3 X	5.3 X	SW-2	Mar-93	9/50	0.02	CREG	9
Barium (Ba)	7 X	280	upstream	May-91	20/50	700	child RMEG	0
Boron (B)	990	5,800	upstream	Apr-89	38/38	600	LTHA	38
Calcium (Ca)	80,700	290,000	SW-06	Jan-88	12/12	NA		
Chromium (Cr)	6.5 X	46	upstream	Jan-87	3/50	30	child RMEG	0
Copper (Cu)	2.5 X	18.3 X	SW-3	Mar-93	10/12	1,300	MCLG	0
Iron (Fe)	10	1,800	upstream	Aug-01	41/49	11,000	RBC-N	0
Lead (Pb)	1.2 X	4	SW-1	Mar-93	4/12	15	EPA AL	0
Lithium (Li)	41	370	upstream	Apr-89	34/38	730	RBC-N	0
Magnesium (Mg)	184,000	1,110,000	SW-5	Mar-93	12/12	NA		
Manganese (Mn)	3	30	upstream	Oct-88	11/50	500	child RMEG	0
Mercury (Hg)	0.17 X	1	SW-4A	Mar-93	7/12	2	LTHA, Inorganic Hg	0
Nickel (Ni)	2	100	upstream	Jul-90	8/50	100	LTHA	0
Potassium (K)	73,200	398,000	SW-5	Mar-93	12/12	NA		
Selenium (Se)	7.2 X	23.2 X	SW-2	Mar-93	2/12	50	child RMEG, LTHA	0
Sodium (Na)	1,590,000	8,910,000	SW-3	Mar-93	12/12	NA		

Table 16. Surface Water Summary Data, Anclote River, Upstream (continued)

Chemical	Minimum Detected (ppb)	Maximum Detected (ppb)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (ppb)	Comparison Value Source	Number Above CV
Inorganics-Other								
Fluoride (F)	370	81,000	upstream	May-91	40/49	4,000	MCL	12
Phosphate-phosphorus	50	140	SW-2	Mar-93	5/10	NA		
Ortho-P (O-P)	10	610	upstream	Oct-88	17/38	NA		
Sulfate (SO_4)	500,000	5,200,000	upstream	Jan-89	38/38	250,000	NSDWRs	38
Radiologic Parameters (pCi/L)								
Gross Alpha	-100±200	199±122	upstream	Jul-94	22/40	15	MCL	15
Gross Beta	3.5±0.3	583±114	upstream	Jul-94	38/40	4	MCL	38
Radium-226	0.00±0.4	5.4±0.5	upstream	Jul-97	34/38	5	MCL	33
Radon-222	-80±40	120±70	upstream	Jan-89	21/38	300	MCL	0
Polonium-210	0.1±0.9	14.1±3	upstream	Jun-93	14/37	NA		

Sources: NUS 1989; SMC 1987-present; Weston 1993.

Key:

CREG	cancer risk evaluation guide
EPA AL	U.S. Environmental Protection Agency action level
LTHA	lifetime health advisory (U.S. Environmental Protection Agency)
MCL	maximum contaminant level (U.S. Environmental Protection Agency)
MCLG	maximum contaminant level goal (U.S. Environmental Protection Agency)
NA	not available
NSDWRs	National Secondary Drinking Water Regulations (U.S. Environmental Protection Agency)
pCi/L	picocuries per liter
ppb	parts per billion
RBC-N	risk-based concentration, for noncancer effects (U.S. Environmental Protection Agency)
RMEG	reference dose media evaluation guide
SMC	Stauffer Management Company
X	result in less than the contract-required detection limit, but greater than or equal to the instrument detection limit

Table 16. Surface Water Summary Data, Anclote River, Upstream (continued)

Notes:

- Upstream sample was taken as part of the ongoing SMC Groundwater Monitoring Program. SMC’s upstream samples are collected immediately upstream of the Stauffer site in the Anclote River directly in line with the eastern property boundary.
- Duplicate samples, collected primarily by SMC as part of its groundwater monitoring program, are counted as individual samples in these summary statistics.
- Negative radiologic readings represent samples in which the amount of radioactivity in the sample blank was larger than that in the sample.

Table 17. Surface Water Summary Data, Anclote River, Adjacent

Chemical	Minimum Detected (ppb)	Maximum Detected (ppb)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (ppb)	Comparison Value Source	Number Above CV
Inorganics-Metals								
Aluminum (Al)	39.7 X	29,000	SW-05	Jan-88	6/6	37,000	RBC-N	0
Arsenic (As)	1.1 X	48 J,N	SW-05	Jan-88	5/6	0.02	CREG	5
Barium (Ba)	8 X	84	SW-05	Jan-88	5/6	700	child RMEG	0
Calcium (Ca)	290	280,000	SW-05	Jan-88	6/6	NA		
Chromium (Cr)	80	80	SW-05	Jan-88	1/6	30	child RMEG	1
Copper (Cu)	2.8 X	10.7 X	SW-6C	Mar-93	3/6	1,300	MCLG	0
Iron (Fe)	60.6 X	28,000	SW-05	Jan-88	5/6	11,000	RBC-N	1
Lead (Pb)	1.2 X	150	SW-05	Jan-88	4/6	15	EPA AL	1
Magnesium (Mg)	160,000	996,000	SW-6B	Mar-93	6/6	NA		
Manganese (Mn)	180	180	SW-05	Jan-88	1/6	500	child RMEG	0
Mercury (Hg)	0.22 X	0.22 X	SW-6A	Mar-93	1/6	2	LTHA	0
Nickel (Ni)	89	89	SW-05	Jan-88	1/6	100	LTHA	0
Potassium (K)	68,000	335,000	SW-6B	Mar-93	6/6	NA		
Sodium (Na)	1,200,000	8,540,000	SW-6C	Mar-93	6/6	NA		
Vanadium (V)	370	370	SW-05	Jan-88	1/6	260	RBC-N	1
Zinc (Zn)	470 J	470 J	SW-05	Jan-88	1/6	2,000	LTHA	0
Inorganics-Other								
Fluoride (F)	510	17,000 J	SW-07	Jan-88	6/6	4,000	MCL	2
Phosphate-phosphorus	50	50	SW-6C	Mar-93	1/4	NA		
Total Phosphorus	40,000 J	40,000 J	SW-05	Jan-88	½	NA		

Table 17. Surface Water Summary Data, Anclote River, Adjacent (continued)

Chemical	Minimum Detected (ppb)	Maximum Detected (ppb)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (ppb)	Comparison Value Source	Number Above CV
Radiologic parameters (pCi/L)								
Gross Alpha	1±1	30±30	SW-05	Jan-88	2/2	15	MCL	2
Gross Beta	15±2	110±30	SW-05	Jan-88	2/2	4	MCL	2

Sources: Sources: NUS 1989; SMC 1987-present, Weston 1993.

Key:

CREG	cancer risk evaluation guide
EPA AL	U.S. Environmental Protection Agency action level
J	estimated quantity below the quantitation limit
LTHA	lifetime health advisory (U.S. Environmental Protection Agency)
MCL	maximum contaminant level (U.S. Environmental Protection Agency)
MCLG	maximum contaminant level goal (U.S. Environmental Protection Agency)
N	presumptive evidence of presence of material
NA	not available
pCi/L	picocuries per liter
ppb	parts per billion
RBC-N	risk-based concentration, for noncancer effects (EPA)
RMEG	reference dose media evaluation guide
X	result in less than the contract-required detection limit, but greater than or equal to the instrument detection limit

Note: Duplicate samples are counted as individual samples in these summary statistics.

Table 18. Surface Water Summary Data, Anclote River, Meyers Cove

Chemical	Minimum Detected (ppb)	Maximum Detected (ppb)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (ppb)	Comparison Value Source	Number Above CV
Inorganics-Metals								
Aluminum (Al)	50	500	downstream	Jul-88	38/60	37,000	RBC-N	0
Antimony (Sb)	8	860	downstream	Jan-89	8/60	4	child RMEG	8
Arsenic (As)	1 X	6 X	SW-7B	Mar-93	12/60	0.02	CREG	12
Barium (Ba)	7 X	200	downstream	Jul-92	14/60	700	child RMEG	0
Boron (B)	970	4,500	downstream	Aug-01	55/55	600	LTHA	55
Calcium (Ca)	228,000	318,000	SW-7C	Mar-93	5/5	NA		
Chromium (Cr)	20	20	downstream	Jan-89	1/59	30	child RMEG	0
Copper (Cu)	2.1 X	10.4 X	SW-7A	Mar-93	4/5	1,300	MCLG	0
Iron (Fe)	20	14,000	downstream	Apr-89	49/60	11,000	RBC-N	1
Lead (Pb)	1.4 X	1.5 X	SW-7B	Mar-93	2/5	15	EPA AL	0
Lithium (Li)	36	370	downstream	Jan-92	51/55	730	RBC-N	0
Magnesium (Mg)	830,000	1,300,000	SW-7C	Mar-93	5/5	NA		
Manganese (Mn)	2	100	downstream	Jul-90	26/60	500	child RMEG	0
Mercury (Hg)	0.15 X	0.36	SW-7A	Mar-93	3/5	2	LTHA, Inorganic	0
Nickel (Ni)	1	100	downstream	Jul-90	12/60	100	LTHA	0
Potassium (K)	240,000	588,000	SW-7C	Mar-93	5/5	NA		
Sodium (Na)	6,700,000	10,900,000	SW-7C	Mar-93	5/5	NA		
Inorganics-Other								
Fluoride (F)	420	80,000	downstream	May-91	48/60	4,000	MCL	27
Phosphate-phosphorus	60	240	SW-7B	Mar-93	3/4	NA		
Ortho-P (O-P)	10	1,300	downstream	Jan-95	31/55	NA		

Table 18. Surface Water Summary Data, Anclote River, Meyers Cove (continued)

Chemical	Minimum Detected (ppb)	Maximum Detected (ppb)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (ppb)	Comparison Value Source	Number Above CV
Sulfate (SO4)	200,000	2,980,000	downstream	Aug-00	55/55	250,000	NSDWRs	53
Radiologic parameters (pCi/L)								
Gross Alpha	-120±90	400±200	downstream	May-87	32/55	15	MCL	11
Gross Beta	3.6±0.3	500±200	downstream	Jan-87	51/57	4	MCL	56
Radium-226	-0.03±0.08	26±0.7	downstream	Apr-90	53/56	5	MCL	1
Radon-222	-80±40	240±0	downstream	Jan-92	33/53	300	MCL	0
Polonium-210	-3±2	62±13	downstream	Jan-88	14/54	NA		

Sources: NUS 1989; SMC 1987-present; Weston 1993.

Key:

CREG	cancer risk evaluation guide
EPA AL	U.S. Environmental Protection Agency action level
LTHA	lifetime health advisory (U.S. Environmental Protection Agency)
MCL	maximum contaminant level (U.S. Environmental Protection Agency)
MCLG	maximum contaminant level goal (U.S. Environmental Protection Agency)
NA	not available
NSDWRs	National Secondary Drinking Water Regulations (U.S. Environmental Protection Agency)
ppb	parts per billion
pCi/L	picocuries per liter
RBC-N	risk-based concentration, for noncancer effects (U.S. Environmental Protection Agency)
RMEG	reference dose media evaluation guide
X	result in less than the contract-required detection limit, but greater than or equal to the instrument detection limit

Notes:

- Downstream samples were taken as part of the SMC ongoing groundwater sampling program. Each semiannual sampling event takes one sample upstream and one downstream in Meyers Cove. Downstream samples are generally taken downstream of the calcium fluoride sludge ponds, 75 to 150 feet off the north shoreline. This sampling site fits into Meyers Cove designation.
- Negative radiologic readings represent samples in which the amount of radioactivity in the sample blank was larger than that in the sample.
- Duplicate samples, collected primarily by SMC as part of its groundwater monitoring program, are counted as individual samples in these summary statistics.

Table 19. Surface Water Summary Data, Anclote River, Downstream

Chemical	Minimum Detected (ppb)	Maximum Detected (ppb)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (ppb)	Comparison Value Source	Number Above CV
Inorganics-Metals								
Aluminum (Al)	22.9 X	640	SW-08	Jan-88	9/9	37,000	RBC-N	0
Arsenic (As)	500 J,N	500 J,N	SW-10	Jan-88	1/9	0.02	CREG	1
Barium (Ba)	6.2 X	7 X	SW-9	Mar-93	7/9	700	child RMEG	0
Calcium (Ca)	237,000	310,000	SW-10	Jan-88	9/9	NA		
Copper (Cu)	9.7 X	12 X	SW-10	Mar-93	4/9	1,300	MCLG	0
Iron (Fe)	17 X	290	SW-08	Jan-88	9/9	11,000	RBC-N	0
Lead (Pb)	1.1 X	2.8 X	SW-9	Mar-93	4/9	15	EPA AL	0
Magnesium (Mg)	810,000	1,210,000	SW-9	Mar-93	9/9	NA		
Mercury (Hg)	0.13 X	0.25 X	SW-11	Mar-93	5/9	2	LTHA, Inorganic	0
Potassium (K)	24,000	442,000	SW-12	Mar-93	9/9	NA		
Selenium (Se)	1.8 X	1.8 X	SW-9	Mar-93	1/9	50	child RMEG	0
Sodium (Na)	6,400,000	9,950,000	SW-10	Mar-93	9/9	NA		
Thallium (Tl)	16.8 X	300 J,N	SW-10	Jan-88	2/9	0.5	LTHA	2
Vanadium (V)	40	40	SW-10	Jan-88	1/9	260	RBC-N	0
Zinc (Zn)	10.1 X	30 J	SW-10	Jan-88	2/9	2,000	LTHA	0
Inorganics-Other								
Fluoride (F)	500	3,000 J	SW-10	Jan-88	8/9	4,000	MCL	0
Phosphate-phosphorus	60	60	SW-11	Mar-93	1/7	NA		
Total Phosphorus	210 J	210 J	SW-08	Jan-88	½	NA		

Table 19. Surface Water Summary Data, Anclote River, Downstream (continued)

Chemical	Minimum Detected (ppb)	Maximum Detected (ppb)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (ppb)	Comparison Value Source	Number Above CV
Radiologic Parameters (pCi/L)								
Gross Alpha	-30±60	50±100	SW-08	Jan-88	2/2	15	MCL	1
Gross Beta	190±96	280±60	SW-10	Jan-88	2/2	4	MCL	2

Sources: NUS 1989; SMC 1987-present; Weston 1993.

Key:

CREG	cancer risk evaluation guide
EPA AL	U.S. Environmental Protection Agency action level
J	estimated quantity below the quantitation limit
LTHA	lifetime health advisory (U.S. Environmental Protection Agency)
MCL	maximum contaminant level (U.S. Environmental Protection Agency)
MCLG	maximum contaminant level goal (U.S. Environmental Protection Agency)
N	presumptive evidence of presence of material
NA	not available
ppb	parts per billion
pCi/L	picocuries per liter
RBC-N	risk-based concentration, for noncancer effects
RMEG	reference dose media evaluation guide
X	result in less than the contract-required detection limit, but greater than or equal to the instrument detection limit

Notes:

- Negative radiologic readings represent samples in which the amount of radioactivity in the sample blank was larger than that in the sample.
- Duplicate samples are counted as individual samples in these summary statistics.

Table 20. Sediment Summary Data, Anclote River, Upstream

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (ppm)	Comparison Value Source	Number Above CV
Inorganics-Metals								
Aluminum (Al)	120	2,160	SED1	Apr-91	12/12	100,000	child i-EMEG	0
Arsenic (As)	0.4	1.6	SED5	Apr-91	5/7	0.5	CREG	4
Barium (Ba)	1.3	6.5	SED1	Apr-91	5/7	4,000	child RMEG	0
Calcium (Ca)	1,200	13,300	SED3	Apr-91	8/12	NA		
Chromium (Cr)	1.3	7.1	SED1	Apr-91	11/12	200	child RMEG	0
Cobalt (Co)	1	1	SED5	Apr-91	1/7	500	child i-EMEG	0
Copper (Cu)	8.2	32.6	SED1	Apr-91	6/12	3,100	RBC-N	0
Iron (Fe)	180	2,020	SED1	Apr-91	12/12	23,000	RBC-N	0
Lead (Pb)	1.4 J	19.9	SED1	Apr-91	8/12	400	EPA AL	0
Magnesium (Mg)	500	1,700	SED5	Apr-91	11/12	NA		
Manganese (Mn)	1.9	19.8	SED3	Apr-91	6/12	3,000	child RMEG	0
Nickel (Ni)	2.5	3	SED5	Apr-91	2/7	1,000	child RMEG	0
Potassium (K)	280	850	SED3	Apr-91	6/12	NA		
Selenium (Se)	0.34	0.34	SED1	Apr-91	1/7	300	child c-EMEG	0
Sodium (Na)	3,400	8,940	SED3	Apr-91	10/11	NA		
Vanadium (V)	1.6	8.2	SED1	Apr-91	6/7	200	child i-EMEG	0
Zinc (Zn)	5.5	33.3	SED1	Apr-91	5/12	20,000	child c-EMEG	0
Inorganics-Other								
Fluoride (F)	2.98	18,000 J	SD-09	Jan-88	17/18	3,000	child c-EMEG	1
Phosphate-phosphorus	19.4	439	SD-4C	Mar-93	11/11	NA		

Table 20. Sediment Summary Data, Anclote River, Upstream (continued)

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (ppm)	Comparison Value Source	Number Above CV
Total Phosphorus	72 J	435	SED1	Apr-91	6/6	NA		
TOC	924	34,800	SD-4C	Mar-93	11/11	NA		
Radiologic parameters (pCi/g)								
Gross Alpha	0.3±0.1	0.6±0.2	SD-09	Jan-88	2/2	NA		
Gross Beta	0.1±0.1	0.3±0.2	SD-09	Jan-88	2/2	NA		

Sources: NUS 1989, 1991; Weston 1991, 1993.

Key:

CREG	cancer risk evaluation guide
EPA AL	U.S. Environmental Protection Agency action level
c-EMEG	chronic environmental media evaluation guide (Agency for Toxic Substances and Disease Registry)
i-EMEG	Intermediate environmental media evaluation guide (Agency for Toxic Substances and Disease Registry)
J	estimated quantity below the quantitation limit
NA	not available
ppm	parts per million
pCi/g	picocuries per gram
RBC-N	risk-based concentration, for noncancer effects (EPA)
RMEG	reference dose media evaluation guide
TOC	total organic carbon

Note: Duplicate samples are counted as individual samples in these summary statistics.

Table 21. Sediment Summary Data, Anclote River, Adjacent

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (ppm)	Comparison Value Source	Number Above CV
Inorganics-Metals								
Aluminum (Al)	358	3,300	SED8	Apr-91	17/17	100,000	child i-EMEG	0
Arsenic (As)	0.49	3.4	SED8	Apr-91	11/14	0.5	CREG	10
Barium (Ba)	0.88	6.4	SED8	Apr-91	12/14	4,000	child RMEG	0
Cadmium (Cd)	1.4	1.4	SD-15C	Mar-93	1/14	10	child c-EMEG	0
Calcium (Ca)	1,650	23,200	SED8	Apr-91	17/17	NA		
Chromium (Cr)	1.7	11.6	SED8	Apr-91	17/17	200	child RMEG	0
Cobalt (Co)	1.2	1.2	SED9	Apr-91	1/14	500	child i-EMEG	0
Copper (Cu)	3.2	33.7	SED8	Apr-91	15/17	3,100	RBC-N	0
Iron (Fe)	370	3,850	SED8	Apr-91	17/17	23,000	RBC-N	0
Lead (Pb)	1.4J	8.4J	SD-07	Jan-88	16/17	400	AL	0
Magnesium (Mg)	357	3,330	SED8	Apr-91	17/17	NA		
Manganese (Mn)	1.4	17.9	SED9	Apr-91	16/17	3,000	child RMEG	0
Mercury (Hg)	0.098	0.098	SD-16B	Mar-93	1/14	20	child RMEG,	0
Nickel (Ni)	1.5	4.6	SED8	Apr-91	3/14	1,000	child RMEG	0
Potassium (K)	204	1,630	SED8	Apr-91	12/17	NA		
Selenium (Se)	0.54	0.54	SED8	Apr-91	1/14	300	child c-EMEG	0
Sodium (Na)	1,740	14,900	SED8	Apr-91	16/17	NA		
Vanadium (V)	1.8	12.8	SED8	Apr-91	14/14	200	child i-EMEG	0
Zinc (Zn)	3.8	36.7	SED8	Apr-91	12/17	20,000	child c-EMEG	0

Table 21. Sediment Summary Data, Anclote River, Adjacent (continued)

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (ppm)	Comparison Value Source	Number Above CV
Inorganics-Other								
Fluoride (F)	3.45	9,100J	SD-07	Jan-88	18/18	3,000	child c-EMEG	1
Phosphate-phosphorus	37.2	1,000	SD-15C	Mar-93	11/11	NA		
Total Phosphorus	217	1,700J	SD-07	Jan-88	7/7	NA		
TOC	4,610	14,100	SD-6A	Mar-93	4/4	NA		
Radiological parameters (pCi/g)								
Gross Alpha	0.7±0.3	13.5±1	SD-15B	Mar-93	9/9	NA		
Gross Beta	0.2±0.2	29.8±0.4	SD-16B	Mar-93	9/9	NA		
Radium-226	0.25*	0.79*	SD-15A	Mar-93	6/7	0.15	NCRP	6
Radon-222	0.2*	0.72*	SD-15A	Mar-93	6/7	NA		
Polonium-210	0.49*	2*	SD-15A	Mar-93	6/7	5.7	NCRP	0

Sources: NUS Corp 1989, NUS Corp 1991, Weston 1991, Weston 1993.

Key:		
	ppm	parts per million
	pCi/g	picoCuries per gram
	CREG	Cancer Risk Evaluation Guide
	EPA AL	EPA Action Level
	c-EMEG	chronic Environmental Media Evaluation Guide (ATSDR)
	i-EMEG	Intermediate Environmental Media Evaluation Guide (ATSDR)
	J	estimated quantity below the quantitation limit
	NA	Not available
	NCRP	National Council on Radiation Protection and Measurements
	RBC-N	Risk-Based Concentration, for non-cancer effects (EPA)
	RMEG	Reference Dose Media Evaluation Guide
	*	Uncertainty/confidence terms not available

Table 22. Sediment Summary Data, Anclote River, Meyers Cove

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (ppm)	Comparison Value Source	Number Above CV
Inorganics-Metals								
Aluminum (Al)	2,130	9,500	SD-04	Jan-88	9/9	100,000	child i-EMEG	0
Arsenic (As)	1.7	8.5 J,N	SD-04	Jan-88	8/8	0.5	CREG	8
Barium (Ba)	3.4	16	SD-04	Jan-88	8/8	4,000	child RMEG	0
Beryllium (Be)	0.26	0.29	SD-14C	Mar-93	4/8	50	child c-EMEG	0
Cadmium (Cd)	0.95	0.95	SD-14C	Mar-93	1/8	10	child c-EMEG	0
Calcium (Ca)	11,600	60,000 J	SD-04	Jan-88	9/9	NA		
Chromium (Cr)	7.1	30	SD-04	Jan-88	9/9	200	child RMEG	0
Copper (Cu)	6.4	25	SC-SD-09	Apr-89	8/9	3,100	RBC-N	0
Iron (Fe)	2,280	8,500	SD-04	Jan-88	9/9	23,000	RBC-N	0
Lead (Pb)	5.6	17.1	SD-13A	Mar-93	9/9	400	EPA AL	0
Magnesium (Mg)	1,180	6,300	SD-04	Jan-88	9/9	NA		
Manganese (Mn)	8.1	36	SD-04	Jan-88	9/9	3,000	child RMEG	0
Mercury (Hg)	0.18	0.18	SD-13A	Mar-93	2/8	20	child RMEG	0
Nickel (Ni)	5.9	14	SD-04	Jan-88	3/8	1,000	child RMEG	0
Potassium (K)	309	2,100	SD-04	Jan-88	9/9	NA		
Selenium (Se)	0.26	1.2 J,N	SD-04	Jan-88	4/8	300	child c-EMEG	0
Silver (Ag)	2.4 J	2.4 J	SD-04	Jan-88	1/8	300	child RMEG	0
Sodium (Na)	3,600	21,000 J	SD-04	Jan-88	9/9	NA		
Vanadium (V)	6.9	32	SD-04	Jan-88	8/8	200	child i-EMEG	0
Zinc (Zn)	12.2	62 J	SD-04	Jan-88	9/9	20,000	child c-EMEG	0

Table 22. Sediment Summary Data, Anclote River, Meyers Cove (continued)

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (ppm)	Comparison Value Source	Number Above CV
Inorganics-Other								
Fluoride (F)	9.11	6,900 J	SD-04	Jan-88	12/12	3,000	child c-EMEG	1
Phosphate-phosphorus	51.9	3,750	SD-13A	Mar-93	11/11	NA		
Total Phosphorus	4,600 J	4,600 J	SD-04	Jan-88	1/1	NA		
TOC	14,200	120,000	SD-7A	Mar-93	4/4	NA		
Radiologic Parameters (pCi/g)								
Gross Alpha	14±3	30.2	SD-13A	Mar-93	7/8	NA		
Gross Beta	8±1	55.5	SD-13A	Mar-93	8/8	NA		
Radium-226	1.1*	2.4*	SD-13A	Mar-93	7/7	0.15	NCRP residential	7
Radon-222	0.99*	2.2*	SD-13A	Mar-93	7/7	NA		
Polonium-210	2.3*	7.7*	SD-13A	Mar-93	7/7	5.7	NCRP residential	1

Sources: NUS 1989, 1991, Weston 1991, 1993.

