Appendix C—Tables

Table C-1. Exposure Pathways Evaluated in Laytonville Landfill PHA, Laytonville, California

Pathway Name	Possible Source	Media	Exposure Point	Exposure Route	Receptor	Time	Hazards	Status
Direct contact with the landfill waste before it was capped	Landfill	Household, commercial, non-hazardous industrial waste	Within the refuse landfill	Dermal, inhalation	Trespassers	Past	Physical, microbiological, chemical	Completed
Swimming in on-site surface water before the cap was installed	Landfill, native, non-native soils	On-site surface water	Sedimentation ponds	Dermal, ingestion	Trespassers	Past	Arsenic, boron, lead, manganese, vanadium, oil and grease	Completed, does not pose a health hazard
Wading and splashing in the leachate before the cap was installed	Landfill, waste, native soils	Leachate (water that came through the waste)	Leachate	Inhalation, dermal	Trespassers	Past	Aluminum, benzene, boron, total chromium, lead, manganese, nickel, TPH-diesel, TPH-gasoline, vinyl chloride	Completed, does not pose a health hazard
Playing or swimming in surface water runoff that formed puddles or flowed in Cahto Creek (before and after their cap was installed)	Landfill, illegal dumping	Cahto Creek water and sediment, puddles off site	Cahto Creek near the landfill	Dermal, ingestion,	Swimmers, waders, other recreational users of creek	Past, present, future	Physical, no chemicals of concern identified	Completed, does not pose a health hazard
Ingestion of fish and eel from Cahto Creek before and after the cap was installed	Landfill, illegal dumping	Cahto Creek wildlife	Cahto Creek	Ingestion	Consumers of fish and other species taken from Cahto Creek	Past, present, future	None	Eliminated
Inhalation of outdoor air onsite and offsite before the cap was installed	Landfill and other nearby sources	Ambient air	On the landfill or nearby the landfill	Inhalation	Trespassers, nearby residents	Past	None identified in air, chemicals in landfill gas sampling	Potential, inadequate sampling
Contact with surface soil offsite before the cap was installed, and subsurface soil after the cap was installed	Landfill	Soil	Surface soil offsite and subsurface soil onsite	Skin contact, ingestion, inhalation	Nearby residents and visitors, trespassers	Past, current, future	None identified in limited sampling	Potential, inadequate sampling

Table C-1. Exposure Pathways Evaluated in Laytonville Landfill PHA, Laytonville, California

Pathway Name	Possible Source	Media	Exposure Point	Exposure Route	Receptor	Time	Hazards	Status
Inhalation of outdoor air onsite and offsite after the cap was installed	Landfill and other nearby sources (fireplaces, automobile exhaust)	Ambient air	On the landfill and nearby the landfill	Inhalation	Trespassers, nearby residents	Current, future	Acrolein, benzene, α-pinene	Completed, does not pose a health hazard
Swimming in on-site surface water after the cap was installed	Landfill, native and non-native soils	Surface water	Sedimentation ponds	Skin contact, ingestion	Trespassers	Recent past, current, future	Arsenic, aluminum, barium, oil and grease, vanadium	Completed, does not pose a health hazard
Wading and splashing in the "leachate" after the cap was installed	Landfill, native and non-native soils	"Leachate"-water coming off cap that has landfill gas dissolved in it	"Leachate"	Inhalation, skin contact	Trespassers	Recent past, current, future	Aluminum, arsenic, barium, benzene, chloroethane, total chromium, lead, manganese, methylene chloride, vanadium, vinyl chloride	Completed, does not currently pose a health hazard but problem should be eliminated
Exposure to household water for residents living nearby the landfill who use private wells	Naturally occurring, landfill, household water pipe system	Ground water	Private well water	Ingestion, inhalation, skin contact	Nearby residents who use a private well	Past, current, future	Aluminum, arsenic, barium, lead, manganese	Completed, may pose hazard for some residents
Using municipal water	Naturally occurring	Ground water	Municipal water tap	Ingestion, skin contact	Residents and visitors who use Laytonville Water District water	Past, current, future	None, treated water meets drinking water standards for arsenic, manganese	Eliminated

TPH—total petroleum hydrocarbon

Table C-2. Presence of Volatile Organic Chemicals (VOCs) in Various Media Tested On or Near the Laytonville Landfill, Laytonville, California

Chemical Name	Ever Present in Groundwater? (Yes / No)	Ever Present in Surface Water? (Yes/No)	Ever Present in Leachate? (Yes/No)	Ever Present in Landfill Gas? (Yes/No)	Ever Present in Ambient Air? (Yes/No)
Acetone	Yes	Yes	Yes	NA	Yes
Acrolein	No	No	No	No	Yes
Benzene	No	No	Yes	Yes	Yes
Bromobenzene	No	No	No	NA	No
Bromochloromethane	No	No	No	NA	No
Bromodichloromethane	No	No	No	NA	No
Bromoform	No	No	No	NA	No
Bromomethane	No	No	No	NA	No
n-Butylbenzene	Yes	No	Yes	NA	No
sec-Butylbenzene	Yes	No	Yes	NA	No
tert-Butylbenzene	No	No	No	NA	No
Carbon tetrachloride	No	No	No	Yes	No
Chlorobenzene	No	No	No	NA	No
Chloroethane (ethyl chloride)	No	No	Yes	NA	No
2-Chloroethylvinyl ether	No	No	No	NA	No
Chloroform	Yes	No	No	Yes	No
2-Chlorotoluene	No	No	No	NA	No
4-Chlorotoluene	No	No	No	NA	No
Dibromochloromethane	No	No	No	NA	No
1,2-Dibromoethane	No	No	No	No	No
Dibromomethane	No	No	No	NA	No
1,2-Dichlorobenzene	No	No	No	NA	No
1,3-Dichlorobenzene	No	No	No	NA	No
1,4-Dichlorobenzene	No	No	No	NA	No
Dichlorodifluoromethane	Yes	No	Yes	NA	Yes
1,1-Dichloroethane	No	No	Yes	NA	No
1,2-Dichloroethane	No	No	No	Yes	No

Table C-2. Presence of Volatile Organic Chemicals (VOCs) in Various Media Tested On or Near the Laytonville Landfill, Laytonville, California

Chemical Name	Ever Present in Groundwater? (Yes / No)	Ever Present in Surface Water? (Yes/No)	Ever Present in Leachate? (Yes/No)	Ever Present in Landfill Gas? (Yes/No)	Ever Present in Ambient Air? (Yes/No)
1,1-Dichloroethene	Yes	No	No	NA	No
cis-1,2-Dichloroethene	No	No	Yes	NA	No
trans-1,2-Dichloroethene	No	No	Yes	NA	No
1,2-Dichloropropane	No	No	No	NA	No
2,2-Dichloropropane	No	No	No	NA	No
1,1-Dichloropropene	No	No	No	NA	No
Ethanol	No	No	No	NA	Yes
Ethylbenzene	No	No	Yes	NA	No
Hexachlorobutadiene	No	No	No	NA	No
Isopropylbenzene	No	No	No	NA	No
Isopropylethanol	No	No	No	NA	Yes
p-Isopropyltoluene	No	No	No	NA	No
Methyl acetate	Yes				
Methylene chloride (chloromethane)	Yes	No	Yes	Yes	No
Methyl ethyl ketone (MEK)	No	Yes	Yes	NA	Yes
Methyl isobutyl ketone	No	No	Yes	NA	No
Naphthalene	No	No	No	NA	No
α-Pinene	No	No	No	NA	Yes
n-Propylbenzene	No	No	No	NA	No
Styrene	No	No	No	NA	No
1,1,2,2-Tetrachloroethane	No	No	No	NA	No
Tetrachloroethene (PCE)	No	No	Yes	Yes	No
Toluene	Yes	No	Yes	NA	Yes
1,2,3 Trichlorobenzene	No	No	No	NA	No
1,2,4 Trichlorobenzene	No	No	No	NA	No
1,1,1-Trichloroethane	No	No	Yes	Yes	No
1,1,2-Trichloroethane	No	No	No	NA	No

Table C-2. Presence of Volatile Organic Chemicals (VOCs) in Various Media Tested On or Near the Laytonville Landfill, Laytonville, California

Chemical Name	Ever Present in Groundwater? (Yes / No)	Ever Present in Surface Water? (Yes/No)	Ever Present in Leachate? (Yes/No)	Ever Present in Landfill Gas? (Yes/No)	Ever Present in Ambient Air? (Yes/No)
Trichloroethene (TCE)	No	No	Yes	Yes	No
1,2,3-Trichloropropane	No	No	No	NA	No
Trichlorotrifluoroethane	No	No	No	NA	No
Trichlorofluoromethane	No	No	No	NA	No
Total Trihalomethanes	No	No	No	NA	No
1,2,4-Trimethylbenzene	No	No	Yes	NA	No
1,3,5-Trimethylbenzene	Yes	No	Yes	NA	No
Vinyl chloride	No	No	Yes	Yes	No
m,p-Xylene	No	No	(Yes)	NA	No
o-Xylene	No	No	(Yes)	NA	No
Xylenes	No	No	Yes	NA	No

NA—not analyzed

Table C-3. Summary of Semi-Volatile Organic Compounds (SVOCs) Test Results for Groundwater and Surface Water, Laytonville, California

Chemical Name	Ever Present in Groundwater? (Yes / No)	Ever Present in Storm Water/Sedimentation Pond? (Yes/No)	Ever Present in Leachate? (Yes/No)
Aldrin	No	No	No
α-BHC	No	No	No
β-BHC	No	No	No
δ-BHC	No	No	No
γ-BHC (Lindane)	No	Yes	No
Chlordane	No	No	No
4,4'-DDD	No	No	No
4,4'-DDE	No	No	No
4,4'-DDT	Yes	No	No
Di-(2-ethylhexyl) phthalate	Yes	Yes	No
Diethyl phthalate	Yes	No	No
Dimethyl phthalate	Yes	No	No
Dieldrin	No	No	No
Endosulfan I	No	No	No
Endosulfan II	No	No	No
Endosulfan sulfate	No	No	No
Endrin aldehyde	No	Yes	No
Endrin ketone	No	Yes	No
Heptachlor	No	No	No
Heptachlor epoxide	No	No	No
Methyl acetate	Yes	Yes	No
Toxaphene	No	No	No
PCB-1016	No	No	No
PCB-1221	No	No	No
PCB-1232	No	No	No
PCB-1242	No	No	No
PCB-1248	No	No	No
PCB-1254	No	No	No
PCB-1260	No	No	No

Organochlorine Pesticides U.S. EPA Method 608.
DDD—1,1-dichloro-2,2-bis (p-chlorophenyl) ethane; BHC—benzene hydrochloride; DD—1,1,1-trichloro-2,2-bis (p-chlorophenyl) ethane; DDE—1,1-dichloro-2,2-bis (p-chlorophenyl) ethane; PCB—.polychlorinated biphenyl.

