RPP-8393
Revision 0

Double-Shell Tank System PCB Risk Assessment

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

CH2MHILL
Hanford Group, Inc.

Richland, Washington

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC27-99RL14047

RPP-8393
Revision 0

Double-Shell Tank System PCB Risk Assessment

J. W. Pratt
CH2M HILL Hanford Group, Inc.

G. L. Dunford
L.G. Coleman
W.G. Cox
WASTREN, Inc.

D. R. Lincoln
Intertox, Inc.

Date Published
August 2001

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

CH2MHILL
Hanford Group, Inc.

P.O. Box 1500
Richland, Washington

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC27-99RL14047

Available electronically at
http://www.doe.gov/bridge. Available for a processing fee to the U.S. Department of Energy ans its contractors, in paper, form:
U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
Phone: 865-576-8401
Fax: 865-576-5728
Email: reports@adonis.osti.gov(423) 576-8401

Available for sale to the public, in paper, form: U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Phone: 800-553-6847
fax: 703-605-6900
email: orders@ntis.fedworld.gov
online ordering:
http://www.ntis.gov/ordering.htm

Printed in the united States of America

CONTENTS

APPENDICES

FIGURES

TABLES

TERMS

CFR	*Code of Federal Regulations*
CHG	CH2M HILL Hanford Group, Inc.
COB	clean-out box
CSF	cancer slope factor
CSM	conceptual Site model
CY	calendar year
DCRT	double contained receiver tank
DOE	U.S. Department of Energy
DST	double-shell tank
ENRAF	brand name for level indicating device
EPA	U.S. Environmental Protection Agency
ERPC	ecological receptors of potential concern
ETF	Effluent Treatment Facility
HEPA	high efficiency particulate air (filter)
HLW	high-level waste
HQ	hazard quotient
IARC	International Agency for Research on Cancer
LERF	Liquid Effluent Treatment Facility
NOAEL	no observed adverse effects
ORP	U.S. Department of Energy, Office of River Protection
OSHA	U.S. Occupational Safety and Health Administration
PCB	polychlorinated biphenyl
PEL	permissible exposure limit
PPE	personal protective equipment
PUREX	Plutonium-Uranium Extraction (facility)
RL	U.S. Department of Energy, Richland Operations Office
RPP	River Protection Project
RA	risk assessment
RCRA	*Resource Conservation and Recovery Act of 1976*
RfD	reference dose
RH	relative humidity
SALDS	State-Authorized Land Disposal Site
SCLERA	screening-level ecological risk assessment
SpG	specific gravity
SAA	satellite accumulation area
SSC	structures, systems, and components
SST	single-shell tank
TEF	toxic equivalency factor
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRV	toxicity reference value
TSCA	*Toxic Substance Control Act of 1976*
WAC	*Washington Administrative Code*
WTP	Waste Treatment Plant

1.0 INTRODUCTION

This Polychlorinated Biphenyls (PCB) Risk Assessment (RA) assesses the operation of the double-shell tank (DST) system for managing PCBs under the *Toxic Substance Control Act of 1976* (TSCA). The U.S. Department of Energy (DOE) and U.S. Environmental Protection Agency (EPA), Region 10, have established the process for approving risk-based disposal under Title 40 *Code of Federal Regulations* (CFR) Part 761.61(c), as outlined in the *Framework Agreement for Management of Polychlorinated Biphenyls (PCBs) in Hanford Tank Waste* (Framework Agreement) (Ecology et al. 2000a). This assessment is focused on demonstrating that the PCBs pose no unreasonable risk through operating the DST system. The risks and the exposure pathways presented in this assessment consider reasonably anticipated or known risk pathways associated with DST system operations. The risk posed by the storage, handling, and processes in support of Site clean-up of actual or potential TSCA PCB remediation waste in the DST system are expected to be bounded by the nuclear safety controls, the controls in the *Hanford Facility Resource Conservation and Recovery Act Permit* (Ecology et al. 2000b) and the standard emission reduction and control components used in the DST system.

1.1 BACKGROUND

In August of 2000, the Framework Agreement was signed by DOE, the EPA and the Washington State Department of Ecology (Ecology). The EPA, Ecology, DOE, and the Hanford Site contractors are actively working to define a mutually acceptable path to implement the Framework Agreement. The DST system and associated operations defines the way in which any TSCA PCB remediation waste will be stored, handled, and disposed of by the Waste Treatment Plant (WTP) and other downstream facilities.

1.2 OBJECTIVE

The objective of the DST system PCB risk assessment is to perform a qualitative and semi-quantitative evaluation of the DST system and associated operational controls to determine if the management of PCB remediation waste does or does not pose an unreasonable risk. This document outlines how the evaluation was performed and provides reasonable assurance of continued safe operations. The evaluation for the DST system was based on the existing operational controls and existing equipment. The following objectives are addressed:

- Present DST operations under the *Resource Conservation and Recovery Act of 1976* (RCRA) and the *Clean Air Act*, as implemented through state codes and regulations, and the *Atomic Energy Act of 1954* provide for the key requirements to adequately handle the actual or potential TSCA PCB remediation waste with reasonable risk.

- Ensure that potential human-health and environmental risks from onsite and offsite exposure to PCBs released during normal operations and upset conditions of the DST system are within the reasonable risk guidelines.

1.3 METHODOLOGY

This risk assessment evaluates the following aspects of PCBs during DST operations:

- Normal DST operations and accidents that may release PCBs to the environment
- Receptor exposure locations
- The effects of PCB releases on the public and the environment.

Figure 1 provides an overview of the scope of this assessment. The risk assessment is consistent with principles established in the EPA's *PCB Risk Assessment Review Guidance Document* (EPA 1989). The EPA guidance was intended to be used to support a short-term disposal action and minor modifications were introduced to tailor this risk assessment for use in evaluating DST operations.

Risks were considered for the normal and upset scenarios evaluated by CH2M HILL Hanford Group, Inc. (CHG), the EPA, Ecology, and the U.S. Department of Energy, Office of River Protection (ORP) representatives to determine their reasonableness before performing the actual risk characterization. Conservative exposure assumptions were developed from existing data. Based on system configuration and scenarios, the air pathway was determined to be the dominant pathway.

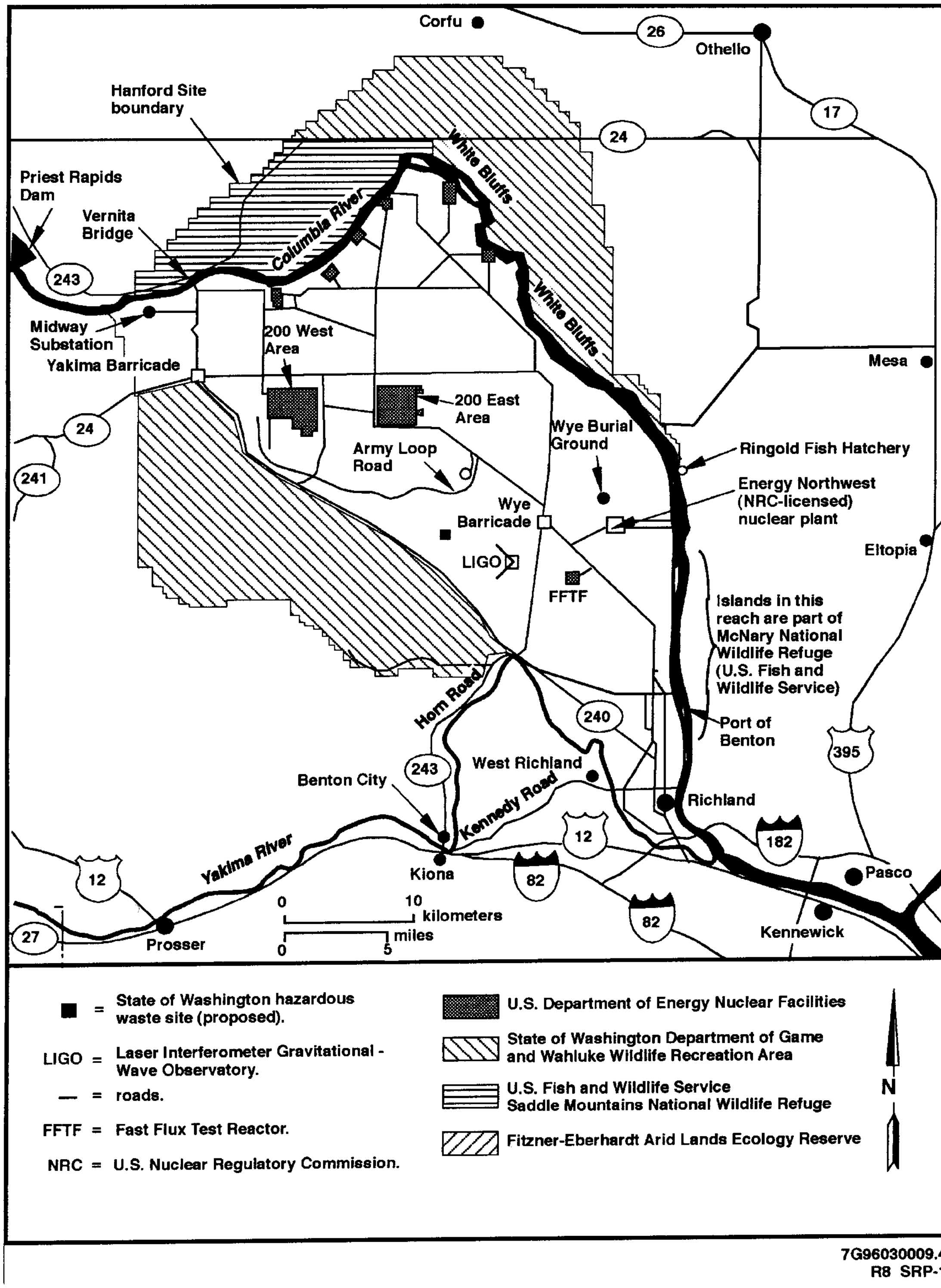
Emissions to the air were modeled using the EPA meteorological dispersion model, SCREEN3. This model assumes the worst case meteorology for creating adverse impacts from plume dispersion and provides estimated concentrations with distance.

Effects to both onsite and offsite human receptor populations and wildlife were characterized. The activities of these receptors were considered in developing the exposure scenarios. The EPA guidance was used to develop quantitative reasonable maximum exposure factors (e.g., inhalation rate, dermal contact).

The release concentrations and information gained during the exposure assessment were integrated to characterize the current and potential risks to human health and the environment caused by the PCB releases. This risk characterization also identifies any uncertainties associated with contaminants, toxicity, release, and exposure assumptions.

This risk assessment is organized into six chapters. Chapter 1 introduces the risk assessment and includes background information on how the risk assessment was performed. Chapter 2 describes the DST system components, PCB inventory in the DST system and the release scenarios. Chapter 3 describes the approach used to quantify exposures to PCBs through normal operation of and accidental releases from the DST system. Chapter 4 evaluates the potential human health impacts caused by exposure to PCB releases and potential carcinogenic risk to human receptors. Chapter 5 is an environmental evaluation of the potential impacts of PCB releases on wildlife receptors. Chapter 6 presents the overall results of the PCB Risk Assessment.

Figure 1-1. Hanford Site Map.



1.4 OVERVIEW OF DST INTERFACES

The DST System, 242-A Evaporator, Liquid Effluent Retention Facility (LERF), 200 Area Effluent Treatment Facility (200 Area ETF), State-Authorized Land Disposal Site (SALDS), and the waste treatment complex (pretreatment and vitrification plants) together make up a liquid waste handling facility. This system is considered under the Framework Agreement collectively as a TSCA disposal system. The operation of the DST system is critical to the cleanup of the Hanford Site.

1.4.1 Nature of Contamination

The DST farms contain about 20 Mgal of mixed waste (Hanlon 2001). This waste was generated over a number of years from operations at the Hanford Site facilities. The waste tends to stratify inside the tank and form distinct boundaries. Inside any given tank the waste exists in the following various forms.

- A gas/vapor mixture in the head-space of the tank with entrained particles released from the surface layer
- A liquid slurry/supernatant liquid with specific gravities greater than 1.0
- A solid/sludge precipitate on the bottom of the tank

Because of their low aqueous solubility, PCBs contained within the DST waste are expected to be associated mostly with the solids. Trace amounts of PCBs also could be dissolved in the supernatant liquid. The risk assessment uses conservative numbers for the PCB concentrations in the solids, supernatant liquid, and vapor space; these numbers are order of magnitudes higher than the concentrations that have been observed in the DST system.

1.4.2 DST System Interface Inputs

Administrative controls will require that external waste transfers into the DST system will not be accepted if the transfer causes an unreasonable human health and/or environmental risk based on this bounding analysis. The following are identified sources of potential future waste additions to the DSTs:

- Single-shell tanks (SST)
- Facilities such as T Plant and the Plutonium Finishing Plant
- The 222-S Laboratory
- Other Hanford Site units.

1.4.3 DST System Interface Outputs

DST waste will be transferred to the WTP. The DST waste may require blending and mixing to meet WTP waste acceptance criteria. The vitrification process incorporates mixed waste from the DST system into the glass matrix. The molten glass is poured into canisters for permanent storage. DOE expects the immobilized high-level waste (HLW) from the WTP to qualify for the radioactive waste exemption under 40 CFR 761.50(b)(7)(ii). This vitrification process will address TSCA requirements with separate documentation from what is provided here.

Waste blending during the normal transfer of waste between tanks for accumulation for storage may result in PCB dilution. Waste-feed blending may be required to meet the WTP waste acceptance criteria and is incidental to treatment. The PCB inventory within the solids and liquid waste transferred to the WTP will be maintained at or below the levels required for the waste feed to the WTP.

The 242-A Evaporator facility operation potentially alters the concentration of PCBs in the DST waste. The evaporator facility provide a means to reduce the volume of the aqueous-phase waste stored in the DST system, and is essential for managing tank waste storage capacity and processing capabilities. Waste from a DST is transferred to the evaporator facility, which heats the waste to evaporate the liquids contained in the waste. Two waste streams are generated from this process, a slurry stream and a process condensate stream.

The process condensate stream is a dilute aqueous waste stream containing low concentrations of radionuclides, inorganic constituents, and volatile constituents such as ammonia and acetone. This waste stream is treated at the Effluent Treatment Facility and eventually discharged to the SALDS, a waste water disposal facility permitted under *Washington Administrative Code* (WAC) 173-216, “State Waste Discharge Permit Program”

This page intentionally left blank.

2.0 DST OPERATIONS

The DST system maintains and manages the mixed waste to both radioactive and hazardous waste requirements. The tank farms presently operate under RCRA interim status standards. Interim status was implemented until issues concerning the ability of some equipment to meet RCRA standards are adequately addressed. The interim status provides management controls that meet the intent of RCRA requirements, while providing adequate time within cost constraints to address or upgrade known deficiencies. The operational controls in place for managing the mixed waste within the DST system are believed to be adequate to address the risk criteria required under TSCA. A primary goal in managing the mixed waste is to ensure the safety of the public and workers just as it is for TSCA requirements.

The long-term mission of DST Operations is the safe storage, retrieval, and delivery of mixed waste to the WTP for disposal. These mission goals are accomplished while adhering to the regulatory requirements (i.e., Washington State and Federal requirements) and to the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1996) commitments. To meet these requirements, engineered and administrative controls are used to monitor and ensure safe storage, retrieval, and transfer of the waste within the DST system.

2.1 DST PROCESS DESCRIPTION

The DST system has been analyzed in detail for the development of the Final Safety Analysis Report (FSAR), HNF-SD-WM-SAR, Rev. 2, (CHG 2001)and controls have been established. The tank farms safety analysis uses a graded approach for identifying structures, systems, and components (SSC) that maintain or perform safety functions. This graded process results in selective application of functional requirements to engineered features of those SSCs that maintain or perform safety functions. Safety functions performed by safety SSCs prevent or mitigate releases of radiological materials to the offsite public and onsite workers, and toxic chemicals to the offsite public and onsite workers. Safety SSCs also include those SSCs that protect the facility worker from serious injury or death from hazards not controlled by institutional safety programs.

"Defense-in-Depth," as a fundamental safety philosophy, has an extensive precedent in nuclear safety and in the operation of the DST system. It builds in many layers of defense against a release of mixed waste so that no one layer by itself, no matter how dependable, is relied on totally. To compensate for potential human and mechanical failures, a Defense-in-Depth philosophy relies on several layers of protection with successive barriers to prevent the release of hazardous material, including PCBs, to the environment. This approach includes protection of the barriers, to avert damage to both the physical plant and the barriers themselves. It also includes other measures to protect the public, the onsite workers, and the environment from harm in case these barriers are not fully effective.

