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APPENDIX C

MERCURY TOXICITY INFORMATION

MERCURY TOXICITY INFORMATION

Mercury ore is found in limestone, calcareous shales, sandstone, and serpentine. Mercury is most commonly used in electrical apparatus and as a catalyst in polyurethane foams. Organomercuric compounds are used as fungicides.

Exposure to mercury is mainly through inhalation and ingestion. Approximately 80 percent of inhaled elemental mercury is retained and transported to the tissues of the body. Most dietary inorganic mercurials dissociate to divalent mercury in the gastrointestinal tract and are poorly absorbed, whereas absorption rates of greater than 90 percent have been observed for lipophilic mercurials such as methylmercury (USEPA, 1984a).

Although mercury becomes widely distributed in the body, it tends to concentrate in specific areas. Both inorganic and organic mercury usually concentrate primarily in the kidneys (Magos, 1973) and also in the liver, blood, spleen, and thyroid (Nordberg and Skerfving, 1972).

The lowest lethal dose (LD_{LO}) from the oral intake of $HgCl_2$ in man was 29 mg/kg caused by erosion of the gastrointestinal tract. The LD_{LO} for largely un-ionized HgI_2 for man was reported to be 357 mg/kg (Clayton and Clayton, 1981).

Animals exposed to mercury by inhalation, injection or oral dose had toxic effects in the kidneys, liver, brain, heart, and lungs (USEPA, 1984a; Druet et al., 1978; Fitzhugh et al., 1950)

Methyl mercury and mercury chloride are associated with increased mutations as measured by sister chromatid exchange in vitro. This effect was antagonized by sodium selenite (Morimoto et al., 1986). A recent study of eskimos has indicated a correlation between mercury in the blood and mutagenic effects as measured by sister chromatid exchange (Wulf et al., 1986). Cantoni and Costa (1983) have presented data suggesting that the genotoxic effects of mercury are related to inhibition of DNA repair rather than direct interaction with the DNA.

Baranski and Szymczyk (1973) exposed female rats for 21 days to 2.5 mg elemental mercury/m^3. They noted changes in the estrus cycle and CNS symptoms. Prenatally exposed rats displayed high mortality, but no teratogenic effects were observed. Increased abortions have been observed in monkeys given 0.5 mg methyl mercury chloride/kg body weight orally during pregnancy (Dougherty et al., 1974).

No confirmed positive reports of mercury carcinogenicity in man have appeared to date, and animal experiments have generally yielded negative results (Leonard et al., 1983; USEPA, 1984a). Mitsumori et al. (1981) and Hirano et al. (1986) reported that methylmercury chloride in the diet at 0.9 mg/kg/day or more for up to 98 weeks caused renal tumors in ICR male mice but not in female mice nor in Sprague-Dawley rats (Mitsumori et al, 1984). These studies have not been confirmed by other laboratories.

Ingestion of high levels of mercuric mercury causes severe abdominal cramps due to corrosive ulceration, bleeding, and necrosis of the gastrointestinal tract, accompanied by shock and circulatory collapse. If death does not occur, renal failure occurs due to necroses of the renal tublules leading to anuria and uremia. Not all renal damage is irreversible.

Occupational studies have demonstrated that chronic exposure to metallic mercury vapor primarily affects the central nervous system and the kidneys. Nonspecific effects associated with the lowest exposure levels (<100 ug mercury/m^3) include insomnia, anxiety, and biochemical alterations. Exposures greater than 1 mg mercury/m^3 can result in memory loss, personality changes, body tremors, and damage to lung tissue. Workers chronically exposed to inorganic mercury compounds have reduced nerve conduction velocities (Singer et al., 1987). Inorganic mercury localizes primarily in the cerebellar Purkinje cells altering metabolism and destroying cellular proteins and membranes (Chang, 1979; Norton, 1980). No effects have been observed upon exposure to mercury vapor at air concentrations of approximately 1 ug mercury/m^3 or less (USEPA, 1984a). Effects on both the nervous system and kidneys are usually reversible, particularly if the effects are mild.

The diet is by far the dominant, if not sole, source of human exposure to methyl mercury. Methyl mercury compounds are known to be toxic via oral exposures, and prenatal and newborn infants are particularly susceptible. In addition, there have been incidences of menstrual disturbances, spontaneous abortions, and postnatal mortality in women occupationally exposed to high concentrations of mercury vapor. Mishonova et al.(1980, in Russian; as described by USEPA, 1984a) reported on the course of pregnancy and parturition in 349 women exposed via inhalation to metallic mercury vapors in the workplace as compared to 215 non-exposed women. They concluded that complications in pregnancy and labor were higher among exposed women and depended on "the length of service and concentration of mercury vapors."

Subchronic methyl mercury poisoning has occurred in humans eating contaminated fish from Minamata Bay in Japan. The median level of total mercury in fish in Minamata Bay was estimated to be about 11 mg/kg fresh weight (Doull et al., 1980). Methyl mercury poisoning also occurred from eating bread produced from seed grain dressed with methyl mercury fungicide. Nerve damage causing "pins and needles" sensations in the hands and feet occurred at an estimated body burden of 25 mg of methylmercury (Bakir et al., 1973).

The largest study on human exposure to mercury vapor involved 642 workers from 21 chlor-alkali plants in the United States and Canada (Smith et al., 1970). The matched control group contained 382 workers. A number of medical findings related to nervcus system effects had a significant correlation to exposure levels, including loss of appetite and weight, insomnia, and tremors. No clear threshold in the dose-response relationship was observed. Chaffin et al. (1973), in a study of 142 workers, were unable to confirm these findings; however, this study had no control group and less accurate data for the exposure analysis. Buchet et al. (1980) described dose-response relationships for preclinical effects of mercury on kidney function. Their study group consisted of 63 workers from two chlor-alkali plants and 88 control workers. The frequency of abnormal urinary albumin increased with increasing mercury exposure. USEPA (1984a) summarized various epidemiological studies indicating the following effects of exposure to mercury vapor: tremors at levels >100 ug/m^3; nonspecific symptoms at 50 ug/m^3; and possible preclinical effects at lower concentrations.

In its carcinogen weight-of-evidence categories, USEPA places inorganic mercury in Group D, which includes compounds for which there is little evidence for carcinogenicity in animals. Methyl mercury has not been evaluated for its carcinogenic potential.

REFERENCES

Bakir, F. S.F. Damhji, L. Amin-Zaki, et al., 1973. "Methyl mercury poisoning in Iraq"; Science 181:230.

Baranski, B., and I. Szymcyzk, 1973. "Effects of Mercury Vapor upon Reproductive Functions of Female White Rats"; Med. Pr. 24:248 (as cited in USEPA, 1984a).

Buchet, J.P., H. Roels, A. Bernard, and R. Lauwerys, 1980. "Assessment of Renal Function of Workers Exposed to Inorganic Lead, Cadmium, or Mercury Vapor"; J. Occup. Med.; 22:741-750 (as cited in USEPA, 1984a).

Cantoni, O. and M. Costa. "Correlations of DNA strand breaks and their repair with cell survival following acute exposure to mercury and x-rays"; Mol Pharmacol.; 24:84-89.

Chaffin, D.B., B.D. Dinman, J.M. Miller, R.G. Smith, and D.H. Zontine, 1973. "An Evaluation of the Effects of Chronic Mercury Exposure on EMG and Psychomotor Functions"; HMS-099-71-62; Final Report; National Institute of Health (as cited in USEPA, 1984a).

Chang, L.W., 1979. "Pathological Effects of Mercury Poisonings"; In: The Biogeochemistry of Mercury in the Environment; J.O. Nriagu, ed.; Elsevier/North Holland Press; pp. 519-580.

Clayton, F.D., and F.E. Clayton, 1981. Patty's Industrial Hygiene and Toxicology; Third Revised Edition; Volume 2A; Toxicology; John Wiley and Sons, New York. NY; pp. 1467-2878.

Derban, L.K., M.H. Noweir, W.O. Phoon, P.K. Sumamur, and I.P. Ulanova. WHO Technical Report Ser. (647):102-115.

Dougherty, W.J., F. Coulston, F., and L. Goldberg, 1974. "Toxicity of Methyl Mercury in Pregnant Rhesus Monkeys; Tox. Appl. Pharmacol.; 29:138 (Abs.).

Druet, P., E. Bruet, F. Potdevin, and C. Sapin, 1978. "Immune Type Glomerulonephritis Induced by $HgCl_2$ in the Brown Norway Rat"; Ann. Immunol.; . 129:777-792 (as cited in USEPA, 1984a).

Fitzhugh, O.G., A.A. Nelson, E. P. Laug, and F.M. Kunze, 1950. "Chronic Oral Toxicities of Mercury-Phenyl and Mercuric Salts"; Arch. Ind. Hyg. Occup. Med.; 2:433-442 (as cited in USEPA, 1984a).

Friberg, L. and G. Nordberg, 1972. "Inorganic mercury - relation between exposure and effects"; In: Mercury in the Environment; L. Friberg and J. Vostal, eds.; CRC Press, The Chemical Rubber Company, Cleveland, Ohio; pp. 113-139.

Hirano, M., K. Mitsumori, K. Maita, and Y. Shirasu, 1986. "Further carcinogenicity study of methylmercury chloride in ICR mice"; Jpn. J. Vet. Sci.; 48:127-135.

Khera, K.S., 1979. "Teratogenic and Genetic Effects of Mercury Toxicity"; In: The Biogeochemistry of Mercury in the Environment; J.O. Nriagu, ed.; Elsevier/North Holland Biomedical Press, Amsterdam; pp. 503-518.

Leonard, A., P. Jacquet, and R.R. Lauwerys, 1983. "Mutagenicity and Teratogenicity of Mercury Compounds"; Mut. Res.; 114:1-18.

Magos, M., 1973. "Factors affecting the uptake and retention of mercury by kidneys in rats"; In: Mercury, Mercurials, and Mercaptans; M.W. Miller and T.W. Clarkson, eds.; C.C. Thomas Publ., Springfield, IL.; pp. 167-186.

Mitsumori, K., K. Maita, T. Saito, S. Tsuda, and Y. Shirasu, 1981. "Carcinogenicity of Methylmercury Chloride in Mice: Pre-liminary Note on Renal Carcinogenesis"; Cancer Lett.; 12:305-310.

Morimoto,K., S. Iijima, and A. Koizumi, 1982. "Selenite prevents the induction of sister chromatid exchanges by methylmercury and mercuric compounds in human whole-blood cultures"; Mut. Res.; 102:183-192.

Nordberg, G.F. and S. Skerfving, 1972. "Metabolism"; In: Mercury in the Environment. L. Friberg and J. Vostal, eds.; CRC Press, The Chemical Rubber Company, Cleveland, Ohio; pp. 29-91.

Norton, S., 1980. "Toxic Responses of the Central Nervous System"; In: Casarett and Doull's Toxicology, The Basic Science of Poisons; C.O. Klassen and M.O. Amdur, eds.; Macmillan Publishing Co., Inc., New York, NY.; pp. 179-205.

Singer, R., J.A. Valciukas, and K.D. Rosenman, 1987. "Peripheral Neurotoxicity in Workers Exposed to Inorganic Mercury Compounds"; Arch. Environ. Health; 42:181-184.

Smith, R.G., A.J. Verwald, L.S. Patil, and T.F. Mooney, 1970. "Effects of Exposure to Mercury in the Manufacture of Chlorine"; Am. Ind. Hyg. Assoc. J.; 31:687-700 (as cited in USEPA, 1984a).

U.S. Environmental Protection Agency (USEPA), 1984a. Mercury Health Effects Update; Health Issue Assessment; Final Report; EPA 600/8-84-019F; Office of Health and Environmental Assessment, Washington, D.C.

USEPA, 1984b. Health Effects Assessment for Mercury; Revised Final Draft; ECAO-CIN-HO42; Prepared for Office of Emergency and Remedial Response by the Environmental Criteria and Assessment Office, Cincinnati, OH.

Wulf, H.C., N. Kromann, N. Kousgaard, J.C. Hansen, E. Niebuhr, and K. Albge, 1986. "Sister chromatid exchange (SCE) in Greenlandic eskimos. Dose-response relationship between SCE and seal diet, smoking, and blood cadmium and mercury concentrations"; Sci Total Environ.; 48:81-94.

APPENDIX D

PUBLIC HEALTH

RISK ASSESSMENT

CALCULATIONS

DIRT9	28-Sep-94

TABLE D-1
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
CURRENT – CHILD TRESPASSER (6 TO 10 YEARS OLD) – CENTRAL TENDENCY
SALTVILLE WASTE DISPOSAL SITE, POND 5
SALTVILLE, VIRGINIA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical specific	mg/kg	
INGESTION RATE (SOIL)	IR_{soil}	120	mg/day	USEPA, 1989a
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm^2-event	USEPA, 1992b
ABSORPTION FRACTION	ABS_i or ABS_d	chemical specific	unitless	
SURFACE AREA EXPOSED	SA	2,526	cm^2	USEPA, 1992b
DOSE ABSORBED PER EVENT	DA_{event}	calculated	mg/cm^2-event	
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT	BW	27	kg	USEPA, 1989b
EXPOSURE FREQUENCY	EF	6	days/year *	Assumption
EXPOSURE DURATION	ED	5	years	Assumption
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991a
NONCANCER	AT	5	years	USEPA, 1991a

* Units for exposure frequency are events/year in the calculation of the dermally absorbed dose.

USEPA, 1989a. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A);

USEPA, 1989b. "Exposure Factors Handbook"; Office of Health and Environmental Assessment; Washington, D.C.; EPA/600/8-89/043.

USEPA, 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Parameters";

USEPA, 1992b. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CSF $(mg/kg\text{-}day)^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / RFD (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{CS \times IR_{soil} \times ABS_i \times FI \times CF \times EF \times ED}{BW \times AT \times 365\ \text{days/yr}}$$

$$\text{INTAKE-DERMAL} = \frac{DAevent \times SA \times EF \times ED}{BW \times AT \times 365\ \text{days/yr}}$$

Where:

$$DAevent = CS \times AF \times ABS_d \times CF$$

Note: For noncarcinogenic effects: AT = ED

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TABLE D-1, continued
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
CURRENT - CHILD TRESPASSER (6 TO 10 YEARS OLD) - CENTRAL TENDENCY
SALTVILLE WASTE DISPOSAL SITE, POND 5
SALTVILLE, VIRGINIA

CARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL CSF (mg/kg-day)^-1	CANCER RISK INGESTION	DERMAL CSF[1] (mg/kg-day)^-1	CANCER RISK DERMAL	TOTAL CANCER RISK
CHLOROFORM	0.003	1	1.6E-11	0.01	3.3E-12	0.0061	9.5E-14	0.0061	2.0E-14	1.2E-13
						SUMMARY CANCER RISK	1E-13		2E-14	1E-13

[1] Calculated from Oral CSFs as described in Section 3.2.3.
ND = No data available

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DIRT9 | 24-Sep-94

TABLE D-1, continued
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
CURRENT - CHILD TRESPASSER (6 TO 10 YEARS OLD) - CENTRAL TENDENCY
SALTVILLE WASTE DISPOSAL SITE, POND 5
SALTVILLE, VIRGINIA

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL RfD [1] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
ACETONE	0.041	1	3.0E-09	0.01	6.3E-10	0.1	3.0E-08	0.1	6.3E-09	3.6E-08
CHLOROFORM	0.003	1	2.2E-10	0.01	4.6E-11	0.01	2.2E-08	0.01	4.6E-09	2.7E-08
TOLUENE	0.003	1	2.2E-10	0.02	9.2E-11	0.2	1.1E-09	0.2	4.6E-10	1.6E-09
INORGANIC MERCURY	164	1	1.2E-05	0.01	2.5E-06	0.0003	4.0E-02	0.00006	4.2E-02	8.2E-02
SODIUM	1890.0									
						SUMMARY HAZARD INDEX	4E-02		4E-02	8E-02

[1] Calculated from Oral RfDs as described in Section 3.2.3.
ND = No data available

AR303629

DIR T10	28-Sep-94

TABLE D-2
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
CURRENT - CHILD TRESPASSER (6 TO 10 YEARS OLD) - CENTRAL TENDENCY
SALTVILLE WASTE DISPOSAL SITE, POND 6
SALTVILLE, VIRGINIA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical specific	mg/kg	
INGESTION RATE	IR	120	mg/day	USEPA, 1989a
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm²-event	USEPA, 1992b
ABSORPTION FRACTION	ABS_i or ABS_d	chemical specific	unitless	
SURFACE AREA EXPOSED	SA	2,526	cm²	USEPA, 1992b
DOSE ABSORBED PER EVENT	DA_{event}	calculated	mg/cm²-event	
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT	BW	27	kg	USEPA, 1989b
EXPOSURE FREQUENCY	EF	6	days/year *	Assumption
EXPOSURE DURATION	ED	5	years	Assumption
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1989a
NONCANCER	AT	5	years	USEPA, 1991a

* Units for exposure frequency are events/year in the calculation of the dermally absorbed dose.

USEPA, 1989a. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part A); Office of Emergency and Remedial Response, Washington, D.C; EPA/540/1-89/002.

USEPA, 1989b. Exposure Factors Handbook.

USEPA, 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Parameters";

USEPA, 1992b. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992.

EQUATIONS

$$\text{CANCER RISK} = \text{INTAKE (mg/kg-day)} \times \text{CSF (mg/kg-day)}^{-1}$$

$$\text{HAZARD QUOTIENT} = \text{INTAKE (mg/kg-day)} / \text{RFD (mg/kg-day)}$$

$$\text{INTAKE-INGESTION} = \frac{CS \times IR_{soil} \times ABS_i \times FI \times CF \times EF \times ED}{BW \times AT \times 365\ \text{days/yr}}$$

$$\text{INTAKE-DERMAL} = \frac{DAevent \times SA \times EF \times ED}{BW \times AT \times 365\ \text{days/yr}}$$

Where:

$$DAevent = CS \times AF \times ABS_d \times CF$$

Note: For noncarcinogenic effects: AT = ED

AR303630

DIRT10 | 28-Sep-94

TABLE D-2, continued
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
CURRENT - CHILD TRESPASSER (6 TO 10 YEARS OLD) - CENTRAL TENDENCY
SALTVILLE WASTE DISPOSAL SITE, POND 6
SALTVILLE, VIRGINIA

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL RfD [1] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
ACETONE	0.02	1	1.5E-09	0.01	3.1E-10	0.1	1.5E-08	0.1	3.1E-09	1.8E-08
INORGANIC MERCURY	78.3	1	5.7E-06	0.01	1.2E-06	0.0003	1.9E-02	0.00006	2.0E-02	3.9E-02
SODIUM	1190									
					SUMMARY HAZARD INDEX		2E-02		2E-02	4E-02

[1] Calculated from Oral RfDs as described in Section 3.2.3.
ND = No data available

AR303631

SVDSWYR	26-Feb-93

TABLE D-3
SALTVILLE WASTE DISPOSAL SITE
SALTVILLE, VIRGINIA
DIRECT CONTACT WITH WATER WHILE WADING, CLOSE-TO-SITE
CHILDREN/TEENAGERS

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
SURFACE AREA EXPOSED (LEGS AND FEET)	SA	4490	cm^2	USEPA, 1989a
TIME OF EXPOSURE	ET	1	hr/day	Assumption
FREQUENCY OF EXPOSURE	EF	15	days/year	Assumption
DURATION OF EXPOSURE	ED	16	year	Assumption
AVERAGE BODY WEIGHT	BW	37	kg	USEPA, 1989a
LIFE EXPECTANCY		70	years	USEPA, 1989b

USEPA, 1989a. Exposure Factors Handbook
USEPA, 1989b. Risk Assessment Guidance for Superfund

SVDSWYR	26-Feb-93

TABLE D-3
SALTVILLE WASTE DISPOSAL SITE
SALTVILLE, VIRGINIA
DIRECT CONTACT WITH WATER WHILE WADING, CLOSE-TO-SITE
CHILDREN/TEENAGERS

NONCARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATION (mg/L)	PERMEABILITY CONSTANT (cm/hr)	DOSE (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT
INORGANIC MERCURY	5.89E-05	0.001	2.9E-10	3.00E-04	9.8E-07
				SUMMARY HAZARD INDEX	9.8E-07

TABLE D-4
INGESTION AND DIRECT CONTACT WITH SEDIMENT
CURRENT AND POTENTIAL FUTURE – CHILD/TEENAGER
SALTVILLE WASTE DISPOSAL SITE, CLOSE-TO-SITE
SALTVILLE, VIRGINIA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SEDIMENT	CS	chemical specific	mg/kg	
INGESTION RATE (SEDIMENT)	IR_{sed}	125	mg/day	USEPA, 1989a
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm^2-event	USEPA, 1992b
ABSORPTION FRACTION	ABS_i or ABS_d	chemical specific	unitless	
SURFACE AREA EXPOSED	SA	5,124	cm^2	USEPA, 1989b
DOSE ABSORBED PER EVENT	DA_{event}	calculated	mg/cm^2-event	
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT	BW	37	kg	USEPA, 1989b
EXPOSURE FREQUENCY	EF	15	days/year *	Assumption
EXPOSURE DURATION	ED	16	years	Assumption
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991a
NONCANCER	AT	16	years	USEPA, 1991a

* Units for exposure frequency are events/year in the calculation of the dermally absorbed dose.

USEPA, 1989a. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A);
USEPA, 1989b. "Exposure Factors Handbook"; Office of Health and Environmental Assessment; Washington, D.C.; EPA/600/8-89/043.
USEPA, 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Parameters";
USEPA, 1992b. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CSF $(mg/kg\text{-}day)^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / RFD (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{CS \times IR_{sed} \times ABS_i \times FI \times CF \times EF \times ED}{BW \times AT \times 365\ \text{days/yr}}$$

$$\text{INTAKE-DERMAL} = \frac{DAevent \times SA \times EF \times ED}{BW \times AT \times 365\ \text{days/yr}}$$

Where:

$$DAevent = CS \times AF \times ABS_d \times CF$$

Note: For noncarcinogenic effects: AT = ED

AR303634

TABLE D-4, continued
INGESTION AND DIRECT CONTACT WITH SEDIMENT
CURRENT AND POTENTIAL FUTURE - CHILD/TEENAGER
SALTVILLE WASTE DISPOSAL SITE, CLOSE-TO-SITE
SALTVILLE, VIRGINIA

NONCARCINOGENIC EFFECTS

COMPOUND	SEDIMENT CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL RfD [1] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
INORGANIC MERCURY	7.79	1	1.1E-06	0.01	4.4E-07	0.0003	3.6E-03	0.00006	7.4E-03	1.1E-02
					SUMMARY HAZARD INDEX		4E-03		7E-03	1E-02

[1] Calculated from Oral RfDs as described in Section 3.2.3.
ND = No data available

AR303635

TABLE D-5
SALTVILLE WASTE DISPOSAL SITE
SALTVILLE, VIRGINIA
DIRECT CONTACT WITH WATER WHILE SWIMMING, DOWNSTREAM
CHILDREN/TEENAGERS

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
SURFACE AREA EXPOSED	SA	12200	cm^2	USEPA, 1989b
TIME OF EXPOSURE	ET	2	hr/day	Assumption
FREQUENCY OF EXPOSURE	EF	34	days/year	Assumption
DURATION OF EXPOSURE	ED	16	year	Assumption
AVERAGE BODY WEIGHT	BW	37	kg	USEPA, 1989b
LIFE EXPECTANCY		70	years	USEPA, 1991a

USEPA, 1989b. Exposure Factors Handbook.
USEPA, 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Parameters";

TABLE D-5
SALTVILLE WASTE DISPOSAL SITE
SALTVILLE, VIRGINIA
DIRECT CONTACT WITH WATER WHILE SWIMMING, DOWNSTREAM
CHILDREN/TEENAGERS

NONCARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATION (mg/L)	PERMEABILITY CONSTANT (cm/hr)	DOSE (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT
INORGANIC MERCURY	4.61E-05	0.001	2.8E-09	3.00E-04	9.4E-06
			SUMMARY HAZARD INDEX		9.4E-06

TABLE D–6
SALTVILLE WASTE DISPOSAL SITE
SALTVILLE, VIRGINIA
FISH INGESTION – CENTRAL TENDENCY
ADULTS

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
INGESTION RATE	IR	10	g/day	Assumption
FRACTION INGESTED FROM SITE	FI	100	%	
AVERAGE BODY WEIGHT	BW	70	kg	USEPA, 1989a
FREQUENCY OF EXPOSURE	EF	365	days/year	Assumption
DURATION OF EXPOSURE	ED	70	years	Assumption
LIFE EXPECTANCY		70	years	USEPA, 1989a

USEPA, 1989a. Risk Assessment Guidance for Superfund

TABLE D–6
SALTVILLE WASTE DISPOSAL SITE
SALTVILLE, VIRGINIA
FISH INGESTION – CENTRAL TENDENCY
ADULTS

NONCARCINOGENIC EFFECTS

COMPOUND	FISH CONCENTRATION (mg/kg)	ORAL RAF	DOSE (mg/kg–day)	REFERENCE DOSE (mg/kg–day)	HAZARD QUOTIENT
ORGANIC MERCURY	1.35	1.00	1.9E–04	3.00E–04	6.4E–01
			SUMMARY HAZARD INDEX		6.4E–01

TABLE D-7
INGESTION AND DIRECT CONTACT WITH SEDIMENT
CURRENT AND POTENTIAL FUTURE – CHILD/TEENAGER
SALTVILLE WASTE DISPOSAL SITE, DOWNSTREAM
SALTVILLE, VIRGINIA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SEDIMENT	CS	chemical specific	mg/kg	
INGESTION RATE (SEDIMENT)	IR_{sed}	125	mg/day	USEPA, 1989a
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm^2–event	USEPA, 1992b
ABSORPTION FRACTION	ABS_i or ABS_d	chemical specific	unitless	
SURFACE AREA EXPOSED	SA	5,124	cm^2	USEPA, 1989b
DOSE ABSORBED PER EVENT	DA_{event}	calculated	mg/cm^2–event	
CONVERSION FACTOR	CF	1.00E–06	kg/mg	
BODY WEIGHT	BW	37	kg	USEPA, 1989b
EXPOSURE FREQUENCY	EF	34	days/year *	Assumption
EXPOSURE DURATION	ED	16	years	Assumption
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991a
NONCANCER	AT	16	years	USEPA, 1991a

* Units for exposure frequency are events/year in the calculation of the dermally absorbed dose.

USEPA, 1989a Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A);
USEPA, 1989b. "Exposure Factors Handbook"; Office of Health and Environmental Assessment; Washington, D.C.; EPA/600/8–89/043.
USEPA, 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Parameters";
USEPA, 1992b. Dermal Exposure Assessment: Principles and Applications; EPA/600/8–91/011B; January 1992.

EQUATIONS

$$\text{CANCER RISK} = \text{INTAKE (mg/kg–day)} \times \text{CSF (mg/kg–day)}^{-1}$$

$$\text{HAZARD QUOTIENT} = \text{INTAKE (mg/kg–day)} / \text{RFD (mg/kg–day)}$$

$$\text{INTAKE–INGESTION} = \frac{CS \times IR_{sed} \times ABS_i \times FI \times CF \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$$

$$\text{INTAKE–DERMAL} = \frac{DAevent \times SA \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$$

Where:

$$DAevent = CS \times AF \times ABS_d \times CF$$

Note: For noncarcinogenic effects: AT = ED

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TABLE D-7, continued
INGESTION AND DIRECT CONTACT WITH SEDIMENT
CURRENT AND POTENTIAL FUTURE - CHILD/TEENAGER
SALTVILLE WASTE DISPOSAL SITE, DOWNSTREAM
SALTVILLE, VIRGINIA

NONCARCINOGENIC EFFECTS

COMPOUND	SEDIMENT CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL RfD [1] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
INORGANIC MERCURY	6.24	1	2.0E-06	0.01	8.0E-07	0.0003	6.5E-03	0.00006	1.3E-02	2.0E-02
SUMMARY HAZARD INDEX							7E-03		1E-02	2E-02

[1] Calculated from Oral RfDs as described in Section 3.2.3
ND = No data available

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TABLE D-8
SALTVILLE WASTE DISPOSAL SITE
SALTVILLE, VIRGINIA
DIRECT CONTACT WITH SURFACE WATER, CLOSE-TO-SITE
ADULTS

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
SURFACE AREA EXPOSED (LEGS AND FEET)	SA	7710	cm^2	USEPA, 1989a
TIME OF EXPOSURE	ET	8	hr/day	Assumption
FREQUENCY OF EXPOSURE	EF	44	days/year	Assumption
DURATION OF EXPOSURE	ED	6	year	Assumption
AVERAGE BODY WEIGHT	BW	70	kg	USEPA, 1989a
LIFE EXPECTANCY		70	years	USEPA, 1989b

USEPA, 1989a. Exposure Factors Handbook
USEPA, 1989b. Risk Assessment Guidance for Superfund

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TABLE D-8
SALTVILLE WASTE DISPOSAL SITE
SALTVILLE, VIRGINIA
DIRECT CONTACT WITH SURFACE WATER, CLOSE-TO-SITE
ADULTS

NONCARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATION (mg/L)	PERMEABILITY CONSTANT (cm/hr)	DOSE (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT
INORGANIC MERCURY	5.89E-05	0.001	6.3E-09	3.00E-04	2.1E-05
				SUMMARY HAZARD INDEX	2.1E-05

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TABLE D-9
DIRECT CONTACT WITH SEDIMENT
CURRENT AND POTENTIAL FUTURE - ADULT
SALTVILLE WASTE DISPOSAL SITE, CLOSE-TO-SITE
SALTVILLE, VIRGINIA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SEDIMENT	CS	chemical specific	mg/kg	
INGESTION RATE (SEDIMENT)	IR_{sed}	0	mg/day	
FRACTION INGESTED	FI	0%	unitless	
ADHERENCE FACTOR	AF	1	mg/cm²-event	USEPA, 1992b
ABSORPTION FRACTION	ABS_i or ABS_d	chemical specific	unitless	
SURFACE AREA EXPOSED	SA	2,300	cm²	USEPA, 1989a
DOSE ABSORBED PER EVENT	DA_{event}	calculated	mg/cm²-event	
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT	BW	70	kg	USEPA, 1989b
EXPOSURE FREQUENCY	EF	44	days/year *	Assumption
EXPOSURE DURATION	ED	6	years	Assumption
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991a
NONCANCER	AT	6	years	USEPA, 1991a

* Units for exposure frequency are events/year in the calculation of the dermally absorbed dose.

USEPA, 1989a. Risk Assessment Guidance for Handbook, Volume I, Human Health Evaluation Manual (Part A);
USEPA, 1989b. "Exposure Factors Handbook"; Office of Health and Environmental Assessment;
Washington, D.C.; EPA/600/8-89/043.
USEPA, 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Parameters";
USEPA, 1992b. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CSF $(mg/kg\text{-}day)^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / RFD (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{CS \times IR_{sed} \times ABS_i \times FI \times CF \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$$

$$\text{INTAKE-DERMAL} = \frac{DAevent \times SA \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$$

Where:

$$DAevent = CS \times AF \times ABS_d \times CF$$

Note: For noncarcinogenic effects: AT = ED

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TABLE D-9, continued
DIRECT CONTACT WITH SEDIMENT
CURRENT AND POTENTIAL FUTURE - ADULT
SALTVILLE WASTE DISPOSAL SITE, CLOSE-TO-SITE
SALTVILLE, VIRGINIA

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NONCARCINOGENIC EFFECTS

COMPOUND	SEDIMENT CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL RfD [1] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
INORGANIC MERCURY	7.79	1	0.0E+00	0.01	5.1E-07	0.0003	0.0E+00	0.00006	5.1E-03	5.1E-03
					SUMMARY HAZARD INDEX		0E+00		5E-03	5E-03

[1] Calculated from Oral RfDs as described in Section 3.2.3.
ND = No data available

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TABLE D-10
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE - CHILD TRESPASSER (6 TO 10 YEARS OLD)
SALTVILLE WASTE DISPOSAL SITE, POND 5
SALTVILLE, VIRGINIA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical specific	mg/kg	
INGESTION RATE (SOIL)	IR_{soil}	120	mg/day	USEPA, 1989a
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm²-event	USEPA, 1992b
ABSORPTION FRACTION	ABS_i or ABS_d	chemical specific	unitless	
SURFACE AREA EXPOSED	SA	2,526	cm²	USEPA, 1992b
DOSE ABSORBED PER EVENT	DA_{event}	calculated	mg/cm²-event	
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT	BW	27	kg	USEPA, 1989b
EXPOSURE FREQUENCY	EF	84	days/year *	Assumption
EXPOSURE DURATION	ED	5	years	Assumption
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991a
NONCANCER	AT	5	years	USEPA, 1991a

* Units for exposure frequency are events/year in the calculation of the dermally absorbed dose.

USEPA, 1989a. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A);

USEPA, 1989b. "Exposure Factors Handbook"; Office of Health and Environmental Assessment; Washington, D.C.; EPA/600/8-89/043.

USEPA, 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Parameters";

USEPA, 1992b. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CSF (mg/kg-day)$^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / RFD (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{CS \times IR_{soil} \times ABS_i \times FI \times CF \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$$

$$\text{INTAKE-DERMAL} = \frac{DAevent \times SA \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$$

Where:

$$DAevent = CS \times AF \times ABS_d \times CF$$

Note: For noncarcinogenic effects: AT = ED

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TABLE D-10, continued
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE - CHILD TRESPASSER (6 TO 10 YEARS OLD)
SALTVILLE WASTE DISPOSAL SITE, POND 5
SALTVILLE, VIRGINIA

CARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL CSF (mg/kg-day)^-1	CANCER RISK INGESTION	DERMAL CSF[1] (mg/kg-day)^-1	CANCER RISK DERMAL	TOTAL CANCER RISK
CHLOROFORM	0.003	1	2.2E-10	0.01	4.6E-11	0.0061	1.3E-12	0.0061	2.8E-13	1.6E-12
					SUMMARY CANCER RISK		1E-12		3E-13	2E-12

[1] Calculated from Oral CSFs as described in Section 3.2.3.
ND = No data available

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TABLE D-10, continued
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE - CHILD TRESPASSER (6 TO 10 YEARS OLD)
SALTVILLE WASTE DISPOSAL SITE, POND 5
SALTVILLE, VIRGINIA

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL RfD [1] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
ACETONE	0.041	1	4.2E-08	0.01	8.8E-09	0.1	4.2E-07	0.1	8.8E-08	5.1E-07
CHLOROFORM	0.003	1	3.1E-09	0.01	6.5E-10	0.01	3.1E-07	0.01	6.5E-08	3.7E-07
TOLUENE	0.003	1	3.1E-09	0.02	1.3E-09	0.2	1.5E-08	0.2	6.5E-09	2.2E-08
INORGANIC MERCURY	164	1	1.7E-04	0.01	3.5E-05	0.0003	5.6E-01	0.00006	5.9E-01	1.1E+00
SODIUM	1890.0									
SUMMARY HAZARD INDEX							6E-01		6E-01	1E+00

[1] Calculated from Oral RfDs as described in Section 3.2.3.
ND = No data available

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TABLE D-11
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE - CHILD RESIDENT (1 TO 6 YEARS OLD)
SALTVILLE WASTE DISPOSAL SITE, POND 5
SALTVILLE, VIRGINIA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical specific	mg/kg	
INGESTION RATE (SOIL)	IR_{soil}	200	mg/day	USEPA, 1989a
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm^2-event	USEPA, 1992b
ABSORPTION FRACTION	ABS_i or ABS_d	chemical specific	unitless	
SURFACE AREA EXPOSED	SA	1,006	cm^2	USEPA, 1992b
DOSE ABSORBED PER EVENT	DA_{event}	calculated	mg/cm^2-event	
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT	BW	15	kg	USEPA, 1991a
EXPOSURE FREQUENCY	EF	350	days/year *	USEPA, 1991a
EXPOSURE DURATION	ED	6	years	USEPA, 1991a
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991a
NONCANCER	AT	6	years	USEPA, 1991a

* Units for exposure frequency are events/year in the calculation of the dermally absorbed dose.