Table C-4. Summary of Metals Detected in All Media Near the Laytonville Landfill, Laytonville, California

Metal Ever Present Above Health Comparison Values?	In Groundwater? (Yes/No)	In Storm Water/ Sedimentation Pond? (Yes/No)	In Leachate? (Yes/No)	In Surface Soil? (Yes/No)	In Cahto Creek? (Yes/No)
Aluminum	Yes	Yes	Yes	No	No
Arsenic	Yes	Yes	Yes	No	Yes
Barium	Yes	Yes	No	Yes	No
Boron	Yes	Yes	Yes	No	No
Chromium	Yes	Yes	Yes	Yes	No
Cobalt	Yes	No	No	No	No
Lead	Yes	Yes	Yes	Yes	No
Manganese	Yes	Yes	Yes	No	No
Mercury	No	No	No	No	No
Nickel	No	No	Yes	Yes	
Vanadium	Yes	Yes	Yes	Yes	No

Table C-5. Contaminants Detected in Surface Water (Storm Water Runoff and Sedimentation Pond Discharge) (ppb) by Year of Detection, Laytonville, California

Year Chemical	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Health Comparison Value
δ-BHC (Lindane)													0.007**	
Acetone	13, 5.5					7.9	19							1,000 (child RMEG) 4,000 (adult RMEG)
Aluminum	52,000, 3,400									1,400, 7,800			1,100**	1,000 (CA MCL)
Arsenic						5.8					28, 20*		4.0, 4.4**	0.02 (CREG) 3 (child EMEG) 10 (adult EMEG)
Barium											1,440*			700 (child RMEG) 2,000 (MCL, adult RMEG)
Boron		500		100, 100	600, 300	100, 190, 130								100 (child interEMEG) 400 (adult interEMEG)
Chromium (total)	97			87		65								50 (CA MCL)
Di-(2-ethylhexyl) phthalate													11, 3, 0.9, 2**	6 (U.S. MCL)
Endrin aldehyde													0.04**	
Endrin ketone													0.029**	
Lead				17										15 (CA Action Level)
Manganese	780													500 (child RMEG) 2,000 (adult RMEG)
Methyl acetate													0.9, 1**	3,000 (odor concern)

Table C-5. Contaminants Detected in Surface Water (Storm Water Runoff and Sedimentation Pond Discharge) (ppb) by Year of Detection, Laytonville, California

Chemical \ Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Health Comparison Value
Methyl ethyl ketone (2-butanone)	7.8, 1.0			7.8									0.8, 0.4 0.5, 0.5**	2,000 (child RMEG) 20,000 (adult RMEG)
Oil and grease				3000		5,300, 5,100		3,600, 3,300	29,000, 4,000, 3,700	7,900, 5,900, 4,000	3,900, 3,900, 8,000, 3,900, 3,900, 6,400, 8,200			NA
Vanadium	140										480*			30 child interEMEG); 100 adult interEMEG

Data expressed as parts per billion (ppb)
Unless otherwise indicated, the data was derived from quarterly monitoring reports, annual storm water discharge reports or other special investigation reports submitted by the county to the RWQCB (3, 38-45, 49, 74-76)
* Masry and Vititoe data
** Data from U.S. EPA site assessment sampling conducted in November 2002 (48)
child EMEG and adult EMEG—ATSDR Environmental Media Evaluation Guide for chronic exposure (greater than 365 days), developed from ATSDR's intermediate MRL
child interEMEG and adult interEMEG—ATSDR Environmental Media Evaluation Guide for intermediate exposure (greater than 14 days and less 365 days)
child and adult RMEG—Reference Dose Media Evaluation Guide for chronic exposure, developed from U.S. EPA's Reference Dose
MCL—U.S. EPA or California Maximum Contaminant Level in Drinking Water
CA Action Level—California Action Level for Drinking Water
CREG—Cancer Reference Evaluation Guide, developed from U.S. EPA's cancer potency factors
refers to polar oil and grease starting in 2000
Empty Cell—not detected if organic chemical or not detected above health comparison value for met

Table C-6. Noncancer Assessment and Cancer Risk from Swimming in the Sedimentation Ponds at the Laytonville Landfill, Laytonville, California

				Swimming in the Sedimentation Ponds Prior to Cap			Swimming in the Sedimentation Ponds After the Cap		
Chemical Name	**Adult or Child**	**Noncancer Health Comparison Value mg/kg/day**	**Source of Comparison Value**	**Noncancer Dose mg/kg/day**	**Exceeds Health Comparison Value Yes/No?**	**Total Cancer Risk**	**Noncancer Dose mg/kg/day**	**Exceeds Health Comparison Value Yes/No?**	**Total Cancer Risk**
Acetone	Adult	2	iMRL	2.24E-06	No				
	Child			3.37E-06	No				
Aluminum	Adult	2	iMRL	7.03E-03	No		1.05E-03	No	
	Child			9.57E-03	No		1.74E-03	No	
Arsenic	Adult	0.0003	cMRL	7.48E-07	No	4.45E-07	3.78E-06	No	6.03E-07
	Child			1.07E-06	No	2.11E-07	6.26E-06	No	8.05E-07
Barium	Adult	0.004	RfD				1.95E-04	No	
	Child						3.22E-04	No	
Boron	Adult	0.09	iMRL	6.76E-05	No				
	Child			9.20E-05	No				
γ-Benzene hydrochloride (lindane)	Adult		iMRL				3.46E-09	No	5.62E-10
	Child						3.84E-09	No	3.62E-10
Chromium	Adult	2.86	RfD	1.66E-05	No	1.99E-08			
	Child			1.92E-05	No	8.44E-09			

Table C-6. Noncancer Assessment and Cancer Risk from Swimming in the Sedimentation Ponds at the Laytonville Landfill, Laytonville, California

				Swimming in the Sedimentation Ponds Prior to Cap			Swimming in the Sedimentation Ponds After the Cap		
Chemical Name	**Adult or Child**	**Noncancer Health Comparison Value mg/kg/day**	**Source of Comparison Value**	**Noncancer Dose mg/kg/day**	**Exceeds Health Comparison Value Yes/No?**	**Total Cancer Risk**	**Noncancer Dose mg/kg/day**	**Exceeds Health Comparison Value Yes/No?**	**Total Cancer Risk**
Endrin aldehyde	Adult	0.003	cMRL				2.12E-09	No	
	Child						2.33E-09	No	
Endrin ketone	Adult	0.2	cMRL				1.54E-08	No	
	Child						1.69E-08	No	
Di-ethylhexyl phthalate (DEHP)	Adult	1	RfD				1.10E-05	No	2.39E-08
	Child						1.10E-05	No	1.33E-08
Lead	Adult			1.75E-06		5.04E-08			
	Child			2.92E-06		2.18E-08			
Manganese	Adult	0.02	RfD	1.05E-04	No				
	Child			1.44E-04	No				
Methylacetate	Adult	0.06	RfD				1.28E-07	No	
	Child						2.17E-07	No	
Methyl ethyl ketone (MEK)	Adult	0.6	RfD	1.04E-06	No		1.07E-07	No	
	Child			1.43E-06	No		1.78E-07	No	

Table C-6. Noncancer Assessment and Cancer Risk from Swimming in the Sedimentation Ponds at the Laytonville Landfill, Laytonville, California

				Swimming in the Sedimentation Ponds Prior to Cap			Swimming in the Sedimentation Ponds After the Cap		
Chemical Name	**Adult or Child**	**Noncancer Health Comparison Value mg/kg/day**	**Source of Comparison Value**	**Noncancer Dose mg/kg/day**	**Exceeds Health Comparison Value Yes/No?**	**Total Cancer Risk**	**Noncancer Dose mg/kg/day**	**Exceeds Health Comparison Value Yes/No?**	**Total Cancer Risk**
Vanadium	Adult	0.0003	RfD	1.89E-05	No		6.49E-05	No	
	Child			2.58E-05	No		1.07E-04	No	

Data taken from maximum values in Table C-5

RFD—U.S. EPA Reference Dose; iMRL—ATSDR intermediate Minimal Risk Level; cMRL—ATSDR chronic Minimal Risk Level; mg/kg/day—milligram chemical(s) per body weight per day

Dermal dose calculated per Exhibit 6-13 of U.S. EPA Risk Assessment Guidance for Superfund (46)

Ingestion dose calculated per Exhibit 6-12 of U.S. EPA Risk Assessment Guidance for Superfund (46)

- Assumptions used for calculating the ingestion dose: Per RAGS (46), we used 50 ml/hour as the incidental ingestion rate of water while swimming for both adults and children
- Assumptions used for calculating the dermal dose: Skin surface area (adult) from U.S. EPA Exposure Factors Handbook Tables(77) 6-2 and 6-3 by averaging the 50th percentile for lower legs, feet and hands of females and males with that of the forearms of males (data not supplied for women) = 5809cm^2; Skin surface area (child before cap) from U.S. EPA Exposure Factors Handbook Tables (77) 6-6 and 6-7 average the 50th percentile for total body surface area for males and females ages 8-15 multiplied by the percentage of total surface area that the legs, hands, and feet obtained from Table 6-8 = 5,323 cm^2; Skin surface area (child exposure after cap) from U.S. EPA Exposure Factors Handbook Tables (77) 6-6 and 6-7 average the 50th percentile for total body surface area for males and females ages 10-11 multiplied by the percentage of total surface area that the legs, hands, and feet obtained from Table 6-8 = 4,886 cm^2
- Assumptions used for calculating both the ingestion and dermal dose for both time periods: Exposure Time = 1 hour/day; Exposure Frequency = 52 days/year
- Assumptions used to calculate exposure before the cap: Exposure Duration for adult = 24 years; Exposure Duration for child = 8 years; BW (kg) for adult taken from average of women and men from Exposure Factors Handbook Table (77) 7-2 = 71.8; BW (kg) for child-average of the 50th percentile of females and males ages 8-15 from Exposure Factors Handbook Tables (77) 7-6 and 7-7 = 41.9
- Assumption used to calculate exposure after the cap: Exposure Duration for adult = 1 year; Exposure Duration for child = 1 year; BW (kg) for adult taken from average of women and men from Exposure Factors Handbook Table (77) 7-2 = 71.8; BW (kg) for child-average of the 50th percentile of females and males ages 10-11 from Exposure Factors Handbook (77) Tables 7-6 and 7-7 = 34.75

Table C-7. Contaminants (ppb) Detected in Leachate (includes Seep Material) by Year of Detection, Laytonville, California

Chemical \ Year	1989	1990	1991	1993	1994	1995	1996	1997	1998	2000	2001	2002	Health Comparison Value
Acetone	NT	13, 5.5	NT	13						9.3, 111, 190, 7.2, 8.4, 16, 46, 7.9, 14, 6.8, 8.5, 6.2, 11, 14, 70, 43, 8.8			1,000 (child RMEG) 4,000 (adult RMEG)
Aluminum	NT									14,000, 9,700, 78,000, 1,200, 58,000, 530,000, 8,100, 2,400,000, 5,200			1,000 (CA MCL)
Arsenic	NT									19, 16, 2,066, 470,			0.02 (CREG) 3 (child EMEG) 10 (adult EMEG)
Benzene	NT	NT	NT	9.3, 0.44	1.8, 0.73, 1.5	1.1		0.62		0.57, 0.53, 0.52, 0.50			0.6 (CREG) 5 (U.S. MCL)
Boron	NT			600, 100									100 (child interEMEG) 400 (adult interEMEG
Butylbenzene	NT	NT	NT	0.96*(sec)						0.87(n-), 1.5 (n-)			70 (CA Action Level for n-butyl benzene) 61 (PRG)
Chloroethane (ethyl chloride)	NT	NT	NT	2.7, 4.1						11, 7.1, 7.9, 4.2, 2.2, 0.9, 5.6, 4.4, 12, 14, 11,	8.0, 3.4, 1.3, 6.6, 6.3		4.6 (PRG)
Chromium (total)	NT	NT	NT	170, 110						100, 130, 65, 97, 650, 3,500			50 (CA MCL)
Dichlorodifluromethane	NT	NT	NT								1.4		2,000 (child RMEG), 7,000 (adult RMEG)