Multiple layers of Defense-in-Depth are built into operation of the DST system. The inner layers rely on quality of design including hazardous waste design requirements (engineered controls) and competent staff personnel who are well trained in their facility operations and maintenance procedures (administrative controls). Staffing with competent personnel translates into fewer errors, failures, or malfunctions of Defense-in-Depth systems and components and, thus, minimizes the challenges to the next layer of defense.

In the event that the inner layer of Defense-in-Depth is compromised by either equipment malfunction (from whatever cause) or operator error, and a progression from a normal to an abnormal condition occurs, the next layer of Defense-in-Depth is relied on to halt the progression of events toward a more serious accident. This layer consists of automatic systems and other devices that alert the operators to either take action or automatically activate systems that will correct the abnormal situation.

The final, or outer, layers of Defense-in-Depth for the DST system provides for mitigation of the consequences of an accident. Passive and automatically or manually activated features (e.g., filtered exhaust) and safety management system programs (e.g., emergency response procedures) minimize accident consequences in the event that all other layers have been breached. The contribution of emergency response actions in minimizing the consequences of an accident cannot be neglected because the emergency response actions represent the truly final measure of protection against releases that cannot be prevented.

2.1.1 Engineered and Administrative Controls

The day-to day operations of the DST system include relying on, andusing, many engineered and administrative controls to ensure safety of the workers and the public. These controls ensure that mixed waste will be maintained under control and ensure that the risk that the waste will be released to the environment, where it could pose a threat to the safety of workers and the general public is acceptable. These controls placed on management of the mixed waste also will provide an acceptable risk for controlling PCBs in the waste. The administrative controls are implemented in operating procedures, alarm response procedures, functional test procedures, operator round sheets, transfer procedures, and maintenance procedures used within the tank farms. Personnel who use these procedures are specifically trained to understand the controls identified by the procedures.

Personnel working in a radiological environment also receive required radiation worker training and hazardous material training. Job hazards analyses are performed on work packages to identify hazards the workers can expect to encounter while performing the required tasks. These procedures, training, and controls help reduce the risk of maintaining and managing the mixed waste. Some general administrative controls are as follows.

- In process pits, open nozzles connected to a transfer line are required to be sealed or capped with process blanks or equivalent to prevent misrouting of waste.

- In a process pit, newly installed or repositioned jumpers used to route waste must be leak tested after installation.

- During waste transfers, the material balance must be closely monitored to ensure that waste is going where it is intended. A predefined material balance discrepancy triggers an immediate response to shut down the transfer and investigate the reason for the discrepancy.

- An administrative lock and tag program requires that all transfer pumps be under administrative lock, which removes any electromotive force from the pump when the pump is not being used in an active transfer. This is done to prevent inadvertent starting of a transfer pump.

- Excavation controls are employed to prevent potential damage to underground piping and to protect excavation workers during transfers.

- Before and, periodically, during waste transfers walkdowns of the transfer route are performed to ensure integrity of the route and provide advance warning of abnormal conditions.

- Valving for transfers requires independent verification to ensure that valves are properly positioned.

- Flushing transfer lines with raw water is required after the completion of transfers to reduce radiation levels and minimize waste that may be trapped inside the piping.

- Administrative controls require Radiological Control and Industrial Health & Safety personnel to review or determine the hazards and prescribe proper personal protective equipment (PPE) for work within radiological areas. This prevents personnel from inadvertently contacting or accessing potentially contaminated equipment, systems, and areas. Radiation monitoring controls ensure personnel do not come into contact with any contamination and, by implication, PCBs while working in potentially contaminated areas.

- Alarm response procedures are provided to personnel to ensure that, under abnormal conditions, immediate actions are takenthat place the equipment or systems in a safe condition while investigating or correcting the alarm condition.

Responses to spills that accidentally release DST waste to the environment also are addressed through administrative controls and personnel training. These controls and training provide personnel with proper responses and techniques for spill cleanup and shall provide an acceptable risk for handling any PCBs that also could be contained in the waste material. Controls provide for the following:

- Minimizing the exposure of personnel

- Expeditious isolation of the source of the spill

- Minimizing further spread of contamination

- Identification of proper PPE to use and also the proper use of the PPE during cleanup
- Monitoring and sampling requirements during cleanup to ensure personnel protection and adequacy of the cleanup
- Ensuring the expeditious return of the waste to a controlled environment.

This emergency response and clean up of soil spills is one of the reasons this assessment focused on the air pathway to evaluate PCB risks.

Administrative controls, the emergency response program, and cleanup of soil spills provide a reasonable demonstration that adequate safeguards are in place to protect the mixed waste from release to the environment. The combination of administrative and engineered controls used to manage mixed waste also can be applied to manage PCBs that could be contained in the mixed waste. Mixed waste containing potential PCBs will be detected if released by the existing instrumentation that monitors for the radioactive content.

The following sections identify the components of the DST system.

2.1.2 Tanks

The DST design features a heat-treated, stress-relieved primary steel liner and a non-stress relieved outer steel liner, both contained inside a reinforced concrete shell. A void space called the annulus is located between the primary and secondary liners. The secondary liner provides containment if the primary tank fails, and the annulus is monitored continually to detect leakage from the primary tank. Each tank is covered by a concrete dome and is buried underground for shielding purposes. Access to the tanks is provided by a series of risers and process pits located on top of the tank domes. These tanks store the mixed waste and are designed to prevent release of waste into the environment.

2.1.3 Ventilation Systems

A ventilation system is installed for each tank farm to maintain a negative differential pressure inside the tanks and to remove heat created from radioactive decay. The design of the ventilation system is such that it prevents or minimizes the escape of radioactive particulate aerosols into the exhaust stack and the environment. This same design helps prevent release of PCB aerosols.

The negative differential pressure ensures that air flow is into the tank and that any air flow out of the tank is treated and filtered to remove any particulate matter. Each ventilation system consists of isolation valving, ducting, a deentrainer/demister, heaters, a prefilter, two-stage high-efficiency particulate air (HEPA) filter, a fan, a seal pot, a drain, and various pieces of monitoring equipment. Each tank within a farm will have one or more ventilation inlet stations that allow air flow into the tank through HEPA filters.

Each DST farm has one ventilation exhauster system that services all the tanks within that farm. The exception is the AY/AZ farms, where all four tanks share a common ventilation exhaust system. The air pathway is a potential pathway for PCBs to escape from the DST system during normal operations. The risk assessment addresses this pathway and provides a very conservative analysis of potential PCB releases that demonstrates acceptable risks that bound DST operations.

2.1.4 Double-Contained Receiver Tanks

Four double-contained receiver tanks (DCRT) are a part of and are located within the DST system (Tank 244-U presently is not in service). Each DCRT has a steel receiver tank inside a reinforced concrete secondary containment (receiver tank vault). The 244-A and 244-BX DCRTs are located in the 200 East Area. The 244-S and 244-TX are located in the 200 West Area. The secondary concrete containment for all DCRTs except 244 BX also has a carbon steel liner. DCRT 244-BX has Amercoat™ applied to the surface. The DCRTs function as small-capacity short-term holdup stations during waste transfers. Each DCRT has a pump pit located above the receiver tank vault. A ventilation system provides airflow through the DCRTs and functions similarly to the DST ventilation systems except that both the annulus and the primary receiver tank are ventilated by the single ventilation system. A filter pit is provided to house the HEPA filters for the ventilation system.

2.1.5 Catch Tanks

A catch tank is an underground storage tank used to collect small amounts of waste drained from diversion boxes, catch stations, valve pits, transfer lines, and other DST system tanks. A water jet pump is installed in the catch tank pump pit. Catch tank liquid is piped through a pumpout jumper and the pumpout line to the associated tank. Each catch tank is equipped with a liquid-level sensor and a pump pit leak detector.

2.1.6 Waste Unloading Facility 204-AR

The 204-AR Waste Unloading Facility is a reinforced-concrete two-story structure used to unload rail tank cars or tank trailers carrying liquid radioactive waste. This facility contains a stainless steel drain system connected to a 1,500-gal (1,200-gal maximum operating capacity) stainless steel catch tank contained in a concrete, stainless steel-lined pit located beneath the unloading area floor. A sump is provided in the pit to capture drainage and leakage. The 204-AR facility also has the ability for chemical adjustment of the incoming waste before transferring it to the DST system.

2.1.7 Diversion Boxes, Valve Pits, and Clean Out Boxes

Diversion boxes are placed below ground level and are reinforced concrete structures that provide a flexible method of directing liquid waste from a given point to another given point. The top of the diversion box is a concrete cover block that usually extends above ground level. Some diversion boxes are lined with steel. Diversion boxes normally are connected to a specific tank farm and are used to establish waste transfer routes between tank farms. Diversion boxes also provide confinement and allow early detection of leaks in waste transfer lines. Diversion boxes drain to a catch tank or nearby underground storage tank and contain a leak detector probe that sets off an alarm if a leak occurs in the diversion box.

Valve pits are located below ground level and are reinforced-concrete structures that contain valves and jumper assemblies to route the liquid waste through the connected pipelines within a tank farm. Valve pits have 0.3 m (1-ft)-thick walls and heavy, 0.51 m (20-in.)-thick grade-level cover blocks. When several tanks are pumped to a single receiver tank, the flow is routed to a valve pit. In the valve pit, the transfer lines of the sending tank are connected to the receiver tank line by means of a series of valves and jumper connections. Two- and three-way valves are built into each rigid jumper assembly to divert the flow in the required direction. Each valve pit is equipped with leak detection. Some of the leak detection systems are interlocked to shut down the transfer pumps on detection of a leak. Each valve pit also has a flush line connected to a flush pit and a drain line connected to an underground storage tank. Unlike a typical diversion box, valve pits allow for routing by manipulating valves with valve handles and operators that extend through the cover blocks. This allows for changing flow paths without removing the cover block or requiring the moving of jumpers.

The cleanout boxes (COB) provide an access to allow cleaning out slurry transfer lines. The boxes are positioned approximately every 30.5 m (100 ft) along the slurry transfer lines between evaporator facilities, valve pits, and storage tanks. The COBs are scheduled to be taken out of service by calendar year (CY) 2005.

2.1.8 Transfer Pipelines and Jumpers

Mixed waste is transferred from a sending facility or tank to a receiving tank through existing underground piping or temporary over-ground piping. This transfer piping provides containment of the mixed waste during the transfer to prevent release to the groundwater and air pathways. The piping (except direct buried piping)contains a secondary encasement that will contain leaks from the primary piping and direct the leakage to pits where it can be detected and routed through drain lines to other tanks. Transfer pipelines are identified and categorized on the basis of the material transferred:

- **Supernatant Lines**. Pipelines that transfer liquid waste between tanks or processing facilities.

- **Slurry Lines**. Pipelines that transfer liquid-solid slurries between tanks or processing facilities.

Jumpers are rigid or flexible sections of piping used to connect transfer lines during transfers using nondedicated routes. Jumpers are removed and installed as needed in diversion boxes or other pits.

The primary pipe used in waste transfer lines is carbon or stainless steel. Waste transfer lines used at the Hanford Site are of three general types:

- Encased piping
- Direct-buried piping
- Over-ground piping.

The term “encased piping” indicates that the primary transfer line is completely enclosed within a secondary confinement barrier. The secondary confinement barrier usually is a larger pipe (newer designs), a concrete jacket (older designs), or a pipe trench. The term “direct-buried piping” indicates that the piping is not encased and is buried directly in the soil. The term “over-ground piping” refers to encased piping that is not buried.

2.1.9 90-Day Storage Area and Satellite Storage Areas

The 209-E Storage Area is located north of the Plutonium-Uranium Extraction (PUREX) Facility in the 200 East Area. It consists of a 90-day waste storage pad for hazardous, mixed waste, low-level radioactive waste, and non-regulated waste. Satellite accumulation areas (SAA) are located at various places within the DST system where waste may be generated (e.g., at each tank farm and maintenance shops). Containers for less-than-90-day storage are stored within DST facilities in conjunction with job-specific activities, such as maintenance.

The 90-day waste storage pad is a 12 m x 18 m (40- x 60-ft) covered and fenced concrete pad used for the temporary accumulation of solid and liquid hazardous, mixed, low-level radioactive, and non-regulated waste. Curbs are used on the periphery of the pad to segregate hazardous and mixed waste areas and to provide for spill containment. The area is inspected weekly. This area is compliant with theRCRA requirements. The engineered and administrative controls for managing mixed, radioactive, hazardous, and PCB remediation waste provide adequate protection so that no unreasonable risk is posed to human health or the environment.

The operation, labeling, and controls used to manage the 90-day waste storage pad, SAAs, and less-than-90-day containers provide adequate protection for storage for up to 90 days of larger PCB-contaminated equipment (e.g., pumps, thermocouple trees) that could need to be removed from tanks. Other equipment and materials that have contacted PCB-contaminated materials (secondary waste) constitute a waste stream that will be managed under the Sitewide PCB management plan.

2.2 PCBS IN THE DST SYSTEM

PCBs are a group of 209 semivolatile organic chemicals consisting of from 1 to 10 chlorine atoms attached to a biphenyl. PCBs were not produced as discrete compounds (congeners) but as technical mixtures of congeners in varying proportions. PCB material was produced in the United States from 1930 to 1974. Most of this material was marketed by Monsanto under the trade name Aroclor (National Research Council 1979). Production of PCBs in the United States peaked in 1970 and had essentially stopped by the late 1970s (Patton et al. 1997).

The physical properties of PCBs made them adaptable for numerous commercial uses. PCBs were used widely as dielectric fluids for capacitors and coolants for transformers; they alsow were used as plasticizers, hydraulic and heat transfer fluids, inks, paints, and adhesives (Erickson 1992). These all are common industrial products that could have been introduced as waste to Hanford Site DSTs, in the past.

Sample analyses of DSTs for PCBs to date have been below method detection limits (Nguyen 2001). PCBs have been detected in waste transfers sent to the DST system; however, they have represented a very small portion of the total liquid wastetransferred into the tanks. The tank waste system was designed to store radioactive liquid waste; PCBs introduced into the tanks would have been incidental waste that had been radiologically contaminated, or relatively small-quantity waste streams that were drained to the tanks from radiologically controlled areas.

The PCBs are unlikely to have survived as soluble specie in a DST environment. PCB solubility values assume the presence of dilute aqueous solutions. DST waste consists of concentrated salt solutions and, as such, the solubility of organics in the tank waste slurry is greatly lowered from that observed in dilute solutions. PCBs are expected to react and be degraded to less complex dichlorobenzene, sodium phenalates, and phenol end products in the basic (high pH) waste solutions. PCB concentrations in the liquid waste would have been reduced further by processing through evaporator facilities (DOE 2001).

Aroclor 1016 was selected as a representative PCB for modeling of releases from DSTs in this risk analysis. Environmental toxicology for PCB is complicated by the large number of congeners in the technical mixtures. The Aroclor mixtures 1016, 1221, 1242, 1248, 1232, 1254, and 1260 are seven PCB compounds that have been identified as possible mixtures used at the Hanford Site (DOE 2001). In comparison to the other Aroclor compounds, Aroclor 1016 exhibits a large molecular weight, relatively high solubility in dilute aqueous solution at standard temperature and pressure, and a relatively high Henry's Law constant.

Calculations using Henry's Law constants for any of the other Aroclor compounds (e.g., 1232) would be expected to result in release rates of one to two orders of magnitude less than that predicted for Aroclor 1016. PCBs present in the DST system could be released to the environment through limited release pathways, but via several mechanisms. Four scenarios were identified for evaluation in this risk assessment based on information gained through review of the FSAR (CHG 2001)and tank farm operations. These scenarios represented events that were deemed to be realistic and consistent with proposed DST operation in support of the WTP.

2.3 RELEASE SCENARIOS

The following sections discuss the release mechanisms and scenarios used in this risk assessment. The discussion addresses releases from routine operations and accident conditions. Because this was a screening-type analysis, bounding or near bounding parameters were selected to project conservative release amounts. The release calculations are shown in Appendix A. Section 2.4 discusses uncertainty and conservation in the defense scenarios.

2.3.1 Normal Operating Stack

Several methodologies were considered for the normal operating stack release. Insufficient characterization information was available to develop an adequate mechanistic release scenario. Therefore, a deterministic approach was selected for the normal operating stack release. A conservative total PCB inventory for the DST system was calculated and 100 percent of this calculated PCB inventory was assumed to be released as a vapor over 20 years. The basis for this release scenario is provided in the remainder of this section.

