Letter Health Consultation

Boeing Commercial Airplane Fabrication Division, Auburn Plant
Exposures to Surface Water in Chicago Avenue Ditch and Government Canal
Algona, King County, Washington

March 28, 2013

Prepared by

The Washington State Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Washington State Department of Health

DOH 334-325 March 2013

Foreword

The Washington State Department of Health (DOH) prepared this health consultation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services. ATSDR is responsible for health issues related to hazardous substances.

The purpose of a health consultation is to assess the health threat posed by hazardous substances in the environment. If needed, a health consultation will also recommend steps or actions to protect public health. Health consultations are initiated in response to health concerns raised by residents or agencies about exposure to hazardous substances.

This health consultation was prepared in accordance with ATSDR methodologies and guidelines. However, the report has not been reviewed and cleared by ATSDR. The findings in this report are relevant to conditions at the site during the time the report was written. It should not be relied upon if site conditions or land use changes in the future.

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STATE OF WASHINGTON

DEPARTMENT OF HEALTH

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March 28, 2013

Mayor David Hill
City of Algona
City Hall
402 Warde Street
Algona, Washington 98001

Re: Letter Health Consultation
Boeing Commercial Airplane Fabrication Division, Auburn Plant
Exposures to Surface Water in Chicago Avenue Ditch and Government Canal
Algona, King County, Washington

Dear Mayor Hill:

At the request of the City of Algona, the Washington State Department of Health (DOH) evaluated surface water chemical data collected in the Chicago Avenue ditch and Government Canal in Algona. The data, which were limited to volatile organic compounds (VOCs), were collected as part of the ongoing groundwater remedial investigation by the Boeing Commercial Airlines Plant in Auburn. This evaluation determines whether the chemicals found in the ditch pose a health concern to:

- Children playing in ditches.
- City personnel working in ditches.

DOH conducts health consultations in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR).

Background

Past releases of chlorinated solvents (VOCs) by Boeing resulted in two plumes of contaminated groundwater. The plumes lie in the shallow, intermediate, and deep zones of the aquifer[a] underlying the Boeing plant and beyond. The contamination consists mainly of trichloroethylene

[a] For remedial purposes, Boeing has defined the aquifer by dividing it into three zones. Monitoring wells represent the depth at which the groundwater is tested. The shallow zone includes the water table to 30 feet below ground surface (bgs). The intermediate zone is from 30–60 feet bgs. The deep zone is from 60–100 feet bgs.

(TCE) and its breakdown products[b] at relatively low levels.[c] Tetrachloroethylene, also called perchloroethylene (PCE) is also present at lower levels in some monitoring wells. Boeing is still locating the extent or edges of the plumes. Recently, Boeing discovered that the shallow zone of one of the plumes has migrated below the north end of the City of Algona.

According to the Algona Public Works Department, the Chicago Avenue ditch flows north from 4th Avenue North to 12th Avenue North. It receives water from the industrial park in northeast Algona and residential area between 4th and 7th avenues. A small portion of the ditch on 10th and 11th avenues flows east into Chicago Avenue Ditch. The source of the contamination found in the ditch is being investigated. Current data suggests that the source is the shallow contaminated groundwater associated with the Boeing Auburn facility. It is unknown if the contaminant levels in the ditch change seasonally. Government Canal flows south from 1st Avenue North toward the White River. Water levels increase in ditches during heavy rainfall; however, water is present in the main ditches year round.

Exposure Pathways

In order to harm health, people must first come into contact with the chemical. An exposure pathway describes how a chemical moves from a source and comes into contact with people. A completed exposure pathway consists of a source, a release, an exposure point, an exposure route, and a potentially exposed population. Government Canal did not have contaminants present in June 2012; therefore, no completed exposure pathway has been identified for this ditch. In the case of the Chicago Avenue ditch, the source is the release of contaminants by Boeing into the groundwater. Contaminated groundwater is assumed to be discharging into the Chicago Avenue ditch. Chicago Avenue ditch has two completed pathways of exposure to TCE, cis-1,2-DCE, or vinyl chloride in water for children and workers.

Children. It was assumed that children up to two years old do not enter the ditch. Children this young would be supervised and the ditch represents a potential drowning hazard. Children three years old up to 16 years old might enter the ditch. These children playing in the ditch at 9th Avenue and north could be exposed to TCE, cis-1,2-DCE, or vinyl chloride. Children could be exposed by touching or accidentally ingesting water and breathing vapors escaping from water. Children most likely wade or walk through the ditch (with or without shoes). They probably do not remain immersed in the ditch. Minimal exposure is expected to occur by feet, legs, and hands. During the school year, children may play in the ditch during weekends or daylight hours after school. The possible health implications for exposed children are discussed in the following section. Contaminants have not been detected in the water in the ditch south of 7th Avenue and no exposures are expected in this area. To evaluate exposures DOH assumed two exposure scenarios, children 1) entering the ditch briefly and getting wet for 15 minutes once a

[b] Breakdown products of TCE in the environment include 1,1-dichloroethylene (1,1-DCE), 1,1dichloroethane (1,1-DCA), cis-1,2-dichloroethylene (cis-1,2,-DCE), trans 1,2-dichloroethylene (trans-1,2-DCE), 1,2-dichloroethane (1,2-DCA), vinyl chloride and chloroethane. Only some of these contaminants have been found in groundwater or surface water samples.

