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Superfund Branch

Reply To
Attn Of: AT-083

MEMORANDUM

SUBJECT: Potential Hazardous Waste Site

FROM: M. Eileen Hayes, EPS
Toxic Substances Section

TO: Debbie Flood, EPS
Hazardous Waste Division

Attached is a copy of the PCB Spill Cleanup Report for Weyerhaeuser Plywood Plant in Snoqualmie, Washington, for your information. The facility had a PCB spill as a result of a fire that occurred on February 7, 1989.

The facility states it is unable to clean the site identified in the report as T-12 to the numerical standards specified by the PCB Spill Cleanup Policy, because further remediation could result in groundwater contamination. The PCB concentrations remaining in the soil range from 33 ppm to 34,000 ppm.

If you have any questions, I can be reached at 2584.

SNOQUALMIE MILL PLYWOOD PLANT FIRE SITE
FORMER TRANSFORMER LOCATIONS T-12 AND T-17: CLEANUP SUMMARIES, RISK ASSESSMENT AND SITE HAZARD RANKING REPORT

WEYERHAEUSER'S CASCADE DIVISION
SNOQUALMIE FALLS
PLYWOOD PLANT FIRE SITE

for

THE WEYERHAEUSER COMPANY

by

HDR ENGINEERING, INC.
BUILDING C - SUITE 200
11225 S.E. 6TH STREET
BELLEVUE, WASHINGTON 98004

APRIL 1990

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EXECUTIVE SUMMARY

This report provides a summary of PCB spill cleanup activities in the vicinity of two former outdoor transformer locations at Weyerhaeuser's Snoqualmie Mill site in Snoqualmie, Washington. Two separate releases of transformer fluids (askarel) occurred as a result of damage to secondary connector bushings caused by falling debris during a plant fire (transformers and spilled fluid were not directly involved in the fire and thermometers on the devices indicated that they were not exposed to excessive heat).

After the fire event, investigation and cleanup of PCB contamination at the two sites (T-12 and T-17) included surface soil sampling, shallow groundwater sampling, excavation, and additional testing. Subsurface PCB contamination was observed at both sites. A perched and seasonal groundwater system overlying a clay layer was noted at a depth of approximately 5 to 6 ft. Later geotechnical investigations determined that this clay layer was approximately 10 ft thick; overlain by a gravelly loam fill. In order to excavate PCB contaminated soil near the top of the clay layer, a lined trench was installed around the two sites. Trench design was based on previous test-pit results to further define the area of contamination. Installation of the cutoff systems permitted deeper excavation of soils.

Site T-17 was excavated to a depth of approximately 6.5 feet and final test results demonstrated a cleanup level at or below 1 ppm PCBs. Cleanup of site T-17 is documented in this report in accordance with the format requirements of the EPA PCB Spill Cleanup Policy under 40 CFR 761. Both sites are restricted access and zoned heavy industrial.

Site T-12, which had experienced a larger release of askarel, was excavated in several stages to a final depth of two feet above the bottom elevation of the clay layer (total depth of approximately 13 ft). This final excavation depth was pre-designated to provide a safe margin between the overlying contaminated clay and underlying water-bearing silts. The average PCB contamination remaining in the bottom of the T-12 excavation at this limit (maximum depth of 13.5 ft) was approximately 1,000 ppm. The mass of PCBs remaining in place is between 1 and 71 lbs. Samples obtained from angle borings beneath the site indicate that PCBs have not penetrated into the underlying silt (water-bearing) layer. After final sampling, the site was backfilled with low-permeability clay compacted in lifts.

Since a TSCA-based cleanup of site T-12 was not achieved and additional excavation of contaminated materials would endanger underlying water-bearing strata, a risk assessment and hazard ranking was performed to evaluate the human and environmental risks associated with remaining materials. Hydrogeologic modeling was undertaken to evaluate the maximum concentration of PCBs that could eventually pass through the clay layer and move downgradient. Based on this evaluation, it was determined that the remaining contaminants at the T-12 site do not pose appreciable health or environmental risks. Attempting to remove these remaining contaminants is not practical and, based on the specific stratigraphy of the site, would pose environmental risk to underlying water resources. The compacted clay backfill at the site has further reduced the potential for exfiltration of contaminants and surface contact. Specific measures for assuring that the site is not accidently excavated in the future must be taken to eliminate the potential for accidental exposure. Examples include demarcation of the site using monuments.

1. INTRODUCTION

1.1. BACKGROUND

On Sunday, February 5th, 1989, a fire erupted at the plywood manufacturing facility located in the southeast portion of Weyerhaeuser's Snoqualmie Mill (Figure 1.1). The large, wood-framed 160,000 square ft. building was a complete loss as fire fighting efforts were hampered by extreme cold weather and frozen water supply mains.

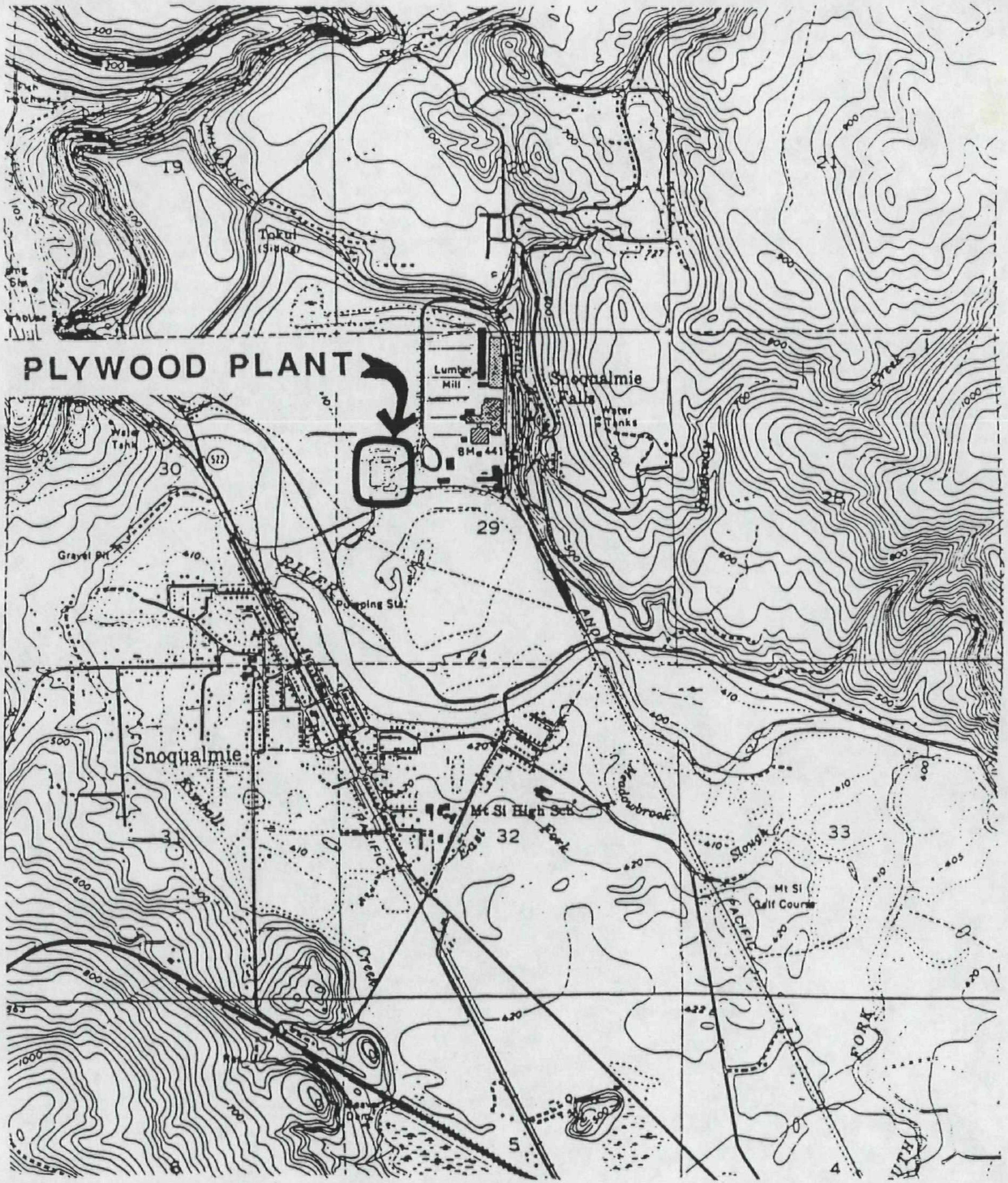
Falling debris from the fire ruptured the secondary bushings around two askarel (PCB-bearing cooling fluid) filled transformers (designated as T-12 and T-17). HDR Engineering Inc. (HDR) sampled the soils adjacent to these transformers in February, 1989 and detected elevated PCB concentrations (HDR Engineering, 1989a, 1989b, 1989c). Figure 1.2 shows the location of the two transformers.

A subsequent investigation occurred in March and April, 1989 and consisted of the installation of six monitoring wells, soil borings, surface soil and groundwater sampling, and water elevation measurements. This investigation established that concentrated transformer fluids were not moving laterally through the shallow aquifer, and a low permeability clay layer was present four to six feet beneath the surface (HDR, 1989d, 1989f).

Two barrier systems were constructed to isolate soils in the vicinity of the two transformers from the shallow, perched groundwater. Following completion of the barrier systems the isolated soils were excavated, sampled and analyzed for PCBs in June, 1989 (1989f). At transformer site T-17, all contaminated soil was removed and all samples taken from the floor and sidewalls of the excavation were at or below the allowable concentrations listed in the PCB Spill Policy (40 CFR 761). Transformer site T-17 was subsequently closed in accordance with the PCB Spill Policy and backfilled.

Excavation and sampling of the T-12 site also occurred in June, 1989. Most of the contaminated soil was removed except for a 5 ft. by 5 ft. area where high concentrations of PCBs existed in the clay matrix (Figure 1.3). Apparently, additional fluids spilled prior to the fire had come into contact with the underlying clay layer and have, over time, been able to permeate into the clay. Some carry-down of fluids may have also occurred adjacent to the building's wall foundation.

Excavation activities at the T-12 site were discontinued to avoid breaking through the clay layer and into the possible underlying aquifer systems. A tarp was placed in the bottom of the excavated pit, serving to separate clean backfill from underlying contaminated clay, and the excavation was then backfilled. The backfilled area was covered with plastic sheeting to exclude rainwater.



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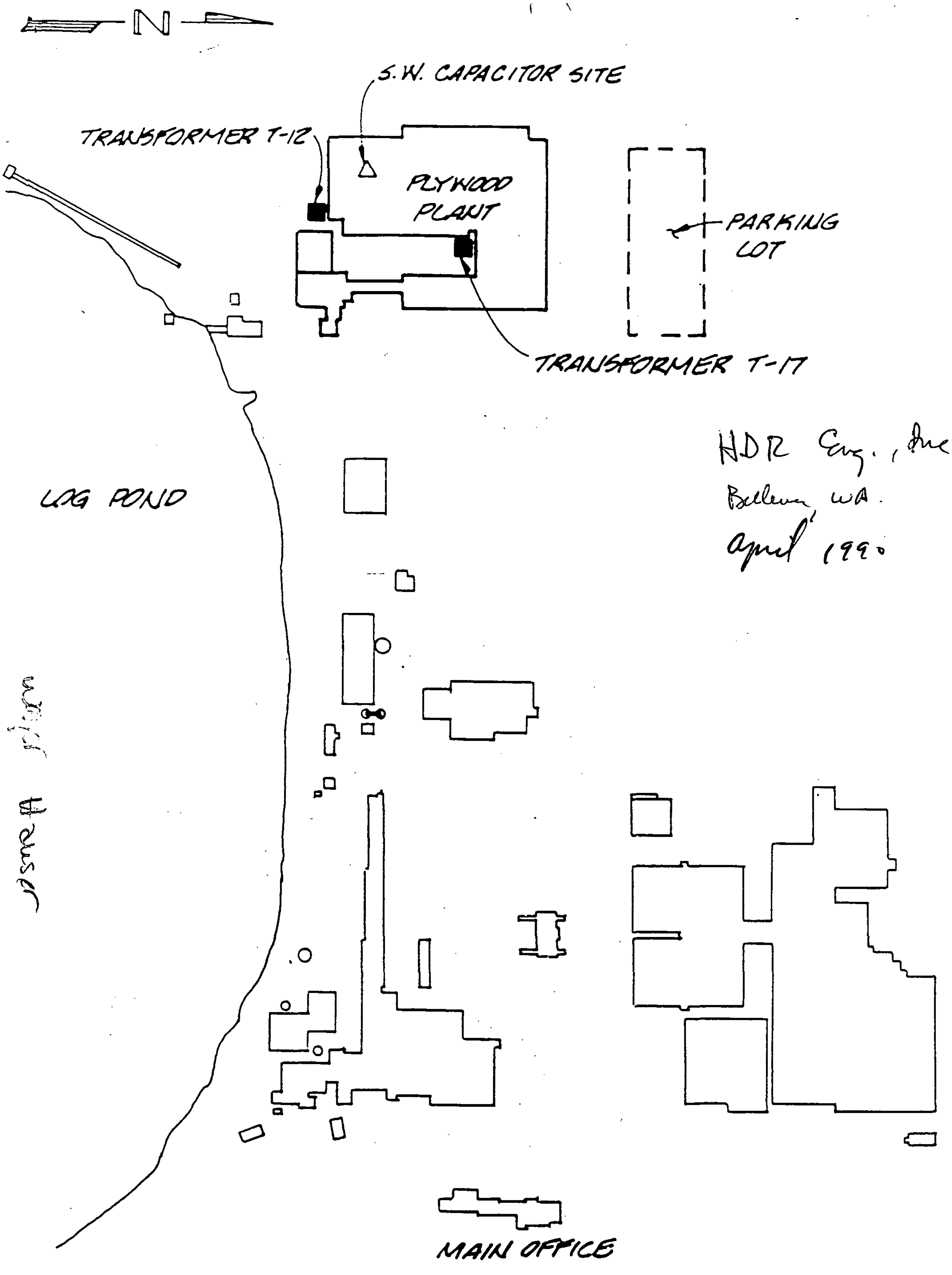
SITE LOCATION MAP