USEPA, 1989a. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part A); Office of Emergency and Remedial Response, Washington, D.C; EPA/540/1-89/002.

USEPA, 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Parameters";

USEPA, 1992b. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CSF $(mg/kg\text{-}day)^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / RFD (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{CS \times IR_{soil} \times ABS_i \times FI \times CF \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

$$\text{INTAKE-DERMAL} = \frac{DAevent \times SA \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

Where:

$$DAevent = CS \times AF \times ABS_d \times CF$$

Note: For noncarcinogenic effects: AT = ED

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TABLE D-11, continued
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE – CHILD RESIDENT (1 TO 6 YEARS OLD)
SALTVILLE WASTE DISPOSAL SITE, POND 5
SALTVILLE, VIRGINIA

CARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL CSF (mg/kg-day)^-1	CANCER RISK INGESTION	DERMAL CSF[1] (mg/kg-day)^-1	CANCER RISK DERMAL	TOTAL CANCER RISK
CHLOROFORM	0.003	1	3.3E-09	0.01	1.7E-10	0.0061	2.0E-11	0.0061	1.0E-12	2.1E-11
SUMMARY CANCER RISK							2E-11		1E-12	2E-11

[1] Calculated from Oral CSFs as described in Section 3.2.3.
ND = No data available

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TABLE D-11, continued
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE - CHILD RESIDENT (1 TO 6 YEARS OLD)
SALTVILLE WASTE DISPOSAL SITE, POND 5
SALTVILLE, VIRGINIA

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL RfD [1] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
ACETONE	0.041	1	5.2E-07	0.01	2.6E-08	0.1	5.2E-06	0.1	2.6E-07	5.5E-06
CHLOROFORM	0.003	1	3.8E-08	0.01	1.9E-09	0.01	3.8E-06	0.01	1.9E-07	4.0E-06
TOLUENE	0.003	1	3.8E-08	0.02	3.9E-09	0.2	1.9E-07	0.2	1.9E-08	2.1E-07
INORGANIC MERCURY	164	1	2.1E-03	0.01	1.1E-04	0.0003	7.0E+00	0.00006	1.8E+00	8.7E+00
SODIUM	1890.0									
SUMMARY HAZARD INDEX							7E+00		2E+00	9E+00

[1] Calculated from Oral RfDs as described in Section 3.2.3.
ND = No data available

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TABLE D-12
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE – ADULT RESIDENT
SALTVILLE WASTE DISPOSAL SITE, POND 5
SALTVILLE, VIRGINIA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical specific	mg/kg	
INGESTION RATE (SOIL)	IR_{soil}	100	mg/day	USEPA, 1989a
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm^2-event	USEPA, 1992b
ABSORPTION FRACTION	ABS_i or ABS_d	chemical specific	unitless	
SURFACE AREA EXPOSED	SA	2,750	cm^2	USEPA, 1992b
DOSE ABSORBED PER EVENT	DA_{event}	calculated	mg/cm^2-event	
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT	BW	70	kg	USEPA, 1991a
EXPOSURE FREQUENCY	EF	350	days/year *	USEPA, 1991a
EXPOSURE DURATION	ED	24	years	USEPA, 1991a
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991a
NONCANCER	AT	24	years	USEPA, 1991a

* Units for exposure frequency are events/year in the calculation of the dermally absorbed dose.

USEPA, 1989a. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part A); Office of Emergency and Remedial Response, Washington, D.C; EPA/540/1-89/002.

USEPA, 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Parameters";

USEPA, 1992b. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CSF $(mg/kg\text{-}day)^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / RFD (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{CS \times IR_{soil} \times ABS_i \times FI \times CF \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

$$\text{INTAKE-DERMAL} = \frac{DAevent \times SA \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

Where:

$$DAevent = CS \times AF \times ABS_d \times CF$$

Note: For noncarcinogenic effects: AT = ED

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TABLE D-12, continued
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE - ADULT RESIDENT
SALTVILLE WASTE DISPOSAL SITE, POND 5
SALTVILLE, VIRGINIA

CARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL CSF (mg/kg-day)^-1	CANCER RISK INGESTION	DERMAL CSF[1] (mg/kg-day)^-1	CANCER RISK DERMAL	TOTAL CANCER RISK
CHLOROFORM	0.003	1	1.4E-09	0.01	3.9E-10	0.0061	8.6E-12	0.0061	2.4E-12	1.1E-11
					SUMMARY CANCER RISK		9E-12		2E-12	1E-11

[1] Calculated from Oral CSFs as described in Section 3.2.3.
ND = No data available

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TABLE D-12, continued
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE - ADULT RESIDENT
SALTVILLE WASTE DISPOSAL SITE, POND 5
SALTVILLE, VIRGINIA

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL RfD [1] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
ACETONE	0.041	1	5.6E-08	0.01	1.5E-08	0.1	5.6E-07	0.1	1.5E-07	7.2E-07
CHLOROFORM	0.003	1	4.1E-09	0.01	1.1E-09	0.01	4.1E-07	0.01	1.1E-07	5.2E-07
TOLUENE	0.003	1	4.1E-09	0.02	2.3E-09	0.2	2.1E-08	0.2	1.1E-08	3.2E-08
INORGANIC MERCURY	164	1	2.2E-04	0.01	6.2E-05	0.0003	7.5E-01	0.00006	1.0E+00	1.8E+00
SODIUM	1890.0									-
					SUMMARY HAZARD INDEX		7E-01		1E+00	2E+00

[1] Calculated from Oral RfDs as described in Section 3.2.3.
ND = No data available

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TABLE D-13
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE - INDUSTRIAL WORKER
SALTVILLE WASTE DISPOSAL SITE, POND 5
SALTVILLE, VIRGINIA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical specific	mg/kg	
INGESTION RATE (SOIL)	IR_{soil}	50	mg/day	USEPA, 1991a
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm^2-event	USEPA, 1992b
ABSORPTION FRACTION	ABS_i or ABS_d	chemical specific	unitless	
SURFACE AREA EXPOSED	SA	2,750	cm^2	USEPA, 1992b
DOSE ABSORBED PER EVENT	DA_{event}	calculated	mg/cm^2-event	
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT	BW	70	kg	USEPA, 1991a
EXPOSURE FREQUENCY	EF	250	days/year *	USEPA, 1991a
EXPOSURE DURATION	ED	25	years	USEPA, 1991a
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991a
NONCANCER	AT	25	years	USEPA, 1991a

* Units for exposure frequency are events/year in the calculation of the dermally absorbed dose.

USEPA, 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Parameters";

USEPA, 1992b. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CSF $(mg/kg-day)^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / RFD (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{CS \times IR_{soil} \times ABS_i \times FI \times CF \times EF \times ED}{BW \times AT \times 365\ \text{days/yr}}$$

$$\text{INTAKE-DERMAL} = \frac{DAevent \times SA \times EF \times ED}{BW \times AT \times 365\ \text{days/yr}}$$

Where:

$DAevent = CS \times AF \times ABS_d \times CF$

Note: For noncarcinogenic effects: AT = ED

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TABLE D-13, continued
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE - INDUSTRIAL WORKER
SALTVILLE WASTE DISPOSAL SITE, POND 5
SALTVILLE, VIRGINIA

CARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL CSF (mg/kg-day)^-1	CANCER RISK INGESTION	DERMAL CSF[1] (mg/kg-day)^-1	CANCER RISK DERMAL	TOTAL CANCER RISK
CHLOROFORM	0.003	1	5.2E-10	0.01	2.9E-10	0.0061	3.2E-12	0.0061	1.8E-12	5.0E-12
						SUMMARY CANCER RISK	3E-12		2E-12	5E-12

[1] Calculated from Oral CSFs as described in Section 3.2.3.
ND = No data available

TABLE D-13, continued
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE - INDUSTRIAL WORKER
SALTVILLE WASTE DISPOSAL SITE, POND 5
SALTVILLE, VIRGINIA

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL RfD [1] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
ACETONE	0.041	1	2.0E-08	0.01	1.1E-08	0.1	2.0E-07	0.1	1.1E-07	3.1E-07
CHLOROFORM	0.003	1	1.5E-09	0.01	8.1E-10	0.01	1.5E-07	0.01	8.1E-08	2.3E-07
TOLUENE	0.003	1	1.5E-09	0.02	1.6E-09	0.2	7.3E-09	0.2	8.1E-09	1.5E-08
INORGANIC MERCURY	164	1	8.0E-05	0.01	4.4E-05	0.0003	2.7E-01	0.00006	7.4E-01	1.0E+00
SODIUM	1890.0									
					SUMMARY HAZARD INDEX		3E-01		7E-01	1E+00

[1] Calculated from Oral RfDs as described in Section 3.2.3.
ND = No data available

AR303657

TABLE D-14
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE - CHILD TRESPASSER (6 TO 10 YEARS OLD)
SALTVILLE WASTE DISPOSAL SITE, POND 6
SALTVILLE, VIRGINIA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical specific	mg/kg	
INGESTION RATE	IR	120	mg/day	USEPA, 1989a
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm² - event	USEPA, 1992b
ABSORPTION FRACTION	ABS_i or ABS_d	chemical specific	unitless	
SURFACE AREA EXPOSED	SA	2,526	cm²	USEPA, 1992b
DOSE ABSORBED PER EVENT	DA_{event}	calculated	mg/cm^2 - event	
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT	BW	27	kg	USEPA, 1989b
EXPOSURE FREQUENCY	EF	84	days/year *	Assumption
EXPOSURE DURATION	ED	5	years	Assumption
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991a
NONCANCER	AT	5	years	USEPA, 1991a

* Units for exposure frequency are events/year in the calculation of the dermally absorbed dose.

USEPA, 1989a. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part A); Office of Emergency and Remedial Response, Washington, D.C; EPA/540/1-89/002.

USEPA, 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Parameters";

USEPA, 1992b. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992.

EQUATIONS

$$\text{CANCER RISK} = \text{INTAKE (mg/kg-day)} \times \text{CSF (mg/kg-day)}^{-1}$$

$$\text{HAZARD QUOTIENT} = \text{INTAKE (mg/kg-day)} / \text{RFD (mg/kg-day)}$$

$$\text{INTAKE-INGESTION} = \frac{CS \times IR_{soil} \times ABS_i \times FI \times CF \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$$

$$\text{INTAKE-DERMAL} = \frac{DAevent \times SA \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$$

Where:

$$DAevent = CS \times AF \times ABS_d \times CF$$

Note: For noncarcinogenic effects: AT = ED

AR303658

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TABLE D-14, continued
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE - CHILD TRESPASSER (6 TO 10 YEARS OLD)
SALTVILLE WASTE DISPOSAL SITE, POND 6
SALTVILLE, VIRGINIA

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL RfD [1] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
ACETONE	0.02	1	2.0E-04	0.01	4.3E-09	0.1	2.0E-07	0.1	4.3E-08	2.5E-07
INORGANIC MERCURY	78.3	1	8.0E-05	0.01	1.7E-05	0.0003	2.7E-01	0.00006	2.8E-01	5.5E-01
SODIUM	1190									
					SUMMARY HAZARD INDEX		3E-01		3E-01	5E-01

[1] Calculated from Oral RfDs as described in Section 3.2.3.
ND = No data available

AR303659

TABLE D-15
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE CHILD RESIDENT (1 TO 6 YEARS OLD)
SALTVILLE WASTE DISPOSAL SITE, POND 6
SALTVILLE, VIRGINIA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical specific	mg/kg	
INGESTION RATE	IR	200	mg/day	USEPA, 1989a
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm² - event	USEPA, 1992b
ABSORPTION FRACTION	ABS_i or ABS_d	chemical specific	unitless	
SURFACE AREA EXPOSED	SA	1,006	cm²	USEPA, 1992b
DOSE ABSORBED PER EVENT	DA_{event}	calculated	mg/cm² - event	
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT	BW	15	kg	USEPA, 1991a
EXPOSURE FREQUENCY	EF	350	days/year *	USEPA, 1991a
EXPOSURE DURATION	ED	6	years	USEPA, 1991a
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991a
NONCANCER	AT	6	years	USEPA, 1991a

* Units for exposure frequency are events/year in the calculation of the dermally absorbed dose.

USEPA, 1989a. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part A); Office of Emergency and Remedial Response, Washington, D.C; EPA/540/1-89/002.

USEPA, 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Parameters";

USEPA, 1992b. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CSF (mg/kg-day)$^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / RFD (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{CS \times IR_{soil} \times ABS_i \times FI \times CF \times EF \times ED}{BW \times AT \times 365\ \text{days/yr}}$$

$$\text{INTAKE-DERMAL} = \frac{DAevent \times SA \times EF \times ED}{BW \times AT \times 365\ \text{days/yr}}$$

Where:

$$DAevent = CS \times AF \times ABS_d \times CF$$

Note: For noncarcinogenic effects: AT = ED

DIRT3	31-Aug-94

TABLE D-15, continued
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE CHILD RESIDENT (1 TO 6 YEARS OLD)
SALTVILLE WASTE DISPOSAL SITE, POND 6
SALTVILLE, VIRGINIA

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL RfD [1] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
ACETONE	0.02	1	2.6E-07	0.01	1.3E-08	0.1	2.6E-06	0.1	1.3E-07	2.7E-06
INORGANIC MERCURY	78.3	1	1.0E-03	0.01	5.0E-05	0.0003	3.3E+00	0.00006	8.4E-01	4.2E+00
SODIUM	1190									
					SUMMARY HAZARD INDEX		3E+00		8E-01	4E+00

[1] Calculated from Oral RfDs as described in Section 3.2.3.
ND = No data available

AR303661

DIR T4 | 31-Aug-94

TABLE D-16
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE – ADULT RESIDENT
SALTVILLE WASTE DISPOSAL SITE, POND 6
SALTVILLE, VIRGINIA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical specific	mg/kg	
INGESTION RATE	IR	100	mg/day	USEPA, 1989a
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm²-event	USEPA, 1992b
ABSORPTION FRACTION	ABS_i or ABS_d	chemical specific	unitless	
SURFACE AREA EXPOSED	SA	2,750	cm²	USEPA, 1992b
DOSE ABSORBED PER EVENT	DA_{event}	calculated	mg/cm²-event	
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT	BW	70	kg	USEPA, 1991a
EXPOSURE FREQUENCY	EF	350	days/year *	USEPA, 1991a
EXPOSURE DURATION	ED	24	years	USEPA, 1991a
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991a
NONCANCER	AT	24	years	USEPA, 1991a

* Units for exposure frequency are events/year in the calculation of the dermally absorbed dose.

USEPA, 1989a. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part A); Office of Emergency and Remedial Response, Washington, D.C; EPA/540/1-89/002.

USEPA, 1991a. *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Parameters"*;

USEPA, 1992b. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CSF $(mg/kg\text{-}day)^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / RFD (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{CS \times IR_{soil} \times ABS_i \times FI \times CF \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

$$\text{INTAKE-DERMAL} = \frac{DAevent \times SA \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

Where:

$$DAevent = CS \times AF \times ABS_d \times CF$$

Note: For noncarcinogenic effects: AT = ED

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TABLE D-16, continued
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE - ADULT RESIDENT
SALTVILLE WASTE DISPOSAL SITE, POND 6
SALTVILLE, VIRGINIA

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL RfD [1] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
ACETONE	0.02	1	2.7E-08	0.01	7.5E-09	0.1	2.7E-07	0.1	7.5E-08	3.5E-07
INORGANIC MERCURY	78.3	1	1.1E-04	0.01	2.9E-05	0.0003	3.6E-01	0.00006	4.9E-01	8.5E-01
SODIUM	1190									
					SUMMARY HAZARD INDEX		4E-01		5E-01	8E-01

[1] Calculated from Oral RfDs as described in Section 3.2.3.
ND = No data available

AR303663

DIRT20 | 31-Aug-94

TABLE D-17
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE - INDUSTRIAL WORKER
SALTVILLE WASTE DISPOSAL SITE, POND 6
SALTVILLE, VIRGINIA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical specific	mg/kg	
INGESTION RATE	IR	50	mg/day	USEPA, 1991a
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm²-event	USEPA, 1992b
ABSORPTION FRACTION	ABS_i or ABS_d	chemical specific	unitless	
SURFACE AREA EXPOSED	SA	2,750	cm²	USEPA, 1992b
DOSE ABSORBED PER EVENT	DA_{event}	calculated	mg/cm²-event	
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT	BW	70	kg	USEPA, 1991a
EXPOSURE FREQUENCY	EF	250	days/year *	USEPA, 1991a
EXPOSURE DURATION	ED	25	years	USEPA, 1991a
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991a
NONCANCER	AT	25	years	USEPA, 1991a

* Units for exposure frequency are events/year in the calculation of the dermally absorbed dose.

USEPA, 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Parameters";

USEPA, 1992b. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CSF (mg/kg-day)$^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / RFD (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{CS \times IR_{soil} \times ABS_i \times FI \times CF \times EF \times ED}{BW \times AT \times 365\ \text{days/yr}}$$

$$\text{INTAKE-DERMAL} = \frac{DAevent \times SA \times EF \times ED}{BW \times AT \times 365\ \text{days/yr}}$$

Where:

$DAevent = CS \times AF \times ABS_d \times CF$

Note: For noncarcinogenic effects: AT = ED

AR303664

TABLE D-17, continued
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE - INDUSTRIAL WORKER
SALTVILLE WASTE DISPOSAL SITE, POND 6
SALTVILLE, VIRGINIA

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL RfD [1] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
ACETONE	0.02	1	9.8E-09	0.01	5.4E-09	0.1	9.8E-08	0.1	5.4E-08	1.5E-07
INORGANIC MERCURY	78.3	1	3.8E-05	0.01	2.1E-05	0.0003	1.3E-01	0.00006	3.5E-01	4.8E-01
SODIUM	1190									
						SUMMARY HAZARD INDEX	1E-01		4E-01	5E-01

[1] Calculated from Oral RfDs as described in Section 3.2.3.
ND = No data available

AR303665

DIRT15 | 31-Aug-94

TABLE D-18
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE – CHILD TRESPASSER (6 TO 10 YEARS OLD)
SALTVILLE WASTE DISPOSAL SITE, FORMER CHLORINE PLANT SITE
SALTVILLE, VIRGINIA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical specific	mg/kg	
INGESTION RATE (SOIL)	IR_{soil}	120	mg/day	USEPA, 1989a
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm^2–event	USEPA, 1992b
ABSORPTION FRACTION	ABS_i or ABS_d	chemical specific	unitless	
SURFACE AREA EXPOSED	SA	2,526	cm^2	USEPA, 1992b
DOSE ABSORBED PER EVENT,	DA_{event}	calculated	mg/cm^2–event	
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT	BW	27	kg	USEPA, 1989b
EXPOSURE FREQUENCY	EF	84	days/year *	Assumption
EXPOSURE DURATION	ED	5	years	Assumption
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991a
NONCANCER	AT	5	years	USEPA, 1991a

* Units for exposure frequency are events/year in the calculation of the dermally absorbed dose.

USEPA, 1989a. Risk Assessment Guidance for Risk Assessment, Volume I, Human Health Evaluation Manual (Part A);

USEPA, 1989b. "Exposure Factors Handbook"; Office of Health and Environmental Assessment; Washington, D.C.; EPA/600/8-89/043.

USEPA, 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Parameters";

USEPA, 1992b. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CSF $(mg/kg\text{-}day)^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / RFD (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{CS \times IR_{soil} \times ABS_i \times FI \times CF \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

$$\text{INTAKE-DERMAL} = \frac{DAevent \times SA \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

Where:

$$DAevent = CS \times AF \times ABS_d \times CF$$

Note: For noncarcinogenic effects: AT = ED

AR303666

DIRT15 | 31-Aug-94

TABLE D-18, continued
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE - CHILD TRESPASSER (6 TO 10 YEARS OLD)
SALTVILLE WASTE DISPOSAL SITE, FORMER CHLORINE PLANT SITE
SALTVILLE, VIRGINIA

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL RfD [1] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
INORGANIC MERCURY	698.29	1	7.1E-04	0.01	1.5E-04	0.0003	2.4E+00	0.00006	2.5E+00	4.9E+00
					SUMMARY HAZARD INDEX		2E+00		3E+00	5E+00

[1] Calculated from Oral RfDs as described in Section 3.2.3.
ND = No data available

AR303667

TABLE D-19
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE - INDUSTRIAL WORKER
SALTVILLE WASTE DISPOSAL SITE, FORMER CHLORINE PLANT SITE
SALTVILLE, VIRGINIA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical specific	mg/kg	
INGESTION RATE (SOIL)	IR_{soil}	50	mg/day	USEPA, 1991a
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm^2-event	USEPA, 1992b
ABSORPTION FRACTION	ABS_i or ABS_d	chemical specific	unitless	
SURFACE AREA EXPOSED	SA	2,750	cm^2	USEPA, 1992b
DOSE ABSORBED PER EVENT	DA_{event}	calculated	mg/cm^2-event	
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT	BW	70	kg	USEPA, 1991a
EXPOSURE FREQUENCY	EF	250	days/year *	USEPA, 1991a
EXPOSURE DURATION	ED	25	years	USEPA, 1991a
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991a
NONCANCER	AT	25	years	USEPA, 1991a

* Units for exposure frequency are events/year in the calculation of the dermally absorbed dose.

USEPA, 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Parameters";

USEPA, 1992b. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CSF $(mg/kg-day)^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / RFD (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{CS \times IR_{soil} \times ABS_i \times FI \times CF \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$$

$$\text{INTAKE-DERMAL} = \frac{DAevent \times SA \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$$

Where:

$$DAevent = CS \times AF \times ABS_d \times CF$$

Note: For noncarcinogenic effects: AT = ED

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DIRT6 | 31-Aug-94

TABLE D-19, continued
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
FUTURE - INDUSTRIAL WORKER
SALTVILLE WASTE DISPOSAL SITE, FORMER CHLORINE PLANT SITE
SALTVILLE, VIRGINIA

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL RfD [1] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
INORGANIC MERCURY	698.29	1	3.4E-04	0.01	1.9E-04	0.0003	1.1E+00	0.00006	3.1E+00	4.3E+00
						SUMMARY HAZARD INDEX	1E+00		3E+00	4E+00

[1] Calculated from Oral RfDs as described in Section 3.2.3.
ND = No data available

AR303669

DRINK3	31-Aug-94

TABLE D-20
INGESTION OF AND DIRECT CONTACT WITH DRINKING WATER
FUTURE – INDUSTRIAL WORKER
SALTVILLE WASTE DISPOSAL SITE, FORMER CHLORINE PLANT SITE
SALTVILLE, VIRGINIA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION WATER	CW	chemical specific	mg/liter	
INGESTION RATE (WATER)	IR_{water}	1	liters/day	USEPA, 1991a
SURFACE AREA EXPOSED	SA	2,300	cm^2	USEPA, 1989b
BODY WEIGHT	BW	70	kg	USEPA, 1991a
CONVERSION FACTOR	CF	0.001	liter/cm^3	
EXPOSURE TIME	ET	0.1	hours/day	Assumption
EXPOSURE FREQUENCY	EF	250	days/year	USEPA, 1991a
EXPOSURE DURATION	ED	25	years	USEPA, 1991a
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991a
NONCANCER	AT	25	years	USEPA, 1991a
PERMEABILITY CONSTANT	PC	chemical specific	cm/hr	USEPA, 1992b
ABSORPTION FACTOR (ING)	ABS_i	1	unitless	

USEPA, 1989b. Exposure Factors Handbook.
USEPA, 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Parameters";
USEPA, 1992b. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)^-1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

INTAKE = (INTAKE-INGESTION) + (INTAKE-DERMAL)

$$\text{INTAKE-INGESTION} = \frac{CW \times IR_{water} \times ABS_i \times EF \times ED}{BW \times AT \times 365\ \text{days/yr}}$$

$$\text{INTAKE-DERMAL} = \frac{CW \times SA \times PC \times CF \times ET \times EF \times ED}{BW \times AT \times 365\ \text{days/yr}}$$

Note:
For carcinogenic effects: AT = ED

AR303670

TABLE D-20, continued
INGESTION OF AND DIRECT CONTACT WITH DRINKING WATER
FUTURE - INDUSTRIAL WORKER
SALTVILLE WASTE DISPOSAL SITE, FORMER CHLORINE PLANT SITE
SALTVILLE, VIRGINIA

CARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATION (mg/l)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	PERMEABILITY CONSTANT (PC) (cm/hr)	INTAKE DERMAL (mg/kg-day)	CANCER SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK INGESTION	CANCER RISK DERMAL	TOTAL CANCER RISK
CHLOROFORM	0.012	1	4.2E-05	0.13	1.3E-06	0.0061	2.6E-07	7.6E-09	2.6E-07
TETRACHLORETHYLENE	0.008	1	2.8E-05	0.37	2.4E-06	0.052	1.5E-06	1.2E-07	1.6E-06
METHYLENE CHLORIDE	0.002	1	7.0E-06	0.0045	7.2E-09	0.0075	5.2E-08	5.4E-11	5.2E-08
ARSENIC	0.019	1	6.6E-05	0.001	1.5E-08	1.75	1.2E-04	2.7E-08	1.2E-04
					SUMMARY CANCER RISK		1E-04	2E-07	1E-04

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TABLE D-20, continued

INGESTION OF AND DIRECT CONTACT WITH DRINKING WATER

FUTURE - INDUSTRIAL WORKER

SALTVILLE WASTE DISPOSAL SITE, FORMER CHLORINE PLANT SITE

SALTVILLE, VIRGINIA

NONCARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATION (mg/l)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	PERMEABILITY CONSTANT (PC) (cm/hr)	INTAKE DERMAL (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT INGESTION	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
CHLOROFORM	0.012	1	1.2E-04	0.13	3.5E-06	0.01	1.2E-02	3.5E-04	1.2E-02
TETRACHLORETHYLENE	0.008	1	7.8E-05	0.37	6.7E-06	0.01	7.8E-03	6.7E-04	8.5E-03
METHYLENE CHLORIDE	0.002	1	2.0E-05	0.0045	2.0E-08	0.06	3.3E-04	3.4E-07	3.3E-04
ARSENIC	0.019	1	1.9E-04	0.001	4.3E-08	0.0003	6.2E-01	1.4E-04	6.2E-01
COBALT	0.002	1	2.0E-05	0.0004	1.8E-09	0.18	1.1E-04	1.0E-08	1.1E-04
COPPER	0.005	1	4.9E-05	0.001	1.1E-08	0.037	1.3E-03	3.0E-07	1.3E-03
LEAD	0.016			0.000004	1.4E-10				
INORGANIC MERCURY	0.7087	1	6.9E-03	0.001	1.6E-06	0.0003	2.3E+01	5.3E-03	2.3E+01
SODIUM	177.8			0.001	4.0E-04				
THALLIUM	0.002	1	2.0E-05	0.001	4.5E-09	0.00008	2.4E-01	5.6E-05	2.4E-01
VANADIUM	0.001	1	9.8E-06	0.001	2.3E-09	0.007	1.4E-03	3.2E-07	1.4E-03
						SUMMARY HAZARD INDEX	2E+01	7E-03	2E+01

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TABLE D-21
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
CURRENT – CHILD TRESPASSER (6 TO 10 YEARS OLD) – RME
SALTVILLE WASTE DISPOSAL SITE, POND 5
SALTVILLE, VIRGINIA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical specific	mg/kg	
INGESTION RATE (SOIL)	IR_{soil}	120	mg/day	USEPA, 1989a
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm^2-event	USEPA, 1992b
ABSORPTION FRACTION	ABS_i or ABS_d	chemical specific	unitless	
SURFACE AREA EXPOSED	SA	2,526	cm^2	USEPA, 1992b
DOSE ABSORBED PER EVENT	DA_{event}	calculated	mg/cm^2-event	
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT	BW	27	kg	USEPA, 1989b
EXPOSURE FREQUENCY	EF	26	days/year *	Assumption
EXPOSURE DURATION	ED	5	years	Assumption
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991a
NONCANCER	AT	5	years	USEPA, 1991a

* Units for exposure frequency are events/year in the calculation of the dermally absorbed dose.

USEPA, 1989a. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A);

USEPA, 1989b. "Exposure Factors Handbook"; Office of Health and Environmental Assessment; Washington, D.C.; EPA/600/8-89/043.

USEPA, 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Parameters";

USEPA, 1992b. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CSF $(mg/kg\text{-}day)^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / RFD (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{CS \times IR_{soil} \times ABS_i \times FI \times CF \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

$$\text{INTAKE-DERMAL} = \frac{DAevent \times SA \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

Where:

$$DAevent = CS \times AF \times ABS_d \times CF$$

Note: For noncarcinogenic effects: AT = ED

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TABLE D-21, continued
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
CURRENT - CHILD TRESPASSER (6 TO 10 YEARS OLD) - RME
SALTVILLE WASTE DISPOSAL SITE, POND 5
SALTVILLE, VIRGINIA

CARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL CSF (mg/kg-day)^-1	CANCER RISK INGESTION	DERMAL CSF[1] (mg/kg-day)^-1	CANCER RISK DERMAL	TOTAL CANCER RISK
CHLOROFORM	0.003	1	6.8E-11	0.01	1.4E-11	0.0061	4.1E-13	0.0061	8.7E-14	5.0E-13
					SUMMARY CANCER RISK		4E-13		9E-14	5E-13

[1] Calculated from Oral CSFs as described in Section 3.2.3.
ND = No data available

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TABLE D-21, continued
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
CURRENT – CHILD TRESPASSER (6 TO 10 YEARS OLD) – RME
SALTVILLE WASTE DISPOSAL SITE, POND 5
SALTVILLE, VIRGINIA

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL RfD [1] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
ACETONE	0.041	1	1.3E-08	0.01	2.7E-09	0.1	1.3E-07	0.1	2.7E-08	1.6E-07
CHLOROFORM	0.003	1	9.5E-10	0.01	2.0E-10	0.01	9.5E-08	0.01	2.0E-08	1.1E-07
TOLUENE	0.003	1	9.5E-10	0.02	4.0E-10	0.2	4.7E-09	0.2	2.0E-09	6.7E-09
INORGANIC MERCURY	164	1	5.2E-05	0.01	1.1E-05	0.0003	1.7E-01	0.00006	1.8E-01	3.6E-01
SODIUM	1890.0									
						SUMMARY HAZARD INDEX	2E-01		2E-01	4E-01

[1] Calculated from Oral RfDs as described in Section 3.2.3.
ND = No data available

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TABLE D-22
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
CURRENT - CHILD TRESPASSER (6 TO 10 YEARS OLD) - RME
SALTVILLE WASTE DISPOSAL SITE, POND 6
SALTVILLE, VIRGINIA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical specific	mg/kg	
INGESTION RATE	IR	120	mg/day	USEPA, 1989a
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm^2-event	USEPA, 1992b
ABSORPTION FRACTION	ABS_i or ABS_d	chemical specific	unitless	
SURFACE AREA EXPOSED	SA	2,526	cm^2	USEPA, 1992b
DOSE ABSORBED PER EVENT	DA_{event}	calculated	mg/cm^2-event	
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT	BW	27	kg	USEPA, 1989b
EXPOSURE FREQUENCY	EF	26	days/year *	Assumption
EXPOSURE DURATION	ED	5	years	Assumption
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1989a
NONCANCER	AT	5	years	USEPA, 1991a

* Units for exposure frequency are events/year in the calculation of the dermally absorbed dose.

USEPA, 1989a. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part A); Office of Emergency and Remedial Response, Washington, D.C; EPA/540/1-89/002.

USEPA, 1989b. Exposure Factors Handbook.

USEPA, 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Parameters";

USEPA, 1992b. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CSF $(mg/kg\text{-}day)^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / RFD (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{CS \times IR_{soil} \times ABS_i \times FI \times CF \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

$$\text{INTAKE-DERMAL} = \frac{DAevent \times SA \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

Where:

$$DAevent = CS \times AF \times ABS_d \times CF$$

Note: For noncarcinogenic effects: AT = ED

TABLE D-22, continued
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
CURRENT - CHILD TRESPASSER (6 TO 10 YEARS OLD) - RME
SALTVILLE WASTE DISPOSAL SITE, POND 6
SALTVILLE, VIRGINIA

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION ABS	INTAKE INGESTION (mg/kg-day)	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL RfD [1] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
ACETONE	0.02	1	6.3E-09	0.01	1.3E-09	0.1	6.3E-08	0.1	1.3E-08	7.7E-08
INORGANIC MERCURY	78.3	1	2.5E-05	0.01	5.2E-06	0.0003	8.3E-02	0.00006	8.7E-02	1.7E-01
SODIUM	1190									
					SUMMARY HAZARD INDEX		8E-02		9E-02	2E-01

[1] Calculated from Oral RfDs as described in Section 3.2.3.
ND = No data available

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TABLE D-23
SALTVILLE WASTE DISPOSAL SITE
SALTVILLE, VIRGINIA
FISH INGESTION – RME
ADULTS

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
INGESTION RATE	IR	27	g/day	Assumption
FRACTION INGESTED FROM SITE	FI	100	%	
AVERAGE BODY WEIGHT	BW	70	kg	USEPA, 1989a
FREQUENCY OF EXPOSURE	EF	365	days/year	Assumption
DURATION OF EXPOSURE	ED	70	years	Assumption
LIFE EXPECTANCY		70	years	USEPA, 1989a

USEPA, 1989a. Risk Assessment Guidance for Superfund

TABLE D-23
SALTVILLE WASTE DISPOSAL SITE
SALTVILLE, VIRGINIA
FISH INGESTION – RME
ADULTS

NONCARCINOGENIC EFFECTS

COMPOUND	FISH CONCENTRATION (mg/kg)	ORAL RAF	DOSE (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT
ORGANIC MERCURY	1.35	1.00	5.2E-04	3.00E-04	1.7E+00
			SUMMARY HAZARD INDEX		1.7E+00

APPENDIX E

QUANTITATIVE UNCERTAINTY ANALYSIS OF FISH CONSUMPTION RISKS

1.0 INTRODUCTION

This probabilistic risk assessment is presented to provide a broader picture of potential risks to receptor populations who might be consuming fish taken from river mile 80.3 to river mile 53 of the North Fork of the Holston River (NFHR). Quantitative health risk assessments often assume single point estimates of important exposure and toxicity parameters. This point estimate approach yields a single point estimate of risk which is then used in making risk management decisions. There are limitations in the use of such point estimates of risk for decision-making. For example, a single number may characterize risk, but it may not always be obvious which individual or group of individuals within a population the risk estimate applies to. Based on the exposure and toxicity assumptions, a single point estimate may overestimate risks for virtually all individuals in a population or it may be a reasonable estimate of risk for the individual with an "average" exposure.

There has been considerable effort in recent years to incorporate meaningful uncertainty analysis into risk assessment. The Deputy Administrator of the USEPA, F. Henry Habicht II, in a guidance memorandum on risk characterization for risk managers and risk assessors (Habicht, 1992) calls for "full disclosure" of assumptions and choices made in the risk assessment and for a thorough discussion of uncertainties in the risk estimates. Also, the Guidelines for Exposure Assessment (USEPA, 1992) discusses the use of probabilistic uncertainty analysis and Monte Carlo analysis in particular to describe the uncertainty in the inputs to the exposure assessment and subsequently in the risk estimates. There have also been numerous published and publicly presented papers on the theoretical and practical uses of Monte Carlo analysis for evaluation of uncertainty (and variability) in risk assessment (McKone et al., 1991; Burmaster et al., 1991; Anderson et al., 1992; Lipton et al., 1992; Finkel, 1990).