An active ventilation system removes heat from the primary tank by providing flow through the tank headspace. The approximate airflow for a DST ventilation system is 1,000 ft^3/min.. Outside air is drawn into the tank through inlet filters, pit cover blocks, or risers because of the reduced pressure created by the exhaust blowers. Air is drawn from the tank and routed to the air-handling unit. The air then passes through a demister consisting of a wire mesh pad that separates heavy moisture particles from the air stream. Air then is passed through an electric heater to further reduce the humidity. The dry, heated air is prefiltered to protect the HEPA filters, then routed through two HEPA filters mounted in series to remove particulate as small as 0.3 μ with at least 99.95-percent efficiency. The air stream from the air-handling unit is routed to five stacks for the six DST tank farms and discharged to the atmosphere. Because of the design of the ventilation system, vapors are the only expected PCB releases from a normal operating stack.

DSTs contain waste from past Site operations. The tank headspace contains gases derived from the waste that is generated by continuing chemical and radiological reactions. Some tanks contain small quantities of PCB constituents. Although the majority of the PCB is expected to be in the tank waste solids and would not be readily available to be released as vapor, this scenario assumes that all PCB is available and will be released as vapor at a steady rate over 20 years.

Tank waste consists of supernatant liquids and solids. The solids are made up of both sludge and saltcake. For this estimate, the volume of saltcake has been included with the volume of supernatant liquid. This was done because saltcake is the result of evaporator campaigns. Evaporator campaigns reduce the concentration of PCB in the waste by more than 95 percent; therefore the saltcake should not contain any appreciable concentration of PCB. However, for conservatism, saltcake volumes have been included with the supernatant liquid volume at an assumed PCB concentration of 2.9 ppm.

The concentration of PCB in the supernatant liquid is not expected to exceed 0.2 ppm (Mulky 2001). The 2.9-ppm concentration of PCB was chosen to add conservatism to the calculation in addition to being the current liquid waste feed limit for the Waste Treatment Plant. Because the bulk of the PCB concentration is expected to be contained in the tank waste solids, the remaining sludge volume was assigned a conservative PCB concentration of 50 ppm (the current solid waste feed limit for the Waste Treatment Plant). These two concentrations are not based on analytical data because PCBs have not been detected in tank waste samples.

The total volume of waste used in the calculation includes the current waste volume in the DST system (~20.6 Mgal from Table B-1 of Hanlon 2001) plus 5 Mgal of waste assumed to be added to the DST system over 20 years. Using this waste volume and the assumed PCB concentrations, a total inventory of PCB was calculated. That inventory of PCB was then assumed to be released through the tank ventilation system linearly over a 20-year period to roughly coincide with the first phase of operation of the Waste Treatment Plant.

The additional volume of 5 Mgal of waste was chosen based on the total nonallocated space in the DST system after deducting operational space, restricted space, and watch list space (Table C-2 of Hanlon 2001). Although this additional waste could be from various sources, it was assumed to come from the SST system because 90 percent of the future waste will come from the SST system. This assumption allowed the use of known solid and liquid waste volumes and the ratio for calculating the total PCB inventory. This additional waste is assumed to move into the DST system at the same liquid-to-solid ratio as the waste exists in the SST system now. The PCB concentration is assumed to be 2.9 ppm for liquids/saltcake and 50 ppm for other solids, as was assumed for the waste in the DST system.

This scenario adds conservatism by not accounting for the following factors.

- Continuing evaporator campaigns would further reduce any PCB available in the waste.

- The volume of waste that could be transferred into the available space of the DST system would be reduced by the amount of process water needed to slurry the waste for pumping.

- The volume of waste that could be transferred into the available space of the DST system would be reduced by the amount of water used to flush the transfer lines.

2.3.2 PCB Release for Valve Pit Jumper Change-Out

This normal release scenario addresses a situation where drainage from a jumper occurs during a DST routine valve pit jumper change-out. In this scenario the valve pit cover blocks are not installed.

During a jumper change-out operation, a jumper is removed and waste is trapped in the jumper. Subsequently the jumper is tipped and the trapped waste is dumped to the valve pit floor, resulting in 7.6 E-3 m^3 (2 gal) of waste draining to the valve pit floor within 10 seconds. An aerosol constituting 0.01 percent (DOE Handbook) of the waste released to the pit is then released to the environs within 1 hour of the drainage.

The slurry is assumed to contain 33 percent entrained solids with the solids containing 50 ppm PCBs and the liquid containing 2.9 ppm PCBs. The slurry density is assumed to be 1.4 g/cm^3. The principal PCB constituent is the Aroclor 1016 compound.

The scenario assumes that no solid particulate is lost by deposition during plume migration to the receptor location and that all of the aerosol released is respirable by receptors.

2.3.3 PCB Release for Valve Pit Spray Leak

This accident scenario addresses a DST slurry spray leak in a valve pit with the cover blocks installed; a scenario similar to the FSAR (CHG 2001)(). The scenario assumes that a crack develops in the piping of a length equal to 1 nominal pipe diameter, i.e., 50.8 mm (2 in.). The slurry is sprayed into the valve pit and begins to collect on the pit floor. The pit has a leak detector that is designed to activate at 25.4 mm (1 in.) above the pit floor. However, the scenario assumes that a 50.8 mm (2-in.) accumulation is required to set off the leak detector. An additional 30 minutes response time is required before the transfer pump is stopped, resulting in 2.78 m^3 (98.0 ft^3) of liquid on the bottom of the pit.

Release of PCB-contaminated material to the environment is caused by the displacement of air with entrained aerosol through gaps and crevices in and around the cover blocks. The largest release would result from a spray accident at the largest valve box. The internal dimensions of the largest valve box at the Hanford Site are 12.8 m x 4.27 m x 1.37 m) ((42 ft x 14 ft x 4.5 ft) deep resulting in a surface area of 54.6 m^2 (588 ft^2) and a pit volume of 74.9 m^3 (2,650 ft^3).

The displaced air is assumed to be mixed with a maximum aerosol loading of 100 mg/m^3. An initial expansion of the air in the pit caused by an assumed increase in air temperature and relative humidity from – 1 °C (30°F) at 15-percent relative humidity (RH) to 49 °C (120 °F) at 100 percent RH leads to a release of 35 percent of the total pit volume. The time required to perform the initial heat-up and expansion is assumed to be less than 1 hour.

The leak is assumed to result in a spray volume rate of 1.41 E-4 m^3/sec, resulting in 5.5 hours elapsing before the leak is detected. A total release time of 6.0 hours results with the inclusion of the response time to secure the transfer pump.

The slurry is assumed to contain 33 percent entrained solids with the solids containing 50 ppm PCBs and the liquid containing 2.9 ppm PCBs. The slurry density is assumed to be 1.4 g/cm^3. The principal PCB constituent is the Aroclor 1016 compound.

The scenario assumes that no solid particulate is lost by deposition during plume migration to the receptor location and that all of the aerosol released is respirable by receptors.

2.3.4 High-Concentration PCB Release from Valve Pit Spray Leak

This accident scenario concerns a DST valve pit slurry spray leak. This scenario is similar to that described in Section 2.3.3 except that the postulated accident occurs during a transfer of waste from a processing facility (e.g., T Plant). Transfers from processing facilities could include waste with PCB concentrations much higher than those of waste normally transferred between DSTs. This scenario was included to provide a realistic bounding case for the exposure assessment.

The scenario assumes that the valve pit cover blocks are installed. The scenario assumes that a crack develops in the piping of a length equal to 1 nominal pipe diameter, (i.e., 50.8 mm [2 in.]). The slurry sprays into the valve pit and collects on the pit floor.

The scenario assumes that the facility pump is shut down within 1 hour after the spray leak commences, instead of the 6-hour release described in Section 2.3.3. This scenario assumes that the pumping/release time is shorter because a smaller volume of waste would be transferred compared to a tank-to-tank transfer, and/or the leak is detected earlier because of increased surveillance maintained during transfers of this type.

The release results in 0.51 m^3 (18 ft^3) of liquid accumulating in the bottom of the pit. Release of PCB-contaminated material to the environment is caused by the displacement of air with entrained aerosol through gaps and crevices in and around the cover blocks. The largest release would result from a spray accident at the largest valve box. The internal dimensions of the largest valve box at the Hanford Site are 12.8 m x 4.27 m x 1.37 m (42 ft x 14 ft x 4.5 ft) resulting in a pit volume of 74.9 m^3 (2,650 ft^3).

The displaced air is mixed with a maximum aerosol loading of 100 mg/m^3. An initial expansion of the air in the pit caused by an assumed increase in air temperature and relative humidity from – 1 °C (30°F) at 15-percent RH to 49 °C (120°F) at 100-percent RH leads to a release of 35 percent of the total pit volume. The time required to perform the initial heat-up and expansion is assumed to be less than 1 hour.

The leak is assumed to result in a spray volume rate of 1.41 E-4 m^3/sec, resulting in 1 hour passing before the leak is detected and the transfer pump is shut off.

The slurry is assumed to contain 33 percent entrained solids with the solids containing 1,000 ppm PCBs and the liquid containing 2.9 ppm PCBs. A 1,000-ppm PCB concentration is believed to be the highest realistic value that would be observed during a transfer from a processing facility. The PCB constituent data is based on Aroclor 1016.

2.4 UNCERTAINTY

The PCB rate release models created for this evaluation rely on simplified chemical, physical, and operational concepts. The assumptions chosen provide a conservative and simple calculational basis. As with any model, attempts to simplify a complex process lead to inherent uncertainty. The uncertainty in this model stems from three overall assumptions, namely, that the PCB concentrations in the matrix are known, that the matrix is a homogeneous solution, and that the kinetics and diffusion rates are sufficient to provide a consistent release from the system. PCB concentrations were based on criteria that are much higher than the concentrations currently documented in the DST systems. Potential still exists for PCBs from existing Hanford Site facilities to enter the DST systems. No consideration was taken for a potential chemical degradation of the PCBs in a high-pH solution.

The model assumes that all DST tanks have a homogeneous matrix. It is very unlikely that this will be the case. Operations are expected to mix tank contents based on the need to provide feed on a scheduled basis over many years. No consideration was made concerning the kinetic and diffusion characteristics associated with the transfer of PCBs from the solid to the liquid to the vapor space. The actual kinetic and diffusion characteristics would be expected to be much slower and would not support a consistent high release of PCB.

Table 2-1 provides a compilation of model parameters used in the exposure scenarios and discusses the implications of changes in these values. The results of the emission rates for the various scenarios show that the stack release during normal operations is significantly higher than for the selected accident. Actual stack emission rates are expected to be two to three orders of magnitude lower.

Table 2-1. Effect of Uncertainty on Model Assumptions.

Parameter	**Model Assumptions and Discussion**	**Effect of Uncertainty**
Source term	• Slurry assumed to contain 33 wt% entrained solids with a PCB concentration in the liquid of 2.9 ppm and in the solids of 50 or 1,000 ppm • Normal operation model based on an upper limit of PCB in the waste	Use of actual PCB solubilities or known sample concentrations would be expected to lower calculated release rates by several orders of magnitude
Source term	• Model concentrations are magnitudes higher than have been observed in tank samples or are expected to be present in the future	
PCB chemistry	• Effects of pH on PCB volatility and stability are not addressed in model	Degradation of PCBs would be expected to lower calculated release amount
Distribution in matrix	• Normal tank conditions tend to be stratified with liquid and solid/sludge phases, not homogeneous solutions • A stratified condition would tend to decrease PCB migration and transfer to the liquid phase because of the reduced solid-liquid contact conditions as opposed to the conditions in a homogeneous solution	Stratified tanks would be expected to lower calculated release rates
Kinetics between solid, liquid and vapor phases	• Model assumes a finite and steady supply of PCBs from solid to liquid to vapor phase until depleted • Diffusion-driven concentration gradients within the waste solution in unmixed DSTs not modeled	• Slower liquid to vapor space kinetic rates would result in decreased calculated release rates

3.0 EXPOSURE ASSESSMENT SCENARIO

This section of the human health risk assessment describes the approach used to quantify human exposures to PCBs posed by potential tank equipment releases from the DSTs for selected normal and accidental release scenarios. Included within the exposure assessment portion of the risk assessment are the following processes: identification of potentially exposed individuals or populations (“receptors”); identification of potentially complete exposure pathways; and quantification of chemical intakes or potential doses for each receptor-pathway combination.

3.1 CHARACTERIZATION OF RECEPTORS

The selection of receptors to be evaluated in this risk assessment was designed to ensure protection of all potentially exposed members of the worker and public populations (see Figure 1-1 for area map). The identification of potential receptors focused on those individuals most likely to be present and unprotected at the time of normal or accidental releases. Given this objective, the following receptors were examined as part of this risk assessment:

- An adult worker occupying office space 100 m downwind of DST operations.
- An adult motorist commuting on Highway 240 west of the DST farms. The distance to Highway 240 is 3800 and 9000 m for the West and East DST farms, respectively.
- An adult resident living in Ringold, Washington. The closest distance to Ringold is 17,100 and 25,900 m for the East and West DST farms, respectively. The minimum distance is consistent with that used in the evaluation of the 242-A Evaporator Study (DOE 2001).

The worker is intended to represent a health-protective, yet realistic potential exposure for onsite personnel within the DST areas. An adult motorist commuting on Highway 240 is included to represent the potential for less frequent and/or shorter duration exposures by public or worker receptors within the DST vicinity. Finally, an adult resident living at Ringold is included to represent the potential long-term risks to populations currently living at a location of offsite exposure.

3.2 DESCRIPTION OF EXPOSURE PATHWAYS

This section identifies the most significant potential pathways through which humans may be exposed to PCBs released from the DST system and presents the basis for elimination of incomplete exposure pathways or insignificant routes of exposure. As described in the *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual, Part A* (EPA 1989), the exposure pathway comprises four characteristics:

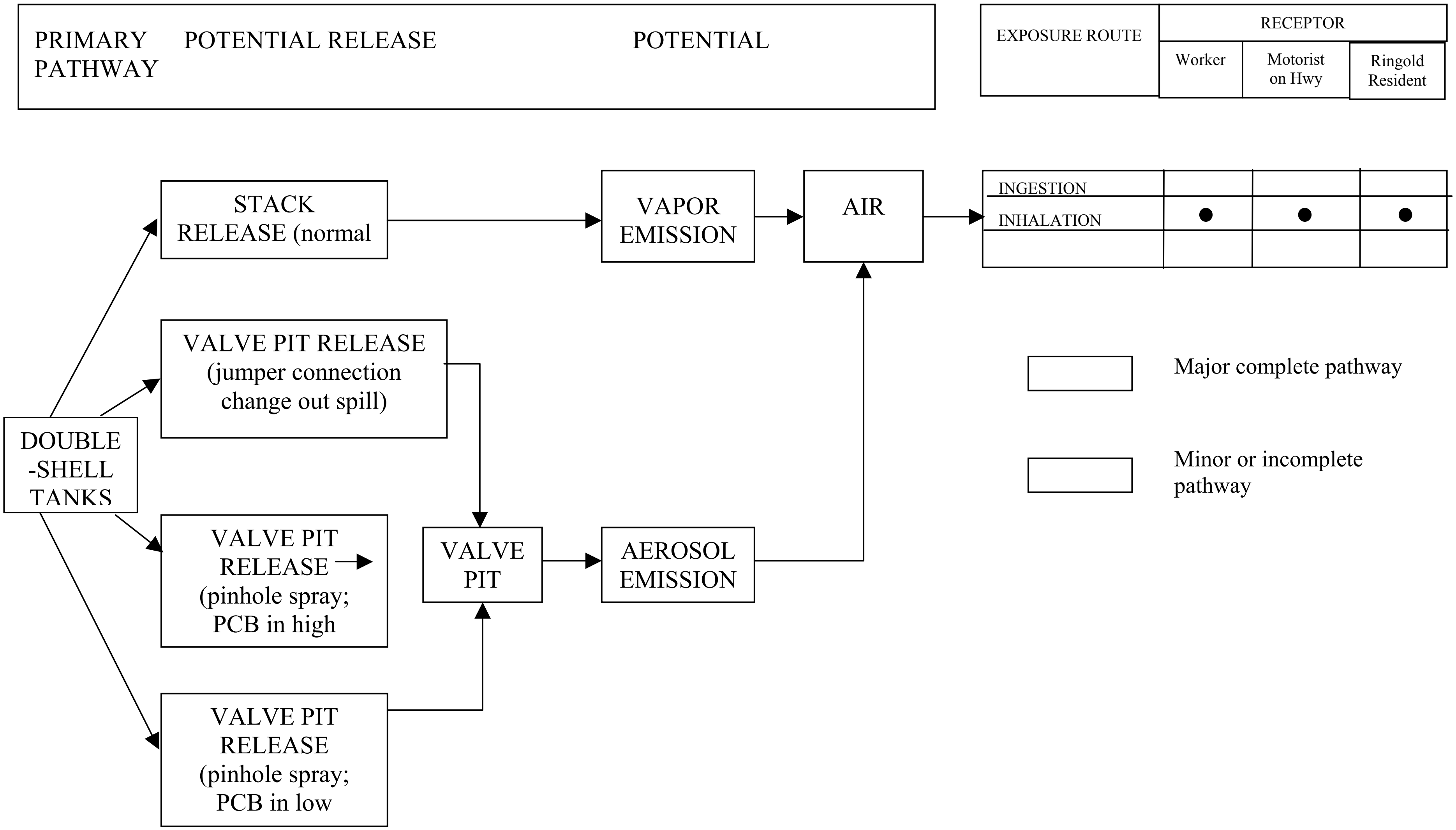
- A source and mechanism of constituent release
- A retention or transport medium (e.g., air, soil, water)
- A point of human contact with the affected medium (e.g., DST workers or resident population)
- An exposure route at the point of contact (e.g., oral, inhalation, or dermal absorption).