H D R

FIGURE 1.1

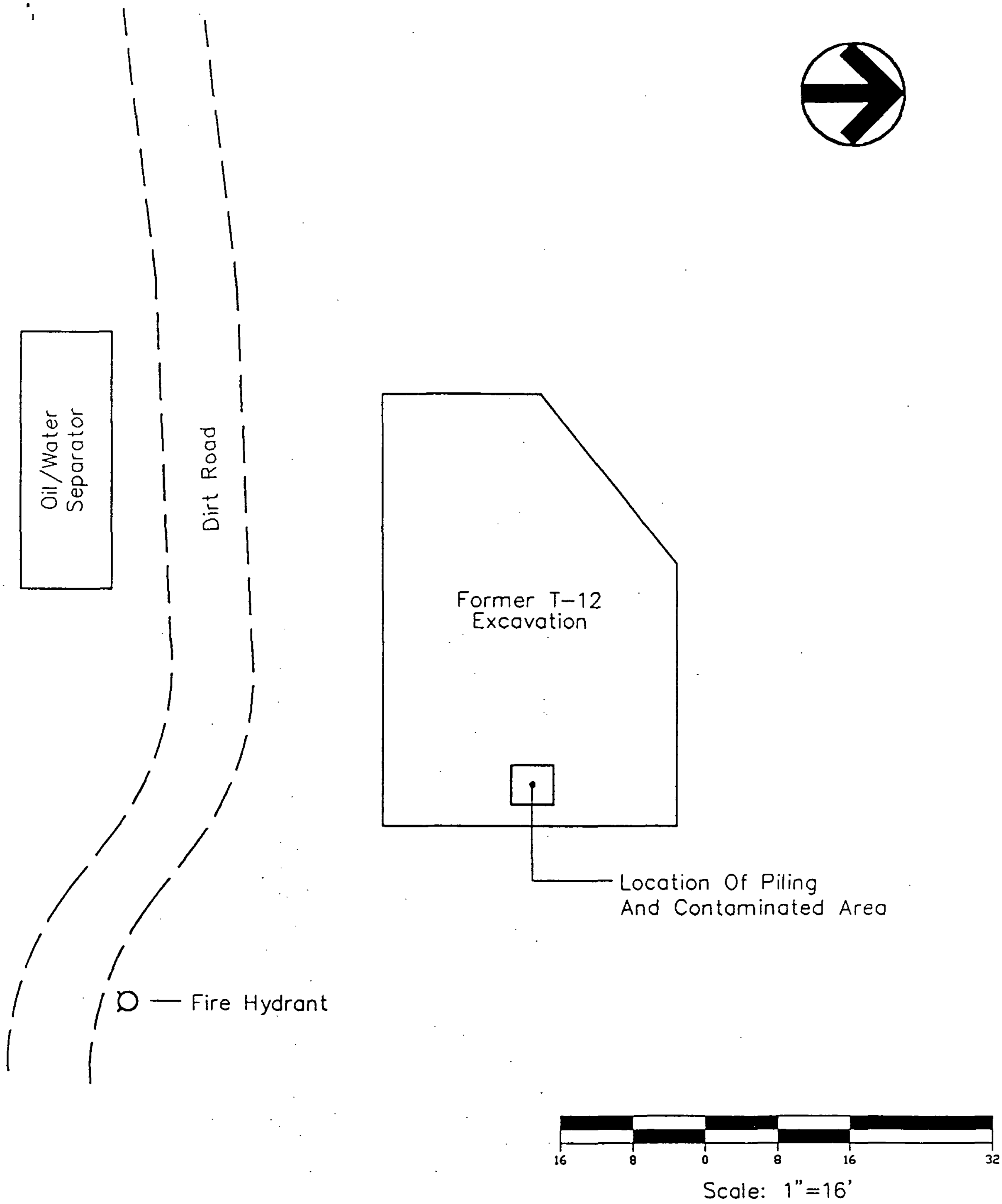


HDR Eng., Inc.
Bellevue, WA.
April 1990

Weyer Hauser

SITE MAP

FIGURE 1.2



HDR

WEYERHAEUSER–SNOQUALMIE
T-12 SITE

FIGURE 1.3

A subsurface investigation at site T-12 was performed during September 5 to 21, 1989 to ascertain the thickness of the clay layer and to determine if contaminants had penetrated deeper into the clay layer or passed through the clay. Three vertical boreholes were drilled adjacent to the former transformer T-12 site and one angled boring was drilled beneath the T-12 location. Results of this investigation indicated the clay layer (underlying 5 to 6 feet of silty cobbles and loamy soil/backfill) averaged ten feet in thickness (bottom depth of 15 to 16 feet) and the contamination has not passed through the clay layer (HDR, 1989h).

On October 11 and 13, 1989, additional excavation of the PCB contaminated clay beneath the T-12 site was performed. Excavation was terminated at a depth of 13 feet to avoid penetrating the bottom of the clay layer; preventing potential contaminant migration to the underlying saturated formation. Samples were obtained from the floor of the excavation and the pit was backfilled with clay obtained from L-BAR Products. Laboratory analysis of soil samples indicated that concentrations of PCBs, trichlorobenzene and tetrachlorobenzene remain in soils at the T-12 location at a depth of 13 feet (Table 1.1 and Figure 1.4).

The actual concentration of PCBs remaining beneath the site is highly variable. During the last stages of soil removal, the clay appeared to contain iron-colored mottling at several sampling stations. Close observation of the clay showed this mottling was associated with small, discontinuous tubules, believed to be voids left by decomposed plant material. As contaminants diffused through the clay, they apparently condensed in some of these tubules (approximately 0.5 mm diameter by 4 to 5 cm length). The likelihood for including these small pockets of concentrated material in a soil sample is therefore, highly variable. It is likely that the relatively high PCB results observed in the duplicate sample No. 13 for sector 13 (34,000 ppm) was caused by one of these tiny pockets of material. Sample No. 13 is therefore not believed to be representative of the overall PCB soil concentration remaining at site T-12. The likelihood that residual PCBs in the T-12 excavation are limited to these tubules points to a lower overall mass of remaining PCBs likely to be remaining at the site (estimates herein are based on an assumption of uniform contamination throughout each sampled sector).

Previous investigations reported the transformer at site T-12 released about 5 to 20 gallons of askarel as a result of the February, 1989 fire and that an earlier, possibly larger askarel release occurred prior to that time. Prior testing of soil below the clay layer, together with spill penetration modeling indicated that the older spill was approximately 60 gallons or less. Based on previous excavation activities and test results, calculations indicate that between 1 and 71 pounds of PCBs remain in the soils at the T-12 site (71 pounds of PCB corresponds to approximately 17.3 gallons of askarel).

1.2. PURPOSE

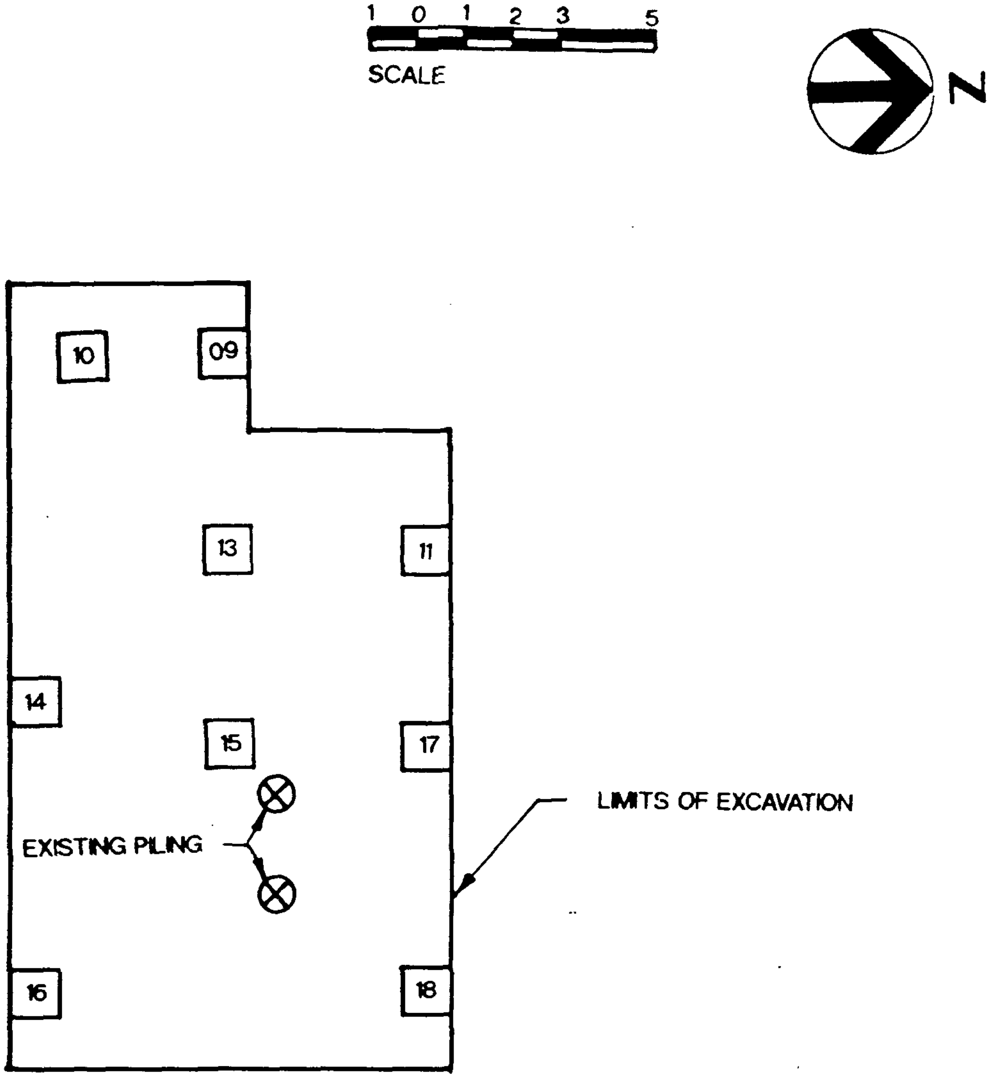
This report documents the cleanup efforts for both transformer sites; including final documentation of the T-17 site cleanup in accordance with the format prescribed in the U.S. EPA PCB Cleanup Policy.

This report also addresses the residual PCBs still present in the deeper clay layers at the T-12 site. This portion of the report is comprised of two parts, a risk assessment and hazard ranking model. The purpose of the risk assessment for the T-12 site is to evaluate PCB and carrier solvent toxicity, potency, migration potential, and quantify the health risks associated with the site. The purpose of applying the hazard ranking model to the T-12 site is to determine how the Washington Department of Ecology would rate the site based on the Washington Ranking Method (WARM) model. The model was developed by Ecology as part of the Model Toxics Control Act of 1988. The objective of the risk assessment and the hazard ranking model for the T-12 site is to determine whether additional remedial measures or monitoring are necessary at the T-12 site.

TABLE 1.1
FINAL SAMPLE RESULTS FROM FLOOR OF T-12 EXCAVATION
OCTOBER 12, 1989

SAMPLE NUMBER	SECTOR NUMBER	UNITS	TOTAL TRICHLOROBENZENES	TOTAL TETRACHLOROBENZENES	PCB-AROCLOR 1260
T12-12-SL-101289-0*	13	mg/kg	380	17	810
T12-13-SL-101289-1*	13	mg/kg	1,400	59	34,000
T12-14-SL-101289-0	14	mg/kg	120	10	1,100
T12-15-SL-101289-0	15	mg/kg	300	22	1,600
T12-16-SL-101289-0	16	mg/kg	36	2.1	1,100
T12-17-SL-101289-0	17	mg/kg	3	<0.13	<0.08
T12-18-SL-101289-0	18	mg/kg	17	12	33

< = Below detection limit, detection limit reported
* 12 and 13 are duplicate samples
PCB = polychlornated biphenyls
mg/kg = milligrams per kilogram



HDR

WEYERHAEUSER-SNOQUALMIE
T-12 Final Sampling Locations

FIGURE 1.4

2. SITE T-17 CLEANUP

2.1 BACKGROUND

Approximately 5 to 10 gallons of askarel were spilled during the fire of February 5, 1989. The bulk of the spilled liquid remained directly beneath the throat of the transformer; little of the PCB contaminated fluid traveled more than a few feet from the transformer.

This fact has been verified by a number of sampling events: groundwater and soil boring sampling in adjacent wells, surface soil sampling in the vicinity of the transformer; subsurface soil sampling on the walls of the four-foot deep pit excavated around the transformer; and subsurface soil and groundwater sampling at the water table interface in test pits dug around the former transformer location.