[c] Landau Associates. 2012. Letter from Eric Weber of Landau Associates to Robin Harrover of the Department of Ecology dated October 15, 2012. Re: status report number 40, July through September 2012 Activity Period, Boeing Auburn Facility, RCRA WAD 041337130, corrective Action Agreed Order No. 01HWTRNR-3345

day 3 days a week (150 days per year) or 2) playing the ditch for an average of 30 minutes on any given day during the summer or on a weekend (50 days a year).

Workers. Algona Public Works personnel also have a completed exposure pathway for TCE, cis-1,2-DCE, or vinyl chloride when working in the Chicago Avenue ditch. The Public Works Department maintains the ditch by mowing/raking and removing flood debris, trash, and culvert blockages. During these tasks workers may enter the water of the ditch. Workers wear gloves, boots, long sleeve shirts, and heavy work pants when working in the ditches. Contact with water is expected to occur intermittently on hands, legs, and feet. Rain gear is used during heavy rain. Personnel estimate that on average they enter the Chicago Avenue ditch two days a week and get wet four times a day while working in the ditch. Workers may also breathe vapors escaping from water. To evaluate exposures DOH assumed that workers entered the ditch either 1) three days a week four times a day for 15 minutes or 2) once a week for four hours (four 1-hour intervals during one day).

Environmental Data

Surface water samples were collected at two ditch locations, Chicago Avenue and Government Canal ditches in June 2012 and at four locations within Chicago Avenue ditch in September 2012. Samples collected from the ditch along Chicago Avenue were taken at intersections of the ditch with 7th, 9th, 11th, and 12th Avenues. The samples were collected using a peristaltic pump and dedicated tubing secured to a dip stick. This is an acceptable method for sampling VOCs. However, if not conducted properly this method of sampling can lower the levels of VOCs in a sample.[d] Table 1 summarizes the chemicals detected in the ditches during 2012. Of the 38 VOCs analyzed, only PCE, TCE, cis-1,2-dichloroethylene (DCE), and vinyl chloride were detected in the Chicago Avenue ditch. No VOCs were detected at 7th Avenue. At 11th Avenue, VOCs were detected at both sampling times, with consistent results. Only one sample was collected from Government Canal in June 2012 and no VOCs were detected in that sample.

Public Health Implications

Screening Evaluation. To begin assessing whether the PCE, TCE, cis-1,2-DCE, and vinyl chloride found in the Chicago Avenue ditch might pose a health concern, we compared surface water concentrations to surface water screening levels protective of health. These screening levels are considered to be protective for people (including sensitive populations) over a lifetime. Screening levels are health-based concentrations derived from equations combining site-specific exposure information with toxicity data. They are used to identify contaminants and conditions that require further evaluation. Chemicals that exceed a screening level suggest does not necessarily reflect a health effect. It indicates that additional evaluation is needed.

The Environmental Protection Agency (EPA) developed surface water screening levels using risk assessment guidance from the EPA Superfund program. This regional screening level calculator can be found at: http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search. The calculator determines exposures from accidental ingestion and skin contact of chemicals in the water. DOH

[d] EPA. 2013. Surface Water Sampling Operating Procedure. Science and Ecosystem Support Division, Region 4, U.S. Environmental Protection Agency.

used site-specific, chronic, recreational, surface water exposure scenarios to calculate screening levels for children and workers. These screening levels are based on an insignificant increase in cancer risk and no risk for non-cancer effects. Cancer risk estimates measures the chance (probability) of developing cancer. An insignificant risk is equivalent to the development of one cancer case in 1,000,000 people exposed for a lifetime (1×10^{-6}). EPA considers a cancer risk up to one additional case of cancer in 10,000 people (1×10^{-4}) to be an acceptable risk. Attachment 1 lists site-specific exposure parameters entered into the calculator and the screening results. Site-specific exposure parameters were described above in the Exposure Pathway section. Table 1 lists the most conservative screening value.

The levels of chemicals in the ditch are low and not expected to pose an inhalation health concern. This is because any vapors coming from the ditch would likely be quickly diluted by ambient air. However, that cannot be confirmed because no air data is available. To conservatively estimate inhalation exposure, DOH estimated inhalation exposure assuming the ditch water was used for showering (data not shown). Predicted air concentrations are lower than ATSDR's health based air comparison values.

Table 1. Comparison of ditch surface water concentrations (ppb) with health-based screening levels, Boeing Commercial Airlines, Auburn Plant, Washington.