Potential exposure pathways were evaluated for these four characteristics early in the risk assessment process to develop a conceptual Site model (CSM) that graphically summarizes these characteristics and those pathways that are considered complete for the purposes of evaluating risk. This is a critical component of the risk assessmentbecause only complete pathways have the potential to pose risks to surrounding populations of workers and the public.

The CSM for this risk assessment is included as Figure 3-1. As shown on this figure and discussed in previous sections of this document, DSTs represent the primary source of PCBs evaluated in this risk assessment. Similarly, four conservative release scenarios have been selected for analysis and are presented in the following sections. Based on the characteristics of the source and release mechanisms, air has been identified as a primary transport medium for all release scenarios. One scenario represents routine operations and the other three represent accident-based releases. Once in the air, the PCB contamination is uncontained and able to make contact with any human receptors in the path of its transport and migration. Once in contact with humans, the primary route of exposure for air is via inhalation. Thus, a complete exposure pathway exists for inhalation of PCB-contaminated air released from the DSTs.

Other pathways considered, but deemed minor or incomplete for this assessment, were incidental ingestion of, or dermal contact with, spilled or sprayed material during valve pit operations. While a source, mechanism of release, and transport/retention medium all exist for these pathways, the potential for human contact with the affected media was determined not to exist. This is because such exposures would be limited to valve pit operations personnel who are required to don PPE (including facial, respiratory, and dermal coverage) during valve pit operations, which would prevent their potential for contact with the PCBs via ingestion, inhalation, or dermal contact. The EPA (1989) notes that dermal absorption of vapor chemicals is lower than inhalation intakes in many cases and, thus, generally is not considered in exposure assessments. Consequently, inhalation of contaminated air by unprotected worker and public receptors was considered to be the only exposure pathway relevant to the four release scenarios included in this assessment.

Figure 3-1. Conceptual Site Model.



3.3 DETERMINATION OF EXPOSURE POINT CONCENTRATIONS

For each potential exposure scenario, exposure point concentrations were estimated using a fate and transport model that simulates transport of the PCB release in air and its resulting concentration at specified points of potential exposure some distance from the point of release. SCREEN3 (version 96013) is a single-source, steady-state Gaussian-plume air dispersion model used to estimate maximum 1-hour air pollutant concentrations from point and area sources. The model is based on equations and calculations that are detailed in *Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised*, EPA-454/R-92-019 (EPA 1992a). SCREEN3 is EPA approved (40 CFR 51, Appendix W) and is designed to be a conservative screening model for use as a first step in evaluating potential impacts from chemical emission sources. Hence, its code was developed so that it is unlikely to underestimate chemical concentrations in air. A brief summary of the input assumptions and results obtained using SCREEN3 for the previously discussed exposure scenarios are provided in Section 3.3.1.

3.3.1 Model Inputs

For each source type (e.g., point or area), SCREEN3 requires a set of input assumptions. Some of these input assumptions remain constant over the various exposure scenarios evaluated for this risk assessment, while others change depending on receptor or release types. The input values that remained constant across the scenarios, and the rationale for their selection, are provided in Table 3-1. Those values that were variable across scenarios and their rationale are provided in Table 3-2.

Table 3-1. Parameters Constant Across All Exposure Scenarios. (2 sheets)

Parameter	Value	Rationale
Ambient temperature	285.3 K	Five-year annual average temperature Richland, Washington, meteorological data.
Effluent temperature	285.3 K	See Section 2.3 and App B
Receptor height above ground	1.75 m	Standard height for an adult.
Urban/Rural Option	Rural	Terrain largely open country.
Building Downwash Option	No	No buildings are located adjacent to DST stacks or pits.
Complex Terrain Option	No	Terrain surrounding DSTs generally is flat and does not rise above the top of the stack.

Table 3-1. Parameters Constant Across All Exposure Scenarios. (2 sheets)

Parameter	Value	Rationale
Simple Elevated or Flat Terrain Option	Flat Terrain	Terrain surrounding DSTs is almost completely flat and does not rise significantly above the bottom of the stack.
Choice of Meteorology	Full Meteorology	SCREEN3 default and most conservative option.
Fumigation Option	No	Parameters for use of fumigation (near large body of water and/or stack higher than 10 m) do not apply at the site.

Table 3-2. Parameters That Vary Across Exposure Scenarios

Parameter	Scenario	Value
Emission Rate	Stack, Normal Operations	West Area: 0.000342 g/sec East Area (Four-stacks): 0.00137 g/sec
	Valve Pit Spill	2.01E-10 g/sec-m^2
	Valve Pit Spray	Low Conc: 4.57E-11 g/sec-m^2 High Conc: 4.57E-09 g/sec-m^2
Stack Height	Stack, Normal Operations	5 m
	Valve Pit Spill	Ground level
	Valve Pit Spray	Ground level
Size of Release Area	Stack, Normal Operations	0.254 m diameter
	Valve Pit Spill	12.80 m × 4.27 m (area release, using pit dimensions)
	Valve Pit Spray	12.80 m × 4.27 m (area release, using pit dimensions)
Stack Gas Flow Rate	Stack, Normal Operations	1,000 ft^3/min
	Valve Pit Spill	NA
	Valve Pit Spray	NA

Data are from Section 2.3 and Appendix A
NA – Not applicable.

SCREEN3 is designed for single-stack releases, but EPA (1992) describes methodology for combining multiple stacks with differing parameters into a single "pseudo-stack." This methodology normally is used for stacks with similar characteristics (e.g., flow rates, heights, diameters) that are within 100 m of one another. It was not necessary to use this technique for the 200 West DSTs because only one stack is present; however, the 200 East DSTs contain four stacks. Although these four stacks are more than 100 m apart, the combination of their identical parameters and the significant distance from this source to the commuter and Ringold receptors were considered to provide adequate rationale for using this technique. For the nearby worker, combining the stacks will result in a substantial overestimate of the expected concentrations, which will only be an issue if the risk assessment identifies an unacceptable risk from this overestimated exposure.

Both the spray and spill scenarios occur in a DST tank farm valve pit. The aerosols were modeled as vapors with SCREEN3. The PCB emissions from the pit are around the cover in the spray scenario and over the area of the pit for the spill. Thus the releases were developed as area sources.

3.3.2 Model Outputs

The PCBs are emitted from the stacks at an estimated concentration of 720 $\mu g/m^3$. SCREEN3 calculates maximum 1-hour pollutant concentrations at distances selected by the user. EPA (1992) provides time adjustment factors for calculating average concentrations for different time periods using this maximum concentration. These factors take into account the variability of wind direction and speed and atmospheric conditions over the time periods. For example, the EPA guidance recommends multiplying the 1-hour concentrations by a factor of 0.7 to calculate 8-hour concentrations. These 8-hour concentrations are suitable for comparison to the U.S. Occupational Safety and Health Administration (OSHA) 8-hour time-weighted PCB Permissible Exposure Limits (PEL). For the public receptor risk estimate, an annual concentration is more appropriate, and the recommended multiplier is 0.08. For the spray and spill release scenarios, which varied in release time from 1 hour to 6 hours, the modeled concentration was not adjusted. This was considered appropriate because these are short-term accident scenarios, and 1-hour maximum concentrations are conservative for these types of exposures. Table 3-3 provides the results of the model calculations for each release scenario, as well as the final adjusted concentrations obtained after using the adjustment factors for the human exposure scenarios. Section 5 applies the air concentrations to the environmental assessment.

Table 3-3. Model Output and Adjusted Concentrations for the Human Exposures.

Scenario	Receptor*	Distance (m)	Modeled One-Hour PCB Concentration (µg/m^3)	Period Adjusted PCB Concentration** (µg/m^3)
Stack, Normal Operations	East-100 m worker	100	1.4	0.95
	West-100 m worker	100	0.34	0.24
	East-max worker	343	1.6	1.1
	West-Max Worker	343	0.40	0.28
	East-Highway 240	9,000	0.039	0.0031
	West-Highway 240	3,800	0.030	0.0024
	East-Ringold	17,100	0.017	0.0014
	West-Ringold	25,900	0.0026	0.00021
Valve Pit Spray (High Conc)	100 m Worker	100	6.1E-03	6.1E-03
	East-Highway 240	9,000	7.2E-06	7.2E-06
	West-Highway 240	3,800	2.3E-05	2.3E-05
	East-Ringold	17,100	3.2E-06	3.2E-06
	West-Ringold	25,900	1.9E-06	1.9E-06
Valve Pit Spray (Low Conc)	100 m Worker	100	6.1E-05	6.1E-05
	East-Highway 240	9,000	7.2E-08	7.2E-08
	West-Highway 240	3,800	2.3E-07	2.3E-07
	East-Ringold	17,100	3.2E-08	3.2E-08
	West-Ringold	25,900	1.9E-08	1.9E-08
Valve Pit Spill	100 m Worker	100	2.7E-04	2.7E-04
	East-Highway 240	9,000	3.2E-07	3.2E-07
	West-Highway 240	3,800	1.0E-06	1.0E-06
	East-Ringold	17,100	1.4E-07	1.4E-07
	West-Ringold	25,900	8.4E-08	8.4E-08

*East" and "West" in this column refer to the area of the source.
**The adjusted concentration is obtained by multiplying the modeled concentration by the time adjustment factor.

3.4 ESTIMATION OF HUMAN DOSES

For this risk assessment, exposure by an individual to PCB may occur only via direct inhalation of air containing PCBs. Each of the receptors was evaluated for all four release scenarios using exposure assumptions and parameters that tend to produce upper-bound exposures. These receptors were chosen to represent health-protective individual exposure scenarios potentially occurring in the DST vicinity. If the risks associated with these individual receptor exposures are found to be within acceptable EPA guideline values, the potential risk to the remaining population is expected to be much lower. Table 3-4 lists all the exposure assumptions and inputs relied on for each public receptor-release scenario. The onsite worker scenario assumed a regular workday schedule.

Table 3-4: Exposure Assumptions for Public Receptors.

Parameter	**Highway 240 Commuter**		**Ringold Resident**	
	Stack, Normal Operations	**Valve Pit Spray or Spill Accident**	**Stack, Normal Operations**	**Valve Pit Spray or Spill Accident**
Inhalation rate (a) (m^3/hr)	20	20	20	20
Exposure (hrs/day)	0.25 (b)	1 (c) – short duration spray, and spill 6 (c)– long duration spray	24 (a)	1 (c)– short duration spray, and spill 6 (c) – long duration spray
Exposure frequency (days/yr)	250 (a)	1 (c)	350(a)	1 (c)
Exposure duration (c) (years)	20	20	20	20
Body weight (d) (kg)	72	72	72	72
Lifetime (d) (years)	75	75	75	75

References
Best professional judgment.
Definition of scenario (Section 2.3 and Appendix A)
EPA, 1991, *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors*," OSWER Directive 9285.6-03, U.S. Environmental Protection Agency, Washington, D.C.
Versar, Inc., 2000, *PCB Risk Assessment Review Guidance Document. Prepared for Office of Pollution Prevention and Toxics*, for the U.S. Environmental Protection Agency, Washington, D.C..

The potential lifetime average daily doses for the Ringold resident and Highway 240 commuter receptor scenarios were calculated using the following equation (EPA 1989):

$$LADD_{pot} = [C \times IR \times ED \times EF] / [BW \times LT]$$

where:

$LADD_{pot}$ = potential lifetime average daily dose (mg/kg-day);
C = contaminant concentration in air (mg/m^3);
IR = inhalation rate (m^3/day);
ED = exposure duration (years);
EF = frequency of exposure events (days/year);
BW = body weight (kg); and
LT = lifetime (days).

Because the Highway 240 commuter and Ringold resident receptors are exposed to continuous emission from stacks in both areas, their total exposure was the sum of the exposures to each stack. The exposure concentration for each receptor was that associated with the distance from each stack to the receptor.

Potential lifetime average daily doses were not calculated for onsite worker receptor scenarios. Instead exposure point concentrations for these receptor scenarios, derived from SCREEN3 modeling, were directly compared to OSHA Permissible Exposure Limits (PEL) for worker exposures to PCBs.

3.5 UNCERTAINTY

The following sections discuss the uncertainty associated in the models and human exposure parameters used in this risk assessment.

3.5.1 SCREEN3 Air Modeling

The SCREEN3 model is a steady-state Gaussian plume model that relies on predefined sets of weather conditions and dispersion parameters along with user inputs to estimate ambient air concentrations at downwind locations. As with any computational model, SCREEN3 attempts to simplify natural processes to answer a complex question; hence, the model contains inherent uncertainty. For this discussion, model uncertainty will be divided into two components: uncertainty inherent in the SCREEN3 model calculations and uncertainty in the model input assumptions.

SCREEN3 uses a generic set of dispersion parameters and weather conditions (e.g., atmospheric stability and wind speeds) to calculate maximum air concentrations. The range of weather conditions included in a SCREEN3 model run is indeed extreme. This assumption and the fundamental parametric choices embedded in SCREEN3 are why it is a conservative screening model. The worst case weather conditions that lead to a maximum concentration for a particular model run seldom occur. Similarly, the time adjustment factors used to create concentration estimates for periods longer than 1 hour are chosen to be conservative estimates of wind variability over the time period. The weather conditions that produced the maximum air concentrations for the commuter and Ringold resident can be expected at the Hanford Site, but their frequency in the direction of these two receptors is uncertain.

For this assessment, the four 200 East Area stacks were modeled as a single pseudo-stack. This simplified approach overestimates the exposures near the stack, but has little effect on estimated exposures for distant receptors, such as the Ringold resident.

The uncertainty in the SCREEN3 input assumptions also are propagated through the model calculations. Table 3-5 provides the various SCREEN3 input parameters used for the exposure scenarios, and discusses the implications of changes in these values.

Table 3-5. The Effect of Uncertainty on Model Parameters. (2 sheets)

Parameter	Value	Effect of Uncertainty
Ambient Temperature	285.3 K	If the ambient temperature is lower than the emissions temperature, more plume rise is expected; this pushes the maximum concentration farther from the source, but also disperses the plume more, leading to lower maximum concentrations. The opposite occurs when the ambient temperature is higher than the emission temperature.
Effluent Temperature	285.3 K	
Receptor Height Above Ground	1.75 m	Increasing and decreasing the receptor height by less than 1 or 2 m is unlikely to have a significant effect on modeled air concentrations.
Urban/Rural Option	Rural	The use of the urban option causes the plume to dispersemore quickly, which can cause higher concentrations at nearby receptors and lower concentrations at distant receptors.
Building Downwash Option	No	The use of building downwash calculations can affect air concentrations near the stack if buildings are present; generally, higher concentrations are found closer to the stack than if building downwash is not considered.
Complex Terrain Option	No	The complex terrain option allows for the calculation of air concentrations assuming the plume touches ground that is at a higher elevation than the stack. If such terrain exists near a stack, the concentrations at impact will be higher than if higher ground is not assumed to exist.

Table 3-5. The Effect of Uncertainty on Model Parameters. (2 sheets)

Parameter	Value	Effect of Uncertainty
Simple Elevated or Flat Terrain Option	Flat Terrain	The simple terrain option assumes that terrain is higher than the stack base, but lower than the stack top. Hence, the modeled plume will touch the ground sooner, and higher concentrations will result if this option is used.
Choice of Meteorology	Full Meteorology	Use of limited meteorological states can lead to lower calculated concentrations if the condition that produces the maximum concentration is omitted.
Fumigation Option	No	Use of the fumigation option will result in higher air concentrations under certain conditions.
Emission Rate	Variable	Decreasing modeled emission rates linearly decreases modeled air concentrations and vice versa.
Stack Height	Variable	Increasing the modeled stack height will push the location of the maximum concentration further from the stack and decrease that concentration. The opposite also applies.
Stack Inside Diameter	Variable	Decreasing the modeled stack diameter will push the location of the maximum concentration further from the stack (because of the subsequent increase in stack exit velocity), especially under high-wind conditions, and decrease that concentration, if the maximum is close to the stack. The opposite also applies.
Stack Gas Flow Rate	Variable	Increasing the modeled stack gas flow rate will push the location of the maximum concentration farther from the stack and decrease that concentration if the maximum is close to the stack. The opposite also applies.
Form (vapor or aerosol) of PCB releases	Variable	The normal stack scenario releases vapor, but PCB may absorb to air particulates. Spray and spill scenarios generate aerosols. The SCREEN3 model runs assumed only vapor emissions. As the proportion of vapor declines, the results of SCREEN3 model runs will tend to underestimate concentrations close to the valve pit, and overestimate concentrations at a distance.