2.2 ACTIVITIES PRIOR TO FINAL EXCAVATION

Site activities at transformer T-17 conducted prior to dewatering and final excavation included:

- surface soil sampling,
- investigation of the shallow groundwater system surrounding the site,
- initial excavations to remove the transformer support pad and surrounding soils, and
- soil and water sampling from test pits surrounding the site to evaluate the extent of lateral PCB migration.

Each of these activities is described in the previous project reports cited in Table 2.1.

2.3 DEWATERING AND FINAL EXCAVATION

On May 30, 1989, a trench surrounding transformer site T-17 was excavated to a depth of approximately 6.0 feet at which point, the clay layer was reached. Following completion of the trench, a neoprene liner was installed.

There were no major problems with the installation of the dewatering system except for some caving problems when the side walls of the trench intersected a former test pit. This problem was rectified by placing boards in the trench to stabilize the sidewalls until the liner was installed.

TABLE 2.1 SUMMARY OF TRANSFORMER SITE CLEANUP DATA FOR TRANSFORMER T-17

SOURCE OF SPILL:

Leakage from secondary bushings on north side of transformer caused by falling debris onto secondary buswork during plant fire.

DATE AND TIME OF SPILL: February 5th, 1989. Late PM.
DATE AND TIME CLEANUP COMPLETED: June 6, 1989. 7:00 PM
SPILL LOCATION:
Transformer Pad T-17 at the central area of the Snoqualmie Falls Plywood Plant, Weyerhaeuser Company

PRE-CLEANUP SAMPLING DATA AND METHODOLOGY:

Pre-cleanup sampling and methodologies documented in following references:

HDR Engineering, Inc. 1989a. Assessment of PCB Contamination - Weyerhaeuser's Cascade Division, Snoqualmie Falls Plywood Plant Fire Site. Prepared for the Weyerhaeuser Company. March 1989.

HDR Engineering, Inc. 1989b. Groundwater Investigation Report - Weyerhaeuser's Cascade Division, Snoqualmie Falls Plywood Plant Fire Site. Prepared for the Weyerhaeuser Company. June 1989.

HDR Engineering, Inc. 1989c. Snoqualmie Falls Plywood Plant Transformer Spill Cleanup - Groundwater Isolation and Soil Removal -Approach and Scheduling. Prepared for the Weyerhaeuser Company. May 1989.

SOLID SURFACES CLEANED:

All solid surfaces (concrete foundations) removed and disposed as PCB-contaminated solids.

DEPTH AND VOLUME OF REMOVED SOILS:

Excavated soils to clay layer at depth of five to six feet. Approximately 50 cubic yards of soil removed.

CLEANUP CERTIFICATION:

To the best of my knowledge, the cleanup requirements of 40 CFR 761 have been met and the information contained in this report is true.

Rodney G. Proctor
for
Weyerhaeuser Company

During the construction of the trenches, a vacuum truck was constantly used to remove water out of the base of the trenches or the standpipes installed specifically to collect water. This enabled greater stability of the trench sidewalls and made it easier to define trench bottom elevations and slopes. Approximately 3,000 gallons of water were pumped out of the T-17 site during barrier construction. The installation of the dewatering system around transformer T-17 was completed in one day. Olympus Environmental Inc. arranged for final treatment/disposal of the water by Chempro Inc. of Seattle, Washington.

On June 6, 1989, the excavation of potentially contaminated soil began. The primary area of concern was in the north half of the isolated area. The south half was not a major concern since earlier test pit results and sampling following removal of the transformer foundation pad indicated that PCB concentrations in the south half were already below cleanup levels. The reason the dewatering/isolation system was brought further south than needed was to include the former plywood plant foundation wall. This was done to 1) recover any material that may have flowed into the wall backfill, and 2) allow the south trench to be installed parallel to, but away from, the wall.

Soil was excavated to a uniform depth of 2.0 feet within the isolated area. A backhoe loaded the soil into a lined dump truck which then transferred its load onto bermed plastic sheeting staged approximately 100 feet away. Four piles of soil were placed on plastic sheeting.

Following excavation to 2.0 feet, the excavation of the north half of the pit proceeded. This was the area of concern as the transformer originally stood in this area. Excavation of material in this half continued until the clay layer was reached (approximately 6 ft depth). The material in this area was placed separate from the previous four stockpiles in a bermed area reserved for PCB-contaminated materials.

There were no major problems encountered during the excavation of soil except for a slight influx of groundwater from the north side of the pit. This water was pumped out and treated in the same method as described above. Excavation activities were completed on the same day.

2.4 CLEANUP GOALS

Prior to undertaking final cleanup, Weyerhaeuser Inc. confirmed a cleanup goal of between 1 and 25 ppm PCB in soil. Recognizing that the draft State of Washington PCB cleanup goal for soil is 1 ppm, Weyerhaeuser agreed to make every attempt to reach this limit. However, in no case would cleanup be deemed complete if the EPA PCB Cleanup Policy of 25 ppm for controlled industrial settings was exceeded. Previous groundwater monitoring showed that PCBs were not migrating away from the site and cleanup measures and goals for groundwater were not necessary.

M. Bray
FBI

2.5 SOIL TESTING RESULTS

There were two separate sampling events performed at T-17 on June 6, 1989: 1) sampling of the first four piles of excavated surface soil, and 2) sampling of the clay layer on the floor of the pit after excavation to the clay layer. All samples were taken to the Friedman and Bruya, Inc. (FBI) on-site laboratory and analyzed for PCBs.

The four piles of excavated soil were all taken from the top 2.0 feet of the pit. It was determined that some, if not all, of this soil may designated as "non-PCB" for purposes of disposal (i.e., less than 50 ppm PCBs). Each pile was sampled at five points: on the north, east, south and west sides of each pile and on the top of the pile. If any of the five sample points in the pile showed greater than 50 ppm PCBs, the entire pile was considered contaminated and must be disposed as a TSCA-regulated waste. If the soil was found to be greater than 1 ppm PCB, it was managed by Olympus Environmental Inc. as a State-designated waste.

Of the four piles, two had PCB levels greater than 50 ppm. Both of these two piles were excavated from the northern half of the pit. This material was then moved into the bermed staging area for PCB-contaminated soil.

The remaining samples taken at T-17 were all located in the clay layer of the pit floor. The north half of the pit was excavated to a depth of approximately 6.0 feet, or until the clay layer was reached.

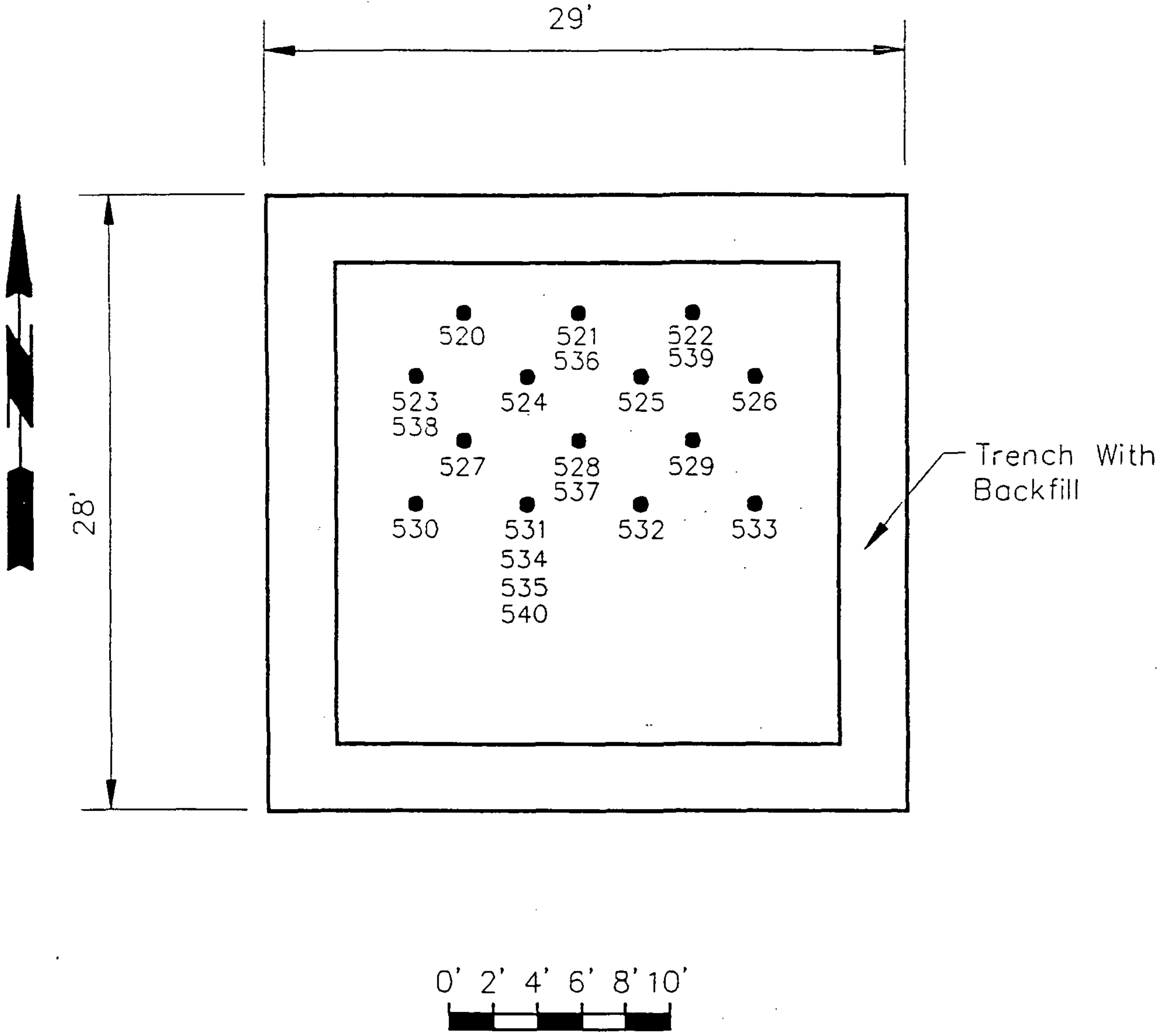
A sampling grid system was established based upon EPA guidelines (U.S. EPA 1985, 1986) in which the floor of the pit was divided into a hexagonal grid system (Figure 2.1). Spacing between adjacent sampling points was approximately 4.72 ft. A sample was taken at each grid center following excavation of the surface of the pit floor by the backhoe. A total of 20 samples were taken at 14 points on the pit floor, six of the samples were duplicates.

Only one sample had PCB levels greater than the cleanup goal (Sample number 531 contained 59 ppm PCB). The soil adjacent to this sampling point was excavated another six inches and the floor was resampled at the same sampling point. The resampled point was clean, verifying the fact that the PCBs had been sufficiently removed from T-17. Test locations and results are shown in Figures 2.1 and 2.2.

Following receipt of the laboratory results, T-17 was backfilled with clean dirt and closed.

2.6 CLEANUP CERTIFICATION

At the completion of cleanup, certification by the responsible party is required in accordance with the PCB Spill Cleanup Policy (40 CFR Part 761.125). Included in Table 2.1 are the source, time and location of the spill, a description of the sampling methodology and of the excavation activities, the time that the cleanup was terminated, and a signature of the responsible party stating the cleanup requirements have been met.



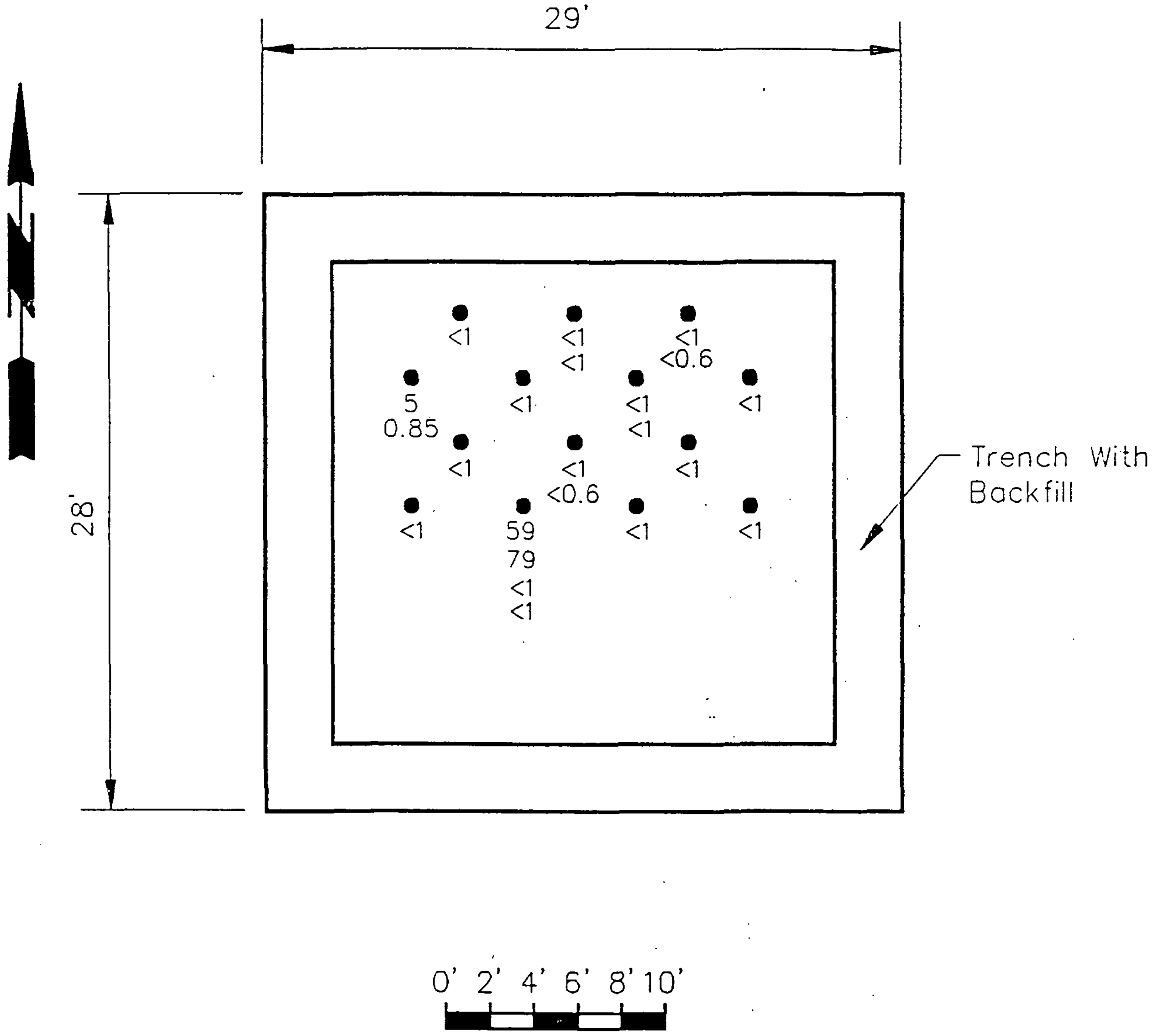
Note:
Samples Taken on June 6, 1989 ,
Numbers Shown are Station/Sample Numbers