Table C-7. Contaminants (ppb) Detected in Leachate (includes Seep Material) by Year of Detection, Laytonville, California

Year / Chemical	1989	1990	1991	1993	1994	1995	1996	1997	1998	2000	2001	2002	Health Comparison Value
1,1-Dichloroethane	NT	NT	NT	0.59, 1.8						4.1, 0.54, 0.91, 0.51, 1.3, 0.88			7 (U.S. MCL) 90 (child EMEG) 300 (adult EMEG)
1,2-Dichloroethene	NT	NT	NT	0.75, 11									70 (U.S. MCL for cis-1,2-DCE 100 (U.S. MCL for trans-1,2-DCE)
Ethylbenzene	NT	NT	NT	11	2.2, 0.61	1.1, 0.6		1.4		0.55			700 (MCL)
Lead	NT	NT	NT	38, 42						110, 18, 450,			15 (CA Action Level)
Manganese	11000	NT	NT	2,000, 2,150						720, 1,400, 1,100, 1,200, 3,400, 2,300, 1,500, 740, 620, 2,500, 6,000, 2,300 28,000 2,600			500 (child RMEG) 2,000 (adult RMEG)
Methylene chloride (chloromethane)	NT	NT	NT	0.61, 2.1						13 , 0.93			5 (U.S. MCL, CREG) 600 (child) EMEG), 2,000 (adult EMEG)
Methyl ethyl ketone (2-butanone)	NT	1, 5.5	NT	171						3.3, 1.1			2,000 (child RMEG) 20,000 (adult RMEG)
Methyl isobutyl ketone	NT	NT	NT	28									40 (CA Action Level)
Nickel	NT	NT	NT	380									200 (child RMEG) 700 (adult RMEG)
Tetrachloroethene (PCE)	NT	NT	NT	0.54									5 (U.S. MCL) 100 (child RMEG) 400 (adult RMEG)

Table C-7. Contaminants (ppb) Detected in Leachate (includes Seep Material) by Year of Detection, Laytonville, California

Chemical \ Year	1989	1990	1991	1993	1994	1995	1996	1997	1998	2000	2001	2002	Health Comparison Value
Toluene	NT	NT	NT	61, 30	16, 3.5, 6.1	1.7, 75		1.2		0.33			200 child interEMEG; 700 adult interEMEG
Total petroleum hydrocarbons -diesel	NT	NT	NT	247, 120, 260, 360	130, 180			540					100 (SNARL)
Total petroleum hydrocarbons- gasoline	NT	NT	NT	NT		270, 58		66					5 (SNARL, based on benzene)
1,1,1-Trichloroethane	NT	NT	NT							1.2			200 (U.S. MCL)
Trichloroethene (TCE)	NT	NT	NT	0.5									5 (U.S. MCL)
1,2,4-Trimethylbenzene	NT	NT	NT	0.56						0.82			300 (CA Action Level)
Vanadium										190			30 child interEMEG); 100 adult interEMEG
Vinyl chloride	NT	NT	NT	1.6, 8.4						4.1, 0.83, 3.7, 7.5, 3.3, 3.9, 0.77, 0.69, 5.1, 3.4, 4.1, 2.5, 2	6.5, 1.3, 0.65, 3.9, 2.6		0.03 (CREG) 0.2 (child EMEG) 0.7 (adult EMEG) 2 (MCL)
Xylenes (total)	NT	NT	NT	6.4, 2.2	16, 1.7, 4.7	2.8, 1.9		7.1		2.4 (m,p)			2,000 (child RMEG) 7,000 (adult RMEG)

Data expressed as parts per billion (ppb)
The data was derived from quarterly monitoring reports submitted by the county to the RWQCB (38-45)
child EMEG and adult EMEG—ATSDR Environmental Media Evaluation Guide for chronic exposure (greater than 365 days)
MCL—U.S. EPA or California Maximum Contaminant Level in Drinking Water
PRG—U.S. EPA Region IX Preliminary Remediation Goal
child interEMEG and adult interEMEG—ATSDR Environmental Media Evaluation Guide for intermediate exposure (greater than 14 days and less 365 days), derived from ATSDR's intermediate MRL
child and adult RMEG—Reference Dose Media Evaluation Guide for chronic exposure, developed from U.S. EPA's Reference Dose
CA Action Level—California Action Level for Drinking Water
CREG—Cancer Reference Evaluation Guide developed from U.S. EPA's cancer potency factors
U.S. EPA SNARL— Suggested No Adverse Response Level
NT—not tested
Empty Cell— not detected if organic chemical or not detected above health comparison value for metals
1974 to 1988, 1992—no leachate samples were tested

Table C-8. Noncancer Assessment and Cancer Risk from Splashing and Playing in the Leachate at the Laytonville Landfill, Laytonville, California

				Splashing and Playing in Leachate Prior to Cap			Splashing and Playing in Leachate in 2000	
Chemical Name	**Adult or Child**	**Noncancer Health Comparison Value mg/kg/day**	**Source of Comparison Value**	**Noncancer Dose mg/kg/day**	**Exceeds Health Comparison Value Yes/No?**	**Total Cancer Risk**	**Noncancer Dose mg/kg/day**	**Exceeds Health Comparison Value Yes/No?**
Acetone	Adult	2	iMRL	7.93E-07	No		1.16E-05	No
	Child			1.09E-06	No		1.47E-05	No
Aluminum	Adult	2	iMRL				2.77E-01	No
	Child						4.18E-01	No
Arsenic	Adult	0.0003	cMRL				5.42E-06	No
	Child						9.41E-06	No
Benzene	Adult	0.004	RfD	1.87E-06	No	5.43E-08	1.25E-07	No
	Child			2.88E-06	No	1.81E-08	2.07E-07	No
Boron	Adult	0.09	RfD	6.92E-06	No	3.07E-08		
	Child			1.09E-05	No	1.06E-08		
Butylbenzene*	Adult			1.61E-06			2.51E-06	
	Child			2.52E-06			4.36E-06	
Chloroethane	Adult	2.86	RfD	2.17E-06	No		7.08E-06	No
	Child			2.87E-06	No		9.12E-06	No
Chromium (total)	Adult	0.003	HexRfD	3.92E-06	No		8.07E-05	No
	Child			6.16E-06	No		1.40E-04	No
Dichlorodifluoromethane	Adult	0.2	RfD					
	Child							

Table C-8. Noncancer Assessment and Cancer Risk from Splashing and Playing in the Leachate at the Laytonville Landfill, Laytonville, California

				Splashing and Playing in Leachate Prior to Cap			Splashing and Playing in Leachate in 2000	
Chemical Name	Adult or Child	Noncancer Health Comparison Value mg/kg/day	Source of Comparison Value	Noncancer Dose mg/kg/day	Exceeds Health Comparison Value Yes/No?	Total Cancer Risk	Noncancer Dose mg/kg/day	Exceeds Health Comparison Value Yes/No?
1,1-Dichloroethane	Adult	1	RfD	2.95E-07	No	8.56E-10	6.72E-07	No
	Child			4.29E-07	No	2.80E-10	9.82E-07	No
1,2-Dichloroethene	Adult	0.02	iMRL	2.28E-06	No	9.85E-09		
	Child			3.30E-06	No	3.20E-09		
Ethylbenzene	Adult	0.1	RfD	6.25E-06	No		3.13E-07	No
	Child			9.81E-06	No		5.42E-07	No
Lead	Adult			4.84E-08		2.15E-10	5.19E-07	
	Child			7.61E-08		7.39E-11	9.01E-07	
Manganese	Adult	0.02	RfD	1.27E-04	No		3.23E-04	No
	Child			1.99E-04	No		5.61E-04	No
Methylene chloride	Adult	0.06	cMRL	4.01E-07	No	1.51E-09	2.48E-06	No
	Child			5.06E-07	No	4.80E-10	3.29E-06	No
Methyl ethyl ketone (2-butanone)	Adult	0.6	RfD	6.17E-06	No		1.19E-07	No
	Child			8.76E-06	No		1.64E-07	No
Methyl isobutyl ketone	Adult	0.08	RfD	1.23E-06	No			
	Child			1.89E-06	No			
Nickel	Adult	0.02	RfD	4.38E-06	No			
	Child			6.88E-06	No			

Table C-8. Noncancer Assessment and Cancer Risk from Splashing and Playing in the Leachate at the Laytonville Landfill, Laytonville, California

				Splashing and Playing in Leachate Prior to Cap			Splashing and Playing in Leachate in 2000	
Chemical Name	**Adult or Child**	**Noncancer Health Comparison Value mg/kg/day**	**Source of Comparison Value**	**Noncancer Dose mg/kg/day**	**Exceeds Health Comparison Value Yes/No?**	**Total Cancer Risk**	**Noncancer Dose mg/kg/day**	**Exceeds Health Comparison Value Yes/No?**
Tetrachloroethene (PCE)	Adult	0.05	RfD	2.11E-07	No	5.62E-09		
	Child			3.30E-07	No	1.93E-09		
Toluene	Adult	0.02	iMRL	2.75E-05	No		1.21E-07	No
	Child			4.31E-05	No		2.09E-07	No
1,1,1-TCA	Adult	0.6	RfD				2.51E-07	No
	Child						3.99E-07	No
Trichloroethene (TCE)	Adult	0.0003	RfD	8.56E-08	No	6.65E-10		
	Child			1.31E-07	No	2.24E-10		
1,2,4-Trimethylbenzene	Adult	0.05	RfD	6.78E-07	No		9.93E-07	No
	Child			1.07E-06	No		1.73E-06	No
Vanadium	Adult	0.0003	iMRL				2.19E-06	No
	Child						3.81E-06	No
Vinyl chloride	Adult	0.00002	cMRL	7.15E-06	No	5.00E-06	6.38E-06	No
	Child		cMRL	9.79E-06	No	1.57E-06	8.01E-06	No
Xylenes	Adult	0.2	RfD	9.28E-06	No		1.47E-06	No
	Child			1.54E-05	No		2.56E-06	No

RFD—U.S. EPA Reference Dose
iMRL—ATSDR intermediate Minimal Risk Level
cMRL—ATSDR chronic Minimal Risk Level
mg/kg/day—milligram chemical(s) per body weight per day

Data taken from maximum values in Table 6
Dermal dose calculated per Exhibit 6-13 of U.S. EPA Risk Assessment Guidance for Superfund (44)
Inhalation dose calculated per Exhibit 6-16 of U.S. EPA Risk Assessment Guidance for Superfund (44)

