RISK ASSESSMENT ADDENDUM

CEDAR CHEMICAL CORPORATION
WEST HELENA, ARKANSAS

EnSafe Project Number:
2162-013

Prepared for:

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ACRONYMS AND SYMBOLS

ADEQ	Arkansas Department of Environmental Quality
AT	averaging time
	body weight
CCC	Cedar Chemical Corporation
cm^2	square centimeters
COC	chemical of concern
COPC	chemical of potential concern
CR	cancer risk
ED	exposure duration
EF	exposure frequency
EPC	exposure point concentration
ET	exposure time
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
	Integrated Risk Information System
kg	kilogram
L/day	liter per day
MCL	maximum contaminant level
μg/L	micrograms per liter
mg/kg-day	milligram per kilogram day
mg/day	milligrams per day
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter
m^3/day	cubic meters per day
MSSL	medium-specific screening level
NA	not applicable
NCEA	National Center for Environmental Assessment
OSWER	Office of Solid Waste and Emergency Response
RAGS	Risk Assessment Guidance for Superfund
RfC	reference concentration
RfD	reference dose

RGO	remedial goal option
RME	reasonable maximum exposure
SF	slope factor
THQ	target hazard quotient
TR	target carcinogenic risk
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

EXECUTIVE SUMMARY

As agreed upon at a meeting of representatives from Cedar Chemical Corporation (CCC), EnSafe Inc., and the Arkansas Department of Environmental Quality on March 1, 2001, an addendum to the *Risk Assessment for Cedar Chemical Corporation — West Helena, Arkansas* (EnSafe, 2001) was prepared to address groundwater data collected from agricultural wells downgradient of the site. Its purpose is to assess risk to offsite agricultural workers who might be exposed to volatile organic compounds released to air from alluvial groundwater during irrigation. To achieve this goal samples from 7 agricultural wells were collected July 2001. 1,2-Dichloroethane, the only compound detected, was found in two agricultural wells: the well identified as AGI-1 (on the property approximately 3,500 feet south of the site) and the Blackhawk agricultural well (approximately 240 feet southeast of the site).

Using the exposure assessment assumptions outlined in the risk assessment cited above, risks were calculated using modeled air concentrations. For the addendum, it was determined that flood irrigation is used for the fields adjacent to CCC. Using this information, the Screen3 Model (USEPA, 1995a), available at http://www.epa.gov/scram001/tt22.htm#screen3, was used to predict the amount of contaminant the receptor might contact during the limited exposure period.

Noncarcinogenic risks to the offsite agricultural worker are less than 1 for both the worker exposed to contaminants emanating from both AGI-1 and BHA-1 agricultural wells. Carcinogenic risks are 7E-06 for the user exposed to groundwater from agricultural well AGI-1 and 5E-06 for the user exposed to groundwater from agricultural well BHA-1.

INTRODUCTION

This report presents results of the addendum to the *Risk Assessment for Cedar Chemical Corporation — West Helena, Arkansas* (EnSafe, 2001). The purpose of this evaluation is to assess risk to offsite agricultural workers who might be exposed to volatile organic compounds (VOCs) released to air from alluvial groundwater during irrigation.

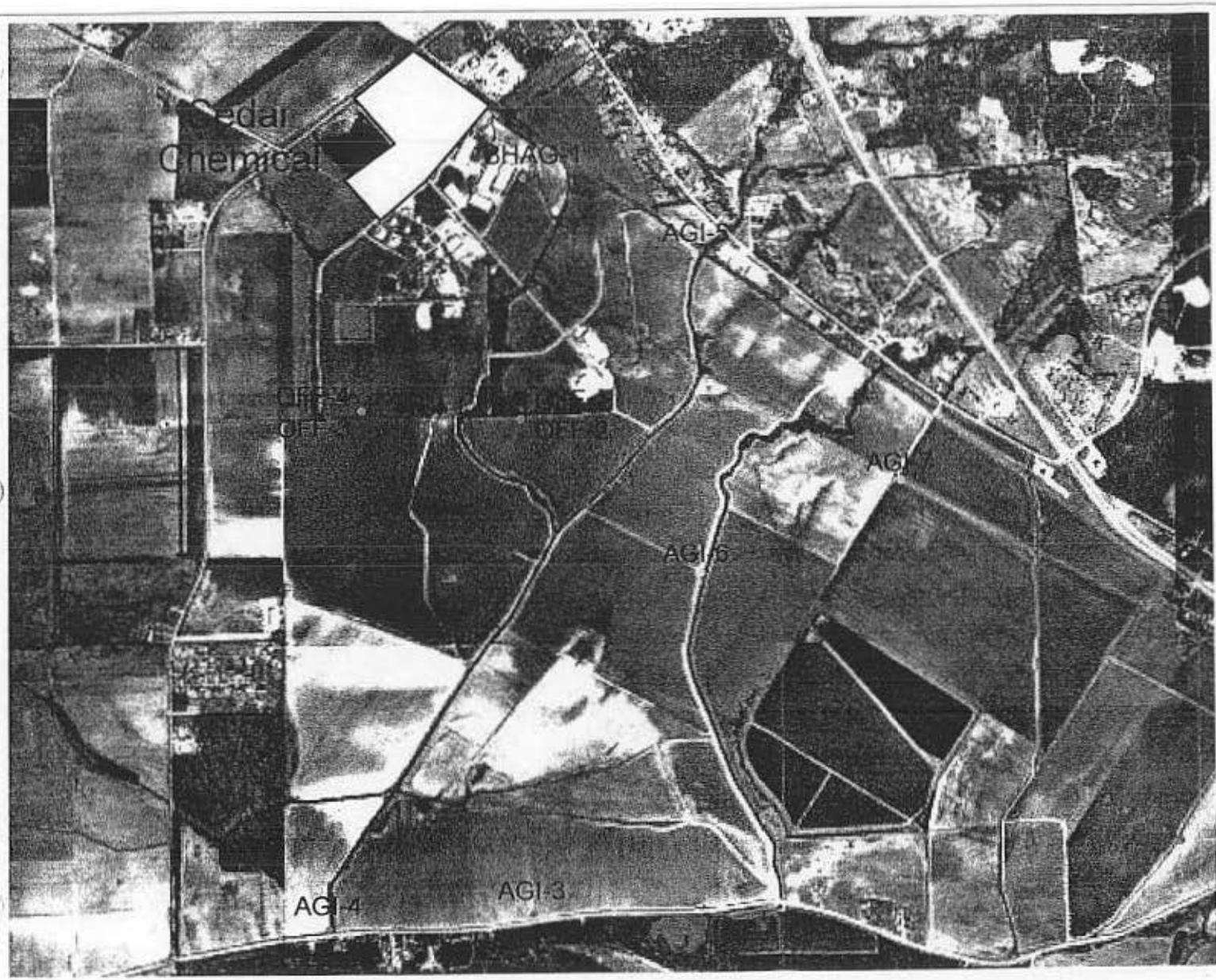
Additional site-specific information concerning irrigation practices was obtained during the July 2001 sampling event. Based on observations during sampling, agricultural lands adjacent to Cedar Chemical Corporation (CCC) are irrigated by either row or sheet flooding. Sheet flooding is the predominant method used at the properties adjacent to CCC and represents the method that will result in the greatest exposure to the offsite agricultural worker. Therefore, exposures associated with sheet flooding will be addressed in this addendum.