HDR

PCB Spill Remediation
PCB Soil Sampling

Locations at T-17

FIGURE
2.1



Note:
Samples Taken on June 6, 1989

PCB Spill Remediation
PCB Soil Sampling

(PPM) at T-17

FIGURE 2.2

3. SITE T-12 RISK ASSESSMENT

3.1 INTRODUCTION

The T-12 site is located several hundred feet south of the T-17 site, near the south side of the former plywood plant building. Topographically, the site is relatively flat at an elevation of approximately 410 feet above mean sea level. The site is almost 2,000 feet east of the Snoqualmie River and approximately 100 feet north of a log pond (an old meander of the Snoqualmie River).

There is a shallow perched groundwater system beneath the site, with a depth of two to three feet at certain locations. This water is perched on a clay aquiclude and fluctuates seasonally. Results of subsurface investigation have shown the clay layer extends from 5 to 15 feet in depth and is underlain by saturated silty sands (HDR, 1989h). Groundwater at the site appears to flow towards the northwest. The Snoqualmie Falls Dam, located almost one mile northwest of the T-12 site, creates a hydraulic control for surface water and groundwater movement.

Initial sampling activities at the former transformer sites included laboratory analysis of PCBs, chlorinated hydrocarbons, and dioxins and dibenzofurans (a toxic substance produced when PCBs are subjected to extreme temperatures). Soil samples analyzed for dioxin/furans were determined to be in association with PCB-contaminated soils and contain less than a 1.0 ppb toxicity equivalence level. Further analysis of dioxin/furans for the purpose of risk reduction was, therefore, not considered necessary.

Investigations indicated that between 1 and 71 pounds of PCBs remain in the deeper soils (below 13 feet in depth) at the T-12 site. In general, chlorobenzene concentrations correlate with PCB concentrations at respective sampling locations; where PCB levels are relatively high, the corresponding chlorobenzene levels are elevated. Based on these correlations it is assumed that approximately 0.1 to 6 pounds of trichlorobenzene and .004 to 0.3 pounds of tetrachlorobenzene remain in the soil below 13 feet in depth at the T-12 site. The subsurface investigation (HDR, 1989h) indicated that contaminants had not penetrated to the saturated soils underlying the clay layer. Remaining PCBs and chlorobenzenes are assumed to be associated with the clay stratum.

The following describes the contaminants of concern, their toxicity, and migration potential. Potential routes of exposure are discussed and the population risk from the remaining contaminants at the T-12 site are estimated.

3.2 HAZARD IDENTIFICATION

Preliminary sampling by Weyerhaeuser Company and subsequent soil testing indicated that the residual contaminants of concern at the T-12 site include PCB as Aroclor 1260, 1,2,4-Trichlorobenzene, 1,2,3-Trichlorobenzene, 1,2,5-Trichlorobenzene, 1,2,3,4-Tetrachlorobenzene, and 1,2,4,5-Tetrachlorobenzene.

PCBs

PCBs consist of a mixture of chlorinated biphenyls that contain a variable number of substituted chlorine atoms on the aromatic rings. The commercial PCBs manufactured in the United States are known as Aroclors followed by a 4-digit number. The first two digits indicate the type of mixture (i.e. "12" as the first two digits are chlorinated biphenyls), and the last two digits represent the approximate weight percent of chlorine in the product (U.S.EPA, 1986). Commercial products range from 12 to 68 percent chlorine. Aroclor 1260 contains 60 percent chlorine. The degree of chlorination is important in toxicological characterization of PCBs because if affects the physiochemical properties that determine bioaccumulation potential and the ability of organisms to metabolize and eliminate PCBs (Safe, 1980). Physical properties of aroclors, including Aroclor 1260 found at the T-12 site, are shown on Table 3.1.

PCBs have a very low water solubility, low vapor pressure, and a high dielectric constant. In addition, PCBs exhibit high distribution coefficient values and therefore adsorb strongly to soil organic matter. PCBs are soluble in lipids, oils, and organic solvents, are resistant to both heat and biological degradation, and are characterized by high bioaccumulation potential. Generally, higher chlorinated PCB isomers are less soluble in water, preferentially adsorbed by soil material, less mobile in soil, less degradable by microorganisms, and less volatile from water than lower chlorinated isomers (Griffin et al., 1980).

PCBs may be transported and partitioned by air, soil, water, aquatic sediments, and biota. The low water solubility and low volatility of PCBs indicate that they are partitioned most heavily into the organic fraction of soil, sediments, airborne particulate, and biological tissues. Major pathways of human exposure are ingestion of soils, inhalation of dust, direct contact with sediments or soils, and ingestion of bottom- feeding or bottom-dwelling aquatic organisms that accumulate PCBs through contact with contaminated sediments or ingestion of contaminated prey (Kimbrough, 1980). Once absorbed, PCBs are initially concentrated in the liver, blood, and muscle tissues. Long-term storage is in the skin and adipose tissue (Safe, 1980). Because PCBs are fat soluble and poorly metabolized, they have entered the food chain and accumulated in the adipose tissues of fish, birds, and mammals, including humans. The bioconcentration factor (BCF) (ratio of tissue concentration/media concentration) in fish for PCBs is high; at approximately 100,000 for PCB-1260 (U.S.EPA, 1986).

Laboratory studies with animals have shown that PCBs can cause enlargement of the liver, induction of hepatic microsomal enzymes, reproductive failures, gastric disorders, skin lesions, and tumors in birds and mammals (Griffin et al., 1980).

An incident in Japan documented approximately 2,000 Japanese people that experienced lesions of the skin, facial swelling, and neurological disorders. The individuals with the highest dosages had nausea, lassitude, anorexia, impotence, and hematuria. The severity of

TABLE 3.1

PROPERTIES OF AROCLORS (a)

Property	1016	1221	1232	1242	1248	1254	1260*
Appearance	Clear Oil	Clear Oil	Clear Oil	Clear Oil	Clear Oil	Light Yellow Viscous Resin	Light Yellow Sticky Resin
Chlorine (percent)	41	20.5–21.5	31.4–32.5	42	48	54	60
Density (gm/cm3) (25 C)	1.33	1.15	1.24	1.35	1.41	1.50	1.58
Distillation Range (C)	325–356	275–320	290–325	325–366	340–375	365–390	385–420
Evaporation Loss (%) 100 C/t hrs	NA	1–1.5	1–1.5	0–0.4	0–0.3	0–0.2	0–0.1
Aqueous Solubility (mg/l)	0.42	[15.0]	[1.45]	0.24 0.34 0.13	0.054	0.012 0.24 0.56	0.0027
Vapor Pressure	0.0004	0.0067	0.00406	0.000406	0.0000494	0.0000771	0.0000405
Octanol/Water Partition Coefficient	4.38 >5.58	[2.8] 4.09	[3.2] >4.54	4.11 >5.58	[5.75] >6.11	[0.03]	[7.14] >6.11
CAS No.		111–042–82	111–411–65	534–692–19	126–722–96	110–976–91	110–968–25

(a) Data from U.S. EPA, 1986, Health Effects Assessment for Polychlorinated Biphenyls.

* Aroclor at T–12

Bracketed data are estimated.

the symptoms were directly related to the quantities of PCBs ingested. Placental transfer of PCBs had occurred in pregnant women and had adversely affected the fetuses. The toxic effects noted were similar to those reported in animal studies (U.S. EPA, 1986). Experiments have shown that PCBs have a relatively low acute toxicity. Death resulting from a single exposure would require a massive dose. The acute rat oral LD50 (the exposure necessary to kill 50 percent of the test rats) for Aroclor 1260 is 1315 mg/kg, which is about the same as that for aspirin (Tatken and Lewis, 1983).

Since PCBs tend to be concentrated and metabolized in the liver, and redistributed to skin and adipose tissues for long-term storage, large exposures or repeated chronic exposures to PCBs may have profound long-term toxic effects. Hepatoxicity and dermal skin lesions are major manifestations of PCB poisoning.

Although PCBs have not been shown to be teratogenic, transplacental transport of PCBs may result in fetotoxicity. Studies indicated that there was sufficient evidence to conclude that PCBs are carcinogenic in laboratory rodents. Applying the criteria for evaluating the overall weight of evidence for carcinogenicity to humans proposed by the Carcinogen Assessment Group of the U.S. EPA (Federal Register, 1984), PCBs are classified as Group B2 - Probable Human Carcinogens (U.S.EPA, 1986).

Chlorinated Benzenes

Chlorinated benzenes are a group of cyclic aromatic compounds in which one to six hydrogen atoms of a benzene ring have been replaced by up to six chlorine substitutions yielding twelve compounds. Five of these compounds have been identified at the T-12 site: three isomers of trichlorobenzene (1,2,4-Trichlorobenzene, 1,2,3-Trichlorobenzene, 1,2,5-Trichlorobenzene), and two out of the possible three isomeric forms of tetrachlorobenzene (1,2,3,4-Tetrachlorobenzene, and 1,2,4,5-Tetrachlorobenzene).

The physical properties of chlorinated benzenes vary with the degree of chlorine substitution. In general chlorinated benzenes have low water solubility (solubility decreasing with increasing chlorination), low flammability, moderate to high octanol/water partition coefficients (coefficients increasing with increasing chlorination) and low to moderate vapor pressures (vapor pressures decreasing with increasing chlorination). Physical properties of the tri-and tetra-chlorobenzenes found at the T-12 site, are shown on Table 3.2.

Once introduced into the environment chlorinated benzenes may be transported and partitioned in air, soil, water, aquatic sediments, and biota. The low solubility of trichlorobenzene (TCB) and tetrachlorobenzene (TTCB) suggest that they are more readily transported onto the organic fraction of soils, sediments, airborne particulates, and biological tissues. The higher volatility of TCB indicate that they may be transported as a vapor in ambient air. Major pathways of human exposure for TCB and TTCB are inhalation of vapors and dust, ingestion of bottom-feeding or bottom-dwelling aquatic animals that have accumulated chlorinated benzenes, ingestion of soils, and direct dermal contact with sediments or soils.

TABLE 3.2

PROPERTIES OF CHLORINATED BENZENES (a)

	Molecular Weight	Melting Point (C)	Boiling Point (C)	Density (g/ml)	Henry's Law Constant x 10 (atm m mol)	Log pod	Water Solubility (mg/l)	Flash Point (C or F)	Index of Refraction at (C)
Trichlorobenzene									
1,2,3–	181.46	52.60	221.0	1.69	1.0	4.10	31.5	113 C	1.5776
1,2,4–	181.46	16.95	213.5	1.45	4.3	4.12	34.6	110 C	1.5717
1,3.5–	181.46	63.40	208.4	1.39		NA	6.6	107 C	1.5662
Tetrachlorobenzene									
1,2,3,4–	215.9	47.5	254	NA		NA	4.30	NA	NA
1,2,4,5–	215.9	139.5	246	1.86		4.93	0.60	311 F	NA

(a) Data From U.S. EPA, 1985, Health Assessment Document for Chlorinated Benzenes.

NA = Not Applicable

P= Partition Coefficient at 25 C.

Chlorinated benzenes are resistant to chemical and biological degradation and tend to accumulate in lipid-containing adipose tissues of animals and humans. The BCF is a function of the number of chlorine atoms in the molecule. The bioconcentration factor (ratio of tissue concentration/media concentration) in fish is greater for tetrachlorobenzene (TTCB) than for trichlorobenzene (TCB); at between 5,200 to 13,000 for TTCB and between 900 to 4,100 for TCB (U.S. EPA, 1984). Both TTCB and TCB have much lower bioconcentration factors than PCBs (100,000).