Key:		
	CREG	cancer risk evaluation guide
	EPA AL	U.S. Environmental Protection Agency action level
	c-EMEG	chronic environmental media evaluation guide (Agency for Toxic Substances and Disease Registry)
	i-EMEG	Intermediate environmental media evaluation guide (Agency for Toxic Substances and Disease Registry)
	J	estimated quantity below the quantitation limit
	N	presumptive evidence of presence of material
	NA	not available
	NCRP	National Council on Radiation Protection and Measurements
	ppm	parts per million
	pCi/g	picocuries per gram
	RBC-N	risk-based concentration, for noncancer effects (EPA)
	RMEG	reference dose media evaluation guide
	TOC	total organic carbon
	*	Uncertainty/confidence terms were not available.

Table 23. Sediment Summary Data, Anclote River, Downstream

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (ppm)	Comparison Value Source	Number Above CV
Volatile Organic Compounds								
Methylethyl ketone	99,000 J	99,000 J	SD-08	Jan-88	1/1	30,000	child RMEG	1
Toluene	160,000	160,000	SD-08	Jan-88	1/1	1,000	child i-EMEG	1
Inorganics-Metals								
Aluminum (Al)	190	2,190	SED11	Apr-91	11/11	100,000	child i-EMEG	0
Arsenic (As)	0.42	1.9	SED11	Apr-91	4/6	0.5	CREG	3
Barium (Ba)	1.1	3.9	SED11	Apr-91	4/6	4,000	child RMEG	0
Calcium (Ca)	940	10,200	SED11	Apr-91	8/11	NA		
Chromium (Cr)	1.3	9.7	SED11	Apr-91	6/11	200	child RMEG	0
Cobalt (Co)	1.8	1.8	SED11	Apr-91	1/6	500	child i-EMEG	0
Copper (Cu)	5.8	21.8	SED11	Apr-91	4/11	3,100	RBC-N	0
Iron (Fe)	100	2,420	SED11	Apr-91	11/11	23,000	RBC-N	0
Lead (Pb)	2.2	16 J	SD-08	Jan-88	6/11	400	EPA AL	0
Magnesium (Mg)	660	2,190	SED11	Apr-91	8/11	NA		
Manganese (Mn)	2	7.6	SED11	Apr-91	5/11	3,000	child RMEG	0
Nickel (Ni)	0.9	2.7	SED11	Apr-91	3/6	1,000	child RMEG	0
Potassium (K)	351	785	SED11	Apr-91	5/11	NA		
Selenium (Se)	0.44	0.44	SED11	Apr-91	1/6	300	child c-EMEG	0
Sodium (Na)	2,200	10,200	SED11	Apr-91	9/11	NA		
Thallium (Tl)	7,800	7,800	SC-SD-14	Apr-89	1/11	4	child RMEG	1
Vanadium (V)	2.1	10	SED11	Apr-91	6/6	200	child i-EMEG	0
Zinc (Zn)	4.7	22.5	SED11	Apr-91	4/11	20,000	child c-EMEG	0

Table 23. Sediment Summary Data, Anclote River, Downstream (continued)

Chemical	Minimum Detected (ppm)	Maximum Detected (ppm)	Location of Maximum	Date of Maximum	Frequency of Detection	Comparison Value (ppm)	Comparison Value Source	Number Above CV
Inorganics-Other								
Fluoride (F)	2.77	360 J	SD-08	Jan-88	12/13	3,000	child c-EMEG	0
Phosphate-phosphorus	38.8	211	SD-11	Mar-93	7/7	NA		
Total Phosphorus	31 J	620	SED10	Apr-91	6/6	NA		
TOC	1,160	17,900	SD-11	Mar-93	7/7	NA		
Radiologic Parameters (pCi/g)								
Gross Alpha	0.2±0.1	10±1	SD-10	Jan-88	2/2	NA		
Gross Beta	0.1±0.1	4±0.4	SD-10	Jan-88	2/2	NA		

Sources: NUS 1989, 1991; Weston 1991, 1993.

Key:

CREG	cancer risk evaluation guide
EPA AL	U.S. Environmental Protection Agency action level
c-EMEG	chronic environmental media evaluation guide (Agency for Toxic Substances and Disease Registry)
i-EMEG	Intermediate environmental media evaluation guide (Agency for Toxic Substances and Disease Registry)
J	estimated quantity below the quantitation limit
NA	not available
ppm	parts per million
pCi/g	picocuries per gram
RBC-N	risk-based concentration, for noncancer effects (EPA)
RMEG	reference dose media evaluation guide
TOC	total organic carbon

Table 24. Surface Water Sampling Location Designations

Study	Date	Location Designation	Sample ID/Location[a]
Expanded site investigation (NUS 1989)	January 1988	Upstream	SW-06 SW-09
		Adjacent	SW-05 SW-07
		Meyers Cove	SW-04
		Downstream	SW-08 SW-10
Remedial investigation (Weston 1993)	March 1993	Upstream	SW-1 SW-2 SW-3 SW-4A SW-4B SW-4C SW-5
		Adjacent	SW-6A SW-6B SW-6C
		Meyers Cove	SW-7A SW-7B SW-7C
		Downstream	SW-8 SW-9 SW-10 SW-11 SW-12
Stauffer Management Company ongoing groundwater monitoring program	1987–present	Upstream	Upstream
		Adjacent	None
		Meyers Cove	Downstream
		Downstream	None

Notes:

[a] Sample IDs were changed slightly in some cases to distinguish samples from different studies taken from different locations, but given the same identifier in the original studies.

Table 25. Sediment Sampling Location Designations

Study	Date	ERG Designation	Sample ID/Location[a]
Expanded site investigation (NUS 1989)	January 1988	Upstream	SD-06 SD-09
		Adjacent	SD-05 SD-07
		Meyers Cove	SD-04
		Downstream	SD-08 SD-10
Sediment sampling program (Weston 1991)	April 1991	Upstream	SED 1 SED 2 SED 3 SED 4 SED 5
		Adjacent	SED 6 SED 7 SED 8 SED 9
		Meyers Cove	NONE
		Downstream	SED 10 SED 11 SED 12 SED 13
Listing site inspection (NUS 1991)	April 1989	Upstream	SC-SD-01 SC-SD-02 SC-SD-03 SC-SD-04 SC-SD-05
		Adjacent	SC-SD-06 SC-SD-07 SC-SD-08
		Meyers Cove	SC-SD-09
		Downstream	SC-SD-10 SC-SD-11 SC-SD-12 SC-SD-13 SC-SD-14

Table 25. Sediment Sampling Location Designations (continued)

Study	Date	ERG Designation	Sample ID/Location[a]
Remedial investigation (Weston 1993)	March 1993	Upstream	SD-1 SD-2 SD-3 SD-4A SD-4B SD-4C SD-5
		Adjacent	SD-6A SD-6B SD-6C SD-15A SD-15B SD-15C SD-16A SD-16B SD-16C
		Meyers Cove	SD-7A SD-7B SD-7C SD-13A SD-13B SD-13C SD-14A SD-14B SD-14C
		Downstream	SD-8 SD-9 SD-10 SD-11 SD-12

Notes:
[a] Sample IDs were changed slightly in some cases to distinguish samples from different studies taken from different location, but given the same identifier in the original studies.

Table 26. Meteorologic Data for the Stauffer Chemical Company Site

Parameter	Location of Meteorologic Station		
	PCDEM's Anclote Road Station	**St. Petersburg/ Clearwater Airport**	**Tampa International Airport**
Source of data	PCDEM 2002	NCDC 2002	NCDC 2002
Period of record	1979–1996	1973–2002	1948–2002
Summary for the Common Period of Record (1979–1996)			
Total possible hours	157,800	157,800	157,800
Calm hours	8,276	9,108	12,184
Missing hours	17,213	4,265	408
Completeness	89.1%	97.3%	99.7%
Summary for the Period of Interest (January 1978–May 1981, School Hours Only)			
Total possible hours	7,056	9,976	9,976
Calm hours	96	164	134
Missing hours	719	458	0
Completeness	89.8%	95.4%	100.0%

Key:

PCDEM Pinellas County Department of Environmental Management

Note:

- A "missing hour" was defined as an hour that did not have a valid observation of wind speed or wind direction.
- For the period of interest, the PCDEM has a lower number of "total possible hours" because the station did not start operating until January 1979.

Table 27. Contaminant Emission Rates for Air Dispersion Model Inputs

Contaminant	Source	Emission Rate		Comments
		Grams/ Second	Tons/ Year	
Sulfur dioxide	Rotary kiln	41.4	1,436	Rate based on results from five stack tests, whose range of emission rates was 34.7 to 47.8 grams per second. The state of Florida used an emission rate of 41.2 grams per second in the dispersion modeling analysis done when preparing the state implementation plan for the nonattainment area.
	Boilers	1.28	44	Rate based on data reported in annual disclosure statements of boiler emissions. The data assumed that all sulfur present in the fuel converts to sulfur dioxide, which is essentially the same approach the U.S. Environmental Protection Agency EPA outlines in AP-42 (EPA 1995b) for sulfur dioxide emissions from boilers. This emission rate reflects SCC's emissions after 1975, when the facility changed to low-sulfur fuels.
Particulate matter (size fraction not specified)	Rotary kiln	5.33	185	SCC has questioned whether these emissions data were accurate. SCC believed that sulfur dioxide gases collected by the sampling impingers converted to sulfate and were measured as particulate, rather than gaseous, emissions. In short, SCC suspected these emissions data include a positive measurement bias.
	Boilers	0.42	14.6	Rate based on data from a single stack test.
	Nodule cooler	0.28	9.6	Rate is an average of six stack tests.
	Coke dryer	0.45	15.6	Rate based on data SCC reported in its 1977 annual emissions disclosure statement.
	Furnace	0.23	8.1	Rate is an average of two of SCC's 1973 and 1974 emissions disclosure statements.
	Condenser	0.18	6.4	Rate is an average of two of SCC's 1973 and 1974 emissions disclosure statements.
	Materials handling	0.08	2.8	Rate is based on data SCC reported in its 1977 annual emissions disclosure statement.

Table 27. Contaminant Emission Rates for Air Dispersion Model Inputs (continued)

Contaminant	Source	Emission Rate		Comments
		Grams/ Second	Tons/ Year	
Fluorides	Rotary kiln	0.165	5.7	Rate based on SCC's 1973 and 1974 emissions disclosure statements.
	Nodule cooler	0.0072	0.25	Average of six stack test results.
	Condenser	0.0012	0.041	Rate based on SCC's 1973 and 1974 emissions disclosure statements.
	Furnace	0.0016	0.054	Rate based on SCC's 1973 and 1974 emissions disclosure statements, which account for emissions through the tap hole scrubber and not fugitive emissions that occur during furnace tapping.

Key: SCC Stauffer Chemical Company

Table 28. Stack Parameters for Air Dispersion Modeling Analysis

Source	Stack Height (feet)	Stack Diameter (feet)	Exit Temperature (°F)	Flow Rate or Velocity
Boilers	20	2	417	5,430 ACFM
Rotary kiln (before May 1979)	85	22	134	0.2 m/s
Rotary kiln (after May 1979)	160	4	134	4.2 m^3/s
Nodule cooler scrubber	85	4	123	56,400 ACFM
Coke dryer	50	2.5	122	12,600 ACFM
Materials handling "burden bin"	100	1.8	97	8,120 ACFM
Phosphorus condenser	112	1	80	1,500 ACFM
Furnace tap hole scrubber	21	3	120	20,800 ACFM

Key:

ACFM	actual cubic feet per minute
m/s	meters per second
m^3/s	cubic meters per second

Table 29. Descriptions and Coordinates for Locations Included in the Air Dispersion Modeling Analysis

Location Number*	Description	Coordinates	
		Latitude	Longitude
1	North-northwest of SCC, in Pasco County	28.175558	-82.780278
2	Gulfside Elementary School	28.173058	-82.774167
3	Residential neighborhood in southern Pasco County, northeast of SCC	28.173058	-82.763889
4	Residential neighborhood west of SCC	28.168336	-82.781111
5	Industrial complex east of SCC	28.166669	-82.771944
6	Piney Point, on shore of Gulf of Mexico	28.161947	-82.797500
7	Residential neighborhood southwest of SCC, and in prevailing downwind direction	28.163891	-82.783056
8	Area near Anclote Road monitoring station and Flaherty Marina	28.163058	-82.773889
9	Residential neighborhood south of SCC	26.160280	-82.778056
10	Residential neighborhood south-southwest and further downwind of SCC	28.155836	-82.784167
11	Howard Park, on shore of Gulf of Mexico	28.153891	-82.793333
12	Residential neighborhood southeast of SCC	28.158613	-82.771944

Key:

SCC	Stauffer Chemical Company

*See Figure 19 for a map of these 12 locations.

Table 30. Predicted and Observed Sulfur Dioxide Concentrations: Anclote Road Monitoring Station

Averaging Time	Before or After Stack Reconfiguration	Sulfur Dioxide Concentration (parts per billion)	
		Predicted	Observed
Annual average	Before	9.2	14.3
Highest 24-hour average	Before	170	311
Highest 1-hour average	Before	1,144	840
Annual average	After	1.6	4.9
Highest 24-hour average	After	45	77
Highest 1-hour average	After	415	290

Notes:

- The Stauffer Chemical Company (SCC) reconfigured the rotary kiln stack in May 1979. The emission rate for this source was not changed, but the increase in stack height and decrease in stack diameter facilitated the atmospheric dispersion in the emissions, thus resulting in a notable decrease in sulfur dioxide levels at the Anclote Road monitoring station after May 1979.

- The predicted concentration estimates the incremental effect that SCC's air emissions have on actual ambient air concentrations. The observed concentration reflects the contributions from all sulfur dioxide emissions sources in the Tarpon Springs area.

- For the predicted concentrations, the "annual average" value is the average concentration observed over 5 years of meteorologic conditions; the "highest 24-hour average" and "highest 1-hour average" concentrations are the peak levels observed over this same time frame.

- The observed concentrations for the time before the stack reconfiguration are computed from all measurements made between July 1977 and May 1979; the observed concentrations for the time after the stack reconfiguration are computed from all measurements made between June 1979 and November 1981, when SCC reportedly shut down its furnace permanently. The "annual average" concentration shown is the average of all observations collected during the two time frames. **The average sulfur dioxide concentration at the Anclote Road monitoring station after SCC shut down was 1.42 ppb.**

Table 31. Predicted Percent Decrease in Sulfur Dioxide Concentrations after the 1979 Rotary Kiln Stack Modification

Location Number (see Table 29)	Percent Decrease in Predicted Sulfur Dioxide Levels, by Averaging Period		
	Annual Average	Highest 24-Hour Average	Highest 1-Hour Average
1	59%	66%	59%
2	61%	70%	62%
3	48%	48%	57%
4	81%	82%	65%
5	68%	67%	62%
6	61%	52%	48%
7	71%	73%	52%
8	83%	74%	64%
9	70%	74%	57%
10	61%	60%	53%
11	60%	38%	46%
12	66%	67%	51%

Note:

- The table presents the predicted percent decrease in *SCC's contribution to* the measured concentrations. The actual percent decreases observed will differ slightly because of relatively small contributions from other sulfur dioxide emissions sources in the area.

Table 32. Predicted Annual Average Concentrations of "Total Particulates" Resulting from Stauffer Chemical Company's Air Emissions

Location Number	Estimated Concentrations (µg/m^3) Before 1979		Estimated Concentrations (µg/m^3) After May 1979	
	Lower Kiln Emissions	Higher Kiln Emissions	Lower Kiln Emissions	Higher Kiln Emissions
1	1.2	1.9	0.8	1.1
2	2.3	3.4	1.6	1.9
3	0.8	1.2	0.6	0.8
4	3.7	5.8	1.9	2.2
5	7.3	10.9	4.6	5.6
6	1.7	2.5	1.1	1.4
7	4.5	6.6	2.8	3.3
8	2.9	4.4	1.6	1.8
9	2.5	3.7	1.6	1.9
10	2.4	3.7	1.6	2.1
11	1.3	2.00	0.9	1.1
12	1.4	2.24	0.9	1.1

Key:

µg/m^3	micrograms per cubic meter
SCC	Stauffer Chemical Company

Note:

- Predictions were made for two different time frames (before May 1979 and after May 1979) to evaluate air quality impacts from SCC's reconfiguring the rotary kiln stack.

- The representativeness of the "total particulate" emissions data for the rotary kiln stack has been questioned. SCC site documents suggest that sulfur dioxide gases collected by the sampling impingers used in the stack tests converted to sulfate and were measured as particulate, rather than gaseous, emissions. In short, SCC suspected the rotary kiln emissions data have a positive measurement bias. The "lower kiln emissions" reflect air quality impacts if the measurement bias is assumed to be double the emission rate, as SCC estimates.

Table 33. Predicted Highest 24-Hour Average Concentrations of “Total Particulates” Resulting from Stauffer Chemical Company’s Air Emissions

Location Number	Estimated Concentrations (µg/m^3) Before May 1979		Estimated Concentrations (µg/m^3) After May 1979	
	Lower Kiln Emissions	Higher Kiln Emissions	Lower Kiln Emissions	Higher Kiln Emissions
1	18.1	29.4	11.4	14.9
2	41.9	62.8	25.8	30.6
3	15.6	23.1	12.0	15.9
4	53.1	87.5	24.1	29.4
5	82.7	121.6	51.6	60.4
6	21.1	29.7	15.0	17.3
7	55.5	84.0	32.9	38.9
8	48.7	75.6	27.5	33.3
9	49.5	75.8	27.8	32.4
10	33.3	53.2	23.9	30.0
11	13.8	21.0	10.7	15.0
12	26.5	40.2	16.8	20.8

Key:

µg/m^3	micrograms per cubic meter
SCC	Stauffer Chemical Company

Note:

- Predictions were made for two different time frames (before May 1979 and after May 1979) to evaluate air quality impacts from SCC’s reconfiguring the rotary kiln stack.

- The representativeness of the “total particulate” emissions data for the rotary kiln stack has been questioned. SCC site documents suggest that sulfur dioxide gases collected by the sampling impingers used in the stack tests converted to sulfate and were measured as particulate, rather than gaseous, emissions. In short, SCC suspected the rotary kiln emissions data have a positive measurement bias. The “lower kiln emissions” reflect air quality impacts if the measurement bias is assumed to be double the emission rate, as SCC has estimated.

Table 34. Index of Air Sampling Studies Conducted While the Stauffer Chemical Company Facility Operated (1948–1981)

Party That Initiated Sampling	Purpose of Sampling	Sampling Dates	Sampling Locations	Contaminants Measured	Overview of Sampling Results
PCDEM	Evaluate attainment status with EPA's National Ambient Air Quality Standards.	1977–2002	Two locations: one immediately southeast of SCC on Anclote Road, the other roughly 7 miles southeast of SCC ("East Lake Tarpon").	Sulfur dioxide	Ambient air concentrations of sulfur dioxide at the Anclote Road monitoring station exceeded EPA's National Ambient Air Quality Standards in 1977, 1978, and 1979. The elevated concentrations have been attributed to emissions from SCC's rotary kiln stack. Annual average concentrations before a stack modification in 1979 were more than ten times higher than those measured after SCC shut down. One-hour average concentrations at the Anclote Road station exceeded 100 ppb several hundred times per year before the stack modification. Annual average sulfur dioxide concentrations at the East Lake Tarpon station in 1980–1981 were not considerably different from those measured since SCC shut down, suggesting that SCC's emissions had minimal air quality impacts at locations 7 miles from the facility.
PCDEM	Evaluate attainment status with EPA's National Ambient Air Quality Standards.	1976–1990	Two locations: one immediately southeast of SCC on Anclote Road, the other roughly 7 miles southeast of SCC ("East Lake Tarpon").	TSP	At the Anclote Road monitoring station, annual geometric mean TSP concentrations ranged from 60.2 to 73.2 μg/m^3 during years when SCC operated, and ranged from 40.7 to 51.2 μg/m^3 after the facility shut down. On average (based on arithmetic means), TSP levels decreased by 24 μg/m^3 after SCC shut down. Several measurements exceeded Florida's air quality standards, but none exceeded EPA's former TSP standards. At the East Lake Tarpon monitoring station, annual geometric mean TSP concentrations in 1979 and 1980 were 37.4 and 38.4 μg/m^3, respectively.

Table 34. Index of Air Sampling Studies Conducted While the Stauffer Chemical Company Facility Operated (1948–1981) (continued)

Party That Initiated Sampling	Purpose of Sampling	Sampling Dates	Sampling Locations	Contaminants Measured	Overview of Sampling Results
PCDEM	Analyze characteristics of particles collected on TSP filters.	1979	PCDEM's Anclote Road station, located immediately southeast of SCC	Filters were inspected for contributions from different source categories.	PCDEM hired an EPA contractor to examine the characteristics (e.g., particle types) of airborne particulate matter collected on at least 14 TSP filters from the Anclote Road monitoring station. In most of the samples considered, Stauffer's emissions were identified as the "cause" of the elevated TSP levels; in some samples, however, Stauffer's emissions were reportedly "a relatively minor source" of the measured TSP levels. Emissions sources other than SCC (e.g., mobile sources, the Anclote Power Plant) contributed, in varying amounts, to the airborne particles detected on the TSP filters.
SCC	The reasons for sampling were not always specified. One reason was to detect air quality impacts before they reached off-site locations.	1975–1982	The number and locations of sampling stations changed from year to year. In general, SCC measured sulfur dioxide levels at various locations along the perimeter of the facility property.	Sulfur dioxide	Limited inferences can be drawn from SCC's sulfur dioxide monitoring results, because the data are of questionable quality and because the data provided to date are incomplete. Several site documents acknowledge that SCC field personnel experienced problems operating the Philips Instruments sulfur dioxide monitors—problems that persisted for more than 2 years. Most site documents provide limited insights on quality control and quality assurance. The data quality concerns notwithstanding, SCC's monitoring results are reasonably consistent with PCDEM's. For instance, a monitoring summary indicated that 1-hour average sulfur dioxide concentrations in 1977 exceeded 100 ppb roughly one out of every 4 days along the facility boundary.

Table 34. Index of Air Sampling Studies Conducted While the Stauffer Chemical Company Facility Operated (1948–1981) (continued)

Party That Initiated Sampling	Purpose of Sampling	Sampling Dates	Sampling Locations	Contaminants Measured	Overview of Sampling Results
SCC	Sampling was conducted for many reasons, but generally to characterize air quality impacts from SCC.	Periodically between 1964 and 1981.	Sampling locations varied from one survey to the next; in each survey, up to 10 sampling locations were employed.	Fluorides	SCC measured ambient air concentrations of fluorides in hundreds of samples collected before the facility shut down. Out of all SCC's field surveys, only a single 24-hour average fluoride concentration (32.2 $\mu g/m^3$) exceeded Agency for Toxic Substances and Disease Registry's minimal risk level for acute inhalation exposures (20 $\mu g/m^3$). The quality of the fluoride measurements is not known and cannot be assessed from the available information, because the site documents reviewed provide no insights on accuracy, precision, or quality assurance measures. As a result, drawing firm conclusions based solely on SCC's measurements is not advised.
SCC	Sampling was conducted for many reasons, but generally to characterize air quality impacts from SCC and from other local sources.	Periodically between 1964 and 1976; routinely in 1981; and possibly during other time frames not identified in the site documents.	Sampling locations varied from one survey to the next; in each survey, up to 10 sampling locations were employed.	Particulate matter. Most air quality surveys reported concentrations of "total particulates," without indicating the particle size fraction of this metric.	Since 1964, SCC has collected hundreds of particulate air samples. In the majority of samples, concentrations were reported as "total particulates," without specifying any information on particle size distribution. One sampling station was located in immediate proximity of PCDEM's Anclote Road monitoring station, but the "total particulate" concentrations reported for SCC's stations were consistently lower than the TSP concentrations reported by PCDEM. Almost every air quality survey that measured particulate matter concentrations lacks important details on study design and quality assurance measures, which greatly limit the inferences (if any) that can be drawn from these sampling results.

Table 34. Index of Air Sampling Studies Conducted While the Stauffer Chemical Company Facility Operated (1948–1981) (continued)

Party That Initiated Sampling	Purpose of Sampling	Sampling Dates	Sampling Locations	Contaminants Measured	Overview of Sampling Results
SCC	Sampling was conducted for many reasons, but generally to characterize air quality impacts from SCC.	1964 and 1975	Ten off-site sampling locations at varying distance from the SCC facility.	Phosphorus pentoxide	The two air quality surveys measured phosphorus pentoxide concentrations at 10 offsite sampling locations. Average concentrations during the surveys ranged from 0.45 to 3.30 $\mu g/m^3$, and the highest concentration measured was 18.03 $\mu g/m^3$. Results are based on a particulate sampling method, which likely did not capture gaseous phosphorus pentoxide. It is not clear whether the methods used characterize particle-bound phosphoric acid or phosphorus pentoxide. Neither field survey provides data quality observations and it is unclear whether the surveys followed air sampling plans or quality assurance plans. For these and other reasons, drawing firm conclusions based solely on SCC's measurements is not advised.
Florida Power Corp.	To characterize air quality in the vicinity of the Anclote Plant.	1980. Monitoring was done in other years, but the results have not been located.	Four stations in northern Pinellas and southern Pasco Counties. One station was adjacent to PCDEM's Anclote Road monitoring station.	TSP	Florida Power Corporation operated an ambient air monitoring network as early as 1977. That network operated routinely, with some periods of inactivity, through 1998. However, the only results available for review are from 1980. Geometric mean TSP concentrations during this year ranged from 36 to 62 $\mu g/m^3$, with the highest levels detected adjacent to PCDEM's Anclote Road monitoring station. The highest 24-hour average concentration at this station was 185 $\mu g/m^3$. Although this ambient air monitoring network followed extensive quality control procedures in future years (1994–1998), it is unclear from the site documents whether these measures were in place in 1980. Therefore, the 1980 monitoring results from this network are of unknown quality.