The use of Monte Carlo analysis in exposure assessment and risk assessment acknowledges and incorporates variability in exposure and toxicity parameters into risk estimates. This is accomplished by assigning a probability density function (PDF) to each parameter, using these distributions as inputs to the exposure assessment and Hazard Index equations, and producing a probability distribution function for the risk estimate. This risk estimate distribution is generated via Monte Carlo sampling, in which values from the input parameter distributions are selected at random and inserted into the risk equations and a risk estimate is generated. This process is repeated many times (5000 iterations in the current analysis) to generate a probability density function for risk like that presented in Figure E-1. This distribution shows the central tendency and the spread of the risk values given the variability in the input parameters.

The distribution can also be graphically presented as a cumulative probability function as shown in Figure E-2. It is possible to read directly from this graph the probability that the risk would be greater than a given value on the x-axis. For example, drawing a vertical line from 1.8 on the x-axis to a point where the line intersects the curve, moving horizontally from that point to the y-axis shows there is approximately 5% chance that the Hazard index is greater than 1.8. The available software packages can also generate percentile probability tables which present the same information as the cumulative probability curve but in a different format (see Table E-1). The presentation of risk estimates as probability density functions, cumulative probability functions and in probability percentiles tables results in a fuller understanding of the nature of the risks than the presentation of a single point estimate. These probabilistic techniques are used here to enhance the risk assessment presented in the main body of this report.

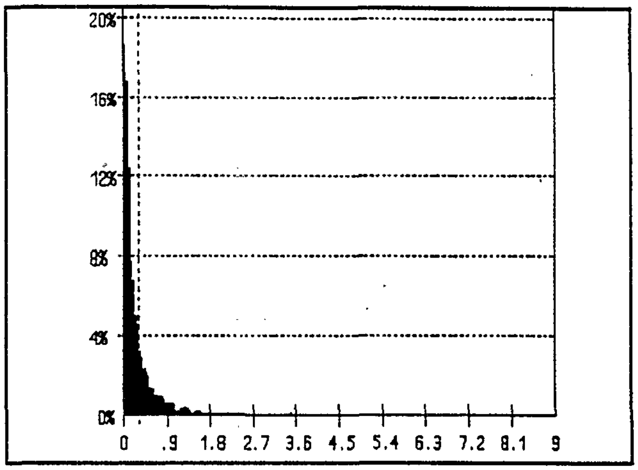

Figure E-1 - Sample Probability Density Function (PDF)

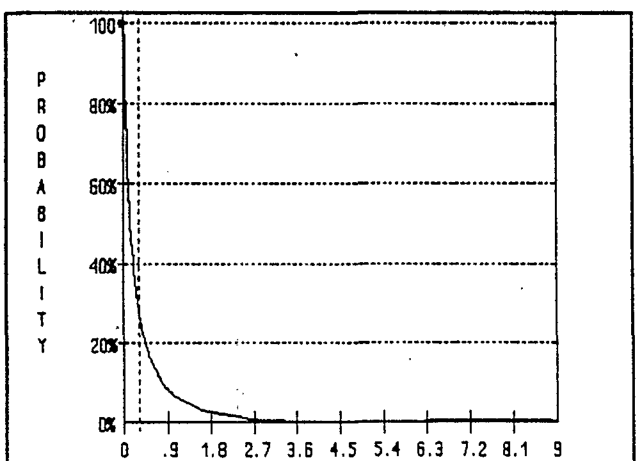

Figure E-2 - Sample Cumulative Probability Function

	Percentile Probabilities:
	(Chance of Result <= Shown Value)
	(Actual Values)
	==============================
	<= .0005 = 0%
	<= .0156 = 5%
	<= .0259 = 10%
	<= .037 = 15%
	<= .0488 = 20%
	<= .0617 = 25%
	<= .0754 = 30%
	<= .089 = 35%
	<= .1048 = 40%
	<= .1226 = 45%
	<= .1491 = 50%
	<= .1778 = 55%
	<= .2095 = 60%
	<= .2497 = 65%
	<= .3001 = 70%
	<= .3671 = 75%
	<= .4558 = 80%
	<= .5848 = 85%
	<= .8063 = 90%
	<= 1.2766 = 95%
	<= 8.892 = 100%

Table E-1 - Sample Probabilities Percentile Table

2.0 METHODS

The estimation of risks is conducted here using the same basic approach as is used in the main body of this report. The risks are estimated for the consumption of fish from the NFHR. The contaminant of concern is methylmercury. The @RISK™ software package is used in conjunction with LOTUS 123™ to insert distributions for exposure parameters and to generate probability density functions and cumulative probability functions for the Hazard Index estimates. The Monte Carlo sampling technique is used in the simulations, and each simulation run incorporated 5000 iterations of Hazard Index calculation. Risk simulations were conducted for two separate exposure scenarios. One of the scenarios evaluates a receptor group identified as "freshwater fish consumers" and the other scenario evaluates "fishermen".

2.1 CALCULATION OF HAZARD INDEX

The method and equations for calculating Hazard Index are identical to those used in the main body of this report. The exposure equation and Hazard Index equations are presented and explained below.

$$Intake\ (\frac{mg}{kg\text{-}day}) = \frac{CF \times IR \times RAF \times EF \times ED \times CF}{BW \times AT}$$

where:

CF	=	chemical concentration in fish (mg/kg)
IR	=	ingestion rate for fish from the Saltville study area (g/day)
RAF	=	relative absorption factor (unitless).
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
CF	=	conversion factor (10^{-3} kg/g)
BW	=	average body weight (kilograms)
AT	=	averaging time (period over which exposure is averaged - days)

The Hazard index is calculated as the ratio of the Intake and the USEPA Reference Dose.

2.2 TOXICITY ASSESSMENT

Consistent with the risk assessment in the main body of this report, methylmercury is the selected contaminant of concern for fish consumption. The toxicity assessment portion of this analysis utilizes the information presented in Section 3.2 of the report. Methylmercury is treated as a non-carcinogenic substance. The oral Reference Dose used to evaluate the potential for adverse non-cancer health effects is taken from USEPA's IRIS database and is 0.0003 mg/kg/day.

2.3 EXPOSURE ASSESSMENT

Except for the use of probability density functions in place of point estimates for some parameters, the exposure assessment used here is consistent with that presented in Section 3.1 of the report. The notable points concerning the exposure points for this uncertainty analysis are presented below.

2.3.1 Potentially exposed populations

There are two potentially exposed populations evaluated in this analysis. In general terms, these populations can be characterized as "consumers of freshwater fish" and "fishermen who consume freshwater fish". The "consumers of freshwater fish" would be those people who consume freshwater fish obtained at the market or from relatives, neighbors or friends who have caught the fish themselves. The "fishermen who consume freshwater fish" represents a more highly exposed population, consisting of people who are fishermen and who consume freshwater fish which they catch or obtain from other sources.

2.3.2 Exposure and Toxicity Parameters Represented by Point Estimates

Among the exposure and toxicity parameters presented above, the Reference Dose for methylmercury, the exposure duration, exposure frequency, Relative Absorption Factor (RAF) and the averaging time are represented in this analysis by the values assigned to the assessment presented in Sections 3.1 and 3.2 of this report. The Reference Dose used is the published USEPA value for methylmercury. The exposure duration and averaging time are held constant at 70 years. Although there are distributions available for life expectancy and time spent or lived in a single residence which could be used in this type of evaluation, these distributions were not included as estimates of exposure duration. In this unique evaluation, no cancer risks are calculated because the contaminant of concern is not carcinogenic. In the exposure calculation shown above, the averaging time is set equal to the exposure

Therefore, variation in the chronic exposure duration would have no effect on the exposure rate or the Hazard index value. Table E-2 presents the values assigned to these parameters.

2.3.3 Exposure Parameters Represented by Probability Density Functions

A number of suggested distributions are available for exposure parameters related to these fish consumption scenarios. Those parameters are: concentration of mercury in fish, freshwater fish consumption rate, fraction of freshwater fish consumed which come from the NFHR, and adult bodyweight. The distributions used to represent these parameters are presented below and are summarized in Table E-2.

Concentration of mercury in fish - A substantial database has been compiled for fish in the NFHR. As described in Section 2.1.6, data for methylmercury are available for fish tissue samples in smallmouth bass, rock bass, sunfish, hogsucker and catfish. Because hogsuckers are not regularly consumed by anglers they were excluded from the risk assessment. Data used in the risk assessment are limited to those data associated with fish weighing 100 grams or more because smaller fish are not regularly consumed. All data for river sections A, B and C were considered in the risk assessment. Data from the "adjacent and downstream" category were used in the fish consumption assessment. These data are presented in Appendix A. These fish concentration data are lognormally distributed with an arithmetic mean of 1.28 mg/kg and standard deviation of 0.51 mg/kg. A lognormal distribution with these characteristics is used in the @RISK simulation as the input for the fish concentration. This distribution of concentrations is depicted graphically in Figure E-3.

Fish consumption rate - The distributions for fish consumption rate for the "consumers of freshwater fish" and "fishermen consuming freshwater fish" are intended to be representative of consumption rates in the Saltville, Virginia area. As described in Appendix B, fish consumption rates described in the Alabama Fish Consumption Survey (Hughes and Woernle, 1992) were considered to be most applicable to the information available on fish consumption rates and therefore fish consumption distributions extracted from the Alabama Fish Consumption Survey are used here.

Among 243 "freshwater fish consumers" in the Alabama survey, the arithmetic mean consumption rate was 18.42 grams of fish per day with a standard deviation of 30.06 grams/day. A truncated lognormal distribution with that mean and standard deviation and minimum and maximum values of zero and 300 grams per day is used in the Monte Carlo analysis performed here. The maximum value is the highest average consumption rate reported in the Hughes and Woernle (1992) study. That maximum value represents a daily consumption rate for freshwater fish 10.7 ounces every day of the year. A graphical presentation of the freshwater fish consumption rate probability density function is contained in Figure E-4.

Input Parameter	Distribution Type	Arithmetic Mean	Standard Deviation	Source
Mercury concentration in fish (mg/kg)	Lognormal	1.28	0.51	(1)
Freshwater fish consumption rate - consumers (grams/day)	Truncated Lognormal	18.42	30.06	(2)
Freshwater fish consumption rate - fishermen (grams/day)	Truncated Lognormal	23.74	38.17	(2)
Fraction of consumed freshwater fish from NFHR (%)	Triangular	20		(3)
Exposure duration (years)	Point estimate	70		(3)
Exposure frequency (days/year)	Point estimate	365		
Relative absorption factor (unitless)	Point estimate	1		
Conversion factor (kg/g)	Point estimate	10^3		
Averaging time (years)	Point estimate	70		(3)
Bodyweight (kg)	Normal	70	16.17	(4)

(1) ABB-ES, 1993
(2) Hughes and Woernle, 1992
(3) Assumption
(4) USEPA, 1989 and Anderson et al., 1985

Table E-2 - Inputs to Monte Carlo analysis

Among 131 "fishermen consuming freshwater fish" in Alabama, the arithmetic mean consumption rate was 23.74 grams per day with a standard deviation of 38.17 grams per day. Based on that information, a truncated lognormal distribution with that mean and standard deviation and minimum and maximum values of zero and 300 grams per day is used in this Monte Carlo analysis. A graphical presentation of the freshwater fish consumption rate probability density function for fishermen is contained in Figure E-5.

Fraction of consumed freshwater fish obtained from NFHR - A triangular distribution with a most likely value of 20% and minimum and maximum values of zero % and 50%, respectively is used in this Monte Carlo analysis. The most likely value of 20% is the high end of the range of 10-20% suggested by local anglers. The maximum value for this distribution is selected because information collected to date indicates that this portion of the river is not a highly productive fishery and other more productive areas are used by local anglers. This distribution is depicted in Figure E-6.

Adult Bodyweight - A bodyweight distribution for adults in the U.S. found in the "Exposure Factors Handbook" (USEPA, 1989) and "Development of Statistical Distributions or Ranges of Standard Factors used in Exposure Assessments" (Anderson et al., 1985) is used here to represent the bodyweight of the potentially exposed population. This normal distribution has an arithmetic mean of 70 kg and a standard deviation of 16.17. Figure E-7 presents this distribution which serves as an input for the simulation.

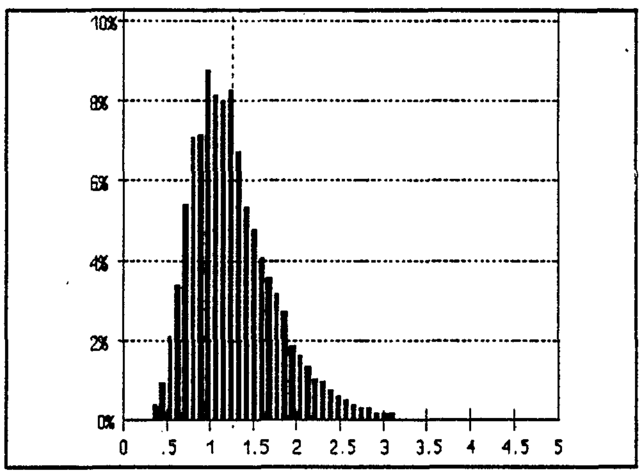

Figure E-3 - Input distribution of mercury concentration in fish (mg/kg)

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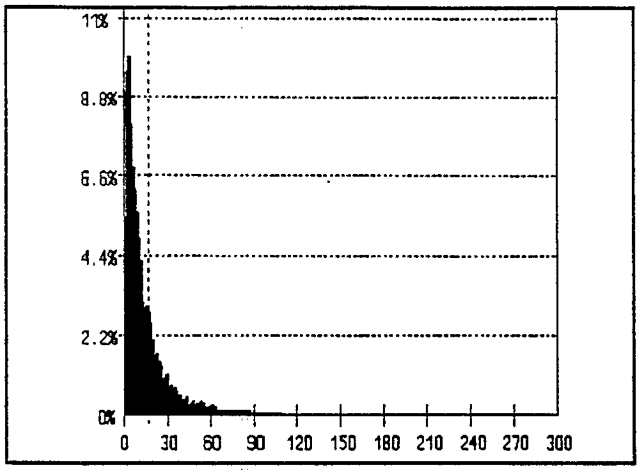

Figure E.4 - Input distribution of freshwater fish consumption rate for consumers (grams/day)

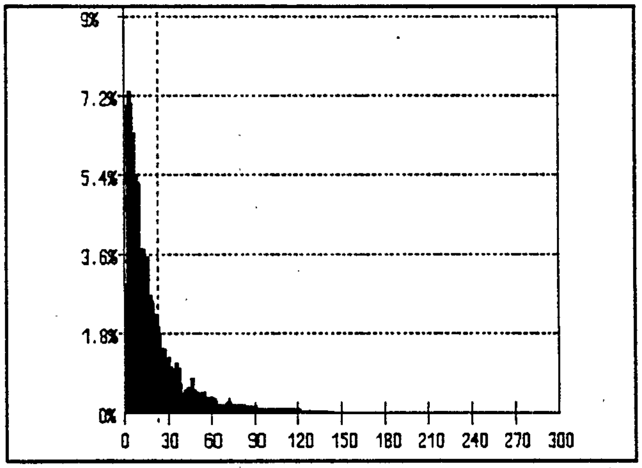

Figure E-5 - Input distribution of freshwater fish consumption by fishermen (grams/day)

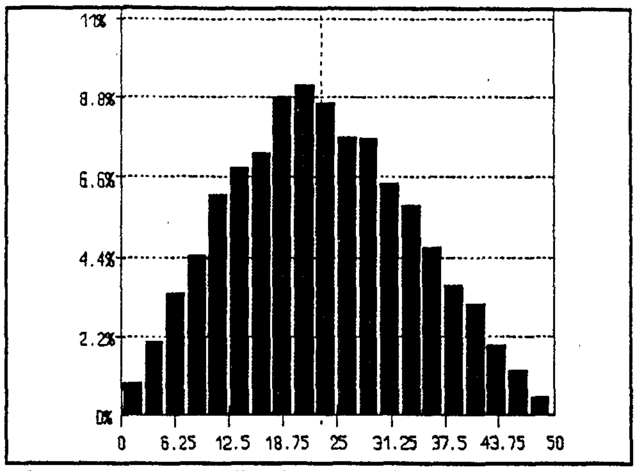

Figure E-6 - Input distribution of fraction of freshwater fish obtained from NFHR (percent)

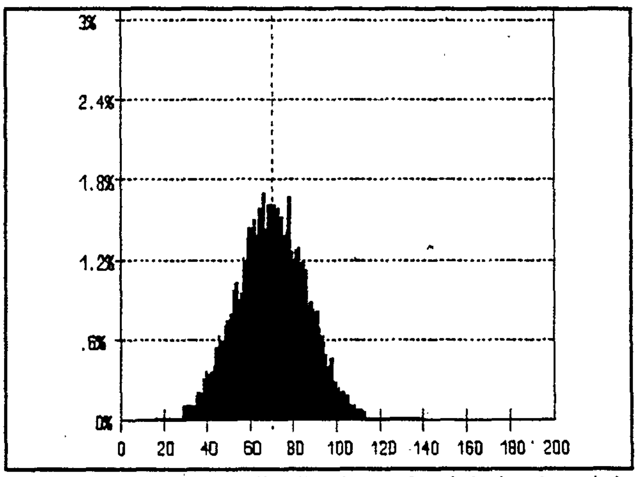

Figure E-7 - Input distribution of adult bodyweight (kg)

2.4 RISK CHARACTERIZATION

In the risk characterization, the input parameters in Table E-2 above have been used with the @RISK software to generate probability density functions, cumulative probability distributions, and probability percentiles tables for the Hazard Index for "consumers of freshwater fish" and for "consumption of freshwater fish by fishermen". Each of these distributions were generated via a Monte Carlo simulation utilizing 5000 iterations. In each iteration, one value for each input parameter was randomly drawn and used to calculate the Hazard Index. These distributions provide a fuller picture of the nature of the non-cancer health risks associated with consumption of fish from the NFHR.

3.0 RESULTS AND SUMMARY

The results of the Monte Carlo simulation for the "consumers of freshwater fish" are shown in Figures E-8 and E-9 and Table E-3, while the results of the simulation for the "fishermen who consume freshwater fish" appear in Figures E-10 and E-11 and Table E-4. The probability density functions show the "spread" in the risk estimates and also show where the where in the range the more probable risks lie. The cumulative probability functions allow the determination of the probability that the true risk is above any given Hazard Index value. The probability percentiles tables provide the same information in a different format.

For the "consumers of freshwater fish", the simulation indicates that there is a 50% chance that the Hazard Index is less than 0.12 and a 90% chance that the Hazard Index is below 0.64. The simulation indicates therefore that there is roughly a 90% chance that the Hazard Index is less than the point estimate for the Hazard Index (0.64) presented in Section 3.3.3.

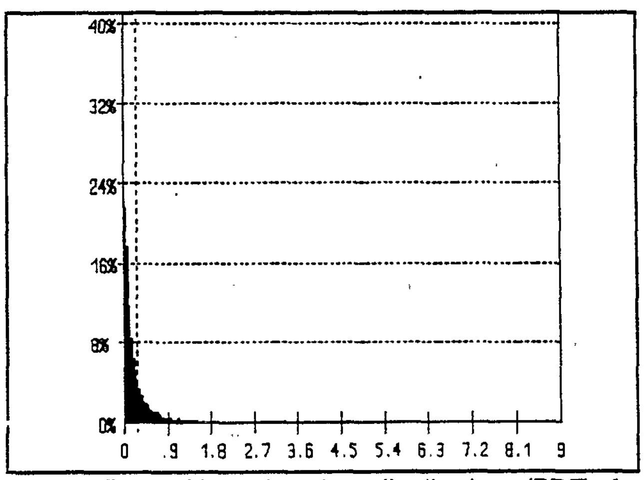

Figure E-8 - Hazard Index distribution (PDF) for consumers of freshwater fish

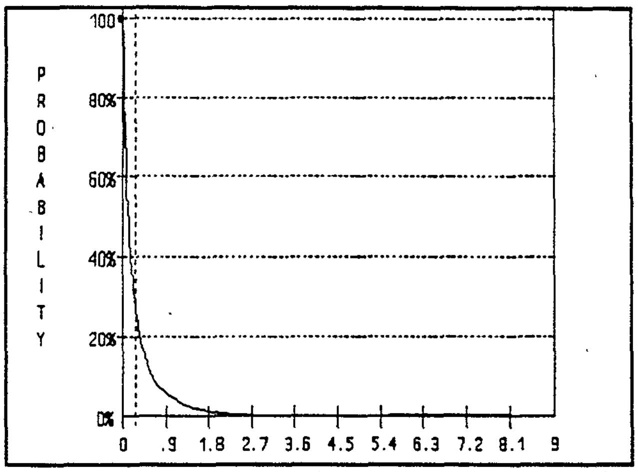

Figure E-9 - Hazard Index cumulative probability function for freshwater fish consumers

Percentile Probabilities:
(Chance of Result <= Shown Value)
(Actual Values)
==============================
<= .0007 = 0%
<= .0128 = 5%
<= .0213 = 10%
<= .03 = 15%
<= .0385 = 20%
<= .0487 = 25%
<= .0592 = 30%
<= .071 = 35%
<= .0852 = 40%
<= .1014 = 45%
<= .1204 = 50%
<= .1432 = 55%
<= .1682 = 60%
<= .2004 = 65%
<= .24 = 70%
<= .295 = 75%
<= .3664 = 80%
<= .467 = 85%
<= .6365 = 90%
<= 1.017 = 95%
<= 8.1087 = 100%

Table E-3 - Probabilities percentile table for Hazard Index for "consumers of freshwater fish".

For "fishermen who consume freshwater fish", the simulation indicates there is a 50% chance that the Hazard index is less than 0.15 and a 90% chance that the Hazard Index is less than 0.81. The simulation suggests the probability that the Hazard Index is below the central tendency point estimate presented in Section 3.3.3 (0.64) is approximately 87%. The simulation also indicates the probability that the Hazard Index is less than the RME point estimate (1.7) is 96.8%. Both simulations suggest that the point estimate generated in Section 3.3.3 could be characterized as a conservative, likely over-estimator of risk.

The simulations also show that given the exposure and toxicity input values and distributions, the maximum possible Hazard Index is 8.1 and 8.9 for "consumers" and "fishermen" respectively. In addition, there is only 5% and 7% chance that the Hazard Index is greater than 1 for the "consumer" and "fishermen" respectively. Given that the Reference Dose is an "allowable" level of exposure and not an unacceptable level of exposure, this information suggests strongly that the potential exposures related to fish consumption do not pose significant health risks.

In any case, this Monte Carlo analysis supports the results and conclusions of Section 3.3.3. In fact, this analysis suggests that the risks are likely to be lower than the Hazard Index presented in that section of the report.

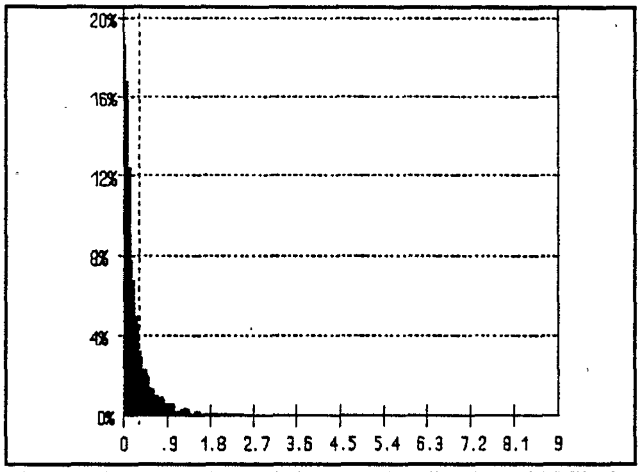

Figure E-10 - Hazard Index distribution (PDF) for fishermen who consume freshwater fish

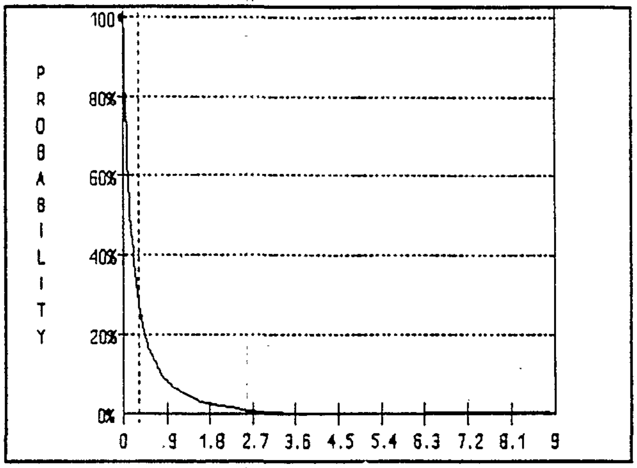

Figure E-11 - Hazard Index cumulative probability function for fishermen who consume freshwater fish

Percentile Probabilities:
(Chance of Result <= Shown Value)
(Actual Values)
==============================
<= .0005 = 0%
<= .0156 = 5%
<= .0259 = 10%
<= .037 = 15%
<= .0488 = 20%
<= .0617 = 25%
<= .0754 = 30%
<= .089 = 35%
<= .1048 = 40%
<= .1226 = 45%
<= .1491 = 50%
<= .1778 = 55%
<= .2095 = 60%
<= .2497 = 65%
<= .3001 = 70%
<= .3671 = 75%
<= .4558 = 80%
<= .5848 = 85%
<= .8063 = 90%
<= 1.2766 = 95%
<= 8.892 = 100%

Table E-4 - Probability percentiles table for Hazard Index for "fishermen who consume freshwater fish".

4.0 REFERENCES

Anderson, E., N. Browne, S. Duletsky, J. Ramig, and T. Warn, 1985. Development of Statistical Distributions or Ranges of Standard Factors used in Exposure Assessments, Prepared for USEPA, Exposure Assessment Group, Washington, D.C.

Anderson, P.D., B. Ruffle, and W. Gillespie, 1992. "A Monte Carlo Analysis of Dioxin Exposures and Risks from Consumption of Fish Caught in Freshwaters of the United States Affected by Bleached Chemical Pulp Mill Effluents", TAPPI Proceedings, Environmental Conference, 1992.

Burmaster, D.E. and K.Von Stackelberg, 1991. "Using Monte Carlo Simulations In Public Health Risk Assessments: Estimating and Presenting Full Distributions of Risk", Journal of Exposure Analysis and Environmental Epidemiology, Vol. 1, No. 4, 491-512.

Finkel, A.M., 1990. Confronting Uncertainty In Risk Management, A Guide for Decision-Makers, Center for Risk Management, Resources for the Future, Washington, D.c.

Habicht, F. H., 1992. "Guidance on Risk Characterization for Risk managers and Risk Assessors", Memorandum from Deputy Administrator of USEPA to Assistant Administrators and Regional Administrators.

Hughes, B.J. and C.H. Woernle, 1992. "Alabama Fish Consumption Survey", Alabama Department of Public Health.

Lipton, J. and J.W. Gillett, 1992. "Uncertainty in risk assessment: Exceedence Frequencies, Acceptable Risk, and Risk-Based Decision Making", Regulatory Toxicology and Pharmacology; 15, 51-61.

McKone, T.E. and K.T. Bogen, 1991. "Predicting the uncertainties in Risk Assessment, A California groundwater case study", Environ. Sci. Technol., Vol. 25, No. 10, 1674-1681.

U.S. Environmental Protection Agency (USEPA), 1989. Exposure Factors Handbook, Final Report, Exposure assessment Group, Office of Health and environmental Assessment, EPA/600/8-89/043.

U.S. Environmental Protection Agency (USEPA), 1992. "Guidelines for Exposure Assessment", Fed. Reg., Vol. 57, No. 104, Friday May 29, 1992, 22888-22938.

APPENDIX F-1

RESPONSE TO USEPA COMMENTS ON THE

DRAFT RISK ASSESSMENT FOR OU2 AND OU3

JANUARY 8, 1992

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
841 Chestnut Building
Philadelphia, Pennsylvania 19107

RECEIVED
JAN 15 1992
KEITH ROBERTS
FILE COPY
SV-RA

VIA FACSIMILE AND FIRST CLASS MAIL

JAN 8 1992

Mr. Keith D. Roberts
Principal Environmental Specialist
Olin Chemicals
P.O. Box 248, Lower River Road
Charleston, TN 37310

RE: Notice of Deficiencies; Review of Risk Assessment for Operable Units 2 and 3, Saltville Waste Disposal Ponds Superfund Site

Dear Keith:

As we discussed on December 18, 1991, EPA is providing you comments to the Draft Risk Assessment for Operable Units 2 and 3 for the Saltville Waste Disposal Site. Due to the extent of comments to this document, EPA will not approve the Risk Assessment as submitted. Pursuant to Section VI.D. of the Consent Decree, Olin is required to submit a revised Risk Assessment within twenty-four (24) days of receipt of this Notice of Deficiencies. A general discussion is provided below and specific comments to the Study are attached to this letter.

As we discussed, substantial deficiencies to both the Public Health Risk Assessment and the Ecological Risk Assessment portions of the document are noted. In particular, the Public Health Risk Assessment does not follow EPA guidance in several instances. In addition, the Ecological Risk Assessment does not adequately reflect the ecological impacts that have occurred and are occurring in the North Fork Holsten River downstream of the Site. The Ecological Risk Assessment assumption procedures, scope, extent and conclusions are faulty throughout the document and do not use sound scientific or deductive reasoning.

At this time, I believe it may be necessary for Olin, EPA, and Virginia Department of Waste Management (VDWM) representatives meet to discuss EPA's comments. While many of the comments can be considered minor and can be addressed easily, several others comments will require discussion. Please contact me at (215)597-1727 if you have any questions regarding the content of the letter.

Sincerely,

Eugene P. Wingert
Remedial Project Manager

ATTACHMENT

cc: Tim Longe, VADWM
Bob Davis, EPA Region III
Reggie Harris, EPA Region III
Gwen Pospisil, EPA Region III
Sadia Kissoon, CH2M-HILL

ATTACHMENT A
SPECIFIC COMMENTS TO THE PUBLIC HEALTH RISK ASSESSMENT SALTVILLE WASTE SITE, OPERABLE UNITS 2 AND 3

The following comments apply to the Public Health Risk Assessment portion of the document:

1. Geometric mean values instead of arithmetic means are used to calculate some upper 95th percentile upper confidence limit values. RAGS clearly states that the arithmetic mean is to be used for the calculation of the 95th percent upper confidence limit value. The geometric mean was inappropriately used in several cases in this risk assessment. If log normal distributed data sets are encountered, as indicated in the RI document, the method of Gilbert should be used to normalize the data and the 95th upper confidence limit calculated on the arithmetic mean.

2. The residence time for lifelong residents is incorrectly used as 70 years instead of 30 years. EPA recommends the use of a 30 year residence time at a site when evaluating long term exposures such as fish ingestion unless there is clear justification for using a longer time period such as 70 years. Since no justification was provided for the use of the 70 year averaging time, 30 years should have been used.

3. Future site use was not fully evaluated for the Saltville Site. No consideration was given to future site construction activities involving on-site workers, or to the conversion of the site to residential use at some future point in time. There should have been future use scenarios developed to take in account the exposure to surface and subsurface soils by on-site workers involved in site related construction activities. These scenarios should include incidental ingestion of surface and subsurface soils, inhalation of volatile mercury, and inhalation and dermal exposure to contaminated soils. Since no data sets related to the various site media were presented, it could not be determined if there were subsurface soils levels of mercury that on-site workers or site residents could potentially be exposed to during the course of construction activities, or as a result of future residential development.

4. Dermal contact and incidental ingestion of contaminated media are considered in this risk assessment, but inhalation of fugitive dusts and inhalation of volatilized mercury have not been considered. It would be appropriate to at least investigate these routes of exposure and make a determination of their significance. There is some mention of air data from 1985 which reported air concentrations of mercury below ambient air quality standard of 1.0 ug/m^3 for 350 days per year over a 30 year residence time would have a calculated Hazard Quotient which would exceed 1.0. The air

data collected should have been provided and health risk based calculations used to make determination of the relative importance of the pathway.

5. Data sets related to various exposure pathways evaluated in the risk assessment are not provided for review and evaluation. The lack of this information makes it very difficult to accurately and appropriately evaluate the data, the exposure scenarios, and the risk characterization. In other words, in order to fully evaluate the risk assessment and to bring the document clearly into focus, the data upon which the assessment is based must be provided. Merely providing the exposure point values, which were calculated inappropriately, is not adequate for the accurate evaluation of this document. The data sets must be included in order that all aspects of the risk assessment may be fairly and correctly assessed. Historical data and other relevant information required to justify the approach taken in the risk assessment would also be helpful. It is noted that Agency guidance indicates that default exposure factors should be utilized unless there is documented site specific exposure values. The documentation for these site specific values is lacking.

6. Some of the exposure parameters used in the exposure assessment are not included in the Exposure Quantification section. It is suggested that all values used in the exposure quantification selection be clearly listed.

7. A review of the exposure parameters used in the assessment raises a number of concerns. It may not be appropriate to use a soil adherence factor (SAF) of 1.5 mg/cm^3 for sediments. The SAF for kaolin clay (2.5 mg/cm^3) may be more appropriate. Questions arise from the selections made with respect to the ages of individuals exposed to contaminated media and the types of exposure of these individuals. It seems that it would be reasonable to expect youths younger than 10 years of age to be in contact with contaminated soils and sediment close to the site. It is understood that access to the pond areas may be more restricted than some other areas, but children in the 6-10 years age bracket are known to explore and to be more inquisitive thereby making it altogether likely that these children may venture onto the site. Missing from the exposure scenarios is any mention of persons exposed to contaminated media while fishing. Persons fishing on the bank of the NFHR may come into contact with contaminated media via dermal contact and incidental ingestion of contaminated sediments and surface water. This exposure during recreational fishing can be expected to occur over a lifetime. Dermal contact with sediments should be calculated over a period of 3 to 18 years of age for persons close to the site as well as for individuals downstream from the site unless there is specific justification for using different values.

8. Site maps do not indicate the locations of residences close to the site, nor do they indicate the concentrations of mercury in soil, sediments, or groundwater at the site. These are important factors which are required for the appropriate evaluation of the site and the risk assessment document. Maps should be provided to address these concerns. Questions also arise related to the existence of mercury contamination off-site and on-site out of the pond areas.

9. Groundwater has been excluded from the risk assessment. However, additional documentation is required to justify this exclusion. The home well survey, while helpful, does not provide enough information with respect to the residences within the area of influence of the plume and those residences that may be impacted in the future by the groundwater contamination. An assessment of future use of groundwater should be included if the contaminants might be expected to migrate beyond the immediate area.

10. There are numerous instances throughout the risk assessment in which assumptions have been made and site specific values utilized without justification. Documentation and justification should be provided for all deviations from standard default values, and for the elimination of any pathways or routes of exposure.

ATTACHMENT B
SPECIFIC COMMENTS TO THE ECOLOGICAL RISK ASSESSMENT
SALTVILLE WASTE SITE, OPERABLE UNITS 2 AND 3

Comments on the Ecological Risk Assessment are broken down into the following categories:

I) Characterization of the area of concern;
II) Approaches and hypotheses used by the investigator;
III) Impacts assessment and extent of contamination; and,
IV) Conclusions and recommendations.