3.5.2 Human Exposure Parameters

The exposure parameter values were designed to be health-protective. Table 3-6 discusses the key exposure assumptions and the effects of uncertainty.

Table 3-6: Effect of Uncertainty on Exposure Assumptions

Parameter	**Highway 240 Commuter**		**Ringold Resident**	
	Stack, Normal Operations	**Valve Pit Spray or Spill**	**Stack, Normal Operations**	**Valve Pit Spray or Spill**
Inhalation rate	Study assumed 20 hr/day. Risk is proportional to inhalation rate. Risk will increase if the person is involved in major exercise.			
Exposure	Study assumed 0.25 hr/day for commuting twice per day through a plume from each DST area. Risk is proportional to exposure.	Study assumed the exposure to be the length of the release. Risk is proportional to exposure.	Study assumed 24 hr/day, which cannot be increased. Risk is proportional to exposure.	Study assumed the exposure to be the length of the release. Risk is proportional to exposure.
Exposure frequency	Study assumed 250 days for a typical work year. Risk is proportional to exposure frequency.	Study assumed 1 time per year. Accident is anticipated with a frequency of 10^{-2} to 1 per year.	Study assumed 350 days per year. Risk is proportional to exposure frequency.	Study assumed 1 time per year. Accident is anticipated with a frequency of 10^{-2} to 1 per year.
Exposure duration	Study assumed 20 years. Occupational average tenure is 6.6 years (Versar 2000). Risk is proportional to exposure duration.		Study assumed 20 years. Thirty years is the 95th percentile. Average value is 9 years (Versar 2000). Risk is proportional to exposure duration.	
Body weight	Study assumed 72 kg. EPA (1991) recommends 70 kg. Risk is inversely proportional to body weight.			
Lifetime	Study assumed 75 years. Risk is inversely proportional to lifetime			

References

EPA, 1991, *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors,"* OSWER Directive 9285.6-03, U.S. Environmental Protection Agency, Washington, D.C.

Versar, Inc., 2000, *PCB Risk Assessment Review Guidance Document. Prepared for Office of Pollution Prevention and Toxics*, for the U.S. Environmental Protection Agency, Washington, D.C.

Definitions

Inversely proportional. Risk will decrease with an increase in the parameter value, and increase with a decrease in the parameter value.

Proportional. Risk will decrease with a decrease in the parameter value and increase with an increase in the parameter value.

4.0 RISK CHARACTERIZATION

4.1 METHODOLOGY FOR QUANTIFYING RISK

The objective of the risk characterization portion of the risk assessment is to evaluate the potential health impacts of exposure to the PCB releases in air in conjunction with toxicity data for PCBs to quantitatively estimate the potential carcinogenic risk posed to the Ringold resident and Highway 240 commuter receptors. The equation used to calculate PCB cancer risk to an individual receptor is

$$R_i = LADD_{pot} \times CSF$$

where

R_i = excess individual lifetime cancer risk level (unitless);
$LADD_{pot}$ = potential lifetime average daily dose (mg/kg-day); and
CSF = cancer slope factor (kg-day/mg)

Excess lifetime cancer risk refers to an individual's increased probability of developing cancer during his or her lifetime because of the scenario exposure conditions. The EPA assumes that no threshold dose exists for cancer risk (i.e., any dose of a carcinogen is assumed to be associated with some risk, however small). The EPA (1991b) has used a target risk range of 10^{-6} to 10^{-4} as generally considered to be acceptable. In this document, each PCB cancer risk presented is an upper-bound estimate based on an upper-bound cancer slope factor. Actual cancer risks are unlikely to be higher than risks calculated using upper-bound cancer slope factors.

For the onsite personnel receptor scenarios, exposure point concentrations for each release scenario were compared to the current OSHA PEL for worker exposure to indoor air concentrations of PCBs.[1] This study used the value of 500 $\mu g/m^3$ for an 8-hour time-weighted-average concentration. Exposure concentrations less than this PEL were considered to pose an acceptable risk to onsite workers in the DST vicinity.

4.2 TOXICITY ASSESSMENT

The most common effects seen in humans from exposure to PCBs are skin rashes and acne, although workplace exposures have resulted in lung and nose irritation. Some evidence has been found that exposure of women to PCBs during pregnancy via ingestion

[1] The PELs for 42 percent and 54 percent chlorine PCBs are 1000 and 500 $\mu g/m^3$ for an 8-hour time-weighted average, respectively (29 CFR 1910, Subpart Z). This study has conservatively used the lowest value.

of fish may lead to developmental toxicity such as decreased birth weights and head circumference in infants (PHS 1997). Animals exposed to PCBs via ingestion and dermal routes showed similar effects as humans, but also showed signs of kidney and liver toxicity. Rats that ate food containing various PCB mixtures throughout their lifetimes showed an increase in liver cancer; however, this result has not been confirmed in human occupational studies. Hence, it is uncertain whether these compounds cause cancer in humans (PHS 1997).

Based on the animal carcinogenisis studies, however, the U.S. Department of Health and Human Services has declared that PCBs can be "reasonably anticipated to be a human carcinogen," (PHS 1997), the EPA has labeled PCBs as "probable human carcinogens," (EPA 2001), and the International Agency for Research on Cancer (IARC) has listed PCBs as "probably carcinogenic to humans" (IARC 2001). Co-planar PCBs have been described as having dioxin-like effects, and have been given toxic equivalency factors (TEF) from 0.00001 to 0.1 times that for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (Van den Berg, et al. 1998).

To assess the potential for adverse effects in humans exposed to chemical compounds, the EPA has developed reference doses (RfD) for non-carcinogenic effects and cancer slope factors (CSF) for carcinogenic effects. Although PCBs are not a known carcinogen in humans, the EPA decided to develop CSFs for PCBs based on the animal toxicity data. In general, CSFs are assigned on an exposure route basis; for example, there might be one CSF for oral exposure to a compound, and a different one for inhalation exposure. However, the literature for PCBs suggests that they are unlikely to have different CSFs for oral versus inhalation exposure based on the similar bioavailability from these two routes (EPA 1997).

According to the EPA (1996), the literature also suggests that the toxicity of environmental PCBs can be very different from the commercial mixtures used in toxicity evaluations (and generally responsible for environmental contamination). Two important and related characteristics have been found to be related to the toxicity of environmental PCBs: persistence and bioaccumulation. Those PCB congeners that are highly persistent tend to be higher in toxicity, and those that bioaccumulate in the food chain tend to have the highest toxicity (EPA 1996). These concepts have led the EPA to propose different CSFs for different types of PCB exposures: exposures to PCBs through the food chain or absorbed to particles (i.e., bioaccumulated or more persistent) are evaluated using a higher CSF than exposures to PCBs in vapor or solution (i.e., lower persistence). In addition, the EPA has developed both upper-bound (i.e., upper 95-percent confidence limit on the maximum likelihood estimate of the slope), and central-estimate (i.e., estimate for a typical individual's risk) CSFs for PCBs (Table 4-1).

Table 4-1. PCB Slope Factors (kg-day/mg).

Exposure Condition	Central CSF	Upper-Bound CSF
Vapor-phase	0.3	0.4
Aerosol	1	2

Reference

EPA, 1996, *PCBs: Cancer Dose-Response Assessment and Application to Environmental Mixtures*, EPA/600/P-96/001F, National Center for Exposure Assessment, Washington, D.C.

The CSF used for each exposure scenario in this study was determined based on information about the types of PCB releases. When the release occurs as a vapor (i.e., normal stack operations scenario), the vapor-phase CSF was used. When the release occurs as an aerosol (i.e., spray and spill scenarios), the aerosol value was used. In each case, however, this study has used the upper-bound CSFs as a health-protective assumption.

The derivation of CSFs requires considerable professional judgment, but they are designed to be upper-bound estimates, reducing the likelihood that the risks are underestimated. The mix of congeners in the release is unknown, however, and thus there is increased uncertainty in determining the appropriate CSFs to use for the releases in this study.

4.3 SUMMARY OF RESULTS

The potential health impacts to human receptors from exposures to PCBs from normal stack emissions and accidental valve pit releases have been evaluated. The stack release concentration of 720 $\mu g/m^3$ is 140 percent of the OSHA standard. Table 4-2 compares the estimated air concentrations for the worker locations to the OSHA PCB standard. The normal stack release scenario presents a worker air exposure with a maximum of 0.056 and 0.22 percent of the OSHA standard in the 200 West and 200 East Areas, respectively. The exposure in the 200 East Area is greater because the four tank stacks in the 200 East Area were modeled as a pseudo-single stack, which had four times the PCB emission rate of a single stack, such as occurs in the 200 West Area. The three accident scenarios all resulted in worker exposure concentrations equal to or less than 0.0012 percent of the OSHA standard at 100 m.

Table 4-2. Comparison of Worker Exposure PCB Concentrations to OSHA Standard.

Location	**Scenario**	**Exposure Concentration ($\mu g/m^3$)**	**OSHA Standard ($\mu g/m^3$)**	**Percent of OSHA Standard**
East Area, 100 m	Stack, Normal Operations	0.95	500	0.19
East Area, 343 m (max conc.)	Stack, Normal Operations	1.1	500	0.22
West Area, 100 m	Stack, Normal Operations	0.24	500	0.048
West Area, 343 m (max conc.)	Stack, Normal Operations	0.28	500	0.056
East and West Areas, 100 m	Valve Pit Spray (high concentration)	0.0061	500	0.0012
East and West Areas, 100 m	Valve Pit Spray (low concentration)	0.000061	500	0.000012
East and West Areas, 100 m	Valve Pit Spill	0.00027	500	0.000054

Note: See Section 3.3 for discussion of air dispersion modeling to estimate the exposure concentration. Worker is assumed to have regular workday schedule.

OSHA U.S. Occupational Safety and Health Administration.

Table 4-3 summarizes the estimated cancer risks for the Ringold resident and Highway 240 commuter for the normal stack and accident scenarios. Because these receptors are exposed to the continuous emissions from the stacks in the 200 East and West Areas simultaneously, the calculated risks for the normal stack scenarios were combined. The Ringold resident and Highway 240 commuter have estimated cancer risks of 4×10^{-8} and 1×10^{-9} , respectively. The cancer risk for both receptors is below a cancer risk criterion of 1×10^{-6}. The cancer risks for these two receptors for all of the accident scenarios are very much lower than a 1×10^{-6} risk criterion.

As discussed in previous sections, this assessment has chosen health-protective assumptions, with the objective of not underestimating the human health risks. Thus it is unlikely that the actual risks exceed the values shown, and the actual risks are likely to be considerably below the estimated values. The specific assumptions and their implications for the actual risks have been discussed in previous sections.

Table 4-3: Estimated Cancer Risks

Scenario	Receptor	
	Ringold Resident	**Highway 240 Commuter**
Stack, Normal Operations (combined east and west area releases)	4×10^{-8}	1×10^{-9}
Valve Pit Spray (high concentration), east area release	5×10^{-14}	1×10^{-13}
Valve Pit Spray (high concentration), west area release	3×10^{-14}	4×10^{-13}
Valve Pit Spray (low concentration), east area release	3×10^{-15}	7×10^{-15}
Valve Pit Spray (low concentration), west area release	2×10^{-15}	2×10^{-14}
Valve Pit Spill, east area release	2×10^{-15}	5×10^{-15}
Valve Pit Spill, west area release	1×10^{-15}	2×10^{-14}

Note: See Sections 3.3 and 3.4 for discussions of exposure point concentrations, and exposure conditions, respectively. Uncertainty is discussed in Section 3.5.

This page intentionally left blank.

5.0 ENVIRONMENTAL ASSESSMENT

This section of the assessment characterizes ecological exposures and risks from PCBs released from the DSTs under the four release scenarios. Uncertainties associated with this screening-level ecological risk assessment (SCLERA) also are presented.

5.1 SCREENING LEVEL PROBLEM FORMULATION

The problem formulation portion of this SCLERA outlines potentially exposed populations (i.e., ecological receptors), toxicity reference values appropriate for assessing hazards to ecological receptors, and a conceptual model for potentially complete exposure pathways. The estimated chemical intakes and potential doses for each receptor-pathway are addressed in the exposure evaluation and risk characterization sections, following problem formulation.

5.1.1 Environmental Setting

The Hanford Site can be characterized as a semiarid shrub-steppe ecosystem, dominated by a shrub overstory and a grass understory (PNNL 1999, Neitzel 2000). The Columbia River borders the Site on the north and east, and provides additional riparian and aquatic habitats (Figure 1-1). Approximately 42 species of mammals, 246 species of birds, 5 species of amphibians, and 12 species of reptiles have been identified in surveys of the area (PNNL 1999, Neitzel 2000, WDFW 1999). In addition, 43 species of fish are present in the Hanford Reach stretch of the Columbia River. The species lists contained in the cited documents were used to identify appropriate ecological receptors of potential concern for the SCLERA.

5.1.2 Contaminant Source, Fate, and Transport

A full description of the source of the airborne PCBs of concern for this SCLERA can be found in Section 2. For the purposes of the SCLERA, a brief preliminary assessment determined that overall releases in the spray and spill scenarios were lower than the normal stack operating scenario by approximately 10 orders of magnitude; hence, only the normal stack operating condition release scenario was assessed. The airborne PCBs were assumed to be deposited on both land and water on the Hanford Site; the models used to evaluate this processes are discussed in greater detail in later sections.

5.1.3 Ecological Receptors of Potential Concern

Table 5-1 provides an initial list of ecological receptors of potential concern (ERPC) as developed by identifying species common to the Hanford Site and those listed as endangered, threatened, or species of concern or candidates by the Washington State Priority Habitat and Species program administered by the Washington Department of Fish and Wildlife (WDFW 1999). Species common to the Site were identified by PNNL (1999) and Neitzel (2000).

Table 5-1. Initial List of Ecological Receptors of Potential Concern.[1] (2 sheets)

Species Name	Common Name	USA E/T/SC/C[2]	WA E/T/C[3]
INVERTEBRATES			
Fluminicola columbiana	Giant Columbia River Spire Snail	SC	C
Fisherola nuttalli	Giant Columbia River Limpet	--	C
FISH			
Oncorhynchus tschawytscha	Chinook Salmon	E	C
Oncorhynchus mykiss	Rainbow Trout/Steelhead	E	C
BIRDS			
Haliaeetus leucocephalus	Bald Eagle	T	T
Buteo regalis	Ferruginous Hawk	SC	T
Centrocercus urophasianus phaios	Western Sage Grouse	SC	T
Pelecanus erythroorhychos	American White Pelican	--	E
Ardea herodias	Great Blue Heron	--	--
Turdus migratorius	American Robin	--	--
Grus Canadensis	Sandhill Crane	--	E
Branta Canadensis	Canada Goose	--	--
Buteo jamaicensis	Red-tailed Hawk	--	--
Tyto alba	Barn Owl	--	--
Athene cunicularia	Burrowing Owl	SC	C
Gavia immer	Common Loon	--	C
Aquila chrysaetos	Golden Eagle	--	C
Lanius ludovicianus	Loggerhead Shrike	SC	C
Falco columbarius	Merlin	--	C
Accipter gentiles	Northern Goshawk	SC	C
Amphispiza belli	Sage Sparrow	--	C
Oreoscoptes montanus	Sage Thrasher	--	C
MAMMALS			
Cervus elaphus nelsoni	Rocky Mountain Elk	--	--
Odocoileus hemionus	Mule Deer	--	--

Table 5-1. Initial List of Ecological Receptors of Potential Concern.[1] (2 sheets)

Species Name	Common Name	USA E/T/SC/C[2]	WA E/T/C[3]
Odocoileus virginianus macroura	White-tailed Deer	--	--
Canis latrans	Coyote	--	--
Mustela vison	Mink	--	--
Perognathus parvus	Great Basin Pocket Mouse	--	--
Sorex Merriami	Merriam's Shrew	--	C
Peromyscus leucopus	Meadow Vole	--	--
Spermophilus washingtoni	Washington Ground Squirrel	C	C
AMPHIBIANS/REPTILES			
Masticophis taeniatus	Striped Whipsnake	--	C
Uta stansburiana	Side-blotched Lizard	--	--
Rana Catesbeiana	Bull Frog	--	--
PLANTS			
Astragalus columbianus	Columbia Milkvetch	SC	T
Camissonia (= Oenothera) pygmaea	Dwarf Evening Primrose	--	T
Lomatium tuberosum	Hoover's Desert Parsley	SC	T
Loeflingia squarrosa var. squarrosa	Loeflingia	--	T
Rorippa columbiae	Persistent Sepal Yellowcress	SC	T
Eriogonum codium	Umtanum Desert Buckwheat	C	E
Lesquerella tuplashensis	White Bluffs Bladderpod	C	E
Eatonella nivea	White Eatonella	--	T
Various	Pigweed	--	--

Notes:
[2] Federal Endangered Species Act Designation. E—Endangered; T—Threatened; SC—Species of Concern; C—Candidate
[3] Washington State Species Designation. E—Endangered; T—Threatened; C—Candidate

[1]References

PNNL, 1999, *Hanford Site 1999 Environmental Report*, PNNL-13230, Pacific Northwest National Laboratory, Richland, Washington. Obtained online at: http://www.hanford.gov/docs/annualrp99.