Key:		
	EPA	U.S. Environmental Protection Agency
	$\mu g/m^3$	micrograms per cubic meter
	ppb	parts per billion
	PCDEM	Pinellas County Department of Environmental Management
	SCC	Stauffer Chemical Company
	TSP	total suspended particulates

Table 35. Sulfur Dioxide Levels Measured at the Anclote Road Monitoring Station

Year	1-Hour Average Concentrations			3-Hour Average Concentrations		24-Hour Average Concentrations		Annual Average Concentration (ppb)
	No. of Observations	No. of Hours with Levels >100 ppb	No. of Days with 1-Hour Average Levels >100 ppb	No. of Observations	No. of Days with 3-Hour Average Levels >500 ppb	No. of Observations	No. of Days with 24-Hour Average Levels >140 ppb	
1977	3,341	158	45	3,235	2	3,374	5	17.36
1978	7,384	287	77	7,040	3	7,540	8	14.64
1979	8,300	70	39	7,991	4	8,437	3	7.19
1980	7,878	54	29	7,504	0	8,041	0	5.68
1981	7,879	32	20	7,536	0	7,936	0	4.40
1982	8,030	3	2	7,638	0	8,194	0	1.47
1983	8,384	2	2	8,000	0	8,631	0	1.32
1984	8,514	0	0	8,164	0	8,722	0	1.14
1985	8,417	1	1	8,067	0	8,602	0	1.49
1986	8,538	0	0	8,335	0	8,629	0	1.68
1987	8,466	2	2	8,315	0	8,494	0	1.41
1988	8,579	0	0	8,479	0	8,620	0	1.71
1989	8,596	1	1	8,458	0	8,641	0	1.75
1990	8,502	0	0	8,348	0	8,567	0	1.46
1991	8,614	1	1	8,410	0	8,711	0	0.88
1992	8,582	0	0	8,452	0	8,593	0	1.33
1993	8,624	0	0	8,464	0	8,687	0	1.36
1994	8,637	3	1	8,469	0	8,737	0	1.13
1995	8,610	0	0	8,400	0	8,721	0	0.77
1996	6,801	1	1	6,671	0	6,881	0	0.89

Table 35. Sulfur Dioxide Levels Measured at the Anclote Road Monitoring Station (continued)

Key:

ppb	parts per billion

Notes:

- Data source: EPA 2002a. All observations accessed were for continuous sulfur dioxide monitoring devices.

- The Anclote Road monitoring station began operating in July 1977 and stopped operating in October 1996. Therefore, the data presented for 1977 and 1996 are based on a partial year of ambient air monitoring data.

- Data for 1-hour average, 3-hour average, and 24-hour average are based on the raw figures for these averaging times reported to the Aerometric Information Retrieval System database (AIRS). Data for annual average concentrations were calculated from the set of 1-hour average observations. The raw data for 3-hour and 24-hour concentrations are running averages, meaning that each day sampling occurred can have as many as 24 observations for 3-hour average and 24-hour average concentrations.

- EPA's primary (or health-based) National Ambient Air Quality Standard for sulfur dioxide is 140 ppb for 24-hour average concentrations and 30 ppb for annual average concentrations (EPA 1995). EPA's secondary National Ambient Air Quality Standard for sulfur dioxide is 500 ppb for 3-hour average concentrations. This secondary air quality standard is not health-based, but rather protects against damage to property, impaired visibility, and other valued resources. A 1-hour average concentration of 100 ppb is the lowest acute exposure concentration that has been associated with adverse health effects in humans (persons with asthma), as documented in the Agency for Toxic Substances and Disease Registry's *Toxicological Profile for Sulfur Dioxide* (ATSDR 1998).

Table 36. Index of Air Sampling Studies Conducted After Stauffer Chemical Company Production Operations Ceased (1982–2002)

Party That Initiated Sampling	Purpose of Sampling	Sampling Dates	Sampling Locations	Contaminants Measured	Overview of Sampling Results
EPA	To determine whether the inactive site releases arsenic, fluorides, or radon to the air	November 1987	Five locations on SCC property; one off-site location	Arsenic Fluorides Radon TSP	TSP concentrations ranged from 22 to 30 µg/m^3; arsenic and fluorides were not detected; radon levels ranged from 0.1 to 2.2 pCi/L, and a control sample contained radon at 1.2 pCi/L.
Pasco County District School Board	To determine whether site demolition activities cause elevated levels of asbestos or phosphorus compounds in the air at Gulfside Elementary School	July and August 1987	Two outdoor and three indoor locations at the Gulfside Elementary School	Asbestos Elemental phosphorus Phosphoric acid Phosphoric pentoxide	Asbestos structures, phosphoric acid, and phosphorus pentoxide were not detected in any of the samples. Detection limits were reported as follows: asbestos, 0.005 structures per cubic centimeter; phosphoric acid, between 1 and 2 µg/m^3; and phosphorus pentoxide, between 1 and 2 µg/m^3. Elemental phosphorus was detected in only one of ten samples, and at a concentration of 11 µg/m^3.
PCDEM	Evaluate attainment status with EPA's National Ambient Air Quality Standards	1982–1989 1992–2002	Two locations: one immediately southeast of SCC, the other roughly 7 miles southeast of SCC	PM_{10} Sulfur dioxide TSP	Since 1981, all annual average and 24-hour average PM_{10}, sulfur dioxide, and TSP concentrations have been in attainment with EPA's primary air quality standards. The 3-hour average sulfur dioxide concentrations are in attainment with EPA's secondary air quality standards.

Table 36. Index of Air Sampling Studies Conducted After Stauffer Chemical Company Production Operations Ceased (1982–2002) (continued)

Party That Initiated Sampling	Purpose of Sampling	Sampling Dates	Sampling Locations	Contaminants Measured	Overview of Sampling Results
SCC	To determine whether site excavation activities release phosphorus compounds and asbestos into the air	May 28–29, 1997	One location upwind from the excavation, and one location downwind from the excavation	Asbestos Elemental phosphorus Phosphoric acid	On May 29, 1997, a single amosite asbestos structure was detected in an upwind sample (0.0033 structures per cubic centimeter), and a single chrysotile structure was detected in a downwind sample (0.0051 structures per cubic centimeter). Phosphoric acid was not detected in any sample, with detection limits ranging from 1 to 34 $\mu g/m^3$. Elemental phosphorus was detected in an upwind sample (2 $\mu g/m^3$) and in a downwind sample (3 $\mu g/m^3$).
SCC	To assess whether site remediation activities, mainly soil sampling, cause releases of asbestos into the air	March and April 1998	24 on-site locations around the perimeters of six former process areas, plus personal exposure samples	Asbestos	The highest time-weighted average asbestos level in the personal exposure sampling (determined by PCM) was 0.0073 fibers per cubic centimeter, which is less than NIOSH’s recommended exposure level. No asbestos structures were identified in the personal exposure samples that were reanalyzed using TEM. The average asbestos concentration in the 24 ambient air samples was 0.00024 structures per cubic centimeter, as measured by TEM.

Table 36. Index of Air Sampling Studies Conducted After Stauffer Chemical Company Production Operations Ceased (1982–2002) (continued)

Party That Initiated Sampling	Purpose of Sampling	Sampling Dates	Sampling Locations	Contaminants Measured	Overview of Sampling Results
SCC	To ensure that the phosphorus drumming project did not cause unhealthy levels of air contamination	April to September 1997	At various on-site locations both upwind and downwind from the source areas	Dust Elemental phosphorus Phosphoric acid	Levels of "dust" (particle size fraction not specified) varied throughout the day, and 24-hour average concentrations ranged from 16 to 65 µg/m^3—lower than EPA's health-based standard for 24-hour average PM$_{10}$ levels. Elemental phosphorus was detected in one sample, at 3 µg/m^3. Phosphoric acid was detected in roughly 40% of the samples—the highest detection was 4.62 µg/m^3.
Florida Power Corp.	To characterize air quality in the vicinity of the Anclote Plant	1994–1998	Three locations: one immediately southeast of SCC, another roughly 1 mile northeast of SCC, and another roughly 2 miles north of SCC	PM$_{10}$ Sulfur dioxide TSP	From 1994 to 1998, all annual average and 24-hour average PMA$_{10}$, sulfur dioxide, and TSP concentrations have been in attainment with EPA's primary air quality standards. The 3-hour average sulfur dioxide concentrations are in attainment with EPA's secondary air quality standards.

Key:

EPA	U.S. Environmental Protection Agency
µg/m^3	micrograms per cubic meter
NIOSH	National Institute for Occupational Safety and Health
PCDEM	Pinellas County Department of Environmental Management
pCi/L	picocuries per liter
PCM	phase contrast microscopy
PM$_{10}$	particulate matter less than 10 µg in diameter
SCC	Stauffer Chemical Company
TEM	transmission electron microscopy
TSP	total suspended particulates

Table 37. Stauffer Chemical Company Site, Completed Exposure Pathways

PATHWAY NAME	EXPOSURE PATHWAY ELEMENTS					TIME	COMMENTS
	Source	Environmental Media	Point of Exposure	Route of Exposure	Exposed Population		
Air (off-site)	Emissions from the roaster and furnace gas condensers, electric arc furnace tap holes, and nodulizing kiln	Air	Residences Commercial properties Schools	Inhalation	Area residents Students	Past	Meteorologic records show that winds predominantly blew from the northeast to the southwest, although winds blowing in all directions at varying speeds were observed throughout the period of record. The least prevalent wind directions were from the south to the north, or the wind directions that would most likely blow emissions from site to the Gulfside Elementary School. During the years of plant operations, outdoor air monitoring detected primarily elevated concentrations of sulfur dioxide and particulates.
Air (on-site)	See above	Air	Work areas	Inhalation	Former Stauffer workers	Past	Workers might have been exposed to emissions during routine work activities. Some worker monitoring data, conducted by Stauffer, are available (work area or personal monitors were examined for dusts, metals, fluorides, sulfur dioxide, and phosphorus).
On-site groundwater	Disposal ponds Slag processing area	Groundwater	On-site supply wells	Ingestion	Workers	Past *Future*	On-site supply wells (from the Floridan Aquifer) were used to provide potable water during the years of Stauffer's operations. Since approximately 1979, the site has been served by public water, which is unaffected by Stauffer activities. Historic sampling data from supply wells did not reveal elevated levels of contaminants. On-site groundwater within the shallow aquifer has been affected by past site activities. Monitoring data reveal elevated concentrations of metals, fluoride, phosphorus, and radionuclides. Available data suggest that the deeper Floridan aquifer has not been affected by site activities (however, only a limited number of locations and samples were tested in the deeper aquifer).

Table 37. Stauffer Chemical Company Site, Completed Exposure Pathways (continued)

PATHWAY NAME	EXPOSURE PATHWAY ELEMENTS					TIME	COMMENTS
	Source	Environmental Media	Point of Exposure	Route of Exposure	Exposed Population		
On-site surface soil and slag	Wastes generated site operations (e.g., calcium silicate slag, metals, furnace off-gas solids, phosphorous-containing sludge)	Soil/slag	Processing and surrounding areas	Incidental (accidental) ingestion Skin contact Inhalation of surface soil dusts	Former and current site workers Remediation workers Trespassers	Past Current Future	Possible exposure to site soils is expected to be limited to on-site workers and occasional trespassers. Planned remedial actions should prevent future exposures. Historically, the majority of the site was fenced, with 24-hour security (NUS 1989). Access to the site continues to be restricted and accessible only to workers. The disposal areas between Anclote Road and Anclote Boulevard have not always been securely fenced; this disposal area is less than 2,000 feet from the Gulfside Elementary School. Past studies have shown elevated levels of contaminants in the on-site surface soils in and around the processing areas of the plant (most significantly in and around former disposal ponds, slag processing/storage areas, and production facilities).
Off-site surface soil	Plant furnace emissions Residual slag	Soil	Residences Commercial properties Schools	Incidental (accidental) ingestion Skin contact Inhalation of surface soil dusts	Area residents Employees Students	Past Current Future	Residential, commercial, and school properties are in the immediate vicinity of the Stauffer site. The Gulfside Elementary School abuts the site on the northern property boundary. The only off-site soil data collected was from the Gulfside Elementary School. No measured contaminants were detected at levels above CVs, except for radium-226. No soil sampling has occurred in areas in predominant downwind areas.

Table 37. Stauffer Chemical Company Site, Completed Exposure Pathways (continued)

PATHWAY NAME	EXPOSURE PATHWAY ELEMENTS					TIME	COMMENTS
	Source	Environmental Media	Point of Exposure	Route of Exposure	Exposed Population		
Off-site slag	Wastes generated from elemental phosphorus production	"Slag"	Roadways Building materials	Incidental (accidental) ingestion Skin contact Inhalation of dusts	Area residents, employees, and students	Past Current Future	Waste slag was used in the community in constructing roads and building materials. The waste slag was first shipped to off-site storage locations before distributing it for community use. In general, testing of slag materials revealed low levels of chemical and radiologic activity.
Surface water (Anclote River and Meyers Cove)	Groundwater discharge and site drainage	Surface water	Along the banks of the Anclote River	Incidental (accidental) ingestion Skin contact	Residents of and visitors to downstream areas	Past Current Future	Site drainage flows to the Anclote River, west to the Gulf of Mexico (~1.6 miles from the site). The river is not currently used for drinking water, however, a Pasco County Park is located 0.9 miles west on the Anclote River (NUS 1989). The river is used extensively for recreational and commercial activities including swimming, boating, and fishing. The site lagoon system is situated approximately 40 feet from the Anclote River and less than 0.5 miles from a shellfish harvesting area.
Sediment (Anclote River and Meyers Cove)	Groundwater discharge and site drainage	Sediment	Along the banks of the Anclote River	Incidental (accidental) ingestion Skin contact	Residents of and visitors to downstream areas	Past Current Future	As mentioned above, the Anclote River has a variety of recreational and industrial uses. Sediments were found to have the highest concentration of many contaminants in Meyers Cove, the area directly adjacent to the site. Meyers Cove is not used for recreational purposes; further, few contaminants exceed CVs. People would not come in contact with river sediments except perhaps infrequently along the immediate shore and possibly during the collection of shellfish.

Italicized text indicate aspects of the pathway for which data are uncertain, incomplete, or unavailable.
Key: CV comparison value SMC Stauffer Management Company

Table 38. Stauffer Chemical Company Site, Potential Exposure Pathways

PATHWAY NAME	EXPOSURE PATHWAY ELEMENTS					TIME	COMMENTS
	Source	Environmental Media	Point of Exposure	Route of Exposure	Exposed Population		
Off-site groundwater (Floridan aquifer)	*Not verified*	Deep groundwater	Residential and commercial potable wells	Ingestion Skin Contact	Residents Visitors	Past Current Future	Groundwater in the area of the site (in Holiday and Tarpon Springs) is used for drinking water. All drinking water wells are believed to be in the deeper Floridan aquifer. Current data suggest that discharge of contaminated groundwater to the Anclote River (in the direction of groundwater flow) prevents any impact on downgradient private wells. The nearest private potable well is believed to be 2,500 feet northwest (upgradient) of the site. Commercial potable wells exist east (cross-gradient) of the site. Arsenic, chromium, lead, nickel, thallium, zinc, chlorides, sulfate, gross alpha radiation, and radium-226 were detected above Agency for Toxic Substances and Disease Registry CVs, but at relatively low frequencies. ATSDR considers this a potential exposure pathway because people are drinking water from areas wells. Though area wells are generally not believed to be in the path of groundwater contaminant flow from the site, ATSDR evaluated this pathway to understand the potential for exposure to harmful levels of contaminants and to address specific community concerns about the safety of drinking private well water in the vicinity of the site.

Table 38. Stauffer Chemical Company Site, Potential Exposure Pathways (continued)

PATHWAY NAME	EXPOSURE PATHWAY ELEMENTS					TIME	COMMENTS
	Source	Environmental Media	Point of Exposure	Route of Exposure	Exposed Population		
Off-site groundwater (Shallow aquifer)	*Not verified*	Shallow groundwater	Irrigation wells	Skin	Residents Visitors	Past Current Future	Though irrigation wells also are not believed to be in the path of groundwater contaminant flow from the site, ATSDR evaluated this pathway to understand the potential for exposure to harmful levels of contaminants. Generally, limited potential likely exists for contact with water from irrigation wells. Arsenic, zinc, and chlorides were detected in some irrigation wells above *drinking water* CVs; however, detected concentrations are not expected to be of public health concern through skin contact.
On-site subsurface soil	Wastes generated from elemental phosphorus production	Soil	Disposal areas	Incidental (accidental) ingestion Skin contact Inhalation of dusts	Remediation workers	*Future*	On-site subsurface soils include those located on and around the main processing area, beneath the slag piles, and within the former disposal ponds. No past or current exposures exists, because soils are not accessible. Site cleanup plans which are still under negotiation will be developed and implemented with the goal of preventing future exposures.
Biota (Anclote River/Gulf of Mexico)	Contaminants in surface water and sediment	Fish Shellfish	*Fish/shellfish harvested from the river/gulf*	Ingestion	Recreational fishers Consumers of commercially harvested fish	Past Current Future	No sampling data (fish tissue) are available to evaluate possible impact of site contaminants on area fish/shellfish. However, the type of, location of, and detection frequency of contaminants reported in river and Meyers Cove sediments show that accumulation of contaminants in fish/shellfish tissue is not likely.

Table 38. Stauffer Chemical Company Site, Potential Exposure Pathways (continued)

PATHWAY NAME	**EXPOSURE PATHWAY ELEMENTS**					**TIME**	**COMMENTS**
	Source	**Environmental Media**	**Point of Exposure**	**Route of Exposure**	**Exposed Population**		
External gamma radiation	*Process waste and slag*		On-site and off-site areas Building and roadway materials		Workers Residents	Past Current Future	Community exposure to gamma radiation was the subject of a recent Agency for Toxic Substances and Disease Registry health consultation (ATSDR 2002), which concluded that doses from homes and pavement with slag are not elevated and do not pose a health threat. No conclusion can be made about the extent to which Stauffer site slag material is contained in surrounding community roads and buildings.

Italicized text indicate aspects of the pathway for which data are uncertain, incomplete, or unavailable.

Key:

CV	comparison value
SMC	Stauffer Management Company

Table 39. Hourly Sulfur Dioxide Levels at the Anclote Road Monitoring Station When Stauffer Chemical Company Was Operating, Number of Samples Greater Than ATSDR's Acute Inhalation MRL of 10 ppb

Year	Hourly Average Concentrations		
	Number of 1-hour Samples	Number of 1-hour Samples Greater Than 10 ppb	Number of Days With Concentrations Greater Than 10 ppb
1977	3,341	507	96
1978	7,384	950	192
1979	8,300	783	194
1980	7,878	663	171
1981	7,879	564	156
Total	34,782	3,467	809

Key:

ppb	parts per billion

Table 40. Summary of Studies Showing Effects to the Lung From Sulfur Dioxide Exposure in Persons With and Without Asthma. Pertinent Animal Studies Are Also Reported.

Sulfur Dioxide, ppb	Duration of Exposure, Minutes	Exposure Conditions	Effect End Point	Reference
8,000	20	Healthy persons without asthma	Redness of airways (trachea, bronchi), Increased inflammatory cells in fluids from lung	Sandstrom et al. 1989
5,000	10	Healthy persons without asthma, quiet mouth breathing	Increased air airway resistance	Lawther et al. 1975
5,000	10 to 30	Healthy persons without asthma	Cough, sense of irritation	Frank et al. 1962
4,000	20	Healthy persons without asthma	Increased number macrophages in fluid from lungs	Sandstrom et al. 1989
1,000	Not specified	Healthy persons without asthma	Increased airway resistance	Lawther et al. 1975
1,000	10	Healthy persons without asthma	Increased heart rate and breathing rate	Amdur et al. 1953
1,000	10	Mouthpiece, exercise, persons with mild asthma	Significantly Increased airway resistance Wheezing and shortness of breath (symptoms of bronchoconstrictions)	Sheppard et al. 1981
1,000	30	Mouthpiece, exercise, healthy adolescents without asthma	Small changes in pulmonary function tests	Koenig et al. 1982
1,000	30	Mouthpiece, exercise, adolescents with asthma	Changes in pulmonary function tests consistent with bronchoconstriction, shortness of breath and wheezing	Koenig et al 1981
950	3 hours	Intermittent periods	Coughing	Dodge 1985
600	immediate 10 20	Mouthpiece, hyperventilation, healthy persons without asthma	increased airway resistance and significant bronchoconstriction in 13 of 26 persons	Islam et al 1992
600	5	Chamber exposure, heavy exercise, persons with asthma	Significantly increased airway resistance	Linn et al. 1983

Table 40. Summary of Studies Showing Effects to the Lung From Sulfur Dioxide Exposure in Persons With and Without Asthma. Pertinent Animal Studies Are Also Reported. (continued)

Sulfur Dioxide, ppb	Duration of Exposure, Minutes	Exposure Conditions	Effect End Point	Reference
500	10	Mouthpiece apparatus, exercise, persons mild with asthma	Significantly Increased airway resistance and bronchoconstriction in seven of seven subjects Wheezing and shortness of breath in three of seven subjects	Sheppard et al. 1981
500	10 to 75	Chamber, exercise, persons with mild asthma	Increased airway resistance, increase less significant with time, except in two subjects. One subject withdrew because of pronounced wheezing and tightness of chest	Roger et al, 1985
500	3 to 5	Mouthpiece apparatus, hyperventilation, persons with asthma	Increased airway resistance	Balmes et al. 1987
500	3	Mouthpiece apparatus, hyperventilation, persons with asthma, cold dry air	bronchoconstriction causing wheezing and shortness of breath in 6 of 7 people, 2 people requested bronchodialators after exposure	Bethel et al 1984
500	5	Mouthpiece apparatus, exercising asthmatics	bronchoconstriction at moderate and high but not low work rate	Bethel et al, 1983
500	5	Facemask (oronasal breathing), exercising asthmatic	bronchoconstriction at high work rate	Bethel et al 1983
400	5	Chamber exposure, heavy exercise, persons with asthma	Moderately increased airway resistance	Linn et al. 1983
250 (lowest exposure tested)	40 with 10 minutes as exercise	Chamber exposure, exercise, persons with asthma	Slight, but statistically significant, decrease in air flow rate	Schachter et al. 1984

Table 40. Summary of Studies Showing Effects to the Lung From Sulfur Dioxide Exposure in Persons With and Without Asthma. Pertinent Animal Studies Are Also Reported. (continued)

Sulfur Dioxide, ppb	Duration of Exposure, Minutes	Exposure Conditions	Effect End Point	Reference
250 (only exposure tested)	5	Chamber exposure, moderate exercise, persons with asthma	Increased airway resistance	Bethel et al. 1985
250	3	Mouthpiece apparatus	Increased airway resistance	Myers, 1986a, 1986b
250	10	Mouthpiece apparatus, exercise, persons with mild asthma	Significantly Increased airway resistance in three of seven subjects No wheezing or shortness of breath	Sheppard et al. 1981
250 (lowest exposure tested)	10 to 75	Chamber exposure, exercise, persons with mild asthma	No increase in airway resistance	Roger et al. 1985
250 (lowest exposure tested)	10	Chamber exposure, exercise, persons with asthma	Reanalysis of Roger et al. 1985 data indicates airway effects in some subjects	Hortsman et al. 1986
200 (lowest exposure tested)	5	Chamber exposure, heavy exercise, persons with asthma	No increase in airway resistance	Linn et al. 1983, 1987
100 (only exposure tested)	40 with 10 minutes as exercise	Mouthpiece apparatus, moderate exercise, allergic adolescents (some with asthma)	No increase in airway resistance from SO_2 alone; increase observed in combination with 68 $\mu g/m^3$ sulfuric acid	Koenig et al. 1989
100	10	Mouthpiece apparatus, moderate exercise, persons with mild asthma	Increased airway resistance in two of seven subjects	Sheppard et al. 1981
100	3	Mouthpiece apparatus; hyperventilation; cold, dry air; persons with asthma	Increased airway resistance	Sheppard et al. 1984

Table 41. Hourly Sulfur Dioxide Levels at the Anclote Road Monitoring Station When Stauffer Chemical Company Was Operating, Number of Samples Greater Than 100 ppb

Year	Hourly Average Concentrations		
	Number of 1-hour Samples	Number of 1-hour Samples Greater Than 100 ppb	Number of Days With Concentrations Greater Than 100 ppb
July to December 1977[29]	3,341	158	45
all 1977[30]	6,682[31]	316	90
1978	7,384	287	77
1979	8,300	70	39
1980	7,878	54	29
1981	7,879	32	20
Total from actual sample measurements (7/1/1977 through 12/31/1981).	34,782	601	210

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[29] Air monitoring began at the Anclote Road monitoring station in July 1977; therefore, the data presented in this row are actual measurements.