I. Characterization:

1. The vegetation survey (Section 4.1.1; p 4-2) failed to mention the presence or absence of wetlands and riparian areas. In addition, the discussion fails to detail the major ecosystems found in the area and to describe sub areas, etc., down to the basics needed to carry out the ecological risk assessment.

2. It is suggested that an effort be made to describe the terrestrial, edge, wetlands, riparian, and aquatic habitats in both a general way as well as in a detailed treatment of each, as needed in light of contamination or control studies. The investigator should also carry out a literature search to ascertain the impacts of site-related contaminants upon plants.

3. It was noted that the description of aquatic species (Sect. 4.1.2; p 4-2) is based upon information dating only to 1971. It is suggested that the authors attempt to located information dating to that point in time prior to operations at the site. It is suspected that information natural resources of the Holston River dates from the 1890's or earlier.

4. Other studies may also exist on fauna that can supplement the information on the description of fauna. As in the other discussions in the document regarding biological resources, the information is too cursory and general for the reviewers to use in determining the potential impacts.

5. The ERA does not include a section on stream characterization to the level of detail presented in the work plan. For example, the work plan indicates that stream gradient profiles would be generated and that data on geology, soils, hydrology, land cover and stream usage would also be generated. This type of data is not included in the ERA.

6. The section on fish studies indicates that relative abundance, health conditions, and concentrations of mercury and methylmercury in fish filets and whole body burden would

be determined for the North Fork of the Holston River (NFHR). None of this information was provided in the ERA. Page 4-1 of the ERA indicates that "recently collected mercury residue and fish population data" were not available for evaluation in this risk assessment. The report indicated that "These risk conclusions may be reevaluated depending upon the results of these recently completed studies".

II. Approaches:

1. The study is limited to a section of the Holston River That is only 30 miles long (river mile 82.8 to 53). It is clear that the extent of contamination is much farther downstream than mile 53 and it is suggested that the investigator search state and federal agency literature to ascertain the limits of contamination.

2. The risk assessment is limited to impacts proven to be caused by mercury and minimizes any effects that cannot be conclusively linked to the mercury contamination alone. Many prior observed and published accounts are dismissed or excluded. The investigator should complete an exhaustive literature search and use the results to establish the geographical and chemical basis for the risk assessment.

3. Other site-related contaminants are not included in the impact analysis or the risk assessment. These are of importance due to toxicity and the possibility of synergistic or additive effects.

4. Even the rigorous benthic studies that were planned may not have supported any exposure trends regarding mercury and methylmercury in discharges from the Saltville site. The approach presented in the ERA does appear to be a reasonable basis for an ecological risk assessment.

III. Impacts:

1. Observed impacts to the ecosystem range from terrestrial potentials through the sediments in the river and downstream to the Cherokee Reservoir. It is possible that impacts from site-related contaminants may be found even farther downstream. At least one additional sampling station should be located downstream of the reservoir at a zone of deposition for both water and sediment sampling.

2. It is not clear from the document if or how the non-aquatic portions of the ecosystem are impacted. However, it is generically known that mercury impacts a wide range of biological systems and based upon this the investigator should develop a plan to address all ecosystems and habitats that may be affected. The section on risks to terrestrial

organisms (see p 4-20) is incomplete.

3. Impacts to the aquatic community is discussed in Section 4.4.1.3 and serves to diffuse impacts attributable to the site. However, it should be noted that the document again fails to take historical observation into account. For example, the degraded fish community is postulated to be attributable to several factors (e.g., upstream agricultural activities), but no specific information is presented to justify this implied conclusion. Another example is the lack of success in the attempt to transplant mussels, a member of the river's ecosystem that once was a thriving, abundant, and diverse. Toxicity has been shown for the effluent of pond #5 and the Brinefield (pp 4-15 &18, respectively). This alone may be indicative of the reason for the decline of mussel transplant success. The use of contaminant concentrations in water as a measure of impacts to mussels is not appropriate. Several studies have shown that mercury levels in mussels are directly related to mercury levels in the sediment and that these mercury levels are usually not methyl mercury found in fish tissue, but rather the element form.

4. With regard to the mussel community, information dating from the early 1900's indicate that 37 species were known to have been indigenous. However, recent information shows that species are now lost for a stretch of 70 miles from the site. Any study of impacts to mussels should include whole life cycles so that impacts to the most sensitive life stages are estimated.

5. The investigator selected organisms that are not necessarily reflective of the contamination. The brown bat and the red fox are only a small portion of the wildlife that are exposed. Raccoons, for example, sample a wider range of prey than foxes. It is also noted that the queen snake, which feed on fish, should have supplemented the studies using milk snake.

6. The impacts assessments should have considered the various life stage of aquatic organisms as well as the reproductive stages of adults. For example, the benthic community taken as a whole would be indicative of levels of impacts, but this is not given devoted consideration at all. It is included with the discussion of IBI (p 4-20) where none of the relevant parameters receives thorough discussion.

7. The extrapolation of bird ingestion studies to hellbenders appears to be inappropriate, as no citation is given that justifies its use. Phylogenetic relationship has no meaning in this analysis as they inhabit totally different habitats.

8. The ERA does present a discussion on toxicity assessment in Section 4.3 that corresponds to Task 3.B.5 (Ambient Water Toxicity and Bioaccumulation) of the work plan. Bioassays

using river water were conducted using Ceriodaphnia, fathead minnows, juvenile mussels, and Selenastrum. The information provided, however, is not sufficient to evaluate the conformance with current NPDES toxicity test requirements. This section used water from the designed mixing zone river segment to assess ambient water toxicity on these organisms. The results were used as the basis for determining the extent of hazard associated with exposure levels in the NFHR. The ERA evaluated mercury toxicity to terrestrial organisms presumed via feeding, inhalation, contact, and drinking water pathways.

9. The last component of Task 3.0 was to evaluate mercury fate and transport. This was to be used to develop a computer model specifically for the NFHR. The ERA did not include data to support this task.

10. Benthic studies to provide data for use in the biological assessment were to include a benthic community analysis (Periphyton) community analysis and an evaluation of mercury and methylmercury in macroinvertebrates. (i.e., crayfish, megalopterans and insects), adult insects and algae. The ERA did not include any benthic community data for the NFHR.

11. Task 3.B.4 of the work plan addressed mussel studies. Upstream and downstream comparisons were to be made of mussel populations. Although the ERA makes reference to trends in populations in the NFHR, no data is presented specific to the approach specified in the work plan.

IV. Conclusions & Recommendations:

1. The investigator has not considered sufficiently the importance of transport and fate of contaminants. For example, on page 4-13, it is stated, "...the BCF used was derived from a study using methylmercury, whereas the majority of mercury...is inorganic..." Aside from the any physical constants of mercury in various phases of the environment, it is known that mercury is readily methylated, especially in aquatic ecosystems. It is true that as methylmercury it is quickly incorporated into the food chain, however, the element mercury remaining represents a continuous reservoir for the methylating mechanism. The investigator should take this into consideration in the analysis.

2. Toxicity testing is the court of last resorts and where it can be related to a site, regardless of the nature of its chemical contamination, is the responsibility of the PRP. For example, the investigator declares on page 4-15 that toxicity associated with Pond 5 is due to some other chemical than mercury. The investigator should instead acknowledge and identify this toxicity and deal with it as

a site-related contaminant.

3. The report fails to adequately characterize all levels of the ecosystem. This should be done and then used as a basis for the risk assessment after the full extent of chemical contamination is characterized. The extent of contamination should be for all chemicals and their chemical as well as biological fate. That is, some chemicals are acted upon chemically in the environment and then become hazardous while others are biologically converted, making them hazardous. Mercury falls into the latter class. While it is toxic in its elemental state, methylation renders it even more hazardous to the ecosystem.

4. The investigator does not fully identify impacts to sensitive species or to sensitive life stages. The range of indigenous organisms in the receiving environment is vastly reduced to the contaminants from the site. At this rate, and if nothing is done, only the most tolerant species will survive, however, these will still serve to render mercury available to the food chain.

5. The geographical limitation is artificial. The investigator should characterize the NFHR beyond the downstream Cherokee Reservoir to assure the limits of contamination are known.

6. It is not clear if all migration pathways have been identified. This should be done prior to the completion of the ecological risk assessment.

7. Impacts are due to a wide range of contaminants from the Olin site. The investigator should acknowledge this and include them in the investigation.

8. The ecological characterization is incomplete. The investigator should complete this with full description of the habitats potentially impacted. In addition, sensitive life stages of indigenous species (from the literature, indicating original populations) should be selected for the ecological risk assessment.

9. Toxicity tests show extensive potential for impact. A thorough toxicity program should be established for aqueous media (sediment and water) and soil should be planned.

10. The conclusion on page ES-1 that "...ecological receptors may be at risk...although the magnitude of this risk is not large" may be wholly incorrect and is not substantiated by the document. It is presumed that the conclusion is based upon the current degraded ecosystem and even if that is true the conclusion is faulty due to the current degraded condition and the consequent downwardly adjusted ecosystem.

11. It is noted that the investigator refers to RBP for stream evaluation (p 4-20). The effort should be more fully

described with maps and descriptions of what was done, where when, how, etc. The brief description included fails to settle issues that it apparently was hoped would be resolved.

12. For ecological risk assessment it is inappropriate to extrapolate from human data. On page ES-1, the document states that "humans do not currently face unacceptable health risks...", but fails to include the fact the Virginia Dept. of Health enforces a ban on fish consumption. The investigator should not imply that no fish impacts from mercury exist simply due to a ban.

Olin CHEMICALS
P.O. BOX 248. LOWER RIVER ROAD. CHARLESTON. TN 37310
PHONE: (615) 336-4000

February 6, 1992

Mr. Gene Wingert
VA/WV Remedial Response Section
USEPA, Region III
841 Chestnut Building
Philadelphia, PA 19107

Dear Mr. Wingert:

EPA recently provided Olin with comments of the Draft Risk Assessment for Operating Units 2 and 3 (OU-2 and OU-3 for the Saltville Waste Disposal Site. We have reviewed EPA's comments which included the comments from Virginia Department of Waste Management and have prepared a response for each comment. For convenience, we have repeated each of the comments and provided a response immediately below the comment.

After review of EPA's comments, several general responses in addition to the individual responses appear to be in order. The Draft Risk Assessment was prepared only as a risk assessment, not a document which would present the findings of the remedial investigations of OU-2 and OU-3. Remedial investigation reports have been prepared to present and discuss the studies conducted under the Work Plan. The draft OU-2 RI report was submitted to EPA in December 1991 and the draft OU-3 RI report will be submitted in late February 1992. It is intended that the draft risk assessment, which EPA has recently reviewed, will become Section 6.0) in each of the final RI reports after the RA and RI reports are revised based on EPA's comments. The RA was submitted separately from the draft RI reports to facilitate the review of the RA and to minimize the overall project schedules. Based on the large numbers of comments which requested additional details of the field investigations, it appears that the reviewers were not aware of the strategy discussed above.

Several comments requested historical information from the time prior to 1895 (when the soda ash plant began operations). The need for this data is not evident. The purpose of a risk assessment as defined by the EPA guidance document is "to assess the human and ecological risk associated with the site if no remedial action was taken". Its purpose is not to ascertain the past impacts of industrial operations at the Saltville site. In the course of the overall RI/FS, recent historical can provide some insight on whether or not the environmental conditions are improving. This issue is discussed in the RI reports.

The scope of the Work Plan was an issue which received several comments. Most of these comments recommended extending the area of study from North Fork Holston River (NFHR) Mile 53 downstream to Cherokee Reservoir. The EPA approved Work Plan covered the section of river from NFHRM 91 to NFHRM 53. The Saltville Waste Disposal Site is located between NFHRM 83 and NFHRM 80.8. Thus, the Remedial Investigation area extended 27 miles downstream. This area of study was selected after the review of 17 years (1970-1987) of environmental studies which were conducted by EPA, TVA, ORNL, Va SWCB, Olin and others. These studies included biota, sediment and water. These studies and their findings are discussed in OU-3 Milestone Report No. 1- Previous Data Summary which was submitted to

EPA in 1990. Review of these studies clearly indicated that mercury concentrations downstream of NFHRM 53 decreased significantly in sediment, water and biota.

Your letter of January 8, 1992 requested Olin to revise the Risk Assessment within 24 days of receipt of EPA comments. During our telephone conversation on January 24, we decided that the best course of action would be for Olin to prepare and submit their responses by February 6, 1992. EPA and VDWM would then review Olin's responses. At that point in time an EPA-VDWM-Olin meeting to discuss the Risk Assessment might be held to clarify any remaining areas of concern. By this time EPA and VDWM would also have had time to review the RI Reports for OU-2 and OU-3 upon which the RA is based. The risk assessment would be revised after our meeting when all comments have been resolved.

If you should require any additional information during your review of the comments, please call me at 615-336-4388.

Sincerely,

OLIN CORPORATION

Keith D. Roberts
Principal Environmental Specialist

KDR/lb
069

cc: J. C. Brown
R. L. Collins
M. L. Fries
W. C. Lawrence
T. A. Longe
D. Pedersen
G. E. Pospisil
T. Pride
K. D. Roberts
EAD File

RESPONSES TO PUBLIC HEALTH COMMENTS

Comment #1: Geometric mean values instead of arithmetic means are used to calculate some upper 95th percentile upper confidence limit values. RAGS clearly states that the arithmetic mean is to be used for the calculation of the 95th percent upper confidence limit value. The geometric mean was inappropriately used in several cases in this risk assessment. If log normal distributed data sets are encountered, as indicated in the RI document, the method of Gilbert should be used to normalize the data and the 95th upper confidence limit calculated on the arithmetic mean.

Response: The fish and soil data sets used in the RA were tested and found to be log normally distributed. The method of Gilbert (1987) will be used to calculate 95th upper confidence limits on log normally distributed data.

Comment #2: The residence time for lifelong residents is incorrectly used as 70 years instead of 30 years. EPA recommends the use of a 30 year residence time at a site when evaluating long term exposures such as fish ingestion unless there is clear justification for using a longer time period such as 70 years. Since no justification was provided for the use of the 70 year averaging time, 30 years should have been used.

Response: A lifetime exposure of 70 years for fish ingestion should be for this location. It is very possible that in this small town, individuals could live in the area for an entire 70 years lifespan. While they may not reside at one location (i.e. one home) for the entire 70 years, they could fish from the NFHR throughout their life. We recommend the use of a lifetime exposure of 70 years.

Comment #3: Future site use was not fully evaluated for the Saltville site. No consideration was given to future site construction activities involving on-site workers, or to the conversion of the site to residential use at some future point in time. There should have been future use scenarios developed to take into account the exposure to surface and subsurface soils by on-site workers involved in site related construction activities. These scenarios should include incidental ingestion of surface and subsurface soils, inhalation of volatile mercury, and inhalation and dermal exposure to contaminated soils. Since no data sets related to the various site media were presented, it could not be determined if there were subsurface soils levels of mercury that on-site workers or site residents could potentially be exposed to during the course of construction activities, or as a result of future residential development.

Response: Our interpretation of this comment is that there is concern that the site may be converted to residential use or other industrial use. As discussed in the OU-2 RI report (Golder Associates, 1991), the stability of the fill material in the waste ponds is such that no buildings would be constructed on them. Waste Pond 5 contains a mixture of ammonia soda ash waste and slaker waste. The waste material exhibits a fracture system that appears to be dynamic, with some fractures collapsing and others opening over time (Golder Associates, 1991). Since it does not appear that any future construction will occur at the site, future exposures to construction workers or residents were not evaluated. (In the case of future remedial actions, health and safety plans will address this issue.)

Comment #4: Dermal contact and incidental ingestion of contaminated media are considered in this risk assessment, but inhalation of fugitive dusts and inhalation of volatilized mercury have not been considered. It would be appropriate to at least investigate these routes of exposure and make a determination of their significance. There is some mention of air data from 1985 which reported air concentrations of mercury below ambient air quality standard of 1.0 g/m^3 for 350 days per year over a 30 year residence time would have a calculated Hazard Quotient which would exceed 1.0. The air data collected should have been provided and health risk based calculations used to make determination of the relative importance of the pathway.

Response: Inhalation of volatilized mercury was addressed in the risk assessment, but will be further discussed in the revised document. The risk assessment prepared by GCA (GCA, 1985) for the USEPA on the Saltville site presents a summary of historical air sampling data. Their conclusion based on the most recent air sampling of the Saltville site "suggests that there is not an increased risk of developing adverse health effects from exposure to mercury vapor". Only the last round of air sampling was conducted after remedial activities at the site were completed in 1983. This last round of sampling was conducted by the Virginia SWPCB and reported a maximum concentration of vaporized mercury of 0.4 ug/m^3 and a maximum concentration of particulate mercury of 0.0014 ug/m^3. If it is assumed that adult breathes 20 m^3 per day and remains at one location 24 hours per day for 350 days per year, a hazard index of 0.4 is obtained for the maximum concentration of mercury reported. NC

Comment #5: Data sets related to various exposure pathways evaluated in the risk assessment are not provided for review and evaluation. The lack of this information makes it very difficult to accurately and appropriately evaluate the data, the exposure scenarios, and the risk characterization. In other words, in order to fully evaluate the risk assessment and to bring the document clearly into focus, the data upon which the assessment is based must be provided. Merely providing the exposure point values, which were calculated inappropriately, is not adequate for the accurate evaluation of this document. The data sets must be included in order that all aspects of the risk assessment may be fairly and correctly assessed. Historical data and other relevant information required to justify the approach taken in the risk assessment would also be helpful. It is noted that Agency guidance indicates that default exposure factors should be utilized unless there is documented site specific exposure values. The documentation for these site specific values is lacking.

Response: The revised document will present all data used in the risk assessment. In addition , the data is presented in the Remedial Investigation Reports for OU-2 and OU-3. The RA will be reviewed to assure that all documentation are provided and appropriate references to the RI reports are cited.

Comment #6: Some of the exposure parameters used in the exposure assessment are not included in the Exposure Quantification section. It is suggested that all values used in the exposure quantification selection be clearly listed.

Response: The RA will be reviewed and all values will be clearly listed.

Comment #7: A review of the exposure parameters used in the assessment raises a number of concerns.

a) It may not be appropriate to use a soil adherence factor (SAF) of 1.5 mg/cm^2 for sediments. The SAF for kaolin clay (2.5 mg/cm^2) may be more appropriate.

Response: We disagree that the SAF for kaolin clay would be more appropriate. While some fine sediment is deposited along the shoreline of the NFHR, the sediments are comprised more of sand than of silt or clay. The reason for this is the very fine silts are scrubbed away during periods of high flow. In addition, we call EPA's attention to the OHEA document "Dermal Absorption of Dioxin and PCBs from Soils" (OHEA-E-342, October, 1989) which presents soil adherence values for various soil types. The maximum soil adherence (mean of three replicates) was for a particle size of less than 150 μm, was 1.9 mg/cm^2. The range of adherence values for the fraction less than 150 μm for the various soil types was 0.8 to 1.9 mg/cm^2. We recommend the use of a SAF of 1.5 mg/cm^2.

b) Questions arise from the selections made with respect to the ages of individuals exposed to contaminated media and the types of exposure of these individuals. It seems that it would be reasonable to expect youths younger than 10 years of age to be in contact with contaminated soils and sediment close to the site. It is understood that access to the pond areas may be more restricted than some other areas, but children in the 6-10 years age bracket are known to explore and be more inquisitive thereby making it altogether likely that these children may venture onto the site.

Response: It should be noted that access to the site is restricted by the high steep river banks, local terrain and fencing. Also, the site is known by the surrounding community to be a restricted area. For this reason it is unlikely that younger children would be permitted to freely roam in this particular area. It seems more likely that youths ages 10-15 would be the potentially exposed population. None the less, we will use the 6 to 10 years old age range to represent the exposed population if EPA requests.

c) Missing from the exposure scenarios is any mention of persons exposed to contaminated media while fishing. Persons fishing on the bank of the NFHR may come into contact with contaminated media via dermal contact and incidental ingestion of contaminated sediments and surface water. This exposure during recreational fishing can be expected to occur over a lifetime.

Response: It was assumed in the assessment that fishermen would wear boots or waders while fishing the river and so would not contact the water or sediments. While unlikely, it is conceivable that a fisherman could be barefoot while wading in the river (a dangerous proposition due to hooks) and therefore we will include dermal contact with surface waters and sediments in the revised document. However, we do not believe that any significant ingestion of surface waters or sediments by fishermen will occur, and thus do not plan to include this in the assessment. It should be noted that even if the ingestion pathways were to included in the assessment, they would not contribute significantly to the total risk.

The comment that exposures to sediments and surface water and sediments can be expected to occur over a lifetime is in contrast to comment #2 which recommends a 30 year exposure duration.

d) Dermal contact with sediments should be calculated over a period of 3 to 18 years of age for persons close to the site as well as for individuals downstream from the site unless there is specific justification for using different values.

Response: Access to the NFHR is restricted in the area close to the site. The shoreline slopes steeply down to the river on either side. It is not plausible that a child as young as 3 years of age, or even 6 years of age would play in this area. Never the less we will use the age range of 3 to 18 years for the population exposed to close to the site sediments if EPA deems it appropriate.

Comment #8: Site maps do not indicate the locations of residences close to the site, nor do they indicate the concentrations of mercury in soil, sediments, or groundwater at the site. These are important factors which are required for the appropriate evaluation of the site and the risk assessment document. Maps should be provided to address these concerns. Questions also arise related to the existence of mercury contamination off-site and on-site out of the pond areas.

Response: The RIs for OU-2 and OU-3 present data for all media of concern. Figures in the RI reports address this comment.

Comment #9: Groundwater has been excluded from the risk assessment. However, additional documentation is required to justify this exclusion. The home poll survey while helpful, does not provide enough information with respect to the residences within the area of influence of the plume and those residences that may be impacted in the future by the groundwater contamination. An assessment of future use of groundwater should be included if the contaminants might be expected to migrate beyond the immediate area.

Response: The reader is referred to Section 3.9 of the OU-2 RI report. The findings of the hydrogeologic investigation of the site are that:

- overall groundwater flow is towards the south to the NFHR
- groundwater discharge from the fill and bedrock is to the NFHR
- there does not appear to have been mercury migration from the fill into the shallow bedrock

Based on the hydrogeological study it appears that groundwater impacted by the site does not migrate beyond the immediate area and therefore receptors in the immediate area are the appropriate population of concern.

Comment #10: There are numerous instances throughout the risk assessment in which assumptions have been made and site specific values utilized without justification. Documentation and justification should be provided for all deviations from standard default values, and for the elimination of any pathways or routes of exposure.

Response: The RA will be reviewed to assure that all documentation is provided.

RESPONSES TO ECOLOGICAL COMMENTS

I. Characterization:

Comment #1: The vegetation survey (Section 4.1.1; p 4-2) failed to mention the presence or absence of wetlands and riparian areas. In addition, the discussion fails to detail the major ecosystems found in the area and to describe subareas, etc., down to the basics needed to carry out the ecological risk assessment.

Response: Additional information regarding vegetation and habitat characteristics in the general area of the site is provided in the OU-3 RI report. This additional information will be summarized and added to the appropriate section of the ERA.

Comment #2: It is suggested that an effort be made to describe the terrestrial, edge, wetlands, riparian, and aquatic habitats in both a general way as well as in a detailed treatment of each, as needed in light of contamination or control studies. The investigator should also carry out a literature search to ascertain the impacts of site-related contaminants upon plant.

Response: See response to Comment #I-1. The specific habitats will be described in further detail based on a summary of information provided in the OU-3 RI report. Toxicity data for aquatic plants have been reviewed and summarized by EPA in developing the AWQC for mercury. During the remedial investigation, samples of amonia soda ash waste (ASAW), groundwater and pond effluent were analyzed for the TCL compounds. No contaminant, other than mercury, was identified (see OU-2 RI report). Thus, toxicological information on other chemicals is not needed.

Comment #3: It was noted that the description of aquatic species (Sect. 4.1.2; p 4-2) is based upon information dating only to 1971. It is suggested that the authors attempt to located information dating to that point in time prior to operations at the site. It is suspected that information natural resources of the Holston River dates from the 1890's or earlier.

Response: The particular reference was to information on fish populations; a comprehensive literature on the NFHR mussel fauna prior to the 1970s was reviewed as part of overall RI activities. Several literature searches were conducted. Unfortunately, historical information is not available for fish species in the NFHR.

Comment #4: Other studies may also exist on fauna that can supplement the information on the description of fauna. As in the other discussions in the document regarding biological resources, the information is too cursory and general for the reviewers to use in determining the potential impacts.

Response: See response to Comments #I-1 and I-3. We believe that the information and data presented in the ERA and OU-3 RI report are sufficient to allow an assessment of impacts at the site.

Comment #5: The ERA does not include a section on stream characterization to the level of detail presented in the work plan. For example, the work plan indicates that stream gradient profiles would be generated and that data on geology, soils, hydrology, land cover and stream usage would also be generated. This type of data is not included in the ERA.

Response: The particular information is presented in the OU-3 RI report.

Comment #6: The section on fish studies indicates that relative abundance, health conditions, and concentrations of mercury and methylmercury in fish filets and whole body burden would be determined for the North Fork of the Holston River (NFHR). None of this information was provided in the ERA. Page 4-1 of the ERA indicates that "recently collected mercury residue and fish population data: were not available for evaluation in this risk assessment. The report indicated that "These risk conclusion may be reevaluated depending upon the results of these recently completed studies".

Response: The information and data requested pertaining to the fish studies are presented and discussed in the OU-3 RI report. Recent information, as presented in the OU-3 RI report will be reviewed and the ERA will incorporate any new findings or significant results.

II. <u>Approaches:</u>

Comment #1: The study is limited to a section of the Holston River that is only 30 miles long (river mile 82.8 to 53). It is clear that the extent of contamination is much farther downstream than mile 53 and it is suggested that the investigator search state and federal agency literature to ascertain the limits of contamination.

Response: During the preparation of the Work Plan in 1989, the limits of the study area was one of the issues addressed by Olin and EPA. Data collected by federal agencies (EPA, TVA, and ORNL), state agencies (Va SWCB and VPI) and Olin which covered a 17 year period (1970 to 1987) was reviewed. The data indicated that mercury concentrations decreased significantly downstream of river mile 53. An extensive review of this data is presented in OU-3 Milestone Report No. 1- Previous Data Summary. This formed the basis for defining the area of study as NFHRM 93 to NFHRM 53.

Comment #2: The risk assessment is limited to impacts proven to be caused by mercury and minimizes any effects that cannot be conclusively linked to the mercury contamination alone. Many prior observed and published accounts are dismissed or excluded. The investigator should complete an exhaustive literature search and use the results to establish the geographical and chemical basis for the risk assessment.

Response: The geographical and chemical basis for the risk assessment was established in the Work Plan. The focus of the risk assessment was to characterize the risk associated with exposure to mercury which EPA identified as the chemical of concern in the ROD.

Comment #3: Other site-related contaminants are not included in the impact analysis or the risk assessment. These are of importance due to the toxicity and the possibility of synergistic or additive effects.

Response: See response to comment #I.2. Site investigations identified mercury as the only contaminant. Two characteristics of the site effluent, pH and dissolved solids (salt) were identified as important considerations.

Comment #4: Even the rigorous benthic studies that were planned may not have supported any exposure trends regarding mercury and methylmercury in discharges from the Saltville site. The approach presented in the ERA does appear to be a reasonable basis for an ecological risk assessment.

Response: No response necessary.

III. Impacts:

Comment #1: Observed impacts to the ecosystem range from terrestrial potentials through the sediments in the river and downstream to the Cherokee Reservoir. It is possible that impacts from site-related contaminants may be found even farther downstream. At least one additional sampling station should be located downstream of the reservoir at a zone of deposition for both water and sediment sampling.

Response: TVA studies of Cherokee Reservoir concluded that mercury concentrations in fish and water samples from Cherokee Reservoir were not of concern. The Work Plan focused on the 30 mile section of NFHR adjacent to and downstream of the site. If mercury from the site is affecting the exosystem, the effects should be most evident in the section studied.

Comment #2: It is not clear from the document if or how the non-aquatic portions of the ecosystem are impacted. However, it is generically known that mercury impacts a wide range of biological systems and based upon this the investigator should develop a plan to address all ecosystems and habitats that may be affected. The section on risks to terrestrial organisms (see p 4-20) is incomplete.

Response: The OU-3 RI describes the findings of ecosystem investigations. Table 4-1 of the Risk Assessment identifies the exposed population which were addressed in the ERA. We believe that assessment of risks to these populations adequately identify the ecological risks.

It is not clear why the commentor thinks the section on risks to the terrestrial organisms is incomplete.

Comment #3: Impacts to the aquatic community is discussed in Section 4.4.1.3 and serves to diffuse impacts attributable to the site. However, it should be noted that the document again fails to take historical observation into account. For example, the degraded fish community is postulated to be attributable to several factors (e.g., upstream agricultural activities), but no specific information is presented to justify this implied conclusion. Another example is the lack of success in the attempt to transplant mussels, a member of the river's ecosystem that once was a thriving, abundant, and diverse. Toxicity has been shown for the effluent of pond # 5 and the Brinefield (pp 4-15 &18, respectively). This alone may be indicative of the reason for the decline of mussel transplant success. The use of contaminant concentrations in water as a measure of impacts to mussels is not appropriate. Several studies have shown that mercury levels in mussels are directly related to mercury levels in the sediment and that these mercury levels are usually not methyl mercury found in fish tissue, but rather the element form.

Response: The OU-3 RI report discusses the factors (e.g. agricultural activities) which have affected the biota. The effluent from Pond 5 and the Brinefield have been shown to be toxic to several test species, however, similar effects were also observed in tests with the effluent from Pond 6 (which does not contain mercury). Some toxicity was also observed in the NFHR water from upstream of the site. Although the causative agent was not identified in these studies, it is difficult to see how mercury could be responsible. Please refer to OU-3 RI report for supporting documentation regarding multiple sources of factors and toxicity testing.

Mussel studies by Virginia Polytechnic Institute (VPI) conducted that the NFHR downstream of the site is capable of supporting mussel population. The studies also stated that the success of the mussel transplants could not be fully evaluated for several years. See the OU-3 RI report for further discussion. Results from the RI mussel survey indicates that mussels may be beginning to reestablish themselves in the NFHR.

Correlations between mercury levels in organisms and sediment does not imply impacts, whereas a comparison of actual exposure levels (i.e., in ambient water) and toxicological data based on the same exposure route does. Moreover, the surface water data used in the evaluation was derived from unfiltered surface water samples, and thus potentially included both the dissolved and suspended- sediment bound fractions of mercury. For a filter feeding organism, such as the mussel, surface water data are appropriate for determining both exposure levels and potential impacts.

Comment #4: With regard to the mussel community, information dating from the early 1900's indicate that 37 species were known to have been indigenous. However, recent information shows that species are now lost for a stretch of 70 miles from the site. Any study of impacts to mussels should include whole life cycles so that impacts to the most sensitive life stages are estimated.

Response: Given the extended lifespans and extreme difficulties in rearing freshwater mussels in the laboratory it is not technically feasible to conduct full life cycle tests on these organisms. The toxicological investigation that was done focused on juveniles, which are typically considered the most sensitive part of the life cycle. These results, as presented in the OU-3 RI report, will be summarized in the ERA. The toxicity program, which was conducted in accordance with the work plan, is discussed in the OU-3 RI report.

Comment #5: The investigator selected organisms that are not necessarily reflective of the contamination. The brown bat and the red fox are only a small portion of the wildlife that are exposed. Raccoons, for example, sample a wider range of prey than foxes. It is also noted that the queen snake, which feed on fish should have supplemented the studies using milk snake.

Response: Obviously, an ecological risk assessment cannot be conducted on every species of receptors which may be exposed to site-related constituents at a site. Consequently, it is necessary to choose representative species to evaluate potential impacts. The risk results determined for these particular species are then extrapolated to other organisms which have similar ecological requirements and trophic status. In choosing the particular species to be modeled, it is necessary to balance the likelihood that a particular species will be regularly exposed to the constituent under investigation with other considerations, such as how representative that species is of the particular trophic level in question. It is also necessary to evaluate specific effects for species of special concern, as in the case of the hellbender. Although raccoons do sample a wide range of prey, they are not representative of tertiary consumers such as the red fox, which may be more subject to the effects of potential bioaccumulation in the food chain.

Comment #6: The impacts assessments should have considered the various life stage of aquatic organisms as well as the reproductive stages of adults. For example, the benthic community taken as a whole would be indicative of levels of impacts, but this is not given devoted consideration at all. It is included with the discussion of IBI (p 4-20) where none of the relevant parameters receives thorough discussion.

Response: The details of the benthic macroinvertebrate community studies are presented in the OU-3 RI report. Recent results will be summarized and included in the ERA.

Comment #7: The extrapolation of bird ingestion studies to hellbenders appears to be inappropriate, as no citation is given that justifies its use. Phylogenetic relationship has no meaning in this analysis as they inhabit totally different habitats.

Response: In situations in which no pertinent toxicological data exist for a particular group of ecological receptors being evaluated in a risk assessment, it is necessary to extrapolate from available data for other taxonomic groups. This situation occur regularly when assessing potential risks to herptiles due to the limited amount of toxicological (particularly ingestion) data for this group of organisms. Most of the available ingestion toxicity testing have been conducted on mammals (especially the laboratory mouse and rat) and to a lesser extent birds. When there is no *a priori* reasons to do otherwise, it seems reasonable to use phylogenetic affinity as a consideration in choosing a particular toxicity data set from which to extrapolate data from. This has some bearing because one would expect that some aspects of an organism's biology which are involved in how it responds toxicologically to a chemical insult, would be expected to be conserved evolutionarily even if the particular lineage shifted into a new ecological arena. Important aspects that may be conserved include enzyme systems important in detoxification or metabolism, or active sites where the particular toxicological effect is realized.

Comment #8: The ERA does present a discussion on toxicity assessment in Section 4.3 that corresponds to Task 3.B.5 (Ambient Water Toxicity and Bioaccumulation) of the work plan. Bioasssays using river water were conducted using Ceriodaphnia, fathead minnows, juvenile mussels, and Selenastrum. The information provided, however, is not sufficient to evaluate the conformance with current NPDES toxicity test requirements. This section used water from the designed mixing zone river segment to assess ambient water toxicity on these organisms. The results were used as the basis for determining the extent of hazard associated with exposure levels in the NFHR. The ERA evaluated mercury toxicity to terrestrial organisms presumed via feeding, inhalation, contact, and drinking water pathways.

Response: The details of these studies are presented in the OU-3 RI report.

Comment #9: The last component of Task 3.0 was to evaluate mercury fate and transport. This was to be used to develop a computer model specifically for the NFHR. The ERA did not include data to support this task.

Response: These data are presented in the OU-3 RI report.

Comment #10: Benthic studies to provide data for use in the biological assessment were to include a benthic community analysis (Periphyton) community analysis and an evaluation of mercury and methylmercury in macroinvertebrates, (i.e., crayfish, megalopterans, and insects), adult insects and algae. The ERA did not include any benthic community data for the NFHR.

Response: The details of these studies are presented in the OU-3 RI report. Recent data, not yet available when the draft ERA was prepared, will be summarized, and the ERA updated as appropriate.

Comment #11: Task 3.B.4 of the work plan addressed mussel studies. Upstream and downstream comparisons were to be made of mussel populations. Although the ERA makes reference to trends in populations in the NFHR, no data is presented specific to the approach specified in the work plan.

Response: These data are presented in the OU-3 RI report. Recent data, not yet available when the draft ERA was prepared, will be summarized, and the ERA updated as appropriate.