2.0 DATA COLLECTION AND EVALUATION

Eight agricultural wells (AGI-1 to AGI-7 and BHA-1) were sampled in July 2001 and the samples analyzed for volatile organic compounds (VOCs). Sampling results for the agricultural wells AGI-1 to AGI-7 and BHA-1 (Figure 1) from the July 2001 sampling event were used to perform this risk assessment. This section summarizes analytical data collected for the site, identifies chemicals of potential concern (COPCs), and determines chemical-specific concentrations to be used in the risk assessment. Analytical results are presented in Appendix A.

2.1 Comparison of Data to Risk-Based Screening Values

As recommended by the Arkansas Department of Environmental Quality (ADEQ), groundwater data were screened against the more stringent of the following values of USEPA Drinking Water Standards (MCLs) or risk-based medium-specific screening levels (MSSLs) adjusted for the industrial-use scenario. Because USEPA Region VI does not provide industrial tap-water screening values, USEPA Region IV Guidance was used to convert



Agricultural Well Location

Subject Property

1000 0 1000 2000 Feet

Figure 1
Agricultural Wells Sampled July 2001
Cedar Risk Assessment Addendum
West Helena, AR

residential tap-water MSSLs to industrial tap-water MSSLs (USEPA, 1994). Using this method, the residential MSSL for 1,2-dichloroethane (1.23E-01 micrograms per liter [μg/L]) is divided by 0.25 to estimate an industrial tap-water MSSL of 4.92E-01 μg/L. As stated in the USEPA Region VI document, MSSLs were based on a risk goal of 1E-06 for carcinogenic effects and a hazard quotient (HQ) of 1 for noncarcinogenic effects. For ease of use, all tables generated for risk calculation and remedial goal options (RGOs) (i.e., Tables 1 to 8) are presented in Appendix B.

2.2 Chemicals of Potential Concern

1,2-Dichloroethane was the only chemical detected and identified as a chemical of potential concern. Table 1 presents the detection frequency for the agricultural wells, detect and nondetect concentration ranges, and the calculated screening values for the industrial scenario.

2.3 Concentrations to be Used in Risk Assessment

The exposure point concentration (EPC) is the concentration of a contaminant in an exposure medium that may be contacted by a receptor. EPCs were selected using suggestions provided in USEPAs *Risk Assessment Guidance for Superfund* (1989). Because of the limited sample detections, the maximum detected concentration from BHA-1 and the average of the original and duplicate sample for AGI-1 were used to assess risk.

3.0 EXPOSURE ASSESSMENT

The objective of the exposure assessment is to estimate the type and magnitude of exposures to the COPCs present at or migrating from it. For this addendum the receptor of interest is the offsite agricultural worker exposed to contaminants released from alluvial groundwater during irrigation activities. Several modifications were made to the exposure assessment assumptions for this receptor. During the collection of groundwater samples from the agricultural wells, it was determined that sheet flooding is used to irrigate the agricultural fields in the areas where

,2-dichloroethane was detected. Based on local irrigation practices the assumptions listed below were made:

- Irrigation is required for the months of June, July, and August
- Assuming drought conditions, irrigation occurs once every 10 days.
- Two days are required to completely irrigate the 40-acre field and day for the 10-acre field.
- The agricultural worker spends approximately 1 hour per day in the field.
- Because sheet flooding is used for irrigating fields associated with agricultural wells AGI-1 and BHA-1, the inhalation route is the primary exposure pathway.

For the remaining assumptions for this receptor, refer to the risk assessment (EnSafe, 2001). Tables 2 and 3 provide the exposure assumptions for this receptor.

Fate-and-Transport Modeling

Concentrations of airborne chemicals from groundwater were estimated using mathematical models to approximate fate-and-transport processes in the ambient environment. The equations used to calculate constant molar flux from water to air and emission rates have not changed since the human health risk assessment (HHRA) was conditionally approved by ADEQ in July 2001. The USEPA Screen3 Model (1995a) was used to determine air concentrations. For this evaluation, the assumptions for the model have changed because additional information was obtained regarding irrigation practices in the areas where 1,2-dichloroethane was detected. The new assumptions are presented below:

- Flood irrigation is used for crops grown on the agricultural land where 1,2-dichloroethane was detected. Fields are flooded to a depth of 1 to 2 inches.

- The source area is the approximate size of the land under irrigation. For AGI-1, the source area is 40 acres; for BHA-1, it is 10 acres.

- The receptor height is equivalent to the average height of an adult male (69.1 inches) as determined by the Centers for Disease Control National Center for Health Statistics (personal communication, 2001).

The groundwater concentration used for air modeling is the maximum concentration measured by the laboratory.

Air Concentrations of VOCs in Alluvial Groundwater

Air concentrations associated with irrigation were estimated for COPCs in alluvial groundwater using the mass transfer equations described in Equations 1 and 2. The following equation, a solution of Fick's Law, was used to calculate the molar flux of COPCs from the water to the air.

$$N_A = \frac{P_{vp} \times D_{AB} (p_{A1} \quad p_{A2})}{(z_2 \quad z) \; RT \; (p_B)_{lm}} \qquad \text{Equation 1}$$

where:

N_A	=	Molar flux (pounds per square feet -sec [lbs/ft^2 - s])
P_{vp}	=	Total pressure of system (14.7 pounds per square inch [psi])
D_{AB}	=	Diffusion coefficient for each VOC (A) in air (B) (≅ 1E-05 square feet per second [ft^2/sec])
p_{A1}	=	Partial pressure of VOC at point 1 (psi)
p_{A2}	=	Partial pressure of VOC at point 2 (psi)

$(p_b)_{lm}$ = Log mean of air pressure (psi)
z_2 = Point 2 (ft)
z_1 = Point 1 starting point of liquid (ft)
R = Gas constant 10.73 psi-ft^3/lb-mol-Rankine (°R)
T = Temperature (°R)

The vapor pressure was estimated using Henry's law, as shown in Equation 2.

$$P_{vp} = H_c \times C_w \qquad \text{Equation 2}$$

where:

P_{vp} = Air vapor pressure (psi)
H_c = Henry's law constant (chemical-specific)
C_w = Concentration in water (milligrams per liter [mg/L])

The Henry's law constants were collected from the literature (Sawyer, 1994: Davis, 1998; DOE 2001). Air vapor pressure estimated using Equation 2 was substituted for p_{A2} in Equation 1. Appendix C presents the calculations used for molar flux.

After the molar flux was determined, USEPA Screen3 Model was used to predict the resulting air concentrations at the breathing zone. Two distinct scenarios were modeled: a 40-acre site with 50 μg/L 1,2-dichloroethane; and a 10-acre site with 100 μg/L 1,2-dichloroethane. The sites were modeled as area sources. The model calculated the concentrations at the breathing zone for an adult male. The modeling input and output files are provided in Appendix C.

4.0 TOXICITY ASSESSMENT

The objectives of the toxicity assessment are to evaluate the potential for particular contaminants to cause adverse effects in exposed individuals and to provide the analytical framework for characterizing human health impacts. Toxicity values used for the addendum have not changed

since the HHRA was submitted. The toxicity values used for the addendum are provided in Tables 4 and 5.