Chemical	Surface Water Concentrations (ppb) from June/September 2012					Surface Water Screening Levels (ppb)*	
	Government Canal	Ditch along Chicago Avenue					
	1st Ave. N	7th Ave N	9th Ave N	11th Ave N	17th Ave N	Child	Worker
Vinyl chloride	ND /–	–/ ND	–/ **0.056**	**0.3 / 0.14**	– / **0.059**	0.70	4.5
Trichloroethylene (TCE)	ND /–	–/ ND	–/ ND	**1.2 / 1.7**	– / **1.3**	74	32
Dichloroethylene, cis-1,2-	ND /–	–/ ND	–/ ND	**1.4 / 1.5**	– / **1.1**	5820**	1400**
Tetrachloroethylene (PCE)	ND /–	–/ ND	–/ ND	**0.032/ 0.023**	– / ND	1380	197
Chloroethane	ND /–	–/ND	–/ ND	ND/ND	– / ND	–	–
Dichloroethane, 1,1 -	ND /–	–/ ND	–/ ND	ND/ND	– / ND	–	–
Dichloroethane, 1,2 -	ND /–	–/ND	–/ ND	ND/ND	– / ND	–	–
Dichloroethylene, 1,1 -	ND /–	–/ ND	–/ ND	ND/ND	– / ND	–	–
Dichloroethylene, trans-1,2-	ND /–	–/ ND	–/ ND	ND/ND	– / ND	–	–

Source: Landau 4Q report (2013); analyzed by EPA method for volatile organic chemicals SW8260/ SW8260 SIM.
Notes: **Bold** values indicate detected compounds; highlighted cells had values that exceeded screening levels;
* per EPA regional screening calculator for recreational surface water exposures (http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search) see letter attachments 1 and 2 for input parameters; ** non-carcinogenic risk only
Abbreviations:

EPA – U.S. Environmental Protection Agency
ND – not detected at 0.2 µg/L (0.02 µg/l for tetrachloroethylene and vinyl chloride)
PCE – tetrachloroethylene, same as perchloroethylene
ppb – parts per billion or micrograms per liter
RSL – Regional Screening Levels developed by EPA
TCE – trichloroethylene

Possible Health Effects. None of the concentrations measured in the ditch exceeded the screening levels for ingestion or skin contact with the chemical in the water (Table 1). As a result, exposures to TCE, cis-1,2-DCE, and vinyl chloride are not expected to result in harmful

effects. However, the levels of vinyl chloride measured in the ditch at 11th Avenue are close to screening levels for children playing in the ditch. Continued monitoring of the ditch is necessary to confirm that harmful exposures do not occur. Likewise, hypothetically estimating inhalation exposure from ditch water as if it were used in a shower did not result in air concentrations associated with health effects.

Uncertainty of Risk. Although we conclude that exposures are not expected to result in harmful effects this assessment is based on the limited available data. Some of the uncertainties in this assessment include:

- Limited ditch surface water data collected from season to season; nothing is known about concentrations in the past.
- Unknown area of contaminated shallow groundwater in Algona that discharges into ditches.
- Unknown interaction between groundwater, surface water, and rain water in backyards.
- Unknown source or sources of contamination (e.g., storm water runoff).
- Unknown amount of contamination in the sediments of the ditch.
- Amount of contaminants evaporating into the air from the ditch water or through the soil.
- Toxic effects in humans at low exposures; toxicity data mostly comes from animal studies.

On-going studies by Boeing are addressing most of these uncertainties (see recommendations).

Other Health Concerns. Ditches are not safe places to play, especially for young children. Water levels in ditches may be a drowning hazard for young children. There is always the possible presence of contaminants unrelated to the site (e.g., fecal coliform from animals, potential sewer overflow). Public Works department reported that mud in the Chicago Avenue ditch, north of 11th Avenue, is quite deep. This may present a hazard to children who could get stuck in the mud and not be able to crawl out.

Conclusion

Exposure to PCE, TCE, cis-1,2-DCE, and vinyl chloride levels found in the Chicago Avenue ditch in June and September 2012 are not expected to result in harmful effects to children or workers. Continued monitoring of the Chicago Avenue ditch is necessary to confirm that harmful exposures do not occur.

Recommendations

DOH recommends the following:

- Contaminant levels in the ditch could change over time:
    - Parents should prevent children's access to the Chicago Avenue ditch north of 8th Avenue.
    - Workers should wear protective clothing when performing duties in the ditch. This should include waterproof gloves and jacket and waders.

- DOH will work with the City of Algona, Department of Ecology, and Boeing to educate residents about the contamination in the ditch and how to prevent exposures. DOH will produce an easy-to-understand fact sheet to accompany this letter.
- To better understand exposures to people, Boeing should
    - Continue to sample the surface water in ditches of Algona to better understand seasonal variations, the extent of contamination, and the interaction between the groundwater and surface water.
    - Continue to search for the source of these contaminants entering into the Chicago Avenue ditch in order to stop the release.
    - Sample backyard surface water as needed. Ditch exposures are different than those that would occur in the backyard.
    - As a part of the vapor intrusion assessment, measure volatile organic chemical levels in ambient air of Algona and within the Chicago Avenue ditch to confirm that vapors do not pose a health threat.

Boeing is already executing or developing work plans to address these uncertainties. DOH intends to review work plans and additional data as they becomes available. We can amend these conclusions and recommendations as necessary.

DOH appreciates this opportunity to assist you with these technical issues. Please contact me at 360-236-3357 if you have any questions.