IV. Conclusions and Recommendations:

Comment #1: The investigator has not considered sufficiently the importance of transport and fate of contaminants. For example, on page 4-13, it is stated, "... the BCF used was derived from a study using methylmercury, whereas the majority of mercury...is inorganic..." Aside from the (m)any physical constants of mercury in various phases of the environment, it is known that mercury is readily methylated, especially in aquatic ecosystems. It is true that as methylmercury is quickly incorporated into the food chain, however, the element mercury remaining represents a continuous source for the methylating mechanisms. The investigator should take this into consideration in the analysis.

Response: Clarification is necessary here; it is not clear what relevant consideration is lacking from the ERA. It is generally agreed that methylmercury present more of hazard to biota than does the inorganic forms. Throughout the ERA, the conservative assumption that the data for total mercury was comprised entirely of methylmercury was made in estimating exposure concentrations for the various exposure pathways. These exposure levels were compared with toxicological data for methylmercury, rather than other forms, whenever appropriate data were available.

Comment #2: Toxicity testing is the court of last resorts and where it can be related to a site, regardless of the nature of its chemical contamination, is the responsibility of the PRP. For example, the investigator declares on page 4-15 that toxicity associated with Pond 5 is due to some other chemical than mercury. The investigator should instead acknowledge and identify this toxicity and deal with it as a site-related contaminant.

Response: A complete discussion of the results and conclusions of the effluent toxicity study are provided in the OU-3 RI report. As discussed in that document, the causative agent of the observed toxicity is most likely not mercury. This conclusion is based on comparison of the toxicity studies for Pond 5 effluent (containing mercury) and Pond 6 effluent (containing no mercury). These studies indicated similar levels of toxicity. Screening of the effluents for TCL compounds did not identify any contaminant other than mercury. Other characteristics of the effluents which may affect toxicity is dissolved solids and pH.

Comment #3: The report fails to adequately characterize all levels of the ecosystem. This should be done and then used as a basis for the risk assessment after the full extent of chemical contamination is characterized. The extent of contamination should for all chemicals and their chemical as well as biological fate. That is, some chemicals are acted upon chemically in the environment and then become hazardous while other are biologically converted, making them hazardous. Mercury falls into the latter class. While it is toxic in its elemental state, methylation renders it even more hazardous to the ecosystem.

Response: The OU-3 RI report provides a detailed characterization of the ecosystem and provides the supporting documentation for the ERA. As discussed earlier, mercury is the contaminant of concern identified in the ROD and confirmed by the subsequent remedial investigation. The effects of mercury methylation and the toxicity of methylmercury was considered in the preparation of the Risk Assessment.

Comment #4: The investigator does not fully identify impacts to sensitive species or to sensitive life stages. The range of indigenous organisms in the receiving environment is vastly reduced to the contaminants from the site. At this rate, and if nothing is done, only the most tolerant species will survive, however, these will still serve to render mercury available the food chain.

Response: As discussed in the relevant sections of the both the OU-3 RI report and the ERA, mercury is only partially responsible for the decline in biotic diversity and abundance in the NFHR. For instance, mussel populations were in serious decline before the introduction of mercury electrodes at the Saltville site. In addition, theoretical risk assessment results do not support the conclusion that the presence of mercury in the ecosystem has been completely responsible for the diminution of the ecological resources in the area. In addition, past studies by VPI and TVA conducted in the 1980's indicate that the ecology of the NFHR is improving. (i.e. increasing diversity, lower mercury concentrations.

Comment #5: The geographical limitation is artificial. The investigator should characterize the NFHR beyond the downstream Cherokee Reservoir to assure the limits of contamination are known.

Response: As discussed in the Response to Comment #I-1, the area of study defined by the RPA approved work plan was based on the review of numerous studies which spanned 17 years and covered biota, sediment and water. Sufficient data were available to confidentially define the area of study.

Comment #6: It is not clear if all migration pathways have been identified. This should be done prior to the completion of the ecological risk assessment.

Response: We believe all relevant exposure pathways were considered and evaluated in the ERA.

Comment #7: Impacts are due to a wide range of contaminants from the Olin site. The investigator should acknowledge this and include them in the investigation.

Response: As discussed in several other responses, mercury is the contaminant of concern identified by the ROD. No additional contaminants were identified from the analysis of site samples for TCL compounds. Characteristics of the effluents which may affect toxicity are dissolved solids and/or pH.

Comment #8: The ecological characterization is incomplete. The investigator should complete this with a full description of the habitats potentially impacted. In addition, sensitive life stages of indigenous species (from the literature, indicating original populations) should be selected for the ecological risk assessment.

Response: The details of the ecological characterization is presented in OU-3 RI report. As discussed in the response to Comments #I-1 and #I-2, a further characterization of the ecological habitats will be provided in the final ERA based on information in the OU-3 RI report. Furthermore, toxicological data for the most sensitive life stage were always used when available in the toxicological literature. It is not clear whether the reviewer is aware that toxicological data do not exist for every potentially exposed species.

Comment #9: Toxicity tests show extensive potential for impact. A thorough toxicity program should be established for aquatic media (sediment and water) and soil should be planned.

Response: The toxicity program defined in the EPA approved Work Plan has been completed and the results are presented in the OU-3 RI report. It is not clear whether the recommended toxicity program would be focused on monitoring associated with a possible effluent discharge permit for Ponds 5 & 6 or as a bioassessment tool as was done.

Comment #10: The conclusions on page ES-1 that "..ecological receptors may be at risk although the magnitude of this risk is not large" may be wholly incorrect and is not substantiated by the document. It is presumed that the conclusion is based upon the current degraded ecosystem and even if that is true the conclusion is faulty due to the current degraded condition and the consequent downwardly adjusted ecosystem.

Response: The standard risk methodology, as described in the RAGs document (USEPA, 1989), is based on a comparison of exposure concentrations (either empirically-derived or estimated with exposure models) with toxicological data in the literature. The bioassessment investigation, by necessity, must rely upon comparisons between results from potentially impacted areas with control area (which may themselves have been degraded by various human activities, but not those associated with the site). While it is true that these site-specific data were incorporated into the conclusions of the ERA, these results serve a supporting function to confirm or call into question the theoretical results. The degree of concordance between the theoretically-derived and site-specific results in the ERA further substantiates the conclusions.

Comment #11: It is noted that the investigator refers to RBP for stream evaluation (p 4-20). The effort should be more fully described with maps and descriptions of what was done, where, when, how, etc. The brief description included fails to settle issues that is apparently was hoped would be resolved.

Response: The Rapid Bioassessment Protocol (RBP) was not actually referenced in the ERA, nor was the RBP used as part of the various bioassessment investigations which have been conducted as part of the Work Plan. A detailed description of those activities is provided in the OU-3 RI report, however.

Comment #12: For ecological risk assessment it is inappropriate to extrapolate from human data. On page ES-1, the document states that "humans do not currently face unacceptable health risks...", but fails to include the fact the Virginia Dept. of Health enforces a ban on fish consumption. The investigator should not imply that no fish impacts from mercury exist simply due to a ban.

Response: No extrapolation from human data was used in the ERA. The human health risks were based on consumption values determined from the literature and from a local survey. The consumption values used in the RA were not decreased due to a ban on consumption of fish from the NFHR.

APPENDIX F-2

RESPONSE TO USEPA COMMENTS ON THE DRAFT REMEDIAL INVESTIGATION REPORT FOR OU2

APRIL 1, 1992

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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Philadelphia, Pennsylvania 19107

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P.O. Box 248, Lower River Road
Charleston, TN 37310

RE: Notice of Deficiencies; Review of Remedial Investigation for Operable Unit 2, Saltville Waste Disposal Ponds Superfund Site

Dear Keith:

As we discussed on March 24, 1992, EPA is providing you comments to the Draft Remedial Investigation for Operable Unit 2 for the Saltville Waste Disposal Site. Due to the extent of comments to this document, EPA will not approve the Remedial Investigation Report as submitted. Pursuant to Section VI.D. of the Consent Decree, Olin is required to submit a revised ~~Risk Assessment~~ within twenty-four (24) days of receipt of this Notice of Deficiencies. Specific comments to the report are attached to this letter.

At this time, I believe it may be necessary for Olin, EPA, and Virginia Department of Waste Management (VDWM) representatives meet to discuss EPA's comments. While many of the comments can be considered minor and can be addressed easily, several others comments will require discussion. Also, additional discussion is needed for comments related to the Risk Assessment and Ecological Assessment previously submitted under separate cover.

Please contact me at (215)597-1727 if you have any questions regarding the content of the letter.

Sincerely,

Eugene P. Wingert
Remedial Project Manager

ATTACHMENT

cc: Tim Longe, VADWM
Bob Davis, EPA Region III
Reggie Harris, EPA Region III
Nancy Cichowicz, EPA Region III
Gwen Pospisil, EPA Region III
Sadia Kissoon, CH2M-HILL

ATTACHMENT A
SPECIFIC COMMENTS TO THE REMEDIAL INVESTIGATION REPORT
SALTVILLE WASTE SITE, OPERABLE UNIT 2

Review Comments
on the Draft Remedial Investigation Report
for the Saltville Superfund Site

Hydrogeologic Review

The conceptual understanding of the hydrology and hydrogeology of the Saltville site presented in the draft remedial investigation (RI) report includes several areas of inconclusive interpretations. This is most apparent in Sections 3.5, 3.7, 3.8, and 3.9 that cover site hydrogeology, the discussion of the water budget for the site, the numerical modeling, and the conceptual groundwater flow model.

Water Budget (Section 3.5)

The water budget and the resulting conceptual model fail to take into account some important flow processes and inflow/outflow mechanisms. Specifically, the RI report does not realistically quantify the groundwater outflow towards the North Fork of the Holston River through the south dike. Also the attempt to quantify groundwater inflow to Pond 5 from the north by extrapolating data from the H-flume in Swale 3 was unsuccessful. The omission of these important groundwater inflow/outflow mechanisms leads to some incorrect assumptions and calculations designed to achieve a mathematical water balance in the absence of these mechanisms.

The water budget presents a progression in the conceptual thinking that starts too simple—considering only precipitation, evapotranspiration and decant outflow—and then considers other factors only as a result of poor mathematical balance. This suggests that a complete conceptual model of the hydrologic system was not developed before quantifying individual components. In the absence of reliable measurements of subsurface inflow, it appears that a variety of differing assumptions were used to produce an estimate of groundwater outflows from the pond. Because these assumptions are generally unconvincing, the water balance effectively leaves the question of subsurface outflows unresolved.

The daily water balance does not increase the reader's confidence in the conclusion that there is no groundwater outflow from Pond 5. The water balance apparently makes use of an arbitrary 2-inch soil storage capacity that must be satisfied before infiltration can occur. This does not appear to be hydrologically realistic.

Unsaturated flow (Section 3.7)

Much of the discussion of the response to precipitation within Pond 5 is based on an assumption that the fractures fill up with water and allow downward infiltration only if the "driving head" exceeds a certain critical value. Water is said to flow rapidly toward the decant structure within the fractures with only minimal recharge. This mechanism is put forth to explain why the water level response in monitoring wells is subdued and why there is a time lag observed between rainfall events and responses in the bedrock aquifer. This, however, does not indicate that there is no recharge of the bedrock from above as asserted in the report.

The unsaturated flow analysis neglects unsaturated flow mechanisms. Water begins to flow downward into the porous medium immediately but generally will do so under unsaturated conditions. Much of the water is expected to reduce the negative suction potential of the unsaturated soil (i.e., moisten it to a point below saturation) and then begin to flow downward to the water table slowly. The unsaturated zone acts as a significant reservoir that delays and decreases the water level response seen in the wells. It is recommended that references to a "critical driving head in fractures" be eliminated and replaced with a discussion based on a more fundamental understanding of the flow involved.

In addition, the hypothesis of rapid flow to the decant structure is not supported by flow data from the structure. On page 3-23, it was stated that outflow from the decant structure lags "far beyond the rainfall, often showing no discernable peak in a long shallow recession". This behavior is not consistent with the hypothesis of rapid flow to the structure through fractures.

Modeling (Section 3.8)

The numerical model of groundwater flow may be useful as a tool for conceptual visualization of general flow patterns. However, the lack of quantitative knowledge, particularly of the deeper bedrock zones, makes it unreliable as a quantitative predictor. The model gives some potentially erroneous results because of the input parameters chosen, the selection of the boundary conditions, and the setup of the grid. Some conclusions reached are also not supported by the data.

The fact that the spring on Little Mountain acts as a recharge point rather than a discharge point (page 3-91) should be a signal that the true system is poorly represented in this area. The phreatic surface near the high point in the section is obviously distorted by the selection of constant head. This distortion was pointed out in the modeling write-up, but was not corrected.

Because of the poor match with the known position of the spring on Little Mountain, the modelers arbitrarily created Unit 9 to make the free surface elevation match the observed position on Little Mountain more closely. Because its hydraulic conductivity is approximately two orders of magnitude less than the units it replaces, this essentially has the effect of artificially raising the base of the flow system. Some distortions are seen across the transition between Unit 9 and units above it. The distortion seen under the northern third of Pond 5 in Figure 3-12 may be the result of this manipulation. The creation of Unit 9 does not seem to be based on reasonable hydrogeologic and modeling judgement but only on the need to improve the fit. This seems to fall outside the limits of normal calibration.

The final calibrated values for the hydraulic conductivity of the other units also appear to be somewhat questionable. The main statement in the text about their selection indicates that they were recalibrated to reflect the change in recharge and the addition of Unit 9. This hinges on whether the addition of Unit 9 is justified. It is also important to note that, while the "correct" match for the calibration nodes can be achieved through a variety of possible parameter settings, some of the parameters may be unjustified based on the available field data.

The strong flow said to occur within the alluvium may be overestimated as a result of the assigned K values and the grid spacing. It is also important to note that there are no calibration nodes in the ammonia soda ash waste (ASAW) or any of the deep units to verify flow relationships there. This is probably because there are no wells installed at either depth; however, this limitation should be acknowledged in the data interpretation.

Several of the modeling conclusions listed on page 3-93 do not appear to be justified based on the modeling and field data. Conclusion 2 (page 3-93), which states that discharge from the pond is primarily along the alluvium layer, does not seem to be supported by Figures 3-12 or 3-15, both of which show streamlines crossing this boundary and flowing into the shallow bedrock in the southern two-thirds of the Pond 5 area (south of the Unit 4 Mccrady shale). The accumulation of streamlines at the base of the alluvium shown in Figure 3-14 is not supported by the vector patterns in Figure 3-15.

Several of the modeling conclusions relate to the magnitude and significance of vertical flow into the bedrock. It is apparent from Figure 3-15 that the horizontal components of velocity in the alluvium are greater than the vertical components entering the bedrock. However, the area of contact between the bedrock and the pond bottom is so large that the volume of water transferred across it is probably greater than the volume transmitted laterally through the alluvium.

The line of strong vectors of exactly the same magnitude designated as "simulated flow near base of Pond 5" in Figure 3-15 is questionable, and does not square with the comparatively similar conductivity values for Unit 3 and the alluvium used in the final calibration. These values are shown in Figure 3-11. The conductivity values shown in this figure, particularly for Unit 3 and the alluvium, do not support the statement made in paragraph 3 on page 3-94 that a conductivity contrast exists between the alluvium and the bedrock.

Flow in the alluvium is not likely to be that different in direction or velocity compared to underlying units--the conductivity and the driving force (see Figure 3-13) are too similar. This disparity may be an artificial result of modeling choices of grid layout and parameter setting, but it leads to the incorrect conclusion that groundwater does not flow from the ASAW to the bedrock (Conclusions 2 and 3, page 3-93). An explanation of the reason for the strong flow vectors observed during modeling would help clarify the conclusions about flow patterns at the base of the fill.

Note also that a refraction towards the horizontal is expected in flowing from a zone of low conductivity into a zone of high conductivity, (see page 173 of Freeze and Cherry). If a conductivity contrast were present, this would be part of the explanation for the horizontal flow patterns.

It appears that groundwater does flow from the ASAW and alluvium into the shallow bedrock over the southern two-thirds of Pond 5, based on both modeling and water level results, which show strong downward gradients in the ASAW and weak downward gradients in the shallow to intermediate bedrock. It is true that streamlines descend at a low angle but they clearly do enter the shallow bedrock and eventually flow to the river. Therefore, Conclusion 4 on page 3-93 is incorrect if the term "limited" is intended to mean volumetrically insignificant, or insignificant in terms of potential mercury transport.

The RI report also notes that groundwater flows up into the ASAW north of Unit 4 in the northern third of Pond 5. After refining the modeling to replicate the flow system more accurately, the hydraulic gradients across all parts of the bottom of Pond 5 can be used to estimate groundwater inflow and outflow volumes to and from Pond 5—a primary deficiency of the existing water budget and conceptual model. However, the questionable calibration of the model will limit the confidence with which these volumes can be estimated.

Conclusion 5 on page 3-93 is also unsubstantiated. It is clear that recharge to Pond 5 includes a substantial contribution from rain falling on the pond. During modeling, recharge was distributed across the pond (see Figure 3-9), so there is no basis for stating that recharge to Pond 5 is principally from Little Mountain.

Hydraulic Communication Between Bedrock and Fill

This discussion of why interconnection is believed to be insignificant (page 3-94) contains several errors, some of which have been covered by the preceding comments.

Conclusion 1, which states that the subdued response of bedrock wells to precipitation events proves that residence time is short, implies that flow is quick and lateral rather than downward. This conclusion is unfounded. The response of bedrock wells is likely to be even more subdued and delayed than the response of wells in the fill. The mechanics of this were discussed previously. Residence time is probably not short, and even if it were, this would not indicate that interconnection is insignificant.

Conclusion 2 is also unfounded. Wells show different water levels as a result of different potentials. This is used to estimate hydraulic gradients. The existence of different heads in different wells in no way implies independent flow systems.

Although it is true that flow occurs preferentially in high permeability units, Conclusion 3 is misleading. Flow is proportional to the product of hydraulic conductivity and the hydraulic gradient, not to hydraulic conductivity alone. In an isotropic system, flow is parallel to the gradient, but in an anisotropic system like this one, flow often occurs at an angle to the general gradient. Refraction across boundaries of units with different permeabilities was mentioned previously. This effect would tend to accentuate horizontal flow in the alluvium. The direction of actual flow is influenced by the conductivity of the various units, but this does not imply that flow to bedrock would not occur as a result.

It is also important to note that the field conductivities quoted at the bottom of page 3-94 are significantly different than the final calibration values used in the modeling. Because of this, the model is potentially a questionable indicator of the effect mentioned in Conclusion 3.

The fourth conclusion regarding interconnection requires some clarification. First, although mercury concentrations are lower in the deeper bedrock wells, there are clearly some shallow bedrock wells with mercury concentrations present (MW-7, MW-3, MW-10; see Figure 3-8). Therefore, to say that shallow bedrock has not been effected by mercury is incorrect. Furthermore, even if mercury were absent, this alone would not imply the absence of advective flow. The fact that much of the mercury in the ASAW is in the upper 15 to 20 feet shows that much of the mercury is still caught up in the unsaturated zone, where it is unavailable for groundwater transport. After it reaches the water table, the mercury is expected to be retarded by adsorption to solids to a degree that depends on site conditions.

Pond 6

If the objective of the RI is to characterize site geology and hydrogeology, why is Pond 6 not included in the characterization and discussion?

Discussion and Conclusions (Section 3.9.4)

Several of the overall conclusions about the hydrology and hydrogeology of the Saltville site listed on page 3-98 are incorrect, or unsupported by the data.

Conclusion 1

Permeability and flow characteristics may be controlled by secondary porosity and permeability features in the bedrock, however, no information on the primary permeability of the bedrock is given to assess its magnitude. This statement is probably not true when applied to the fill material. The overestimate of the role of fracture flow in the ASAW flow pattern was discussed previously. Almost all of the flow through the dike and out the decant structure is via saturated groundwater flow below the water table. It is unclear whether fractures extend to this depth in the fill near the decant structure, but it is known that fractures are concentrated in the west near the decant structure. (These fractures are probably caused by structural weakening of the ASAW due to drainage.) Where they are absent, they cannot expect to "control" permeability and flow characteristics. Because the horizontal flow through the dike along the entire river front next to Pond 5, as well as downward flow in the southern two-thirds of the site is not taken into account, it is understandable that the importance of fracture flow is overestimated.

Conclusion 4

The first sentence is partially true—water level fluctuation is related to the duration and intensity of rainfall—but the response is subdued and delayed. The explanation that runoff and direct rainfall are quickly communicated out of the Pond system via the decant structure and that short precipitation events do not contribute substantially to groundwater level fluctuations is unfounded. This was discussed previously.

Conclusion 5

In light of conclusion 5, it is surprising that the conceptual water balance model was not modified to attempt to quantify this flow.

Conclusion 6

This is incorrect, first because it underestimates the importance of precipitation falling on Pond 5 directly, and second because it falsely contends that precipitation flowing into surface fractures needs to exceed some "critical driving head" before it can infiltrate down to the water table.

Conclusion 7

This conclusion is essentially correct, except that the authors apparently believe that the starter dike acts as a quasi-impermeable barrier, since they mention flow occurring only over and under it. Considering that it was constructed primarily out of blasted boulders and cobbles infilled with sand and some silt, and its conductivity was assumed to be 0.006 cm/sec during modeling, this is hard to understand. The earth blanket of crushed shale probably did not have a low permeability either, unless it was crushed to silt or clay size, which is unlikely. Pond dikes are designed to allow a controlled flow through them so that water levels in the dike do not build up and lead to collapse. Elsewhere in the document, water flowing over the internal starter dike is compared to a weir responding to surface water. On page 3-12, it is stated that there are higher heads in the dike than outside of it. This indicates flow through the dike. Groundwater flows at some unquantified rate through the entire dike, including the starter dike and blanket.

Conclusion 8

This is incorrect on several counts, as discussed in detail previously. There is a definite interconnection between the fill and the bedrock. Flow patterns should not be confused with interconnection. There is clearly some downward flow.

Conclusion 9

This is not correct in light of the presence of mercury in at least three of the deeper bedrock wells, albeit at low levels. Mercury clearly has migrated to the bedrock to some degree, based on the available data. These concentrations are assumed to be validated, and therefore represent actual site conditions.

Additional detailed comments

1. The symbol on the thrust fault in Figure 2.2 is backwards. See Figure 3-17.

2. Page 3-8, third paragraph: temperature symbol typo.

3. The term "head driven" on page 3-9 needs clarification.

4. Page 3-11, second paragraph: Extent and depth of fracturing have not been characterized thoroughly, therefore this horizontal fracture flow is questionable. Is this horizontal flow in fractures above the water table?

5. A more complete explanation of the decant structure would make the flow data at the top of page 3-18 easier to follow.

6. The fraction of flow out the decant structure needs to be reassessed before the statement at the bottom of page 3-20 can be made.

7. Page 3-22. If the soils (i.e., alluvium) underlying the ASAW are locally discontinuous, how can they achieve rapid transmission and carry the "preferential" flow mentioned elsewhere?

8. The "fractured sponge" model on page 3-23 is flawed by the overestimate of the importance of fracture flow. It is assumed that a substantial amount of rainfall flows directly to the outfall structure through the fractures. This claim is unsubstantiated.

9. In light of earlier discussions, the degree of confidence in Pond 5 flow estimates is clearly unjustified (page 3-25, 3-30).

10. The use of Little Mountain stream flow as a sole groundwater volume inflow is unrealistic (page 3-29).

11. If the culvert is inundated at 405 gpm, then flow rates are either higher above this level, if flow is unrestricted, or below it, if the system backs up (page 3-30).

12. The assumption of a direct correlation of peak precipitation and peak discharge is likely to be a poor one (page 3-31).

13. The "only remaining explanation" referred to in Section 3.5.5.7 on page 3-32 suggests that the authors quantified, then came up with a conceptual model, rather than the other way around.

14. Page 3-33, last paragraph: A rainfall-runoff model cannot be expected to predict the behavior of a groundwater flow system. It is not designed to do so.

15. Infiltration is not limited to cases in which the "maximum soil storage capacity" is two inches of rainfall, as stated on page 3-34. This needs clarification. The "trigger point" discussion on page 3-35 is unrealistic.

16. Page 3-37, second paragraph. The observation that outflows are accounted for with "relying on" losses by groundwater seepage shows that the conceptual model is extremely unrealistic.

17. Page 3-37, last paragraph. The syncline is not recumbent. Its dip is 30 degrees.

18. The geology discussion is well-written and thorough.

19. It is untrue that upward flow is a result of "decreased pressures in the upper portions of the flow system caused by reduced recharge to the upper bedrock". (page 3-63).

20. How can water contents be 100 to over 200 percent of dry weight?

21. The last sentence on page 3-87 may be true, but the concentration/flow rate relationship has not been characterized by the RI work to date.

22. Page 3-88, third paragraph, second line: "trending" not "trenching".

23. It is stated on page 3-92 that groundwater is forced upward into the alluvium north of the barrier and flows back down into the bedrock south of the barrier; therefore, why is it a major conclusion of the RI that there is essentially no downward flow?

Nature and Extent of Contamination

There appears to be little data on the concentration of mercury in groundwater in the waste material. Well MW-7S appears to be the only well screened in the fill. This well contained 0 to 0.5 ppb of mercury during sampling rounds in 1990 and 1991. Greater concentrations of mercury were found in some shallow wells screened at the base of the fill and the top of the bedrock, as shown in Figure 3-8. Concentrations of mercury were generally very low or below detection limits in deeper bedrock wells . Because of the lack of mercury concentrations in the fill; however, it is difficult to draw strong conclusions about overall mercury transport in the saturated zone.

Analysis of the ASAW materials has shown mercury to be present at parts-per-million levels in the unsaturated zone. This leads one to question the partitioning characteristics of mercury between the ASAW and the groundwater. It would be advisable to obtain more groundwater samples from different locations with Pond 5. Also, it is recommended that partitioning tests be run with the ASAW using rain water to see what leaching potential the mercury has in these waste materials.

Mercury Fate and Transport

The hydrogeologic data presented does not eliminate downward flow into the bedrock. Mercury compounds are known to be quite soluble in oxidizing environments (EPRI, 1984, EA-3356), but their solubility drops off substantially under reducing conditions. The redox potential and other geochemical characteristics of either the saturated or unsaturated zones are not available, however, the pond was created by a chemical waste stream so there is a possibility that conditions are reducing. If so, mercury compounds would be expected to precipitate out and not have a significant presence in the saturated zone, particularly at depth. The geochemical fate of mercury needs to be examined closely before the "lack" of mercury in the bedrock (which is not supported fully by the analytical data) can be used to infer anything about downward flow. Certainly, the statement that downward flow "does not exist" is not proven by mercury concentrations. The existence of some downward flow can be proven on several counts.

Baseline Risk Assessment

EPA has already submitted specific comments to the Public Health Risk Assessment for OUs 2 and 3 for Saltville and their comments will not be repeated. These comments are supplemental to EPA's comments.

One general comment is that the document could incorporate several recent guidance documents and advances in analytical technology, particularly if there will be continuing studies at the site. The exposure assumptions should be based on the values in

OSWER Directive 9285.6-03, March 1991, *Human Health Evaluation Manual, Supplemental Guidance*: "Standard Default Exposure Factors." This guidance suggests using 54 gm for the daily intake rate for fish consumption rather than the 17 gm/day used in the report. Since consumption rate and risk are directly related, this will increase the risk from eating fish by a factor of 3.

The default value for the permeability constant for mercury is $1x10^{-3}$ cm/hr according to the new guidance document for dermal absorption *Interim Guidance for Dermal Exposure Assessment* (personnel communication, John Schaum, EPA—final to be released shortly) rather than the default value for water used in the report. This will increase the risk calculated from dermal exposure to mercury contaminated water by 25 percent.

On page 6-17 of the report there is a discussion of Sediment Quality Criteria (SQCs) or the concentration in sediment that will not produce a concentration in water that exceeds the ambient water quality criteria. A recent EPA Science Advisory Board report entitled "Evaluation of the Equilibrium Partitioning Approach for Assessing Sediment Quality (EPA-SAB-EPEC-90-006, Feb., 1990) states that there is potentially a large amount of uncertainty in this approach and recommends that a more sophisticated uncertainty analysis be carried out to set limits/bounds on it applicability. This report may influence the acceptance of the "non-polluted threshold value" of 0.8 mg/kg developed by EPA for mercury in sediment or the "contamination index" of 0.3 ug/kg established by the Commonwealth of Virginia for total mercury in freshwater sediment.

The noncarcinogenic toxicity value (RfD) is the same for inorganic mercury and methyl mercury. This implies that total mercury values can be used for risk characterization rather than separating inorganic and methyl mercury fractions. It might be more practical to use an analytical method for total mercury rather than one for methyl mercury and one for total mercury. Also, it appears that the Bloom method is more appropriate (greater sensitivity, precision, and accuracy) than the methods used in the report.

Ecological Risk Assessment

The draft RI report has referenced the ABB-Environmental Services Inc. *Risk Assessment Report for Saltville Waste Disposal Site, Saltville, Virginia-Draft Report*, July 1991 and included it as Attachment Q. Section 6.2.2 is essentially taken verbatim from the ABB report. The subheadings in Section 6.2.2 include the introductory and conclusionary text, deleting the discussion section from the ABB report.

The comments presented on the draft ABB report in our November 26, 1991 memo to Mr. Gene Wingert/EPA and those presented by Mr. Wingert in his letter of Notice of Deficiencies to Mr. Keith D. Roberts at Olin Chemicals dated January 8, 1992 were not addressed in the draft RI report. It is recommended that deficiencies which exist in the Ecological Risk Assessment be addressed.

WDCR603/027.51

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
841 Chestnut Building
Philadelphia, Pennsylvania 19107

SUBJECT: Saltville

DATE: March 12, 1992

FROM: Robert S. Davis, Coordinator
Biological Technical Assistance Group

TO: Eugene Wingert, Project Manager (3HW24)
Saltville Site

The BTAG has reviewed the Draft RI/OU-2 for the Saltville Site. The following comments are submitted on behalf of EPA, NOAA and USFWS.

In general, this document compounds the ecological problems voiced in our previous memo because it relies upon the inadequate ecological risk assessment. As you recall, BTAG found that document to be inadequate. The weaknesses in this document parallel those of the risk assessment, leaving most if not all, of our previously enumerated concerns as outstanding issues of remaining unresolved.

Contaminants of Concern

On page 1-3 one of the stated objectives for identification of contaminants of concern but the assessment focuses almost exclusively on mercury, mentioning others only incidentally. In addition, the document fails to adequately address other contaminants from past or present discharges.

Ground Water

On pages 3-86 and 87, a quarterly ground water sampling for organics and pesticides is discussed. No metals other than mercury appear to have been analyzed. It is our recollection that other metals may be associated with the site and should have been included. If this is incorrect, please inform us. However, chloroform and tetrachloroethene were detected and these as well as other organic contaminants are vaguely described as being "largely not present" or "in extremely low concentrations". This ground water discharges to the North Fork of the Holston River but this discussion does not include a comparison of these discharge concentrations to surface AWQC.

On page 4-1, the document states that TCL/TAL substances were analyzed but no data is presented or discussed. The investigator should clearly identify and discuss the chemical characterization of ground water as well as discharges from the ponds.

Surface Water

On page 6-22, it is stated that elevated chloride levels may be affecting the resources but this is not adequately discussed. Specifically, we are concerned whether this is due to salinity or to some other causative agent. We suggest you have the investigator define the ecological risk of this discharge and to detail plans for remediating the problem.

Impacts

On page 6-16, it is stated that pH and TDS may be causing impacts but it fails to discuss the topic.

On page 6-22, the document states that fish may be affected by the discharge of mercury but that mussels are adequately protected. This statement is not supported by the literature and does not take into consideration sensitive larval and juvenile forms. The statement seems especially misleading in view of the bioassay work that shows effluent from Pond 5 is toxic (see page 6-20) and exceeds AWQC for mercury (see page 6-18).

The conclusion on page 6-23 that only slight adverse effects be site related contamination is a contradiction in are view to the bioassay results and to the historical information that describes the elimination of mussels from below the discharge. It is our view that a loss of mussel habitat is a direct result of discharges from the site.

Recommendations

On page 7-5 the document recommends that additional remedial technologies be evaluated to reduce effluent flow from Pond 5. It has been demonstrated that the effluent is toxic and exceeds criteria for mercury. In addition to reducing flow, the effluent should be treated to non-toxic levels and to levels below criteria concentrations for all toxic constituents.

The conclusions described on page 7-5 are based upon the RA which was rejected by the BTAG. We recommend that the conclusions be delayed until the risk assessment is fully revised and found to be acceptable.

Conclusions

In much of the report neither AWQC nor other ecological endpoints are used in addressing environmental concerns. The document takes refuge in vague generalities by implying that, while problems may exist, they are not attributable to the site. No hard statistical evidence is offered to substantiate these claims. Both AWQC and toxicity data are available (and if toxicity data is unavailable, it can be easily retrieved either through literature searches or alternatively through bioassays) and should be used to form the bases for conclusions. The previously reviewed ecological risk assessment should be revised in light of previous BTAG comments prior to submitting this document for further review.

If you have any questions concerning these comments, please contact me at 597-3155.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
841 Chestnut Building
Philadelphia, Pennsylvania 19107

SUBJECT: Review of Draft RI for OU 2 Saltville Waste Disposal Site in Saltville, VA — DATE: 3-9-92

FROM: Nancy L. Cichowicz, Geologist *nlc*
Technical Support Section (3HW15)

TO: Gene Wingert, RPM
VA/WV Remedial Section (3HW24)

A review of the above-mentioned report that was prepared by Golder Associates and dated December 1991 has been completed. The following comments are offered for your consideration.

Section 2.7 Ground-Water Investigations

1. Although the conceptual hydrogeologic model presented in Figure 2-11 hypothesizes the existence of a deep flow system, the geologic and hydrogeologic data that were collected before and during the RI have provided little information to examine the validity of this system. A comparison of the vertical scale for the conceptual model and the interpretive subsurface profiles shown in Figures 2-8 through 2-10 shows that few borings extend below an elevation of 1600 feet. The conceptual model in Figure 2-11 seems to extend to nearly 2500 feet, as well as to the other side of the NFHR. Please discuss the data that have been collected to support the conceptual model in these areas.

Section 3.0 Physical Characteristics of the Study Area

1. It is suggested that a brief section be added to discuss the water supply source for the 91 residences near the site that are mentioned in Section 3.1.2. Section 6.1.1.2 notes that nearby residences are on a municipal water supply, but the source of that supply is not discussed.

2. Although the interpretive subsurface profiles presented in Section 2 are useful, it is suggested that several cross-sections be included to augment the hydrogeologic discussion. These cross-sections should show all borings along the profile and the geology, but more importantly, monitoring wells, screened interval and water levels, so that the sections may be compared with Figure 2-11.

Section 3.8 Numerical Modeling of Ground-Water Flow

1. Please state the method used to analyze the numerical accuracy of the finite element grid.

2. Regarding Table 3-22 and model calibration, please show the accuracy of measured and simulated water levels to the same significant digit. Please compare simulated water levels to the midpoint of the minimum and maximum water level at each monitoring well. Please show the residual mean and standard deviation of residuals. Note that deviations in Table 3-22 are not computed correctly (see wells W-2 and P-2S, for example).

3. Given the limited number of monitoring locations used as calibration nodes and the uncertainties that remain regarding the conceptual model, the modeling effort should include sensitivity and uncertainty analyses. The sensitivity analysis should document the sensitivity of simulated water levels to changes in recharge and hydraulic conductivity. For the uncertainty analysis, it is suggested that alternative solutions to the steady-state model be generated by varying the recharge within a reasonable range and uniformly adjusting hydraulic conductivities by the same percentage. Then, if the model is used to evaluate potential remedial actions, each action may be simulated with the alternative model configurations in an attempt to quantify the impact of hydrogeologic uncertainty upon the predicted effectiveness of each action.