Inhalation and oral toxicity studies in several species indicate that subchronic exposure to chlorinated benzenes resulted in hepatic and renal degeneration and necrosism disrupting porphyrin metabolism, and depressing the short-term functioning of the nervous system. Acute toxic effects in experimental animals include local irritation, convulsion, and death. Animal studies indicate a trend of increasing toxicity with increased chlorination of the benzene ring, i.e tetrachlorobenzene is more porphyrinogenic than trichlorobenzene. The oral dose causing death in 50 percent of the test specimens (lethal dose-50 or "LD50" for 1,2,4,5-tetrachlorobenzene was reported as 1500 mg/kg in rats and rabbits (U.S.EPA, 1984). The oral LD50 value of 1,2,4 trichlorobenzene is about 760 mg/kg in experimental rats (Tatken and Lewis, 1983).

High occupational or domestic human exposure to chlorinated benzene may cause eye irritation, respiratory irritation, and aplastic anemia. Acute exposure may cause drowsiness, incoordination, and unconsciousness. Chronic exposure may result in liver, kidney and lung damage as indicated by animal experiments (U.S.EPA, 1984).

Tetrachlorobenzene and trichlorobenzene have not been shown to be either teratogenic or carcinogenic in experimental animals.

3.3. DOSE-RESPONSE ASSESSMENT

Dose-response is the relationship between the dose and an incidence in humans. It can be described as the chemical's potency, or how strongly it elicits a response at various levels of exposure. This section describes the pertinent criteria, for the protection of human health and the environment from contaminants at the site, that will be used in the risk assessment

For carcinogenic chemicals such as PCBs, a safe level of exposure cannot be determined. Instead, EPA and other Federal agencies have taken the position that cancer may occur at any dose with the risk of cancer increasing as exposure increases. The risk of developing cancer is determined by knowing the cancer potency (potency factor) of the chemical and amount of chemical to which a person is exposed to. The amount of chemical to which a person is exposed to, discussed in Section 3.4, is based on the selected exposure scenarios and parameters. The potency factor is ultimately derived from data generated by chronic feeding studies in rats and mice. The potency factor is calculated using a linearized multistage model procedure for low-dose extrapolation. This model leads to a plausible upper limit (upper 95 percent confidence limit) of carcinogenic risk. It is based on a 70 kg (154 lb) person who drinks 2 liters of water per day over a 70-year lifetime. The potency factor is expressed in units of (mg/kg/day). The carcinogenic potency, or potency factor for PCB is 7.7 mg/kg/d (Davoli, Woodruff, 1990).

As indicated in the previous section, trichlorobenzene and tetrachlorobenzene are noncarcinogenic. Consequently, the health risk is conducted by comparing the estimated daily exposure, discussed in Section 3.4, to the reference dose (RFD). The reference dose is based on the no observable effects level (NOEL), or the level that a study group exposed to a chemical has no observable effects, and uncertainty factors. The NOEL is divided by an uncertainty factor to obtain the reference dose. The uncertainty factors depends on what the study data is derived from. The uncertainty factor used to determine the RFDs for TCB and TTCB is 1,000. The oral, chronic reference dose for trichlorobenzene is .02 mg/kg/d and for tetrachlorobenzene is .0003 mg/kg/d (Davoli, Woodruff).

3.4. EXPOSURE ASSESSMENT

3.4.1. Migration Potential

Migration Pathways

Generally, there are four environmental media through which people and animals can come into contact with hazardous wastes from uncontrolled sites: 1) groundwater, 2) surface water, 3) air, and 4) solids (i.e. soil, sediments, sludge, and actual wastes).

Previous studies at the Snoqualmie T-12 site indicated that PCBs and chlorobenzenes are located in the deeper soils, below 13 feet in depth, and have not migrated to saturated soils underlying the clay layer. The only potential migration pathways of these chemicals would be into the saturated soil zone and through the groundwater downgradient towards the Snoqualmie River.

Environmental media through which people and animals could potentially come in contact with PCBs and chlorobenzenes from the T-12 site, therefore, would be groundwater and possibly surface water (Snoqualmie River). Since the contaminants of concern at the T-12 site are buried, inhalation via air and direct contact with contaminated soils and/or sediments are not considered to be a potential exposure routes.

Mobility of PCBs and Chlorobenzenes

Studies have shown that the mobility of different PCB Aroclors in soils as it pertains to leaching is based mainly on the characteristic of the soils and the nature of the Aroclors (U.S.EPA, 1986). As the chlorine content of an Aroclor increases, the adsorption characteristics in soils increase, thereby decreasing its rate of leaching. Similarly, soils with more organic matter content tend to increase the adsorption and decrease the leaching rate. Therefore, maximum leaching of Aroclors is expected in sandy soils and with Aroclors having lower chlorine content, such as Aroclor 1221 and Aroclor 1232. Aroclor 1260, found at the T-12 site, has a higher chlorine content decreasing its rate of leaching.

Studies where water was percolated through soil columns containing PCBs concluded that PCBs are not readily leached from soils (Tucker et al, 1975). A number of experiments have shown that PCB are quickly and extensively adsorbed onto clays (Hamelink, et al., 1971) and other soil types (Oloffs, et al., 1974; Haque, et al., 1974; Moein, et al., 1976; Paris, et al., 1978). Studies performed of PCB adsorption by various earth materials concluded that total organic carbon was the most important property of earth material controlling PCB adsorption. Additionally surface area of soils was also found to be an important property controlling PCB adsorption. The adsorption constant (K) was found to increase with the amount of total organic carbon and surface area of soil (Griffin et al, 1980). Clayey soils in the unsaturated zone and found at the T-12 site will have higher adsorption characteristics as compared to sandy soils. Saturated silty fine sand containing organic matter was observed in the soil borings below the clay layer at the T-12 site. According to studies, these soils would also exhibit relatively high adsorption characteristics.

Studies indicate that PCB adsorbed onto soil will not easily desorb in the aqueous phase. Additionally, the hydrophobic characteristics of PCBs make them easily adsorbed from aqueous solution onto available surfaces. PCBs, therefore, are expected to exhibit very limited mobility in groundwater as dissolved compounds (Griffin, 1984).

An investigation was performed of PCB and chlorobenzene migration at an askarel spill two years after the occurrence of the spill. Results of the study showed that PCBs as Aroclor 1254 was preferentially retained in the soil. The more water-soluble components of the chlorobenzene askarel solvent migrated almost immediately after the occurrence of the spill. Leaching was the migration mechanism responsible for the intrusion of the lower chlorinated benzenes (i.e. trichlorobenzene) into the groundwater. The higher chlorinated benzenes such as tetrachlorobenzene were retained in the soil (Moein, 1976). From this study it appears that TTCB exhibits similar adsorption characteristics as PCBs. Both have relatively low solubility, bind tightly to soils and remain highly immobile under stable conditions.

Computer Modeling of PCB Migration

The computer model SLAPMAN was used to evaluate the migration of PCBs through the unsaturated zone at the T-12 site. SLAPMAN is a set of computer programs designed to estimate concentrations for chosen chemicals migrating from an application area through the unsaturated zone, and to the saturated zone where sorption due to eh/ph differences is simulated. The SLAPMAN methodology consists of a series of data manipulation and transport simulation programs. The model then predicts the concentrations of the chemicals at the interface of the saturated zone and assumes the point of use is where the contaminants enter the groundwater, i.e. there is no saturated zone transport.

SLAPMAN was developed to evaluate the risks to human health and the environment associated with the land application of municipal sewage sludge as a disposal option. The model calculates a "reasonable worst case" level of human exposure to chemical leaching from an application area. Application of the model of the model to the scenario present at the T-12 site required multiple runs to evaluate how key parameters effected the model for this type of site and contaminants (i.e., one-time contaminant application vs periodic applications).

To simulate PCB migration at the T-12 site the characteristics of contaminated site soils were input as the characteristics of a municipal sewage sludge. Input parameters were developed from existing physical and chemical data collected on the site. Default parameters supplied by the model were used in cases where specific data was not available from direct field or laboratory measurements. All default values supplied from the model were obtained from the literature as cited in the SLAPMAN users manual. The chemical concentration of PCB at the saturated zone, calculated by the model was 6.45 mg/kg.

3.4.2. Exposure Scenarios

Potential routes of exposure of contaminants include ingestion, inhalation, and dermal penetration. Since the contaminants of concern at the T-12 site are buried (below 13 feet in depth) exposure from inhalation and dermal penetration is not likely. Therefore, only ingestion is considered as a potential exposure route at the T-12 site. Ingestion may include soil ingestion, drinking water ingestion, and fish ingestion. Again, since the contamination at the T-12 site is buried, soil ingestion would not be likely. The routes of exposure examined in this risk assessment will be drinking water ingestion and fish ingestion. All exposure scenarios assume institutional controls will be established to prevent future accidental excavation of the site.

Drinking Water

Exposure to contaminated drinking water may occur if site contaminants migrate downward into groundwater or surface water and if these sources are utilized for drinking water. At present no drinking water is obtained from the Snoqualmie River or streams in the immediate vicinity of the Weyerhaeuser facility except for the Snoqualmie Mill which obtains its water from Tokul Creek; upgradient of the T-12 site (McCullough, 1990). The City of Snoqualmie currently supplies water to the majority of the area within the town of Snoqualmie, including the Snoqualmie Falls Lodge and Park and the sewage treatment facility, northwest of the T-12 site. The City of Snoqualmie obtains its water from a spring several miles upstream of the City of Snoqualmie City Limits. North of the Snoqualmie mill, water is obtained from groundwater well. These wells are located upgradient of the T-12 site.

As was discussed earlier, deeper groundwater in the vicinity of the T-12 site appears to flow in a northwest direction towards the Snoqualmie Falls Dam. Currently no groundwater wells are located immediately northwest of the T-12 site. Land northwest of the T-12 site is mostly owned by Weyerhaeuser and is wooded or is used for log storage. Between Weyerhaeuser property and the Snoqualmie Falls Dam, northwest of the T-12 site, is the wastewater treatment facility and the Snoqualmie power plant substation and control facilities, serviced by City of Snoqualmie water. Below the Snoqualmie Falls Dam are a few domestic wells. Examination of water well reports of these wells and from wells throughout the area, indicate that groundwater is obtained from an aquifer much deeper than the groundwater potentially contaminated by the T-12 site. Clay layers would isolate the deeper aquifer from potentially contaminated surface or groundwater originating from the site.

Investigations of future land use plans for the area were performed to determine if residential development and/or potential domestic groundwater wells may locate immediately downgradient of the T-12 site. Future land use plans have classified land use northwest of the T-12 site, up to the Snoqualmie Falls Dam as heavy manufacturing (King

County, 1989). As a result of this type of future land use, no future domestic groundwater wells are expected in this area. Low density residential development is planned north, and northwest of the T-12 site below Snoqualmie Falls. However, domestic wells in these areas would be either up gradient, north of the T-12 site, or within a separate deeper aquifer than the groundwater potentially contaminated by the T-12 site.

Despite the unlikelihood of current or future groundwater use (and lack of data indicating any groundwater contamination), contaminated drinking water would be a potential exposure route. Results from the groundwater model, described earlier, indicate the concentration of PCBs present at the interface of the saturated zone is 6.45 mg/kg. The water solubility, the mass of a compound that is miscible with water, for PCB-1260 is .0027 mg/kg. Therefore, .0027 mg/kg is the maximum amount of PCB-1260 that can be in groundwater. For the purpose of the exposure determination, it will be assumed that the concentration of PCBs in the groundwater for a worse case scenario is .0027 mg/kg.

Previous studies indicated that chlorobenzene concentrations at the T-12 site correlated with PCB concentrations (HDR 1989h). Based on these correlations it is assumed that the concentration of TCB at the T-12 site is 8.5% of the concentration of PCBs. The concentration of TTCB is assumed to be .44% of the concentration of PCBs. Assuming the concentration of PCBs at the interface of the saturated zone is 6.45, the concentration of TCB at the interface would be .548 for trichlorobenzene and .028 for tetrachlorobenzene. The water solubility for both TCB and TTCB are above .548 and .028 (see Table 3.2).

The following additional assumptions are made in estimating the drinking water exposure:

> Worst-case PCB and chlorobenzene concentrations in the medium of concern (i.e. drinking water) will be the same as the concentration assumed at the groundwater interface beneath the T-12 site (i.e. no adsorption or dilution will occur as groundwater at the T-12 site migrates towards drinking water wells)
>
> PCB and chlorobenzene concentrations in drinking water will remain the same over the next 70 years (i.e. no changes in groundwater concentration occur)
>
> A consumption rate of 2,000 g (2 L) of water/day
>
> Water will be consumed over a 70 year life span
>
> The absorption of waterborne contaminants in the gastrointestinal tract is 30%
>
> The average body weight of exposed individual(s) is 70 kg

Fish Ingestion

Although no commercial fishing is conducted on the Snoqualmie River, the Snoqualmie River supports an outstanding steelhead fishery. A review of steelhead catch records for the winter runs reveals that the Snoqualmie River was consistently in the top 10 rivers in Washington for number of steelhead harvested by anglers. Other resident fish species include cutthroat, rainbow trout and brook trout. There are no anadromous species in the upper Snoqualmie River because of the barrier created by the Snoqualmie Falls. However, chinook and coho salmon species reside in the Snoqualmie River below the falls. (King County, 1984)

Fish contamination resulting from the transport of eroded soil via runoff from the contaminated site to local surface waters is unlikely since contamination at the T-12 site is located below 13 feet in depth. However, exposure to contaminated fish may occur if site contaminants migrate into groundwater and eventually flow into a water body (i.e. Snoqualmie River). Studies of the area suggest that the groundwater flow is hydrologically linked to the Snoqualmie River. Once contaminants such as PCBs have entered a water body, it has been shown to accumulate in river sediments and bioconcentrate in aquatic species.