5.0 RISK CHARACTERIZATION

This step of the risk assessment integrates information from the exposure and toxicity assessments (Sections 3 and 4) to characterize potential risks posed by site COPCs. The risk assessment methodology used for the addendum has not been modified since the HHRA was submitted. Refer to the HHRA for a detailed discussion of the risk characterization process. Equations used to estimate noncarcinogenic and carcinogenic risk are presented as Equations 3 and 4.

5.1 Quantification of Noncarcinogenic Risk

Noncarcinogenic risk is expressed as an HQ, which is the ratio of the exposure intake (calculated in the exposure assessment) over the reference dose (acceptable intake indicated by oral RfD or inhalation reference value from the toxicity assessment). An HQ less than or equal to 1 indicates that an individual is unlikely to experience adverse health effects from exposure to the COPC (USEPA, 1989). The HQ is calculated as follows:

$$HQ = \frac{EPC_R \times DI}{RfD} \qquad \text{Equation 3}$$

where:

HQ	=	hazard quotient (unitless)
EPC_R	=	route-specific exposure point concentration (mg/m^3)
DI	=	daily intake (mg/kg-day)
RfD	=	reference dose (mg/kg-day)

A hazard index (HI) is calculated by summing the HQs to address noncarcinogenic additive effects between chemicals and cumulative effects across all exposure routes.

5.2 Quantification of Carcinogenic Risk

Carcinogenic risk (CR) is characterized by calculating a probability. The CR is a unitless incremental probability of an individual developing cancer from a lifetime exposure to a COPC (USEPA, 1989). For low risk levels (below estimated risk of 0.01), the CR is calculated by multiplying the exposure intake (calculated in the exposure assessment) by the cancer slope factor (from the toxicity assessment). The criterion typically used by regulatory agencies for demonstration of no carcinogen risk of concern is a CR of less than one in a million. A CR is calculated as follows:

$$CR = EPC_R \times DI \times SF \qquad \text{Equation 4}$$

where:

CR = cancer risk (unitless)
EPC_R = route exposure point concentration (mg/m^3)
DI = daily intake (mg/kg-day)
SF = slope factor $(mg/kg\text{-}day)^{-1}$

5.3 Discussions of Risk Characterization

Regulatory agencies have developed criteria for the demonstration of carcinogenic and noncarcinogenic risks. A CR ranging from one in one million (1E-06) to one in ten thousand (1E-04) is currently used by USEPA as the target risk level for carcinogenic effects, whereas an HI of 1 is used as the target risk level for noncarcinogenic effects. Tables 6 (A, B, and C) and 7 (A, B, and C) present the risk characterization results.

Groundwater carcinogenic risk for alluvial groundwater at the Blackhawk well (BHA-1) is 5E-06 and 7E-06 at AGI-1. Noncarcinogenic risks are less than 1 for both the BHA-1 and AGI-1 wells.

5.4 Chemicals of Concern

A contaminant was selected as a chemical of concern (COC) if its CR exceeded 1E-6 or it had an HQ greater than 1. 1,2-Dichloroethane was identified as a COC based on its carcinogenic risk at both wells.

6.0 UNCERTAINTY DISCUSSION

Data Evaluation Uncertainties

A conservative approach was used to review available analytical data and select COPCs for the quantitative risk assessment. The selection of a compound as a COPC does not necessarily suggest that it poses a human health concern for the site under investigation. Inclusion of a chemical in the quantitative risk assessment only indicates a need for further examination of the compound to determine any risks from exposure to this chemical.

Exposure Assessment Uncertainties

Uncertainties in the exposure assessment could arise from the following sources:

- Use of standard assumptions instead of site-specific data selected on the basis of "best professional judgment."

  Selection of a value from a wide range reported in published literature thought to best represent the site under study.

- The degree of "protectiveness" or "conservatism" inherent in the current risk assessment guidance.

  Lack of sufficient data and necessary assumptions made to complete the quantitative risk assessment.

The types and sources of exposure uncertainties are outlined below.

Calculation of Exposure Point Concentrations

A conservative approach was used to estimate the concentrations at the point of exposure, not considering degradation of any chemicals in the environmental media. Because it is well recognized that many organic chemicals can degrade in the environment, this conservative approach is expected to result in an overestimate of risk.

Exposure Parameter Values for the Groundwater Inhalation Pathway

To conduct a quantitative exposure assessment, many assumptions must be made concerning the exposure scenarios (e.g., frequency and duration of exposure, intake rate of contaminated media). Site-specific values are often unavailable and using the default values (primarily upper-bound estimates) is likely to contribute to exposure assessment uncertainty. For the hypothetical future scenarios (i.e., agricultural exposures), default values used in the exposure assessment are worst-case values and overestimate exposure. Summarized below are examples of uncertainties related to the selection of parameter values:

Exposure Frequency: Inhalation of VOCs from groundwater for the offsite agricultural worker is a site-specific exposure pathway. The exposure frequency represents the number of irrigation events during a growing season. Information from the local farmers indicates that irrigation events generally occur once every 10 days during a growing season which begins in June and ends in August.

The number of irrigation events depends on climate, the number of rain events, and the type of crop irrigated. Some crops might require more irrigation during the growing season than others, especially if the region of interest is under drought conditions. The number of irrigation events

selected for this evaluation assumes that the fields are irrigated during drought conditions suggesting that the EF selected may result in an overestimate of risks to agricultural workers.

Exposure Time: The exposure time represents the time the agricultural worker is present during irrigation events. Because this is a site-specific scenario, limited information is available to address this parameter. However, it was conservatively assumed that the agricultural worker would be present 1 hour per day for each irrigation event. Generally, flood irrigation does not require the presence of an operator during irrigation. The agricultural worker is only present in the field to open levees that drain water from one portion of the field to the next, indicating the exposure time is most likely less than 1 hour. Therefore risks associated with this exposure time are most likely overestimated.

Concentration in Air: Mathematical models were used to estimate the concentrations of VOCs released from groundwater during irrigation. The groundwater concentrations used for modeling are from agricultural wells AGI-1 and BHA-1. Because 1,2-dichloroethane has not been detected in agricultural wells downgradient of AGI-1 and BHA-1, the risks calculated are only for agricultural workers using groundwater from AGI-1 and BHA-1.

6.3 Toxicity Assessment Uncertainties

Uncertainties in the quantitative toxicity assessment are well recognized, but the degree can vary depending on the major sources of uncertainty for a particular site. The types of toxicity information uncertainties for this risk assessment are outlined below.

Uncertainties Inherent in the Risk Assessment Process

- Use of animal data to predict potential human health effects.

- Extrapolation of effects observed in animals exposed to high doses to probable outcomes in humans following exposure to low environmental contaminant levels.

  A conservative approach to calculate toxicological criteria such as the inhalation RfC with uncertainty spans of perhaps one order of magnitude. These estimates can change when additional information becomes available. The carcinogenic slope factors and unit risks are typically calculated by the USEPA using a linearized multistage model, which leads to a plausible upper-bound estimate of the risk, although the true value of the risk is unknown and may be as low as zero (USEPA, 1986)

Site-Specific Uncertainties

The estimated VOC concentrations in air are applicable using the assumptions defined for the model used. However, given the variability in irrigation rates, the types of irrigation devices used, differences in irrigation methods, and changes in climate, the calculated VOC concentration in air could be an overestimate of the actual concentration.

- The mathematical model used to estimate VOC concentrations released from alluvial groundwater is based on a model that does not take into account any affects dispersion to the atmosphere might have on airborne VOC concentrations. This would indicate that the airborne VOC concentrations are most likely overestimated.