Section 3.9 Site Conceptual Ground-Water Flow Model

1. Although the hypothesis of the conceptual model is that ground water flows from the bedrock to the pond and/or the NFHR, point (1) at the top of page 3-94 and point (2) at the bottom of page 3-96 both imply that data are not sufficient (i.e., wells are not deep enough) to prove this hypothesis. Given that hydrologic data that were collected for the RI are inconclusive with respect to the hydraulic connection between the pond and bedrock, statements throughout Section 3.0 should be revised to indicate that the apparent lack of connection is based solely on limited vertical migration of mercury in ground water.

2. Conclusion (6) on page 3-98 seems to underestimate the importance of direct precipitation to recharge the pond and bedrock system. Please revise to agree with the conclusion of the water balance.

Section 4.0 Nature and Extent of Contamination

1. Section 4.2.1 presents a summary of mercury concentrations that were detected in soil samples collected at the FCPS as part of a 1981 geohydrologic study, but a summary of mercury concentrations detected in ground water at this location is not presented. Please include.

Olin CHEMICALS
P.O. BOX 248, LOWER RIVER ROAD, CHARLESTON, TN 37310
PHONE: (615) 336-4000

April 30, 1992

Mr. Gene Wingert
VA/WV Remedial Response Section
USEPA, Region III
841 Chestnut Building
Philadelphia, PA 19107

Dear Mr. Wingert;

EPA recently provided Olin with comments on Olin's draft Remedial Investigation Report for Operable Unit 2 at the Saltville Waste Disposal Site. We have reviewed EPA's comments and have prepared a response for each comment.

During our discussions since Olin's receipt of the letter, we agreed that Olin should submit responses to the comments within the 24 day period dating from the Olin's receipt of EPA's letter. We have scheduled a meeting on May 7 at Saltville, Va to discuss the comments and responses pertaining to the OU-2 RI Report. Following that meeting, Olin will revise the RI Report for OU-2 and resubmit the report to EPA.

Olin responses to EPA's comments are attached for your review. For convenience, we have repeated each of the comments and provided the response immediately below the comment.

We are looking forward to the opportunity to meet with you and your associates to discuss the OU-2 Remedial Investigation. If you should need any additional information prior to our meeting, please call me at 615-336-4388.

Sincerely,

OLIN CORPORATION

Keith D. Roberts

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Responses to EPA Comments on

Draft Remedial Investigation Report

Operable Unit 2

Saltville Waste Disposal Site

Comment No. I:

Hydrogeologic Review

The conceptual understanding of the hydrology and hydrogeology of the Saltville site presented in the draft remedial investigation (RID) report includes several areas of inconclusive interpretations. This is most apparent in Sections 3.5, 3.7, 3.8 and 3.9 that cover site hydrogeology, the discussion of the water budget for the site, the numerical modeling, and the conceptual groundwater flow model.

A. Water Budget (Section 3.50)

1. The water budget and the resulting conceptual model fail to take into account some important flow processes and inflow/outflow mechanisms. Specifically, the RI report does not realistically quantify the groundwater outflow towards the North Fork of the Holston River through the south dike. Also the attempt to quantify groundwater inflow to Pond 5 from the North by extrapolating data from the H-flume in Swale 3 was unsuccessful. The omission of these important groundwater inflow/outflow mechanisms leads to some incorrect assumptions and calculations design to achieve a mathematical water balance in the absence of these mechanisms.

Response to Comment No. IA1:

In the development of the water budget for Pond 5, the inflow and outflow via groundwater were considered. As with all water balances, the most easily quantifiable components were identified first and remaining factors quantified or estimated subsequently. In the case of the Pond 5 water balance, the values for precipitation, infiltration, evapotranspiration, outfall flow and base surface runoff flow in the diversion ditch were considered the most easily identified. The remaining parameters of groundwater inflow from Little Mountain (predominately interflow) and outflow as seepage through the bottom of the pond and Pond 5 dike were the least certain. The seepage out of Pond 5 was the least quantifiable and the groundwater inflow into Pond 5 considered the easiest to estimate.

Based on field observations of surface water flow in Swales 3 and 4, and groundwater discharge observations made in Swale 5, it was assumed that a base flow of shallow groundwater was entering Pond 5 beneath the diversion ditch and along the Pond margin. The presence of an aquitard that induced artesian conditions in a piezometer and monitoring well in Swales 2 and 4, respectively, suggested that the inflow would be primarily from the shallow non-artesian zone and that artesian conditions would extend downdip beneath the pond.

The flows from Swale 5 and in Swale 3 were measured to give an indication of the quantity of base flow available to the pond and the flow averaged (based on swale area and precipitation) for the five swales along Pond 5. The resultant value was input into the water balance. The base flow was considered a reasonable groundwater inflow to use as the volume of surface water infiltration into the bedrock would be limited by the factors of driving head (which in a shallow stream is not high) and the hydraulic capacity of the observed bedding plane and fracture apertures, observed to be capturing all of the base surface flow in Swale 3, would be limited and decrease with depth (due to reduced weathering and isostatic pressure). The presence of runon controls (Western and Eastern Diversion Ditches) was considered to negate the effects of high intensity runoff entering the pond.

With the inputs and major outputs identified and all but the groundwater output quantified or estimated, the difference in the water balance was assumed to be the missing output value. Sensitivity analyses were done in the form of temporal variation and variation of the value of the estimated groundwater input from Little Mountain. It is recognized that this outflow value is small and may not be what was anticipated by the reviewers, however, it should be noted that the Pond functioned as a water retention structure for 65 years, and maintained standing water for six years following closure of Olin's Saltville plant, until the decant structure stop logs were removed to drain the Pond.

2. **The water budget presents a progression in the conceptual thinking that starts too simple - considering only precipitation, evapotranspiration and decant outflow - and then considers other factors only as a result of poor mathematical balance. This suggests that a complete conceptual model of the hydrologic system was not developed before quantifying individual components. In the absence of reliable measurements of subsurface inflow, it appears that a variety of differing assumptions were used to produce an estimate of groundwater outflows from the pond. Because these assumptions are generally unconvincing, the water balance effectively leaves the question of subsurface outflows unresolved.**

Response to Comment No. IA2:

The development of the water budget started as a conceptual model and the individual components were quantified later. The justification for the water budget is discussed in response IA1, above. Because estimates of subsurface inflow were used, a variety of assumptions were investigated as a sensitivity analysis. These assumptions were presented in the report as part of the discussion and illustrate the fact that groundwater outflow is not of the same order of magnitude as the outfall discharge. If only the quantifiable data are used in the analysis; (i.e., precipitation, evapotranspiration and outfall flow) discharge exceeds inflow. By estimating the inflow to be a multiple (for the 5 swales) of observed infiltration of surface flow in Swale 3 and groundwater discharge from Swale 5, the water balance becomes negative suggesting seepage, but accurate to within 6 to 13 percent indicating a close budget fit. The estimated seepage losses are reasonable in our opinion given the limited interflow recharge possible due to an aquitard in the Price-Parrot Formation that probably extends beneath the pond, a thin zone of recharge, the low flows observed, and the relatively tight pond base and clogged drains observed.

3. **The daily water balance does not increase the reader's confidence in the conclusion that there is no groundwater outflow from Pond 5. The water balance apparently makes use of an arbitrary 2-inch soil storage capacity that must be satisfied before infiltration can occur. This does not appear to be hydrologically realistic.**

Response to Comment No. IA3:

The report does not assume that there is no groundwater outflow from Pond 5. As with all water retaining structures, some seepage occurs, and in this case occurs through the dike and the shallow fractured bedrock foundation of the dike. The point of discharge is the NFHR, and as such, the groundwater system involved is very shallow and considered to be confined to the alluvial plain deposits and upper weathered bedrock zone of the pre-pond topography.

The 2-inch soil storage capacity is not arbitrary. It is a calibrated parameter in the daily water balance model that results in a best fit of Pond 5 outfall flow data.

The surface of the ASAW is very inhomogeneous. In isolated lows, very fine particles on the surface result in very low infiltration. Over a majority of the pond surface, well established grasses, and in places woody plants, result in large amounts of interception storage, and block sheet flow. Finally, while we consider the fractures to extend down to the base of the pond, the fracture apertures decrease with depth. The result is no flow in fractures under short duration storms or for storms of longer duration and low intensity. Porous media flow dominates for these storms, and the peak at the outfall is very low and the lag is long.

However, under higher intensity storms, or storms of modest to high intensity following wet antecedent conditions, sufficient water reaches the fractures (whether or not unsaturated flow has ceased) to fill them to a point where less restricted flow due to wider apertures is possible. Since the fractures radiate from the outfall, where a free outfall exists, a steep gradient develops along the fracture flow paths, and water flows very quickly along the fractures to the outfall. Under these conditions, the outfall hydrograph peaks earlier, the recession limb is shorter and flows are higher.

Both conditions are observed in the outfall flow records; the 2-inch storage is a lumped parameter estimate that accounts for the "lag" while fractures saturate, and accounts for many other surface storage factors (vegetation, etc.).

B. Unsaturated flow (Section 3.70

1. **Much of the discussion of the response to precipitation within Pond 5 is based on an assumption that the fractures fill up with water and allow downward infiltration only if the "driving head" exceeds a certain critical value. Water is said to flow rapidly toward the decant structure within the fractures with only minimal recharge. This mechanism is put forth to explain why the water level response in monitoring wells is subdued and why there is a time lag observed between rainfall events and responses in the bedrock aquifer. This, however, does not indicate that there is no recharge of the bedrock from above as asserted in the report.**

Response to Comment No. IB1:

As noted in the previous responses, it is not the intention of the report to disallow seepage from the pond. It does state that the seepage is not of a magnitude to be of major consequence.

The relationship of the fractures and the porous medium they are in (ASAW), and its effect on groundwater flow within the pond is complex. The fractures have been observed to extend below water levels during pond operation and in the laboratory, and are considered to extend to the base of the pond. The major fractures in the ASAW are the product of consolidation of the ASAW material; first under its own weight during deposition and submerged conditions; and secondly as a result of rapid draining of the pond in 1978 and the resultant change in effective stress which induced settlement. The major fractures in the pond generally trend from the decant structure to the swales indicating that they are dynamic and to some extent maintained by drainage. One major fracture system rings the pond along the north, west and east side. The major fractures are most pronounced where the ASAW is thickest. Minor fractures occur in the ASAW above the water table and are the result of desiccation. The result of the fracture systems is to convey precipitation, groundwater (subsurface pondwater)and runon to the major fractures and the outfall relatively rapidly.

The bottom of the pond and drains from the pond have been observed to be clogged/blinded by precipitation of calcium from the ASAW. Thus seepage downward into the bedrock and through the dike is inhibited. It stands to reason that when the fractures are full and heads in the pond are highest the increase in gradient will increase the value of seepage. The relatively low drainage times for single isolated events induces a low head on the bottom of the pond and thus limits seepage to the underlying bedrock and through the dike.

2. **The unsaturated flow analysis neglects unsaturated flow mechanisms. Water begins to flow downward into the porous medium immediately but generally will do so under unsaturated conditions. Much of the water is expected to reduce the negative suction potential of the unsaturated soil (i.e., moisten it to a point below saturation) and then begin to flow downward to the water table slowly. The unsaturated zone acts as a significant reservoir that delays and decreases the water level response seen in the wells. It is recommended that references to a "critical driving head in fractures" be eliminated and replaced with a discussion based on a more fundamental understanding of the flow involved.**

Response to Comment No. IB2:

The flow analysis has taken into account unsaturated flow mechanisms but is also tempered by visual observations made in the field and the results of previous in-situ treatment studies conducted at the site. These studies showed that the solutions (Sodium Thiosulfate) applied to the surface of the pond were ineffective at fixing the mercury to the ASAW because of an inability to maintain sufficient contact time and control solution contact with the waste. Infiltration during site testing was extremely rapid, and the solution drained out of the test zone with the migration path of the solution of identified. It is recognized that traditionally wetting in a porous medium will be as discussed in the above comment. It is believed this is indeed happening along the surfaces of the fractures, however the rapid drainage into fractures is the controlling flow mechanism.

If the ASAW was a homogeneous isotropic medium it could be analyzed using fundamental approaches. The recognition of the importance of the fractures in the ASAW prohibits such an approach. The analysis used is based on fundamentals of flow through a fractured crystalline rock mass. While the strength parameters of the compared materials (ASAW and crystalline rock) do not compare favorably, the method of fracture formation through accumulation of tensile and shear stresses and the contrast between the fracture porosity and intact material porosity and resultant contrast in unsaturated flow characteristics of the two media compare quite well.

The surface of the ASAW is very inhomogeneous. In isolated lows, very fine particles on the surface result in very low infiltration. Over a majority of the pond surface, well established grasses, and in places woody plants, result in large amounts of interception storage, and block sheet flow. Finally, while we consider the fractures to extend down to the base of the pond, the fracture apertures decrease with depth. The result is no flow in fractures under short duration storms or for storms of longer duration and low intensity. Porous media flow dominates for these storms, and the peak at the outfall is very low and the lag is long.

However, under higher intensity storms, or storms of modest to high intensity following wet antecedent conditions, sufficient water reaches the fractures (whether or not unsaturated flow has ceased) to fill them to a point where less restricted flow due to wider apertures is possible. Since the fractures radiate from the outfall, where a free outfall exists, a steep gradient develops along the fracture flow paths, and water flows very quickly along the fractures to the outfall. Under these conditions, the outfall hydrograph peaks earlier, the recession limb is shorter and flows are higher.

3. **In addition, the hypothesis is rapid flow to the decant structure is not supported by flow data from the structure. On page 3-23, it was stated that outflow from the decant structure lags "far beyond the rainfall, often showing no discernable peak in a long shallow recession". This behavior is not consistent with the hypothesis of rapid flow to the structure through fractures.**

Response to Comment No. IB3:

The rapid flow referred to is relative to the flow that would be expected through a low permeability, homogeneous isotropic medium (such as intact ASAW). During high intensity storms, or during storms of low to modest intensity following wet antecedent conditions, rapid flow to the decant structure is observed, as explained in Response IA3 above. Outflow does lag "far behind rainfall" during short duration storms or during storms of low intensity.

C. Modeling (Section 3.8)

1. **The numerical model of groundwater flow may be useful as a tool for conceptual visualization of general flow patterns. However, the lack of quantitative knowledge, particularly of the deeper bedrock zones, makes it unreliable as a quantitative predictor. The model gives some potentially erroneous results because of the input parameters chosen, the selection of the boundary conditions, and the setup of the grid. Some conclusions reached are also not supported by the data.**

Response to Comment No. IC1:

The work plan states that the computer model will be used "...as a tool to aid understanding of the significant influences on groundwater flow patterns". While it represents a numerical refinement of the conceptual model presented early in the project, the model is only intended to be a qualitative predictor in its current configuration. The model presented in the RI reflects our understanding of the geologic and hydrogeologic systems affecting the site, and was extended to no flow boundaries, beyond the limits of specific data for illustrative purposes.

The boundary conditions selected can be justified by the relatively close correlation to the actual readings of phreatic surface elevations predicted. Specific comments regarding deeper bedrock zones, boundary conditions used and grid setup should be noted so they can be individually addressed.

2. **The fact that the spring on Little Mountain acts as a recharge point rather than a discharge point (page 3-91) should be a signal that the true system is poorly represented in this area. The phreatic surface near the high point in the section is obviously distorted by the selection of constant head. This distortion was pointed out in the modeling write-up, but was not corrected.**

Response to Comment No. IC2:

After reanalyzing the computer output of the calibration run, it was found that the constant head node at the spring on Little Mountain acted as a discharge point. The discharge rate per unit thickness perpendicular to the cross-sectional modeling area is 2.6 ft^3 day. The report will be revised to reflect this.

In previous model runs, the extreme north end of the mesh (node 585) was simulated as a constant head boundary condition. As mentioned in the RI report, the elevation of the phreatic surface beneath the upper slopes of Little Mountain was unrealistically low. This situation has been corrected by making some modifications to the model around the peak of Little Mountain. The nodes on the vertical lines passing though the peak of the mountain (nodes 574, 575, 576, 577, and 568) are now simulated with constant head boundary condition. Because little information beyond the spring, especially around the peak of the mountain, is available for calibration, the head for those nodes was obtained during the calibration process and its value estimated at approximately 2337 feet. Obviously, the constant head nodes at Little Mountain establish the northern boundary of the modeling area and the area beyond these nodes is and of inactive zone with respect to the rest of modeling area.

3. **Because of the poor match with the known position of the spring on Little Mountain, the modelers arbitrarily created Unit 9 to make the free surface elevation match the observed position on Little Mountain more closely. Because its hydraulic conductivity is approximately two orders of magnitude less than the units it replaces, this essentially has the effect of artificially raising the base of the flow system. Some distortions are seen across the transition between Unit 9 and units above it. The distortion seen under the northern third of Pond 5 in Figure 3-12 may be the result of this manipulation. The creation of Unit 9 does not seem to be based on reasonable hydrogeologic and modeling judgement but only on the**

need to improve the fit. This seems to fall outside the limits of normal calibration.

Response to Comment No. IC3:

As stated in the report (p. 3-91), the vertical and horizontal hydraulic conductivities of Unit 9 were determined during the calibration process. As mentioned in the report (p. 3-91), the decreased hydraulic conductivity for the deep bedrock strata replicates the probable decrease in hydraulic conductivity for bedrock units at depth due to isostatic loads compressing pore/fracture aperture. These values achieved good correlation between measured and modeled heads and a net water balance approximating an overall infiltration rate of 13.1 inches per year.

Unit 9 was created to improve the fit of the model which is a normal activity of calibration. The selection of a decreased hydraulic conductivity was not "arbitrary", and it would not have been done just to make the model fit the measured phreatic surfaces if it could not be justified. Flow in the bedrock was considered to be controlled by structural geology and fracture porosity. It has been documented (see reference list below) that with increased depth in fractured crystalline rock masses, fracture apertures decrease as does rock mass hydraulic conductivity. It has been Golder Associates' experience in the mining industry that groundwater inflow into underground mines decreases at about 300 beet below ground surface and that mines are generally very tight (unless a large fault is encountered) below a depth of 700 feet. This type of behavior has also been observed by Golder Associates in pressure packer testing of rock units from the surface to below depths of 500 feet. In these instances, changes in hydraulic conductivity of 2 or more orders of magnitude have been observed.

Selected References Concerning Rock Fractures and Permeability at Depth:

Brown, S.F., and Scholtz, C.H., 1985. "Closure of Random Elastic Surfaces in Contact" Journal of Geophysical Research, Vol. 90, No.B7, pp. 5531-5545.

Brown, S.F., and Scholtz, C.H., 1986. "Closure of Rock Joints", Journal of Geophysical Research, Vol. 91, No.B5, pp. 4939-4948.

Elsworth, D., and Goodman, R.E., 1986. "Characterization of Rock Fissure Hydraulic Conductivity Using Idealized Wall Roughness Profiles," International Journal of Rock Mechanics, Mining and Science Geomechanical Abstract, Vol. 23, No. 3, pp.233-243.

Gangi, A.F., 1978. "Variation of Whole and Fractured Porous Rock Permeability with Confining Pressure," International Journal of Rock Mechanics, Mining Science and Geomechanical Abstract, Vol. 15, No. 5, pp. 249-257.

Hopkins, D.L., Cook, N.G.W., and Myer, L.R., 1987. "Fracture Stiffness and Aperture as a Function of Applied Stress and Contact Geometry," Rock Mechanics; Proceedings of 28th U.S. Symposium, pp. 673-680.

Pyrak-Nolte, D.L., Myer, L.R., Cook, N.G.W., and Witherspoon, P.A., 1987. Hydraulic and Mechanical Properties of Natural Fractures in Low Permeability Rock," Proceedings of the Sixth International Congress on Rock Mechanics, Montreal, Vol. 1, pp. 225-232.

Sour, L. and Ubbes, W., 1987. "Fracture Flow Response to Applied Stress; A Field Study," Rock Mechanics; Proceedings of 28th U.S. Symposium, pp. 501-508.

4. **The final calibrated values for the hydraulic conductivity of the other units also appear to be somewhat questionable. The main statement in the text about their selection indicates that they were recalibrated to reflect the change in recharge and the addition of Unit 9. This hinges on whether the addition of Unit 9 is justified. It is also important to note that, while the "correct" match for the calibration nodes can be achieved through a variety of possible parameter settings, some of the parameters may be unjustified based on the available field data.**

Response to Comment No. IC4:

Following development of the cross-sectional finite element mesh, initial estimates for values of the horizontal and vertical hydraulic conductivities were input in the model. For hydrogeologic units not tested, representative values were selected from the literature. The precipitation recharge rate was derived from the HELP model for the southwestern region of Virginia. After these assignments, an iterative procedure was used to calibrate the groundwater flow by matching computed potentiometric heads with measured values and the differences were examined. Each succeeding computer run included revised data. This process was repeated until results closely matched the potentiometric head data. The measured potentiometric heads at 11 points were compared with the computed values and the results were evaluated statistically. In Table 3-21 of the report, measured and calibrated hydraulic conductivity values are compared.

As previously stated, the purpose of the model was to enhance and verify the validity of the conceptual model, not provide a quantitative analytical tool. From this perspective the model in the RI is successful and well calibrated. The model has been subsequently refined to focus on the interflow zone of the lower slopes on Little Mountain and the pond and river area for evaluation and screening of potential remedial alternatives. The refined model can be presented in the RI report if necessary.

5. **The strong flow said to occur within the alluvium may be overestimated as a result of the assigned K values and the grid spacing. It is also important to note that there are no calibration nodes in the ammonia soda ash waste (ASAW) or any of the deep units to verify flow relationship there. This is probably because there are no wells installed at either depth; however, this limitation should be acknowledged in the data interpretation.**

Response to Comment No. IC5:

The strong flow within the alluvium is the result of its relatively high hydraulic conductivities not the grid spacing. It is true that there are no calibration nodes in the ASAW with exception of M-7, which is located at the ASAW/alluvium contact and serves as an indicator of head in the ASAW.

Drilling was not extended to the deep units, and as such there are no calibration nodes in these units. It is not considered necessary to provide calibration nodes in the deep units as the groundwater base level and discharge is the NFHR. As noted previously, little flow is anticipated at great depth beneath the syncline due to reduced hydraulic conductivity and a closer and shallower discharge point (NFHR).

6. **Several of the modeling conclusions listed on page 3-93 do not appear to be justified based on the modeling and field data. Conclusion 2 (page 3-93), which states that discharge from the pond is primarily along the alluvium layer, does not seem to be supported by Figures 3-12 or 3-15, both of which show streamlines crossing this boundary and flowing into the shallow bedrock in the southern two-thirds of the Pond 5 area (south of the Unit 4 Mccrady shale). The accumulation of streamlines at the base of the alluvium shown in Figure 3-14 is not supported by the vector patterns in Figure 3-15.**

Response to Comment No. IC6:

It is true that both Figures 3-12 or 3-15 show that the discharge from the pond is not primarily along the alluvium layer at its base, they pass through the shallow bedrock as well. The FPM computer program plots the velocity vectors at the centroid of each finite element. The stream function is calculated at each node of the finite element mesh and are given in the output. Using the nodal coordinates and stream function values at each node streamlines were generated using a contouring package. Therefore, one should not expect the same density of the flow vectors as the density of the streamlines.

7. **Several of the modeling conclusions relate to the magnitude and significance of vertical flow into the bedrock. It is apparent from Figure 3-15 that the horizontal components of velocity in the alluvium are greater than the vertical components entering the bedrock. However, the area of contact between the bedrock and the pond bottom is so large that the volume of water transferred across it is probably greater than the volume transmitted laterally through the alluvium.**

Response to Comment No. IC7:

Because of the existence of the North Folk Holston River the groundwater flow directions tend to become vertical between the pond and river. This may result in a situation where the volume of water transferred between the bedrock and pond may be greater than the volume transmitted laterally through the alluvium.

8. **The line of strong vectors of exactly the same magnitude designated as "simulated flow near base of Pond 5" in Figure 3-15 is questionable, and does not square with the comparatively similar conductivity values for Unit 3 and the alluvium used in the final calibration. These values are shown in Figure 3-11. The conductivity values shown in this figure, particularly for Unit 3 and the alluvium, do not support the statement made in paragraph 3 on page 3-94 that a conductivity contrast exists between the alluvium and the bedrock.**

Response to Comment No. IC8:

The reason of the strong vectors is explained in the Response to Comment No. IC5.

Figure 3-11 and Table 3-21 of the report show that the hydraulic conductivities of the alluvium and Unit 3 are approximately in the same order of magnitude. Therefore, the first sentence in a paragraph 3 on page 3-94 of the report should read as: "A hydraulic conductivity contrast exists between the shallow bedrock and deep bedrock. Hydraulic conductivity contrast also exists between the pond alluvium and deep bedrock."

9. **Flow in the alluvium is not likely to be that different in direction or velocity compared to underlying units - the conductivity and the driving force (see Figure 3-13) are too similar. This disparity may be an artificial result of modeling choices of grid layout and parameter setting, but it leads to the incorrect conclusion that groundwater does not flow from the ASAW to the bedrock (Conclusions 2 and 3, page 3-93). An explanation of the reason for the strong flow vectors observed during modeling would help clarify the conclusions about flow patterns at the base of the fill.**

Response to Comment No. IC9:

The report does not state that no flow occurs from the ASAW to bedrock rather that this flow is not significant, with in comparison with one outfall discharge. An explanation of the level flow vectors will be included in the revised RI Report.

10. **Note also that a refraction towards the horizontal is expected in flowing from a zone of low conductivity into a zone of high conductivity, (see page 172 of Freeze and Cherry). If a conductivity contrast were present, this would be part of the explanation for the horizontal flow patterns.**

Response to Comment No. IC10:

While the Tangent Law of heterogeneous flow systems documented in Freeze and Cherry (Groundwater, 1979) may account for some of the horizontal flow in the fill at the base of the ASAW, it is not expected to account for flow in the bedrock, which is best thought of as a fractured rock mass and not a porous medium. As such, most flow in near surface bedrock is expected in fractures, and the fracture apertures decrease rapidly with depth, resulting in minimal flow through bedrock at depth.

Even if this were not the case, the Tangent Law would indicate that the bedrock would be an aquitard relative to the ASAW, and would have a near vertical flow lines. Due to the difference in hydraulic conductivities, a small flow rate would result in the vertical direction. Vertical mass transport would be small, and lateral transport to the river in bedrock would be limited.

11. **It appears that groundwater does flow from the ASAW and alluvium into the shallow bedrock over the southern two-thirds of Pond 5, based on both modeling and water level results, which show strong downward gradients in the ASAW and weak downward gradients in the shallow to intermediate bedrock. It is true that streamlines descend at a low angle but they clearly do enter the shallow bedrock and eventually flow to the river. Therefore, Conclusion 4 on page 3-93 is incorrect if the term "limited" is intended to mean volumetrically insignificant, or insignificant in terms of potential mercury transport.**

Response to Comment No. IC11:

Conclusion 4 on page 3-93 indicates that hydraulic communication between the fill and the bedrock is volumetrically insignificant and of small potential concern with respect to mercury transport. The mild downward gradients observed in the southern section of the pond generate a small downward flow of groundwater through fractures in the bedrock. Fracture aperture decreases with depth, greatly reducing volumetric flow rates. A significant volumetric flow of Pond 5 groundwater into the deep bedrock is not supported by the chemical analysis of samples taken to date.

12. The RI report also notes that groundwater flows up into the ASAW north of Unit 4 in the northern third of Pond 5. After refining the modeling to replicate the flow system more accurately, the hydraulic gradients across all parts of the bottom of Pond 5 can be used to estimate groundwater inflow and outflow volumes to and from Pond 5-a primary deficiency of the existing water budget and conceptual model. However, the questionable calibration of the model will limit the confidence with which these volumes can be estimated.

Response to Comment No. IC12:

The model calibration will be provided as an Appendix to the RI Report. It should be noted however that the model was not intended to be used to quantify the pond inflow and outflow, rather it was developed as an qualitative tool to verify the conceptual model. The model presented in the RI Report was refined beyond a simple qualitative model in the interest of presenting a more thorough illustration of the conceptual model. In this refinement, the model was extended beyond the limits of the areas of concern (the toe of Little Mountain and the Pond 5 and shallow bedrock system) to include regional no flow boundaries such as the brine field of Saltville and the Little Mountain divide. The model has undergone sensitivity analyses of the assumed boundary conditions, the results of which can be included in the calibration Appendix. If the model purpose is considered as previously discussed, further model refinement is unwarranted.

13. Conclusion 5 on page 3-93 is also unsubstantiated. It is clear that recharge to Pond 5 includes a substantial contribution from rain falling on the pond. During modeling, recharge was distributed across the pond (see Figure 3-9), so there is no basis for stating that recharge to Pond 5 is principally from Little Mountain.

Response to Comment No. IC13:

The statement should have included direct precipitation on Pond 5 along with the recharge from Little Mountain.

D. Hydraulic Communication Between Bedrock and Fill

1. **This discussion of why interconnection is believed to be insignificant (page 3-94) contains several errors, some of which have been covered by the preceding comments.**

Response to Comment No. ID1:

The responses to the preceding comments have addressed the agency concerns.

2. **Conclusion 1, which states that the subdued response of bedrock wells to precipitation events proves that residence time is short, implies that flow is quick and lateral rather than downward. This conclusion is unfounded. The response of bedrock wells is likely to be even more subdued and delayed than the response of wells in the fill. The mechanics of this were discussed previously. Residence time is probably not short, and even if it were, this would not indicate that interconnection is insignificant.**

Response to Comment No. ID2:

Rapid lateral flow in fractures occurs under conditions of high intensity rainfall, or modest to high intensity rainfall following wet antecedent conditions. A steep lateral gradient exists along the fracture path to the free outfall at the decant outlet. Contact time with the ASAW is short; downward gradients are much smaller than lateral gradients and downward migration is correspondingly small.

During short duration or low intensity storms, saturation is slow to develop, and the necessary vertical driving head is absent; again, downward migration exists but it is relatively small.

In either case, the interconnection between the fractured ASAW and the fractured near surface bedrock is insignificant with respect to the volumetric flow rate of outfall discharge water.

3. **Conclusion 2 is also unfounded. Wells show different water levels as a result of different potentials. This is used to estimate hydraulic gradients. The existence of different heads in different wells in no way implies independent flow systems.**

Response to Comment No. ID3:

The presence of different head levels in wells constructed with screens at different elevations in a homogeneous isotropic medium would not imply the presence of different flow systems. The presence of different potentials in wells screened in heterogeneous materials; (e.g., MW-1) does suggest the presence of independent flow systems. In MW-1, the separation of the flow systems is a thick competent sandstone confining layer. The continuity of the system is inferred by the presence of similar artesian conditions in SW-5 constructed in Swale 4. Drilling in the Pond indicated the presence of a similar layer of cemented alluvium and cemented residual soils that would behave as a similar isolating medium.

Conclusion 2 states "suggesting that the pond and the bedrock behave more as independent flow systems". The existence of different heads in different wells is necessary but not sufficient to determine a separate flow system. While the dry season observations made do not conclusively indicate a total hydraulic separation between bedrock and fill, they strongly suggest flows dominated by two moderately disconnected systems rather than one, unified flow regime. This evidence, the water level disparities and the fact that Pond 5 functioned as a water retaining structure support the conclusion.

4. **Although it is true that flow occurs preferentially in high permeability units, Conclusion 3 is misleading. Flow is proportional to the product of hydraulic conductivity and the hydraulic gradient, not to hydraulic conductivity alone. In an isotropic system, flow is parallel to the gradient, but in an anisotropic system like this one, flow often occurs at an angle to the general gradient. Refraction across boundaries of units with different permeabilities was mentioned previously. This effect would tend to accentuate horizontal flow in the alluvium. The direction of actual flow is influenced by the conductivity of the various units, but this does not imply that flow to bedrock would not occur as a result.**

Response to Comment No. ID4:

It is not the intent of the RI to suggest that there is no flow from the base of the pond to the shallow fractured bedrock. Flow from the pond to the deep bedrock system is considered unlikely in that the local base level is delineated by the NFHR and subvertical fractures in the rock are more likely to transmit water laterally to discharge in the river. Flow in the shallow bedrock is similarly considered to be limited by the contrast in permeability between the bedrock and alluvium. The flow would therefore prefer the alluvium to the fractures of the bedrock to transmit pond water to the NFHR.

5. **It is also important to note that the field conductivities quoted at the bottom of page 3-94 are significantly different than the final calibration values used in the modeling. Because of this, the model is potentially a questionable indicator of the effect mentioned in Conclusion 3.**

Response to Comment No. ID5:

The purpose of the model and the validity of the model calibration have been previously addressed. The values noted in the conclusion are valid, and the conclusion drawn from those data is well founded. The model is not cited as proof of the conclusion because the model is qualitative and was developed for illustrative purposes and not as a quantitative tool.

6. **The fourth conclusion regarding interconnection requires some clarification. First, although mercury concentrations are lower in the deeper bedrock wells, there are clearly some shallow bedrock wells with mercury concentrations present (MW-7, MW-3, MW-10; see Figure 3-8). Therefore, to say that shallow bedrock has not been effected by mercury is incorrect. Furthermore, even if mercury were absent, this alone would not imply the absence of advective flow. The fact that much of the mercury in the ASAW is in the upper 15 to 20 feet shows that much of the mercury is still caught up in the unsaturated zone, where it is unavailable for groundwater transport. After it reaches the water table, the mercury is expected to be retarded by adsorption to solids to a degree that depends on site conditions.**

Response to Comment No. ID6:

The mechanism for mercury uptake as a result of direct precipitation and its transport through the pond groundwater system is discussed in the report. The shallow fractured and weathered bedrock zone in which the shallow wells are screened is considered part of the Pond 5 flow system and separate from the deeper bedrock systems.

The ASAW in the pond is up to 80 feet thick and downward migration of the mercury taken up by precipitation inflow certainly goes through some of the processes outlined in the agency comment. The depths in bedrock below the pond to which mercury in groundwater, even in minor concentrations, is noted is limited and the concentrations are well below those observed in the outfall discharge water which would be presumably from the same source if significant downward groundwater migration was occurring.

Thus, if significant flow through the bottom of the pond into deep bedrock was occurring, higher concentrations, similar to those measured in outfall discharge water, would have been noted in the sampled groundwater.

If strong adsorption is occurring, the contrast in mercury concentrations between the groundwater in the shallow bedrock wells and the outfall discharge is an indication that the residence time in the Pond is very short and that the primary flow is in the pond fractures and alluvium discharging through the outfall.

E. Pond 6

If the objective of the RI is to characterize site geology and hydrogeology, why is Pond 6 not included in the characterization and discussion?

Response to Comment No. IE:

The Pond 6 geology and hydrogeology are similar to the Pond 5 systems in that Pond 6 is downstrike from Pond 5 and underlain by the same units. The ASAW in Pond 6 is essentially the same type of material as is in Pond 5. The First ROD identified the contaminant of concern to be Mercury and the primary flux to be from Pond 5. Measurements of mercury concentrations in Pond 6 outfall discharge indicates that, for the most part, concentrations are below detection limits and that Pond 6 is not appreciably contributing to the mercury loading of the NFHR. This is verified by the results of analytical sampling from monitoring wells MW-8 and MW-9.

As discussed in the OU-2 RI Report, a no action alternative is being considered for Pond 6 due to its apparent lack of impact on the NFHR.

F. Discussion and Conclusions (Section 3.9.4)

Several of the overall conclusions about the hydrology and hydrogeology of the Saltville site listed on page 3-98 are incorrect, or unsupported by the data.