Sincerely,

Rhonda S. Kaetzel, Ph.D., DABT
Toxicologist, Health Assessor
Site Assessments and Toxicology Section

Enclosures (2)

cc: Joanne Snarski, Department of Health
Robin Harrover, Department of Ecology
James Bet, The Boeing Company
Dennis Dowdy, Public Works Director, Auburn
Chris Anderson, Environmental Manager, Auburn

Attachment 1
Site-specific equation inputs for ditch water screening levels, Boeing Auburn Plant, Algona, Washington

	Scenario inputs			
Variable	**Child 150 day**	**Child 50 day**	**Worker 150 day**	**Worker 50 day**
TR (target cancer risk) unitless	0.000001	0.000001	0.000001	0.000001
THQ (target hazard quotient) unitless	1	1	1	1
EF_{recwc} (child exposure frequency) day/year	150	50	0	0
EF_{recwa} (adult exposure frequency) day/year	150	50	150	50
EF_{0-2} (mutagenic exposure frequency) day/year	0	0	0	0
EF_{2-6} (mutagenic exposure frequency) day/year*	150	50	0.00001	0.00001
EF_{6-16} (mutagenic exposure frequency) day/year	150	50	0	0
EF_{16-30} (mutagenic exposure frequency) day/year	0	0	150	50
ED_{recwc} (exposure duration - child) year	4	4	0	0
ED_{recwa} (exposure duration - adult) year	10	10	25	25
ED_{0-2} (mutagenic exposure duration) year	0	0	0	0
ED_{2-6} (mutagenic exposure duration) year*	4	4	0.00001	0.00001
ED_{6-16} (mutagenic exposure duration) year	10	10	0	0
ED_{16-30} (mutagenic exposure duration) year	0	0	25	25
LT (lifetime - recreator) year	70	70	70	70
EV_{recwa} (adult) events/day	1	1	4	4
EV_{recwc} (child) events/day	1	1	0	0
EV_{0-2} (mutagenic) events/day	0	0	0	0
EV_{2-6} (mutagenic) events/day*	1	1	0.00001	0.00001
EV_{6-16} (mutagenic) events/day	1	1	0	0
EV_{16-30} (mutagenic) events/day	0	0	4	4
ET_{recwa} (adult exposure time) hour/event	0.25	0.5	0.25	1
ET_{recwc} (child exposure time) hour/event	0.25	0.5	0	0
$ET_{recw0-2}$ (mutagenic exposure time) hour/event	0	0	0	0
$ET_{recw2-6}$ (mutagenic exposure time) hour/event*	0.25	0.5	0.00001	0.00001
$ET_{recw6-16}$ (mutagenic exposure time) hour/event	0.25	0.5	0	0
$ET_{recw16-30}$ (mutagenic exposure time) hour/event	0	0	0.25	1
$ET_{recw-adj}$ (age-adjusted exposure time) hour/event	0.25	0.5	0.25	1
$ET_{recw-madj}$ (mutagenic age-adjusted exposure time) hour/event	0.25	0.5	0.25	1
BW_{recwa} (body weight - adult) kg	41	41	70	70
BW_{recwc} (body weight - child) kg	15	15	15	15
BW_{0-2} (mutagenic body weight) kg	0	0	0	0
BW_{2-6} (mutagenic body weight) kg	15	15	15	15
BW_{6-16} (mutagenic body weight) kg	41	41	0	0
BW_{16-30} (mutagenic body weight) kg	0	0	70	70
IRW_{recwa} (water intake rate - adult) L/hr	0	0	0	0
IRW_{recwc} (water intake rate - child) L/hr	0.004	0.004	0	0
IRW_{0-2} (mutagenic water intake rate) L/hr	0	0	0	0
IRW_{2-6} (mutagenic water intake rate) L/hr**/*	0.0037	0.0037	0.00001	0.00001
IRW_{6-16} (mutagenic water intake rate) L/hr**	0.0037	0.0037	0	0
IRW_{16-30} (mutagenic water intake rate) L/hr***	0	0	0.0037	0.0037
SA_{recwa} (skin surface area - adult) cm^2	3721	3721	6600	6600
SA_{recwc} (skin surface area - child) cm^2	1642	1642	0	0
SA_{0-2} (mutagenic skin surface area) cm^2	0	0	0	0
SA_{2-6} (mutagenic skin surface area) $cm^{2**/*}$	1642	1642	0.00001	0.00001
SA_{6-16} (mutagenic skin surface area) cm^{2**}	3721	3721	0	0
SA_{16-30} (mutagenic skin surface area) cm^{2**}	0	0	6600	6600
I_{sc} (apparent thickness of stratum corneum) cm	0.001	0.001	0.001	0.001
$IFW_{rec-adj}$ (age-adjusted water intake rate) L/kg	0.04	0.027	0	0
$IFWM_{rec-adj}$ (mutagenic age-adjusted water intake rate) L/kg	0.213	0.142	0.198	0.264
$DFW_{rec-adj}$ (age-adjusted dermal factor) cm^2-event/kg	201814.146	67271.382	1414285.714	471428.571
$DFWM_{rec-adj}$ (mutagenic age-adjusted dermal factor) cm^2-event/kg	605442.439	201814.146	1414285.714	471428.571