Neitzel D.A., ed., 2000, *Hanford Site National Environmental Policy Act (NEPA) Characterization*, PNNL-6415 Rev. 12, Pacific Northwest National Laboratory, Richland, Washinton.

WDFW, 1999, *Washington State Priority Habitat and Species List*, Washington Department of Fish and Wildlife, Olympia, Washington.

5.1.4 Assessment and Measurement Endpoints

Effects endpoints represent the product of stressor exposure and receptor sensitivity, and can be manifest at the population, community, or individual level. Assessment endpoints particularly represent an explicit expression of the actual environmental and societal values that should be protected (EPA 1992b, Suter et al. 1994). For this screening-level risk assessment, the assessment endpoint is considered to be the continued viability of ecological receptors on the Site. The measurement endpoints to address the assessment were derived from toxicity reference values (TRV) for no observed adverse effects levels (NOAEL), as obtained from a variety of appropriate reference sources (ORNL 1997, EPA 1999, Suter and Tsao 1996, Efroymson et al. 1997).

Because it was neither possible nor necessary to address risks to every species identified in Table 5-1, a truncated list was developed on the basis of species, and trophic sensitivity, and data quality for available TRVs. A NOAEL TRV is a species-specific (generally) media concentration or dose below which adverse impacts to an organism are not expected. Normally, NOAELs from chronic toxicity studies are used as TRVs. If a species-specific TRV was not found for a species, the species was eliminated from the ERPC list. For those species for which more than one potential TRV was available (either for different PCB mixtures or for different toxicity tests evaluations), the most conservative value (i.e., the lowest) was used for this SCLERA. For comparison purposes, general biota TRVs developed by the EPA also were included for species on the final ERPC list.

The finalized ERPC list is provided in Table 5-2. It should be noted that when toxicity data were available, multiple species were represented in each subset of wildlife to provide for a comprehensive evaluation. For example, three species of birds (with different diets) were selected to be representative of different exposure pathways. If available literature provided TRVs for multiple Aroclor mixtures, the most toxic of the Aroclor TRVs listed in the literature was used to reflect our lack of understanding of the exact PCB formulation potentially released.

Table 5-2. Ecological Receptors of Potential Concern and Associated Toxicity Reference Values (2 sheets)

Common Name	Species Specific TRV[1]	TRV Units	EPA General TRV[2]	EPA Units
FISH				
Rainbow Trout/Steelhead	2.1[5]	ug/L	0.14[4]	ug/L
BIRDS				
Red-tailed Hawk	0.173[7]	mg/kg/day	0.072[11]	mg/kg/day
Great Blue Heron	0.135[6]	mg/kg/day	0.072[11]	mg/kg/day
American Robin	0.42[6]	mg/kg/day	0.072[11]	mg/kg/day

Table 5-2. Ecological Receptors of Potential Concern and Associated Toxicity Reference Values (2 sheets)

Common Name	Species Specific TRV[1]	TRV Units	EPA General TRV[2]	EPA Units
MAMMALS				
White-tailed Deer	0.004[9]	mg/kg/day	2.06E-03[11]	mg/kg/day
Mink	0.0685[7]	mg/kg/day	2.06E-03[11]	mg/kg/day
Meadow Vole	0.048[9]	mg/kg/day	2.06E-03[11]	mg/kg/day
PLANTS				
Pigweed	40[8]	mg/kg	1.00E+01	mg/kg

Notes:
[1] Species-specific Toxicity Reference Value.
[2] Recommended TRV from BNFL, 2000.
[4] Suter II G. W. and Tsao C. L. 1996.
[5] No-observed-adverse-effect level (NOAEL) exposed chronically to Aroclor 1254 for 90 days measuring survival.
[6] Oak Ridge National Laboratory Environmental Sciences and Health Sciences Research Division for U.S. Department of Energy, 1997. Value is PCB 1254 NOAEL.
[7] Oak Ridge National Laboratory Environmental Sciences and Health Sciences Research Division for U.S. Department of Energy, 1997. Value is PCB 1254 NOAEL.
[8] 40 mg/kg is noted by Efroymson, R. A. et al., 1997 for NOEC Pigweed in sand.
[9] Oak Ridge National Laboratory Environmental Sciences and Health Sciences Research Division for U.S. Department of Energy, 1997. Value is PCB 1248 NOAEL.
[10] Toxicity for Aroclor 1254 to ring dove used as representative of PCB mixtures,(EPA 1999).
[11] Based on toxicity of 3,4,5-hexachlorobiphenyl to mink (EPA 1999).

References

BNFL, 2000, *Final Work Plan for Screening Level Risk Assessment for the RPP-WTP*, RPT-W375-EN00001, Rev. 1, BNFL Inc., Richland, Washington. Obtained online at: http://www.hanford.gov/orp/twti/contract/DWPA/Supp01.pdf

Efroymson, R. A., M. E. Will, G. W. Sutter, II, and A. C. Wooten, 1997, *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision.* ES/ER/TM-85, Oak Ridge National Laboratory, Oak, Ridge, Tennessee.

EPA, 1999, *Screening Level Ecological Risk Assessment Protocol*, *Appendix E*, EPA530-D-99-001C, U.S. Environmental Protection Agency, Office of Solid Waste, Washington, D.C.

Suter, G. W., and C L. Tsao, 1996, *Toxicological Benchmarks for Screening of Potential Contaminants of Concern for Effects on Aquatic Biota on Oak Ridge Reservation: 1996 Revision,* ES/ER/TM-96/R2, Lockheed Martin Energy Systems, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

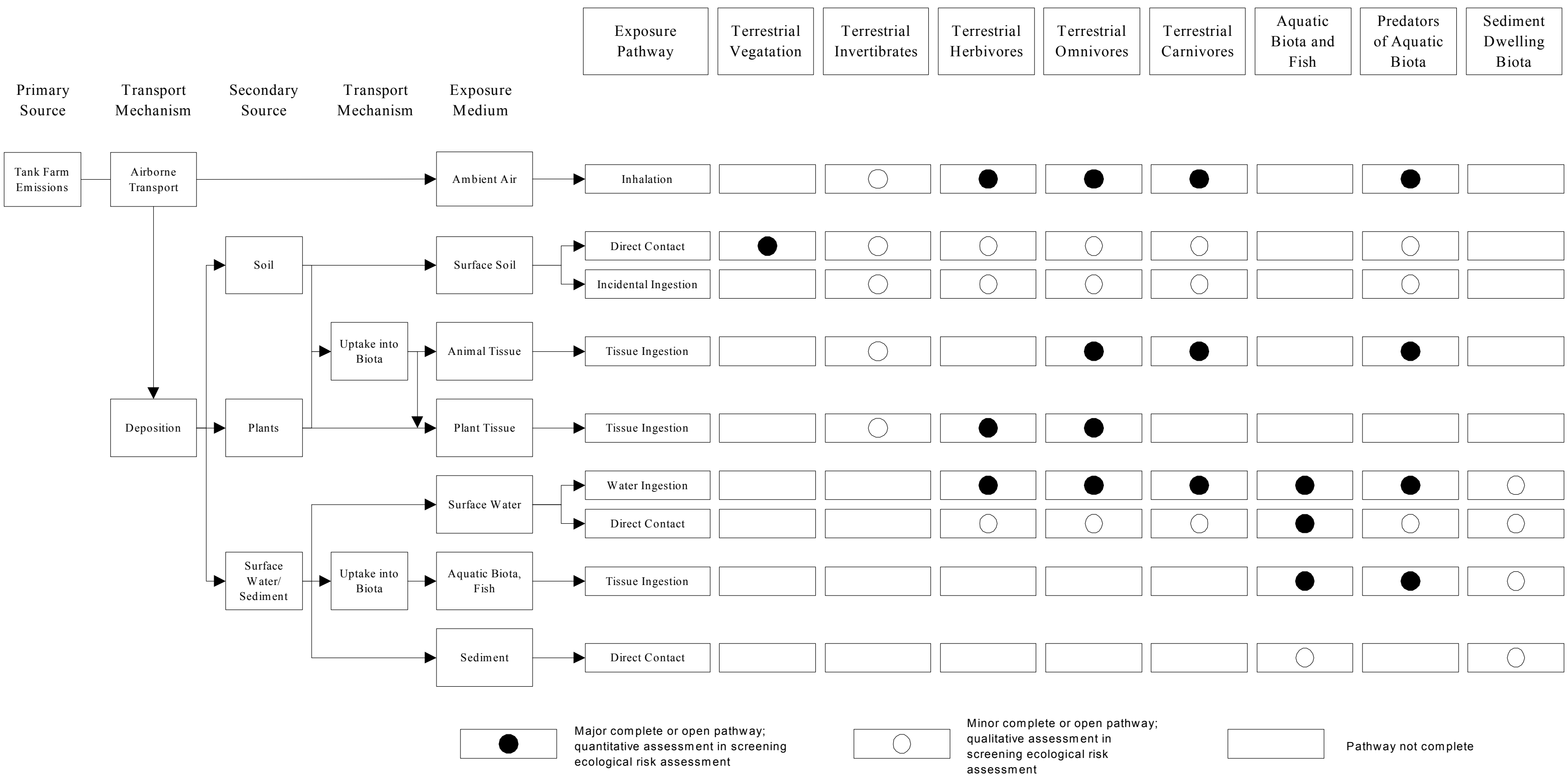
5.1.5 Conceptual Exposure Model

The exposure pathways that were considered in this assessment are provided as a conceptual model in Figure 5-1. Many potential exposure pathways were not evaluated quantitatively because of lack of data for that pathway or receptor species—either lack of species-specific TRVs (e.g., invertebrates), or lack of data concerning exposure concentrations in that pathway (e.g., sediment concentrations). These pathways generally were considered to be less significant exposure pathways, and were considered to be protected by inclusion of species further up the food chain because of the tendency for PCBs to bioaccumulate.

5.2 EXPOSURE ASSESSMENT TO ERPCS

Once the ERPC list had been finalized using the addition of toxicity values, exposure factors for all the relevant species were either calculated or identified in the literature. Because many different sources potentially exist for the various factors (e.g., body weight, ingestion rate, inhalation rate), a hierarchal approach was used. Priority was given to EPA values (EPA 1993), followed by values identified in other Hanford Site ecological assessments, followed by general literature and websites. The exposure factors identified in this manner and their source are provided in Table 5-3.

Figure 5-1. Screening Ecological Risk Assessment Conceptual Model.



Adapted from BNFL, 2000.

Table 5-3. Exposure Factors for Species of Interest.

Common Name	Water IR (mL/day)	Air IR (m^3/day)	Food IR (kg/day)	Animal Fraction	Plant Fraction	Prey Items	Average BW (kg)
FISH							
Rainbow Trout/Steelhead	NA	NA	NA	NA	NA	NA	NA
BIRDS							
Red-tailed Hawk	65	0.45	0.119	1	0	Meadow Voles	1.134
Great Blue Heron	100	0.76	0.4012	1	0	Fish	2.229
American Robin	11	0.17	0.069	0.48	0.52	Invertebrates, Plants	0.0773
MAMMALS							
White-tailed Deer	6303	22	2.51	0	1	Plants	101.0
Mink	102	0.44	0.224	0.98	0.02	Fish, Invertebrates, Meadow Voles, Plants	1.019
Meadow Vole	7.8	0.048	0.0121	0	1	Plants	0.0373
PLANTS							
Pigweed	NA	NA	NA	NA	NA	NA	NA

Notes:
NA = not applicable
All intake rates are from EPA (1993).
All body weights are from EPA (1993) except the weight for white-tailed deer, which was obtained from the median of range values found at the site: http://www.state.nj.us/dep/fgw/deer.htm.
All prey item and food factors are from BNFL (2000).

References:

BNFL, 2000, *Final Work Plan for Screening Level Risk Assessment for the RPP-WTP*, RPT-W375-EN00001, Rev. 1, BNFL Inc., Richland, Washington. Obtained online at: http://www.hanford.gov/orp/twti/contract/DWPA/Supp01.pdf.

EPA, 1993, *Wildlife Exposure Factors Handbook*, EPA/600/R-93/187, U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C.

5.2.1 Calculation of Exposure Concentrations

For a complete discussion of the relevant release scenarios in this assessment, see Section 2. Because the SCREEN3 modeling (Section 3) indicated that the most conservative PCB emissions and concentrations (i.e., the highest) would result from the normal stack operations release scenario; this was the only scenario considered for this SCLERA. The air concentration used for the SCLERA for all land-dwelling biota is the maximum estimated 1-hour concentration modeled by SCREEN3 at the Site. Because of the possibility that some of the receptors have very small or immobile home ranges and short life spans, the use of a maximum short-term concentrations, while highly conservative, was considered appropriate.

To assess many of the exposure pathways discussed in the previous section, the deposition of PCB emissions to soil at the Hanford Site was calculated. A very simple model was used for this process: it was assumed that all of the PCBs emitted (0.00171 g/sec over 20 years by the 5 stacks in the DST farms) would be deposited within a 20 km radius around the Site. These PCBs were assumed to mix evenly with the top 2 cm of soil in this entire area. (This might be conservative in areas of soil disturbance, but might not be conservative in areas of soil crust formation.) To calculate final soil concentrations, a soil bulk density of 1.0 megagram/m^3 was assumed (Brady and Weil 1996). Because of the simple design of this model, all the DST tank stacks were considered to be in an identical location. Thus, soil concentrations for the entire Site were averaged over the total area.

A model similar to that employed to calculate soil concentrations was used to estimate a maximum water concentration in the Columbia River bordering the Site. Using 7Q10 (7-day average low flow data over the last 10 years, or a 10-percent probability of occurring every year) low flow data (38,012 ft^3/sec) and low flow velocity data (2.0 ft/sec) obtained from the U.S. Geological Survey (GS 2001), the maximum width of the Columbia River bordering the Site (1.2 km), and the maximum 1-hour air concentration (0.0171 $\mu g/m^3$) and plume height (67.4 m) found at the Ringold receptor (bordering the river), a concentration in river water was calculated using the SCREEN3 model. Thus, the model calculated the maximum estimated 1-hour concentration in the Columbia River assuming every PCB molecule in the plume above the river was deposited in the river at once, during a period of low water flow.

To model the bioaccumulation of PCBs in the food chain, transfer factors were used to calculate concentrations of PCBs in various prey animals. These transfer factors (BNFL 2000) use media concentration (i.e., soil, water, tissue) to model tissue concentrations in wildlife that either live or prey on that medium. The transfer factors used in this SCLERA are provided in Table 5-4; calculated media concentrations are provided in Table 5-5.

Table 5-4. Transfer Factors for PCBs (BNFL 2000).

Pathway	Factor	Units
Soil to Plant (veg tissue)	2.00E-03	(mg/kg wet weight)/(mg/kg soil)
Soil to Plant (repro tissue)	2.00E-03	(mg/kg wet weight)/(mg/kg soil)
Air to Plant	5.19E+01	(mg/kg wet weight)/(mg/m^3 air)
Soil to Invertebrates	1.13E+00	(mg/kg wet weight)/(mg/kg soil)
Tissue to Tissue	4.04E-02	(mg/kg wet weight)/(mg ingested/day)
Water to Invertebrate	5.54E+03	(mg/kg wet weight)/(mg/L)
Water to Fish	2.30E+05	(mg/kg wet weight)/(mg/L)

BNFL, 2000, *Final Work Plan for Screening Level Risk Assessment for the RPP-WTP*, RPT-W375-EN00001, Rev. 1, BNFL Inc., Richland, Washington. Available online at: http://www.hanford.gov/orp/twti/contract/DWPA/Supp01.pdf

Table 5-5. PCB Concentration in Various Media and Wildlife.