1. Conclusion 1

Permeability and flow characteristics may be controlled by secondary porosity and permeability features in the bedrock, however, no information on the primary permeability of the bedrock is given to assess its magnitude. This statement is probably not true when applied to fill material. The overestimate of the role of fracture flow in the ASAW flow pattern was discussed previously. Almost all of the flow through the dike and out the decant structure is via saturated groundwater flow below the water table. It is unclear whether fractures extend to this depth in the fill near the decant structure, but it is known that fractures are concentrated in the west near the decant structure. (These fractures are probably caused by structural weakening of the ASAW due to drainage.) Where they are absent, they cannot expect to "control" permeability and flow

characteristics. Because the horizontal flow through the dike along the entire river front next to Pond 5, as well as downward flow in the southern two-thirds of the site is not taken into account, it is understandable that the importance of fracture flow is overestimated.

Response to Comment No. IF1:

A discussion of the relative difference between primary and secondary porosity in bedrock will be included in the revised RI report.

The major flow characteristics in bedrock flow regimes are generally controlled by structural features and discontinuities such as bedding planes, joints and fractures. Control of permeability and flow characteristics in fill is generally by changes in material hydraulic conductivity and the geometry and spatial extends of the materials in question. In the case of the dike materials and rock fill core, this maxim holds true. The ASAW; however, is a fractured low permeability material and the importance of fracture flow within the ASAW is not overestimated. The fracture porosity, due to the aperture size of the fractures has a strong effect on the flow characteristics within the pond. The largest and most pronounced fractures trend from the decant structure to the swales on Little Mountain, and a large fracture depression rings Pond 5. The fractures are consolidation features and are associated with past consolidation of the ASAW during placement (a similar fracture formed in a hydrometer jar during testing of ASAW in the laboratory under approximately 1-foot of water) and following the draining of the ponds in 1978. The fractures are thus endemic and not concentrated in just one area.

It should be recognized that the facility in question is a former waste pond and served as a water retention structure for over 65 years. Observations made in the field during the investigations for the RI indicated that significant blinding of the pond bottom had taken place due to the precipitation of a pozzolanic crust of solids on the surface of alluvium at the pond base and in dike drains at the toe of the Pond 5 dike. While it is assumed that some seepage has and is occurring through shallow fractured bedrock and the base of the dike and discharging to the NFHR, there is no apparent evidence, past or present, to suggest that this flow is of major consequence. No flow was observed from the Pond 5 dike drains during the RI investigations.

2. **Conclusion 4**

The first sentence is partially true - water level fluctuation is related to the duration and intensity of rainfall - but the response is subdued and delayed. The explanation that runoff and direct rainfall are quickly communicated out of the Pond system via the decant structure and that short precipitation events do not contribute substantially to groundwater level fluctuations is unfounded. This was discussed previously.

Response to Comment No. IF2:

Water level fluctuations within the pond are directly related to rainfall duration and intensity. The discharge response at the pond outfall is only subdued and delayed for short duration rainfall, or rainfall under dry antecedent conditions. The response is much more rapid for high intensity rainfall, or rainfall of longer duration following wet antecedent conditions. Since the majority of runoff generating events are in the latter category, Conclusion 4 is substantially correct.

3. Conclusion 5

In light of conclusion 5, it is surprising that the conceptual water balance model was not modified to attempt to quantify this flow.

Response to Comment No. IF3:

The conceptual water balance model was developed as a lumped parameter model due to a lack data available to define individual flows.

Conclusion 5 was intended to convey the fact that the point of discharge for flow in the Pond 5 system comprising ASAW and the underlying alluvium and shallow fractured bedrock, whether shallow seepage or outfall flow, is the NFHR. It is our opinion that the seepage quantity has been sufficiently identified to allow remedial decisions to be made. The results of the RI indicate that the migration of mercury from Pond 5 is to the NFHR. The primary source of mercury loading to the NFHR is the Pond 5 outfall. Minor loading by seepage through the dike and through the fractured bedrock beneath the dike is occurring. The relative quantity of this flow and very low mercury concentrations noted in the bedrock suggest that this flow is not of major consequence.

4. Conclusion 6

This is incorrect, first because it underestimates the important of precipitation falling on Pond 5 directly, and second because it falsely contends that precipitation flowing into surface fractures needs to exceed some "critical driving head" before it can infiltrate down to the water table.

Response to Comment No. IF4:

The conclusion will be rewritten. It was intended to reflect the effects upon the deep groundwater flow conditions due to precipitation on Pond 5 which are generally small. The discussion of critical driving head explains that when water backs up in the pond system such that a significant rise in head occurs (which can be rapid in the fracture system) the magnitude of the flow from the base of the pond into the underlying bedrock will increase. Because the residence time of water in the pond system is generally low, the buildup of such heads and attendant increase in downward flow is infrequent.

5. Conclusion 7

This conclusion is essentially correct, except that the authors apparently believe that the starter dike acts as a quasi-impermeable barrier, since they mention flow occurring only over and under it. Considering that it was constructed primarily out of blasted boulders and cobbles infilled with sand and some silt, and its conductivity was assumed to be 0.006 cm/sec during modeling, this is hard to understand. The earth blanket of crushed shale probably did not have a low permeability either, unless it was crushed to silt or clay size, which is unlikely. Pond dikes are designed to allow a controlled flow through them so that water levels in the dike do not build up and lead to collapse. Elsewhere in the document, water flowing over the internal starter dike is compared to a weir responding to surface flow. On page 3-12, it is stated that there are higher heads in the dike than outside of it. This indicates flow through the dike. Groundwater flows at some unquantified rate through the entire dike, including the starter dike and blanket.

Response to Comment No. IF5:

The starter dike is not believed to act as an impermeable barrier. The upstream shale blanket, constructed from the locally available earthy and plastic shales (Cooper, 1966) along the upstream side of the starter dike undoubtedly does function as a quasi-impermeable barrier. This type of construction is common to dam construction, and the condition and consistency of the shale following placement and grading is commonly that of a clay or silty clay.

Pond dikes are designed to control flow or seepage such that erosive forces do not develop within the structures. the Pond 5 dike has an innovative design for its date of construction (1925) in that it incorporates an impermeable core in the form of an upstream blanket, a truncated chimney drain in the form of the rockfill core, and drains discharging collected seepage from the rockfill core to the NFHR.

The discussions in the report relating heads in the dike and flow over the starter dike review the conditions noted above. groundwater in the pond is retained by the blinded pond base and the upstream shale blanket and when the levels rise above the elevation of the shale blanket, seepage occurs and discharges into the rockfill starter dike and is discharged by the dike drains.

Seepage does occur through the dike but undoubtedly at various rates. Rates through the upstream blanket will be very slow due to the fact that the local shales weather to illitic/chloritic clays. Rates through the slaker waste dike material will be variable and may be impeded by the zones of increased cementation. The rockfill starter dike will transmit water quickly, given a source.

6. Conclusion 8

This is incorrect on several counts, as discussed in detail previously. There is a definite interconnection between the fill and the bedrock. Flow patterns should not be confused with interconnection. There is clearly some downward flow.

Response to Comment No. IF6:

Interconnection was not stated to be nonexistent, but limited. There are no data to support high flow quantities from the base of the pond to the bedrock. There is a definite interconnection between the ASAW and the bedrock, but this interconnection is not as preferred a flowpath as the alluvium/fracture/outfall or fracture/outfall flowpaths. The upper bedrock comprising a fractured and weathered zone is considered the lower limit of the pond system, and the pond system drains to the NFHR.

7. Conclusion 9

This is not correct in light of the presence of mercury in at least three of the deeper bedrock wells, albeit at low levels. Mercury clearly has migrated to the bedrock to some degree, based on the available data. These concentrations are assumed to be validated, and therefore represent actual site conditions.

Response to Comment No. IF7:

This will be rewritten to indicate that only minor mercury migration has occurred due to limited seepage of Pond water into shallow fractured bedrock.

Comment No. II

Additional Detailed Comments

1. **The symbol on the thrust fault in Figure 2.2 is backwards. See Figure 3-17.**

Response to Comment No. II1:

The tick marks on the thrust fault line are on the wrong side of the line and will be corrected.

2. **Page 3-8, third paragraph: temperature symbol typo.**

Response to Comment No. II2:

The typos will be corrected.

3. **The term "head driven" on page 3-9 needs clarification.**

Response to Comment No. II3:

The term head driven will be clarified.

4. **Page 3-11, second paragraph: Extent and depth of fracturing have not been characterized thoroughly, therefore this horizontal fracture flow is questionable. Is this horizontal flow in fractures above the water table?**

Response to Comment No. II4:

The fractures have been observed to form underwater, are consolidation features and are assumed to be endemic to the pond and extend to the full depth of the ASAW. Flow is assumed to extend to the full depth of the fractures.
Most of the time, the water table is somewhere in the fractures. It is probable that the fracture aperture varies with elevation. Slow response to light rain suggests that the aperture is small; rapid response to hard rain suggests a rise in water levels to elevations where fractures are more open.

5. **A more complete explanation of the decant structure would make the flow data at the top of page 3-18 easier to follow.**

Response to Comment No. II5:

A more detailed explanation will be provided.

6. **The fraction of flow out the decant structure needs to be reassessed before the statement at the bottom of page 3-20 can be made.**

Response to Comment No. II6:

The statement is based on over one year continuous inlet and outlet data from the decant structure and evaluation of the site hydrogeologic and hydrologic systems.

7. **Page 3-22. If the soils (i.e., alluvium) underlying the ASAW are locally discontinuous, how can they achieve rapid transmission and carry the "preferential" flow mentioned elsewhere?**

Response to Comment No. II7:

They are discontinuous in the valley floor in that they do not cover the entire cross section. The alluvium is concentrated around the former NFHR River channel and is continuous from one end of the pond to the other in a narrow band.

8. **The "fractured sponge" model on page 3-23 is flawed by the overestimate of the importance of fracture flow. It is assumed that a substantial amount of rainfall flows directly to the outfall structure through the fractures. This claim is unsubstantiated.**

Response to Comment No. II8:

In the instance of the ASAW within Pond 5, the importance of fracture flow cannot be overemphasized. The fractures have been observed to form underwater, and thus can be assumed to extend to the full depth of the pond. The apertures of the fractures range from several millimeters to one meter and the persistence of the fractures is up to hundreds of meters. The fractures are endemic to the ASAW material and are distributed throughout the ponds.

The assumption that a substantial amount of rainfall flows directly to the outfall structure through the fractures is based on field observations made in the course of the RI investigations, and experience in-situ treatment studies conducted at site (refer to Appendix F of the Previous Data Summary Report, Milestone Report No.1). The fractures are dynamic and have formed as a result of consolidation of the ASAW under its own weight during deposition, and as a result of effective stress changes induced by draining the pond in 1978.

9. **In light of earlier discussions, the degree of confidence in Pond 5 flow estimates is clearly unjustified (page 3-25, 3-30).**

Response to Comment No. II9:

The high correlation between observed behavior and behavior predicted by the fractured sponge conceptual model supports our confidence in the magnitude of flows in the Pond 5 system. A daily water balance model does not attempt to predict flows to any degree finer than order of magnitude, and serves to focus attention on the flows or the unknowns with the greatest significance. The fractured sponge model has highlighted the unknown flow paths at the decant structure under high flows, and in the western diversion ditch at all times. The potential magnitudes of these flows have helped focus the attention of mercury fate and transport modelling, have highlighted the high risk flow paths to the NFHR, and have shown the relative significance of vertical groundwater discharge as a mercury contaminant pathway to be relatively minor.

10. The use of Little Mountain stream flow as a sole groundwater volume inflow is unrealistic (page 3-29).

Response to Comment No. II10:

This flow together with the measured groundwater flow discharge from Swale 5 were used to estimate volume inflow from each swale. The decision to use this volume as inflow was predicated on the presence of an aquitard in the Price-Parrot Formation at a shallow depth, the loss of all of the stream flow into open bedding planes and fractures below the flume and above the runoff catch basin for the Western diversion Ditch, and the similarity of the surface flow lost in Swale 3 and the Groundwater discharge at the edge of Pond 5 from Swale 5. Based on these observations and the previous discussion regarding the limits of inflow possible to bedrock in the bedding planes and fractures, we do not feel the inflow volumes are unrealistic.

11. If the culvert is inundated at 405 gpm, then flow rates are either higher above this level, if flow is unrestricted, or below it, if the system backs up (page 3-30).

Response to Comment No. II11:

This is correct.

12. The assumption of a direct correlation of peak precipitation and peak discharge is likely to be a poor one (page 3-31).

Response to Comment No. II12:

This assumption was made only to test the conceptual model and the "best fit" assumptions that most closely attain a zero balance. The result of this test was to demonstrate that the corresponding outflow stage required to support the hypothesis was obscured by NFHR inundation, denying the test a satisfactory resolution.

13. **The "only remaining explanation" referred to in Section 3.5.5.7 on page 3-32 suggests that the authors quantified, then came up with a conceptual model, rather than the other way around.**

Response to Comment No. II13:

The choice of wording on page 3-32 is misleading and will be replaced with more precise text. The conceptual model was derived first, together with identification of readily quantifiable parameters. Remaining unknowns were addressed and estimated based on site observations and review of measured values and responses to precipitation events.

14. **Page 3-33, last paragraph: A rainfall-runoff model cannot be expected to predict the behavior of a groundwater flow system. It is not designed to do so.**

Response to Comment No. II14:

The distinction between non-Pond 5 groundwater systems and the local system of subsurface flow within Pond 5 is difficult to convey. It should be recognized that the Pond functioned as a water retaining structure for over 65 years with no record of having suffered high water losses to groundwater or bedrock beneath the pond. In this instance, when describing the system within the pond, a rainfall-runoff model is appropriate to describe the behavior observed because the system replicates a reservoir that is hydrologically controlled.

15. **Infiltration is not limited to cases in which the "maximum soil storage capacity" is two inches of rainfall, as stated on page 3-34. This needs clarification. The "trigger point" discussion on page 3-35 is unrealistic.**

Response to Comment No. II15:

As discussed under IA3, the trigger point is quite realistic, representing the bimodal behavior of the system: slow under light rain, fast under heavy rain or following wet antecedent conditions where the lower, narrow aperture portions of the fractures are filled with water, allowing water to build up in upper elevations where apertures are open.

In addition, increased porous media flow occurs when the surface soil suction is satisfied and saturated flow begins to dominate over unsaturated flow. But first, vegetal storage must be satisfied, and rain must fall hard enough to generate sheet flow directly into fractures: hence, the 2-inch trigger point.

16. Page 3-37, second paragraph. The observation that outflows are accounted for without "relying on" losses by groundwater seepage shows that the conceptual model is extremely unrealistic.

Response to Comment No. II16:

As discussed previously, the conceptual model was developed based on field observations of flow and records of precipitation and outfall discharge. The least measurable, and hence quantifiable, are subsurface pond inflow which was estimated to equal the base interflow from swales (determined from measurement of flow in Swale 3), and subsurface outflow in the form of seepage through shallow fractured bedrock and the pond dike into the NFHR. While no balance can be expected to have perfect resolution, the water balance for Pond 5 replicates the observed flow behavior well. That the former water retention structure would largely behave as a reservoir system is not surprising. The difference between the "perfect" balance and the balance presented in the RI probably reflects the presence of seepage which comprises a small component of the overall water balance.

17. Page 3-37, last paragraph. The syncline is not recumbent. Its dip is 30 degrees.

Response to Comment No. II17:

The Greendale Syncline is, in the area of the project, recumbent. Please refer to Figure 14 of the Work Plan taken from a paper by B.N.Cooper (1966).

18. The geology discussion is well-written and thorough.

Response to Comment No. II18:

No Response Necessary

19. It is untrue that upward flow is a result of "decreased pressures in the upper portions of the flow system caused by reduced recharge to the upper bedrock". (page 3-63).

Response to Comment No. II19:

The upward gradient is due to the presence of a confining layer comprising a relatively unfractured sandstone bed. Beneath this layer, artesian conditions have been measured. The layer is considered to be continuous by virtue of the fact that the artesian conditions were noted in MW-1 and P-1 which are located in Swales 2 and 4, respectively. The text of the report will be modified to reflect this.

20. How can water contents be 100 to over 200 percent of dry weight?

Response to Comment No. II20:

Water content in the Unified Soil Classification System is expressed as a percentage of the dry weight of the solids. In soils where the specific gravity of the solids is low, or in soils where the void ratio is high, and hence the weight of solids is low, water contents in excess of 100 percent can occur. In the case of the ASAW, the dry unit weight of some samples was low enough to yield water contents in excess of 100 percent.

21. The last sentence on page 3-87 may be true, but the concentration/flow rate relationship has not been characterized by the RI work to date.

Response to Comment No. II21:

The contrast in mercury concentrations in groundwater samples from shallow, intermediate and deep monitoring wells and the mercury concentrations of outfall discharge samples supports the sentence which reads "The Pond 5 outfall discharge, rather than groundwater flow appears to be the most significant source of mercury discharge from the site".

22. Page 3-88, third paragraph, second line: "trending" not "trenching".

Response to Comment No. II22:

This typographical error will be corrected.

23. **It is stated on page 3-92 that groundwater is forced upward into the alluvium north of the barrier and flows back down into the bedrock south of the barrier; therefore, why is it a major conclusion of the RI that there is essentially no downward flow?**

Response to Comment No. II23:

The RI concluded that downward flow is limited to a zone of shallow fractured bedrock directly beneath the Pond. This flow is inhibited by blinding of the pond base by calcium precipitation and a transmissive layer of alluvium that discharges to the decant structure.

Comment No. III

Nature and Extent of Contamination

A. **There appears to be little data on the concentration of mercury in groundwater in the waste material. Well MW-7S appears to be the only well screened in the fill. This well contained 0 to 0.5 ppb of mercury during sampling rounds in 1990 and 1991. Greater concentrations of mercury were found in some shallow wells screened at the base of the fill and the top of the bedrock, as shown in Figure 3-8. Concentrations of mercury were generally very low or below detection limits in deeper bedrock wells. Because of the lack of mercury concentrations in the fill; however, it is difficult to draw strong conclusions about overall mercury transport in the saturated zone.**

Response to Comment No. IIIA:

The presence of mercury in the outfall discharge that is drained from the saturated and unsaturated zones within the Pond, and lack of similar concentrations in the bedrock strongly suggest that the primary transport is through the outfall, and that flow downward into deep bedrock is insignificant.

B. **Analysis of the ASAW materials has shown mercury to be present at parts-per-million levels in the unsaturated zone. This leads one to questions the partitioning characteristics of mercury between the ASAW and the groundwater. It would be advisable to obtain more groundwater samples from different locations within Pond 5. Also it is recommended that partitioning tests be run with the ASAW using rain water to see what leaching potential the mercury has in these waste materials.**

Response to Comment No. IIIB:

We are unable to understand the purpose of the recommended partitioning testing. Partitioning testing has been conducted in the past using potable water from the Town of Saltville water supply. The results of the testing are presented in an appendix to the Previous Data Summary Report. To date, the best data regarding mercury uptake by rainfall and groundwater have been considered to be the outfall discharge data which correlate to the mercury loading of the NFHR by Pond 5.

Comment No. IV

Mercury Fate and Transport

The hydrogeologic data presented does not eliminate downward flow into the bedrock. Mercury compounds are known to be quite soluble in oxidizing environments (EPRI, 1984, EA-3356), but their solubility drops off substantially under reducing conditions. The redox potential and other geochemical characteristics of either the saturated or unsaturated zones are not available, however, the pond was created by a chemical waste stream so there is a possibility that conditions are reducing. If so, mercury compounds would be expected to precipitate out and not have a significant presence in the saturated zone, particularly at depth. The geochemical fate of mercury needs to be examined closely before the "lack" of mercury in the bedrock (which is not supported fully by the analytical data) can be used to infer anything about downward flow. Certainly, the statement that downward flow "does not exist" is not proven by mercury concentrations. The existence of some downward flow can be proven on several counts.

Response to Comment No. IV:

If a redox boundary exists at the base of the pond or the bedrock the likelihood is that mercury does not pass the boundary. As such, the presence of such a boundary would tend to inhibit transport of mercury via groundwater in the bedrock. Some downward flow is anticipated, however the lack of significant concentrations of mercury in groundwater samples taken from intermediate and deep bedrock wells suggests that the migration of mercury is preferentially through the upper fractured rock zone of the pond flow system and discharging to the NFHR. There is no apparent evidence that suggests the migration of mercury into the deep bedrock flow system.

Comment No. V:

Baseline Risk Assessment

EPA has already submitted specific comments to the Public Health Risk Assessment for OUs 2 and 3 for Saltville and their comments will not be repeated. These comments are supplemental to EPA's comments.

One general comment is that the document could incorporate several recent guidance documents and advances in analytical technology, particularly if there will be continuing studies at the site. The exposure assumptions should be based on the values in OSWER Directive 9285.6-03, March 1991, *Human Health Evaluation Manual, Supplemental Guidance:* "Standard Default Exposure Factors." This guidance suggests using 54 gm for the daily intake rate for fish consumption rather than the 17 gm/day used in the report. Since consumption rate and risk are directly related, this will increase the risk from eating fish by a factor of 3.

The default value for the permeability constant for mercury is $1x10^{-3}$ cm/hr according to the new guidance document for dermal absorption *Interim Guidance for Dermal Exposure Assessment* (personnel communication, John Schaum, EPA-final to be released shortly) rather than the default value for water used in the report. This will increase the risk calculated from dermal exposure to mercury contaminated water by 25 percent.

On page 6-17 of the report there is a discussion of Sediment Quality Criteria (SQCs) or the concentration in sediment that will not produce a concentration in water that exceeds the ambient water quality criteria. A recent EPA Science Advisory Board report entitled "Evaluation of the Equilibrium Partitioning Approach for Assessing Sediment Quality" (EPA-SAB-EPEC-90-006, Feb., 1990) states that there is potentially a large amount of uncertainty in this approach and recommends that a more sophisticated uncertainty analysis be carried out to set limits/bounds on it applicability. This report may influence the acceptance of the "non-polluted threshold value" of 0.8 mg/kg developed by EPA for mercury in sediment or the "contamination index" of 0.3 ug/kg established by the Commonwealth of Virginia for total mercury in freshwater sediment.

The noncarcinogenic toxicity value (RfD) is the same for inorganic mercury and methyl mercury. This implies that total mercury values can be used for risk characterization rather than separating inorganic and methyl mercury fractions. It might be more practical to use an analytical method for total mercury rather than one for methyl mercury and one for total mercury. Also, it appears that the Bloom method is more appropriate (greater sensitivity, precision, and accuracy) than the methods used in the report.

Response to Comment No. V:

The findings of the Draft Risk Assessment were included in the RI before EPA comments had been received. The Final RI report will incorporate the findings of the EPA approved RA.

Comment No. VI:

Ecological Risk Assessment

The draft RI report has referenced the ABB-Environmental Services Inc. *Risk Assessment Report for Saltville Waste Disposal Site, Saltville, Virginia-Draft Report,* July 1991 and included it as Attachment Q. Section 6.2.2 is essentially taken verbatim from the ABB report.

The comments presented on the draft ABB report in our November 26, 1991 memo to Mr. Gene Wingert/EPA and those presented by Mr. Wingert in his letter of Notice of Deficiencies to Mr. Keith D. Roberts at Olin Chemicals dated January 8, 1992 were not addressed in the draft RI report. It is recommended that deficiencies which exist in the Ecological Risk Assessment be addressed.

Response to Comment No. VI:

See Response to Comment V

Comment No. VII:

Memo from USEPA dated 3/12/92

A. Contaminants of Concern

On page 1-3 one of the stated objectives for identification of contaminants of concern but the assessment focuses almost exclusively on mercury, mentioning others only incidentally. In addition, the document fails to adequately address other contaminants from past or present discharges.

Response to Comment No. VIIA:

Additional metals data will be supplied in the revised RI Report.

B. Ground Water

1. **On pages 3-86 and 87, a quarterly ground water sampling for organics and pesticides is discussed. No metals other than mercury appear to have been analyzed. It is our recollection that other metals may be associated with the site and should have been included. If this is incorrect, please inform us. However, chloroform and tetrachloroethane were detected and these as well as other organic contaminants are vaguely described as being "largely not present" or "in extremely low concentrations". This ground water discharges to the North Fork of the Holston River but this discussion does not include a comparison of these discharge concentrations to surface AWQC.**

Response to Comment No. VIIB1:

The first round of sample analyses for groundwater samples included VOAs, SVOAs and RCRA metals. Analyses of the outfall discharge includes analysis for metals. The chloroform and tetrachloroethane concentrations reported are considered to be laboratory artifacts.

2. **On page 4-1, the document states that TCL/TAL substances were analyzed but no data is presented or discussed. The investigator should clearly identify and discuss the chemical characterization of ground water as well as discharges from the ponds.**

Response to Comment No. VIIB2:

An expanded discussion and data presentation will be included.

3. **Surface Water**

On page 6-22, it is stated that elevated chloride levels may be affecting the resources but this is not adequately discussed. Specifically, we are concerned whether this is due to salinity or to some other causative agent. We suggest you have the investigator define the ecological risk of this discharge and to detail plans for remediating the problem.

Response to Comment No. VIIB3:

A discussion of the ecological risk of elevated chloride levels is presented in the OU-3 RI Report.

4. **Impacts**

On page 6-16, it is stated that pH and TDS may be causing impacts but it fails to discuss the topic.

On page 6-22, the document states that fish may be affected by the discharge of mercury but that mussels are adequately protected. This statement is not supported by the literature and does not take into consideration sensitive larval and juvenile forms. The state seems especially misleading in view of the bioassay work that shows effluent from Pond 5 is toxic (see page 6-20) and exceeds AWQC for mercury (see page 6-18).

The conclusion on page 6-23 that only slight adverse effects be site related contamination is a contradiction in are view to the bioassay results and to the historical information that describes the elimination of mussels from below the discharge. It is our view that a loss of mussel habitat is a direct result of discharges from the site.

Response to Comment No. VIIB4:

The concerns raised by these comments are addressed in detail in the OU-3 RI Report and in the Risk Assessment. Following EPA review of these documents the conclusions will be amended as necessary to reflect the final findings with regard to these issues.

5. **Recommendations**

On page 7-5 the document recommends that additional remedial technologies be evaluated to reduce effluent flow from Pond 5. It has been demonstrated that the effluent is toxic and exceeds criteria for mercury. In addition to reducing flow, the effluent should be treated to non-toxic levels and to levels below criteria concentrations for all toxic constituents.

The conclusions described on page 7-5 are based upon the RA which was rejected by the BTAG. We recommend that the conclusions be delayed until the risk assessment is fully revised and found to be acceptable.

Response to Comment No. VIIB5:

A correlation between discharge and mercury concentration has been noted in the RI. If discharge is reduced, and subsequent concentrations are reduced the need for treatment may be eliminated. This will depend on the reduction in concentration and total mercury loading of the NFHR relative to ARAR target criteria. Refer to Response V regarding the RA.

6. Conclusion

In much of the report neither AWQC nor other ecological endpoints are used in addressing environmental concerns. The document takes refuge in vague generalities by implying that, while problems may exist, they are not attributable to the site. No hard statistical evidence is offered to substantiate these claims. Both AWQC and toxicity data are available (and if toxicity data is unavailable, it can be easily retrieved either through literature searches or alternatively through bioassays) and should be used to form the bases for conclusions. The previously reviewed ecological risk assessment should be revised in light of previous BTAG comments prior to submitting this document for further review.

Response to Comment No. VIIB6:

Refer to Response to Comment V.

Comment No. VIII

Memo from USEPA Dated 3/9/92

A. Section 2.7 Ground-Water Investigations

1. Although the conceptual hydrogeologic model presented in Figure 2-11 hypothesizes the existence of a deep flow system, the geologic and hydrogeologic data that were collected before and during the RI have provided little information to examine the validity of this system. A comparison of the vertical scale for the conceptual model and the interpretive subsurface profiles shown in Figures 2-8 through 2-10 shows that few borings extend below an elevation of 1600 feet. The conceptual model in Figure 2-11 seems to extend to nearly 2500 feet, as well as to the other side of the NFHR. Please discuss the data that have been collected to support the conceptual model in these areas.

Response to Comment No. VIIIA1:

The conceptual model was developed for illustrative purposes and was extended beyond the area of interest to no flow boundaries. These boundaries include deep bedrock, the Little Mountain Divide and the Saltville Trust. As these features have no effect on the behavior on the system of interest, their detailed characterization is not warranted. Deep geologic data have been developed by mining companies in the areas around Plasterco, Saltville and Broady Bottom. These data are discussed in the literature (Cooper, 1966) and increase the understanding of the site. Because of the economic value of the minerals mined in the area, extensive field mapping and exploratory drilling have been conducted in the area. These data were reviewed and used to develop the interpretive model at depth.

B. Section 3.0 Physical Characteristics of the Study Area

1. **It is suggested that a brief section be added to discuss the water supply source for the 91 residences near the site that are mentioned in Section 3.1.2. Section 6.1.1.2 notes that nearby residences are on a municipal water supply, but the source of that supply is not discussed.**

Response to Comment No. VIIIB1:

This is discussed in the RA, and a discussion of the water system will be added to Section 3.

2. **Although the interpretive subsurface profiles presented in Section 2 are useful, it is suggested that several cross-sections be included to augment the hydrogeologic discussion. These cross-sections should show all borings along the profile and the geology, but more importantly, monitoring wells, screened interval and water levels, so that the sections may be compared with Figure 2-11.**

Response to Comment No. VIIIB2:

The boreholes are shown on the cross sections. The lithologies were developed on the profiles based on the borehole data. The profiles are intended to show the degree of coverage and agreement with the measured geologic section, and agree with Figure 2-11. Additional sections can be added to enhance the clarity of the hydrogeologic discussion.

C. Section 3.8 Numerical Modeling of Ground-Water Flow

1. **Please state the method used to analyze the numerical accuracy of the finite element grid.**

Response to Comment No. VIIIC1:

The finite element grid was developed following careful geometrical layout procedures. Transitions in element dimensions were kept gradual in order to ensure numerical stability and model convergence. The model, as outlined in the Work Plan, was intended to enhance and verify the conceptual model and was not intended for use as a quantitative tool. This approach was considered appropriate for the RI report. The model has subsequently been refined to focus on the area of interest and is being used as a predictive tool in screening and evaluating potential remedial measures for the Feasibility Study.

2. **Regarding Table 3-22 and model calibration, please show the accuracy of measured and simulated water levels to the same accuracy of measured and simulated water levels to the same significant digit. Please compare simulated water levels to the midpoint of the minimum and maximum water level at each monitoring well. Please show the residual mean and standard deviation of residuals. Note that deviations in Table 3-22 are not computed correctly (see wells W-2 and P-28, for example).**

Response to Comment No. VIIIC2:

The comments and corrections noted above will be incorporated in the final RI Report.

3. **Given the limited number of monitoring locations used as calibration nodes and the uncertainties that remain regarding the conceptual model, the modeling effort should include sensitivity and uncertainty analyses. The sensitivity analysis should document the sensitivity of simulated water levels to changes in recharge and hydraulic conductivity. For the uncertainty analysis, it is suggested that alternative solutions to the steady-state model be generated by varying the recharge within a reasonable range and uniformly adjusting hydraulic conductivities by the same percentage. Then, if the model is used to evaluate potential remedial actions, each action may be simulated with the alternative model configurations in an attempt to quantify the impact of hydrogeologic uncertainty upon the predicted effectiveness of each action.**

Response to Comment No. VIIIC3:

The model's purpose, as outlined in the Work Plan, was to provide a qualitative tool for enhancing and verifying the conceptual model. The level of detail provided in the model for the RI was considered appropriate in that it enhanced the understanding of the site flow systems and provided sufficient information to identify possible remedial alternatives.

The model has been subsequently refined as part of the FS to allow screening and evaluation of potential remedial alternatives. It is anticipated that remedial design will involve further model refinement so that final remedial design can be optimized.

D. Section 3.9 Site Conceptual Ground-Water Flow Model

1. **Although the hypothesis of the conceptual model is that ground water flows from the bedrock to the pond and/or the NFHR, point (10 at the top of page 3-94 and point (20 at the bottom of page 3-96 both imply that data are not sufficient (i.e., wells are not deep enough) to prove this hypothesis. Given that hydrologic data that were collected for the RI are inconclusive with respect to the hydraulic connection between the pond and bedrock, statements throughout Section 3.0 should be revised to indicate that the apparent lack of connection is based solely on limited vertical migration of mercury in ground water.**

Response to Comment No. VIIID1:

The conclusion is based on the site water budget for the Pond System, observations of pond base blinding, and the lack of significant mercury migration into the bedrock.

2. **Conclusion (6) on page 3-98 seems to underestimate the importance of direct precipitation to recharge the pond and bedrock system. Please revise to agree with the conclusion of the water balance.**

Response to Comment No. VIIID2:

The conclusion will be revised to reflect the effect of direct precipitation on recharge of the pond flow system. The bedrock system, with the exception of the shallow fractured bedrock zone below the pond which is considered part of the pond system, is affected more by recharge from infiltration on Little Mountain and adjacent bedrock than by direct precipitation on the ponds.

E. Section 4.0 Nature and Extent of Contamination

1. **Section 4.2.1 presents a summary of mercury concentrations that were detected in soil samples collected at the FCPS as part of a 1981 geohydrologic study, but a summary of mercury concentrations detected in ground water at this location is not presented. Please include.**

Response to Comment No. VIIIE1:

A summary of mercury concentrations is groundwater will be included in the RI report.

C:6174\RESPCOM1

APPENDIX F-3

RESPONSE TO USEPA AND VDEQ COMMENTS ON THE

DRAFT RISK ASSESSMENT

AUGUST 27, 1993

FILE COPY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
841 Chestnut Building
Philadelphia, Pennsylvania 19107-4431

RECEIVED
AUG 30 1993
KEITH ROBERTS

Mr. Keith Roberts
Principal Environmental Specialist
Olin Chemicals
P.O. Box 248
Lower River Road
Charleston, TN 37310

AUG 27 1993

Re: Notice of Deficiencies; Review of Remedial Investigation Report and Risk Assessment Report for Operable Unit 2, Saltville Waste Disposal Superfund Site

Dear Mr. Roberts:

Attached are the comments for the Operable Unit 2 (OU2) revised Remedial Investigation (RI) Report and Risk Assessment Report. Due to the extent of the comments to these documents EPA will not approve the RI or Risk Assessment as submitted. Please note that the Risk Assessment comments pertain only to the OU2 Public Health Risk Assessment.

EPA believes there are still significant data gaps in the documents. The Former Chlorine Plant Site and Pond 6 are insufficiently addressed. Furthermore, there is an issue regarding the presence of other contaminants. Maximum Contaminant Levels are exceeded for several inorganic constituents and one organic constituent. These issues are detailed in the enclosed comments.

It remains EPA's goal to issue a Record of Decision for OU2 later this fall. In light of this, and pursuant to Section VI.D of the Consent Decree, Olin is required to submit a revised OU2 Remedial Investigation Report and Risk Assessment Report within twenty-four (24) days of receipt of this Notice of Deficiencies. Should you have any questions regarding the review comments please contact me at (215) 597-9023.

Sincerely,

Russell H. Fish
Remedial Project Manager
VA/WV Superfund Remedial Section

cc: Gwen Pospisil, 3RC23
Jeffrey Howard, VDEQ
Julie Pfeffer, CH2M Hill
Saltville File

AR303786

OU-2 REMEDIAL INVESTIGATION REVIEW COMMENTS
SALTVILLE WASTE DISPOSAL PONDS SUPERFUND SITE

1. ES-3. The first full sentence on this page states that the ponds were operated only for the containment of ASAW. Pond 5 was also used to precipitate mercury wastes from wastewaters. The sentence should be revised to reflect this.