- Assumptions used for calculating the inhalation dose before the cap: IR (m^3/hour) for the adult is the averaging of female and male adult rates doing moderate activity taken Exposure Factors Handbook (76) Table 5-6 = 2.35; IR (m^3/hour) for child exposure before the cap was installed is derived from weighting the rates of males and females aged 3-<10 (weighted = 1) and 10<18 (weighted = 2) doing moderate activity from U.S. EPA's Child Exposure Factors Handbook (78) Table 7-11 = 1.85
- Assumptions used for calculating the dermal dose: Skin surface area (adult) from U.S. EPA Exposure Factors Handbook (77) Tables 6-2 and 6-3 by averaging the 50^{th} percentile for lower legs, feet, and hands of females and males with that of the forearms of males (data not supplied for women) = 5,809 cm^2; Skin surface area (child before cap) from U.S. EPA Exposure Factors Handbook (77) Tables 6-6 and 6-7 average the 50th percentile for total body surface area for males and females ages 8-15 multiplied by the percentage of total surface area that the legs, hands, and feet obtained from Table 6-8 = 5,323 cm^2; Skin surface area (child exposure after cap) from U.S. EPA Exposure Factors Handbook (77) Tables 6-6 and 6-7 average the 50^{th} percentile for total body surface area for males and females ages 10-11 multiplied by the percentage of total surface area that the legs, hands, and feet obtained from Table 6-8 = 4,886 cm^2
- Assumptions used for calculating both the inhalation and dermal dose for both time periods: Exposure Time = 1 hour/day; Exposure Frequency = 52 days/year
- Assumptions used to calculate exposure before the cap: Exposure Duration for adult = 24 years; Exposure Duration for child = 8 years; BW (kg) for adult taken from average of women and men from Exposure Factors Handbook (77) Table 7-2 = 71.8; BW (kg) for child-average of the 50^{th} percentile of females and males ages 8-15 from Exposure Factors Handbook (77) Tables 7-6 and 7-7 = 41.9
- Assumption used to calculate exposure after the cap: Exposure Duration for adult = 1 year; Exposure Duration for child = 1 year; BW (kg) for adult taken from average of women and men from Exposure Factors Handbook (77) Table 7-2 = 71.8; BW (kg) for child-average of the 50^{th} percentile of females and males ages 10-11 from Exposure Factors Handbook (77) Tables 7-6 and 7-7 = 34.75

The volatilization rate of VOCS from the leachate was defined by a model that estimates the chemical releases from wastes that are discharged directly on a soil surface. The Dragun analytical model, which estimates the rate of vapor generation of pure chemicals under steady state conditions, can be used for this purpose (79). The Dragun model is defined by the following equation:

$$E = \left[2 \cdot Pv \cdot Wa \cdot \sqrt{(La \cdot Da \cdot U)/(3.1416) \cdot f}\right] \cdot [Wc / W]$$

where:	E	=	Emission rate, cubic centimeters per second, cm^3/sec
	Pv	=	Vapor pressure, (mm Hg) / 760
	Wa	=	Width of area occupied by the waste, centimeters, cm
	La	=	Length of source area, cm
	Da	=	Diffusion coefficient of chemical in air, cm^2/sec
	U	=	Wind speed, cm/sec
	f	=	Correction factor, (0.985-0.00775 Pv)
	Wc/W	=	Weight fraction of the chemical in waste, g/g

The volumetric emission rate is converted into a mass emission rate per unit area through the following equation:

$$Q = E \cdot (MW / G)$$

where:	Q	=	Mass emission flux, g/sec
	MW	=	Molecular weight, g/mole
	G	=	24,860 cm^3/mole
	All others as previously defined.		

A simple atmospheric dispersion model, commonly called a box model, was used to estimate ambient air concentrations of chemicals volatilizing from the leachate. A box model is a simple mass-balance equation that uses the concept of a theoretically enclosed space or box over the area of the leachate. The model assumes the emission of compounds into a box with their removal rate from the box being proportional to wind speed. Airborne concentrations for this enclosed space can then be calculated and used as the breathing zone air contaminant concentration for people playing in the leachate. The exposure concentration in the theoretical box is calculated using the following equation:

$$C = Q \cdot w / H \cdot U \cdot Ab$$

where:	C	=	Chemical concentration inside box, mg/m^3
	w	=	Length of box, m
	H	=	Height of the box, m
	Ab	=	Area occupied by the "box", m^2
	All others as previously defined.		

Assumptions used for calculating air level breathed while splashing and playing: Width of source area in feet = 10; Length of source area in feet = 10; Wind speed in mph = 1.8 (wind speed is average speed for the 3-day sampling conducted by U.S. EPA Au13-16, 2002 (54); Height of the box in feet = 7; Length of the box in feet = 10.

Table C-9. Results of Chemicals Analysis of Ambient Air and Landfill Gas Sampling Prior to Landfill Capping, Laytonville, California

Chemical Name	1987 Sampling by Ecoserve Inc. for the County			1993 Sampling by the California Air Resources Board						Health Comparison Value for Ambient Air
	Landfill Gas Well	Ambient Air		Landfill Gas Wells	Perimeter Gas Wells	Flux Chamber	24-Hour Ambient Air 6/9/93-6/11/93			
	32085	32103	32104	6/ 7/93		34128	Background	Northeast Perimeter	Southeast Perimeter	
Benzene	3000	<2	<2	194 (177-817)	<1	<2	<2	<2	<2	4 interMRL 19 REL 0.03 CREG
Carbon tetrachloride	<0.2	<0.2	<0.2	34.3 (<1-167)	<1	<0.5	<0.5	<0.5	<0.5	50 interMRL 200 acute MRL 0.01 CREG
Chloroform	1	<0.8	<0.8	4.4 (<1-22)	<1	<0.5	<0.5	<0.5	<0.5	20 MRL 50 interMRL 100 acuteMRL 0.08 CREG
1,2-Dibromoethane	<0.5	<0.5	<0.5	<1	<1	<0.5	<0.5	<0.5	<0.5	0.00065 CREG
1,2-Dichoroethane	65000	<0.2	<0.2	11 (2.89-35.2)	<1	<0.5	<0.5	<0.5	<0.5	600 MRL 0.01 CREG
Methylene chloride	14000	<1	<1	2,574 (<1-10,200)	<1	<2	<2	<2	<2	300 MRL and interMRL 600 acuteMRL 0.86 CREG
Tetrachloroethene	171	<0.2	<0.2	130 (3.4-383)	<1	<0.5	<0.5	<0.5	<0.5	40 MRL 200 acute MRL
1,1,1-Trichloroethane	162	<0.5	<0.5	1,674 (<1-7,350)	<1	<0.5	<0.5	<0.5	<0.5	700 interMRL 2,000 acute MRL
Trichloroethene (TCE)	372	<0.6	<0.6	194 (<1-780)	<1	<0.5	<0.5	<0.5	<0.5	100 interMRL 2,000 acuteMRL
Vinyl chloride	7	<2	<2	1,444 (904-2,060)	<1	0.712/ <0.5	<2	<2	<2	30 interMRL 500 acuteMRL 0.025 CREG

Data expressed in parts per billion (ppb); data obtained from references (49, 51); MRL—ATSDR chronic duration (>365 days) inhalation Minimal Risk Level; inter MRL—ATSDR intermediate duration (15-365 days) inhalation Minimal Risk Level; acute MRL—ATSDR acute duration (less than 15 days) inhalation Minimal Risk Level; CREG—Cancer Risk Evaluation Guide for 1 in 1,000,000 increased cancer risk; REL—California Reference Exposure Level.

Table C-10. Ambient Air Sampling on the Cahto Rancheria and Sylva Property in 2002 (After Landfill is Capped), Laytonville, California

Chemical Name	Sampling Time: 8/13/02 at 2 PM to 8/14/02 at 1PM					Sampling Time: 8/14/02 at 1:30 PM to 8/15/02 at 12:30 PM					Sampling Time: 8/15/02 at 12:30 to 8/16/02 at 11:30 AM					Health Comparison Value
	Sampling Stations on Cahto Rancheria				Adjacent Ranch	Sampling Stations on Cahto Rancheria				Adjacent Ranch	Sampling Stations on Cahto Rancheria				Adjacent Ranch	
	# 1	# 2	# 3	# 4		#1	#2	#3	#4		#1	#2	#3	#4		
Acetone	31	34	44	34	34/35	32	30	35/29	30	44	33	26/33	40	34	29	13,000 MRL
Acrolein	<0.44	**2***	<0.44	**1.9**	<0.44/<0.44	**1.8**	<0.44	**2.9/1.7**	<0.44	2.6	<0.44	**1.8/1.8**	**2**	<0.44	<0.44	0.009 interMRL 0.5 acuteMRL
Benzene	<0.31	<0.31	<0.31	<0.31	<0.31/<0.31	<0.31	<0.31	<0.31/<0.31	<0.31	<0.31	<0.31	<0.31/**1.5**	<0.31	<0.31	<0.31	19 REL 4 interMRL 0.03 CREG
Dichlorodifluoromethane	2.5	2.5	2.6	2.5	2.6/2.5	2.5	2.6	2.6/2.4	2.5	2.6	2.5	2.5/2.4	2.5	2.5	2.6	42 PRG
Ethanol	52	59	120	75	50//110	45	46	77/38	68	83	51	45/48	93	73	86	NA
Isopropyl alcohol	26	5.3	47	6.5	4.1/36	13	3	18/2.7	3.3	16	10	2.1/2.6	17	7	12	1,304 acuteREL
Methyl ethyl ketone	3.7	4.4	4.3	4.4	3.1/4.0	3.7	3.7	4.7/3.4	3.5	6.9	3.3	2.4/4.0	4.2	4.1	3	340 chronicREL 4,415 acuteREL
a-Pinene	**1.9**	<0.18	<0.18	<0.18	<0.18/<0.18	<0.18	<0.18	<0.18/**1.7**	<0.18	<0.18	<0.18	<0.18/**1.4**	<0.18	<0.18	<0.18	NA
Toluene	4	3.6	<0.27	4.9	1.9/2.9	<0.27	<0.27	<0.27/<0.27	<0.27	<0.27	<0.27	<0.27/<0.27	<0.27	<0.27	<0.27	80 MRL 9,833 acuteREL

Data expressed in parts per billion (ppb)
Data taken from reference (54)
Bolded concentrations exceed their health comparison values
MRL—ATSDR chronic duration (>365 days) inhalation Minimal Risk Level
inter MRL—ATSDR intermediate duration (15-365 days) inhalation Minimal Risk Level
acute MRL—ATSDR acute duration (less than 15 days) inhalation Minimal Risk Level
CREG—Cancer Risk Evaluation Guide for 1 in 1,000,000 increased cancer risk
REL—California Reference Exposure Level
PRG—U.S. EPA Region IX Preliminary Remediation Goal

Table C-11. Monitoring Well Installation on Landfill Property, Laytonville, California

Depth (Feet Below Ground Surface) / Years Used	MW 87-1	MW 87-2	MW 87-3	MW 90-1	MW 91-1	MW 93-1	MW 93-2	MW 94-1
	10/1987 to 4/1992	10/1987 to 4/1992	10/1987 to 4/1992	10-1990 to present	10/1991 to present	7/1993 to present	7/1993 to present	8/1994 to present
1775							GS-1775.4	
1770								
1765				GS-1768				
1760								
1755								
1750						GS-1752.1		
1745								
1740			GS-1744					GS-1743.8
1735								
1730				wl-1729.7		TS-1730.1	wl-1734.4	
1725	GS-1726					wl-1729.98	TS-1729.4	TS-1725.8
1720			TS-1725			BS1720.1		wl-1724.1
1715	wl-1718-1724						BS-1719.4	
1710			wl-1711-1715					BS-1710.8
1705	TS1708	GS-1707		TS-1708	GS-1706.8			
1700		wl-1700-1705						
1695					wl-1696.1			
1690								
1685		TS-1687		BS-1688				
1680								
1675								
1670					TS-1673.8			
1665								
1660					BS-1663.8			
1655								
1650								
1645			BS-1645					
1640								
1635								
1630								
1625	BS1628							
1620								
1615								
1610								
1605		BS-1607						
1600								

Data taken from references (3, 25, 49)
All measurements are in feet above mean sea level elevation
Grayed area illustrates approximate extent of screened interval in well
MW—Monitoring Well; TS—Top of Screen (Well Screen); wl—Water Level in Well; GS—Ground Surface; BS—Bottom of Screen.