Notes: per EPA regional screening calculator for recreational surface water exposures

Highlighted cells are site-specific input values (using recreational surface water scenario)

* An estimate of 0 (0.00001) was used to retain carcinogenic calculation estimates for adults

** Average ingestion rate for wading and splashing in swimming pool (EFH Table 3-93)

*** Surface area consists of feet, lower legs, and hands; child surface area was calculated using total surface for 3-6 and 11-16 year olds (EFH Table 7-7) multiplied by portion of extremity (EFH Table 7-9); For equivalent adult surface area see (EFH Table 7-16)

EFH - Exposure Factors Handbook (U.S. EPA 2011)

EPA - U.S. Environmental Protection Agency

Attachment 2

Output from EPA's Site-specific Recreator Screening Levels for Surface Water, Boeing Auburn Plant, Algona, Washington

ca=Cancer, nc=Noncancer, ca* (Where nc SL < 100 x ca SL),
ca** (Where nc SL < 10 x ca SL),
max=SL exceeds ceiling limit (see User's Guide), sat=SL exceeds csat

Scenario	Chemical	CAS Number	Mutagen?	VOC?	Chemical Type	Ingestion SF (mg/kg-day)$^{-1}$	SFO Ref	Chronic RfD (mg/kg-day)	RfD Ref	RAGSe GIABS (unitless)	kp	mw	pi	logds
Child 150 days	Vinyl Chloride	75-01-4	Yes	Yes	Organics	1.40E+00	U	3.00E-03	U	1	0.00838	62.5	3.1415927	-3.15
Child 50 days	Vinyl Chloride	75-01-4	Yes	Yes	Organics	1.40E+00	U	3.00E-03	U	1	0.00838	62.5	3.1415927	-3.15
Worker 150 days	Vinyl Chloride	75-01-4	Yes	Yes	Organics	7.20E-01	I	3.00E-03	I	1	0.00838	62.5	3.1415927	-3.15
Worker 50 days	Vinyl Chloride	75-01-4	Yes	Yes	Organics	7.20E-01	I	3.00E-03	I	1	0.00838	62.5	3.1415927	-3.15
Child 150 days	Dichloroethane, 1,1-	75-34-3	No	Yes	Organics	5.70E-03	U	2.00E-01	U	1	0.00675	98.96	3.1415927	-3.354176
Child 50 days	Dichloroethane, 1,1-	75-34-3	No	Yes	Organics	5.70E-03	U	2.00E-01	U	1	0.00675	98.96	3.1415927	-3.354176
Worker 150 days	Dichloroethane, 1,1-	75-34-3	No	Yes	Organics	5.70E-03	U	2.00E-01	U	1	0.00675	98.96	3.1415927	-3.354176
Worker 50 days	Dichloroethane, 1,1-	75-34-3	No	Yes	Organics	5.70E-03	U	2.00E-01	U	1	0.00675	98.96	3.1415927	-3.354176
Child 150 days	Dichloroethane, 1,2-	107-06-2	No	Yes	Organics	9.10E-02	U	6.00E-03	U	1	0.0042	98.96	3.1415927	-3.354176
Child 50 days	Dichloroethane, 1,2-	107-06-2	No	Yes	Organics	9.10E-02	U	6.00E-03	U	1	0.0042	98.96	3.1415927	-3.354176
Worker 150 days	Dichloroethane, 1,2-	107-06-2	No	Yes	Organics	9.10E-02	U	6.00E-03	U	1	0.0042	98.96	3.1415927	-3.354176
Worker 50 days	Dichloroethane, 1,2-	107-06-2	No	Yes	Organics	9.10E-02	U	6.00E-03	U	1	0.0042	98.96	3.1415927	-3.354176
Child 150 days	Dichloroethylene, 1,1-	75-35-4	No	Yes	Organics	-		5.00E-02	U	1	0.0117	96.94	3.1415927	-3.342864