Although PCBs and chlorobenzenes were not detected in the groundwater in previous studies (HDR, 1989h) and contamination of river sediments and aquatic species is unlikely, ingestion of contaminated fish species is a potential exposure route. Assumptions used in estimating the exposure via the fish ingestion route include:

> Worse-case PCB and chlorobenzene concentrations assumed for groundwater/drinking water will be the same for sediments (i.e. no adsorption or dilution will occur as groundwater migrates towards the Snoqualmie River)
>
> Fish in the Snoqualmie River contain PCBs and chlorobenzene at about 20% of the sediment level
>
> PCB and chlorobenzene concentrations in the medium of concern (i.e. fish muscle) will remain the same over the next 70 years
>
> A consumption rate of 6.5 g/day of fish from the Snoqualmie River
>
> Fish will be consumed from the Snoqualmie River over a 70 year life span
>
> The absorption of contaminants in the gastrointestinal tract is 30%.
>
> The average body weight of exposed individual(s) is 70 kg

3.5. RISK CHARACTERIZATION

3.5.1 Estimation of Risks Associated with Exposures

The potential health and environmental risks resulting from exposure to the contaminants identified at the T-12 site have been calculated based on the results of the exposure assessment combined with toxicity information. Risks have been estimated for worst- ,mid- and low- case conditions. Worst-case assumptions are very conservative and exceed probable field conditions. Mid- and low- range analyses, therefore, were conducted to provide more reasonable estimates. Mid- and low- case estimates assume reductions in contaminant concentrations in the exposure medium.

PCBs

The carcinogenic risks due to exposure to PCBs at the T-12 site are assumed to be a function of the computed exposure value and the potency factor. The exposure value is calculated using the exposure scenarios and assumptions previously described. The potency factor was provided by U.S. EPA. Risks for PCB-1260 have been calculated by the unit risk method (exposure times potency). The cancer risk is expressed as a unitless probability of cancer incident at some point during an assumed 70-yr human life span.

Results of the worst-case risk analysis for PCBs indicate a total increased lifetime cancer risk of 1.8 x 10-4 or 1.8 chances in 10,000. This includes exposure from drinking water and fish ingestion; at 1.8 chances in 10,000 for drinking water and 1.2 chances in 10,000,000 (1.2 x 10-7) for fish ingestion. Mid-case and low-case risk analysis totals are 1.8 chances out of 100,000 (1.8 x 10-5) and 1.8 chances out of 1,000,000 (1.8 x 10-6), respectively. Worst-, mid- and low-case risk estimates for each route of exposure are presented in Tables 3.3, 3.4 and 3.5.

Migration of PCBs was calculated to determine the concentrations of PCBs at a distance from the T-12 site if PCBs were to enter the water-bearing zone beneath the clay layer. Calculations were performed assuming that the mass of PCBs retained in the overlying clay layer is proportional to the reduction in PCB concentration calculated by the SLAPMAN model. The resulting "worst-case" amount of PCBs entering the silt layer would be (6.45/900) x 71 lbs = 0.5 lbs. The amount of PCB adsorbed per unit weight of adsorbent was assumed to be 200 ug/g or .10 kg per cubic foot of soil. Adsorption data was obtained from a study entitled "Adsorption of Water-Soluble Polychlorinated Biphenyl Aroclor 1242 and Used Capacitor Fluid by Soil Materials and Coal Chars" (Lee, et al. 1980). Studies indicate a linear correlation in PCB concentration to the adsorption capacity in soil. Even though Aroclor 1260 is the predominant aroclor at the T-12 site, an assumed adsorption factor of 200 ug/g is a conservative estimate; based on a PCB concentration of 0.5 ppm. The adsorption factor would actually be above 200 ug/g. PCB contaminant migration fronts of .05 square feet and 0.5 square feet were used together with the PCB adsorption factor to estimate a range for the absolute migration distance (i.e. where the PCB mass is exhausted by soil absorption) to be between 5 and 45 feet from the T-12 site. With a higher adsorption factor and a widening (diffusive) contaminant front, the distance from the T-12 site would be even less. The results of the migration calculations are shown on Figure 3.1.

For worst-case risk estimates it is assumed that PCB concentrations are directly below the T-12 site. For a mid-case scenario, it is assumed that PCBs have been attenuated to ten percent of the original amount at approximately 40 feet from the T-12 site. For a low-case scenario, PCBs would have attenuated to one percent of the original amount at no more than 45 feet from the T-12 site. The log pond is over 100 feet from the site, the Snoqualmie River is over 2,000 feet from the T-12 site, and existing groundwater wells are even further away from the T-12 site.

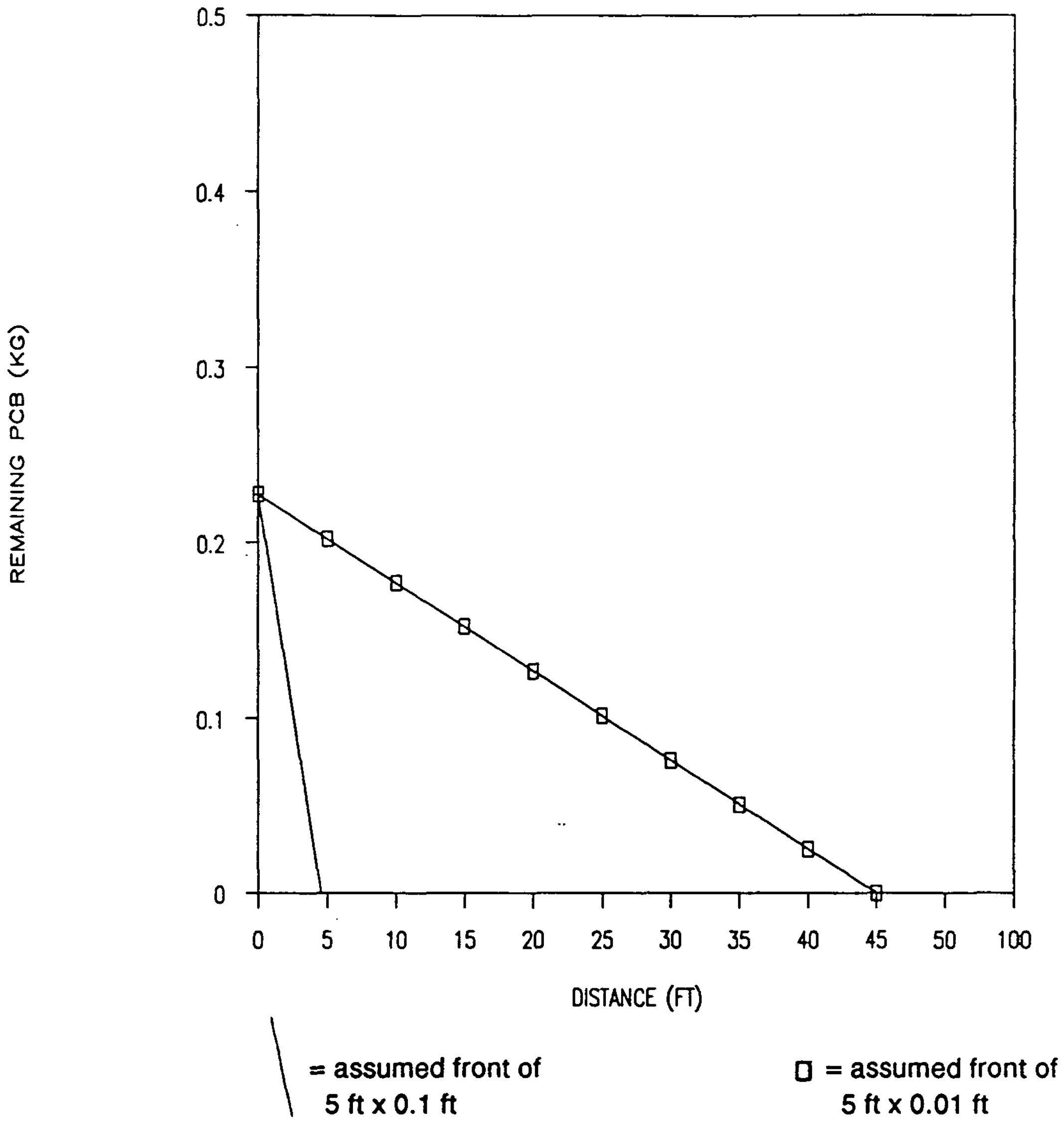


FIGURE 3.1: PCB MIGRATION

TABLE 3.3
WORST–CASE ESTIMATED CANCER RISK FOR EXPOSURE TO PCB CONTAMINATED GROUNDWATER AND SURFACE WATER

	Exposure Determination					Risk Determination		
Route of Exposure	Concen–tration (mg/kg)	Contact Rate (g/day)	Exposure Duration (yrs)	Absorbed Fraction (g/g)	Body Weight (kg)	Exposure Value (mg/kg/d)	Potency Factor (mg/kg/d)	Risk
Drinking Water	0.0027000	2000	70	0.30	70	2.3E–05	7.7	1.8E–04
Fish Ingestion	0.0005400	6.5	70	0.30	70	1.5E–08	7.7	1.2E–07
Sum						2.3E–05		1.8E–04

Concentration of contaminant in exposure meduim

Amount of contaminated medium ingested per day

Ratio of g of contaminant absorbed/g of contaminant ingested

Risk = potency factor x exposure value

TABLE 3.4
MID–CASE ESTIMATED CANCER RISK FOR EXPOSURE TO PCB CONTAMINATED GROUNDWATER AND SURFACE WATER

	Exposure Determination						Risk Determination	
Route of Exposure	Concen–tration (mg/kg)	Contact Rate (g/day)	Exposure Duration (yrs)	Absorbed Fraction (g/g)	Body Weight (kg)	Exposure Value (mg/kg/d)	Potency Factor (mg/kg/d)	Risk
Drinking Water	0.0002700	2000	70	0.30	70	2.3E–06	7.7	1.8E–05
Fish Ingestion	0.0000540	6.5	70	0.30	70	1.5E–09	7.7	1.2E–08
Sum						2.3E–06		1.8E–05

Concentration of contaminant in exposure meduim

Amount of contaminated medium ingested per day

Ratio of g of contaminant absorbed/g of contaminant ingested

Risk = potency factor x exposure value

TABLE 3.5
LOW-CASE ESTIMATED CANCER RISK FOR EXPOSURE TO PCB CONTAMINATED GROUNDWATER AND SURFACE WATER

	Exposure Determination					Risk Determination		
Route of Exposure	Concentration (mg/kg)	Contact Rate (g/day)	Exposure Duration (yrs)	Absorbed Fraction (g/g)	Body Weight (kg)	Exposure Value (mg/kg/d)	Potency Factor (mg/kg/d)	Risk
Drinking Water	0.0000270	2000	70	0.30	70	2.3E-07	7.7	1.8E-06
Fish Ingestion	0.0000054	6.5	70	0.30	70	1.5E-10	7.7	1.2E-09
Sum						2.3E-07		1.8E-06

Concentration of contaminant in exposure meduim

Amount of contaminated medium ingested per day

Ratio of g of contaminant absorbed/g of contaminant ingested

Risk = potency factor x exposure value

Chlorobenzenes

Since trichlorobenzene and tetrachlorobenzene are not considered carcinogenic, the risk assessment was conducted by estimating the average daily exposure for drinking water ingestion and fish ingestion. These exposure values were then compared to the reference dose (RFD) provided by the U.S. EPA.

The estimated worst-case daily exposure values summed for both the drinking water and fish ingestion exposure pathways was .0047 for TCB and .00024 for TTCB. The greatest proportion of exposure was from the drinking water pathway. The U.S. EPA's interim reference dose values for TCB and TTCB are .02 and .0003, respectively. Thus, under worst-case assumptions, the total estimated intake of TCB is less than the RFD, therefore posing no appreciable health risk. Tables 3.6, 3.7 and 3.8 present worst- mid- and low- case risk estimates for each route of exposure for TCB. Complete worst-, mid-, and low-case risk estimates for TTCB are presented in Tables 3.9, 3.10, and 3.11.

3.5.2. Assumptions and Uncertainties of the Risk Assessment

Since PCB, TCB and TTCB were not detected in previous studies (HDR, 1989h) in the saturated zone below the T-12 site, the assumption that these chemicals will eventually migrate into the groundwater is unlikely. Additionally, the possibility of drinking water wells being located within the same aquifer is unlikely due to the present and planned future land uses in the vicinity. The potential for fish to come in contact with contaminated sediments is also extremely improbable since the distance from the T-12 site to the Snoqualmie River is over 2000 feet.

Using water solubility as the concentration of PCB in groundwater wells is a very conservative approach. As discussed in Section 3.4.1, PCBs will be adsorbed onto soil particles as they migrate through the groundwater. The concentration of PCBs in the groundwater and/or river sediments, therefore, will be significantly diluted downgradient of the source. This phenomenon is described in a study for the U.S.EPA of a PCB spill site: "By definition, dynamic equilibrium between the contaminated soil and the groundwater results in some finite soluble PCB value, although extremely low. However the equilibrium would shift towards the soil phase when the groundwater moves downgradient to areas of lesser or no soil contamination. This would result in increased adsorption of any PCB in the groundwater onto the soil" (GCA Technology Division, 1986). Although the adsorption constant (K) value may be a better indicator of the potential for PCB migration than PCB water solubility, water solubility was used for the purpose of this risk assessment as a worst-case scenario.