7.0 REMEDIAL GOAL OPTIONS

RGOs are site-specific chemical concentrations used by risk managers during the development of remedial alternatives. They are calculated to equate with specific target carcinogenic and noncarcinogenic risk levels. For this HHRA, RGOs were calculated if the incremental lifetime cancer risk was greater than 1E-6 or the HQ greater than 1. Inclusion in the RGO table does not necessarily indicate that remedial action will be required to address a

specific chemical. Instead, RGOs are provided to facilitate risk-management decisions. were calculated for risks exceeding the levels defined above for the inhalation pathway.

In accordance with USEPA Region IV Supplemental Guidance (USEPA, 1995b), RGOs were calculated at 1E-6, 1E-5, and 1E-4 risk levels for carcinogenic COCs and HQ levels of 0.1, 1, and 3 for noncarcinogenic COCs using the following equations:

$$RGO_{NCR} = \frac{EPC \times THQ}{Calculated\ HQ} \qquad \text{Equation 5}$$

$$RGO_{CR} \frac{EPC \times TR}{Calculated\ CR} \qquad \text{Equation 6}$$

where:

RGO_{NCR}	=	noncarcinogenic remedial goal option (unitless)
EPC	=	exposure point concentration (mg/L)
THQ	=	target hazard quotient (0.1, 1, 3) (unitless)
HQ	=	hazard quotient (unitless)
RGO_{CR}	=	carcinogenic remedial goal option (unitless)
TR	=	target carcinogenic risk (1E-06, 1E-05, 1E-04)
CR	=	cancer risk (unitless)

RGOs are presented in Table 8.

8.0 CONCLUSIONS

Although alluvial groundwater risks based for the offsite agricultural workers using sheet flood irrigation are below those presented in the HHRA, 1,2-dichloroethane remains a COC because the cancer risk is greater than 1E-06. However, risk is most likely overestimated because workers are present in the fields completing irrigations tasks for limited periods of time.

9.0 REFERENCES

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Appendix A

Analytical Data

CEDAR CHEMICAL CORPORATION
West Helena, Arkansas
Agricultural Well Data July 2001

VOA																	
	SHORT ID -------->	AGI-1		AGI-1 DUP		AGI-2		AGI-3		AGI-4		AGI-5	
	ORIGINAL ID ----->	AGIG000101		AGIH000101		AGIG000201		AGIG000301		AGIG000401		AGIG000501	
	SAMPLE DATE ----->	07/24/01		07/24/01		07/25/01		07/25/01		07/25/01		07/25/01	
	DATE ANALYZED --->	08/01/01		07/31/01		08/02/01		08/02/01		08/02/01		08/02/01	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	UG/L		UG/L		UG/L		UG/L		UG/L		UG/L	
CAS #	Parameter	47097	VAL	47097	VAL	47116	VAL	47116	VAL	47116	VAL	47116	VAL
74-87-3	Chloromethane	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
75-01-4	Vinyl chloride	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
74-83-9	Bromomethane	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
75-00-3	Chloroethane	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
75-69-4	Trichlorofluoromethane	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
75-35-4	1,1-Dichloroethene	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
67-64-1	Acetone	12.	U	10.	U	5.	U	5.	U	5.	U	5.	U
75-15-0	Carbon disulfide	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
75-09-2	Methylene chloride	9.	U	4.	U	2.	U	5.	U	2.	U	2.	U
156-60-5	trans-1,2-Dichloroethene	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
75-34-3	1,1-Dichloroethane	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
108-05-4	Vinyl acetate	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
156-59-2	cis-1,2-Dichloroethene	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
78-93-3	2-Butanone (MEK)	12.	U	10.	U	5.	U	5.	U	5.	U	5.	U
74-97-5	Chlorobromomethane	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
67-66-3	Chloroform	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
71-55-6	1,1,1-Trichloroethane	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
56-23-5	Carbon tetrachloride	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
71-43-2	Benzene	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
107-06-2	1,2-Dichloroethane	46.		55.		1.	U	1.	U	1.	U	1.	U
79-01-6	Trichloroethene	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
78-87-5	1,2-Dichloropropane	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
74-95-3	Methylene bromide	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
75-27-4	Bromodichloromethane	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
110-75-8	2-Chloroethylvinylether	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
10061-01-5	cis-1,3-Dichloropropene	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
108-10-1	4-Methyl-2-Pentanone (MIBK)	12.	U	10.	U	5.	U	5.	U	5.	U	5.	U
108-88-3	Toluene	2.	U	2.	U	1.	U	1.	U	1.	U	0.6	U
10061-02-6	trans-1,3-Dichloropropene	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
79-00-5	1,1,2-Trichloroethane	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
106-93-4	1,2-Dibromoethane	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
127-18-4	Tetrachloroethene	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
591-78-6	2-Hexanone	12.	U	10.	U	5.	U	5.	U	5.	U	5.	U
124-48-1	Dibromochloromethane	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
108-90-7	Chlorobenzene	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
100-41-4	Ethylbenzene	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
1330-20-7	Xylene (total)	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
100-42-5	Styrene	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
75-25-2	Bromoform	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U

*** Validation Complete ***

CEDAR CHEMICAL CORPORATION
West Helena, Arkansas
Agricultural Well Data July 2001

VOA																	
	SHORT ID -------->	AGI-1		AGI-1 DUP		AGI-2		AGI-3		AGI-4		AGI-5	
	ORIGINAL ID ----->	AGIG000101		AGIH000101		AGIG000201		AGIG000301		AGIG000401		AGIG000501	
	SAMPLE DATE ----->	07/24/01		07/24/01		07/25/01		07/25/01		07/25/01		07/25/01	
	DATE ANALYZED --->	08/01/01		07/31/01		08/02/01		08/02/01		08/02/01		08/02/01	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	UG/L		UG/L		UG/L		UG/L		UG/L		UG/L	
CAS #	Parameter	47097	VAL	47097	VAL	47116	VAL	47116	VAL	47116	VAL	47116	VAL
108-86-1	Bromobenzene	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
79-34-5	1,1,2,2-Tetrachloroethane	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
541-73-1	1,3-Dichlorobenzene	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
106-46-7	1,4-Dichlorobenzene	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U
95-50-1	1,2-Dichlorobenzene	2.	U	2.	U	1.	U	1.	U	1.	U	1.	U

*** Validation Complete ***

CEDAR CHEMICAL CORPORATION
West Helena, Arkansas
Agricultural Well Data July 2001