Table C-12. Contaminant Concentration (ppb) and Monitoring Well(s) It Was Detected in by Year of Detection, Laytonville, California

Year / Chemical	1987*	1988*	1989*	1990*	1991*	1992*	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Health Comparison Value
Acetone				3 (87-1)	9.2 (87-2)						8 (93-2)						1,000 (child RMEG) 4,000 (adult RMEG)
Aluminum		40,000(87-1), 5,300(87-2), 5,200(87-3)	1,000(87-1), 2,000(87-2)												1,900; 14,300; 15,400; 20,900; 28,700; 41,106; 52,800; 113,000		1,000 (CA Action Level)
Arsenic		25 (87-2)			10, 16 (87-3); 11 (91-1)	12, 32 (87-2)	14 (91-1)	8.1, 14 (91-1)	8.8 (91-1)	11 (91-1)	16, 10 (91-1)	8.5 (91-1)		2.5 (90-1); 7.7 (91-1); 5.4 (93-2)	10, 12, 29, 99*	13.2 (91-1), 7.9 (93-2)**	0.02 (CREG) 3 (child EMEG) 10 (adult EMEG)
Barium														760 (90-1)	5,400, 840*	728 (90-1)**	700 (child RMEG) 2,000 (U.S. MCL, adult RMEG)
Boron	150 (87-2) 120 (87-3)	200 (87-2) 300 (87-3)		120 (87-2); 170 (87-3); 180 (90-1)		600 (87-3); 200 (90-1)	300 (90-1); 200 (91-1); 300 (93-2)	300 (93-1)									100 (child interEMEG) 400 (adult interEMEG)
Butylbenzene							9.9 (93-2)#	1.6 (94-1)***									70 (CA Action Level for n-butyl benzene) 61 (PRG)
Chloroform							0.54(90-1); 0.52 (91-1)										80 (U.S. MCL)
Chloromethane (methyl chloride)					0.77 (87-1); 1.2 (87-2); 1.1 (87-3); 1.3 (90-1)											0.3 (93-1)**	3 (U.S. MCL)

Table C-12. Contaminant Concentration (ppb) and Monitoring Well(s) It Was Detected in by Year of Detection, Laytonville, California

Chemical \ Year	1987*	1988*	1989*	1990*	1991*	1992*	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Health Comparison Value
Chromium (Total)		110 (87-1)	110 (87-1)												65, 90, 140, 300, 81, 52*		50 (CA MCL)
Cobalt																105 (93-1)**	100 (child interEMEG) 400 (adult interEMEG)
4,4-DDT	0.04 (87-3)		0.1 (87-3)														0.1 (CREG) 5 (child interEMEG), 20(adult interEMEG)
Dichlorodifluoromethane												0.8 (93-1)				0.2 (93-1)**	2,000 (child RMEG) 7,000 (adult RMEG)
1,1-Dichloroethene																0.1 (91-1)**	90 (child EMEG) 300 (adult EMEG) 7 (U.S. MCL)
Di-(2-ethylhexyl)phthalate															11, 96*	5 (90-1), 3 (91-1), 3 (93-2), 2 (94-1)**	6 (U.S. MCL)
Diethylphthalate							3.4 (90-1); 3.7 (90-1)										8,000 (child RMEG), 30,000 (adult RMEG)
Dimethylphthalate																39 (93-1)**	NA
Lead											15 (90-1)				20, 38*		15 (CA Action Level)

Table C-12. Contaminant Concentration (ppb) and Monitoring Well(s) It Was Detected in by Year of Detection, Laytonville, California

Chemical \ Year	1987*	1988*	1989*	1990*	1991*	1992*	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Health Comparison Value
Manganese	1,200 (87-1); 590 (87-2); 840 (87-3)	2,700, 1800 (87-1); 790, 1,100 (87-2); 1,700, 2,100 (87-3)	3,200, 2,400 (87-1); 2,200, 2,400 (87-2); 9,800, 2,200 (87-3)	1,540 (87-1); 2,020 (87-2); 1,550 (87-3), 2,120 (90-1)	3,800, 1,900 (87-1); 2,100, 2,000 (87-2); 1,700 (87-3); 1,100, 1,300 (90-1); 1,200 (91-1)	2,300 (87-1); 1,700 (87-2); 1,500 (87-3); 1,200, 970 (90-1); 2,800, 2,550 (91-1)	930, 1,820 (90-1); 2,980, 2920, 2,910 (91-1); 470, 430 (93-1); 2,830, 3,000, 3,810 (93-2)	1,100, 1,140 (90-1); 1,180, 2,710 (91-1); 2,270, 3,020 (93-2); 790, 650, 1,820 (94-1)	980, 1,100 (90-1); 2,000, 2,900 (91-1); 4,130, 5,300 (93-2; 1,350 (94-1)	1,000 (90-1); 2,900 (91-1); 4,100 (93-2); 970 (94-1)	1,300,1, 300 (90-1); 2,800, 2,500 (91-1); 4,400, 4,900 (93-2)	1,200 (90-1); 4,700 (93-2)		1,300 (90-1); 2,900 (91-1); 4,700 (93-2)	750; 1,200; 1,500; 2,000; 2,100; 2,200; 4,200; 8,500*	1,480(90-1), 2,820(91-1), 5,470(93-2)**	500 (child RMEG) 2,000 (adult RMEG)
Methyl acetate																0.3 (94-1)**	3,000 (odor concern)
Methylene chloride (Chloromethane)				0.6 (87-1); 1.3 (87-2)													5 (U.S. MCL, CREG) 600 (child) EMEG), 2,000 (adult EMEG)
Toluene								0.3 (93-2)									200 child interEMEG; 700 adult interEMEG
1,3,5-Trimethyl benzene								0. 77 (94-1)									330 (CA Action Level)
Vanadium		140 (87-1); 30 (87-2)													43, 53, 69, 91, 120, 200, 380*		30 child interEMEG; 100 adult interEMEG

Unless other indicated, data was derived from quarterly monitoring reports and other specific investigation reports submitted by the county to the RWQCB (3, 38-45, 49); Detections listed are measured in parts per billion (ppb); Monitoring well where detection was found is indicated in parenthesis
*Data from Seacor sampling; **Data from U.S. EPA site assessment sampling conducted in November 2002 (48); ***n-Butylbenzene; #sec-Butylbenzene
(87-2) denotes monitoring well number
PRG—U.S. EPA Region IX Preliminary Remediation Goal; child EMEG and adult EMEG—ATSDR Environmental Media Evaluation Guide for chronic exposure (greater than 365 days); MCL—U.S. EPA Maximum Contaminant Level in Drinking Water; CA MCL—California Maximum Contaminant Level in Drinking Water; child interEMEB and adult interEMEG—ATSDR Environmental Media Evaluation Guide for intermediate exposure (greater than 14 days and less 365 days); U.S. EPA SNARL—Suggested No Adverse Response Level; child and adult RMEG—Reference Dose Media Evaluation Guide for chronic exposure, developed from U.S. EPA's Reference Dose; CA Action Level—California Action Level for Drinking Water; CREG—Cancer Reference Evaluation Guide developed from U.S. EPA's cancer potency factors; Empty Cell—not detected if organic chemical or not detected above health comparison value for metals.

Table C-13. Contaminants Measured in Private Wells Located Near the Laytonville Landfill, Laytonville, California

Address of Private Well	Date of Water Test	Types of Analytical Tests Performed on Samples	Contaminants Detected	Amount of Contaminant (ppb)	Exceeds Health Comparison Value (y/n)
Unknown	2/11/93	Some metals, VOCs, no As	Lead	5	No
Branscomb Road	11/6/02	Metals, VOCs, SVOCs	Arsenic Bromodichloromethane Bromoform Chloroform Dibromochloromethane Di-(2-ethylhexyl)phthalate	36.9 10 6 6 15 1	No No No No No No
Branscomb Road	2/11/93	Some metals, VOCs, no As	Lead	33	Yes
	3/23/93	Lead	None		No
	4/16/93	Lead	None		No
	5/27/93	Lead	None		No
	9/3/93	Lead	None		No
	6/25/02	Metals, VOCs, PCBs	Toluene	1.6	No
	5/22/03	BTEX	None		No
Branscomb Road	6/25/02	Metals, VOCs, PCBs	Toluene	0.55	No
	12/3/02	MTBE, BTEX	None		No
Branscomb Road	4/2/93	VOCs	Toluene	4.1	No
	3/3/93	Metals, VOCs	1,1,1-Trichloroethane	0.5	No
	10/93	VOCs	Toluene	0.35	No
Lower Well	11/02	Metals, VOCs, SVOCs	Aluminum Manganese Di-(2-ethylhexyl)phthalate	1,370 & 4,370 1,970 & 1,870 1	Yes Yes No
Upper Well	11/02	Metals, VOCs, SVOCs	Manganese	2,590	Yes

Table C-13. Contaminants Measured in Private Wells Located Near the Laytonville Landfill, Laytonville, California

Address of Private Well	Date of Water Test	Types of Analytical Tests Performed on Samples	Contaminants Detected	Amount of Contaminant (ppb)	Exceeds Health Comparison Value (y/n)
Branscomb Road	2/11/93	Some Metals, VOCs, no As	Lead	5	No
Branscomb Road	3/3/93	Metals, VOCs	None		No
	5/2/97	Metals, VOCs	None		No
	7/23/00				
	6/25/02	Metals, VOCs, PCBs	Barium Toluene	28 0.74	No No
	11/4/02	Metals, VOCs, SVOCs	Bromodichloromethane Chloroform	0.2 5	No No
	12/3/02	MTBE, BTEX	None		No
Lakeview Drive	4/8/93	Some Metals, VOCs, no As	Lead	3	No
Lakeview Drive	8/22/97	Metals, VOCs	Arsenic	16	No
North Road	5/27/93	Metals	Arsenic	17	No
	6/25/02	Metals, VOCs, PCBs	Barium Toluene	1,100 2.4	Yes No
	12/3/02	MTBE, VOCs, Barium	Barium	970 (pre-filter) 470 (post-filter)	Yes No
North Road	2/11/93	Some Metals, VOCs, no As	Lead	5	No
North Road	6/25/02	Metals, VOCs, PCBs	Toluene	1.4	No
	12/3/02	MTBE, VOCs	None		No
North Road	11/7/02	Metals, VOCs, SVOCs	Arsenic Manganese Di-(2-ethylhexyl)phthalate	26.2 1,010 2	No Yes No