Child 50 days	Dichloroethylene, 1,1-	75-35-4	No	Yes	Organics	-		5.00E-02	U	1	0.0117	96.94	3.1415927	-3.342864
Worker 150 days	Dichloroethylene, 1,1-	75-35-4	No	Yes	Organics	-		5.00E-02	U	1	0.0117	96.94	3.1415927	-3.342864
Worker 50 days	Dichloroethylene, 1,1-	75-35-4	No	Yes	Organics	-		5.00E-02	U	1	0.0117	96.94	3.1415927	-3.342864
Child 150 days	Dichloroethylene, 1,2- (Mixed Isomers)	540-59-0	No	Yes	Organics	-		9.00E-03	U	1	0.011	96.94	3.1415927	-3.342864
Child 50 days	Dichloroethylene, 1,2- (Mixed Isomers)	540-59-0	No	Yes	Organics	-		9.00E-03	U	1	0.011	96.94	3.1415927	-3.342864
Worker 150 days	Dichloroethylene, 1,2- (Mixed Isomers)	540-59-0	No	Yes	Organics	-		9.00E-03	U	1	0.011	96.94	3.1415927	-3.342864
Worker 50 days	Dichloroethylene, 1,2- (Mixed Isomers)	540-59-0	No	Yes	Organics	-		9.00E-03	U	1	0.011	96.94	3.1415927	-3.342864
Child 150 days	Dichloroethylene, 1,2-cis-	156-59-2	No	Yes	Organics	-		2.00E-03	U	1	0.011	96.94	3.1415927	-3.342864
Child 50 days	Dichloroethylene, 1,2-cis-	156-59-2	No	Yes	Organics	-		2.00E-03	U	1	0.011	96.94	3.1415927	-3.342864
Worker 150 days	Dichloroethylene, 1,2-cis-	156-59-2	No	Yes	Organics	-		2.00E-03	U	1	0.011	96.94	3.1415927	-3.342864
Worker 50 days	Dichloroethylene, 1,2-cis-	156-59-2	No	Yes	Organics	-		2.00E-03	U	1	0.011	96.94	3.1415927	-3.342864
Child 150 days	Dichloroethylene, 1,2-trans-	156-60-5	No	Yes	Organics	-		2.00E-02	U	1	0.011	96.94	3.1415927	-3.342864
Child 50 days	Dichloroethylene, 1,2-trans-	156-60-5	No	Yes	Organics	-		2.00E-02	U	1	0.011	96.94	3.1415927	-3.342864
Worker 150 days	Dichloroethylene, 1,2-trans-	156-60-5	No	Yes	Organics	-		2.00E-02	U	1	0.011	96.94	3.1415927	-3.342864
Worker 50 days	Dichloroethylene, 1,2-trans-	156-60-5	No	Yes	Organics	-		2.00E-02	U	1	0.011	96.94	3.1415927	-3.342864
Child 150 days	Tetrachloroethylene	127-18-4	No	Yes	Organics	2.10E-03	U	6.00E-03	U	1	0.0334	165.83	3.1415927	-3.728648
Child 50 days	Tetrachloroethylene	127-18-4	No	Yes	Organics	2.10E-03	U	6.00E-03	U	1	0.0334	165.83	3.1415927	-3.728648
Worker 150 days	Tetrachloroethylene	127-18-4	No	Yes	Organics	2.10E-03	U	6.00E-03	U	1	0.0334	165.83	3.1415927	-3.728648
Worker 50 days	Tetrachloroethylene	127-18-4	No	Yes	Organics	2.10E-03	U	6.00E-03	U	1	0.0334	165.83	3.1415927	-3.728648
Child 150 days	Trichloroethylene	79-01-6	Yes	Yes	Organics	4.60E-02	U	5.00E-04	U	1	0.0116	131.39	3.1415927	-3.535784
Child 50 days	Trichloroethylene	79-01-6	Yes	Yes	Organics	4.60E-02	U	5.00E-04	U	1	0.0116	131.39	3.1415927	-3.535784
Worker 150 days	Trichloroethylene	79-01-6	Yes	Yes	Organics	4.60E-02	U	5.00E-04	U	1	0.0116	131.39	3.1415927	-3.535784
Worker 50 days	Trichloroethylene	79-01-6	Yes	Yes	Organics	4.60E-02	U	5.00E-04	U	1	0.0116	131.39	3.1415927	-3.535784