VOA											
	SHORT ID -------->	AGI-6		AGI-7		BHA-1					
	ORIGINAL ID ----->	AGIG000601		AGIG000701		BHAG000102					
	SAMPLE DATE ----->	07/25/01		07/26/01		07/25/01					
	DATE ANALYZED --->	08/02/01		08/02/01		08/02/01					
	MATRIX ---------->	Water		Water		Water					
	UNITS ---------->	UG/L		UG/L		UG/L					
CAS #	Parameter	47116	VAL	47116	VAL	47116	VAL				
74-87-3	Chloromethane	1.	U	1.	U	5.	U				
75-01-4	Vinyl chloride	1.	U	1.	U	5.	U				
74-83-9	Bromomethane	1.	U	1.	U	5.	U				
75-00-3	Chloroethane	1.	U	1.	U	5.	U				
75-69-4	Trichlorofluoromethane	1.	U	1.	U	5.	U				
75-35-4	1,1-Dichloroethene	1.	U	1.	U	5.	U				
67-64-1	Acetone	5.	U	5.	U	25.	U				
75-15-0	Carbon disulfide	1.	U	1.	U	5.	U				
75-09-2	Methylene chloride	2.	U	2.	U	13.	U				
156-60-5	trans-1,2-Dichloroethene	1.	U	1.	U	5.	U				
75-34-3	1,1-Dichloroethane	1.	U	1.	U	5.	U				
108-05-4	Vinyl acetate	1.	U	1.	U	5.	U				
156-59-2	cis-1,2-Dichloroethene	1.	U	1.	U	5.	U				
78-93-3	2-Butanone (MEK)	5.	U	5.	U	25.	U				
74-97-5	Chlorobromomethane	1.	U	1.	U	5.	U				
67-66-3	Chloroform	1.	U	1.	U	5.	U				
71-55-6	1,1,1-Trichloroethane	1.	U	1.	U	5.	U				
56-23-5	Carbon tetrachloride	1.	U	1.	U	5.	U				
71-43-2	Benzene	1.	U	1.	U	5.	U				
107-06-2	1,2-Dichloroethane	1.	U	1.	U	100.					
79-01-6	Trichloroethene	1.	U	1.	U	5.	U				
78-87-5	1,2-Dichloropropane	1.	U	1.	U	5.	U				
74-95-3	Methylene bromide	1.	U	1.	U	5.	U				
75-27-4	Bromodichloromethane	1.	U	1.	U	5.	U				
110-75-8	2-Chloroethylvinylether	1.	U	1.	U	5.	U				
10061-01-5	cis-1,3-Dichloropropene	1.	U	1.	U	5.	U				
108-10-1	4-Methyl-2-Pentanone (MIBK)	5.	U	5.	U	25.	U				
108-88-3	Toluene	1.	U	0.5	U	5.	U				
10061-02-6	trans-1,3-Dichloropropene	1.	U	1.	U	5.	U				
79-00-5	1,1,2-Trichloroethane	1.	U	1.	U	5.	U				
106-93-4	1,2-Dibromoethane	1.	U	1.	U	5.	U				
127-18-4	Tetrachloroethene	1.	U	1.	U	5.	U				
591-78-6	2-Hexanone	5.	U	5.	U	25.	U				
124-48-1	Dibromochloromethane	1.	U	1.	U	5.	U				
108-90-7	Chlorobenzene	1.	U	1.	U	5.	U				
100-41-4	Ethylbenzene	1.	U	1.	U	5.	U				
1330-20-7	Xylene (total)	1.	U	1.	U	5.	U				
100-42-5	Styrene	1.	U	1.	U	5.	U				
75-25-2	Bromoform	1.	U	1.	U	5.	U				

*** Validation Complete ***

CEDAR CHEMICAL CORPORATION
West Helena, Arkansas
Agricultural Well Data July 2001

VOA													
	SHORT ID -------->	AGI-6			AGI-7			BHA-1					
	ORIGINAL ID ----->	AGIG000601			AGIG000701			BHAG000102					
	SAMPLE DATE ----->	07/25/01			07/26/01			07/25/01					
	DATE ANALYZED --->	08/02/01			08/02/01			08/02/01					
	MATRIX ---------->	Water			Water			Water					
	UNITS ---------->	UG/L			UG/L			UG/L					
CAS #	Parameter	47116		VAL	47116		VAL	47116		VAL			
108-86-1	Bromobenzene		1.	U		1.	U		5.	U			
79-34-5	1,1,2,2-Tetrachloroethane		1.	U		1.	U		5.	U			
541-73-1	1,3-Dichlorobenzene		1.	U		1.	U		5.	U			
106-46-7	1,4-Dichlorobenzene		1.	U		1.	U		5.	U			
95-50-1	1,2-Dichlorobenzene		1.	U		1.	U		5.	U			

*** Validation Complete ***

Appendix B

Risk Assessment Tables

TABLE 1
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
CEDAR CHEMICAL CORPORATION, WEST HELENA, ARKANSAS

Scenario Timeframe:	Current
Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Point:	Alluvial Groundwater (Agri-wells)(1)

CAS Number	Chemical	Minimum (2) Concentration	Minimum Qualifier	Maximum (2) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (mg/L)	Screening (3) Toxicity Value (mg/L)		COPC Flag	Rationale for (4) Contaminant Deletion or Selection
107062	1,2-Dichloroethane	4.60E-02		1.00E-01		mg/L	BHA-1	3 / 9	1.0E-03 – 1.0E-03	1.00E-01	4.93E-04	C	YES	ASL

(1) Agricultural well data from the July 2001 sampling event were used for screening.
(2) Minimum/maximum detected concentration.
(3) Industrial MSSLs calculated as the residential tap-water MSSL divided by 0.5 for all parameters except for VOCs. For VOCs, the tap-water MSSL is divided by 0.25 (USEPA, 1994).
(4) Rationale Codes Selection Reason:
Above Screening Levels (ASL)

Definitions:
COPC = chemical of potential concern
C = Carcinogenic
mg/L = milligrams per liter
MSSL = medium-specific screening level
MCL = maximum contaminant level
VOC = volatile organic compounds

TABLE 2
VALUES USED FOR DAILY INTAKE CALCULATIONS
CEDAR CHEMICAL CORPORATION, WEST HELENA, ARKANSAS

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Alluvial Groundwater (AGI-1, BHA-1)
Receptor Population: Offsite Agricultural Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	USEPA, RME Rationale/ Reference	Intake Equation/ Model Name
Inhalation	IR-A	Inhalation Rate of Air	m^3/hour	0.83	USEPA, 1991	$IF_{inh} = \frac{IR-A \times EF \times ED \times ET}{BW \times AT}$
	EF	Exposure Frequency	days/year	AGI-1 = 18 BHA-1 = 9	Site-specific [a]	
	ED	Exposure Duration	years	25	USEPA, 1989	
	ET	Exposure Time	hours/day	1	Site-specific [a]	
	BW	Body Weight	kg	70	USEPA, 1989	
	AT-C	Averaging Time (Cancer)	days	25,550	USEPA, 1989	
	AT-N	Averaging Time (Noncancer)	days	9,125	USEPA, 1989	
Dermal[b]	FA	Fraction absorbed	unitless	1	USEPA, RAGS Part E	$DA_{event} = FA \times K_p \times \left[\frac{t_{event}}{1+B} + 2\tau_{event}\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]$
	K_p	Dermal permeability constant	cm/hour	0.0043	USEPA, RAGS Part E	
	t_{event}	Event duration	hour/event	0.25	USEPA, RAGS Part E	
	B	Ratio of permeability coefficient	unitless	0	USEPA, RAGS Part E	
	τ	Lag time per event	hour/event	0.38	USEPA, RAGS Part E	$DAD = \left(\frac{DA_{event} \times SA \times EV \times EF \times ED}{BW \times AT}\right)$
	t*	Time to reach steady-state	hour	0.9	USEPA, RAGS Part E	
	DA_{event}	Absorbed does per event	mg/cm^2-event	calculated	USEPA, RAGS Part E	
	SA	Skin surface area (hands only)	cm^2	1,120	USEPA, 1997	
	EV	Event frequency	events/day	1	USEPA, RAGS Part E	

AGI -1 = agricultural well 1
BHA-1 = Blackhawk well 1
RME = Reasonable Maximum Exposure
CT = Central Tendency
kg = kilograms
m^3 = cubic meters
IF inh = inhalation intake factor

(a) Based on local flood irrigation practices the following assumptions were made:
- irrigation is required during the months of June, July, and August
- irrigation occurs once every 10 days
- 2 days are required to completely irrigate the 40 acre field and 1 day to irrigate the 10 acre field
- the receptor spends approximately 1 hour per day in the field

(b) The FA, K_p, τ_{event}, t_{event}, t*, and B values presented for the dermal pathway are chemical-specific and represent values for 1,2-dichloroethane.