[30] The data presented for all of 1977 is estimated based on actual measurements from July to December 1977.

[31] Estimated.

Table 42. Frequency of Significantly Elevated Hourly Sulfur Dioxide Levels at the Anclote Road Monitoring Station in Relation to Wind Direction

Year	No. Hours Downwind at the Anclote Road Monitoring Station	No. Hours Above 100 ppb Sulfur Dioxide and Known Wind to the Southeast	Frequency in Percent
January to May 1979	720	48	6.7
1979	1,577	57	3.6
1980	1,687	50	3.0
1981	1,558	27	1.7

Table 43. Estimated Number of Hours That Hourly Sulfur Dioxide Levels Might Have Exceeded 100 ppb in Four Areas from January to May 1979.

Direction from Kiln	Geographic Area	January to May 1979		
		No. Hours Wind Blows to Each Location	Estimated Percent of Time That Levels Exceed 100 ppb	Estimated No. Hours Sulfur Dioxide Is Above 100 ppb
Southwest	Residences southwest of Stauffer who live along the shore of the Anclote River	785	6.7	52
West	Residences west of Stauffer	908	6.7	60
East	Businesses east of Stauffer	575	6.7	38
North	The slag processing area north of the kiln but still part of Stauffer[1]	463	6.7	31

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[1] Gulfside Elementary School is another 1,000 feet north of the former slag processing area.

Table 44. Annual Average Sulfur Dioxide Levels From 1977 to 1982

Year	Sulfur Dioxide Level* (parts per billion)
1977	17
1978	15
1979	7
1980	6
1981	4
1982	1

*Sulfur dioxide levels are rounded to the nearest whole number. The exact level can be found in Table 35.

Table 45. Predicted Maximum Hourly Sulfur Dioxide Levels, 1977 to 1981, at Various Locations Around Tarpon Springs

Location*	Description	Predicted Maximum Hourly Sulfur Dioxide Levels (ppb)**
1	North-northwest of Stauffer facility, in Pasco County	629
2	Gulfside Elementary School	1,052
3	Residential neighborhood in southern Pasco County, northeast of Stauffer facility	526
4	Residential neighborhood west of Stauffer facility	1,052
5	Industrial complex east of Stauffer facility	1,167
6	Piney Point, on the shore of the Gulf of Mexico	412
7	Residential neighborhood southwest of Stauffer facility, and in prevailing downwind direction	824
8	**Anclote Road monitoring station near the Flaherty Marina**	1,144
9	Residential neighborhood south of Stauffer facility	847
10	Residential neighborhood south-southwest and further downwind of Stauffer facility	561
11	Howard Park, on the shore of the Gulf of Mexico	400
12	Residential neighborhood southeast of Stauffer facility	618

*See Figure 19, Appendix A
** parts per billion

Table 46. Predicted Annual Average Sulfur Dioxide Levels, 1977 to 1981, at Various Locations Around Tarpon Springs

Location*	Description	Predicated Annual Average Sulfur Dioxide Levels (ppb)**	
		1977 to April 1979	May 1979 to 1981
1	North-northwest of Stauffer facility, in Pasco County	4	2
2	Gulfside Elementary School	7	3
3	Residential neighborhood in southern Pasco County, northeast of Stauffer facility	3	1
4	Residential neighborhood west of Stauffer facility	13	3
5	Industrial complex east of Stauffer facility	23	7
6	Piney Point, on the shore of the Gulf of Mexico	6	2
7	Residential neighborhood southwest of Stauffer facility, and in prevailing downwind direction	14	4
8	**Anclote Road monitoring station near the Flaherty Marina**	9	2
9	Residential neighborhood south of Stauffer facility	8	2
10	Residential neighborhood south-southwest and further downwind of Stauffer facility	8	3
11	Howard Park, on the shore of the Gulf of Mexico	4	2
12	Residential neighborhood southeast of Stauffer facility	5	2

* See Figure 19, Appendix A
** parts per billion, levels are rounded to the nearest whole number

Table 47. Summary of Recent Important Epidemiologic/Controlled Human Particulate Matter Exposure Studies of Specific Physiologic End Points

Physiologic End Point	Observed Association With Particulate Matter Exposure	Reference
Lung function	Small declines in lung function; large risk of substantial decrements Growth of lung function in children reduced	Pope 2000 Gauderman et al. 2000
Hypoxemia	No clear associations with blood oxygen saturation	Pope et al. 1999
Plasma viscosity	Increased risk of elevated blood plasma viscosity	Peters et al. 1997
Heart rate	Increased mean heart rate and odds of substantially elevated heart rate	Pope et al. 1999 Peters et al. 1999
Heart rate variability	Changes in cardiac rhythm Decrease in overall heart rate variability	Liao et al. 1999 Pope et al. 1999 Gold et al. 2000
Pulmonary inflammation	Elevated white blood cell counts, band cells expressed as percent of polymorphonuclear leukocytes, neutrophils, platelets, lymphocytes, and/or eosinophils	Tan et al. 2000 Salvi et al. 1999 Ghio et al. 2000
RBC sequestration	Changes in hemoglobin adjusted for albumin suggest that inhalation of some component of particulate matter may cause sequestration of red cells in the circulation by changes in RBC adhesiveness	Seaton et al. 1999
Heart arrhythmia	Increased risk of implanted cardioverter-defibrillator discharges	Peters et al. 2000

Partially adapted from Pope (2000).

Table 48. Estimated PM_{10} Levels Based on TSP Levels Measured at the Anclote Road Monitoring Station From 1977 to 1989

Year	TSP (μg/m^3)	Estimated PM_{10} (μg/m^3)	Estimated Overall Average PM_{10} (μg/m^3)
SCC Facility Open			
1977	60	30	34
1978	65	33	
1979	70	35	
1980	73	37	
1981	71	36	
SCC Facility Closed			
1982	46	23	24
1983	46	23	
1984	51	26	
1985	51	26	
1986	49	25	
1987	48	24	
1988	49	25	
1989	41	20	

Key:

μg/m^3	micrograms per cubic meter
TSP	total suspended particulates
PM_{10}	particulate matter less than 10 micrometers in diameter

Table 49. Estimated $PM_{2.5}$ Levels at the Anclote Road Monitoring Station From 1977 to 1989

Year	Estimated PM_{10} ($\mu g/m^3$)	Estimated $PM_{2.5}$ ($\mu g/m^3$)	Overall Estimated Average $PM_{2.5}$ ($\mu g/m^3$)
SCC Facility Open			
1977	30	18	20
1978	33	20	
1979	35	21	
1980	37	22	
1981	36	21	
SCC Facility Closed			
1982	23	14	14
1983	23	14	
1984	26	15	
1985	26	15	
1986	25	15	
1987	24	14	
1988	25	15	
1989	20	12	

Key:

$\mu g/m^3$	micrograms per cubic meter
PM_{10}	particulate matter less than 10 micrometers in diameter
$PM_{2.5}$	particulate matter less than 2.5 micrometers in diameter

Table 50. Summary of Epidemiologic Evidence of Health Effects of Acute Exposure to Particulate Matter Air Pollutants

Health End Points	Observed Association with Particulate Matter
Episodes of death and hospitalizations	Elevated respiratory and cardiovascular mortality and hospitalizations.
Mortality (death)	Elevated daily respiratory and cardiovascular mortality counts. Effects persisted with various approaches to control for time trends, seasonality, and weather. Near-linear associations with little evidence of threshold.
Hospitalization and other health-care visits	Elevated hospitalizations, emergency room visits, and clinic/outpatient visits for respiratory and cardiovascular disease. Effects generally persisted with various approaches to control for time trends, seasonality, and weather.
Symptoms/lung function	Increased occurrence of lower respiratory symptoms, cough, and exacerbation of asthma. Only relatively weak associations with respiratory symptoms. Small, often significant declines in lung function.

Adapted from Pope (2000).

Table 51. Summary of Arsenic and Lead Levels in Private Wells Near the Stauffer Chemical Company Site

Contaminant	Maximum Level in ppb	Date	Comments
Arsenic	26 and 23 (commercial)	March 2000	Levels in the remaining commercial and residential wells were less than the federal drinking water standard of 10 ppb.
	24 (residential, Pasco County)		
Lead	270 (residential)	March 2001	Other private wells contained 160, 24, and 18 ppb lead. The remaining residential and all commercial wells were below the lead drinking water standard of 15 ppb.

Key:

ppb	parts per billion

Table 52. Summary of Arsenic Levels in On-Site Surface Soils, Pond Soils, and Slag

	No. Samples			**Arsenic Levels, ppm**	
Media	**Above ATSDR CV**	**With Detectable Arsenic**	**Collected**	**Average**	**Maximum**
Surface Soils	30	32	91	20	140
Pond Soils	48	48	59	122	340*
Slag	1	2	11	2	4.2

Key:

ATSDR	Agency for Toxic Substances and Disease Registry
CV	comparison value
ppm	parts per million

*estimated concentration

Table 53. Estimated Dose of Arsenic in Children From Exposure to On-Site Surface Soils, Pond Soils, and Slag

Age Group	Surface Soils, µg/kg/day	Pond Soils, µg/kg/day	Slag, µg/kg/day
1-year-old child	0.28	1.7	0.028
Preschool children	0.18	1	0.017
Elementary school children	0.039	0.23	0.0039
Teenagers	0.025	0.15	0.0025
Adult men	0.02	0.12	0.002
Adult women	0.023	0.14	0.0023
Minimal risk level	0.3	0.3	0.3
Highest level not harmful	0.8	0.8	0.8
Lowest harmful level	14	14	14

Key:

µg/kg/day	milligrams per kilogram per day
MRL	minimal risk level

Note:
Average arsenic levels, in parts per million, are as follows:

- 20 ppm in surface soil
- 122 ppm in pond soil
- 2 ppm in slag.

Table 54. Theoretical Risk of Cancer from Arsenic in Soil

Media	Average Arsenic Level, Parts per Million	Estimated Number of Cancers*	Theoretically Exposed Population
Background for Florida	1	0 to 3	1,000,000
Background for eastern United States	7	0 to 20	1,000,000
On-Site Surface soils	20	0 to 50	1,000,000
On-Site Pond soils	122	0 to 300	1,000,000

*Numbers are rounded

Table 55. List of Area/Job Classification Categories for Stauffer Chemical Company, Tarpon Springs

Area Name	Job Classifications
Yard Department	Yard Labor, Diesel Equipment Operator, Switcher, Truck Driver, Janitor, Foreman
Kiln Department	Kiln Operator, Kiln Helper, Raw Materials Operator, Kiln Utility Person, Kiln Relief Operator
Furnace Department	Furnace Operator, Tapper, Utility Person, Furnace Relief Operator, Shift Foreman, Mudmill Operator (historic classification, not current)
P_4 Handling Department	P_4 A Operator, P_4 B Operator, Pond Clarifier, Drum Loader
Laboratory Department	Analyst, Sampler, Chemist
Mechanical Department	Lubrication Mechanic, Mechanic Leadmen, Mechanics, Painters, Electrical Leadmen, Electricians, Storeroom Clerk, Mechanical Foreman, Electrical Foreman, Storeroom Foreman, Pollution Mechanic
Plant (General)	Supervision, All Personnel

Key:

P_4	Phosphorus

Table 56. Worker Exposure Concentrations and Limits From Stauffer Chemical Company, Tarpon Springs, Monitoring Data

Contaminant	Concentration		Area/Job Classification or Area and Specific Location	Protect Equip. Used	Type	Year	Freq	Date Range
	Minimum	Maximum						
Arsenic	<0.01 μg/m^3	<0.5 μg/m^3	Furnace Department, Furnace Operator	N	TWA	1978	43	1975–1978
Arsine	ND	0.05 ppm	P_4 Handling Department, Condenser Deck	N	Grab	1975	6	1975
Asbestos	ND	0.33 f/cc	Storeroom, Asbestos Room	N/S[†]	N/A	1976	13	1975–1976
Carbon Monoxide	0 ppm	>700 ppm	Furnace Department, Rotoclone Collection	N	Grab	1975	96	1974–1980
Fluoride	0.00583 mg/m^3	0.5 mg/m^3	Kiln Department, Kiln Operator	N	EXC	1975	14	1975–1979
Hydrogen Sulfide	26 ppm	>60 ppm	P_4 Handling Department, P_4 Tank Car	N	Grab	1978	3	1978
Hydrogen Fluoride	0 ppm	0 ppm	Furnace Department, Furnace Building Roof	N	Grab	1977	1	1977
Iron Oxide	0.01 mg/m^3	1.82 mg/m^3	Mechanical Department, Mechanics	C	TWA	1981	12	1981
Lead	50 μg/m^3	423 μg/m^3	Mechanical Department, Painters	C	TWA	1981	4	1981
Ni (Sol/Metal)	<0.01 mg/m^3	0.26 mg/m^3	Mechanical Department, Mechanics	C	TWA	1981	8	1981
Nuisance dust: silica[‡]	<0.052 mg/m^3	3.94 mg/m^3	Furnace Department, Burden Bins	N	Area	1975	3	1975
Oxygen	18.8%	21.0%	P_4 Handling Department, P_4 Tank Car	N	Grab	1978	80	1974–1980
P_2O_5/H_3PO_4	0.05 mg/m^3	4.99 mg/m^3	P_4 Handling Department, P_4 A Operator	C	TWAN	1981	31	1981
Phosphine	ND	>7 ppm	P_4 Handling Department, P_4 Tank Car	N	Grab	1978	10	1975–1978
Phosphoric Acid: "filter (leach)"	ND	4.06 mg/m^3	P_4 Handling Department, Condenser Deck	N	Grab	1979	15	1977–1979
Phosphorus (P_4)	ND	88.9 μg/m^3	P_4 Handling Department, Pond Clarifier	N	N/A	1975	16	1975–1977
Phosphorus-Yellow	3.04 μg/m^3	255.67 μg/m^3	P_4 Handling Department, P_4 B Operator	C	PAR	1979	48	1976–1981
Quartz	<6.2 μg/m^3	74.7 μg/m^3	Furnace Department, Utility Person	C	TWA	1980	56	1980
Quartz-T	220.3 μg/m^3	1,392 μg/m^3	Yard Department, Yard Labor	C	TWA	1979	7	1979–1980

Table 56. Worker Exposure Concentrations and Limits From Stauffer Chemical Company, Tarpon Springs, Monitoring Data (continued)

Contaminant	Concentration		Area/Job Classification or Area and Specific Location	Protect Equip. Used	Type	Year	Freq	Date Range
	Minimum	Maximum						
Respirable Dust	0.03 mg/m^3	15.6 mg/m^3	P_4 Handling Department, P_4 Operator	N	Area	1975	56	1975–1980
Silica Mixt-T	103%	604%[§]	Yard Department, Yard Labor	C	TWA	1979	7	1979–1980
Silica Mixture	<1%	148%[§]	Furnace Department, Utility Person	C	TWA	1980	55	1975–1980
Sulfur Dioxide	ND	1.39 ppm	Mechanical Department, Pollution Mechanic	C	TWA	1981	59	1979–1981
Total Dust	3.05 mg/m^3	590 mg/m^3	Kiln Department, Feed End	N/S	N/A	1972	7	1972–1980
Total Chromium	<0.01 mg/m^3	0.46 mg/m^3	Mechanical Department, Mechanics	C	TWA	1981	8	1981

[§] The concentration is expressed as a percentage of the PEL. OSHA's PEL when the facility operated was 100%. According to site documents, silica mixture is a combination of quartz and respirable dust exposures.
[†] Document does not give protective equipment code, but refers to the use of "OSHA-Approved Respirator."
[‡] Calculated value, based on level of nuisance dust (mg/m^3) and percent silica content.

Key:

Protect Equip. (Protective Equipment) Code
N - None
C - half-face air-purifying respirator
N/S - Not Specified

Concentration Units
µg/m^3 - micrograms per cubic meter
mg/m^3 - milligrams per cubic meter
ppm - parts per million
f/cc - fiber per cubic centimeter
% - percent

Other Abbreviations
EXC - excursion sample, short-term breathing zone sample of 10–60 minutes
N/A - not available
ND - not detected
OSHA - Occupational Safety and Health Administration
PAR - partial shift breathing zone sample of 60–360 minutes duration
PEL - permissible exposure limit
TWA - time-weighted average
TWAN - full shift breathing zone sample that is not representative of typical plant operations

Table 57. Contaminants Exceeding an Occupational Standard or Agency for Toxic Substances and Disease Registry Comparison Value at Stauffer Chemical Company in Tarpon Springs

Contaminant	Maximum Concentration	Threshold Limit Value	Comparison Value
Arsenic	< 0.5 µg/m^3 or 0.0005 mg/m^3	0.01mg/m^3 TWA	0.0002 µg/m^3 CREG
Asbestos	0.33 f/cc or 10 µg/m^3	0.1 f/cc TWA	0.000004 µg/m^3 CREG
Carbon Monoxide	> 700 ppm	25 ppm TWA	None
Hydrogen Sulfide (H_2S)	>60 ppm or 60,000 ppb	10 ppm TWA	30 ppb EMEG I 70 ppb EMEG A
Lead	423 µg/m^3 or 0.423 mg/m^3	0.05 mg/m^3 TWA	None
Nickel (Sol/Metal)	0.26 mg/m^3 or 260 µg/m^3	0.1 mg/m^3 TWA	0.2 µg/m^3 MRL C
Phosphine	>7 ppm or 0.0009 µg/m^3	0.3 ppm TWA	0.3 µg/m^3 RFC
Phosphoric Acid: “filter (leach)”	4.06 mg/m^3 or 4,060 µg/m^3	1 mg/m^3 TWA	10 µg/m^3 RFC I
Phosphorus (P_4)	54.12 µg/m^3 or 0.054 mg/m^3	0.1 mg/m^3 TWA	20 mg/m^3 MRL A
Phosphorus-Yellow	255.67 µg/m^3 or 0.255 mg/m^3	0.1 mg/m^3 TWA	20 mg/m^3 MRL A
Quartz	74.7 µg/m^3 or 0.0747 mg/m^3	0.05 mg/m^3 TWA	None
Quartz-T	355.3 µg/m^3 or 0.3553 mg/m^3	0.05 mg/m^3 TWA	None
Respirable Dust	15.6 mg/m^3	5 mg/m^3 TWA Resp	None
Silica Mixt-T	604%†	100%†	None
Silica Mixture	148%†	100%†	None
Sulfur Dioxide (SO_2)	1.39 ppm or 1,390 ppb	2 ppm TWA Resp 5 ppm TWA STEL	10 ppb EMEG A
Total Dust	590 mg/m^3	10 mg/m^3 TWA	None

Table 57. Contaminants Exceeding an Occupational Standard or Agency for Toxic Substances and Disease Registry Comparison Value at Stauffer Chemical Company in Tarpon Springs (continued)

Contaminant	Maximum Concentration	Threshold Limit Value	Comparison Value
Total Chromium	0.46 mg/m^3 or 460 µg/m^3	0.01 mg/m^3 TWA CrVI	0.01 µg/m^3 RFC

Key:

Concentration Units
µg/m^3 - micrograms per cubic meter
mg/m^3 - milligrams per cubic meter
ppm - parts per million
ppb - parts per billion
f/cc - fiber per cubic centimeter
% - percent

Other
A - Acute
C- Chronic
CREG - cancer risk evaluation guide
EMEG - environmental media evaluation guide
I - Intermediate
MRL - Minimal Risk Level
OSHA - Occupational Safety and Health Administration
PEL - permissible exposure limit
RFC - Reference Concentration
STEL - short-term exposure limit
TWA - Time Weighted Average

[†] The concentration is expressed as a percentage of the PEL. OSHA's PEL when the facility operated was 100%. According to site documents, silica mixture is a combination of quartz and respirable dust exposures.

Table 58. Theoretical Cancer Risks from Stauffer Occupational Exposures

Contaminant	Increased Risk (Quantitative)	Increased Risk (Qualitative)	Class
Asbestos	9.9E-04	Moderate	A
Chromium	7.2E-02	Significant	A

Sample Equation: C x EF x ED x CSF
Assumptions for calculations:
Exposure frequency was 50 days per year (1 day per week, 50 weeks per year) and 8 hours per day
Exposure duration was 20 years

Cancer Risk Discussion

There is insufficient knowledge of cancer mechanisms to decide whether a level of exposure to a cancer-causing agent exists below which there is no risk for cancer (namely, a threshold level). Therefore, exposure to a cancer-causing compound, even at low concentrations, is assumed to be associated with some increased risk for evaluation purposes. It is assumed that as the dose of a carcinogen decreases, the chance of cancer also decreases.

The U.S. Environmental Protection Agency (EPA) classifies chemicals as Class A, Class B, Class C, Class D, or Class E. This classification defines a specific chemical's ability to cause cancer in humans and animals. This classification system been adapted from the International Agency for Research on Cancer (IARC). These EPA classifications are defined as follows:

Group A	Chemicals that are known human carcinogens.
Group B	Chemicals that are probable human carcinogens. Class B is further subdivided into two groups:
Group B1	Chemicals for which there is limited evidence of carcinogenicity from epidemiologic studies in humans
Group B2	Chemicals for which there is sufficient evidence of carcinogenicity in animals, but inadequate evidence or no data available from epidemiologic studies in humans.
Group C	Chemicals that are possible human carcinogens.
Group D	Chemicals that are not classifiable as to human carcinogenicity.
Group E	Chemicals for which there is evidence that they are not carcinogenic to humans.

For carcinogenic substances, EPA established the cancer slope factor (CSF), also referred to as cancer potency estimates, for exposure evaluation. CSF is used to determine the number of excess cancers resulting from exposure to a contaminant. The National Toxicology Program, in its *Biennial Report on Carcinogens* classifies a chemical as a "known human carcinogen" based on sufficient human data. Its classification of a chemical as being "reasonably anticipated to be a carcinogen" is based on limited human or sufficient animal data. The Agency for Toxic Substances and Disease Registry considers the above physical and biological characteristics when developing health guidelines for cancer-causing substances.

Table 58. Theoretical Cancer Risks from Stauffer Occupational Exposures (continued)

Increased cancer risk was estimated by using information about exposure levels for the contaminant of concern and multiplying by the chemical-specific CSFs to calculate a theoretical excess cancer risk estimate. An increased excess lifetime cancer risk is not a specific estimate of expected cancers. Rather, it is an estimate of the increase in the probability that a person might get cancer sometime in his or her lifetime after exposure to that contaminant.

Because of the uncertainties regarding the mechanism of cancer, varying suggestions exist among those in the scientific community about an acceptable excess lifetime cancer risk. The recommendations of many scientists have been in the risk range of one in one million to one in ten thousand (as referred to as 1×10^{-6} to 1×10^{-4}) excess cancer cases. An increased lifetime cancer risk of one in one million or less is generally considered an insignificant increase in cancer risk. An important consideration when determining cancer risk estimates is that the risk calculations incorporate a number of very conservative assumptions that are expected to overestimate actual exposure scenarios.

APPENDIX C – DETAILED DISCUSSION OF SITE SAMPLING INVESTIGATIONS AND ENVIRONMENTAL CONTAMINATION DATA

DETAILED DISCUSSION OF SITE SAMPLING INVESTIGATIONS AND ENVIRONMENTAL CONTAMINATION DATA

This appendix contains detailed information on the sampling studies, environmental contaminant data, and data trends that ATSDR evaluated for the public health assessment. The information presented here supplements that discussed in the Environmental Contamination and Other Hazards section of the public health assessment.

C.1. On-Site Contamination

C.1.1. Soil

Surface and subsurface soil data were collected at and near the Stauffer Chemical Company (SCC) site during a number of site investigations including

- *Expanded site investigation (ESI) (1988)*: to collect soil and water samples from on- and off-site locations to support EPA's completion of hazard ranking system (HRS) documentation (NUS 1989).

- *Listing site inspection (1989)*: to augment existing data to provide the necessary data for a scoring of the site using the revised HRS (NUS 1991).

- *Site soil characterization study (1990)*: to conduct extensive characterization of site soils, including radiologic evaluations (PBS&J 1990; Weston 1990a, 1990b).

- *Environmental sampling program (1990)*: follow-up sampling activities to sampling reported by Weston (1990a, 1990b) to further characterize soils for radium-226 and various organic and inorganic constituents (Weston 1990c).

- *Elemental phosphorus borings program (1991)*: to identify phosphorus associated with buried wastes (Weston 1991).

- *RI (1993)*: to confirm the results of past investigations and address identified data gaps to more completely delineate the nature and extent of site contamination (Weston 1993).

- *Gulfside Elementary School environmental monitoring program (1996–1997)*: to evaluate conditions of the surface soils at Gulfside Elementary School, which is directly north of the SCC site (Weston 1996; EE&G 1997a, 1997b).

- *Soil/slag leachability study (1997)*: to determine the extent of contaminant leaching from soil and slag in the slag processing area (Parsons 1997).

- *Radiologic incident reports (1997–1998)*: set of 28 radiologic incident final reports summarizing findings of "slag" radiation concentrations in several area homes, schools, and businesses (FDOH 2002).

- *Sitewide asbestos sampling (1998)*: as a follow up to the sampling conducted as part of the Parsons 1997 study. A comprehensive survey of the site soils for the presence of asbestos (Parsons 1998).