2. ES-6. Mention is made here, and in many other places throughout the RI report, of the "cap" that was constructed over the former chlorine plant site after the burial of the dredged river sediments. More information is required regarding the construction and maintenance of this cap. Construction diagrams should be provided along with information regarding design of the cap and the construction practices employed (e.g., lift sequencing, materials testing). The final hydraulic conductivity of the cap should be given. A great deal of emphasis is being placed ont the cap's ability to prevent infiltration and further migration of mercury from the site. In order to accept the supposition that the cap at the former chlorine plant site is adequate for protection of human health and the environment, much more information is required. (As requested during the site visit of 7/29/93, please include a set of as-built drawings with this documentation).

3. ES-16. The first paragraph on this page states that discharge from Pond 5 occurs "to a lesser extent as seepage through the dike". This statement contradicts later statements that there is no loss of mercury through the dike or into the ground water beneath Pond 5.

4. The statement in the second paragraph regarding the reduction in mercury loading of ground water at the Former Chlorine Plant Site is not conclusively supported by the data submitted by Olin In Appendix Q. While mercury concentrations have been reduced somewhat in most wells it is not clear if the reduction is statistically significant. In addition, Well 12 shows an increase in mercury concentration since capping.

5. ES-26. Only one well was installed in Pond 6. Insufficient information exists to discuss the extent of mercury contamination in the ground water beneath Pond 6.

6. ES-26. There is no discussion here or anywhere else in the RI report regarding the extreme alkalinity of the discharge from Pond 6 and its potential impact on human health or the environment. This is a significant deficiency in the RI.

7. ES-28. The section on fate and transport of mercury ignores both the Former Chlorine Plant Site and Pond 6 without

sufficient justification. There is mercury in Pond 6 as demonstrated by the soil borings taken, but the outfall is assumed to be the only possible transport route for the mercury in Pond 6 outfall . The conclusion that the absence of mercury in the Pond 6 outfall demonstrates that mercury in Pond 6 is immobile is not adequately supported by the evidence. One ground water monitoring well within Pond 6 and screened in construction debris does not demonstrate that mercury is not in the ground water.

8. p. 1-8. The first paragraph on this page states that overflow from Pond 5 into Pond 6 was "either rare or may never have occurred". If this is accurate, how did the mercury get into Pond 6? The boring logs taken in Pond 6 all showed the presence of mercury. As the pond reportedly never received mercury cell plant waste and may never have received Pond 5 overflow, there is no apparent source for the mercury.

9. Section 1.2.3 refers to the decant structure and the fact that the "north side of the shaft is open, with guide slots on the inlet sides for the positioning of stoplogs..." Please revise Figure 1-5 to show that the north side is open (or covered with a steel grate and the approximate location of guide slots. Also, please define "stoplogs."

10. p. 1-10. The description of sediment dredging does not match the description in the FS report. Were different size particles separated and one size placed entirely within the liner and capped, and the other size capped? Please add to the RI description if so.

11. p. 2-2. One of the stated investigation objectives was the understanding of the hydrogeology of the <u>ponds</u>. However, no discussion of the hydrology or geology of Pond 6 is included in this section of the RI report. One well in Pond 6 is not sufficient to describe the ground water system recharge and discharge relationships beneath Pond 6.

12. p. 2-4, Section 2.3.1.1. TVA Tipping Bucket Rain Gauge Section. The section describes a rain gauge at the Saltville WWTP that is read daily and apparently recorded by hand. This does not sound like a typical tipping bucket rain gauge, which would provide continuous automatically recorded data. Please clarify.

13. p. 2-12, Section 2.5.2. Please include a discussion of any borings or other geotechnical work in Pond 6 and FCPS.

14. Page 3-4 refers to a french drain system (blanket drain) and an upstream impervious soil blanket that were incorporated in the design of the Pond 5 dike, yet the six materials that were encountered in the nine dike borings did not include "blanket drain" or "impervious soil blanket." Thus, does

the blanket drain simply mean that coarser material was used at the bottom of the starter dike? Are the locations for the upstream blanket on cross-sections 1-1′ and 5-5′ shown because they were included in the 1958 Chas. T. Main design, and not because they were indicated in any dike boring? Please clarify the dike design and actual dike conditions. Perhaps the third paragraph of Section 4.2.2.3, which mentions a crushed shale low permeability facing (shown on old drawings) and a "system of drains," should be moved or repeated in Section 3.1.4.

15. Page 3-17 refers to the fact that water levels in dike borings were significantly lower than those measured in the Pond 5 borings, and then references Figure 3-10. However, aren't the water levels shown of Figure 3-10 and labeled "existing phreatic surface" and "flooded condition phreatic surface" taken from the 1958 Chas. T. Main report? Please clarify.

16. p. 3-17, Groundwater Section. There is reference to French drains beneath the dike, yet they are not shown on figures. Please elaborate on where they are located, what their function is (was), and what significance they may have on current groundwater flow conditions.

17. Section 5. Enhance figures and discussion in this section to include the FCPS. In general, this section is very light on groundwater discussion for the FCPS. <u>There have been no conclusions made prior to the RI that groundwater at the FCPS is not an issue.</u>

18. Section 5. The issue of a permeability contrast between the pond alluvium, shallow bedrock, and deep bedrock as a reason for insignificant hydraulic communication between the pond and the bedrock (page 5-43), and as a finding of the hydrogeologic investigation (page 5-46) is still troubling. In these cases, the two order-of-magnitude difference between the mean hydraulic conductivity of the pond alluvium and that of the deep bedrock is described as a reason for preferential flow within the alluvial sediments and as a "distinct contrast," whereas a one order-of-magnitude difference between the slug test and packer test at MW-1S is "not considered to be of major significance" (page 5-9). It may be preferable to simply delete these discussions of an apparent permeability contrast from section 5.6.1 and 5.6.4.

19. p. 5-1, Section 5.1. Please include discussion of other areas of the site. If the section is not labeled as specific to Pond 5, please discuss the issue also for Pond 6 and FCPS, as appropriate.

20. p. 5-9. It is stated that the bedrock flow system appears to be strongly controlled by fractures and partings oriented in the direction of the bedding, which dip approximately 30

degrees across the site. Thus, because of the dip of the bedrock strata beneath the site relative to the orientation of the boreholes and test wells, the hydraulic conductivity values may or may not represent actual maximum values of horizontal permeability. It is apparent from this statement that the hydrogeology of the area is not well understood. The flow of groundwater is very complicated due to the presence of fractures and blasting activities. Fracturing and blasting has created secondary permeability that will be difficult to predict.

21. p. 5-12. The statement in the first paragraph on this page regarding recharging of the bedrock aquifer through precipitation falling on Pond 5 contradicts the statement made in the document that the pond does not influence ground water.

22. p. 5-28. While the statement made in paragraph 2, that very little water must actually infiltrate immediately to significant depths following isolated storm events may be correct, one cannot use this statement to conclude that there is not infiltration and migration of water (and contaminant) into the shallow and upper bedrock aquifers.

23. p. 5-30. The first paragraph on this page appears to contradict the contention that there is no seepage through the Pond 5 dike.

24. p. 5-33. Why was the model not run for the FCPS? The groundwater conceptual model in the FCPS is relevant to this RI report.

25. p. 5-37. Since the bedrock dips at 30 degrees in the area, and the ground water flow is thought to be vertical in the in the area, then the ground water should have a vertical component in the alluvium also. Since the alluvium at the site is probably due to the weathering of the bedrock, then some of the structure of the alluvium should mimic the overall structure of the bedrock in the area. Quantification of vertical flow within the alluvium should be attempted. It can then be concluded whether it is a significant factor.

26. p. 5-39. Items 2, 3, and 4 are qualitative judgements that are not supported by any analytical data. Faulting, bedding dips, fracturing, and blasting may all lead to vertical communication and migration of contaminants. This possibility has been prematurely discarded.

27. p. 5-40 states that tetrachloroethene is often found in small concentrations in chlorinated municipal water supplies, or that past chlorine production might account for the presence of chloroform and tetrachloroethene. Neither statement provides a sufficient explanation to exclude these

contaminants from further discussion.

Because past chlorine production at the plant may explain the presence of chloroform and tetrachloroethene in the groundwater, these constituents are important and must be included in further discussions. The report may not exclude further discussions on the basis that they were possibly caused by the plant.

28. p. 5-41. Contrary to the conclusions on this page, the presence of metals both in the groundwater and in both pond discharges above MCLs and, more importantly, ambient water quality criteria (AWQC), makes other metals besides Hg contaminants of the site. Further discussions regarding background concentrations, fate and transport (including discussing filtered versus unfiltered results), and risk must be included in the RI report and risk assessment. It is acknowledged that further discussions may lead to the conclusion that the other metals are not candidates for contaminants of concern, but this must be shown. Additionally, from an environmental risk perspective, these contaminants may be of great significance. Please note the following exceedances (other than Hg) that could be determined from the report tables: barium, lead, arsenic, antimony, thallium, and selenium above MCLs in groundwater; antimony, beryllium, and thallium above MCLs in Pond 5 effluent; and cadmium, selenium, and silver above AWQC in both Ponds 5 & 6 effluent.

29. Please include Hg analytical results in Table 13.

30. p 5-41. The text states, "Quarterly samples taken from the outfalls of Ponds 5 and 6 were analyzed for RCRA metals in addition to mercury". It is unclear how Tables 5-14 & 5-15 were structured. Why were the results of other quarterly sampling events not included in the tables.

31. Include pH results in Tables 5-14 and 5-15.

32. Figure 5-9. The presentation of numerical groundwater flow simulation results in Figure 5-9 indicated that the simulated water level at the location of the spring on Little Mountain is significantly below the ground surface, even though the spring was represented as a constant head node. The specified head for a flowing spring would be expected to be at or above the ground surface; otherwise, the spring would not flow. The presentation of the simulation water budget in Table 5-12 seems to indicate that the spring on Little Mountain is simulated as an inflow to the groundwater system. In other words, the spring sucks, which is most unusual. Please clarify.

It is still difficult to accept the ground-water model as "successfully calibrated," when Table 5-12 shows that it is necessary to model the spring on Little Mountain as an inflow to the system. A previous comment addressed this issue (IC2), and the response indicated that the constant head node at the spring did, in fact, act as a discharge point. Apparently, the spring is still a recharge point. Please clarify.

33. Please relate the modeled outflow to the NFHR at constant head nodes that is shown in Table 5-12 to estimated seepage along the Pond 5 dike.

34. Section 6 needs to be reworked to include the FCPS to the same extent as the ponds. Conclusions about the future condition of the FCPS are dependent on the hydrology. As the cap erodes, contamination may be able to migrate via erosion.

35. Section 6.2.4.1 The discussion of flow in the swales indicates that well MW-1D flow constantly at 0.5 gpm, even though it is completed as a monitoring well. This would make it difficult to interpret any water level measurements made in the well, even though water level measurements are reported in Table 5-5B. Were these measurements made in a flowing well? This brings up a similar question about piezometer P-1, which was completed in a borehole (SW-5) that flowed at 4 gpm when it was drilled. Did this borehole continue to flow after it was completed as a piezometer? If so, it is not a very good piezometer.

36. Section 7-1 states, "Liquid (elemental) mercury was noted only in boreholes drilled at the FCPS." Were these boreholes used to collect samples? If so please include this data and reference it in the text.

37. p. 7-2. Section 7.1 Provide a more detailed discussion of the remediation of the NFHR river bed. Include quantities of sediments and soils containing mercury that were remediated and provide an explanation of how they were "encapsulated."

38. p. 7-2. Section 7.2.1 Provide specifications pertaining to the construction of the cap and vegetative cover over the FCPS. (See comment No. 2)

39. p. 7-2, Section 7.2.1 Include a discussion on what type of loadings may occur once the existing containment system is eroded.

40. p. 7-4. The conclusion that the higher levels of mercury in Pond 6 were found in the eastern end of the pond is not correct. Examination of Figure ES-4 shows mercury to be distributed through the pond. The second highest concentration of mercury was found in the westernmost soil boring.

41. p. 7-5. An explanation for the presence of mercury in samples collected between the Pond 6 dike and the river should be provided.

42. p. 7-8. The statements made in Section 7.3 regarding the extent of mercury contamination in ground water seem to imply that there is not significant contamination of ground water. This is not supported by careful examination of figure 5-13. Some wells do show significant contamination, yet no attempt has been made in the RI to use the existing data to identify a contamination plume.

43. Figure 7-10. Please include the location of the buried debris on this figure. Conclusions in the text are difficult to understand without the approximate area delineated on the figure.

44. p. 7-5. A conclusion is drawn that the organic contamination found is not significant. Since this conclusion is critical to the FS, please include a detailed rationale for the conclusion in the text. The fact that they may have been produced from past plant activities only serves to cement a conclusion that they are of concern at Saltville.

45. p.7-5. This page mentions that TAL (metals) were also sampled for in the waste material. Please include these results as they may assist in explaining the presence of metals in the groundwater and in the pond effluent.

46. p. 7-9, Section 7.3. Please summarize the groundwater results for the FCPS and include in this section. This data is critical to support the risk assessment and the FS.

47. p.7-11, Section 7.4.2. The conclusion, "The results demonstrate that RCRA metals, except for mercury are not a concern at the site." is unfounded. Metals have been detected above MCLs and AWQC. This conclusion can only be drawn in the RI report if another source (not an Olin site) or natural conditions are causing the contamination (or if the results are inaccurate). This conclusion can possibly be drawn in the risk assessment if there is no risk associated with the levels found. This conclusion can be drawn after alterative evaluation if it is determined to not be cost-effective to remedy the contamination. Please determine how to support the conclusion and supply the necessary details, or carry these contaminants into the risk assessment.

48. Figure 7-10 is incorrectly identified in the Table of Contents.

49. Table 7-1 provides soil sample results for samples collected during well installation. Were any soils borings done at

this location? If so, please provide a figure delineating the location and a table with analytical results.

50. For Figure 7-1 please provide the Depth and screen information for well No. 2.

51. Section 8. Please include a detailed (more than that included on p. 8-8) discussion on why Pond 6 effluent is noticeably lower in mercury and other metal contamination than Pond 5 effluent. Also include a detailed discussion on the possible future conditions of the Pond 6 effluent. Since Pond 6 is considerably younger than Pond 5, the issue of continued degradation of the Pond 6 effluent quality to eventually that of Pond 5 must be considered in the future condition discussion. This issue is critical to selecting an alternative for Pond 6, and must be thorough.

52. Section 8. If the nature and extent of contamination discussion cannot show that the metals contamination is naturally occurring, please discuss the fate and transport of these metals also.

53. Section 10. The conclusions seem inappropriate in light of the questions remaining. This section will need to be redone if further discussions and evaluations show other metals to be an issue, and if the future condition of Pond 6 is possibly worse that the current condition.

54. p. 10-5, section 10.2.2. Please do not include FS conclusions in this section. For instance, the FCPS is considered a significant risk under a no-action alterative and must be included in the FS. Conclusions about what action is needed for Pond 6 (maintenance of institutional controls) is an FS conclusion and can only be reached after full evaluation of a range of alternatives. Please redo this section to identify preliminary remediation goals as defined by EPA risk assessment guidance.

55. The discussion in Section 10.2.2 should be replaced with preliminary remedial action objectives for Ponds 5 and 6 and the FCPS, rather than presenting conclusions regarding the need for future remediation.

56. Appendix A entitled Record of Decision contains two copies of the Consent Decree.

OU-2 RISK ASSESSMENT REVIEW COMMENTS
SALTVILLE WASTE DISPOSAL PONDS SUPERFUND SITE

1. Page 1-4 refers to the "Eastern Division Ditch". This should be "Eastern Diversion Ditch".

2. Page 2-1 through 2-4. The description of the selection of data sets for the pond soils is unclear. It appears from the last paragraph on page 2-1 that no samples were taken from pond 5 since 1979. Figure 2.2, however, shows two soil samples from Pond 5. Presumably, these were part of the 1990 sampling event. The first paragraph on page 2-4 states that mercury concentrations from the two data sets were similar. This appears to contradict the statement on page 2-1 that indicates that mercury concentrations appear to be decreasing over time. This section should be rewritten to clarify the data that were used in the risk assessment. In addition, the rationale should be provided for not taking a complete set of samples from Pond 5 in the 1990 sampling round.

3. Explain why values for the 95th percent UCL on the arithmetic mean of both transformed and non-transformed data are given in Table 2-3 for the benthos species crayfish and megaloptera.

4. Page 2-3. Please include results of soil sampling at the chlorine plant site in the discussion of soil contamination.

5. Page 2-4. Please include results of groundwater sampling at the chlorine plant site in the discussion of groundwater contamination. Page 3-5 indicates that it is a potential media for receiving contamination.

   A map showing the locations of the ground water monitoring wells should be provided along with a summary of the sampling results to support the conclusions made in section 2.1.2.

   The ground water contamination for the former chlorine plant site was not evaluated, either from an ingestion or a dermal contact with ground water seeps scenario. A full evaluation of these exposure scenarios should be provided in the Risk Assessment.

6. Page 2-4. Please include the range of contamination for wells not thought to be screened in fill material. The contamination range indicated is 0.01 to 0.1 ppm. Yet, the MCL for mercury is 0.002 ppm, oftentimes below even the detection limit. Furthermore, the concentration of mercury in ingested water that corresponds to a hazard quotient of 1 is 0.01 ppm. Therefore, the groundwater below the ponds is considered contaminated. The groundwater below the chlorine plant site is probably also contaminated, and potential

future risks as a result of potable use of groundwater may be unacceptable.

7. Page 2-5. It should be noted that several of the mercury concentrations listed on Table 2-1 exceed the risk-based screening concentration recommended be EPA Region III (0.031 ug/m^3). (See **Selecting Exposure Routes and Contaminants of Concern by Risk Based Screening, January 1993.**) Although risk-based concentrations are based on assumptions of long term, frequent exposure, insufficient data has been presented in this document to eliminate this exposure pathway. Because no sampling has been performed, it is not known whether the air pathway is significant in residential or recreational areas.

8. Please elaborate on the impact of groundwater at concentrations of 0.01 to 0.1 ppm on the river. What volumes of flows are expected through the dike and through the bedrock, and what dilution will occur in the river? The chronic limit for aquatic organisms is 0.012 ppb (3 orders of magnitude less than the lowest level detected and, therefore, the levels in the groundwater could represent a risk to the river. Much more information and evaluation of groundwater conditions is needed before groundwater can be ascertained to not be a concern. Carry groundwater through the entire risk assessment process. The issue of risk from groundwater is very important to the selection of a remedy for OU2.

9. Page 2-7. The second paragraph states that only data for the unscreened "bulk" size fraction were used. This statement should be explained and the significance of this decision should be noted.

10. Page 2-8. Log-normal distributions have geometric means, not arithmetic means.

11. Page 3-3. last paragraph describes the population centers that are located near the site. It would be helpful if those population centers were also clearly marked on the site map.

12. Page 3-4 and Others. The future land use of the site must be considered residential (including the plant site). Accessibility will not be controlled in the future under no action. According to EPA (Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions, 1991), only areas located within or near active industrial facilities may be considered to remain as such in the future. Therefore, the current and future exposure scenarios at Saltville are different and must be separated. In the future assume the fencer is not present, the cap on the plant site is not maintained, and that the land use is residential. The issue of building on the waste is not

relevant; gardens can still be grown and the groundwater can be ingested. Additionally the former chlorine plant site can be developed.

13. EPA's Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992, requires consideration of both the reasonable maximum exposed (RME) individual and the average exposed individual (both using the 95th percent UCL). It appears that the document considers the average exposure individual and not the RME individual. Please include the more conservative RME individual with the modified exposure parameters. In particular, an exposure frequency of six events/year for wading would not be considered an RME exposure.

14. Page 3-6. Fourth paragraph states that migration occurs through the dike in Pond 5. This contradicts the Feasibility Study conclusion but agrees with pervious reports on Pond 5. This issue requires resolution.

15. Page 3-8 (and others). Discussions have been limited to the ponds. Expand discussions to include the chlorine plant site and include groundwater ingestion. Table 3-2 must include current and future exposure scenarios. Soil exposure must be considered at the plant site.

16. An exposure frequency of six events/year for wading seems low. At best, this represents the average conditions. Increase the frequency for and RME individual along with the other exposure parameters for all exposure scenarios.

17. According to RAGS HHEM, Part A (1989), the RAF is not a factor in calculating soil ingestion. Instead, use the fraction ingested (FI). This is the fraction of daily soil ingested that is believed to be from the site, the default value being 1.

18. According the RAGS HHEM, Part A, if adjustments are made based on dermal absorbance efficiency, the oral RfD must also be adjusted appropriately. For example, because absorbance efficiency is assumed to be 0.1, the oral RfD must also be adjusted accordingly for a dermal RfD of 3E-5. This would increase the HQs derived for dermal contact with surface soil and sediments by an order of magnitude.

19. Page 3-13 discusses the quantification of exposure due to dermal contact with mercury in contaminated soil. It should be noted that EPA Region III recommends quantitative assessment of dermal exposure to soil for only three contaminants (TCDD, PCBs and cadmium) since these are the only contaminant for which there are approved the dermal assessment. This comment does not imply that the dermal assessment should be removed from the document. However, it should be noted that the absorption factors chosen were not

based on EPA-approved values.

It should also be noted that the **Dermal Exposure Assessment** (EPA, January, 1992) recommends a value of 1.0 mg/cm^2 for the SAF in the dermal exposure equation. (A value of 1.5 mg/cm^2 is used in the equation on page 3-13.) It is also not clear why the surface area used in this equation is based only on exposure to hands and arms. Since the exposure is assumed to take place during May through October, it would be reasonable to assume that part of the legs and the face would be exposed as well. In addition, the assumption of one trespass event per month appears to be low; particularly when children are assumed to be the trespassers. An exposure frequency of once per week would be more reasonable assumption.

20. Page 3-19. For the quantification of dermal exposure to sediment see above comments concerning quantification of exposure to soil and the SAF value.

21. Include the RME calculations in the Appendices of the baseline Risk Assessment.

22. Sources of exposure parameter values deviating from default values in some cases need additional clarification. It is not satisfactory to simply state that knowledge of the site is the basis for such estimates. What is the basis of this knowledge? If for example, residents were surveyed in order to obtain certain information, then that should be clearly stated. In any case, the justification for such deviation from default parameters should be properly documented. As presented this information seems to represent a subjective assessment of exposure.

23. Page B-1 notes that two fishermen were interviewed concerning fish ingestion rates. Since this is such a small sample of fishermen, it is not clear why some combination of the fisherman's estimates and the game wardens estimates were not used to derive the ingestion rate. While the explanation of the rejection of the warden's estimate is plausible, using a sample size of two does not appear to be very reliable.

24. Appendix D. The significance of the life expectancy value in the tables in not clear. The use of this value for non carcinogenic effects should be clarified in the text or the value should be eliminated from the tables.

25. It is not clear why two different values were used for the permeability constant in Tables 3 and 6. This should be changed or clarified in the text.

26. On all monte carlo graphs please show the RME as well as the 50th percentile value.

27. Provide information on the derivation of non-standard parameter values.

FILE COPY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
841 Chestnut Building
Philadelphia, Pennsylvania 19107-4431

September 28, 1993

RECEIVED
OCT 4 1993
KEITH ROBERTS

Mr. Keith D. Roberts
Principal Environmental Specialist
Olin Chemicals
P.O. Box 248, Lower River Road
Charleston, TN 37310

Re: Meeting Minutes for Saltville OU2 Remedial Investigation/Risk Assessment Review Comment Meeting of 9/16/93

Dear Mr. Roberts:

Attached is a summary of the agreements reached during the meeting held at EPA Region III offices to resolve comments made on the Saltville OU2 Remedial Investigation and Risk Assessment. The comments were discussed in the order of presentation in the comment letter from EPA to Olin dated 8/27/93. The Executive Summary comments, RI comments 1 through 7, were not discussed in the meeting because they duplicate later comments.

Should you have any questions regarding the meeting minutes please contact me at (215) 597-9023.

Sincerely,

Russell H. Fish
Remedial Project Manager
VA/WV Superfund Remedial Section

cc: Julie Pfeffer, CH2M Hill
Jeffrey Howard, VDEQ
Saltville File

RI Comment Resolution

RI Comment 8

Keith Roberts explained that in general, the RI was written under the initial assumption that Pond 6 was not a source of mercury. It was agreed that the focus of the RI had changed as a result of the data that were collected. Although it is not possible to identify the source of mercury contamination in Pond 6, it was agreed to avoid confusion to remove statements regarding the unlikeliness of overflow between the ponds.

RI Comment 9

Olin will implement the requests of this comment.

RI Comment 10

A letter report describing previous remediation efforts is currently being produced by Olin and will be appended to the Feasibility Study (FS) report. The RI and FS summaries of the remediation efforts will be made consistent.

RI Comment 11

It was agreed that essentially the geology and hydrogeology of Pond 5 and Pond 6 (and areas beneath the ponds) were the same. The descriptions of the ponds in the RI report will be rewritten to emphasize the similarities and to use information collected for Pond 5 to describe Pond 6. A sufficient description of the similarities between the two ponds will negate the need for more Pond 6-specific data. The other agreement that was reached to address this comment was that despite the original focus of the RI, the report needs to address all areas of the site equally (to the extent the data collected in all studies will allow).

RI Comment 12

Olin agreed to clarify the discussion of the rain gauges.

RI Comment 13

As discussed as part of Comment 11, the revised RI report will address the FCPS to the same extent as Pond 5 using previously collected data.

RI Comment 14

In the meeting, Olin indicated that the figures presented are drawings from dike construction verified by RI borings. The water level presented is extrapolated from well information. As suggested in the comment, part of subsection 4.2.2.3 will be repeated in Section 3.1.4 for clarification.

RI Comment 15

Olin said that the water levels shown in the figure are not from the main report. The text will be clarified.

RI Comment 16

The significance of the french drains to RI conclusions about water flow through the dike will be included in the report at the point that they are first mentioned. The drains were installed for dike stability during dike construction. It is hypothesized that they are no longer functioning.

RI Comment 17

See response to Comment 13. In addition, Olin agreed to update all data presented with monitoring data collected since the initial RI was written.

RI Comment 18

As a result of the comment, the text will be reworded to reflect that "significant" difference and "not major significant" difference is based on the quantity of data not just the size of the difference.

RI Comment 19

See response to Comment 13.

RI Comment 20

Although the flow of the groundwater is complicated, there has been no blasting under the site. Olin believes that there is sufficient understanding of the flow to proceed with the FS. EPA concurred in the meeting. No change will be made.

RI Comments 21 and 22

Clarification will be made in the document to address these comments and remove any apparent contradiction.

RI Comment 23

The document assumes that there is minor seepage through the dike that cannot be quantified and is not visible. The statement referred to does not result in a contradiction. However, the document will be checked to remove any statements that imply there is no seepage.

RI Comment 24

In an attempt to address the FCPS to the same degree as Pond 5, Olin agreed to review past FCPS work and incorporate relevant results into the document. No additional modeling work will be conducted.

RI Comments 25 and 26

These comments were not understood and therefore were deferred. Russell will check with the State to assess the purpose of these comments and, if relevant, will communicate the purpose to Olin.

RI Comment 27

Organic contamination will be evaluated with respect to pattern of contamination, potential sources, and comparison to standards. The evaluation will be presented in the RI report. It was recognized if the organic contamination can not be shown to be non-site related that the contamination will be addressed in the RA.

RI Comment 28

As with organic contamination, the presence of metals in addition to mercury will be evaluated in the report. Those metals that are present and cannot be shown to be non-site related will be carried forward into the RA for further evaluation. In addition, the metals contamination data will be updated with additional monitoring data that may have become available since the initial report was written.

RI Comment 29

The table does not include mercury data since the sampling efforts were for a different purpose. No change to the table will be made.

RI Comment 30

The title of the tables will be changed to not include the word "quarterly." Additionally, Olin explained that while the samples were taken to represent a three months worth of data, samples were not taken every quarter due to several reasons. To address the comment, the 7/90 quarter sample results that were inadvertently left out will be included, other results will be checked to see if both filtered and unfiltered fraction results are available, and if available, newer data will be included.

RI Comment 31

The decision to include or not include the Ph results in the OU 2 RI was left unresolved. However, it was agreed that the Ph of the effluent was an issue for the OU 3 RI and RA.

RI Comment 32

Olin recognizes that the groundwater model indicates that the spring is a recharge point. That is a boundary condition that was necessary to have the model represent conditions at the site. It is solely an artifact of the modeling. Since that information is not critical to any conclusions and since the modeling results are only used to develop a conceptual model, no change is necessary.

RI Comment 33

No change is needed considering the purpose of the model.

RI Comment 34

The future condition of the cap does not need to be addressed in the RI report, however, the change in hydrology as a result of the cap will be included in the report.

RI Comment 35

The text will be clarified to reflect that water levels are based on pressure readings.

RI Comment 36

The referenced statement will be removed.

RI Comments 37 and 38

See resolution of Comment 10.

RI Comment 39

A discussion of the future of the existing containment system under no action will be addressed in the FS report not the RI report.

RI Comment 40

The conclusion will be modified to reflect that contamination is found throughout Pond 6 materials.

RI Comment 41

The source of contamination cannot be provided. As discussed before, reference to none or limited flow between Ponds 5 and 6 will be deleted. Olin requested that EPA verify that this is acceptable to the State.

RI Comment 43

Location of the buried debris will be added to figures.

RI Comment 44

See resolution of Comment 27.

RI Comment 45

Metal results for the waste will be included in the report along with an explanation and evaluation of the data.

RI Comment 46

Groundwater data for the FCPS will be included and evaluated in the RI report even though it originates from other studies.

RI Comment 47

See the response for Comment 28. The conclusions based on the evaluation will be carried throughout the document.

RI Comment 48

The figure identification will be corrected.

RI Comment 49

Olin will see if there are soil sample results other than those provided in Table 7-1. If so, they will be included in the RI report.

RI Comment 50

Requested information will be provided.

RI Comment 51

Olin will further evaluate the differences between Ponds 5 and 6 to determine if there is an explanation to the difference in effluent quality. If there is no explanation, the uncertainty may have to be considered and addressed in the FS with a contingency plan. Regardless of the conclusion of the reevaluation, the existing conclusion in the report needs to be modified.

RI Comment 52

See response to Comment 28.

RI Comment 53

See response to Comment 51.

RI Comments 54 and 55

Only conclusions that will be included are whether action is needed or not. The type of action is not an appropriate conclusion for the RI report. No resolution was reached on if preliminary remediation goals are to be included in the RI or FS. If sufficiently presented in the FS, they may not have to be included also in the RI.

RI Comment 56

Noted. If the appendix is resubmitted in the future, only one copy will be submitted.

Risk Assessment Comment Resolution

RA Comment 1

Typo will be corrected.

RA Comment 2

Clarification on the data sets used will be added to the RA.

RA Comment 3

Although the UCL on the non-transformed data was used in the risk calculations, both values were presented for information purposes. This section will be clarified.

RA Comment 4

This comment led to a discussion on the land use that should be considered to reflect future conditions at the site. EPA's position is that the site could potentially be residential in the future and therefore a residential land use needs to be included in the RA. EPA also indicated that an industrial scenario was also likely but in order not to expand the extent of the comments, this additional scenario would not be required in preference of conducting a residential RA. Keith Roberts said that in general they were opposed to assuming residential use in light of the small industries in the area. It was agreed that Keith could take EPA's position back to Olin management and the issue could be temporarily deferred. This deferral also affects comments on using groundwater exposure pathways and the issue of using soil data at the FCPS as potential future exposure pathways. Therefore resolution of numerous comments has been deferred, including Comment 4.

Follow-up After reviewing this issue further, EPA is requesting a future use industrial scenario be evaluated at the FCPS. An RME from all the soils data presented in Table 7.1 of the RI should be used in this evaluation. If additional data is available for the soils or the dredged sediments deposited on the FCPS, include this data in the calculation for the RME. Regarding Ponds 5 & 6, EPA is requesting that a future use residential and industrial scenario be evaluated. Consumption of groundwater at both the FCPS and the Ponds area should be evaluated unless Olin can demonstrate that the ground water quality is non-potable. It is not sufficient to dismiss the evaluation of ground water for a future use scenario by simply stating that the current population is supplied with a municipal system and future use is not expected to change. The basis for a non-potable water supply needs to be clearly stated or the ground water needs to be evaluated in the future use scenarios.

RA Comment 5

Deferred. Follow-up See RA Comment 4

RA Comment 6

Deferred. Follow-up See RA Comment 4

RA Comment 7

Those present at the meeting agreed that the existing air quality information and the qualitative discussion in the RA appeared to sufficiently address the air pathway. EPA is to clarify the comment with the state.

RA Comment 8

Deferred.

Follow-up The response to this comment needs to be specific to the loading to the NFHR from the contamination at the FCPS. The intent is to ascertain whether the loadings will result in the Ambient Water Quality Criteria being exceeded in the river as defined by Virginia regulations in both the current and future use (no effective cap) scenarios. The last part of this comment has been addressed in comment 4.

RA Comment 9

The revised report will provide clarification on the significance of using data for the unscreened "bulk" size fraction.

RA Comment 10

Olin disagrees with the comment. No change.

RA Comment 11

Population centers will be marked on the appropriate maps.

RA Comment 12

Deferred.

Follow-up See RA Comment 4.

RA Comment 13

The comment is not correct in that the report assumed that wading occurred 15 times a year and this represents an RME. Justification for the 15 times a year will be provided.

RA Comment 14

As discussed in the RI comment resolution section, the report does not state that no migration occurs through the dike rather that the migration is limited. There is no conflict although Olin will carefully review both reports to ensure that no migration through the dike is not implied.

RA Comment 15

The resolution of this comments depends on the resolution of the future land use scenarios.

Follow-up See RA Comment 4

RA Comment 16

See resolution for Comment 13. However, the discussion also centered around the assumptions for trespassing on the site. For current conditions, one time per week for 40 weeks was requested by EPA. For future, less controlled conditions, EPA requested 5 times per week for 12 weeks plus 1 time per week for 24 weeks. The future condition for trespasser more closely resembles a recreational user.

RA Comment 17

Olin agreed to change the RAF to a default value of 1.

RA Comment 18

It was agreed to adjust the oral RfD as requested in the comment.

RA Comment 19

The SAF will be changed to 1 mg/cm^2 and lower legs will be included in the exposure assumption.

RA Comment 20

See resolution of Comment 19.

RA Comment 21

The increase in exposure parameters requested in other comments will reflect the RME and will address this comment. No other additions to the document are needed.

RA Comment 22

Additional clarification for each exposure parameter will be provided.

RA Comment 23

No change to the numbers is needed. In order to strengthen the basis for the exposure parameters, the text will be modified to indicate that the study in Alabama where the numbers are taken from is validated by interviewing two local fishermen.

RA Comment 24

The significance will be clarified.

RA Comment 25

The use of permeability constants will be claıified.

RA Comment 26

The RME will be shown on the graphs but the monte carlo graphs are used only to show a trend not to identify specific numbers.

RA Comment 27

The requested information will be provided.

After the comments were resolved, the resubmittal of the document was discussed with Olin. EPA said that they need to see the wording of each proposed change as soon as possible so work can begin on the proposed plan. As opposed to initially resubmitting the document, EPA requested that only the changes be submitted. It then may be possible, upon approval of the changes, to only resubmit Volumes 1 and 2 of the report. Olin proposed that by the 8th of October, they would submit the proposed changes to the RI document. Russell indicated that he would pass this proposal by his management and would quickly let Olin know if this was acceptable.