Table C-13. Contaminants Measured in Private Wells Located Near the Laytonville Landfill, Laytonville, California

Address of Private Well	Date of Water Test	Types of Analytical Tests Performed on Samples	Contaminants Detected	Amount of Contaminant (ppb)	Exceeds Health Comparison Value (y/n)
North Road	5/27/93	Metals	None		No
	6/28/02	Metals, VOCs, PCBs	Toluene	2.4	No
	12/3/02	MTBE, BTEX	None		No
North Road	6/25/02	Metals, VOCs, PCBs	Barium Toluene	10,000 4.9	Yes No
	5/22/03	Barium, BTEX	Barium	2,500 (pre-filter) <5 (after-filter)	Yes No
North Rd.	2/11/93	Some metals, VOCs, no As	None		No
Stump Road	3/3/93	Arsenic, VOCs	None		No
	12/3/02	MTBE, BTEX	None		No
	5/22/03	Metals, VOCs, PCBs	Arsenic	22	No
Mulligan Road	11/7/02	Metals, VOCs, SVOCs	Manganese	689	Yes
Briggs Lane	11/4/02	Metals, VOCs, SVOCs	Manganese Methyl ethyl ketone	663 0.2	Yes No
Steele Lane	11/6/02	Metals, VOCs, SVOCs	None		No
Mather Lane	11/6/02	Metals, VOCs, SVOCs	Aluminum Manganese Thallium	5,060 339 17.4	Yes Yes Yes
Mather Lane	11/6/02	Metals, VOCs, SVOCs	None		No

Data taken from references (3, 7, 25, 48, 49, 60, 61, 69)

VOCs—volatile organic compounds; As—arsenic; SVOCs—semi-volatile organic compounds; BTEX—benzene, toluene, ethyl benzene and xylenes; MTBE—methyl tertbutyl ether; PCBs—polychlorinated biphenyls; ppb—parts per billion.

Table C-14. Laytonville County Water District Monitoring for Arsenic in Treated Drinking Water (ppb), Laytonville, California

Sampling Month / Sampling Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1991												
1992												
1993				32						30	41	26
1995				42								
1996										34		
1997								36		34		32
1998	33	40	38	33	41	35	36	26	39	40	33	35
1999	36	32	33	35	38	36	35	39		39	43	42
2000	41	42	41	41	37	54						41
2001							41	39		40		
2002		41	41	40	43			41			43	
2003	43	41		37	43	36		40	40			

Data obtained from Laytonville Water District and the California Department of Health Services Drinking Water Program (73)
Empty cell—not tested or not available
Ppb—parts per billion

Appendix D—Brief Summaries About the Chemicals of Concern

This appendix summarizes background information from toxicological profiles published by the Agency for Toxic Substances and Disease Registry (ATSDR). It highlights the toxicological effects of the chemicals of concern (COCs) detected in the surface waters, leachate, landfill gas, ambient air, soil, or groundwater in and around the Laytonville landfill.

Acrolein (57)

- Used in the manufacture of many other chemicals; as a pesticide in irrigation waters, water treatment ponds, and recirculating process water system; and in military poison gas mixtures.
- Produced from combustion sources such as forest fires, fireplaces and cigarette smoke, when gasoline or oil are burned in a car or power plant, and when fat burns.
- Enters body easily after breathing it.
- Causes eye, nose, and throat irritation.
- Decreases bactericidal activity of respiratory tract probably through damage to epithelium
- Acute (<14 days) inhalation MRL = 0.00005 ppm (eye irritation in humans).
- Intermediate (15-364 days) inhalation MRL = 0.000009 ppm (damage to epithelial of the bronchi and lungs in rats).
- Reference concentration (RfC) = 0.02 $\mu g/m^3$.
- Chronic (>365 days) oral MRL = 0.0005 mg/kg/day (decreased monocytes in female rats)
- Carcinogenicity: U.S. Department of Health and Human Services (DHHS)—not classified; International Agency for Research on Cancer (IARC)—not classifiable.

Aluminum (80)

- Naturally-occurring element that is the third most abundant element in soil; occurs naturally in food.
- Very little uptake of aluminum occurs in the intestines and very little aluminum is breathed.
- Factory workers who breathed large amounts of aluminum dust can have lung problems.
- Has been linked with neurological effects in children with short-term exposure to high levels in drinking water, in Alzheimer’s disease, and in uremic patients receiving aluminum-containing dialysates.
- Aluminum-containing antiperspirant may cause rashes in some people.
- Intermediate (15-364 days) oral MRL = 2 mg/kg/day.
- Carcinogenicity: U.S. Department of Health and Human Services (DHHS)—not classified.

Arsenic (81)

- Naturally-occurring chemical commonly found in surface soil and surface water.
- Long-term exposures of lower levels of arsenic through drinking water (170-800 ppb) can lead to a condition known as “blackfoot disease”.
- Other effects include gastrointestinal irritation, and contact with skin can cause discoloration (hypo-or hyper-pigmentation), wart-like growths, and skin cancer.
- Acute oral MRL = 0.005 mg/kg/day (gastrointestinal effects in humans).
- Chronic oral MRL = 0.0003 mg/kg/day (dermal effects in humans).
- RfD = 0.0003 mg/kg/day (dermal effects in humans).
- U.S. EPA cancer slope factor = 1.5 $(mg/kg/day)^{-1}$.

- Carcinogenicity: U.S. Environmental Protection Agency (EPA)—human carcinogen (due to its ability to cause skin cancer); U.S. Department of Health and Human Services (DHHS)—known human carcinogen; International Agency for Research on Cancer (IARC)—human carcinogen (sufficient human evidence).

Barium (82)
- Naturally-occurring element that is commonly found in surface soil and surface water.
- General population is exposed normally through ingestion of drinking water or food.
- Soluble forms of barium are of more concern than insoluble ones.
- Human and animal evidence suggest cardiovascular effects (increased blood pressure, changes in heart rhythm, myocardial damage, changes in heart physiology and metabolism) are the main concern.
- Reference dose (RfD) = 0.07 mg/kg/day.
- Carcinogenicity: U.S. Environmental Protection Agency (EPA)—not classifiable as to human carcinogenicity; U.S. Department of Health and Human Services (DHHS)—not classified.

Benzene (32, 83)
- Naturally-occurring chemical, also in top 20 (by volume) of chemicals produced in the U.S.; used in a very wide range of products and industrial processes; found in environment as a result of both human and natural processes.
- Degrades relatively quickly in air, slowly in soil and water; does not bioaccumulate.
- Enters body through inhalation, ingestion, and dermal absorption.
- Adverse health effects due to intermediate or chronic exposures include disruption of blood production and possible reproductive problems in women.
- RfD = 0.004 mg/kg/day (decreased lymphocyte count in humans).
- RfC = 30 $\mu g/m^3$ (decreased lymphocyte count in humans).
- REL = 60 $\mu g/m^3$ (blood system, developmental and nervous system effects).
- Intermediate inhalation MRL = 4 ppb (13 $\mu g/m^3$) (neurological effects in mice).
- U.S. EPA oral slope factor = 5.5×10^{-2} $(mg/kg/day)^{-1}$.
- California Office of Environmental Health Hazard Assessment (OEHHA) inhalation unit risk = 2.9×10^{-5} $(\mu g/m^3)^{-1}$.
- U.S. EPA inhalation unit risk = 7.8×10^{-6} $(\mu g/m^3)^{-1}$.
- Carcinogenicity: U.S. Environmental Protection Agency (EPA)—human carcinogen (due to its ability to cause leukemia); U.S. Department of Health and Human Services (DHHS)—known human carcinogen; International Agency for Research on Cancer (IARC)—human carcinogen (sufficient human evidence).

Boron (84)
- Naturally-occurring element found in soil and water.
- Breathing moderate levels of boron can irritate the nose, throat, and eyes.
- Ingesting large amounts of boron over a short period can harm the stomach, intestines, liver, kidneys, and brain.

- Intermediate oral MRL = 0.01 mg/kg/day.
- U.S. EPA has not classified boron as to its carcinogenicity.
- Oral reference dose = 0.09 mg/kg/day (testicular atrophy, spermatogenic arrest).
- Intermediate (15-364 days) oral MRL = 0.01 mg/kg/day.
- Carcinogenicity: U.S. Department of Health and Human Services (DHHS)—not classified.

Chloroethane (85)

- Synthetic chemical
- Used in the production of chemicals and pharmaceuticals, as anesthesia, and as a solvent.
- Used more in the past, in the production of tetraethyl lead.
- Evaporates rapidly from water; typically found as a gas.
- Produced skin, brain, uterine, and lymphoma cancer in rats.
- Acute inhalation MRL = 15 ppm (based on no effect level from a reproductive study in mice).
- Reference concentration (RfC) = 10 mg/m^3 or 4 ppm (based on no effect level from a reproductive study in mice).
- Carcinogenicity: U.S. Department of Health and Human Services (DHHS)—not classified; International Agency for Research on Cancer (IARC)—not classifiable.

Chromium (86)

- Naturally-occurring element that is commonly found in surface soil and surface water.
- Chronic (>365 days) oral MRL for hexavalent chromium = 0.003 mg/kg/day.
- Chronic (>365 days) oral MRL for trivalent chromium = 1.5 mg/kg/day.
- Carcinogenicity for hexavalent chromium: U.S. Environmental Protection Agency (EPA)—human carcinogen; U.S. Department of Health and Human Services (DHHS)—known human carcinogen; International Agency for Research on Cancer (IARC)—carcinogenic to humans.
- Carcinogenicity for trivalent and total chromium: U.S. Environmental Protection Agency (EPA)—not classifiable; U.S. Department of Health and Human Services (DHHS)—not classified; International Agency for Research on Cancer (IARC)—not classifiable.

Lead (87)

- Naturally-occurring metal found in small amounts in the earth's crust; most of the high levels of lead found in the environment are from human activities.
- People may be exposed to lead by eating foods or drinking water that contains lead (as from lead pipes, leaded-crystal glassware, etc.) from spending time in areas where leaded paints have been used or are deteriorating, and from other sources.
- People who live near hazardous waste sites may be exposed to lead and chemicals containing lead by breathing the air, swallowing dust and dirt containing lead, or drinking lead-contaminated water.
- Lead affects the nervous system, the blood system, the kidneys and the reproductive system.
- Low blood levels (30 µg/dL) may contribute to behavioral disorders; lead levels in young children have been consistently associated with deficits in reaction time and with reaction behavior. These effects on attention occur at blood lead levels extending below 30 ug/dL,

and possibly as low as 15-20 µg/dL.
- Health effects associated with lead are not based on an external dose, but on internal dose that takes into account total exposure.
- Federal agencies and advisory groups have redefined childhood lead poisoning as a blood lead level of 10 µg/dL.
- OSHA requires workers with a blood lead level >50 µg/dL be removed from the work area where lead exposure is occurring.
- Carcinogenicity: U.S. Environmental Protection Agency (EPA)—probable human carcinogen (inadequate human, sufficient animal studies); U.S. Department of Health and Human Services (DHHS)—not classified; International Agency for Research on Cancer (IARC)—possibly carcinogenic to humans (limited human evidence, less than sufficient evidence in animals).