- *Slag sampling (1998)* to identify radiologic and nonradiologic contaminants in specified households, schools, driveways, yards, and area roadways (EPA 1999a).

- *Background levels of arsenic and beryllium (1999)*: to sample soils from undisturbed on-site areas to better characterize on-site background arsenic and beryllium levels (Parsons 1999).

Six categories of "soils" were sampled during one or more or these investigations:

- surface and subsurface soils from the former ponds and an on-site drainage ditch,
- on-site slag material (e.g., surface soils from the slag pits and storage area, as well as roadway materials),
- surface and subsurface soils from other areas of the site,
- on-site asbestos sampling of surface and subsurface soils,
- off-site soils (including data from the Gulfside Elementary School), and
- off-site building materials containing slag.

C.1.1.1. Former Pond Soils and Dredged Soils

The following soil sampling programs were conducted as part of site investigations and include analyses of soils or dredge material taken from the former ponds. Not all of the samples obtained for each study were analyzed for the same contaminants.

Because several sampling events were conducted by different investigators, the designation of the sampling locations has changed over the years. Table 2 in Appendix B describes the pond designations used in the various studies. Both Table 1 and Figure 4 (in Appendix B) use the pond designations from the *Site Soil Characterization Study* (PBS&J 1990, Weston 1990a, 1990b).

- In January 1988, NUS Corporation collected eight samples from former ponds and dredge piles as part of an ESI. These eight samples were as follows: two composited surface soil samples from two former ponds; two subsurface samples (from the "saturated zone") from two ponds; one composited surface soil sample from one dredge pile; and three samples from a second dredge pile, each taken at a different subsurface depth (4, 10, and 15 feet). Three samples were also obtained from a drainage ditch running along the northwest border of the site down into Meyers Cove. Samples were analyzed for EPA Contract Laboratory Program (CLP) organics and inorganics (NUS 1989).

- In April 1989, NUS Corporation collected additional surface and subsurface soil samples from six of the ponds, as well as from the two piles of dredged pond material. Three samples were taken from each pond/pile. Samples were analyzed for target analyte list (TAL) inorganics (NUS 1991).

- In November 1989, Post, Buckley, Schuh, Jernigan, Inc. (PBS&J) conducted a radiologic evaluation of the site. PBS&J performed an EGR survey of several areas of the site, including the former settling ponds in the southeast property and the dredged material piles. The surface and subsurface pond and dredged material soils were also analyzed for the presence of radium-226 (PBS&J 1990). This study is documented as part of the *Site Soil Characterization Study* (Weston 1990b).

- Between December 1989 and April 1990, Weston was contracted to perform soil sampling activities at the site. Composite depth samples were collected from 16 of the ponds and analyzed for arsenic, cadmium, chromium, lead, cyanide, fluoride, chloride, total phosphorus, and radium-226. Six of these ponds were also analyzed by the environmental pollutants (EP) toxicity and toxicity characteristic leaching procedure (TCLP) tests for the RCRA metals. Soils from four of these ponds were analyzed for radium-226 at the surface, midpoint, and bottom of their respective borings. Each of the 17 former pond areas were examined to determine the presence of elemental phosphorus (Weston 1990a). This study is documented as part of the *Site Soil Characterization Study* (Weston 1990b).

- In September 1990, Weston performed additional sampling of the surface soils from two of the ponds. These samples were analyzed for hazardous substance list (HSL) organics and inorganics (Weston 1990c).

- In June 1991, Weston performed additional borings in and around the areas of the former ponds to determine the presence of elemental phosphorus (Weston 1991).

- In March 1993, Weston analyzed four surface soil samples taken from three ponds, as well as one surface soil sample taken from a previous location of dredged pond material on the southeast property. This sampling was performed as part of the RI. The samples were analyzed for TAL metals, cyanide, fluoride, phosphorus, and total compound list (TCL) VOCs, SVOCs, pesticides and PCBs (Weston 1993).

Table 2 in Appendix B summarizes the findings of these pond and dredged material soil studies. The pond data summarized here include both surface soil and subsurface soil samples.

Highlights of the Table 2 data summary are presented here, including observed trends and details of sample locations:

- Five VOCs were detected in at least one of the eight samples. All detected VOCs were well below the ATSDR CVs. Acetone and methylene chloride were detected in more than half of the samples. The remaining VOCs were each detected in only one or two samples.

- Thirteen SVOCs were detected in at least one sample of the eight that were analyzed. Benzo[a]pyrene was detected slightly above the CV (0.1 ppm) in three samples with concentrations between 0.11 and 0.15 ppm. These samples were surface soils taken from ponds 49a, 49c, and 49D. Surface soil collected from pond 48 in March 1993 contained concentrations of three SVOCs at concentrations above their respective CVs: benzo[a]anthracene, benzo[b]fluoranthene, and indeno[1,2,3,-cd]pyrene.

The remaining SVOC concentrations were below ATSDR CVs. Five SVOCs were detected in at least 50 % of the samples: benzo[g,h,i]perylene, benzo[k]fluoranthene, chrysene, di-n-butyl phthalate, and fluoranthene.

- Seven samples were analyzed for pesticides and PCBs. Arochlor-1248 was the only PCB detected in any of these samples (one sample). The sample concentration exceeded the CV. No pesticides were detected in the samples.

- Fifty-nine samples were analyzed for various metals. Antimony was detected at concentrations above the ATSDR CV in 10 of 15 samples analyzed for this contaminant. The maximum value was 52 ppm in a surface soil sample from pond 51. The other samples with antimony concentrations above the CV were taken from the saturated zone depths of ponds 39 and 42; surface soils of ponds 49A, 49C, and 48; and subsurface soils taken from pile 2. Pile 2 contains dredged soils from several of the ponds located in the southern portion of the main production area.

- Arsenic was detected at concentrations above the CV in 48 of the 59 samples. The maximum concentration detected was 340 ppm arsenic in soil from the saturated zone of pond 42. Arsenic was detected at concentrations above the CV in all but the following pond/pile locations: dredged soil from pond 39 (pile 1); ponds 44A, 44B, 45, 48, and 52; and soil from the former dredged material pile location (pile 4).

- Cadmium was detected in 54 of the 59 samples; 47 of these samples showed concentrations above the CV (10 ppm). The maximum concentration was 66 ppm in a subsurface sample taken from pond 39 (from the saturated zone). Concentrations of cadmium were below the CV or not detected in the following locations: piles 1 and 4 and ponds 44a, 44b, 48, and 52.

- Chromium was detected in all but one of the 59 samples. Only one sample, however, slightly exceeded the CV for chromium (200 ppm) and came from the surface soils of pond 48. This sample contained 226 ppm chromium.

- Lead was detected in all 59 pond/pile samples; however, only two samples had concentrations exceeding the ATSDR CV. Surface soils from ponds 48 and 49C had 900 and 440 ppm lead, respectively. Previous composite depth samples from these ponds taken in December 1989 showed lower concentrations of lead (i.e., 14.5 ppm in pond 48 and 70.5 ppm in pond 49C).

- Thallium was detected in 32 of 42 samples analyzed for this metal; 31 of these samples had concentrations exceeding the ATSDR CV (4 ppm). The maximum concentration was 37 ppm, and was found in a subsurface soil sample from pile 2 in April 1989 (depth: 8 feet). Surface soils taken from this pile during the same sampling effort showed similar concentrations of thallium (28 and 32 ppm). A previous subsurface soil sample taken from this pile in January 1988 also tentatively showed a concentration of 31 ppm at a depth of 15 feet.

- Fluoride was detected in all 32 samples analyzed for this contaminant. Four of these samples had concentrations that exceeded the ATSDR CV for sodium fluoride (3,000 ppm). The maximum concentration (410,000 ppm) was found at the saturated zone of pond 39. The remaining three fluoride concentrations that exceeded the CV were significantly less than the maximum. One sample measured 5,280 ppm and was a composite sample from several depths of pond 45. The CV was also exceeded in composite samples from ponds 49A and 49C (3,170 and 3,120 ppm, respectively).

- Chloride was detected in more than half of the samples analyzed for this contaminant. Cyanide was detected in few samples, and all measured concentrations were less than the CV. Twenty-seven samples were analyzed for total phosphorus.

- In December 1989 and in June 1991, borings were obtained from several pond locations to determine the presence of elemental phosphorus. Elemental phosphorus was found in borings from ponds 44A, 44B, 47, 48, 49D, and 50 in December 1989 at depths ranging from 3.5 to 14.8 feet below ground surface (bgs). The maximum concentration of total phosphorus was 121,000 ppm in surface soils taken from pond 49D. In June 1991, elemental phosphorus was found in three areas next to ponds 46B and 47 at depths ranging from 10 to 24 feet bgs. This area is where waste drums containing roaster fines (i.e., calcined phosphate sand, elemental phosphorus, and sandy clay/water) were formerly buried (NUS 1989).

- Thirty-two samples were analyzed for radium-226. The ATSDR CV (5.4 Bq/kg) was exceeded in 30 of these samples. The maximum concentration of radium-226 was 1,258 Bq/kg in two composite samples taken from several depths of ponds 44A and 45. Only two samples from the lower depths of ponds 39 and 47 contained radium-226 below the detection limit.

Most of the maximum concentrations of contaminants detected in the pond soils were found in surface samples. The contaminants most frequently at levels detected above available ATSDR CVs were several SVOCs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, and fluoranthene), several metals (antimony, arsenic, cadmium, lead, and thallium), fluoride, and radium-226. The following metals were detected in at least 50% of the samples, but were all below the respective ATSDR CV: aluminum, barium, beryllium, copper, iron, manganese, mercury, nickel, selenium, silver, vanadium, and zinc. Few VOCs/SVOCs and pesticides/PCBs were detected; of those detected, most were at levels below their respective CVs.

Overall, soils sampled in the ditch indicated little contamination (NUS 1989). No VOCs or SVOCs were detected in the one sample analyzed for these contaminants. One sample (taken closest to the cove) had a sodium concentration (20,000 ppm) that was slightly higher than the maximum found in the pond soils or other on-site surface soils (on-site surface soil results are discussed later in this section). The remaining metals and other inorganics analyzed in the samples were either not detected or detected at concentrations below the respective CVs and below the maximum concentrations found in the pond soils and other on-site surface soils. The three ditch soils were also analyzed for gross alpha and beta radiation; in all three, levels of radiation measured were within the readings found for other on-site surface soils.

C.1.1.2. Slag (On-Site)

The following soil sampling programs were conducted as part of site investigations and include analyses of slag material taken from the slag pits and slag storage area. The soil sampling locations are shown in Figure 4. Not all of the samples obtained for each study were analyzed for the same contaminants.

- In November 1989, PBS&J conducted a radiologic evaluation of the site. PBS&J performed an EGR survey of several areas of the site, including the slag storage area in the North property. The surface and subsurface soils were also analyzed for the presence of radium-226 (PBS&J 1990). This study is documented as part of the *Site Soil Characterization Study* (Weston 1990b).

- Between December 1989 and April 1990, Weston was contracted to perform soil sampling activities at the site. Two surface soil samples from the slag pits and four surface soil samples from the slag storage area were analyzed for arsenic, cadmium, chromium, lead, cyanide, fluoride, chloride, and total phosphorus. One of the slag pit samples and six additional surface soil samples from the storage area were analyzed for radium-226 (Weston 1990a). This study is documented as part of the *Site Soil Characterization Study* (Weston 1990b).

- In March 1993, Weston analyzed one surface soil sample taken from the slag pit area. This sampling was performed as part of the RI. The sample was analyzed for TAL metals, cyanide, fluoride, phosphorus, and TCL VOCs, SVOCs, pesticides, and PCBs (Weston 1993).

- In September 1997 Parsons conducted a study to determine the extent of contaminant leaching from soil and slag in the slag storage area. A field radiation survey was conducted over the entire slag storage area. Three slag samples were then taken from areas with the highest radiation readings and analyzed for TAL metals, other inorganics, and radionuclides. These samples were also analyzed by the synthetic precipitation leaching potential (SALP) protocol (Parsons 1997).

- In July 1998, EPA Region 4 conducted a survey of several off-site materials containing slag. As part of this study, one sample from the on-site slag pile was taken for the purposes of microscopically fingerprinting the community slag materials to the Stauffer slag. This on-site sample was analyzed for the following metals and other inorganics: aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, zinc, fluoride, and radium-226 (EPA 1999a).

Table 3 in Appendix B summarizes the findings of the on-site slag studies. This table excludes data obtained from the slag-containing road materials. The on-site road material data are discussed at the end of this section.

Highlights of the Table 3 data summary are presented below:

- Only one sample (from the slag pit) was analyzed for VOCs, SVOCs, pesticides, and PCBs. No VOCs were detected in the sample. Benzo[a]pyrene was detected at 0.11 ppm, which is slightly above the ATSDR CV. An additional ten SVOCs and four pesticides/PCBs were detected in the sample at concentrations below the CV.
- Arsenic was detected in only 2 of the 11 samples analyzed for this contaminant. One of these samples (collected from the slag pit) contained arsenic at a concentration (4.2 ppm) that exceeded the CV.
- Cyanide was detected in 7 of 10 samples at a maximum concentration of 6.5 ppm. Fluoride and total phosphorus were detected in all 11 samples analyzed; the maximum concentrations were 1,920 and 48,500 ppm, respectively. The maximum concentrations for all three contaminants were found in samples taken from the slag storage area.
- Only one sample (from the slag storage area) was analyzed for gross alpha and beta radiation. This sample showed concentrations of 9,990 and 4,590 Bq/kg, respectively. All 12 samples analyzed for radium-226 had concentrations exceeding the CV. The maximum radium-226 concentration was 2,730 Bq/kg in a sample taken from the slag storage area.

Thirteen metals were detected in at least 50% of samples analyzed: aluminum, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, vanadium, and zinc. These were all detected below the respective CVs.

One study examined on-site road materials that were constructed from the slag. This study collected two samples of roadbed material at a depth of 1 foot and another at a depth of 4 feet (Weston 1993). All of these samples were obtained from the roadway along the western border of the site. These samples were analyzed for metals, cyanide, fluoride, total phosphorus, and radionuclides. The findings are summarized below:

- The road samples contained arsenic at concentrations ranging from 0.54 to 4.1 ppm, which are above ATSDR's CV.
- Several other metals were detected at higher concentrations in some or all of the road samples when compared with the slag samples discussed previously. All three road samples contained elevated concentrations of calcium (113,000–128,000 ppm), magnesium (1,670–1,870 ppm), potassium (862–2,340 ppm), selenium (0.98–2.8 ppm),

and sodium (1,610–1,990 ppm). In addition, the 4-foot sample contained higher concentrations of mercury (0.14 ppm), thallium (1.3 ppm), and zinc (281 ppm). Finally, one of the 1-foot samples and the 4-foot sample contained between 1.5 and 1.6 ppm silver. The remaining metals, as well as the cyanide, fluoride, and total phosphorus concentrations were within the ranges detected for the slag.

- The gross beta radiation levels detected in the road materials were above those detected in the slag sample discussed previously. These levels ranged from 7,220 to 7,896 becquerels/kilogram (Bq/kg). The gross alpha radiation and radium-226 levels were below those of the slag samples.

- The road materials were also sampled for radon-222 (1,140–1,200 Bq/kg) and polonium-210 (818–1,820 Bq/kg). The polonium-210 concentrations exceeded ATSDR's CV (210 Bq/kg).

C.1.1.3. Surface Soil

The following soil sampling programs were conducted as part of site investigations and include analyses of on-site surface soils material taken from locations around the site. These data exclude soils previously discussed (those taken from the former ponds, from dredged pond material, and samples obtained from the slag pits and slag storage area). Figure 1 in Appendix A shows the layout of the Stauffer site. Not all of the samples obtained for each study were analyzed for the same contaminants.

- In January 1988, NUS Corporation collected one surface soil sample from a wooded area on the northeast property. This sample was used to establish background surface soil conditions and analyzed for EPA CLP organics and inorganics (NUS 1989).

- In April 1989, NUS Corporation collected an additional two surface soil samples from the wooded area on the northeast property. These samples were used to establish background surface soil conditions and were analyzed for aluminum, calcium, chromium, iron, lead, and manganese (NUS 1991).

- In November 1989, PBS&J conducted a radiologic evaluation of the site. PBS&J performed an EGR survey of several areas of the site. In addition, six surface soils were analyzed for the presence of radium-226 (PBS&J 1990). This study is documented as part of the *Site Soil Characterization Study* (Weston 1990b).

- Between December 1989 and April 1990, Weston was contracted to perform soil sampling activities at the site. Fifty-two surface soil samples from various locations on the site were analyzed for arsenic, cadmium, chromium, lead, cyanide, fluoride, chloride, and total phosphorus. Twenty-three surface soils were analyzed for radium-226 and 16 were analyzed for VOCs, SVOCs, pesticides, and PCBs (Weston 1990a). This study is documented as part of the *Site Soil Characterization Study* (Weston 1990b).

- In September 1990, Weston performed additional sampling of three surface soils from one location previously sampled in December 1989. These samples were analyzed for radium-226 (Weston 1990c).

- In March 1993, Weston analyzed seven surface soil samples for TCL VOCs and SVOCs; 12 samples for TCL pesticides and PCBs; 14 samples for TAL metals; 18 samples for cyanide, fluoride, total phosphorus; and one sample for radionuclides. This sampling was performed as part of the RI (Weston 1993).

- In September 1997, Parsons conducted a study to determine the extent of contaminant leaching from soil and slag in the slag storage area. Six surface soil samples were obtained from three areas of the site and analyzed for the TAL metals, other inorganics, and radionuclides. Three of these samples were also analyzed by the SALP protocol (Parsons 1997).

- In May 1999, Parsons conducted sampling of 18 surface soils from various undisturbed locations on the site to establish background concentrations of arsenic and beryllium (Parsons 1999).

Table 4 in Appendix B presents a summary of the on-site surface soil data. Thirteen contaminants exceeded their respective CVs in the surface soils: benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, dibenzo[a,h]anthracene, indeno[1,2,3-cd]pyrene, antimony, arsenic, cadmium, iron, thallium, vanadium, fluoride, and radium-226. One sample from the southeast property was also analyzed for polonium-210, which exceeded the CV. The maximum concentrations found in the other on-site surface soils were primarily from parts of the main production area and the northeast property. Interestingly, two of the samples with maximum contaminant concentrations were from undisturbed portions of the site and were intended to establish background concentrations of contaminants in the on-site surface soils.

The main contaminants of concern were arsenic, cadmium, thallium, fluoride, and total phosphorus. These include contaminants that were detected most frequently above ATSDR CVs and/or by the greatest margin (e.g., arsenic, cadmium, and thallium), as well as those associated with site operations (e.g., fluoride, total phosphorus) in the on-site surface soils .

Highlights of the Table 4 data summary follow:

- Ten VOCs were detected in at least one of the 22 samples analyzed; none of these concentrations exceeded the ATSDR CV. Methylene chloride was the only VOC detected in more than 50 % of the samples.
- Twenty-nine SVOCs were detected in at least 1 of the 24 samples analyzed for various SVOCs. Two locations within the main production area and one location in the northeast property consistently showed concentrations exceeding the CV for the following contaminants: benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, dibenzo[a,h]anthracene, and indeno[1,2,3-cd]pyrene.

- Benzo[a]anthracene was detected at concentrations above the CV (0.87 ppm) in four of the samples. The maximum concentration was 2.9 ppm in a sample collected from the eastern portion of the main production area of the site (near the railroad track). Another sample from the same location also slightly exceeded the CV (0.88 ppm). The remaining two surface soil samples that contained elevated concentrations of this contaminant were collected from the main production area (between the water tower and railroad track) and northeast property (near pond 39).

- Benzo[a]pyrene was detected at concentrations exceeding the CV in six surface soil samples and indeno[1,2,3-cd]anthracene exceeded the CV in four samples. The maximum concentrations were 2.7 ppm benzo[a]pyrene and 3.1 ppm indeno[1,2,3-cd]anthracene. Both of these maximum concentrations were in one sample from the main production area (between the water tower and railroad track).

- The CV was exceeded for benzo[b]fluoranthene in four samples. The maximum concentration was 4.3 ppm. Dibenzo[a,h]anthracene was detected in only 3 of the 23 samples that were analyzed; however, all three of these samples contained concentrations that exceeded the CV. The maximum concentration was 0.34 ppm. Both of these maximum concentrations were found in a sample from the northeast property (near pond 39).

- Five pesticides/PCBs were detected in the 28 samples analyzed; however, each of these contaminants was found in less than 25% of these samples. The most frequently detected contaminant was a pesticide (p,p-DDT), detected in six of the samples. The maximum concentration was 0.013 ppm obtained in a composite surface soil sample taken from the eastern portion of the northeast property. The maximum concentration of p,p-DDT is well below the CV (2 ppm).

- Ninety-one samples were analyzed for various metals. Antimony was detected above the ATSDR CV in four of 21 samples analyzed for this contaminant. The maximum value was 48.9 ppm in a surface soil sample from the main production area of the site (near the railroad track between the clarifier and the road along the western border). Another sample from this same location also had an elevated concentration of 32.3 ppm. The remaining two samples with antimony concentrations above the CV were taken from the main production area (between K.V.A. substation and pond 42) and the northeast property (near pond 39).

- Arsenic was detected above the CV in 30 of 91 samples. The maximum concentration detected was 140 ppm in soil from an area near pond 39 in the northeast property. This sample also showed the maximum concentration found for cadmium (59 ppm), which also exceeded the CV. Cadmium was detected in 45 of the 73 samples; seven of these samples showed concentrations above the CV. The mean detected concentration for cadmium was 8.0 ppm.

- Only two samples were obtained in which arsenic was detected at concentrations below the CV (arsenic was not detected in 59 samples). These two samples were both taken from a relatively unused location in the northeastern portion of the main production area. Both of these samples were analyzed to determine background concentrations of arsenic in the surface soils on-site. The mean detected concentration for arsenic was 20 ppm.

- Iron was detected in all 17 samples analyzed for iron. Concentrations in two of these samples exceeded the CV for iron (23,000 ppm) and came from the surface soils in the main production area (one between K.V.A. substation and pond 42 and one between the clarifier and the road along the western border). Both of these samples showed similar concentrations that were the highest detected (between 42,900 and 44,800 ppm).

- Thallium was detected in 9 of 21 samples analyzed for this metal; four the samples had concentrations exceeding the ATSDR CV (4 ppm). The maximum detected concentration was 15 ppm; this concentration was found in the northeast property near pond 39. The remaining three samples containing elevated concentrations of thallium were obtained from the main production area (near the railroad tracks between the clarifier and the road along the western border) and the northeast property. The mean detected concentration of thallium was 6.4 ppm.

- Vanadium was detected in all 15 samples analyzed. The maximum concentration was found in a surface soil sample from the main production area (between the clarifier and the road along the western border); this concentration slightly exceeded the CV (200 ppm). The maximum concentration of vanadium was 252 ppm.

- Fluoride was detected in 75 of 77 samples analyzed for this contaminant. Only one of these had a concentration that exceeded the ATSDR CV. The maximum concentration (4,230 ppm) was found in a surface soil sample from a central location in the main production area of the site. The mean detected concentration of fluoride was 474 ppm.

- Seventy-six samples were analyzed and contained phosphorus (as total phosphorus). The maximum concentration of total phosphorus was 84,800 ppm in surface soils taken from the eastern portion of the main production area of the site (near railroad track). The mean detected concentration of total phosphorus was 24,600 ppm.

- Seven samples were analyzed for gross alpha and beta radiation. These samples showed concentrations of between 77 and 29,800 Bq/kg gross alpha radiation and between 67 and 17,800 Bq/kg gross beta radiation.

- All 39 samples analyzed for radium-226 had concentrations exceeding the CV. The maximum radium-226 concentration was 1,813 Bq/kg in a sample taken in December 1989 from an area in the northwestern portion of the main production area. A subsequent sampling effort obtained three more samples from this location less than a year later (Weston 1990c). The radium-226 concentrations in the 1990 sampling were significantly less, ranging from 67 to 100 Bq/kg.

- One sample from along the southwestern corner of the site (in the southeast property) was also analyzed for polonium-210 and radon-222 (this was the only on-site surface soil analyzed for these radionuclides). The polonium-210 concentration (7,522 Bq/kg) greatly exceeded the CV (200 ppm).

The following SVOCs and metals were detected in at least 50% of the samples, although the concentrations did not exceed the CV: benzoic acid, chrysene, di-n-butyl phthalate, fluoranthene, pyrene, aluminum, barium, beryllium, chromium, cobalt, copper, lead, manganese, nickel, selenium, and zinc.

C.1.1.4. Subsurface Soil

The following soil sampling programs were conducted as part of site investigations and include analyses of on-site subsurface soils taken from several locations around the site. These data exclude soils previously discussed (those taken from the former ponds, dredged pond material, and surface soils obtained from the slag pits and slag storage area). Figure 1 in Appendix A shows the layout of the SCC site. Not all of the samples obtained for each study were analyzed for the same contaminants.

- In January 1988, NUS Corporation collected 18 subsurface soil samples from several locations on the site. These samples were analyzed for EPA CLP organics and inorganics (NUS 1989).

- In November 1989, PBS&J conducted a radiologic evaluation of the site. PBS&J performed an EGR survey of several areas of the site. In addition, 12 subsurface soil samples were analyzed for radium-226 (PBS&J 1990). Samples were collected from two depths at six areas of the site. This study is documented as part of the *Site Soil Characterization Study* (Weston 1990b).