TABLE 3.6
WORST–CASE COMPARISON OF ESTIMATED DAILY EXPOSURE TO TRICHLOROBENZENE TO THE INTERIM U.S. EPA RFD VALUES

	Exposure Determination					Risk Determination		
Route of Exposure	Concen–tration (mg/kg)	Contact Rate (g/day)	Exposure Duration (yrs)	Absorbed Fraction (g/g)	Body Weight (kg)	Exposure Value (mg/kg/d)	RFD (mg/kg/d)	Chronic Exposure/ RFD
Drinking Water	0.5480000	2000	70	0.30	70	4.7E–03	0.02	2.3E–01
Fish Ingestion	0.1100000	6.5	70	0.30	70	3.1E–06	0.02	1.5E–04
Sum						4.7E–03		2.4E–01

Concentration of contaminant in exposure meduim

Amount of contaminated medium ingested per day

Ratio of g of contaminant absorbed/g of contaminant ingested

Reference Dose (RFD) provided by the U.S. EPA (January 1990, personal communication)

TABLE 3.7
MID–CASE COMPARISON OF ESTIMATED DAILY EXPOSURE TO TRICHLOROBENZENE TO THE INTERIM U.S. EPA RFD VALUE

	Exposure Determination					Risk Determination		
Route of Exposure	Concen–tration (mg/kg)	Contact Rate (g/day)	Exposure Duration (yrs)	Absorbed Fraction (g/g)	Body Weight (kg)	Exposure Value (mg/kg/d)	RFD (mg/kg/d)	Chronic Exposure/ RFD
Drinking Water	0.0548000	2000	70	0.30	70	4.7E–04	0.02	2.3E–02
Fish Ingestion	0.0110000	6.5	70	0.30	70	3.1E–07	0.02	1.5E–05
Sum						4.7E–04		2.4E–02

Concentration of contaminant in exposure meduim

Amount of contaminated medium ingested per day

Ratio of g of contaminant absorbed/g of contaminant ingested

Reference Dose (RFD) provided by the U.S. EPA (January 1990, personal communication)

TABLE 3.8
LOW-CASE COMPARISON OF ESTIMATED DAILY EXPOSURE TO TRICHLOROBENZENE TO THE INTERIM U.S. EPA RFD VALUE

	Exposure Determination					Risk Determination		
Route of Exposure	Concentration (mg/kg)	Contact Rate (g/day)	Exposure Duration (yrs)	Absorbed Fraction (g/g)	Body Weight (kg)	Exposure Value (mg/kg/d)	RFD (mg/kg/d)	Chronic Exposure/ RFD
Drinking Water	0.0054800	2000	70	0.30	70	4.7E-05	0.02	2.3E-03
Fish Ingestion	0.0011000	6.5	70	0.30	70	3.1E-08	0.02	1.5E-06
Sum						4.7E-05		2.4E-03

Concentration of contaminant in exposure meduim

Amount of contaminated medium ingested per day

Ratio of g of contaminant absorbed/g of contaminant ingested

Reference Dose (RFD) provided by the U.S. EPA (January 1990, personal communication)

TABLE 3.9
WORST–CASE COMPARISON OF ESTIMATED DAILY EXPOSURE TO TETRACHLOROBENZENE TO THE INTERIM U.S. EPA RFD VALUE

	Exposure Determination					Risk Determination		
Route of Exposure	Concentration (mg/kg)	Contact Rate (g/day)	Exposure Duration (yrs)	Absorbed Fraction (g/g)	Body Weight (kg)	Exposure Value (mg/kg/d)	RFD (mg/kg/d)	Chronic Exposure/ RFD
Drinking Water	0.0280000	2000	70	0.30	70	2.4E–04	0.0003	8.0E–01
Fish Ingestion	0.0056000	6.5	70	0.30	70	1.6E–07	0.0003	5.2E–04
Sum						2.4E–04		8.0E–01

Concentration of contaminant in exposure meduim

Amount of contaminated medium ingested per day

Ratio of g of contaminant absorbed/g of contaminant ingested

Reference Dose (RFD) provided by the U.S. EPA (January 1990, personal communication)

TABLE 3.10
MID-CASE COMPARISON OF ESTIMATED DAILY EXPOSURE TO TETRACHLOROBENZENE TO THE INTERIM U.S. EPA RFD VALUE

	Exposure Determination					Risk Determination		
Route of Exposure	Concentration (mg/kg)	Contact Rate (g/day)	Exposure Duration (yrs)	Absorbed Fraction (g/g)	Body Weight (kg)	Exposure Value (mg/kg/d)	RFD (mg/kg/d)	Chronic Exposure/ RFD
Drinking Water	0.0028000	2000	70	0.30	70	2.4E-05	0.0003	8.0E-02
Fish Ingestion	0.0005600	6.5	70	0.30	70	1.6E-08	0.0003	5.2E-05
Sum						2.4E-05		8.0E-02

Concentration of contaminant in exposure meduim

Amount of contaminated medium ingested per day

Ratio of g of contaminant absorbed/g of contaminant ingested

Reference Dose (RFD) provided by the U.S. EPA (January 1990, personal communication)

TABLE 3.11
LOW-CASE COMPARISON OF ESTIMATED DAILY EXPOSURE TO TETRACHLOROBENZENE TO THE INTERIM U.S. EPA VALUE

	Exposure Determination					Risk Determination		
Route of Exposure	Concen-tration (mg/kg)	Contact Rate (g/day)	Exposure Duration (yrs)	Absorbed Fraction (g/g)	Body Weight (kg)	Exposure Value (mg/kg/d)	RFD (mg/kg/d)	Chronic Exposure/ RFD
Drinking Water	0.0002800	2000	70	0.30	70	2.4E-06	0.0003	8.0E-03
Fish Ingestion	0.0000560	6.5	70	0.30	70	1.6E-09	0.0003	5.2E-06
Sum						2.4E-06		8.0E-03

Concentration of contaminant in exposure meduim

Amount of contaminated medium ingested per day

Ratio of g of contaminant absorbed/g of contaminant ingested

Reference Dose (RFD) provided by the U.S. EPA (January 1990, personal communication)

The worst-case risk assessments for TCB and TTCB are also very conservative since it was assumed, as with PCB, that the concentrations of these chemicals at the interface of the saturated zone at the T-12 site is the same as the concentration in downgradient drinking water wells and river sediments. Migration of these chemicals would reduce the concentrations through adsorption and dilution. As discussed in Section 3.4.1, studies have indicated that TTCB, like PCBs, have a strong affinity for soils and would be adsorbed to soils rather than migrate in groundwater. TCB, on the other hand, has a higher water solubility and less adsorption potential than PCB and TTCB, therefore will have a relatively greater migration potential in groundwater. Even so, the concentration of TCB at drinking water wells and/or river sediments would still be significantly lower than directly below the site due to dilution with clean water and sediments.

The contact rates for the contaminants of concern at the T-12 site assume that 2000 grams of water are consumed per day from a drinking water well that has concentrations of PCB, TCB and TTCD as shown on Tables 3.3 through 3.11. To our knowledge downgradient drinking water wells have not been tested for PCB, TCB and TTCB, but it is highly unlikely that they would be contaminated with chemicals from the T-12 site given that they are within a different aquifer, as described earlier. Even if drinking water wells in the area did contain concentrations of PCBs, TCB and TTCB, it is unlikely that a person would only drink water from that well every day for the rest of their life.

The risk assessment assumes that 6.5 grams per day of fish is ingested that are contaminated with chemicals from the T-12 site. The assumption rate of 6.5 g/day is the U.S. average for fresh water fish (U.S. EPA, 1984). Even if concentrations of PCB, TCB and TTCB as shown on Tables 3.3 through 3.11 were in fish in the Snoqualmie River, few individuals receive their entire fish diet from fish caught in one location.

Additionally, the contaminant source may not last for 70 years and the concentrations in water and/or sediments would not remain the same. Concentrations would generally be reduced over time through environmental processes. Also, individuals in the area may not live, drink water and/or eat fish in the same location for 70 years.

From this discussion it can be seen that the risk assessment involves considerable uncertainty derived from the numerous assumptions which may not accurately reflect actual conditions. Actual conditions would be extremely difficult, time consuming and expensive to estimate. Assumptions made for this risk assessment reflect extreme conditions. In other words, if actual conditions near the T-12 site were used to calculate the risks from contaminants of concern at the T-12 site, the risks would undoubtedly be substantially lower than what was presented in this risk assessment.

4. SITE T-12 HAZARD RANKING

4.1 INTRODUCTION

The purpose of a Hazard Ranking System is to rank sites to provide regulatory agencies a basis for program planning and priority assessment for those sites identified as potential threats to human health or the environment. Two ranking systems were evaluated for application at the T-12 site. These are the Washington Ranking Method (WARM) to be used by Ecology and the national Hazard Ranking System (HRS) to be used by US EPA. The regulatory history and status of these two systems is discussed below.

4.1.1 Washington Ranking Method Status

Ecology adapted a Hazard Ranking System Regulation (WAC 173-338) on July 15, 1988, which established criteria for evaluating sites and established the basis for developing of a ranking system. In November, 1988, the people of the State of Washington passed a citizens' initiative for a new hazardous waste cleanup law called the Model Toxics Control Act, which also called for the development of a ranking system. Ecology contracted with Science Applications International Corporation (SAIC) to assist with the development and field testing of the Washington Ranking Method (WARM) in October, 1988. The ranking of sites will provide Ecology a basis for program planning and priority assessment for those sites identified as potential threats to human health or the environment.

In June, 1989, Ecology published the WARM Development and Field Testing Final Report for public review and comment. Currently, SAIC is incorporating comments on the Final Report and revising the model algorithm. Ecology anticipates adoption of the WARM by reference in the rule. Details concerning the final version were not available. Discussions with SAIC and Ecology have indicated that modifications to the algorithm will change the results of route scores and the overall ranking number assigned to each site evaluated.

The model is designed as a tool for State decision-makers to assist in establishing priorities for state agency resources to be applied to investigation, cleanup, and oversight of contaminated sites around the state. Route scores will be used to produce ordinal rankings of sites for their potential risks. By placing the sites in descending order for each routes score, the model indicates the relative risk potential for the sites based on the data elements. Because most data elements are categorical or partially continuous variables, numerical comparison of route scores for different sites cannot be used to quantify differences in risks in absolute terms (e.g., if two sites score 50 and 25 for a route, the potential risk of one site is not necessarily twice that of the other). While route scores cannot be used to evaluate absolute differences in risks, similar route scores do indicate similar potential risks for sites. Until route scores are available from other sites and the components of the final algorithm are known; comparison of ranking numbers from the T-12 site cannot be evaluated.

4.1.2 National Hazard Ranking System Status

In 1980, Congress enacted the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) in response to the dangers posed by uncontrolled releases of hazardous substance, pollutants, or contaminants into the environment that occur form hazardous waste sites or facilities. Section 105 of CERCLA required EPA to establish criteria for determining priorities among releases or threatened releases of hazardous substances throughout the United States. The criteria were based upon relative risk or danger to public health or welfare or the environment. To meet this requirement EPA developed and adopted the HRS on July 16, 1982 (47 Federal Register 31180). The HRS is used in the Superfund program to evaluate sites for possible placement on the National Priorities List (NPL). The Superfund Amendments and Reauthorization Act of 1986 (SARA) required EPA to revise the HRS so that, to the maximum extent feasible, it accurately assesses the relative risks of sites. In response to these mandates, EPA proposed HRS revisions for public comment on December 23, 1988 (53 Federal Register 51962-52081). Discussions with the Region 10 office of EPA indicate the revised HRS will be approved the Spring of 1990. Prior to its approval, the revised HRS may be further modified, however EPA is using the HRS in its current revised form and using professional judgement concerning the potential further modifications (personnel communication David Bennet, Region 10 EPA, February 20, 1990).

Considering the status of the two identified ranking systems, HDR used the national HRS to evaluate the T-12 site. Results of this effort are presented below.

4.2 REVISED NATIONAL HAZARD RANKING SYSTEM

The revised HRS score is determined for a site by evaluating four pathways:

- Air migration;
- Groundwater migration;
- Surface water migration; and,
- Onsite exposure.

The score for each pathway is obtained by evaluating factor categories (i.e. Likelihood of Release to an Aquifer, Waste Characteristics and Targets). Each factor category contains factors which are assigned numerical values (i.e. Toxicity/mobility and Hazardous Waste Quantity). The factors are summed within each factor category to yield the value of that factor category. The values of the factor categories within a pathway are multiplied and the resultant value divided by the maximum possible score for that pathway. This ratio is multiplied by 100 to obtain the pathway score. The HRS site score is a composite of the four possible pathway scores as calculated in the following equation:

$$S = \sqrt{\frac{S^2_{(a)} + S^2_{(gw)} + S^2_{(sw)} + S^2_{(os)}}{4}}$$

Where:

$S_{(a)}$ = Air migration pathway score;
$S_{(gw)}$ = Groundwater migration pathway score;
$S_{(sw)}$ = Surface water migration pathway score; and,
$S_{(os)}$ = Onsite exposure pathway score.

4.2.1 Results of the HRS at the T-12 site

The T-12 site was evaluated for each of the HRS pathways. Because each pathway score is a product of factor categories if one factor category within a pathway has a value of zero (0), then the resultant pathway score is zero. At the T-12 site the air migration, surface water migration and onsite exposure pathway scores were assigned a value of zero. Only the groundwater migration pathway scored a value greater than zero. Each of the pathway scores are discussed below.