Manganese (88)
- Naturally-occurring element that is commonly found in surface soil and surface water.
- General population exposed through food.
- Essential nutrient.
- Chronic exposure can cause neurological effects, sometimes resulting in a syndrome called manganism.
- Decreased libido and impotence have been observed in manganese-exposed subjects.
- Exposure to workers caused suppression of immune T and B lymphocytes and impaired fertility.
- Chronic (>365 days) inhalation MRL = 0.00004 mg/m^3, based on neurobehavioral tests (reaction time and finger tapping) of people.
- Reference dose (RfD) = 0.005 mg/kg/day in water or 0.14 mg/kg/day in food.
- Reference concentration (RfC) = 0.05 µg/m^3.
- Carcinogenicity: U.S. Environmental Protection Agency (EPA)—not classifiable; U.S. Department of Health and Human Services (DHHS)—not classified.

Methylene chloride (dichloromethane) (89)
- Synthetic chemical, widely used in solvents, paint strippers, and other products.
- Evaporates easily, but does not easily dissolve in water.
- Enters the body most commonly through inhalation, but also through ingestion and dermal absorption.
- Breaks down slowly in air.
- Chronic oral MRL = 0.06 mg/kg/day (liver effects in rats).
- Oral reference dose = 0.06 mg/kg/day (liver effects in rats).
- Inhalation reference concentration = 3,000 µg/m^3 (adverse health effects in rats).
- Oral slope factor = 0.0075 (mg/kg/day)$^{-1}$.
- Inhalation unit risk = 0.4 x 10^{-7} (µg/m^3)$^{-1}$.
- Chronic inhalation MRL = 300 ppb; intermediate inhalation MRL = 300 ppb; acute inhalation MRL = 600 ppb.
- Carcinogenicity: U.S. Environmental Protection Agency (EPA)—probable human

carcinogen (inadequate human, sufficient animal studies); U.S. Department of Health and Human Services (DHHS)—reasonably anticipated to be a carcinogen; International Agency for Research on Cancer (IARC)—possibly carcinogenic to humans (limited evidence, less than sufficient evidence in animals).

Nickel (90)
- Naturally-occurring element that is commonly found in surface soil and surface water.
- Exposure occurs to most people on a daily basis, primarily from food intake.
- The most common adverse health effect is an allergic reaction, for instance skin rashes as the point of contact or on other parts of the body or asthma attacks.
- Workers exposed to nickel had an increased amount of lung and nasal cancers compared to the general population.
- Inhalation unit risk factor = 4.8×10^{-4} $(mg/m3)^{-1}$.
- Chronic inhalation MRL = 2 µg/m^3 or 0.2 µg/m^3 (chronic active inflammation and lung fibrosis in rats).
- Reference dose (RfD) = 0.02 mg/kg/day.
- Carcinogenicity: U.S. Environmental Protection Agency (EPA)—known human carcinogen; U.S. Department of Health and Human Services (DHHS)—reasonably anticipated to be a carcinogen; International Agency for Research on Cancer (IARC)—possibly carcinogenic to humans (limited human evidence, less than sufficient evidence in animals).

Alpha(α-)-pinene (55, 56)
- Present in indoor and outdoor air.
- Emitted from trees and wood especially pine, spruce and citrus; used as a fragrance in household products or in some cases as a solvent.
- Causes irritation of the skin and mucous membranes.
- Prolonged exposure may result in allergic contact dermatitis and chronic lung function impairment.
- Airway irritation has been shown to occur at 38,000 ppbv.

Toluene (91)
- Naturally-occurring chemical; also the result of industrial processes.
- Widely used solvent in many industrial processes and products.
- Enters body through ingestion, inhalation and dermal absorption.
- Adverse health effects due to intermediate and chronic exposures include tiredness, confusion, weakness, drunken-type actions, memory loss, nausea and loss of appetite.
- Chronic inhalation MRL = 0.08 ppm (0.30 mg/m^3) (neurological effects in humans).
- Intermediate oral MRL = 0.02 mg/kg/day (neurological effects in mice).
- Oral reference dose = 0.2 mg/kg/day (increased organ weight in rats).
- Inhalation reference concentration = 0.4 mg/m^3 (neurological effects in humans).
- Carcinogenicity: U.S. Environmental Protection Agency (EPA)—not classifiable as to human carcinogenicity; U.S. Department of Health and Human Services (DHHS)—not classified; International Agency for Research on Cancer (IARC)—not classifiable.

Total petroleum hydrocarbons—diesel (92)

- Defined as a measurable amount of petroleum-based hydrocarbons with diesel-like characteristics.
- Hydrocarbons ranging from 8-12 carbons to 24-26 carbons present in various ratios.
- Health effects assessment not based on mixture but on important components such as naphthalene and pyrene.

Total petroleum hydrocarbons—gasoline (92)

- Defined as a measurable amount of petroleum-based hydrocarbons with gasoline-like characteristics.
- Hydrocarbons ranging from 6 carbons to 10-12 carbons present in various ratios.
- Health effects assessment not based on mixture but on important components such as
- benzene, ethyl benzene, toluene, xylenes, and n-hexane.

Vanadium (93)

- Naturally-occurring element that is commonly found in air, surface soil and surface water.
- Exposure occurs to most people on a daily basis, primarily from food intake.
- Chronic intermediate MRL = 0.003 mg/kg/day based on a kidney study that saw no effects in rats exposed to 5 ppm in the drinking water for 3 months.
- Acute inhalation MRL = 0.2 $\mu g/m^3$.
- Carcinogenicity: U.S. Department of Health and Human Services (DHHS)—not classified.

Vinyl chloride (94)

- Synthetic chemical used in a variety of products, especially PVC (polyvinylchloride) plastic products.
- Gas at ambient conditions.
- Degrades quickly in air to other chemicals that are also toxic.
- Most likely route of exposure is inhalation, though ingestion can also occur.
- Adverse health effects from chronic inhalation exposures include changes in liver structure, neurological damage, immune reactions, decreased blood flow to extremities, reproductive effects and cancer.
- Intermediate inhalation MRL = 0.03 ppm (76.7 $\mu g/m^3$) (liver effects in rats).
- Chronic oral MRL = 0.00002 mg/kg/day (liver effects in rats).
- Reference concentration (RfC) = 100 $\mu g/m^3$.
- Reference dose (RfD) = 0.003 mg/kg/day.
- Inhalation slope factor = 0.295 $(mg/kg/day)^{-1}$.
- Oral slope factor = 1.4 $(mg/kg/day)^{-1}$.
- Inhalation unit risk = 7.8×10^{-5} $(\mu g/m^3)^{-1}$.
- Carcinogenicity: U.S. Environmental Protection Agency (EPA)—human carcinogen; U.S. Department of Health and Human Services (DHHS)—known human carcinogen; International Agency for Research on Cancer (IARC)—carcinogenic to humans (sufficient human evidence).

Appendix E—Health Consultation: Response to Community Questions About Groundwater at the Laytonville Landfill Site, June 2001

HEALTH CONSULTATION

Response to Community Questions about Groundwater at the LAYTONVILLE LANDFILL SITE

Laytonville, Mendocino County, CALIFORNIA

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Background and Statement of Issues

CDHS-EHIB requested Agency for Toxic Substances and Disease Registry (ATSDR) assistance in responding to community questions concerning possible contamination of domestic water supply wells near the Laytonville Landfill in Mendocino County, California. The Laytonville Landfill is a now-closed municipal waste landfill. It is regulated under Subtitle D of the Resource Conservation and Recovery Act, and California solid waste laws and regulations. Covering approximately 37 acres, the Laytonville Landfill site is on Branscomb Road, some 1.7 miles southwest of downtown Laytonville. Sanitary waste disposal was confined to an approximately 4.7 acre area within the site boundaries.

During the late 1960s and early 1970s the site operated as a “burn dump.” Beginning in 1974, residential waste, commercial waste, and construction debris were land filled. Following a 1993 decision to close the landfill, a closure plan was created and in 1997 the landfill was capped.

In 1987, three groundwater monitoring wells were installed on site (MW87-1, MW87-2, and MW87-3). Additional monitoring wells were installed in the 1990s. The 1987 monitoring wells were abandoned during installation of new monitoring wells MW93-1 and MW93-2. The current groundwater monitoring system comprises five monitoring wells installed between 1990 and 1994 (MW90-1, MW91-1, MW93-1, MW93-2, MW94-1).

In 1991, regular water analyses of landfill leachate emissions began. Chemical parameters for the analyses included metals and other inorganic compounds, volatile organic compounds (VOCs), and pesticides.

In 1986, Mendocino County Solid Waste Division (MCSWD) and the Regional Water Quality Control Board (NCRWQCB) received complaint letters from several nearby residents which included reports of “bright yellow” water flowing from the landfill.

CDHS-EHIB is currently preparing a PHA of the Laytonville Landfill under a cooperative agreement with ATSDR. In the course of investigating community health concerns, CDHS scientists learned of concerns regarding the possible contamination of local domestic drinking water wells. The concerns are summarized below:

1A. Are existing monitoring wells properly located to detect groundwater contamination?
1B. If the answer to 1A is no, how many more wells are needed, and where?
1C. Could gross contamination remain substantially undetected by current monitoring wells?
1D. Are the monitoring wells at the correct depth to detect contamination?
1E. If the answer to 1D is no, are deeper monitoring wells needed?

2A. Is there an existing true upgradient monitoring well?
2B. If the answer to 2A is no, where would an upgradient monitoring well be placed?

3. Should a monitoring well be installed south of the dumpsite, but within the landfill property?

4A. Is the Rancheria downgradient?
4B. Are Rancheria residents in danger of their groundwater becoming contaminated?

5. Are contaminated groundwater or surface water runoff likely to enter Canto Creek?

6. Are the private wells near Canto Creek likely to become contaminated?

7. Could any groundwater contamination flow into the bedrock aquifer, then off site?

8A. How many aquifers are under the landfill site?
8B. Are the aquifers confined, semi-confined or unconfined?

9A. Does the groundwater under the dumpsite follow the ground surface, in the shape of an inverted "U," or does it only remain at the level of the base of the hill?
9B. If the groundwater follows an inverted "U," is there a possibility of any seepage from the sides of that inverted "U"?

10. In winter and spring, how close is the groundwater flow to the underside of the dumpsite?

11. In the initial water tests, mineralization and high total dissolved solids, and high specific conductance were detected. Do those test results shed any light on the groundwater contamination question?

Discussion

Community questions focus on whether existing monitoring wells are effective in determining the existence of groundwater contamination on the landfill site, and, if so, whether any detected contamination threatens off-site drinking water wells.

To answer those questions, the CDHS scientists obtained and forwarded to ATSDR excerpts from site-specific groundwater investigations conducted by consultants on behalf of the MCSWD (references 1-4). CDHS scientists also forwarded excerpts from reports prepared by environmental consultants for the Bureau of Indian Affairs (5) and U. S. Army Corps of Engineers = groundwater investigation and monitoring reports on the Laytonville Rancheria property east of the landfill (6). This technical information—including the drilling logs—was reviewed during preparation of this health consultation.

This health consultation supports the PHA process by addressing questions regarding possible groundwater contamination at the landfill. The responses to these questions are for public health purposes. They are not intended to be used for regulatory purposes, nor as a peer review of environmental investigations at the site. The quality of the responses is limited by the quality and quantity of the technical information reviewed. The information used in preparing this health consultation does not include a site visit by its principal author, nor interviews with any California-licensed hydrogeologists who might have conducted site specific investigations.