USEPA. 1991. *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors."* (OSWER Directive 9285.6-03). Washington, DC. Office of Solid Waste and Emergency Response.

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

USEPA. 1997. *Exposure Factors Handbook: Volume I - General Factors*. (EPA/600/P-95/002Fa). Washington, DC. Office of Research and Development.

USEPA. Unpublished. *Risk Assessment Guidance for Superfund - Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Interim Guidance.* Office of Emergency and Remedial Response. Washington, DC.

TABLE 3
INHALATION-SPECIFIC INTAKE FACTOR
OFFSITE AGRICULTURAL WORKER EXPOSURE: INHALATION OF AIRBORNE (VAPOR PHASE) CHEMICALS FROM GROUNDWATER
CEDAR CHEMICAL CORPORATION, WEST HELENA, ARKANSAS

EQUATION	IFinh	=	(	IR-A	×	EF	×	ED	×	ET	)	÷	(	BW	×	AT	)
UNITS	m^3/kg-day			m^3/hour		days/year		year		hours/day				kg		days	
40 Acre Field																	
Noncarcinogenic Effects	5.85E-04	=	(	0.83	×	18	×	25	×	1	)	÷	(	70	×	9,125	)
Carcinogenic Effects	2.09E-04	=		0.83		18		25				÷	(	70		25,550	
10 Acre Field																	
Noncarcinogenic Effects	2.92E-04	=	(	0.83	×	9	×	25	×	1	)	÷	(	70	×	9,125	)
Carcinogenic Effects	1.04E-04	=	(	0.83	×	9	×	25	×	1	)	÷	(	70	×	25,550	)

See Table 2 for definitions and sources of equation variables identified as follows:
IF inh = Inhalation intake factor
IR-A = Inhalation Rate
EF = Exposure frequency
ED = Exposure duration
ET = Exposure time
BW = Body weight
AT = Averaging time

TABLE 4
NON-CANCER TOXICITY DATA -- INHALATION
CEDAR CHEMICAL CORPORATION, WEST HELENA, ARKANSAS

Chemical of Potential Concern	Chronic/ Subchronic	Value Inhalation RfC	Units	Adjusted Inhalation RfD (1)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC:RfD: Target Organ	Dates (2)
1,2-Dichloroethane	ND	5E-03	mg/m^3	1.40E-03	mg/kg-day	gastrointestinal tract, liver, and gallbladder	3000	NCEA	04/05/93

RfC = reference concentration
RfD = Reference Dose
ND = no data
mg/m^3 = milligrams per cubic meter
mg/kg-day = milligram per kilogram - day
NCEA = National Center for Environmental Assessment

(1) The inhalation RfD was calculated using the following equation:
Inhalation RfD = (RfC × 20 m^3/day) / 70 kg
(2) Date of the NCEA provisional guidance paper.

TABLE 5
CANCER TOXICITY DATA -- INHALATION
CEDAR CHEMICAL CORPORATION, WEST HELENA, ARKANSAS

Chemical of Potential Concern	Inhalation Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	Inhalation Unit Risk (mg/m^3)	Weight of Evidence/ Cancer Guideline Description	Source	Date (1)
1,2-Dichloroethane	9.10E-02	2.60E-05	B2	IRIS	01/01/91

IRIS = Integrated Risk Information System
mg/m^3 = millgrams per cubic meter
mg/kg-day = milligram per kilogram per day
B2 = Indicates a probable human carcinogen based on sufficient evidence in animals and inadequate or no evidence in humans.

(1) For IRIS, this is the date of the last revision.

TABLE 6A
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
CEDAR CHEMICAL CORPORATION, WEST HELENA, ARKANSAS

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Alluvial Groundwater
Exposure Point:	Alluvial Groundwater (AGI-1)
Receptor Population:	Offsite Agricultural Workers
Receptor Age:	Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Hazard Quotient
I	1,2-Dichloroethane	0.05	mg/L	[illegible]	mg/m^3	R	5.8E-04	m^3/kg-day	1.40E-03	mg/kg-day	0.2
										Total Hazard Index Across All Exposure Routes/Pathways	0.2

See Table 2 for definitions and sources of equation variables for pathway-specific intake factor calculations.

AGI-1 = agricultural well 1
EPC = Exposure point concentration is the average concentration of the AGI-1 (46 parts per billion [ppb]) and AGI-1 Dup (55 ppb) detections.
mg/L = milligrams per liter
R = Route-specific concentration is the maximum air concentration based on the Screen 3R model for agricultural well 1. The value is the maximum 1-hour concentration at 172 meters.
mg/m^3 = milligrams per cubic meter

TABLE 6B
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
CEDAR CHEMICAL CORPORATION, WEST HELENA, ARKANSAS

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Alluvial Groundwater
Exposure Point:	Alluvial Groundwater (AGI-1)
Receptor Population:	Offsite Agricultural Workers
Receptor Age:	Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Inhalation	1,2-Dichloroethane	0.05	mg/L	3.67E-01	mg/m^3	R	2.09E-04	m^3/kg-day	9.1E-02	$(mg/kg\text{-}day)^{-1}$	7.0E-06
											7E-06

See Table 2 for definitions and sources of equation variables for pathway-specific intake factor calculations.

AGI-1 = agricultural well 1
EPC = Exposure point concentration is the average concentration of the AGI-1 (46 parts per billion [ppb]) and AGI-1 Dup (55 ppb) detections.
NA = not applicable
R = Route-specific concent

TABLE 6C
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
CEDAR CHEMICAL CORPORATION, WEST HELENA, ARKANSAS

Scenario Timeframe:	Future
Receptor Population:	Offsite Agricultural Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient			
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Ingestion	Inhalation	Dermal	Exposure Routes Total
Water	Alluvial Groundwater	Agricultural Well 1 (AGI-1)	1,2-Dichloroethane	NA	7E-06	NA	7E-06	1,2-Dichloroethane	NA	0.2	NA	0.2
						Total Risk Across[Air]	7E-06	Total Hazard Index Across All Media and All Exposure Routes				0.2
						Total Risk Across All Media and All Exposure Routes	7E-06					

NA = Not Applicable

TABLE 7A
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
CEDAR CHEMICAL CORPORATION, WEST HELENA, ARKANSAS

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Alluvial Groundwater
Exposure Point:	Alluvial Groundwater (BHA-1)
Receptor Population:	Offsite Agricultural Workers
Receptor Age:	Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Hazard Quotient
Inhalation	1,2-Dichloroethane	0.1	mg/L	4.8E-01	mg/m^3	R	2.92E-04	m^3/kg-day	1.40E-03	mg/kg-day	0.1
										Total Hazard Index Across All Exposure Routes/Pathways	0.1

See Table 2 for definitions and sources of equation variables for pathway-specific intake factor calculations.