Air Migration Pathway

The air migration pathway consists of the following three (3) factor categories:

- Likelihood of Release;
- Waste Characteristics; and,
- Targets.

The likelihood of release factor category consists of two (2) factors; observed release and potential to release. No observed release to the atmosphere is demonstrated under the existing conditions at the T-12 location, therefore this factor is assigned a value of zero. The Potential to Release factor is determined by multiplying the sum of the source type factor value and source mobility factor value by the source containment factor value. The source containment factor value is zero since the site is covered with an essentially impermeable cover with no exposed soil or waste-bearing liquids; therefore the potential to release factor is zero. Because both factors within the likelihood of release factor category are assigned a value of zero, that factor category is assigned a factor of zero. The air migration pathway score is determined by multiplying the factor categories. If one of the factor categories is zero than the product of the equation is zero. Therefore the air migration pathway score is zero.

Groundwater Migration Pathway

The groundwater migration pathway consists of the following three (3) categories:

- Likelihood of Release to an Aquifer;
- Waste Characteristics; and,
- Targets.

The Likelihood of Release to an Aquifer category contains two main factors: observed release and potential to release. Samples obtained during the additional investigation at the T-12 site (HDR Engineering, Inc. 1989h) indicated that no release has occurred to the aquifer; therefore this factor was assigned a value of zero. The potential to release factor evaluates containment, net precipitation, depth to aquifer/hydraulic conductivity and sorptive capacity. Physical data obtained at the T-12 location was evaluated and this factor was assigned a value of 336.

The waste characteristics category consists of two factors; toxicity/mobility and hazardous waste quantity. Toxicity/mobility was assigned a value of 50 based on data generated during the risk assessment. Hazardous waste quantity was based on the calculation of pounds of PCBs remaining in site soils and was assigned a value of 7.1. The values assigned to these factors were summed to equal the value assigned to the waste characteristic factor category (57.1).

The targets category reflects the human population and resources potentially at risk from an actual or potential release of hazardous substances from the site to an aquifer. The following four factors are evaluated for an aquifer: maximally exposed individual, population, groundwater use and wellhead protection area. These factors are evaluated within the target distance limit defined by the HRS instructions. Boundaries of the aquifer underlying the T-12 site were determined to be the Snoqualmie River to the west, the topographic rise to the east, the hydraulic gradient to the south and Snoqualmie Falls to the northwest.

No wells are located within the aquifer boundaries identified above; therefore both the maximally exposed individual and population factors were assigned a value of zero.

Groundwater use indicates the use and value of groundwater for the aquifer being evaluated. Since no wells are located within the target distance limit a value was assigned to the target aquifer based on its resource value for drinking water use. The value assigned was 10 indicating that the aquifer is not used but is usable.

The wellhead protection area factor is evaluated for sites that, either partially or fully, lie within or above a wellhead protection area designated according to Section 1428 of the Safe Drinking Water Act as amended. The T-12 site is not within a designated wellhead protection area; therefore this factor was assigned a value of zero.

The target factor category was assigned a value 10 and was determined by adding the values assigned to the four factors identified above.

The groundwater migration pathway score was determined by multiplying the factor category values and dividing by the maximum possible score for the pathway. This ratio is multiplied by 100 to obtain the Groundwater migration pathway score of 0.9576.

The HRS scoresheet for the groundwater migration pathway calculation is included in Appendix A.

Surface Water Migration Pathway

The surface water migration pathway addresses four (4) different types of threat:

- Drinking Water Threat;
- Human Food Chain Threat;
- Recreational Threat; and,
- Environmental Threat.

Each of these threats are evaluated based on the following three (3) factor categories:

- Likelihood of Release;
- Waste Characteristics; and,
- Targets.

The likelihood of release category consists of three (3) factors; observed release, potential to release by overland flow, and potential to release by flood.

No observed release of a hazardous substance to the surface water in the watershed has been demonstrated at the T-12 site; therefore this factor is assigned a value of zero.

Potential to release by overland flow is based on three (3) factors; containment, runoff, and distance to surface water. The potential to release by overland flow is assigned a value of zero for the watershed under either of two conditions: no overland segment of the hazardous substance migration path can be defined for the watershed (i.e. the site lies in a topographic depression) or the overland segment of the hazardous substance migration path for the watershed exceeds two (2) miles before surface water is encountered. The T-12 site lies in a topographic depression and PCB contaminated soils are located 13 feet below the land surface; therefore the potential to release by overland flow factor was assigned a value of zero.

The potential to release by flood factor is evaluated as a function of flood frequency and containment. The T-12 site is located in the 10-year floodplain and was assigned a value of 10 for the flood frequency factor. Containment reflects the potential for hazardous substances to be released to surface water as a result of a site being partially or fully inundated by a flood from surface water in the watershed. Containment at the T-12 site is adequate to prevent any washout of hazardous substances by the flooding being evaluated.

The Potential to Release by Flood is determined by multiplying the assigned value for containment by the flood frequency factor value. The product of this calculation is zero.

The potential to release factor is the sum of the potential to release by overland flow and the potential to release by flood. The values assigned to these factors is zero; therefore the potential to release is zero. The value assigned to the likelihood of release factor category is the higher of the values of observed release or likelihood of release and is therefore also zero. The zero value assigned to the likelihood of release factor category is multiplier for each of the surface water migration pathway threat scores; therefore each threat score is assigned a value of zero. The surface water migration pathway score is a sum of the threat scores (each of which equals zero) divided by the maximum possible score for the pathway. This ratio is multiplied by 100 to obtain the surface water migration pathway score of zero.

Onsite Exposure Pathway

The onsite exposure pathway addresses two types of threats:

- Resident Population Threat; and,
- Nearby Population Threat.

Each of these threats are evaluated based on the following categories:

- Likelihood of Exposure;
- Waste Characteristics; and,
- Targets.

The resident population consists of people living or attending school or day care on property where there is observed contamination and terrestrial sensitive environments where there is observed contamination. Neither of these conditions are present at the T-12 location; therefore the resident population threat was assigned a value of zero.

The nearby population consists of individuals who live or go to school within a one-mile travel distance of the site and who do not meet the criteria for the resident population targets. Two factors are included in the nearby population likelihood of exposure factor category: waste quantity and accessibility/frequency of use. The likelihood of exposure is then determined by selecting a number from a matrix combining these factors. The waste quantity factor was assigned a value of 7 based on the worst-case scenario of up to 71 pounds of PCBs remaining at the T-12 location. The accessibility/frequency factor was assigned a value of 5 because of the presence of an artificial and natural barrier combining to restrict access to the hazardous substance. Evaluation of the matrix yields a value of zero for the likelihood of exposure factor category to a site containing these specific factor values. The nearby population threat score is calculated by multiplying likelihood of exposure value (zero) by the other factor categories within the nearby population threat yielding a product of zero. The onsite exposure pathway score is a sum of threat scores (each of which equals zero) divided by the maximum possible score for the pathway. This ratio is multiplied by 100 to obtain the onsite exposure pathway score of zero.

Imputing the route scores into the HRS site score equation yields a site score of 0.4788.

$$0.4788 = \sqrt{\frac{0^2_{(a)} + 0.9576^2_{(gw)} + 0^2_{(sw)} + 0^2_{(os)}}{4}}$$

5. CONCLUSIONS AND RECOMMENDATIONS

Transformer Site T-17 was cleaned up to pre-agreed levels and in compliance with the EPA Spill Cleanup Policy under 40 CFR 761.

Based on the results of the risk assessment, population risks from the remaining contaminants at the T-12 site would be negligible. Worst-case risk analysis for people who drink two liters per day of groundwater directly below the T-12 site and who eat 6.5 grams per day of fish from the Snoqualmie River, above the falls and downgradient of the T-12 site, for 70 years have less than two chances in ten thousand of contracting cancer due to PCB contamination. For people who drink water from groundwater up gradient of the site, or down gradient of the site and within a different aquifer than that which could be potentially impacted by the T-12 site; and who eat less than 6.5 grams of fish per day from the Snoqualmie River, above the falls and downgradient of the T-12 site, the health risk from the remaining PCB contamination at the T-12 site is essentially zero. Review of the population and present and future land use in the area indicate the later is the scenario of the population in the vicinity of the T-12 site. Risk analyses for trichlorobenzene and tetrachlorobenzene in a worst-case scenario indicate average daily exposure levels below the U.S. EPA reference doses. No significant health risks, therefore, are expected from the remaining TCB and TTCB at the T-12 site.

Due to the unavailability of calibration rankings, the Washington State hazard ranking model (WARM) was not used. Results of the national Hazard Ranking System yielded a score of 0.4788. The air migration, surface water migration and onsite exposure pathway scores were assigned values of zero because of the existing containment and stabilization of the T-12 location. The groundwater migration pathway score yielded a relatively low value (0.9576) because no drinking or irrigation wells are located within the boundaries of the target aquifer and there is no demonstration of an observed release. The purpose of the HRS was to screen sites for placement on the National Priorities List. The first NPL contained 418 sites. These site scored above an EPA designated cutoff score of 28.50, far above the current HRS score for the T-12 site. During the revision of the HRS, EPA studied the 28.50 cutoff score and its relationship to the risks of NPL sites (CH2M Hill, September, 1988). The study did not yield definitive conclusions, however it did indicate that some sites with scores below the cutoff could also pose potential dangers to human health and the environment. The cutoff score was not intended to set a no-risk threshold, but to set a level above which a site becomes a priority. Currently, EPA is proposing that the cutoff score for the revised HRS be functionally equivalent to the current cutoff score; that is, the revised HRS cutoff score will be chosen to develop a list of at least 400 NPL sites. Although EPA is proposing that the cutoff be functionally equivalent to the current score, it is premature to specify a numerical cutoff score for the revised HRS. After further analyses and reviewing public comments, EPA will select a means of establishing a cutoff score for the revised HRS. This revised cutoff score will presented in the preamble to the final rule. The relative low score assigned to the T-12 location is anticipated to be far below even the revised HRS cutoff score.

Results of the risk assessment and hazard ranking indicate that the remaining contaminants at the T-12 site do not pose appreciable health or environmental risks. Therefore, attempting to remove these remaining contaminants is not practical and, based on the specific stratigraphy of the site, would pose environmental risk to underlying water resources greater than the benefits that which could be realized by further excavation. Specific measures for assuring that the site is not accidently excavated in the future must be taken to eliminate the potential for accidental exposure. These measures could include demarcation of the site using monuments. Since the projected long-term use for the site is similar to that of its present use (industrial/log storage) and no appreciable health risks are posed, no additional remedial measures are warranted at this time.

6. REFERENCES

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APPENDIX A

TABLE 3-1
GROUND WATER MIGRATION PATHWAY SCORESHEET

Factor Categories and Factors

	Likelihood of Release to an Aquifer	Maximum Value	Value Assigned	
1.	Observed Release	500	0	
2.	Potential to Release			
2a.	Containment	10	7	
2b.	Net Precipitation	10	10	
2c.	Depth to Aquifer/Hydraulic Conductivity	35	35	
2d.	Sorptive Capacity	5	3	
2e.	Potential to Release (Lines 2a x (2b + 2c + 2d))	500	336	
3.	Likelihood of Release (Higher of Lines 1 or 2e)	500		336
	Waste Characteristics			
4.	Toxicity/Mobility	100	50	
5.	Hazardous Waste Quantity	100	7	
6.	Waste Characteristics (Lines 4 + 5)	200		57
	Targets			
7.	Maximally Exposed Individual	50	0	
8.	Population			
8a.	Level I Concentrations	200		
8b.	Level II Concentrations	200		
8c.	Level III Concentrations	200		
8d.	Potential Contamination	200		
8e.	Population (Lines 8a + 8b + 8c + 8d, subject to a maximum of 200)	200	0	
9.	Ground Water Use			
9a.	Drinking Water Use	50	10	
9b.	Other Water Use	20	0	
9c.	Ground Water Use (Lines 9a + 9b, with a maximum of 50)	50	10	
10.	Wellhead Protection Area	50	0	
11.	Targets (Lines 7 + 8e + 9c + 10, subject to a maximum of 200)	200		10

TABLE 3-1
GROUND WATER MIGRATION PATHWAY SCORESHEET (CONCLUDED)

	Maximum Value	Value Assigned
Ground Water Migration Score for an Aquifer		
12. Aquifer Score [(Lines 3 x 6 x 11)/2 x 10^5][1]	100	0.9576
Ground Water Migration Pathway Score		
13. Pathway Score (S_{gw}), (Highest value from Line 12 for all aquifers evaluated)[1]	100	$\boxed{0.4788}$

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[1] These scores are not to be rounded to the nearest integer.

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Likelihood of Release (LR)		Waste Characteristics (WC)		Targets (T)
Observed Release or Potential to Release o Containment o Net Precipitation o Depth to Aquifer/ Hydraulic Conductivity o Sorptive Capacity	X	Toxicity/Mobility o Toxicity - Acute - Chronic - Carcinogenic o Mobility - Water Solubility - Coefficient of Aqueous Migration Hazardous Waste Quantity o Hazardous Constituent Quantity o Site Wastestream Quantity o Site Disposal Capacity	X	Maximally Exposed Individual Population o Level I Concentrations o Level II Concentrations o Level III Concentrations o Potential Contamination Ground Water Use o Drinking Water Use o Other Water Use Wellhead Protection Area

FIGURE 3-1
OVERVIEW OF GROUND WATER MIGRATION PATHWAY

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