- Between December 1989 and April 1990, Weston was contracted to perform soil sampling activities at the site. Fifty-one subsurface soil samples from various locations on-site were analyzed for radium-226 (Weston 1990a). This study is documented as part of the *Site Soil Characterization Study* (Weston 1990b).

- In September 1990, Weston performed additional sampling of 35 subsurface soils from various locations previously sampled in December 1989. These samples were analyzed for arsenic, cadmium, chromium, lead, cyanide, fluoride, chloride, and total phosphorus. Thirteen samples were analyzed for radium-226 (Weston 1990c).

- In March 1993, Weston analyzed two subsurface soil samples for TCL VOCs, SVOCs, pesticides, and PCBs; eight samples for TAL metals, as well as cyanide, fluoride, and total phosphorus; and one sample for radionuclides. This sampling was performed as part of the RI (Weston 1993).

- In September 1997, Parsons conducted a study to determine the extent of contaminant leaching from soil and slag in the slag storage area. Eighteen subsurface soil samples were obtained from several areas of the site, including the slag storage area. These were analyzed for the TAL metals, other inorganics, and radionuclides. Three of these samples were also analyzed by the SALP protocol (Parsons 1997).

Five contaminants exceeded their respective CVs in the subsurface soils: antimony, arsenic, cadmium, thallium, and fluoride. More specific findings of the subsurface soil sampling are presented below:

- One subsurface soil sample taken from the saturated zone of a wooded area in the northeast property showed a slightly higher concentration of toluene (0.066 ppm, based on presumptive evidence) than the maximum measured in any of the surface soils; however, it is significantly less than the ATSDR CV for toluene (1,000 ppm).

- Two locations showed antimony concentrations that slightly exceeded the CV (20 ppm) at depths of 1.5 and 8 feet. The concentrations ranged from 22.6 to 29.3 ppm and were located near ponds 42 and 39, respectively.

- Nineteen subsurface soil samples of the 79 analyzed contained arsenic at a concentration exceeding the CV. The highest measured subsurface concentrations slightly exceeded the maximum surface soil concentration and ranged from 146 to 160 ppm. These were obtained from depths of 1.5 and 4 feet in areas near pond 39, as well as between the clarifier and the road along the western border of the property.

- Four subsurface soils contained concentrations of cadmium that exceeded the CV. These concentrations ranged from 18.6 to 78 ppm. Two of these samples contained concentrations that exceed the maximum surface soil concentration. The samples were obtained from the northeast property, near pond 39.

- One subsurface soil sample contained a concentration of magnesium that was slightly higher than the maximum surface soil concentration. This sample measured 4,500 ppm at a depth of 4 feet and was from an area between the clarifier and the road along the western border of the property. This same sample also contained a higher concentration of mercury (1.1 ppm, based on presumptive evidence); however, this concentration is well below the CV for mercury (20 ppm).

- The CV for thallium was exceeded in five subsurface soil samples taken from the main production area between the K.V.A. substation (depth: 6 feet), south of pond 42 (depth: 8 feet), and in the northeast property near pond 39 (depth: 1.5 feet). The northeast property samples contained thallium concentrations (between 15.9 and 18 ppm) that slightly exceeded the maximum surface soil concentration.

- Two subsurface samples contained fluoride concentrations that exceeded the CV and the maximum concentration measured for surface soils. These samples were both taken at a depth of 4 feet. One sample was obtained from an area between the clarifier and the road along the western border and measured 260,000 ppm fluoride. The other sample was from the wooded area in the northeast property and measured 19,000 ppm (this sample was obtained to establish background concentrations in the subsurface soils).

Other metals tested were either not detected or detected at concentrations within the ranges generally found in site surface soils. Virtually all of the subsurface soils showed low concentrations (less than their CVs) of VOCs, SVOCs, pesticides, and PCBs.

C.1.2. Groundwater

Many groundwater investigations have been conducted at the Stauffer site over the years. Evaluating the findings of these groundwater investigations provides a better understanding of the nature and extent of groundwater contamination associated with the site, including the vertical and lateral extent of contamination. Although groundwater in the shallow aquifer beneath the site is contaminated with site-related substances (e.g., various metals, fluoride, phosphorus, sulfate, and radiologic contamination), migration off-site and to the deeper aquifer that serves as a drinking water source for some area residents does not appear to be extensive.

Studies in which groundwater was evaluated included:

- *Evaluation of Existing Waste Sludge Lagoon System (hydrogeologic investigation)* (PBS&J 1982).
- *Hydrogeologic investigation (1987)*: to conduct water level and hydraulic conductivity testing to characterize the surficial and Floridan aquifers beneath the site (Seaburn and Robertson 1988).
- *ESI (1989)*: to collect soil and water samples from on-site and off-site locations to support EPA’s completion of HRS documentation. Installed groundwater monitoring wells; performed a land survey and geophysical investigation (NUS 1989).
- *NPL listing site inspection (1991)*: to augment existing data to provide the necessary data for a scoring of the site using the revised HRS (NUS 1991).
- *RI (1993)*: to confirm the results of past investigations and address identified data gaps to delineate the nature and extent of site contamination (Weston 1993).
- *SMC groundwater monitoring program (1987–present).* To monitor seven surficial wells on a semiannual basis.
- *Baseline groundwater evaluation*: to characterize groundwater conditions up gradient (background) and down gradient (toward the river) of source areas (Parsons 1999).

- *Private well sampling (1990, 1997, 1999, and 2001)*: conducted by FDOH in support of its underground storage tank program and/or in response to requests from area residents. Thirty-six nearby wells sampled.

- *Final data evaluation report*: conducted by Black & Veatch Special Projects Corporation (Black & Veatch 2000) to independently assess groundwater contamination migration and impacts.

- *Summary of on-site and off-site groundwater investigations (2001)*: conducted by Flow Science, Inc. to capture key findings of all site-related groundwater studies (Flow 2001).

The scope and findings of these studies are detailed in the remainder of this section. SMC plans to conduct additional groundwater studies that will include expanding the monitoring well network in both the surficial and upper Floridan aquifers and re-evaluating hydrogeologic conditions (see Groundwater Hydrogeology subsection in the Natural Resource Use section) (Parsons 2002).

C.1.2.1. Monitoring Wells

The following groundwater sampling programs were conducted as part of site investigations or routine monitoring by SMC. In general, the objective of each of these programs was to measure the nature and extent of site groundwater contamination, including the potential for off-site migration. Because several sampling events were conducted by different investigators, the designation of the sampling locations has changed over the years. Table 6 in Appendix B describes the well designations used in the various studies. The data summary tables and Figure 5 in Appendix A (monitoring well locations) use the well designations from the RI.

- SMC has had a groundwater monitoring program in place since 1987. As part of this program, SMC has been testing seven surficial monitoring wells (M-1 through M-7). From 1987 through 1990, SMC sampled these wells quarterly; subsequent sampling has been on a semiannual basis. Samples collected as part of this program are analyzed for the following chemical parameters: aluminum, antimony, arsenic, barium, boron, chromium, fluoride, iron, lithium, manganese, nickel, ortho-phosphate, and sulfate. In addition, the following radiologic analyses are conducted: gross alpha and beta, radium-226, radon-222, and polonium-210. SMC submits semiannual reports with monitoring results to the Florida Department of Environmental Regulation (FDER), which oversees this monitoring program. Only samples collected for ortho-phosphate analysis are filtered as is required by the method.

- In January 1988, NUS Corporation collected 26 on-site groundwater samples as part of an ESI. Ten samples were from temporary monitor well boreholes, 4 from newly installed Floridan aquifer wells, 5 from newly installed surficial wells, and 7 from existing wells initially installed by Stauffer as part of the FDER quarterly monitoring requirements. Samples were analyzed for EPA CLP organics and inorganics, as well as radon. In addition to the monitoring wells, one on-site “industrial well” (no. 14) was sampled for metals, cyanide, and fluoride. Samples were also collected from three public wells and three private wells (see below) (NUS 1989).

- In April 1989, NUS Corporation collected an additional 20 groundwater samples, including 16 from existing monitoring wells and 4 from nearby private wells. Samples were analyzed for TCL organics and TAL inorganics (NUS 1991).

- Between March 17 and April 22, 1993, Weston conducted the following groundwater investigation activities as part of the site RI (Weston 1993):

  - Four additional monitoring wells and five temporary well points were constructed in the surficial aquifer.

  - Groundwater samples were collected from the four new monitoring wells, the 11 existing surficial aquifer monitoring wells, and 3 existing Floridan aquifer monitoring wells (April 1993). Groundwater samples collected from the four new wells (MW93-1 through MW93-4) and existing wells (MW-1S, MW-01F, MW-9S, and MW-02F) were analyzed for TCL and TAL parameters. Newly installed well MW93-5 and the remaining monitoring wells (MW-2ES, -4ES, -5ES, -6ES, -7ES, -8ES, -7S, -10S, -3F, and -4F) were analyzed for TAL and radiologic parameters (gross alpha and beta, radon 222, polonium 210, and radium 226). All groundwater samples were analyzed for fluoride, cyanide, and total phosphorus.

  On the basis of findings from the March/April 1993 investigations, the following supplemental groundwater investigation activities occurred:

  - One additional monitoring well and three piezometers were constructed in the surficial aquifer.

  - Groundwater samples were collected from the two background wells, the new monitoring well, and the Floridan aquifer monitoring well across the Anclote River from the site (July 1993).

  - In 1998 and 1999, Parsons implemented a sampling program to establish conditions in the surficial aquifer both up gradient and down gradient (at the shoreline) from the contaminant source areas on-site. Four new surficial aquifer monitoring wells (MW-98-1 through MW-98-4) were installed to expand the existing network of on-site monitoring wells (Parsons 1999). MW-98-2 was installed as a replacement well for MW-93-3. Groundwater samples were analyzed for TAL metals, cyanide, fluoride, total phosphorus, elemental phosphorus, and radiologic parameters (gross alpha and beta, polonium-210, radium-226, and radon-222). The 1998 and 1999 samples were the only samples analyzed for "elemental phosphorus" (using gas chromatography).

Table 7 (surficial aquifer) and Table 8 (Floridan aquifer) in Appendix B summarize groundwater data sampled from on-site monitoring wells and two monitoring wells southwest of the site on the other side of the Anclote River (MW-11S and MW-04F). No potable water supplies currently exist on site; therefore, no one is ingesting or otherwise coming in contact with groundwater beneath the site. Tables 7 and 8 present the range of contaminant concentrations detected in each aquifer during the various sampling rounds. Unless otherwise noted, the number of samples represent a unique sampling event, which includes multiple samples from individual monitoring wells. The tables also compare the maximum detected concentrations to health-based CVs.

Highlights of the groundwater monitoring well data analyses are presented below:

C.1.2.1.1. Shallow Aquifer

- The contaminants most frequently exceeding ATSDR CVS (in greater than 40%–50% of the samples) include arsenic, fluoride, and radon-222. Other contaminants exceeding ATSDR CVS in one or more samples include aluminum, antimony, boron, cadmium, chromium, iron, lead, lithium, manganese, mercury, nickel, selenium, thallium, vanadium, sulfate, gross alpha, and radium-226.

- MW93-3 (south of lagoon 5) and MW-11S were the locations of many of the maximum detected concentrations. MW93-3 appears to be within disposal materials associated with pond 42 and was replaced by MW-98-2 in 1998 (Flow 2001). The elevated hits in MW-11S, detected during the 1988 NUS study, are considered “suspect.” Sample results from subsequent samples of arsenic, fluoride, and phosphorus in this well were 10–100 times lower. Flow (2001) points out that measured concentrations of several contaminants during the 1988 NUS study exceed the highest concentrations recorded in on-site wells during the more than 10 years of groundwater sampling that have followed.

- The highest detected concentration of fluoride (71,000 ppb) was detected in MW-3ES (down gradient of the calcium fluoride deposit). Not surprisingly, calcium concentrations (up to 2,200,000 ppb) were also highest in MW-3ES.

- Total phosphorus concentrations were detected as high as 380,000 ppb down gradient of the lagoons and the calcium fluoride storage areas. “Background” phosphorus concentrations ranged from 25 ppb (MW-7ES) to 900 ppb (also in MW-7ES) (see Attachment A).

- Sulfate, analyzed only as part of the SMC monitoring program, was detected at concentrations above NSDWR in nearly 30% of tested samples. The maximum concentration (2,400,000 ppb) was detected in the MW-7ES (background); this results appears to be anomalous, however—sulfate was detected well below NSDWR in the nearly 40 other samples tested from MW-7ES. Other locations in which sulfate detections exceed NSDWR were primarily MW2-ES on the northeast property and MW-8ES (southeast of the ponds in the main production area).

- Radon-222 was detected at concentrations above its CV (EPA's MCL of 300 pCi/L) in 47% of the samples, with up to 11,600 pCi/L detected in MW-3ES. "Background" concentrations reported in the surficial aquifer were on the order of 1,000 pCi/L.

C.1.2.1.2. Floridan Aquifer

- Because only two Floridan aquifer wells are at or near source areas (MW-2F and MW-3F) and because these wells have only been sampled three times (1988–1993), it is not possible to draw firm conclusions about the groundwater quality in the deeper aquifer.

  Two other Floridan aquifer monitoring wells are in the site area—MW-1F and MW-4F. MW-1F is designated as background and MW-4F is south of the Anclote River. Interestingly, the highest concentration of many of the metals (including arsenic) and gross alpha were detected in MW-4F (1988). However, as mentioned previously, the 1988 NUS data are considered suspect.

- Few detected concentrations of contaminants exceeded ATSDR CVS in tested wells in the Floridan aquifer. Site-related contaminant concentrations were generally lower in the Floridan aquifer compared with the surficial aquifer, although similar concentrations of arsenic and fluoride were reported in nested wells MW-9S and MW-3F, which are on the river shore down gradient of the main production area.

- The highest concentration of radon-222 (2,536 pCi/L) was detected in MW-1F (designated "background").

- One additional Floridan well not included in any of the summary samples is IW-01 (a Stauffer industrial well) was sampled in 1988 for metals, cyanide, and fluoride. All detections were below ATSDR CVS.

To more closely study the possible relationship between site-related contaminants in the surficial and Floridan aquifers, ATSDR looked at the sampling results of the few "nested" wells (i.e., wells in the same location, screened in both the surficial and Floridan aquifers). ATSDR also studied the lateral extent of contamination by evaluating groundwater quality in perimeter wells (east, west, and south of source areas) and in the wells designated "background" (i.e., to the north/northeast of source areas). The contaminants in these wells that were selected for further analysis were arsenic, lead, fluoride, and phosphorus. Arsenic and lead were selected because these were the two of the few constituents elevated in off-site private wells (see below). Fluoride and phosphorus were selected because they are site-related contaminants.

Generally, the sampling data alone are inadequate (too few samples and too little coverage) to demonstrate the lack of a connection between the surficial and Floridan aquifer. The ability to evaluate the possible extent of contamination migration toward the east (toward private wells) is also limited by the coverage and number of samples. MW-3F is the only well screened in the Floridan aquifer along the entire east/southeast perimeter of the site. Although SMC concluded that little if any contamination is migrating to the deeper aquifer and that the predominant groundwater flow direction is to the south/southwest, some uncertainty exists about the vertical and lateral extent of contamination. The upcoming groundwater studies are intended to fill such data gaps.

Results from the monitoring wells on the eastern perimeter of the site (MW93-2 and MW-10S/MW-3F) do indicate generally lower arsenic concentrations than those detected at or down gradient of source areas (and are comparable to arsenic background). The highest concentration of lead at the site perimeter was 57 ppb at MW93-2. Lead was detected as high as 680 ppb at or near source areas. The highest concentration of fluoride along the site perimeter was also detected in MW93-2, at 6,800 ppb; fluoride was detected up to 71,000 ppb in the main production area. MW93-2 was sampled only one time—during the RI in 1993. Total phosphorus concentrations in perimeter wells ranged from 790 to 3,000 ppb. A one-time high of 10,900 ppb total phosphorus was recorded in MW-9S (in 1993). Again, total phosphorus was detected as high as 380,000 ppb in the plant production areas (MW-8ES); total phosphorus concentrations ranged between 37 and 1,800 ppb in background wells

C.1.2.2. Plant Water Supply Wells

Sampling of the SCC facility's water supply wells was conducted periodically from 1948 to 1982 by SCC. The contaminant data for these wells are discussed in the Environmental Contamination and Other Hazards section of this document.

C.2. Off-Site Contamination

C.2.1. Soil

Several studies investigated soils, as well as road and building materials, off of the SCC site. All of the areas are accessible to the public and include public roads, private residences, schools, a recreation complex, a government building, and commercial facilities. Not all of the samples obtained for each study were analyzed for the same contaminants.

- In April 1989, NUS Corporation collected two surface soil samples from areas in front of and behind Gulfside Elementary School. These samples were analyzed for aluminum, calcium, chromium, iron, lead, and manganese (NUS 1991).

- In November 1989, PBS&J conducted a radiologic evaluation of the site. As part of this evaluation, PBS&J performed an EGR survey of a commercial property across the southeastern fence line. In addition, one surface soil sample and two subsurface samples from this location were analyzed for the presence of radium-226 (PBS&J 1990). This study is documented as part of the *Site Soil Characterization Study* (Weston 1990b).

- In July 1993, Weston analyzed four surface soil samples obtained from the Gulfside Elementary School for TAL metals, cyanide, fluoride, total phosphorus, and radionuclides. This sampling was performed as part of the RI (Weston 1993).

- In February 1996, Weston conducted additional surface soil sampling of soils around Gulfside Elementary School as part of the RI. Ten surface soil samples were analyzed for TAL metals, cyanide, fluoride, and total phosphorus. Twelve samples were analyzed for radionuclides (Weston 1996).

- Between July and August 1997, Evans Environmental & Geological Science and Management, Inc. (EE&G) conducted surface soil sampling at Gulfside Elementary School to determine baseline phosphorus concentrations and pH levels at the school. Fourteen surface soil samples from six locations around the school were analyzed for ortho-phosphorus and total phosphorus. Twenty surface soil samples (coinciding with the Weston 1996 sampling locations) were analyzed for the presence of asbestos (EE&G 1997a).

- In September 1997, EE&G conducted additional sampling of construction materials used at Gulfside Elementary School that were believed to contain slag from the Stauffer site. In this study, four soil samples from beneath roadways around the school property were analyzed for radionuclides. In addition to these, samples of the roofing material and asphalt were also analyzed for radionuclides (EE&G 1997b).

- Between July 1997 and March 1998, the FDOH Bureau of Radiation Control conducted investigations at 25 off-site locations in the surrounding community in response to citizen concerns about the existence of slag material in their buildings and/or driveways. These locations consisted of residences, commercial properties, a recreational complex, and a school (not Gulfside Elementary School). Most of these investigations involved examination of EGR emitted from the materials. Soil, driveway, and roadway materials from two locations were also sampled for radium-226 (FDOH 2002).

- In July 1998, EPA Region 4 conducted a survey of several materials containing slag located off-site. As part of this study, one sample from the on-site slag pile was taken for the purposes of microscopically fingerprinting the community slag materials to the SCC slag. Twenty-five off-site samples were analyzed for the following metals and other inorganics: aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, zinc, and radium-226 (EPA 1999a).

- In May 1999, Parsons conducted sampling of five surface soils from off-site fill material suppliers. These samples were analyzed for arsenic and beryllium to determine the feasibility of using these soils for future remediation activities on the site. (Parsons 1999).

C.2.1.1. Gulfside Elementary School

Table 11 in Appendix B presents a summary of the surface soils analyzed from Gulfside Elementary School. Samples were analyzed for metals, other inorganics, radionuclides, and asbestos. Highlights of the Gulfside Elementary School data summary are presented below:

- Arsenic slightly exceeded the CV (0.5 ppm) in 1 sample of the 14 analyzed. This sample was obtained from the front yard of the school and measured 0.6 ppm arsenic. Another eight samples showed concentrations of arsenic below the CV, ranging from 0.13 to 0.43 ppm.

- Ortho-phosphorus was detected in only 2 samples of 14 analyzed. These samples were obtained from the side of the school building/patio and the back fields, measuring 6.9 and 7.3 ppm ortho-phosphorus, respectively.

- Radium-226 was measured above the CV (5.4 Bq/kg) in all 15 samples analyzed. The maximum concentration was detected in the front yard sample and measured 59.2 Bq/kg. The asphalt on the roads around the school, as well as the roofing material, also contained radium-226 above the CV, as did the soils beneath the roads. The concentrations in the asphalt, roofing material, and soils were 6.7, 12, and between 45.5 and 73.6 Bq/kg, respectively.

- The soils beneath the roads also showed higher concentrations of radon-222 when compared with the maximum SCC surface soil concentration. These concentrations ranged from 73.3 to 77.0 Bq/kg.

- The Gulfside Elementary School building materials sampled (e.g., asphalt, roofing material) contained far lower concentrations of the contaminants found in the on-site slag material.

C.2.1.2. Other Off-Site Soils

Several other locations in the community surrounding the SCC site were examined, mostly in response to citizen concerns that slag material was used in the construction of their homes, driveways, and roadways. Highlights of the off-site data summary are presented below:

- The surface soil from six locations in July 1998 contained concentrations of arsenic that were higher than the CV, ranging from 0.612 to 4.85 ppm. Arsenic was detected in 26 of the 31 samples analyzed. The highest concentrations were in the pavement and road base materials of Bluff Boulevard. The Bluff Boulevard arsenic concentrations were similar to the maximum concentrations in the on-site slag material. The remaining metals analyzed in this study all were below the respective CVS (EPA 1999a).

- In May 1999, five off-site locations that store fill material used by several surrounding communities were sampled for arsenic and beryllium. Arsenic was not detected in any of the samples. Beryllium was detected in four of the samples, with concentrations ranging from 0.08 to 0.14 ppm (Parsons 1999). The purpose of this study was to determine the feasibility of using these resources in future site remediation activities.

- All 29 samples analyzed for radium-226 showed concentrations above the CV, ranging from 8.29 to 2,600 Bq/kg. These concentrations were all below the maximum in the on-site slag material. The maximum concentrations were found in road material obtained from Bluff Boulevard and Gulfview Road. No other radionuclide was analyzed for off-site soils or building materials.

- Several other contaminants exceeded the maximum concentrations found in the slag material at the Stauffer site. These contaminants include aluminum, antimony, barium, cobalt, copper, mercury, selenium, silver, thallium, and vanadium. All of the off-site samples contained concentrations of these contaminants below their respective CVS. Several of the maximum concentrations were from the pavement and/or roadbed materials used on Bluff Boulevard, Anclote Road, and Gulfview Road. Other samples with relatively high concentrations were from residential slab and driveway materials.

C.2.2. Groundwater

C.2.2.1. Private Wells (Off-Site)

Thirty-eight private wells (residential, commercial, and irrigation) have been sampled in the Stauffer site area since 1988. These sampling events consisted of the following:

- NUS Corporation collected six off-site groundwater samples as part of EPA's ESI in 1988. These samples were from private and public wells within a 4-mile radius of SCC (NUS 1989). Samples were analyzed for metals, cyanide, fluoride, gross alpha and beta radiation, and radon-222.

- The FDOH/Pinellas County Health Department collected and analyzed samples from private wells near the site in 1990, 1997, 1999, 2000, and 2001. Sampling was triggered in combination by Florida's SuperAct Underground Storage Tank Program and individual resident requests for follow-up sampling. Most samples were analyzed for selected VOCs/SVOCs (methyl tertiary-butyl ether, naphthalene, bis(2-ethyl hexyl)phthalate, and chloroform), metals, fluoride, chloride, sulfate, nitrate/nitrite, and radiologic parameters (gross alpha and beta radiation, radium-226, and radium-228).

The sampling data for the residential, commercial, and irrigation wells is summarized are Tables 13, 14, and 15 (Appendix B), respectively. Specific findings from the private well sampling events are highlighted below.

C.2.2.1.1. Residential Wells

- Trace concentrations of VOCs and SVOCs were detected in residential wells, with only bis(2-ethylhexyl)phthalate (detected up to 7.6 ppb) exceeding its ATSDR CV (3 ppb).

- Of the metals detected above ATSDR CVS, arsenic and lead were the most frequently detected. The remaining metals were detected at concentrations below or within the same order of magnitude of CVS.

- Arsenic was detected below its enforceable drinking water standard (10 ppb) in all but one sample with a concentration of 24 ppb (well 16, northwest of the site). All reported concentrations exceeded ATSDR's CREG for arsenic (0.02 ppb). Background concentrations of arsenic have not been well defined in the Floridan aquifer. The only up gradient monitoring well in the deeper aquifer (MW-1F) showed arsenic as "not detected" (less than 1.2 ppb) during the RI. Earlier samples from that well (1988 and 1989) also indicate no detection of arsenic, but detection limits are not reported.

- Lead was detected in 24 of the 38 samples, but only 4 samples had concentrations exceeding the CV for lead. The highest detected concentration (270 ppb) was detected in a well south of the river (well 14). The same well was tested four other times within a year's time, with lead reported at concentrations between 1.2 and 4.6 ppb. The next highest concentration (160 ppb) was detected in another well south of the river (well 10), but the well was sampled only once. Other wells tested on the same street, however, had lead concentrations ranging from 0.12 to 4.6 ppb. The remaining two samples only slightly exceeded the CV for lead.