Attachment 2

Scenario	dsclc	dsc	c	littleb	B	tstar	tau_event	FA	In EPD?	Carcino-genic DAevent	Noncarcino-genic Daevent	DAeventna	Ingestion SL TR=1.0E-6 (µg/L)	Dermal SL TR=1.0E-6 (µg/L)	Carcinogenic SL TR=1.0E-6 (µg/L)
Child 150 days	0.0007079	7.0795E-7	0.3505315	0.3189446	0.0254807	0.565015	0.2354229	1	Yes	6.086E-6	0.066687	0.0804354	1.05E+01	1.08E+00	9.82E-01
Child 50 days	0.0007079	7.0795E-7	0.3505315	0.3189446	0.0254807	0.565015	0.2354229	1	Yes	6.3719E-6	0.2000609	0.2413061	5.32E+00	8.02E-01	6.97E-01
Worker 150 days	0.0007079	7.0795E-7	0.3505315	0.3189446	0.0254807	0.565015	0.2354229	1	Yes	0.0000251	-	0.0193561	-	4.47E+00	4.47E+00
Worker 50 days	0.0007079	7.0795E-7	0.3505315	0.3189446	0.0254807	0.565015	0.2354229	1	Yes	0.0000753	-	0.0580682	-	6.16E+00	6.16E+00
Child 150 days	0.0004424	4.4241E-7	0.3507675	0.3191598	0.0258262	0.9041406	0.3767253	1	Yes	0.0222108	4.4457978	5.3623578	1.12E+05	3.88E+03	3.75E+03
Child 50 days	0.0004424	4.4241E-7	0.3507675	0.3191598	0.0258262	0.9041406	0.3767253	1	Yes	0.0666324	13.337393	16.087073	1.66E+05	8.23E+03	7.84E+03
Worker 150 days	0.0004424	4.4241E-7	0.3507675	0.3191598	0.0258262	0.9041406	0.3767253	1	Yes	0.0031694	-	1.290404	-	5.54E+02	5.54E+02
Worker 50 days	0.0004424	4.4241E-7	0.3507675	0.3191598	0.0258262	0.9041406	0.3767253	1	Yes	0.0095082	-	3.8712121	-	8.06E+02	8.06E+02
Child 150 days	0.0004424	4.4241E-7	0.3441311	0.3131135	0.0160696	0.9041406	0.3767253	1	Yes	0.0013912	0.1333739	0.1608707	7.02E+03	3.91E+02	3.70E+02
Child 50 days	0.0004424	4.4241E-7	0.3441311	0.3131135	0.0160696	0.9041406	0.3767253	1	Yes	0.0041737	0.4001218	0.4826122	1.04E+04	8.28E+02	7.67E+02
Worker 150 days	0.0004424	4.4241E-7	0.3441311	0.3131135	0.0160696	0.9041406	0.3767253	1	Yes	0.0001985	-	0.0387121	-	5.57E+01	5.57E+01
Worker 50 days	0.0004424	4.4241E-7	0.3441311	0.3131135	0.0160696	0.9041406	0.3767253	1	Yes	0.0005956	-	0.1161364	-	8.10E+01	8.10E+01
Child 150 days	0.0004541	4.5408E-7	0.3634974	0.3307845	0.0443062	0.8808947	0.3670395	1	Yes	-	1.1114495	1.3405894	-	-	-
Child 50 days	0.0004541	4.5408E-7	0.3634974	0.3307845	0.0443062	0.8808947	0.3670395	1	Yes	-	3.3343484	4.0217683	-	-	-
Worker 150 days	0.0004541	4.5408E-7	0.3634974	0.3307845	0.0443062	0.8808947	0.3670395	1	Yes	-	-	0.322601	-	-	-
Worker 50 days	0.0004541	4.5408E-7	0.3634974	0.3307845	0.0443062	0.8808947	0.3670395	1	Yes	-	-	0.967803	-	-	-
Child 150 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	0.2000609	0.2413061	-	-	-
Child 50 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	0.6001827	0.7239183	-	-	-
Worker 150 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	-	0.0580682	-	-	-
Worker 50 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	-	0.1742045	-	-	-
Child 150 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	0.044458	0.0536236	-	-	-
Child 50 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	0.1333739	0.1608707	-	-	-
Worker 150 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	-	0.012904	-	-	-
Worker 50 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	-	0.0387121	-	-	-
Child 150 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	0.4445798	0.5362358	-	-	-
Child 50 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	1.3337393	1.6087073	-	-	-
Worker 150 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	-	0.1290404	-	-	-
Worker 50 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	-	0.3871212	-	-	-
Child 150 days	0.0001868	1.8679E-7	0.4514447	0.4132241	0.1654263	2.1414503	0.8922709	1	Yes	0.0602865	0.1333739	0.1608707	3.04E+05	1.38E+03	1.38E+03
Child 50 days	0.0001868	1.8679E-7	0.4514447	0.4132241	0.1654263	2.1414503	0.8922709	1	Yes	0.1808595	0.4001218	0.4826122	4.51E+05	2.93E+03	2.91E+03
Worker 150 days	0.0001868	1.8679E-7	0.4514447	0.4132241	0.1654263	2.1414503	0.8922709	1	Yes	0.0086027	-	0.0387121	-	1.97E+02	1.97E+02
Worker 50 days	0.0001868	1.8679E-7	0.4514447	0.4132241	0.1654263	2.1414503	0.8922709	1	Yes	0.0258081	-	0.1161364	-	2.96E+02	2.96E+02
Child 150 days	0.0002912	2.9122E-7	0.3682564	0.3351426	0.0511406	1.3735485	0.5723119	1	Yes	0.0009174	0.0111145	0.0134059	2.61E+03	7.56E+01	7.35E+01
Child 50 days	0.0002912	2.9122E-7	0.3682564	0.3351426	0.0511406	1.3735485	0.5723119	1	Yes	0.0027522	0.0333435	0.0402177	3.91E+03	1.60E+02	1.54E+02
Worker 150 days	0.0002912	2.9122E-7	0.3682564	0.3351426	0.0511406	1.3735485	0.5723119	1	Yes	0.0003927	-	0.003226	2.81E+03	3.24E+01	3.20E+01
Worker 50 days	0.0002912	2.9122E-7	0.3682564	0.3351426	0.0511406	1.3735485	0.5723119	1	Yes	0.0011782	-	0.009678	2.10E+03	4.86E+01	4.75E+01