Responses are in italics, immediately below the questions.

1A. Are the monitoring wells properly located to detect groundwater contamination?
Past and current monitoring wells installed on site probably would have detected contamination if a large and continuous volume of highly contaminated groundwater flowed from the landfill. However, the complex hydrogeology of the site reduces the capability of a few monitoring wells to detect low volume, low concentration, groundwater contamination.

1B. If the answer of 1A is no, how many more wells are needed, and where?
For public health purposes, two additional monitoring wells are probably needed to provide an early warning if groundwater contamination exists and is moving toward residential wells immediately north of the property boundaries. The monitoring wells should be screened at the same depth as the residential wells. One monitoring well located in the northwestern corner of the property and another near the center of the northern boundary could provide some indication if groundwater contamination is occurring at levels of concern, and whether that contamination could reach residential wells.

1C. Could gross contamination remain substantially undetected by current monitoring wells?
Gross groundwater contamination (gross contamination is defined as a large and continuous volume of highly contaminated groundwater) is unlikely to be undetected. As indicated in the answer to 1A, past and current monitoring wells would probably have detected any large and continuous volume of highly contaminated groundwater.

1D. Are the monitoring wells at the correct depth to detect contamination?
For public health purposes, groundwater monitoring wells should serve as sentinels, guarding against contamination moving toward nearby drinking water supplies. To provide an early warning of drinking water well contamination, monitoring wells should monitor the aquifer and the depths from which the nearest drinking water well draws water. One of the earliest monitoring wells, MW 87-3 (now abandoned), appears to have been designed to monitor the same aquifer and depths as residential wells adjacent to the landfill's northern boundary. Monitoring Well 87-2 (also now abandoned) appears to have been designed to monitor groundwater in the bedrock aquifer near the landfill's eastern boundary, adjacent to the Rancheria property. Current monitoring well MW91-1 is, apparently, also designed to monitor the same aquifer and depths that supply water to drinking water wells located east of the landfill.

The remaining current monitoring wells appear to be designed to intercept contaminants in the uppermost aquifer on the east, north, and west sites of the capped disposal area. Because of the complexity of the site hydrogeology, no single well depth would be adequate to monitor all possible pathways of groundwater contamination. The different depths of the current monitoring wells appear to be a reasonable attempt to intercept likely groundwater contamination pathways. As indicated in response to question 1B above, two additional monitoring wells located closer to the northern boundary might provide additional warning if groundwater contaminants are present in that area and moving toward off-site drinking water wells. If installed, the two monitoring wells should monitor the aquifer utilized by the nearest drinking water wells, and should be at the same depths as those wells.

1E. If the answer to 1D is no, are deeper monitoring wells needed?
Not necessarily. Two additional monitoring wells near the northern boundary should be considered to monitor the same aquifer and depths of the nearby drinking water wells. Information from current and past bedrock monitoring wells indicates the fracture aquifer has an upward groundwater gradient; thus downward movement of groundwater contaminants from the landfill into a deeper groundwater zone seems unlikely. Consequently, it is doubtful that installing wells to monitor zones deeper than the abandoned 1987 monitoring wells would provide any new information or an improved monitoring system.

2A. Is there an existing true upgradient monitoring well?
No monitoring well upgradient of the landfill waste disposal area could be discerned from the information reviewed.

2B. If the answer to 2A is no, where would an upgradient monitoring well be placed?
For public health purposes, an upgradient well is not needed. A residential well in a similar geology but not downgradient from the site could, for public health purposes, provide general information about local water chemistry.

3. Should a monitoring well be installed south of the waste disposal site, but within the landfill property?
Not unless there is a drinking water spring or well adjacent to that southern boundary that requires protection by providing additional on-site monitoring.

4A. Is the Rancheria downgradient?
A portion of the groundwater flowing from the landfill could flow beneath the Rancheria property. Monitoring wells MW93-2 and MW91-1 probably intercept some of the groundwater moving from the capped disposal area toward the Rancheria property. The complexity of the hydrogeology limits complete characterization of the volume and

chemistry of the groundwater flow toward the Rancheria property. However, available groundwater monitoring does not indicate a major contaminant plume.

4B. Are the Ranchiera residents in danger of their groundwater becoming contaminated?

In 1996, monitoring by the U.S.Army Corps of Engineers (COE) did not detect landfill groundwater contaminants present in Rancheria groundwater. However, the monitoring of Rancheria groundwater is limited. For example, the technical information reviewed indicates that past and existing drinking water wells in Rancheria have not been monitored for any specific contamination from the landfill.

5. Are contaminated groundwater or surface water runoff likely to enter Cahto Creek?

Based on the technical information provided, Cahto Creek is unlikely to receive enough contaminated groundwater from the landfill to be discernible from other contaminants flowing from upstream sources, (i.e., mining operations). A portion of the surface runoff from the landfill property probably does drain into Cahto Creek.

A review of topographic maps and aerial photographs indicates surface water runoff from the southwestern side of the landfill could flow into a minor tributary of Cahto Creek. Also, the southeastern side of the landfill appears to drain toward Cahto Creek. However, the northern portion of the landfill property probably drains toward Cahto Lake north of Branscome Road rather than into Cahto Creek. Review of the technical information provided did not indicate the presence of high levels of surface water contaminants flowing from the landfill into Cahto Creek.

Although some groundwater flowing from the landfill property probably reaches Cahto Creek, the marshy area on the northeastern side of the landfill property and Cahto Lake to the northeast are also likely receiving areas for groundwater flowing from the landfill site.

6. Are the private wells near Cahto Creek likely to become contaminated?

The COE report did not identify any site-specific chemical contaminant moving from the landfill to the uppermost groundwater zone on the Cahto Reservation. Past and current on-site groundwater monitoring does not indicate sufficient concentrations or volume of groundwater contaminants to pose a problem for most off-site residential wells. However, the information is too limited to predict continued safety of nearby domestic drinking water wells. For example, a domestic well is reported in use immediately north of the central border of the landfill property. No analysis of that well water has been provided to determine if the well has been contaminated by landfill sources.

7. Could any groundwater contamination flow into the bedrock aquifer, then off site?
The reviewed technical information does not provide enough information on the vertical groundwater gradient to or from the bedrock aquifer to completely answer this question. As previously discussed, there is probably some downward leakage of groundwater into the bedrock aquifer in the general area. However, contaminants and levels reported from the past and current groundwater monitoring wells do not indicate any significant levels of contaminants in the deeper groundwater.

Also, information from some of the monitoring wells screened in fractured material (assumed bedrock aquifer) indicate the vertical flow gradient maybe upward, not downward, at the monitoring well location. If the bedrock groundwater is under higher pressure than the overlying groundwater, vertical movement of landfill contaminants into a zone of higher pressure seems unlikely.

8A. How many aquifers are under the landfill site?
The best estimate would be at least one perched zone, a water table aquifer in unconsolidated material such as alluvium, and a confined or semi-confined bedrock aquifer. However, the multiple clay lenses and clayey layers could create multiple isolated perched zones of water in thin layers.

8B. Are the aquifers confined, semi-confined or unconfined?
The perched zones are unconfined, as is the water table aquifer. The bedrock aquifer might vary from semi-confined to confined, depending on overlying materials and hydraulic connection to alluvium.

9A. Does the groundwater under the dumpsite follow the ground surface in the shape of an inverted "U," or does it only remain at the level of the base of the hill?
Flow patterns in the upper groundwater zones probably follow the topography. However, the multiple zones of mixed clays, sands, and gravels are too complex to produce a simplistic flow pattern such as an inverted "U." As indicated above, drilling logs and monitoring wells indicated some perched zones; that is, thin layers of water separated from the water table (zone of water-saturated geologic materials) by unsaturated geologic materials.

These thin layers of water do not constitute a true aquifer capable of providing an adequate well water supply. If contaminants are moving downward into soil and rock beneath the landfill, the contaminants will first flow into, then laterally along, the thin layers of water until a vertical pathway is available for further downward movement. If an effective leachate drainage system is not operating at the landfill, some of the contaminated water will emerge from the sides of the landfill as leachate or contaminated seeps and springs, flowing downhill along surface drainage pathways.

Consequently, the flow pattern from the closed disposal area is not so much an inverted "U" as it is a leaky series of clayey steps with both lateral and vertical flow components. Some vertical components will enter the fractured rocks of the Franciscan formation at elevations higher than the elevations at the northern dumpsite boundary. Water in those fractures will be confined by the clayey layers and rock above.

9B. If the groundwater follows an inverted "U," is there any seepage from the sides of that inverted "U"?
See response to 9A, above.

10. In winter and spring, how close is the groundwater flow to the underside of the dumpsite?
The technical information reviewed is insufficient to address adequately this question.

11. In the initial water tests, mineralization and high total dissolved solids, and high specific conductance were detected. Do those results shed any light on the groundwater contamination question?
Groundwater may be naturally high in minerals and dissolved solids, resulting in high conductance readings. The only way to determine if the high levels of specific conductance are indicate a public health problem is to measure for specific metals and other contaminants and compare those results with other, uncontaminated local groundwater sources. By themselves, reports of high total dissolved solids do not provide any meaningful information for public health analysis of drinking water.

Conclusions

Public health conclusions about groundwater contamination at the Laytonville Landfill are limited by the complexity of the site hydrogeology and available technical information. Sampling and analytical results from past and current monitoring wells do not indicate the presence of a large volume of highly contaminated groundwater on the site. Existing municipal water supply wells in Laytonville are unlikely to be affected by any groundwater contamination from the Laytonville Landfill because of the distance and direction the contaminants would have to travel to affect the municipal wells. Also, the monitoring by the COE does not indicate the abandoned water supply wells on the Rancheria property are likely to be affected by possible groundwater contaminants from the landfill. However, monitoring information is too limited to determine if residential, drinking water wells immediately north of the landfill are threatened by groundwater contaminants from the landfill.

Recommendations

1. Install of two additional monitoring wells on the northwestern and north-central boundaries of the landfill property to determine if any significant groundwater

contamination exists in those areas, and, if so, to determine whether the contaminants could move toward nearby drinking water wells. The monitoring wells should be designed to monitor the same groundwater zones as the nearest drinking water wells still in use.

2. Perform sampling and analysis of all drinking water wells still in use near the northeastern and north-central landfill boundaries.

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Appendix F— Public Comment Release of the Laytonville Landfill Public Health Assessment

On July 16, 2004, this PHA for the Laytonville Landfill site was released for public comment. The comment period was scheduled to end August 20, 2004, but at the request of a community member, CDHS extended the public comment period to September 20, 2004.

CDHS presented the PHA findings and recommendations at a community meeting in Laytonville on July 26, 2004 and at the Cahto Tribe General Council meeting on August 5, 2004. CDHS sent the PHA Summary and a flyer announcing the Laytonville community meeting to 1,760 post office boxes in Laytonville. CDHS sent the PHA to a mailing list of 66 agency, Mendocino County Observer newspaper office, Healthy Start office, Laytonville County Water System office, and the Cahto Tribe headquarters. CDHS also posted the PHA on the state's web site (www.cdhs.ca.gov/ps/deodc.ehib).

No public comment was received.