BHA-1 = Blackhawk well
EPC = Exposure point concentration is the maximum detected concentration from the July sampling event.
NA = not applicable
R = Route-specific concentration is the maximum air concentration based on the Screen 3R model for agricultural well 1. The value is the maximum 1-hour concentration at 308 meters.

TABLE 7B
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
CEDAR CHEMICAL CORPORATION, WEST HELENA, ARKANSAS

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Alluvial Groundwater
Exposure Point:	Alluvial Groundwater (BHA-1)
Receptor Population:	Offsite Agricultural Workers
Receptor Age:	Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Inhalation	1,2-Dichloroethane	0.1	mg/L	4.8E-01	mg/m^3	R	1.04E-04	m^3/kg-day	9.1E-02	$(mg/kg\text{-}day)^{-1}$	4.6E-06
											5E-06

See Table 2 for definitions and sources of equation variables for pathway-specific intake factor calculations.

BHA-1 = Blackhawk well
EPC = Exposure point concentration is the maximum detected concentration from the July sampling event.
mg/L = milligrams per liter
NA = Not applicable
R = Route-specific concentration is the maximum air concentration based on the Screen 3R model for agricultural well 1. The value is the maximum 1-hour concentration at 308 meters.

TABLE 7C
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
CEDAR CHEMICAL CORPORATION, WEST HELENA, ARKANSAS

Scenario Timeframe:	Future
Receptor Population:	Offsite Agricultural Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient			
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Ingestion	Inhalation	Dermal	Exposure Routes Total
Water	Alluvial Groundwater	Blackhawk Agricultural Well	1,2-Dichloroethane	NA	5E-06	NA	5E-06	1,2-Dichloroethane	NA	0.1	NA	0.1
						Total Risk Across[Air]	5E-06	Total Hazard Index Across All Media and All Exposure Routes				0.1

NA = Not Applicable

TABLE 8
REMEDIAL GOAL OPTIONS
ALLUVIAL GROUNDWATER
CEDAR CHEMICAL CORPORATION, WEST HELENA, ARKANSAS

					Remedial Goal Options (mg/L)					
					Carcinogenic Risk			Noncarcinogenic Risk		
Receptor and Pathway	Parameter	EPC (1) (mg/L)	Estimated Carcinogenic Risk	Estimated Noncarcinogenic Risk	1E-06	1E-05	1E-04	0.1	1	3
Inhalation Pathway										
Offsite Agricultural Worker (AGI-1)	1,2-Dichloroethane	0.05	7E-06	NA	7.2E-03	7.2E-02	7.2E-01	NA	NA	NA
Offsite Agricultural Worker (BHA-1)	1,2-Dichloroethane	0.1	5E-06	NA	2.2E-02	2.2E-01	2.2E+00	NA	NA	NA

EPC = Exposure point concentration
mg/L = milligrams per liter
AGI-1 = agricultural well 1

Appendix C

Air Concentration Calculations

09/18/01
11:58:10

```
 ***  SCREEN3r MODEL RUN  ***
 *** VERSION DATED 96043 ***

CEDAR 10 ACRE SITE ** 0

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE                    =        AREA
   EMISSION RATE (G/(S-M**2))     =     .876255E-05
   SOURCE HEIGHT (M)              =       .0000
   LENGTH OF LARGER SIDE (M)      =    201.1680
   LENGTH OF SMALLER SIDE (M)     =    201.1680
   RECEPTOR HEIGHT (M)            =      1.7551
   URBAN/RURAL OPTION             =      RURAL
THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED

   MODEL ESTIMATES DIRECTION TO MAX CONCENTRATION


BUOY. FLUX =      000 M**4/S**3;  MOM  FLUX =      000 M**4/S**2.

*** FULL METEOROLOGY

**********************************
*** SCREEN AUTOMATED DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***
```

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	MAX DIR (DEG)
1.	240.9	6	1.0	1.0	10000.0	.00	45.
100.	398.8	6	1.0	1.0	10000.0	.00	45.
200.	455.6	6	1.0	1.0	10000.0	.00	45.
300.	331.3	6	1.0	1.0	10000.0	.00	45.
400.	258.8	6	1.0	1.0	10000.0	.00	45.
500.	212.7	6	1.0	1.0	10000.0	.00	45.
600.	180.6	6	1.0	1.0	10000.0	.00	45.
700.	157.3	6	1.0	1.0	10000.0	.00	45.
800.	139.9	6	1.0	1.0	10000.0	.00	45.
900.	126.4	6	1.0	1.0	10000.0	.00	45.
1000.	115.3	6	1.0	1.0	10000.0	.00	45.
1100.	106.0	6	1.0	1.0	10000.0	.00	45.
1200.	98.21	6	1.0	1.0	10000.0	.00	45.
1300.	91.34	6	1.0	1.0	10000.0	.00	45.
1400.	85.25	6	1.0	1.0	10000.0	.00	45.
1500.	79.80	6	1.0	1.0	10000.0	.00	45.
1600.	74.89	6	1.0	1.0	10000.0	.00	45.
1700.	70.45	6	1.0	1.0	10000.0	.00	45.
1800.	66.41	6	1.0	1.0	10000.0	.00	45.
1900.	62.73	6	1.0	1.0	10000.0	.00	45.
2000.	59.41	6	1.0	1.0	10000.0	.00	45.
2100.	56.47	6	1.0	1.0	10000.0	.00	45.
2200.	53.82	6	1.0	1.0	10000.0	.00	45.
2300.	51.35	6	1.0	1.0	10000.0	.00	45.
2400.	49.06	6	1.0	1.0	10000.0	.00	45.
2500.	46.92	6	1.0	1.0	10000.0	.00	45.
2600.	44.92	6	1.0	1.0	10000.0	.00	44.
2700.	43.06	6	1.0	1.0	10000.0	.00	44.
2800.	41.31	6	1.0	1.0	10000.0	.00	45.
2900.	39.68	6	1.0	1.0	10000.0	.00	45.
3000.	38.16	6	1.0	1.0	10000.0	.00	45.
3500.	32.10	6	1.0	1.0	10000.0	.00	44.
4000.	27.47	6	1.0	1.0	10000.0	.00	42.
4500.	23.86	6	1.0	1.0	10000.0	.00	45.