Medium	Concentration	Units
Air	0.0016	μg/m^3
Soil	0.043	mg/kg
Water	0.00078	μg/L
Fish	0.16	mg/kg
Plants	0.083	mg/kg
Invertebrates	0.049	mg/kg
Herbivores (Meadow Vole)	0.000041	mg/kg

5.2.2 Dose Calculation

Using the media and tissue concentrations discussed above, as well as the exposure and transfer factors, doses were calculated for relevant ERPCs (Table 5-6). For species (mammals and birds) with toxicity reference values expressed as milligrams PCB per kilogram body weight per day (mg/kg-day), average daily exposure doses were calculated in those units. The general dose equation used in the calculations is

$$Dose = (Media\ Concentration) \times (Intake\ Rate) / (Body\ Weight) .$$

This general equation was modified where necessary to account for the mink and the robin, two animals with more than one food type. An example of a total dose exposure calculation is:

$$D_{total} = \frac{C_a \times IR_a + C_w \times I_w + C_p \times IF_p + C_m \times IF_m}{BW},$$

where:

D_{total} = Total dose (mg/kg-day)
C_a = Concentration in air (mg/m3)
IR_a = Intake rate of air (m^3/day)
C_w = Concentration in water (mg/L)
I_w = Intake rate of water (L/day)
C_p = Concentration in plants (mg/kg)
IF_p = Intake rate for plant food (kg/day)
C_m = Concentration in animal prey (mg/kg)
IF_m = Intake rate for animal food (kg/day).

Table 5-6. Average Daily Doses for Species of Interest.

Common Name	Inhalation Dose (mg/kg-day)	Water Dose (mg/kg-day)	Plant Dose (mg/kg-day)	Animal Dose (mg/kg-day)	Total Dose (mg/kg-day)
FISH					
Rainbow Trout/Steelhead	NA	NA	NA	NA	NA
BIRDS					
Red-tailed Hawk	6.4E-04	4.5E-08	0.0E+00	4.3E-06	6.4E-04
Great Blue Heron	5.5E-04	3.5E-08	0.0E+00	2.8E-02	2.9E-02
American Robin	3.5E-03	1.1E-07	3.9E-02	2.1E-02	6.3E-02
MAMMALS					
White-tailed Deer	3.5E-04	4.9E-08	2.1E-03	0.0E+00	2.4E-03
Mink	6.9E-04	7.8E-08	3.7E-04	1.1E-02	1.2E-02
Meadow Vole	2.1E-03	NA	2.7E-02	0.0E+00	2.9E-02
PLANTS					
Pigweed	NA	NA	NA	NA	NA

NA = not applicable

The doses to each receptor from each exposure pathway (plant food, animal food, water, and inhalation) were calculated and summed to obtain a total average daily dose. For those species with TRVs expressed as media concentrations, calculating doses was unnecessary; the TRVs were compared to media concentrations.

5.3 EFFECTS ASSESSMENT

Using the dose calculations or exposure concentrations, hazard quotients (HQ) were calculated to screen for potential effects to ERPCs. The general equation for calculating a HQ is

$$HQ = (\text{Dose or Exposure Concentration}) / TRV .$$

In general, an HQ above "1" indicates that the concentration or dose an organism is exposed to is above a level where that organism could potentially be affected. An HQ below "1" indicates that adverse effects are not expected in an organism. HQs were calculated using both species-specific TRVs and the EPA TRVs for general biota classes. The results of these calculations are provided in Table 5-7.

Table 5-7. Hazard Quotients for Species of Interest

Species Name	Common Name	Species Specific Hazard Quotient	EPA Hazard Quotient
FISH			
Oncorhynchus mykiss	Rainbow Trout/Steelhead	0.00037	0.0056
BIRDS			
Buteo jamaicensis	Red-tailed Hawk	0.0037	0.0089
Ardea herodias	Great Blue Heron	0.21	0.40
Turdus migratorius	American Robin	0.15	0.87
MAMMALS			
Odocoileus virginianus macroura	White-tailed Deer	0.60	1.2
Mustela vison	Mink	0.18	5.9
Peromyscus leucopus	Meadow Vole	0.61	14
PLANTS			
Various	Pigweed	0.0011	0.0043

The HQs calculated for fish, birds, and plants all were below species-specific and EPA TRVs. All the mammals evaluated were below their species-specific TRVs; however, they all exceeded their EPA TRVs. The Meadow Vole had the highest calculated HQ—a value of 14. HQs calculated for either the spill or spray release scenarios would be expected to be much less than 1, indicating that no adverse effects are anticipated.

5.4 UNCERTAINTY ANALYSIS

This SCLERA relied solely on modeled exposures and literature TRVs to estimate effects. The absence of Site-specific empirical data to support or refute exposure modeling calculations results in high uncertainty in the estimation of risks to ecological receptors. Under almost every situation in this SCLERA where an assumption was necessary to complete a calculation, the value for that assumption was selected to maximize conservatism and avoid an HQ that would underestimate risks. The specific uncertainties in data quality that affect exposure and effects calculations described in this SCLERA include the following.:

- **Nonspecific Aroclor Data**. Because of the lack of information about the specific composition of PCB releases from the DSTs, if multiple values were available, the TRVs from the most toxic Aroclor mixture were used in this assessment. More information regarding the types of PCBs in the DSTs could result in lower emission rates and higher TRVs; use of these values could reduce HQs by as much as one to three orders of magnitude because of a one-to-two-order-of-magnitude difference in release rates for different congeners, and a one-order-of-magnitude difference in toxicity factors.

- **Simplistic Land Deposition Model**. The simple deposition model used for PCBs on land is more appropriate for PCBs associated with particulates, while the emissions from the DSTs are almost completely vapor phase (because of the HEPA filters on the DST ventilation systems). This model most likely overestimates the amounts of PCBs (and hence risk) found in the outer perimeter of the 20 km site radius, and may underestimate the exposure (and hence risk) to ecological receptors restricted to areas close to the tank farms. Plant species and wildlife with small home ranges would be most likely to be affected by this element of uncertainty.

- **Simplistic Water Deposition Model**. The use of the 7Q10 low-flow water data coupled with maximum 1-hour concentrations indicates that the water concentration modeled for the Columbia River most likely is overestimated in this assessment.

- **Plant Uptake Transfer Factors**. The use of the simple deposition model assumes that all the PCBs emitted from the DSTs are deposited on soil. However, the air-to-plant transfer factor uses an air concentration of PCBs to calculate part of the tissue concentration in plants on the Site. If some of the PCBs emitted from the DST are assumed to be deposited on or taken up by plants, those PCBs should not be available for deposition on soil. Thus, the concentration of PCBs in plant tissue used in this assessment is overestimated.

- **Average Daily Dose Calculation**. The calculation of daily dose did not consider the potential uptake from dermal exposure to animals or plants. This exposure route is considered quantitatively insignificant and likely immeasurable, but counters measures of conservatism already discussed.

- **Maximum 1-Hour Air Concentrations**. The use of maximum 1-hour air concentrations in the exposure calculations results in overestimation of the HQs in this assessment. Because the effects endpoints that were assessed generally are more chronic or long term in nature, the use of an annual average concentration would result in more realistic HQs.

- **Toxicity Reference Values**. This assessment has used the screening-level TRVs as recommended by the EPA, even when species-specific values that are relevant to the Site were available (Table 5-2). In general, the species-specific values should be emphasized, but both have been included to be consistent with the EPA guidance.

This page intentionally left blank.

6.0 RISK EVALUATION FINDINGS AND CONCLUSIONS

Reasonable assurance has been provided to show that potential human-health and environmental risks from onsite and offsite exposure to PCBs released during normal operations and upset conditions of the DST system are within acceptable risk guidelines using the controls already in place to meet nuclear safety and RCRA requirements. These controls address how the waste is received, stored, and transferred, while providing acceptable risks in preventing release of the mixed waste to the environment and subsequently affecting onsite workers and the public. Under abnormal conditions where the waste could be released to the environment accidentally (e.g., spills, spray releases), the present controls demonstrate that PCBs also would be controlled adequately within acceptable risk guidelines. The final conclusion is that, although these controls are meant to specifically address the radioactivity and RCRA concerns, PCBs that would be contained in the waste also would be controlled adequately.

Release scenarios were determined using conservative estimates for PCBs concentrations that could be contained within the DST system waste stream. Concentrations of 2.9 ppm in the supernatant liquid and 50 ppm in the solid were used for conservatism. It should be understood that no PCB measurements above specified detection limits have been obtained.

6.1 HUMAN HEALTH ASSESSMENT

This assessment identified three human receptors as most likely to be present and unprotected during normal or accidental PCB releases from the DSTs:

- An adult worker occupying office space 100 m, or at the point of maximum estimated concentration, downwind of DST operations.
- An adult motorist commuting on Highway 240 west of the DST farms.
- An adult resident living in Ringold, Washington.

For each of these receptors, PCB air concentrations were estimated using SCREEN3, a conservative, EPA-approved air dispersion model. The estimated air concentrations were compared to the OSHA PEL for the adult office worker. For the motorist and resident, exposures were estimated using default exposure parameters, and the cancer risks were estimated using EPA upper-bound CSFs for PCBs.

For the normal stack operations scenario, the estimated office worker exposure point concentrations were all less than 20 percent of the OSHA PEL. For the spray and spill scenarios, the exposure point concentrations were less than 0.001 percent of the OSHA PEL. Thus, there was no exceedance of the OSHA regulatory limit for the office worker exposure.

For the normal stack operations, the estimated excess lifetime cancer risks for the Ringold resident and the Highway 240 commuter were 4×10^{-8} and 1×10^{-9}, respectively. Thus the estimated cancer risks for both receptors are below 1×10^{-6}, the minimum value of the target cancer risk range of 1×10^{-6} to 1×10^{-4} used by the EPA.

The estimated cancer risks from the spill and spray accidents, assuming one accident per year for 20 years, were all below 4 x 10^{-13}, which is well below the lower value of 1 x 10^{-6} in the EPA's target risk range.

As with all risk assessments, the results of this study are subject to uncertainty. The objective of this study was to produce a conservative bounding perspective, providing results that are unlikely to underestimate the health risks. Thus, models and specific parameter values were chosen to be health protective. The air dispersion model, SCREEN3, is health protective. The use of an air dispersion model that used more Site-specific information (e.g., observed wind and stability classes) might reduce the estimated risks.

6.2 ENVIRONMENTAL ASSESSMENT

The SCLERA was performed using a simplistic exposure model that used conservative, modeled air concentrations coupled with conservative deposition models to obtain doses for various ecological receptors. Each ecological receptor was assumed to inhale (or otherwise take up) the maximum modeled 1-hour concentration calculated by SCREEN3 on the Site. In addition, the land deposition model employed assumed that all of the PCBs emitted by the DSTs would be deposited evenly over a 20 km radius around the tanks. Finally, ecological receptors in the Columbia River were assumed to be exposed continuously to a concentration of PCBs that represented the maximum 1-hour mass of PCBs feasibly released from the tanks over the modeling period under 7Q10 low flow conditions. Yet, salmonid migrations are generally triggered by higher flows, thus, at a practical level, normal flow conditions would further minimize exposure.

The SCLERA indicated that ecological receptors would not be exposed to PCB levels above their TRVs during either the spill or spray release scenarios. Although plants, birds, and fish at the Hanford Site would not be affected by PCB emissions during normal DST stack operating conditions, mammals might be exposed to PCB doses above their EPA TRVs. However, the species-specific HQs for these mammals are all below the guideline value of 1. The use of upper-bound emission rates coupled with conservative deposition models and toxicity data indicate that the HQs calculated in the assessment most likely are overestimated by at least an order of magnitude—use of less conservative release rates and toxicity values alone could decrease HQs by three orders of magnitude.

7.0 REFERENCES

29 CFR 1910, 1992, "Occupational Safety and Health Standards," *Code of Federal Regulations*, as amended.

40 CFR 51, 1992, "Requirements for Preparation, Adoption, and Submittal of Implementation Plans," *Code of Federal Regulations*, as amended.

40 CFR 761, 1992, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," *Code of Federal Regulations*, as amended.

Atomic Energy Act of 1954, 42 USC 2011, et seq.

BNFL, 2000, *Final Work Plan for Screening Level Risk Assessment for the RPP-WTP*, RPT-W375-EN00001, Rev. 1, BNFL Inc., Richland, Washington. Available online at: http://www.hanford.gov/orp/twti/contract/DWPA/Supp01.pdf.

Brady, N. C., and R. W. Weil, 1996, *The Nature and Properties of Soil*, Prentice Hall, Upper Prentice River, New Jersey.

CHG, 2001, *Tank Farms Final Safety Analysis Report*, HNF-SD-WM-SAR-067, Rev. 2-D, CH2M HILL, Hanford Group, Inc., Richland, Washington.

Clean Air Act, 1955, as amended, 42 USC 7401, et seq.

DOE, 2001, *Transmittal of Toxic Substances Control Act (TSCA) Risk Evaluation of the 242-A Evaporator for the Evaporator Campaign 2001-01*, Attachment "Toxic Substances Control Act Risk Evaluation for the 242-A Evaporator—Campaign 201-01" (letter 0100916 from J. Hebdon to C. Findley, U.S. Environmental Protection Agency, Washington, D.C., February 13), U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, EPA, and DOE, 1996, *Hanford Federal Facility Agreement and Consent Order*, as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Ecology, EPA, and DOE, 2000a, *Framework Agreement for Management of Polychlorinated Biphenyls (PCBs) in Hanford Tank Waste*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Ecology, EPA, and DOE, 2000b, *Hanford Facility Resource Conservation and Recovery Act Permit*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Erickson, M.D., 1992, *Analytical Chemistry of PCBs*, Lewis Publications, Chelsea, Michigan.

Efroymson, R. A., M. E. Will, G. W. Sutter, II, and A. C. Wooten, 1997, *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision.* ES/ER/TM-85, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

EPA, 1989, *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual*, Part A, EPA/540/1-89/002, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1991a, *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors,"* OSWER Directive 9285.6-03,U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1991b, Role of the Baseleine Risk Assessment in Superfund Remedy Selection Decisions, OSWER Directive 9355.0-30,U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1992a, *Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised*, EPA-454/R-92-019, Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

EPA, 1992b, *Framework for Ecological Risk Assessment. Risk Assessment Forum*, EPA/630/R-92-001, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1993, *Wildlife Exposure Factors Handbook*, EPA/600/R-93/187, U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C.

EPA,, 1996, *PCBs: Cancer Dose-Response Assessment and Application to Environmental Mixtures*, EPA/600/P-96/001F, U.S. Environmental Protection Agency, National Center for Exposure Assessment, Washington, D.C.

EPA, 1999, *Screening Level Ecological Risk Assessment Protocol*, *Appendix E*, EPA530-D-99-001C, U.S. Environmental Protection Agency, Office of Solid Waste, Washington, D.C.

EPA, 2001, *Integrated Risk Information System Data Sheet for Polychlorinated Biphenyls*, U.S. Environmental Protection Agency, Washington, D.C. Obtained online at: www.epa.gov/iriswebp/iris/subst/0294.htm.

GS, 2001,. Information obtained during phone call to Luis Fuste, Information Officer, U.S. Geological Survey, in the Tacoma, Washington. office on June 21, 2001.

Hanlon, B. M., 2001, *Waste Tank Summary Report for Month Ending March 31, 2001*, HNF-EP-0182, Rev. 156, Fluor Hanford, Richland, Washington.

IARC, 2001, *Overall Evaluations of Carcinogenicity to Humans*, International Agency for Research on Cancer, World Health Organization, New York, New York. Obtained online at: http://193.51.164.11/monoeval/crthall.html.

PNNL, 1999, *Hanford Site 1999 Environmental Report*, PNNL-13230, Pacific Northwest National Laboratory, Richland, Washington. Obtained online at: http://www.hanford.gov/docs/annualrp99.

Mulkey, C. H., 2001, *Management of the Polychlorinated Biphenyl Inventory in the Double-Shell Tank System*, RPP-6623, Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington.

Neitzel D.A., ed., 2000, *Hanford Site National Environmental Policy Act (NEPA) Characterization*, PNNL-6415 Rev. 12, Pacific Northwest National Laboratory, Richland, Washington.

Nguyen, D. M., 2001, *Characterization Plan for Establishing a PCB Baseline Inventory in Hanford Waste Tanks*, RPP-6693, Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington.

ORNL, 1997, *Screening Benchmarks for Ecological Risk Assessment* Oak Ridge National Laboratory Environmental Sciences and Health Sciences Research Division for the U.S. Department of Energy, Oak Ridge, Tennessee.

Patton, G.W., A.T. Cooper, M.L. Blanton, L.F. Lefkovitz, and T.J. Gilfoil, 1997, *Measurement and Estimated Health Risks of Semivolatile Organic Compounds (PCBs, PAHs, Pesticides, and Phthalates) in Ambient Air at the Hanford Site*, PNNL-11650, Pacific Northwest National Laboratory, Richland, Washington.