- Only 1 of the 36 samples tested detected radiologic contamination exceeding an ATSDR CV. Gross alpha radiation was detected in 2000 sampling at 26.2 ± 5 pCi/L in well 11 south of the Anclote River.

C.2.2.1.2. Commercial Wells

- Trace concentrations of VOCs and SVOCs were detected in potable wells; only bis(2-ethylhexyl)phthalate (detected up to 4.4 ppb) exceeded its ATSDR CV (3 ppb) in one commercial well east of the site (well 3).

- Arsenic was the only metal detected at concentrations that consistently exceeded its CV. However, arsenic was only detected in two samples at concentrations exceeding its drinking water standard—both from wells east of the site (wells 2 and 8). In one of these wells, arsenic was reported at 8.9 and 9 ppb during two other sampling events in the same well. The other well was sampled just once.

- Other inorganics exceeded CVS in only one or two samples (iron, nickel, thallium, zinc, chloride, and sulfate) and at concentrations less than 3 times the CV.
- Gross alpha radiation and radium-226 were detected in two samples (wells 7 and 2, respectively) at concentrations slightly exceeding their respective CVS.
- Sulfate was detected at concentrations above its CV (250,000 ppb) in two samples. Detected concentrations of 270,000 and 650,000 ppb were found in wells 3 and 27, respectively. Only 1990 and 1997 samples were analyzed for sulfate.

C.2.2.1.3. Irrigation Wells

- No VOCs or SVOCs were detected in irrigation wells.
- Of the eight irrigation wells sampled, arsenic concentrations in six samples (maximum detected concentration reported at 4.4 ppb) exceeded the ATSDR CV.
- Only two other inorganics exceeded their respective CVS (zinc and chloride) by less than two times.
- No radiologic parameters exceeded CVS in the irrigation wells tested. Natural uranium was analyzed for in two irrigation wells and detected at a maximum concentration of 0.3 ± 0.5 pCi/L, which is substantially below the CV.[2]

C.2.3. Surface Water (Anclote River)

For the past 15 years, the surface water around the SCC site has been monitored and tested to establish whether the site has adversely affected the quality of the water in the Anclote River. Two discrete studies were conducted as a part of site investigations in addition to ongoing semiannual monitoring conducted by SMC. Although most of the surface water was sampled from the Anclote River upstream, adjacent to, or downstream of the site, one sample was taken from a tidal lagoon adjacent to the site on the southeast shoreline (SW-05; NUS 1989). Because sampling events were conducted by different investigators, multiple sampling location designations were used over the years. Table 24 in Appendix B describes the location designations used in compiling data from the different studies. Figure 7, Appendix A shows approximate surface water sampling locations from the various studies.

- *Final ESI (NUS 1989).* The purpose of the ESI was to collect soil and water samples from both on-site and off-site locations to obtain the data necessary to support EPA's completion of HRS documentation.

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[2] Reported as "natural uranium." ATSDR used the CV for uranium, as reported in the Final Rule for National Primary Drinking Water Regulations: Radionuclides (December 2000). MCL is 30 ppb, which "typically" corresponds to 27 pCi/L.

NUS Corporation collected and analyzed seven surface water samples from the Anclote River. Two samples were taken upstream of the site, two adjacent to the site (including one from a tidal pond connected to the Anclote River by a culvert), one in Meyers Cove, and two downstream of the site. The far upstream and downstream samples were taken to evaluate the background concentrations in the river and the Gulf of Mexico. Each sample was tested for metals, fluoride, and phosphorus concentrations.

According to investigators, the only contamination attributable to the site discovered from any of the samples was in the tidal pond (sampling location SW-05). The pond is adjacent to the site at the dredge disposal area. The location showed elevated concentrations of barium, chromium, lead, fluoride, and phosphorus (NUS 1989).

- *RI (Weston 1993).* The RI was undertaken by Weston in 1993 to confirm the results of past investigations and address specific data gaps to more fully determine the nature and extent of site contamination. From March 29 to April 4, 1993, 18 samples were collected at 12 locations ("transects" were taken at 3 of the locations) to further evaluate surface water conditions. The samples were taken from two depths (0.3 meters below the surface and 1 meter above the bottom) and pooled to avoid the surface microlayer, depths prone to contamination by sediment resuspension, and freshwater lenses. Of the 12 sample locations, 5 were upstream of the site, 2 adjacent to the site, and 5 downstream of the site. The transect samples were collected upstream of the site, adjacent to the site, and in Meyers Cove. Each transect was made up of three samples taken from the shore outward; the samples were designated A, B, and C, with A being closest to the shore.

  All samples were taken at low tide and analyzed for TAL metals, fluoride, and phosphate-phosphorus. Three samples (SW-1, 7B, and 11) were also analyzed for TCL analytes including VOCs, SVOCs, and pesticides. In addition, a profile of conductivity, temperature, and depth (CTD) was taken to evaluate vertical mixing.

  Weston (1993) concluded that surface water contaminant concentrations measured during the RI were consistently lower than those measured during the ESI or in the SMC monitoring discussed below; Weston attributes these differences to differences in sampling procedures. Both the ESI (NUS 1989) and SMC semiannual investigations test water on the surface, whereas the RI intended to avoid the surface and freshwater lenses by averaging samples from two depths to achieve a more representative sample and avoid concentrations of contaminants on the surface.

- *Ongoing Surficial Groundwater Monitoring Program (SMC 1987 to present).* Since 1987, SMC has sampled two locations in the Anclote River—one just upstream of the site and one in Meyers Cove. From 1987 to 1990 SMC sampled quarterly; subsequent sampling has been semiannually. This sampling is conducted in conjunction with SMC's on-site groundwater monitoring program.

  The river samples are taken at low tide upstream of the site (roughly in line with the southeastern property line approximately 75 to 100 feet from shore) and downstream (in

Meyers Cove, generally taken downstream of the calcium fluoride sludge ponds, 75 to 150 feet off the north shoreline). This sample has been included with "Meyers Cove" samples in ERG's analysis. Field measurements of temperature, water level, pH, and conductivity are taken in addition to laboratory analysis of metals, fluoride, sulfate, phosphorus, and radiologic parameters. SMC collected samples in conformance with FDEP-approved Comprehensive Quality Assurance Plan. Samples are taken biannually, once in January or February and again in July or August.

Tables 16, 17, 18, and 19 in Appendix B contain the combined surface water data for the Anclote River system (upstream of the site, adjacent to the site, Meyers Cove, and downstream of the site, respectively) from all of the above-mentioned studies. These tables list the results for substances (chemical and radiologic) that were detected at least once. ATSDR compared all measured values of contaminants in surface water with available CVS for drinking water. The use of drinking water CVS serves as a very conservative approach to screening surface water contaminants. As noted before, the Anclote River is not used as a source of drinking water, although it contains popular fishing, boating, and swimming areas.

The sampling results revealed the following:

- Of the chemical and radiologic parameters tested, only antimony, arsenic, boron, chromium, iron, lead, thallium, vanadium, fluoride, sulfate, gross alpha, and gross beta, and radium-226 were detected at concentrations that exceeded available CVS (each to varying degrees). Phosphorus/phosphate and polonium-210 (tested in upstream and Meyers Cove only) were also detected, but no CVS are available.

  Calcium, magnesium, potassium, and sodium detected throughout the areas of the river tested at generally consistent concentrations. These are naturally occurring elements and essential nutrients and their presence at detected concentrations in an estuarine system would be expected. Therefore, no further discussion of these substances is provided in this section.

- Organic compounds do not appear to be an issue in the river, although only three samples were tested for organics (during the RI). Only trace concentrations of acetone and toluene, which are common laboratory contaminants, were detected.

- No distinct contamination patterns were observed across upstream, adjacent, Meyers Cove, and downstream areas. The following trends are notable:

  - *Upstream areas.* As shown in Table 16, most substances were detected at concentrations well below CVS, with the exception of antimony, arsenic, boron, fluoride, sulfate, gross alpha and beta radiation, and radium-226—where maximum detected concentrations exceeded CVS by approximately 10 to 300 times.

  - Because one of the SMC data points was directly upstream of the site, many of the upstream samples and maximum detected concentrations are from the SMC data set. It is possible that the site had a greater influence on this location than on other upstream locations.

- *Areas adjacent to Stauffer.* Table 17 summarizes the concentrations of the various contaminants detected adjacent to the Stauffer site. Data represent surface water conditions in 1988 and 1993 only. No samples were taken directly adjacent to the site by the SMC during its semiannual surface water monitoring. As a result, only six sampling locations are considered in this grouping. CVS were exceeded for arsenic, chromium, iron, lead, vanadium, fluoride, and gross alpha and beta radiation. With the exception of fluoride, the maximum concentration for each of these contaminants was detected in the tidal lagoon adjacent to the site.

- *Meyers Cove*. Table 18 in Appendix B summarizes the concentrations of the contaminants detected in Meyers Cove. The SMC semiannual monitoring program took a sample just downstream of the site in Meyers Cove on a semiannual basis and, as a result, much of the Meyers Cove data are SMC data. Water collected in Meyers Cove exceed CVS for antimony, arsenic, boron, iron, fluoride, sulfate, and gross alpha and beta radiation. Detected concentrations in Meyers Cove appear to be generally consistent with those reported upstream. Note that this comparison becomes largely a comparison of SMC's "upstream" and "downstream" samples.

- *Downstream areas.* Table 19 in Appendix B summarizes the concentrations of the contaminants detected downstream of Meyers Cove. A total of nine samples, collected in 1988 and 1993, comprise the downstream grouping. The only CV exceedances were for arsenic and thallium, both detected in 1988 samples. The available data suggest that the site has not affected the water quality further down river. No sampling of downstream areas are available, however, after the RI sampling in 1993.

An elaboration of substance-specific trends in the aforementioned areas is presented below:

- *Antimony* exceeded its CV (4 ppb) in 5 of 46 samples upstream (up to 850 ppb) and 8 of 52 samples in Meyers Cove, at concentrations up to 860 ppb.

- *Arsenic* was detected at concentrations exceeding its CV in a portion of samples collected throughout the river. The maximum detected concentration was an "estimated" measurement of 500 ppb from a downstream sample analyzed in 1988; however, this was the only detection in the nine samples tested downstream. Arsenic was detected more frequently in Meyers Cove (10 of 52 times), adjacent to the site (5 of 6 times), and upstream (8 of 46 times). The next-highest concentration of 48 ppb (detected in the tidal lagoon adjacent to the site) also represents an estimated value from the 1988 NUS sampling; all other detected arsenic concentrations were below 6 ppb. Many of the SMC measurements for arsenic were "non-detects" (with reported detection limits ranging from 1 to 30 ppb).

- *Boron* exceeded its CV of 600 ppb in all 34 samples taken upstream and all 47 taken in Meyers Cove, with maximum detected concentrations of 5,800 and 4,500 ppb, respectively. Only the SMC sampling included boron analysis; therefore, boron was not analyzed for in any of the samples taken further upstream, adjacent to, or downstream of the site.

- Chromium was detected infrequently throughout the river. It only exceeded its CV (30 ppb) in two samples, one upstream (46 ppb) and one adjacent to the site (80 ppb).

- *Iron* was detected frequently in all stretches of the river. Although detected concentrations in Meyers Cove and adjacent to the site were up to 10 times higher than those detected in upstream or downstream samples, the CV for iron (11,000 ppb) was exceeded just one time in each of these areas (14,000 and 28,000 ppb, respectively).

- *Lead*, detected in approximately half of the 32 samples tested for it in the river, was only detected in one sample (adjacent to the site) at a concentration (150 ppb) exceeding its CV (15 ppb).

- *Thallium* exceeded its CV (0.5 ppb) downstream of the site in the only two samples in which it was detected. The highest detected concentration was an estimated value of 300 ppb from a sample collected in the 1988 NUS ESI. Thallium was sampled in each section of the river, but not measured above the detection limit in any other samples.

- *Vanadium* was detected in only one location adjacent to and one location downstream of the site. The concentration adjacent to the site (370 ppb) only slightly exceeded its CV (260 ppb).

- *Fluoride* was detected throughout the river areas tested and exceeded its CV (4,000 ppb) in approximately half the samples in which it was detected. Detected concentrations did not vary greatly in different portions of the river, although no CV exceedences occurred in downstream samples.

- *Sulfate* was consistently detected at concentrations above its CV (250,000 ppb) in Meyers Cove (45 of 47 samples) and upstream of the site (34 of 34 samples), at maximum detected concentrations of 2,980,000 and 5,200,000 ppb, respectively. Only the SMC sampling included sulfate analysis; therefore, it was not analyzed for in any of the samples taken further upstream, adjacent to, or downstream of the site.

- Of the *radiologic parameters* tested, gross alpha and beta radiation were consistently detected at concentrations above CVS in samples collected throughout the river. Radium-226, analyzed for only in SMC samples collected in Meyers Cove and upstream, exceeded the CV in nearly all samples collected in upstream areas but only once in Meyers Cove. Polonium-210 was also detected in most samples for which it was tested, just upstream of the site and in Meyers Cove.

C.2.4. Sediment (Anclote River)

C.2.4.1. Sediment Data

Four site-related studies included sampling and analysis of sediments from the Anclote River. This section includes a summary of the four major sediment studies conducted to date and their major findings. Because sediment is so closely linked with the surface water, many of the studies sampled surface water and sediment at the same time and from the same locations. As with surface water, because sampling events were conducted by different investigators, multiple sampling location designations were used across studies. Table 25 in Appendix B describes the sample designations used in compiling data from the different studies. Figure 8 in Appendix A shows sediment sample locations.

- *Final ESI (NUS 1989).* The ESI was conducted to provide necessary data for scoring using revised HRS. As part of the ESI, NUS collected 10 sediment samples from the Anclote River and a local drainage ditch.[3] These samples were analyzed for metals, cyanide, fluoride, phosphorus, and gross alpha and beta radiation.

- *Listing Site Inspection (NUS 1991).* The NPL listing site inspection was conducted to obtain additional information to support scoring of the site using the revised HRS. NUS collected 14 sediment samples along the Anclote River on April 17–18, 1989. These samples were analyzed for TCL organics and metals.

- *Sediment Sampling Program (Weston 1991).* Thirteen sediment samples were taken in the Anclote River on April 4–5, 1991, to characterize sediments upstream, adjacent to, and downstream of the site. Five of these samples were collected upstream along the same bank as the site; four adjacent to the site, and four downstream; sample SED 14 was 200 yards downstream of the boat dock adjacent to Pasco County Park. Each sample was analyzed for TAL metals, fluoride, and phosphate-phosphorus.

- *RI (1993).* This study was conducted to confirm the nature and extent of site-related contamination and to fill data gaps. Sediments were collected during two sampling events (March/April 1993 and July 1993) by Spaulding Environmental Associates of Wakefield, Rhode Island. The first sampling event was similar to the previous studies in that it sampled surface sediments. From March 29 to April 4, 1993, 18 samples were taken in the river, at the same location as the surface water samples. Each sample was taken at an interval of 0–2 centimeters and analyzed for fluoride, phosphate-phosphorus, TOC, and grain size. Three samples (SD-1, -7B, and -11) were also analyzed for TAL organic components. The second sampling event occurred from July 26 to 29, 1993, and included twelve 12-inch sediment cores collected in Meyers Cove and other areas adjacent to the

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[3] The "sediment" samples from the local drainage ditch are not included in this section. Rather, these samples were compiled and described in the soil contaminants section.

> site. Samples were taken from four transects 25 to 200 feet from shore. The core samples were analyzed for metals, fluoride, phosphorus, radiologic parameters, and grain size.
>
> Investigators indicated that most elevated metals concentrations were generally associated with higher TOC concentrations and fine-grained sediment—higher concentrations of contaminants were found in finer sediments ("ooze," mud, sandy mud) with high organic content. Fine sediments increased with proximity to Meyers Cove. Fine sediments are generally indicative of a depositional area. If sediments are being deposited, it is likely, but not certain, that contaminants are bound to sediments and are less likely to be resuspended or transported in the tidal cycle. Such an assessment is consistent with the fact that Meyers Cove is protected, shallow, and has low tidal current speeds. Sand dominated all other locations. The bottom sediments were all at least 77% sandy material except at station SD-07A, where the grain size was clay (46%) and silt (44%) (Weston 1993).

Tables 20, 21, 22, and 23 in Appendix B summarize available sediment data from the Anclote River (upstream of the site, adjacent to the site, Meyers Cove, and downstream of the site, respectively). ATSDR examined data from the four separate studies mentioned above and compared measured concentrations of contaminants in sediment with available CVS. As noted previously, because listed CVS are those used for soil and people contact soil more frequently than sediment, CVs serve as a protective screen.

Key findings are highlighted below beginning with trends found across the river and also addressing chemical specific trends where possible:

- Of the chemical and radiologic parameters tested, only arsenic, fluoride, thallium, methylethyl ketone, toluene, radium-226, and polonium-210 were detected at concentrations above their CVS, each to varying degrees. Phosphate-phosphorus, total phosphorus, gross alpha and beta radiation, radon-222, and TOC were also detected in parts of the river but do not have available CVS.
- The following trends are notable in each specific area of the river:
    - *Upstream sediment.* Table 20 in Appendix B summarizes the concentrations of the various substances detected in the sediment upstream of the Stauffer site. In the four investigations, 18 samples were collected, although not all locations were measured for every contaminant. CVS were exceeded only for arsenic and for one fluoride sample.
    - *Adjacent sediment.* Table 21 in Appendix B summarizes the concentrations of the contaminants detected in the 18 sediment samples collected adjacent to the Stauffer site. As with the upstream samples, CVS were only exceeded for arsenic and fluoride (in a single sample).
    - *Meyers Cove sediment.* Table 22 in Appendix B summarizes the concentrations of the various contaminants detected in the sediment from Meyers Cove. Although

only arsenic, fluoride, radium-226, and polonium-210 exceeded their CVS, Meyers Cove tended to have higher concentrations than any other location on the river for the majority of the contaminants including aluminum, arsenic, barium, chromium, silver, vanadium, zinc, phosphate-phosphorus, and total phosphorus. Of the samples collected in Meyers Cove, sample SC-SD-04, collected in 1988 approximately 15 feet from shore, showed the highest concentrations of multiple metals, fluoride, and total phosphorus.

  - *Downstream sediment.* Table 23 in Appendix B summarizes the concentrations of contaminants detected in the sediment downstream of the site. Thallium was detected in a single sample at a concentration 1,000 times its CV. This was the only sample of sediment in which thallium was detected in the river and appears to be an anomaly. Arsenic was detected at concentrations above its CV, as it was in all other locations of the river. Downgradient sample locations near the mouth of the river indicated no elevated contaminant concentrations.

- An elaboration of substance-specific trends is presented below:

  - Taking into consideration data from every location, of all the contaminants tested, only *arsenic* was consistently detected at concentrations above its CV. Although arsenic was detected above CV in all sections of the river, samples taken both adjacent to the site and in Meyers Cove seem to have consistently higher detected concentrations and occur more frequently than either up or down stream.

  - *Fluoride* exceeded its CV in one sample at each of the upstream, adjacent, and Meyers Cove regions. The highest fluoride concentration was an estimated value from a sample upstream of the site 6 times greater than its CV. All three of the concentrations over the CV were part of the same study (NUS 1989) and were laboratory estimated quantities. With those three exceptions, fluoride concentrations in Meyers Cove are generally higher than concentrations elsewhere in the river. The 1991 sediment sampling program and 1993 RI measurements for fluoride were significantly and consistently lower than those measured by NUS for the ESI in 1989. According to investigators, if values measured away from the site area during the RI are considered background values, then those found in close proximity to the site are elevated (Weston 1993).

  - Concentrations of *phosphate-phosphorus, total phosphorus, and TOC* are highest at Meyers Cove. Although phosphorus is measured the highest and is elevated near or in Meyers Cove according to all studies, it is otherwise variable throughout the rest of the river and does not indicate a consistent pattern.

  - *Gross alpha and beta radiation* are higher in Meyers Cove than other portions of the river. *Radium-226 and polonium-210* were also highest in Meyers Cove. According to Weston (1993), gross alpha and beta radiation might be expected to have a large background concentration in a high phosphorous area such as southwestern Florida. The phosphorus-bearing formations in west central Florida (Bone Valley and Hawthorn formations) could cause not only elevated phosphorus concentrations but also unusually high numbers of uranium series isotopes in surface waters all the way out to the continental shelf (Weston 1993). Concentrations of uranium series isotopes generally increase with proximity to the SCC site but are reportedly low for such a high phosphorus area (Weston 1993).

APPENDIX D – DESCRIPTION OF COMPARISON VALUES AND OTHER HEALTH-BASED GUIDELINES

DESCRIPTION OF COMPARISON VALUES AND OTHER HEALTH-BASED GUIDELINES

As noted in the text of this public health assessment, ATSDR's comparison values are media-specific concentrations that are considered to be "safe" under default conditions of exposure. They are used as screening values in the preliminary identification of "contaminants of concern" at a site. The latter is, perhaps, an unfortunate term since the word "concern" might be misinterpreted as an implication of "hazard." As ATSDR uses the phrase, however, a "contaminant of concern" is merely a site-specific chemical substance that has been selected for further evaluation of potential health effects.

Generally, a chemical is selected as a contaminant of concern because its maximum concentration in air, water, or soil at the site exceeds one of ATSDR's comparison values. However, it cannot be emphasized strongly enough that comparison values are not thresholds of toxicity. While concentrations at or below the relevant comparison value might reasonably be considered safe, it does not automatically follow that any environmental concentration that exceeds a comparison value would be expected to produce adverse health effects. Indeed, the whole purpose behind highly conservative, health-based standards and guidelines is to enable health professionals to recognize and resolve potential public health problems before they become actual health hazards. The probability that adverse health outcomes will actually occur as a result of exposure to environmental contaminants depends on site-specific conditions and individual lifestyle and genetic factors that affect the route, magnitude, and duration of actual exposure, and not on environmental concentrations alone.

Screening values based on non-cancer effects are obtained by dividing the lowest concentrations associated with health effects found in animal or (less often) human studies by cumulative safety margins (variously called safety factors, uncertainty factors, and modifying factors) that typically range from 10 to 1,000 or more. By contrast, cancer-based screening values are usually derived by linear extrapolation from animal data obtained at high doses, because human cancer incidence data for very low levels of exposure simply do not exist, and probably never will. In neither case can the resulting screening values (i.e., EMEGs or CREGs) be used to make realistic predictions of health risk associated with low-level exposures in humans.

A description of the various comparison values that ATSDR used in this public health assessment are provided below.

Cancer Risk Evaluation Guides (CREGs) are estimated concentrations of contaminants that are expected to cause no more than one excess cancer case for every million (1 x 10-6) persons who are continuously exposed to the concentration for an entire lifetime. These concentrations are calculated from EPA's cancer slope factors, which indicate the relative potency of carcinogenic chemicals. Only chemicals that are known or suspected of being carcinogenic have CREG comparison values. It should be noted that exposures equivalent to CREGs are not actually expected to cause one excess cancer in a million persons exposed over a lifetime. Nor does it mean that every person in an exposed population of one million has a 1-in-a-million chance of developing cancer from the specified exposure. Although commonly interpreted in precisely these ways, the CREGs reflect only a rough estimate of population risks, which should not be applied directly to any individual.

Environmental Media Evaluation Guide (EMEGs) are estimates of chemical concentrations that are not likely to cause an appreciable risk of deleterious, noncancerous health effects for fixed durations of exposure. These concentrations factor in estimates of receptor body weights and rates of ingestion. EMEGs might reflect several different types of exposure: acute (<14 days), intermediate (15–364 days), and chronic (>365 days). These concentrations are ultimately based on data published in ATSDR Toxicological Profiles for specific chemicals.

Lowest-Observed-Adverse-Effect-Level (LOAEL) is defined as the lowest dose of chemical in a study, or group of studies, that produces statistically or biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control.

Minimal Risk Level (MRL) is defined as an estimate of daily human exposure to a substance that is likely to be without an appreciable risk of adverse effects (non-carcinogenic) over a specified duration of exposure. MRLs are derived when reliable and sufficient data exist to identify the target organ(s) of effect or the most sensitive health effect(s) for a specified duration within a given route of exposure. MRLs are based only on noncancerous health effects, and do not consider carcinogenic effects. MRLs can be derived for acute, intermediate, and chronic durations of exposure for the inhalation route.

National Ambient Air Quality Standards (NAAQS) are developed by EPA to protect people and the environment from unhealthy and undesirable levels of air pollution. As of the writing of this report, EPA has promulgated NAAQS for seven pollutants (known as “criteria pollutants”). These standards have been developed specifically to protect the health and welfare of humans. To be conservative, these standards were designed to be protective of exposed persons, including most “sensitive” populations (e.g., persons with asthma).

No-Observed-Adverse-Effect-Level (NOAEL) is defined as the dose of chemical at which there were no statistically or biologically significant increases in the frequency or severity of adverse effects seen between the exposed population and its appropriate control. Effects may be produced at this dose, but they are not considered to be adverse.

Risk-Based Concentrations (RBCs) are derived by Region 3 of the U.S. Environmental Protection Agency (EPA) and represent concentrations of contaminants in tap water, ambient air, fish or soil (industrial or residential) that are considered unlikely to cause adverse health effects. They are derived using conservative exposure assumptions and EPA’s Reference Doses, Reference Concentrations, or slope factors. RBCs are based either on cancer or non-cancer effects.