Attachment 2

Scenario	Ingestion SL (Child) HQ=1 (µg/L)	Dermal SL (Child) HQ=1 (µg/L)	Noncarcino-genic SL (Child) HQ=1 (µg/L)	Ingestion SL (Adult) HQ=1 (µg/L)	Dermal SL (Adult) HQ=1 (µg/L)	Noncarcino-genic SL (Adult) HQ=1 (µg/L)	Screening Level (µg/L)
Child 150 days	1.10E+05	1.19E+04	1.07E+04	-	1.43E+04	1.43E+04	9.82E-01 ca**
Child 50 days	1.64E+05	2.52E+04	2.18E+04	-	3.04E+04	3.04E+04	6.97E-01 ca**
Worker 150 days	-	-	-	-	3.44E+03	3.44E+03	4.47E+00 ca**
Worker 50 days	-	-	-	-	4.75E+03	4.75E+03	6.16E+00 ca**
Child 150 days	7.30E+06	7.76E+05	7.02E+05	-	9.37E+05	9.37E+05	3.75E+03 ca**
Child 50 days	1.10E+07	1.65E+06	1.43E+06	-	1.99E+06	1.99E+06	7.84E+03 ca**
Worker 150 days	-	-	-	-	2.25E+05	2.25E+05	5.54E+02 ca**
Worker 50 days	-	-	-	-	3.28E+05	3.28E+05	8.06E+02 ca**
Child 150 days	2.19E+05	3.74E+04	3.20E+04	-	4.52E+04	4.52E+04	3.70E+02 ca**
Child 50 days	3.29E+05	7.94E+04	6.40E+04	-	9.58E+04	9.58E+04	7.67E+02 ca**
Worker 150 days	-	-	-	-	1.09E+04	1.09E+04	5.57E+01 ca**
Worker 50 days	-	-	-	-	1.58E+04	1.58E+04	8.10E+01 ca**
Child 150 days	1.83E+06	1.13E+05	1.07E+05	-	1.37E+05	1.37E+05	
Child 50 days	2.74E+06	2.41E+05	2.21E+05	-	2.90E+05	2.90E+05	
Worker 150 days	-	-	-	-	3.29E+04	3.29E+04	
Worker 50 days	-	-	-	-	4.80E+04	4.80E+04	
Child 150 days	3.29E+05	2.17E+04	2.04E+04	-	2.62E+04	2.62E+04	
Child 50 days	4.93E+05	4.61E+04	4.21E+04	-	5.56E+04	5.56E+04	
Worker 150 days	-	-	-	-	6.31E+03	6.31E+03	
Worker 50 days	-	-	-	-	9.18E+03	9.18E+03	
Child 150 days	7.30E+04	4.83E+03	4.53E+03	-	5.82E+03	5.82E+03	
Child 50 days	1.10E+05	1.02E+04	9.36E+03	-	1.24E+04	1.24E+04	
Worker 150 days	-	-	-	-	1.40E+03	1.40E+03	
Worker 50 days	-	-	-	-	2.04E+03	2.04E+03	
Child 150 days	7.30E+05	4.83E+04	4.53E+04	-	5.82E+04	5.82E+04	
Child 50 days	1.10E+06	1.02E+05	9.36E+04	-	1.24E+05	1.24E+05	
Worker 150 days	-	-	-	-	1.40E+04	1.40E+04	
Worker 50 days	-	-	-	-	2.04E+04	2.04E+04	
Child 150 days	2.19E+05	3.06E+03	3.02E+03	-	3.69E+03	3.69E+03	1.38E+03 ca**
Child 50 days	3.29E+05	6.49E+03	6.36E+03	-	7.83E+03	7.83E+03	2.91E+03 ca**
Worker 150 days	-	-	-	-	8.88E+02	8.88E+02	1.97E+02 ca**
Worker 50 days	-	-	-	-	1.33E+03	1.33E+03	2.96E+02 ca**
Child 150 days	1.83E+04	9.16E+02	8.73E+02	-	1.11E+03	1.11E+03	7.35E+01 ca**
Child 50 days	2.74E+04	1.94E+03	1.82E+03	-	2.34E+03	2.34E+03	1.54E+02 ca**
Worker 150 days	-	-	-	-	2.66E+02	2.66E+02	3.20E+01 ca**
Worker 50 days	-	-	-	-	3.99E+02	3.99E+02	4.75E+01 ca**

Notes: Chemical-specific model inputs are defined in Attachment 1

Abbreviations not defined in Attachment 1

b - Correlation coefficent fitted to Flynn data set

B - Ratio of permeability through stratum corneum: viable epidermis

c - correlation coefficient fitter to Flynn's data

CAS - Registry number assigned by Chemical Abstracts Service

DA event - Dose absorbed per event

Ds - Effective diffusivity of the absorbing chemical through the epidermis

Dsc - Effective diffusion coefficient chemical transfer though stratum corneum

Lsc - Apparent thickness of stratum corneum

EPD - Effective predictive domain

FA - Fraction absorbed water

GIABS - Fraction of contaminant absorbed in intestinal tract

HQ - Hazard quotient

kp - Dermal permeability coefficent

MW - Molecular weight

RAGSe - Risk Assessment Guidance for Superfund, Vol. 1 Part E (2004)

RfD - EPA reference dose

SF/SFO - Oral cancer slope factor

SL - Screening level

t* - Time to reach steady-state

tau - Lag time per event

TR - Target risk

ug/L - Micrograms per liter

VOC - Volatile organic compound