PHS, 1997. *Toxicological Profile for Polychlorinated Biphenyls. ATSDR's Toxicological Profiles* (on CD-ROM, Version 3:1, 2000), U.S. Public Health Service, Washington, D.C.

Suter, G.W., M.A. Futrell, and G.A. Kerchner. 1994. *Toxicological benchmarks for screening of potential contaminants of concern for effects on aquatic biota on Oak Ridge Reservation: 1994 revision*, ES/ER/TM-96/R1, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Suter, G. W., and C L. Tsao, 1996, *Toxicological Benchmarks for Screening of Potential Contaminants of Concern for Effects on Aquatic Biota on Oak Ridge Reservation: 1996 Revision,* ES/ER/TM-96/R2, Lockheed Martin Energy Systems, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Toxic Substances Control Act of 1976, 15 USC 2601, et seq.

Van den Berg, M., L. Birnbaum, B. T. C. Bosveld, B. Brunström, P. Cook, M. Feeley, J. P. Giesy, A. Hanberg, R. Hasegawa, S. W. Kennedy, T. Kubiak, J. C. Larsen, F. X. R. van Leeuwen, A. K. D. Liem, C. Nolt, R. E. Peterson, L. Poellinger, S. Safe, D. Schrenk, D. Tillitt, M. Tysklind, M. Younes, F. Waern, T. Zacharewski, 1998, "Toxic Equivalency Factors (TEFs) for PCBs, PCDDs, PCDFs for Humans and Wildlife," *Environmental Health Perspective, 106* (12), 775-792.

Versar, Inc., 2000, *PCB Risk Assessment Review Guidance Document*, prepared for Office of Pollution Prevention and Toxics, U.S. Environmental Protection Agency, Washington, D.C.

WAC 173-216, 1990, "State Waste Discharge Permit Program," *Washington Administrative Code*, as amended.

WDFW, 1999, *Washington State Priority Habitat and Species List*, Washington Department of Fish and Wildlife, Olympia, Washington.

APPENDIX A

Details of PCB Release Calculations

WASTREN, Inc.

Engineering Calculations

Prepared by ___________________________________Date____________________

Verified by ___________________________________Date____________________

Subject: Calculation of Maximum PCB contents and Corresponding Release Rates

References:

1. HNF-EP-0182, Rev. 156, Waste Tank Summary Report for Month Ending March 31, 2001
2. Memo from Process Control to Distribution, Dated Sept 2, 1997, Subj: Double Shell Tank Composition Status – Quarterly Report

Assumptions:

1. Maximum PCB concentration in the solids/sludge is 50 ppm.
2. Maximum PCB concentration in the supernate and saltcake is 2.9 ppm. Saltcake is included with supernate because the saltcake is formed through the evaporator process that removes over 95% of the PCBs.
3. Specific gravity (SpG) for supernate and saltcake is 1.22 (average SpG for from reference 2).
4. Specific gravity (SpG) for solids/sludge is 1.5 (average for solids/sludge from reference 2).
5. Assumed that the remaining available space in the DSTs would be filled with waste from the SSTs (with same PCB concentration as DST). This represents approximately $5.0E^{+06}$ gals of added waste. The ratio of sludge to supernate/saltcake would be the same as exists in the SSTs now (approximately 1/3 sludge to 2/3 supernate/saltcake).
6. The total mass of PCBs would be released at a linear rate over a 20 year time span.

1. From Reference 1, Table A-1: Total of supernate and saltcake in DSTs = 19.579E+06 gals.
   Total supernate/saltcake added from SSTs = 3.34E+06 gals
   Total Combined supernate/saltcake = 22.919E+06 gals
   Total solids/sludge of DSTs = 1.048E+06 gals.
   Total solids/sludge added from SSTs = 1.66E+06 gals
   Total combined solids/sludge = 2.708E+06 gals

2. Calculate the total PCBs in grams, for the waste in the DSTs (including estimated addition):

   supernate + saltcake:

$$22.919E^{+06}\ gal \times 3.785\frac{l}{gal} \times 1000\frac{gms}{l} \times 1.22\ SpG \times \frac{2.9\ gms\ PCB}{1.0E^{+06}\ gms\ waste} = \left[3.07E^{+05}\ gms\ PCB\right]$$

   Solids/Sludge:

$$2.708E^{+06}\ gal \times 3.785\frac{l}{gal} \times 1000\frac{gms}{l} \times 1.5\ SpG \times \frac{50.0\ gms\ PCB}{1.0E^{+06}\ gms\ waste} = \left[7.69E^{+05}\ gms\ PCB\right]$$

   Total quantity in grams of PCBs in DSTs:

$$3.07E^{+05}\ gms + 7.69E^{+05}\ gms = \left[1.08E^{+06}\ gms\ PCB\right]$$

3. Calculate number of seconds in a year:

$$60\frac{Sec}{Min} \times 60\frac{Min}{Hr} \times 24\frac{Hr}{Day} \times 365\frac{Day}{Year} = \left[3.1536E^{+07}\ \frac{Seconds}{Year}\right]$$

4. Calculate the release rates for 20 year time span (assuming the entire PCB content is released at a constant rate).

   For 20 years: $$\frac{1.08E^{+06}\ total\ gms\ PCB\ in\ DST}{3.1536E^{+07}\ \frac{Sec}{Yr} \times 20\ Yrs} = \left[1.71E^{-03}\ \frac{gms}{\sec}\right]$$

WASTREN, Inc.

Engineering Calculations

Prepared by ___________________________________Date____________________

Verified by ___________________________________Date____________________

Subject: Calculation of PCB release for Valve Pit Spray Leak Scenario

References:

1. *Refined Radiological and Toxicological Consequences of Bounding Spray Leak Accidents in Tank Farm Waste Transfer Pits*, HNF-SD-WM-CN-096, Rev 0-A

Assumptions:

1. Spray leak model for the determination of radiological and toxicological consequences described in reference 1, provides the basis for determining the quantity of PCB released in the spray leak.
2. Assumptions from reference 1 are as follows:
   a) Displaced air is assumed to be mixed with a maximum aerosol loading of 100 mg/m^3.
   b) Valve pit internal dimensions are 42 ft x 14 ft x 4.5 ft deep. Total pit volume is 2650 ft^3 or 74.9 m^3.
   c) All aerosol released is respirable by receptors.
   d) Initial expansion of air in the pit due to assumed increase in air temperature and relative humidity from 30°F at 15% R.H. to 120°F at 100% R.H. leading to a release of 35% of the total pit volume.
   e) Time required to perform initial heat-up and expansion is assumed to be less than 1 hour.
   f) Time to stop transfer is 6 hours and includes an additional 30 minutes beyond leak detection to secure the farm transfer pump
   g) Slurry is assumed to contain 33 wt.% entrained solids.
   h) Total spray volume rate is 1.41 E-4 m^3/s.
   i) There is no loss of solid particulate by deposition during plume migration to receptor location.
3. Assumptions for the scenario are as follows:
   a) PCB concentration in the liquid is 2.9 ppm. PCB concentration in the solids is 50 ppm.

1. Calculate air displacement of initial expansion of the air in the pit due to an assumed increase in air temperature and relative humidity from 30°F at 15% R.H. to 120°F at 100% R.H that results in a release of 35% of the total pit volume:

$$\text{Expansion air released } (m^3) = (74.9\ m^3)\cdot(0.35) = \boxed{26.2\ m^3}$$

2. Calculate the air volume displaced from the pit by in-leaking liquid in 6.0 hours:

   Displaced air from in-leaking liquid (m^3) = (6.0 h) (1.41 E-4 m^3/s) (3600 s / h) = **3.05 m^3**

3. Calculate total air displaced:

   Total air displaced (m^3) = (26.2 m^3) + (3.05 m^3) = **29.3 m^3**

4. Calculate quantity of waste accompanying the air release:

   Waste released (g waste) = (29.3 m^3) (100 mg / m^3) (.001 g / mg) = **2.93 g waste**

5. Calculate quantity of PCB contributed by solids in waste that is 33 wt.% solids with a PCB concentration of 50 ppm

   A gram of material contains 1.0 E6 parts; therefore the material contains 5.0 E-5 g PCB per gram material

   Quantity of PCB in solids (g PCB) = (2.93 g waste) (.33) (5.0 E-5 g PCB / g waste)

   = **4.8 E-5 g PCB**

6. Calculate quantity of PCB contributed by liquid in waste that is 67 wt.% liquid with a PCB concentration of 2.9 ppm

   A gram of material contains 1.0 E6 parts; therefore the material contains 2.9 E-6 g PCB per gram material

   Quantity of PCB in (g PCB) = (2.93 g waste) (.67) (2.9 E-6 g PCB / g waste)

   = **5.7 E-6 g PCB**

7. Calculate total quantity of PCB in air displaced:

   Total quantity of PCB (g PCB) = (4.8 E-5 g PCB) + (5.7 E-6 g PCB) = **5.4 E-5 g PCB**

8. Calculate PCB release rate:

   PCB release rate (g PCB/sec) = (5.4 E-5 g PCB) (1 / 6 h) (h / 3600 s)

   = **2.5 E-9 g PCB / s**

WASTREN, Inc.

Engineering Calculations

Prepared by ___________________________________Date____________________

Verified by ___________________________________Date____________________

Subject: Calculation of PCB release for Valve Pit Jumper Change-out Scenario

References:

1. *Refined Radiological and Toxicological Consequences of Bounding Spray Leak Accidents in Tank Farm Waste Transfer Pits*, HNF-SD-WM-CN-096, Rev 0-A

Assumptions:

1. Coverblocks removed and leak assumed to drain 2 gallons of waste to the pit floor.
2. Assumptions from reference 1 are as follows:
   a) Slurry is assumed to contain 33 wt% entrained solids.
   b) Slurry density is 1.4 g / cm^3.
   c) Jumper drains in 10 seconds.
3. Assumptions for the scenario are as follows:
   j) The aerosol available for release is 0.01 wt% of the waste leaked to the pit.
   k) All aerosol released is respirable by receptors.
   l) The waste quantity is not dependent on time, temperature or relative humidity.
   m) PCB concentration in the liquid is 2.9 ppm. PCB concentration in the solids is 50 ppm.
   n) Aerosol released from pit over 30 minutes.

1. Calculate the volume of waste drained (m^3) = (2 gal) (.00378 m^3 / gal) = **7.6 E-3 m^3**

2. Calculate the quantity of waste drained (g waste) = (7.6 E-3 m^3) (1.4 g m^3) / cm^3) (1 E+6 cm^3 /m^3)

   = **1.1 E+4 g waste**

3. Calculate the quantity of waste available for respiration (g waste) =

   = (0.0001) (1.1 E+4 g waste) = **1.1 g waste**

4. Calculate quantity of PCB contributed by solids in waste that is 33 wt% solids with a PCB concentration of 50 ppm

A gram of material contains 1.0 E6 parts; therefore the material contains 5.0 E-5 g PCB per gram material

quantity of PCB in solids (g PCB) = (1.1 g waste) (.33) (5.0 E-5 g PCB / g waste)

= **1.8 E-5 g PCB**

5. Calculate quantity of PCB contributed by liquid in waste that is 67 wt% liquid with a PCB concentration of 2.9 ppm

   A gram of material contains 1.0 E6 parts; therefore the material contains 2.9 E-6 g PCB per gram material

   quantity of PCB in (g PCB) = (1.1 g waste) (.67) (2.9 E-6 g PCB/g waste)

   = **2.1 E-6 g PCB**

6. Calculate total quantity of PCB in air displaced:

   Total quantity of PCB (g PCB) = (1.8 E-5 g PCB) + (2.1 E-6 g PCB) = **2.0 E-5 g PCB**

7. Calculate PCB release rate (g PCB / s) = (2.0 E-5 g PCB) / (30 min) (60 s / min)

   = **1.1 E-8 g PCB / s**

WASTREN, Inc.

Engineering Calculations

Prepared by ______________________________ Date__________________

Verified by ______________________________ Date__________________

Subject: Calculation of High Concentration Spray Leak Scenario

References:

1. *Refined Radiological and Toxicological Consequences of Bounding Spray Leak Accidents in Tank Farm Waste Transfer Pits*, HNF-SD-WM-CN-096, Rev 0-A

Assumptions:

1. Spray leak model for the determination of radiological and toxicological consequences described in reference 1, provides the basis for determining the quantity of PCB released in the spray leak.
2. Assumptions from reference 1 are as follows:
   a) Displaced air is assumed to be mixed with a maximum aerosol loading of 100 mg/m^3.
   b) Valve pit internal dimensions are 42 ft x 14 ft x 4.5 ft deep. Total pit volume is 2650 ft^3 or 74.9 m^3.
   c) All aerosol released is respirable by receptors.
   d) Initial expansion of air in the pit due to assumed increase in air temperature and relative humidity from 30°F at 15% R.H. to 120°F at 100% R.H. leading to a release of 35% of the total pit volume.
   e) Time required to perform initial heat-up and expansion is assumed to be less than 1 hour.
   f) Time to stop transfer is 1 hour. Transfers and pump shutdown from T Plant do do not exceed 1 hour.
   g) Slurry is assumed to contain 33 wt% entrained solids.
   h) Total spray volume rate is 1.41 E-4 m^3/s.
   i) There is no loss of solid particulate by deposition during plume migration to receptor location.
3. Assumption for the scenario are as follows:
   a) PCB concentration in the liquid is 2.9 ppm. PCB concentration in the solids is 1000 ppm.

1. Calculate air displacement of initial expansion of the air in the pit due to an assumed increase in air temperature and relative humidity from 30°F at 15% R.H. to 120°F at 100% R.H that results in a release of 35% of the total pit volume:

$$\text{Expansion air released } (m^3) = (74.9\ m^3)(0.35) = \boxed{26.2\ m^3}$$

2. Calculate the air volume displaced from the pit by in-leaking liquid in 1.0 hours:

Displaced air from in-leaking liquid (m^3) = (1.0 h) (1.41 E-4 m^3/s) (3600 s / h) = **5.1 E-1 m^3**

3. Calculate total air displaced:

   Total air displaced (m^3) = (26.2 m^3) + (5.1 E-1 m^3) = **26.7 m^3**

4. Calculate quantity of waste accompanying the air release:

   Waste released (g waste) = (26.7 m^3) (100 mg / m^3) (0.001 g / mg) = **2.67 g waste**

5. Calculate quantity of PCB contributed by solids in waste that is 33 wt% solids with a PCB concentration of 1000 ppm

   A gram of material contains 1.0 E+6 parts; therefore the material contains 1.0 E-3 g PCB per gram material

   quantity of PCB in solids (g PCB) = (2.67 g waste) (.33) (1.0 E-3 g PCB / g waste)

   = **8.8 E-4 g PCB**

6. Calculate quantity of PCB contributed by liquid in waste that is 67 wt% liquid with a PCB concentration of 2.9 ppm

   A gram of material contains 1.0 E6 parts; therefore the material contains 2.9 E-6 g PCB per gram material

   quantity of PCB in (g PCB) = (2.67 g waste) (.67) (2.9 E-6 g PCB / g waste)

   = **5.2 E-6 g PCB**

7. Calculate total quantity of PCB in air displaced:
   Total quantity of PCB (g PCB) = (8.8 E-4 g PCB) + (5.2 E-6 g PCB) = **8.9 E-4 g PCB**

8. Calculate PCB release rate:

   PCB release rate (g PCB/sec) = (8.9 E-4 g PCB) (1 / 1 h) (h / 3600 s)

   = **2.5 E-7 g PCB / s**

APPENDIX B

Air Modeling Details

This appendix contains the SCREEN3 model runs that produced the exposure point concentrations used in this report. Five model runs were required for the conditions described in Section 2. Each model run provides the exposure point concentration for each receptor at the appropriate distance from the source to the receptor.

- **One stack, normal operating conditions, ambient conditions**. This model output addresses the single stack in the 200 West Area.
- **Pseudo four stack, normal operating conditions, ambient conditions**. This model output addresses the single pseudo-stack in the 200 East Area.
- **Spray release, high concentration, and short duration**. This model output addresses the valve pit spray leak of contaminated material with PCBs at a high concentration in both DST areas.
- **Spray release, low concentration, and long duration**. This model output addresses the valve pit spray leak of contaminated material with PCBs at a low concentration in both DST areas.
- **Spill release**. This model output addresses the valve pit jumper change-out spill of PCB-contaminated material in both DST areas.

DISTRIBUTION

Onsite

1	U.S. Department of Energy Richland Operations Office	
	DOE Public Reading Room	H2-53
1	Pacific Northwest National Laboratory	
	Hanford Technical Library	P8-55
2	Lockheed Martin Services, Inc.	
	Central Files	B1-07
	Document Processing Center	A3-94

This page intentionally left blank.