APPENDIX E – BRIEF REVIEW OF PERTINENT HUMAN AND ANIMAL STUDIES FOLLOWING BRIEF EXPOSURES TO SULFUR DIOXIDE

A REVIEW OF HARMFUL EFFECTS OF SULFUR DIOXIDE FROM VERY SHORT EXPOSURES

This is a brief review of the most important human studies about the effects of sulfur dioxide from acute exposures. In conducting this review, ATSDR used not only its Toxicological Profile for Sulfur Dioxide but also conducted extensive searches of a national toxicological database (TOXLINE).

The most sensitive people to sulfur dioxide exposure are persons with asthma. Children with asthma might be particularly sensitive because of an inherent sensitivity or because children exercise more frequently than do adults, which increases the breathing rate resulting in more exposure to sulfur dioxide in air (ATSDR 1998). It should be noted also that exercise alone can trigger asthma attacks. If sulfur dioxide levels are high enough, children and adults who do not have asthma could also experience harmful effects. The effects of sulfur dioxide on the lungs of persons with asthma are summarized in Table 40 in Appendix B.

Sheppard et al. reported that persons with mild asthma who were exposed to 100 ppb sulfur dioxide for 10 minutes experienced an increase in airway resistance and bronchoconstriction in the lungs during moderate exercise (ATSDR 1998; Sheppard et al. 1981). An increase is airway resistance means that air traveling through the airway passages in the lungs is meeting more resistance; bronchoconstriction is the narrowing of the air passages in the lung. The increases in airway resistance and bronchoconstriction do not produce noticeable symptoms at this level of sulfur dioxide exposure and can only be measured in a clinical setting. Increases in airway resistance and bronchoconstriction are more pronounced in persons exposed to 250 and 500 ppb, and at 500 ppb, the increased airway resistance and bronchoconstriction are associated with wheezing and shortness of breath in some persons with asthma.

Similarly, Balmes et al. reported an increase in airway resistance in persons with asthma exposed to 500 ppb sulfur dioxide for 3 minutes (ATSDR 1998; Balmes et al. 1987). The resulting bronchoconstriction also resulted in wheezing, chest tightness, and shortness of breath. It is important to know that some persons with asthma had to take a bronchodilator after exposure to 500 ppb, whereas others were not able to complete the experiment because of breathing problems. Some authors report that these persons experienced pronounced wheezing and tightness of the chest, with some requesting bronchodialators to relieve the symptoms of bronchoconstriction (ATSDR 1998; Bethel et al. 1984; Koenig et al. 1985, 1993; Balmes et al. 1987; Horstman et al. 1986, 1988; Linn et al. 1984a, 1984b, 1984c; Roger et al. 1985). Numerous other human studies support the findings of these studies in causing an increase in airway resistance and bronchoconstriction in persons with asthma who are exposed to several hundred parts per billion sulfur dioxide (ATSDR 1998). In addition to persons with asthma, another sensitive group is elderly adults with preexisting respiratory or cardiovascular disease or chronic lung disease, such as bronchitis or emphysema (WHO 1979).

Persons without asthma can also experience pulmonary effects when exposed to sulfur dioxide; however, a higher level of exposure is required. Islam et al. report that persons without asthma who were exposed to 600 to 800 ppb sulfur dioxide for 5 minutes, *using a mouthpiece apparatus*, can experience an increase in airway resistance (Islam et al. 1992). It should be noted that the 600-

ppb exposure group in the Islam study is an effect level; the authors did not identify a no-effect level in their study. Uncertainty exists in applying this study to the members of the public who do not have asthma because the authors used a mouthpiece to measure the delivered dose of sulfur dioxide. Using a mouthpiece might increase the amount of sulfur dioxide that enters the lungs because trapping of sulfur dioxide in the nasal passages is avoided. The levels used in this study might be more applicable to exercising persons who do not have asthma, because exercise increases breathing through the mouth rather than the nose. That levels of 600 to 800 ppb sulfur dioxide can cause an effect in persons without asthma, however, is supported by other research. Lawther et al. showed that a similar response occurred at 1,000 ppb sulfur dioxide (Lawther et al. 1975). Also at 1,000 ppb, people can experience an increase in heart rate and breathing rate (Amdur et al. 1953; ATSDR 1998). Therefore, somewhere between 600 and 1,000 ppb sulfur dioxide, persons without asthma might begin to experience lung effects.

Several human studies show additional harmful effects occurring for exposures above 1,000 ppb. The adverse effects observed included increased heart rate and breathing rate, increased number of macrophages in lung fluid, cough, irritation, redness of the airways, and increased inflammatory cells in lung fluid (Sandstrom et al. 1989; Lawther et al. 1975; Amdur et al. 1953).

Activity level and weather conditions are also a factor in whether or not sulfur dioxide can cause harmful effects. When people are at rest and breathing normally, sulfur dioxide is absorbed in the moist environment of the nasal passages and less sulfur dioxide reaches the air passages in the lung. Therefore, people at rest can be exposed to higher levels of sulfur dioxide before experiencing effects on the lung than people who are exercising. During exercise or increased activity, however, people breathe faster and are more likely to breathe through their mouth; therefore, more sulfur dioxide is likely to reach the lower air passages in the lung. These factors result in more sulfur dioxide reaching the lungs, thus causing an increase in airway resistance and bronchoconstriction. Weather also becomes a factor, because more sulfur dioxide will reach the air passages in cold, dry (low humidity) atmospheres, thus increasing the likelihood of increased airway resistance and bronchoconstriction (ATSDR 1998; Bethel et al. 1984; Linn et al. 1985; Sheppard et al. 1984).

From the information presented in Table 40 (Appendix B), 100 ppb sulfur dioxide might cause mild effects in the lungs of exercising persons with asthma from exposures as short as 3 minutes. About 10% (or 10 of every 100) children have asthma. At 100 ppb sulfur dioxide, the responses do not produce any signs or symptoms but can be measured in a clinical setting. The effects on airway resistance become more pronounced with increasing sulfur dioxide concentration to point that wheezing and shortness of breath can occur when sulfur dioxide levels reach about 500 ppb. When sulfur dioxide levels reach about 5,000 ppb, throat irritation and cough can occur along with effects that can only be detected in a clinical setting.

APPENDIX F – DEFINITIONS FOR TSP, PM_{10}, AND $PM_{2.5}$

DEFINITIONS FOR TSP, PM_{10}, AND $PM_{2.5}$

Introduction

For nearly 20 years, EPA has closely monitored the levels of solid particles and liquid droplets or aerosols, or "particulate matter," in the air that people breathe. Many health studies have shown that the size of airborne particles is closely related to potential health effects among exposed populations (see Public Health Implications section for more details). As a result, EPA and public health agencies focus on the size of airborne particles when evaluating levels of air pollution. Over the years, particulate matter has been generally classified into three categories: TSP, PM_{10}, and $PM_{2.5}$; therefore, it is first important to understand the definition for these terms before describing the ability of particulates to cause harmful effects.

Total suspended particulates (TSP)

TSP refers to a wide range of solid particles and liquid droplets found in ambient air, and typically is measured as particles having aerodynamic diameters of 25 to 40 microns or less (EPA 1996). EPA's health-based National Ambient Air Quality Standards (NAAQS) regulated ambient air concentrations of TSP until 1987; these standards required annual average concentrations of TSP to be less than 75$\mu g/m^3$ and 24-hour average concentrations to be less than 260 $\mu g/m^3$ (EPA 1996). Many industrial, commercial, mobile, and natural sources emit TSP to the air.

Particulate matter smaller than 10 microns (PM_{10})

PM_{10} refers to the subset of TSP composed of particles smaller than 10 microns in diameter. With research showing that PM_{10} can penetrate into sensitive regions of the respiratory tract, EPA stopped regulating airborne levels of TSP in 1987, and began regulating ambient air concentrations of PM_{10}. EPA continues to regulate levels of PM_{10} today, and requires annual average concentrations to be less than 50 $\mu g/m^3$ and 24-hour average concentrations to be less than 150 $\mu g/m^3$ (EPA 1996). Typical sources of PM_{10} include, but are not limited to, wind-blown dust, grinding operations, and dusts generated by motor vehicles driving on roadways.

Particulate matter smaller than 2.5 microns ($PM_{2.5}$)

$PM_{2.5}$ or "fine particulates" refers to the subset of TSP composed of particles with aerodynamic diameters of 2.5 microns or less. By definition, $PM_{2.5}$ is also a subset of PM_{10}. With recent studies linking inhalation of fine particles to adverse health effects in children and other sensitive populations, EPA proposed regulating ambient air concentrations of $PM_{2.5}$ in 1997. These health-based regulations require annual average concentrations of $PM_{2.5}$ to be less than 15 $\mu g/m^3$ and 24-hour average concentrations to be less than 65 $\mu g/m^3$ (EPA 1997). Although many sources emit $PM_{2.5}$, the pollutant is primarily emitted by combustion sources (e.g., motor vehicles, power generation, boilers and industrial furnaces, residential heating). Fine particles are also formed in the air from other pollutants. Although EPA's promulgation of the $PM_{2.5}$ standard is still under legal review, ATSDR uses the proposed standard and other scientific evidence to evaluate inhalation exposures to $PM_{2.5}$.

APPENDIX G – ESTIMATION OF PM_{10} AND $PM_{2.5}$ CONCENTRATIONS FROM MEASURED TSP CONCENTRATIONS

ESTIMATION OF PM_{10} AND $PM_{2.5}$ CONCENTRATIONS FROM MEASURED TSP CONCENTRATIONS

The only ambient air monitoring data available for the years Stauffer was operating is for TSP, and no sampling data characterized the size distribution of these particles. ATSDR prefers to base conclusions regarding exposures to particulate matter on measurements of PM_{10} or $PM_{2.5}$ concentrations, which are more predictive of adverse health effects. Because no sampling studies measured air concentrations of these particle size fractions, ATSDR investigated options for estimating the PM_{10} and $PM_{2.5}$ exposure levels.

This appendix describes how we *estimated* PM_{10} and $PM_{2.5}$ exposure levels from the TSP monitoring data, based on our knowledge of particle size distributions in the vicinity of elemental phosphorus production facilities. Important information on the uncertainty and limitations associated with this estimation is also presented.

Estimating Long-Term PM_{10} Levels from TSP Levels

PM_{10} is a subset of TSP. The relative amount of PM_{10} within TSP depends on many factors, such as the local sources of air pollution. ATSDR investigated multiple options to *estimate* the amount of PM_{10} within the TSP that was measured at the Anclote Road monitoring station. One option was to use PM_{10}:TSP ratios, based on sampling data collected in northern Pinellas County and southern Pasco County in the 1990s. Comments from peer reviewers suggested that such an approach involves considerable uncertainty, because we would be using ratios derived from a time period when Stauffer was not operating.

As an improved approach, ATSDR estimates PM_{10} levels during the time Stauffer operated using a PM_{10}:TSP ratio derived from extensive ambient air monitoring data collected near the fence-line of an active elemental phosphorus production facility in southeastern Idaho—a sampling arrangement similar to the Anclote Road monitoring station being adjacent to the Stauffer facility. At the Idaho facility, the average PM_{10}:TSP ratio, based on nearly 2 whole years of concurrent sampling, was 0.50, with a standard deviation of 0.14. ATSDR applied this average ratio to estimate annual average PM_{10} concentrations in the years for which only TSP data are available. Table 48 in Appendix B documents these results. The end of this section describes the uncertainties inherent in this approach.

Estimating Long-Term $PM_{2.5}$ Levels from PM_{10} Levels

To *estimate* the exposure concentrations for $PM_{2.5}$, ATSDR similarly applied $PM_{2.5}$:PM_{10} ratios to the estimated PM_{10} levels. We had considered using $PM_{2.5}$:PM_{10} ratios measured in St. Petersburg and other parts of the southeastern United States for this analysis, but comments from peer reviewers questioned whether such data would be representative of ambient conditions in the vicinity of an elemental phosphorus plant. Based on these comments, we decided that particle size ratios observed near the elemental phosphorus production facility a more representative of the airborne particle size distribution that occurred near Stauffer. Thus, we used the same data set identified in the previous section, which indicates that the average $PM_{2.5}$:PM_{10} ratio near the elemental phosphorus plant was 0.6. Table 49 shows we used this factor to *estimate* $PM_{2.5}$ concentrations in the vicinity of Stauffer based on this particle size ratio.

Uncertainty and Limitations

Since ambient air concentrations of PM_{10} and $PM_{2.5}$ were never measured near Stauffer while the facility operated, ATSDR could only *estimate* the airborne levels of these pollutants, and our estimates—no matter what approach we took—would involve some uncertainty. The extent of uncertainty in our $PM_{2.5}$ and PM_{10} estimates depends on the validity of the assumptions made in applying the ratios. The key question for this calculation is to what extent particle size ratios observed at the fence-line of one elemental phosphorus production facility are representative of ratios at the fence-line of another. While we expect the magnitude of particulate matter levels to differ considerably between the Idaho and Florida facilities (due to the differences in production levels), there is less reason to believe that the composition of various particle sizes would differ dramatically, especially considering the similarity in the production processes.

Nonetheless, ATSDR emphasizes that the PM_{10} and $PM_{2.5}$ exposure concentrations are *estimates* of actual air pollution levels, and they might understate or overstate actual exposures. The fact that our estimated $PM_{2.5}$ concentrations are consistent with those predicted by our dispersion modeling analysis (see Section 5.3.2) reassures us that the concentrations estimated using the ratio approach are reasonable, though some uncertainties undoubtedly remain.

APPENDIX H – ATSDR GLOSSARY OF ENVIRONMENTAL HEALTH TERMS

ATSDR Glossary of Environmental Health Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health.

This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

Absorption
The process of taking in. For a person or animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

Acute
Occurring over a short time [compare with **chronic**].

Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with **intermediate duration exposure** and **chronic exposure]**.

Additive effect
A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together [compare with **antagonistic effect** and **synergistic effect]**.

Adverse health effect
A change in body function or cell structure that might lead to disease or health problems.

Aerobic
Requiring oxygen [compare with **anaerobic**].

Ambient
Surrounding (for example, *ambient* air).

Anaerobic
Requiring the absence of oxygen [compare with **aerobic**].

Analyte
A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

Analytic epidemiologic study
A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.

Antagonistic effect
A biologic response to exposure to multiple substances that is **less** than would be expected if the known effects of the individual substances were added together [compare with **additive effect** and **synergistic effect**].

Background level
An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biodegradation
Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

Biologic indicators of exposure study
A study that uses (a) **biomedical testing** or (b) the measurement of a substance [an **analyte**], its **metabolite**, or another marker of exposure in human body fluids or tissues to confirm human exposure to a hazardous substance [also see **exposure investigation**].

Biologic monitoring
Measuring hazardous substances in biologic materials (such as blood, hair, urine, or breath) to determine whether exposure has occurred. A blood test for lead is an example of biologic monitoring.

Biologic uptake
The transfer of substances from the environment to plants, animals, and humans.

Biomedical testing
Testing of persons to find out whether a change in a body function might have occurred because of exposure to a hazardous substance.

Biota
Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Body burden
The total amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone or because they leave the body very slowly.

CAP
See **Community Assistance Panel**.

Cancer
Any one of a group of diseases that occurs when cells in the body become abnormal and grow or multiply out of control.

Cancer risk
A theoretical risk of for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen
A substance that causes cancer.

Case study
A medical or epidemiologic evaluation of one person or a small group of people to gather information about specific health conditions and past exposures.

Case-control study
A study that compares exposures of people who have a disease or condition (cases) with people who do not have the disease or condition (controls). Exposures that are more common among the cases may be considered as possible risk factors for the disease.

CAS registry number
A unique number assigned to a substance or mixture by the American Chemical Society Abstracts Service.

Central nervous system
The part of the nervous system that consists of the brain and the spinal cord.

CERCLA [see **Comprehensive Environmental Response, Compensation, and Liability Act of 1980**]

Chronic
Occurring over a long time (more than 1 year) [compare with **acute**].

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with **acute exposure** and **intermediate duration exposure**].

Cluster investigation
A review of an unusual number, real or perceived, of health events (for example, reports of cancer) grouped together in time and location. Cluster investigations are designed to confirm case reports; determine whether they represent an unusual disease occurrence; and, if possible, explore possible causes and contributing environmental factors.

Community Assistance Panel (CAP)
A group of people, from a community and from health and environmental agencies, who work with ATSDR to resolve issues and problems related to hazardous substances in the community.

CAP members work with ATSDR to gather and review community health concerns, provide information on how people might have been or might now be exposed to hazardous substances, and inform ATSDR on ways to involve the community in its activities.

Comparison value (CV)
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway [see **exposure pathway**].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
CERCLA, also known as **Superfund**, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances.

Concentration
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Delayed health effect
A disease or injury that happens as a result of exposures that might have occurred in the past.

Dermal
Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact
Contact with (touching) the skin [see **route of exposure**].

Descriptive epidemiology
The study of the amount and distribution of a disease in a specified population by person, place, and time.

Detection limit
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Disease prevention
Measures used to prevent a disease or reduce its severity.

Disease registry
A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

DOD
United States Department of Defense.

DOE
United States Department of Energy.

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose (for radioactive chemicals)
The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

Dose-response relationship
The relationship between the amount of exposure [**dose**] to a substance and the resulting changes in body function or health (response).

Environmental media
Soil, water, air, **biota** (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism
Environmental media include water, air, soil, and **biota** (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The **environmental media and transport mechanism** is the second part of an **exposure pathway**.

EPA
United States Environmental Protection Agency.

Epidemiologic surveillance
The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.

Epidemiology
The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Exposure
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [**acute exposure**], of intermediate duration, or long-term [**chronic exposure**].

Exposure assessment
The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure-dose reconstruction
A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.

Exposure investigation
The collection and analysis of site-specific information and biologic tests (when appropriate) to determine whether people have been exposed to hazardous substances.

Exposure pathway
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a **source of contamination** (such as an abandoned business); an **environmental media and transport mechanism** (such as movement through groundwater); a **point of exposure** (such as a private well); a **route of exposure** (eating, drinking, breathing, or touching), and a **receptor population** (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a **completed exposure pathway**.

Exposure registry
A system of ongoing followup of people who have had documented environmental exposures.

Feasibility study
A study by EPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well.

Geographic information system (GIS)
A mapping system that uses computers to collect, store, manipulate, analyze, and display data. For example, GIS can show the concentration of a contaminant within a community in relation to points of reference such as streets and homes.

Grand rounds
Training sessions for physicians and other health care providers about health topics.

Groundwater
Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with **surface water**].

Half-life ($t_{½}$)
The time it takes for half the original amount of a substance to disappear. In the environment, the half-life is the time it takes for half the original amount of a substance to disappear when it is changed to another chemical by bacteria, fungi, sunlight, or other chemical processes. In the human body, the half-life is the time it takes for half the original amount of the substance to disappear, either by being changed to another substance or by leaving the body. In the case of radioactive material, the half life is the amount of time necessary for one half the initial number of radioactive atoms to change or transform into another atom (that is normally not radioactive). After two half lives, 25% of the original number of radioactive atoms remain.

Hazard
A source of potential harm from past, current, or future exposures.

Hazardous Substance Release and Health Effects Database (HazDat)
The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

Hazardous waste
Potentially harmful substances that have been released or discarded into the environment.

Health consultation
A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with **public health assessment**].

Health education
Programs designed with a community to help it know about health risks and how to reduce these risks.

Health investigation
The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to estimate the possible association between the occurrence and exposure to hazardous substances.

Health promotion
The process of enabling people to increase control over, and to improve, their health.

Health statistics review
The analysis of existing health information (i.e., from death certificates, birth defects registries, and cancer registries) to determine if there is excess disease in a specific population, geographic area, and time period. A health statistics review is a descriptive epidemiologic study.

Indeterminate public health hazard
The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence
The number of new cases of disease in a defined population over a specific time period [contrast with **prevalence**].

Ingestion
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see **route of exposure**].

Inhalation
The act of breathing. A hazardous substance can enter the body this way [see **route of exposure**].

Intermediate duration exposure
Contact with a substance that occurs for more than 14 days and less than a year [compare with **acute exposure** and **chronic exposure**].

In vitro
In an artificial environment outside a living organism or body. For example, some toxicity testing is done on cell cultures or slices of tissue grown in the laboratory, rather than on a living animal [compare with **in vivo**].

In vivo
Within a living organism or body. For example, some toxicity testing is done on whole animals, such as rats or mice [compare with **in vitro**].

Lowest-observed-adverse-effect level (LOAEL)
The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Medical monitoring
A set of medical tests and physical exams specifically designed to evaluate whether an individual's exposure could negatively affect that person's health.

Metabolism
The conversion or breakdown of a substance from one form to another by a living organism.

Metabolite
Any product of **metabolism**.

mg/kg
Milligram per kilogram.

mg/cm^2
Milligram per square centimeter (of a surface).

mg/m^3
Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration
Moving from one location to another.

Minimal risk level (MRL)
An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see **reference dose**].

Morbidity
State of being ill or diseased. Morbidity is the occurrence of a disease or condition that alters health and quality of life.

Mortality
Death. Usually the cause (a specific disease, condition, or injury) is stated.

Mutagen
A substance that causes **mutations** (genetic damage).

Mutation
A change (damage) to the DNA, genes, or chromosomes of living organisms.

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No-observed-adverse-effect level (NOAEL)
The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL [see **National Priorities List for Uncontrolled Hazardous Waste Sites]**

Physiologically based pharmacokinetic model (PBPK model)
A computer model that describes what happens to a chemical in the body. This model describes how the chemical gets into the body, where it goes in the body, how it is changed by the body, and how it leaves the body.

Pica
A craving to eat nonfood items, such as dirt, paint chips, and clay. Some children exhibit pica-related behavior.

Plume
A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure
The place where someone can come into contact with a substance present in the environment [see **exposure pathway**].

Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Potentially responsible party (PRP)
A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.

ppb
Parts per billion.

ppm
Parts per million.

Prevalence
The number of existing disease cases in a defined population during a specific time period [contrast with **incidence**].

Prevalence survey
The measure of the current level of disease(s) or symptoms and exposures through a questionnaire that collects self-reported information from a defined population.

Prevention
Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public comment period
An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public availability session
An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.

Public health action
A list of steps to protect public health.

Public health advisory
A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with **health consultation**].

Public health hazard
A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or **radionuclides** that could result in harmful health effects.

Public health hazard categories
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are **no public health hazard, no apparent public health hazard**, **indeterminate public health hazard**, **public health hazard**, and **urgent public health hazard**.

Public health statement
The first chapter of an ATSDR **toxicological profile**. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.

Public meeting
A public forum with community members for communication about a site.

Radioisotope
An unstable or radioactive isotope (form) of an element that can change into another element by giving off radiation.

Radionuclide
Any radioactive isotope (form) of any element.

RCRA [See **Resource Conservation and Recovery Act (1976, 1984)**]

Receptor population
People who could come into contact with hazardous substances [see **exposure pathway**].

Reference dose (RfD)
An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Registry
A systematic collection of information on persons exposed to a specific substance or having specific diseases [see **exposure registry** and **disease registry**].

Remedial Investigation
The CERCLA process of determining the type and extent of hazardous material contamination at a site.

Resource Conservation and Recovery Act (1976, 1984) (RCRA)
This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.

RFA
RCRA Facility Assessment. An assessment required by RCRA to identify potential and actual releases of hazardous chemicals.

RfD
See **reference dose**.

Risk
The probability that something will cause injury or harm.

Risk reduction
Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

Risk communication
The exchange of information to increase understanding of health risks.

Route of exposure
The way people come into contact with a hazardous substance. Three routes of exposure are breathing [**inhalation**], eating or drinking [**ingestion**], or contact with the skin [**dermal contact**].

Safety factor [see **uncertainty factor]**

SARA [see **Superfund Amendments and Reauthorization Act**]

Sample
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see **population**]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Sample size
The number of units chosen from a population or environment.

Solvent
A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an **exposure pathway**.

Special populations
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Stakeholder
A person, group, or community who has an interest in activities at a hazardous waste site.

Statistics
A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance
A chemical.

Substance-specific applied research
A program of research designed to fill important data needs for specific hazardous substances identified in ATSDR's **toxicological profiles**. Filling these data needs would allow more accurate assessment of human risks from specific substances contaminating the environment. This research might include human studies or laboratory experiments to determine health effects resulting from exposure to a given hazardous substance.

Superfund Amendments and Reauthorization Act (SARA)
In 1986, SARA amended CERCLA and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with **groundwater**].

Surveillance [see **epidemiologic surveillance**]

Survey
A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see **prevalence survey**].

Synergistic effect
A biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves [see **additive effect** and **antagonistic effect**].

Teratogen
A substance that causes defects in development between conception and birth. A teratogen is a substance that causes a structural or functional birth defect.

Toxic agent
Chemical or physical (for example, radiation, heat, cold, microwaves) agents which, under certain circumstances of exposure, can cause harmful effects to living organisms.

Toxicological profile
An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological

profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology
The study of the harmful effects of substances on humans or animals.

Tumor
An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor
Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a **safety factor**].

Urgent public health hazard
A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Volatile organic compounds (VOCs)
Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Other glossaries and dictionaries:

Environmental Protection Agency	http://www.epa.gov/OCEPAterms/
National Center for Environmental Health (CDC)	http://www.cdc.gov/nceh/dls/report/glossary.htm
National Library of Medicine	http://www.nlm.nih.gov/medlineplus/dictionaries.html