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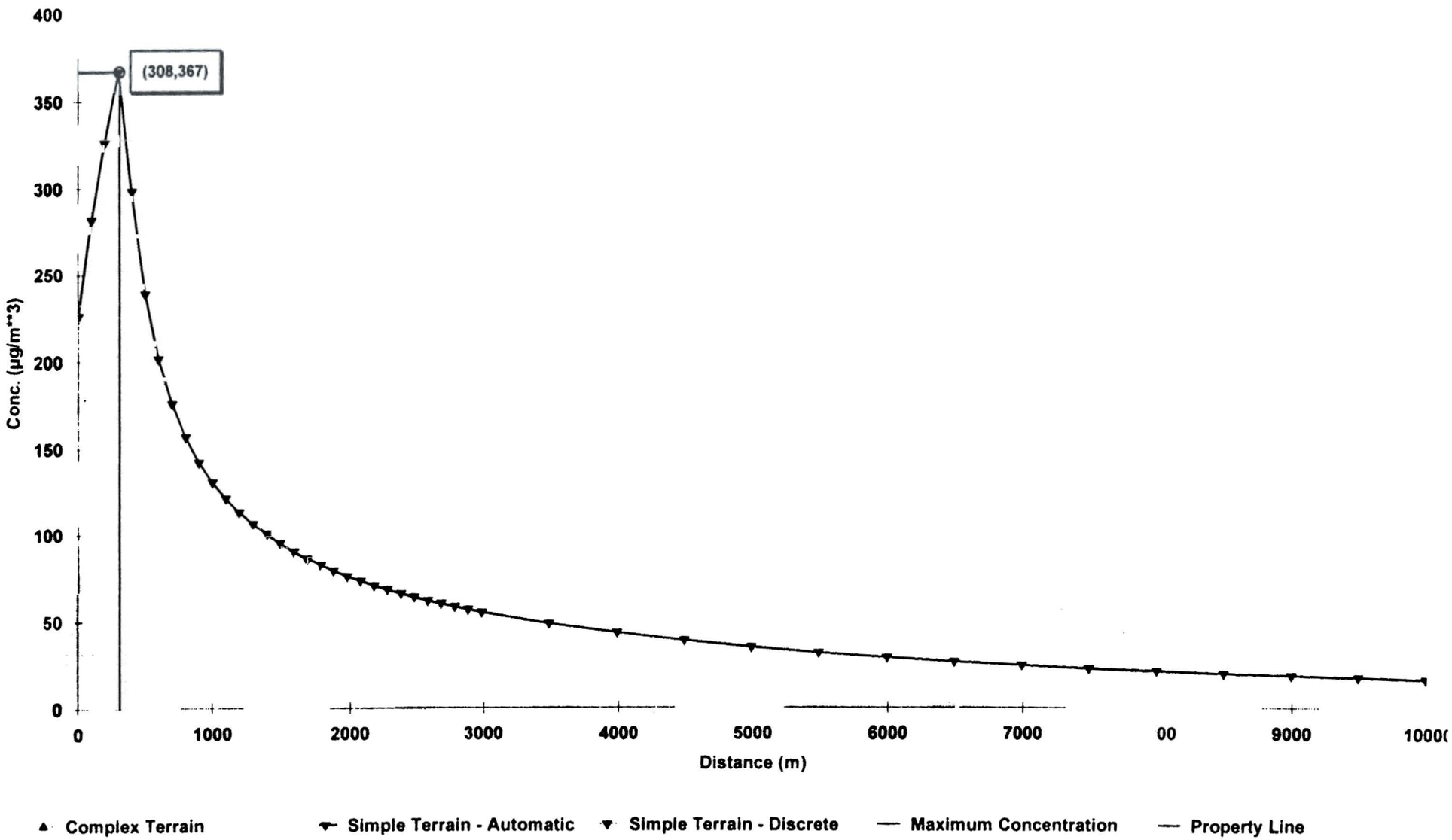
UMMAR OF CR UL

CALCULA MAX CON TERRA
UG/ MAX HT

MPL ERRA

EMEMB CLUDE CON ENTRA

CEDAR 40 ACRE SITE



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12:05:13

*** SCREEN3r MODEL RUN ***
*** VERSION DATED 96043 ***

CEDAR 40 ACRE SITE ** 0

SIMPLE TERRAIN INPUTS:

SOURCE TYPE	=	AREA
EMISSION RATE (G/(S-M**2))	=	.438128E-05
SOURCE HEIGHT (M)	=	.0000
LENGTH OF LARGER SIDE (M)	=	402.3360
LENGTH OF SMALLER SIDE (M)	=	402.3360
RECEPTOR HEIGHT (M)	=	1.7551
URBAN/RURAL OPTION	=	RURAL

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED

MODEL ESTIMATES DIRECTION TO MAX CONCENTRATION

BUOY. FLUX = 000 M**4/S**3; MOM. FLUX = .000 M**4/S**2

*** FULL METEOROLOGY **

****
*** SCREEN AUTOMATED DISTANCES ***
****

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	MAX DIR (DEG)
1.	226.4	6	1.0	1.0	10000.0	.00	45.
100.	281.7	6	1.0	1.0	10000.0	.00	45.
200.	326.4	6	1.0	1.0	10000.0	.00	45.
300.	366.8	6	1.0	1.0	10000.0	.00	45.
400.	298.4	6	1.0	1.0	10000.0	.00	45.
500.	239.1	6	1.0	1.0	10000.0	.00	45.
600.	201.7	6	1.0	1.0	10000.0	.00	45.
700.	175.7	6	1.0	1.0	10000.0	.00	45.
800.	156.6	6	1.0	1.0	10000.0	.00	45.
900.	142.0	6	1.0	1.0	10000.0	.00	45.
1000.	130.6	6	1.0	1.0	10000.0	.00	45.
1100.	121.3	6	1.0	1.0	10000.0	.00	45.
1200.	113.4	6	1.0	1.0	10000.0	.00	45.
1300.	106.6	6	1.0	1.0	10000.0	.00	45.
1400.	100.7	6	1.0	1.0	10000.0	.00	45.
1500.	95.42	6	1.0	1.0	10000.0	.00	45.
1600.	90.68	6	1.0	1.0	10000.0	.00	45.
1700.	86.39	6	1.0	1.0	10000.0	.00	45.
1800.	82.49	6	1.0	1.0	10000.0	.00	45.
1900.	78.98	6	1.0	1.0	10000.0	.00	45.
2000.	75.81	6	1.0	1.0	10000.0	.00	45.
2100.	72.94	6	1.0	1.0	10000.0	.00	45.
2200.	70.34	6	1.0	1.0	10000.0	.00	45.
2300.	67.95	6	1.0	1.0	10000.0	.00	45.
2400.	65.72	6	1.0	1.0	10000.0	.00	45.
2500.	63.63	6	1.0	1.0	10000.0	.00	45.
2600.	61.65	6	1.0	1.0	10000.0	.00	45.
2700.	59.78	6	1.0	1.0	10000.0	.00	45.
2800.	58.00	6	1.0	1.0	10000.0	.00	45.
2900.	56.34	6	1.0	1.0	10000.0	.00	44.
3000.	54.79	6	1.0	1.0	10000.0	.00	45.
3500.	48.31	6	1.0	1.0	10000.0	.00	45.
4000.	43.05	6	1.0	1.0	10000.0	.00	44.
4500.	38.66	6	1.0	1.0	10000.0	.00	44.

5000.	34.93	6	1.0	1.0	10000.0	.00	45.
5500.	31.74	6	1.0	1.0	10000.0	.00	45.
6000.	28.98	6	1.0	1.0	10000.0	.00	45.
6500.	26.60	6	1.0	1.0	10000.0	.00	45.
7000.	24.52	6	1.0	1.0	10000.0	.00	44.
7500.	22.76	6	1.0	1.0	10000.0	.00	45.
8000.	21.21	6	1.0	1.0	10000.0	.00	44.
8500.	19.82	6	1.0	1.0	10000.0	.00	42.
9000.	18.58	6	1.0	1.0	10000.0	.00	43.
9500.	17.47	6	1.0	1.0	10000.0	.00	44.
10000.	16.46	6	1.0	1.0	10000.0	.00	45.

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 1. M:

308.	367.0	6	1.0	1.0	10000.0	00	45.

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*** SUMMARY OF SCREEN MODEL RESULTS ***
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CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
SIMPLE TERRAIN	367.0	308.	0.

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** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
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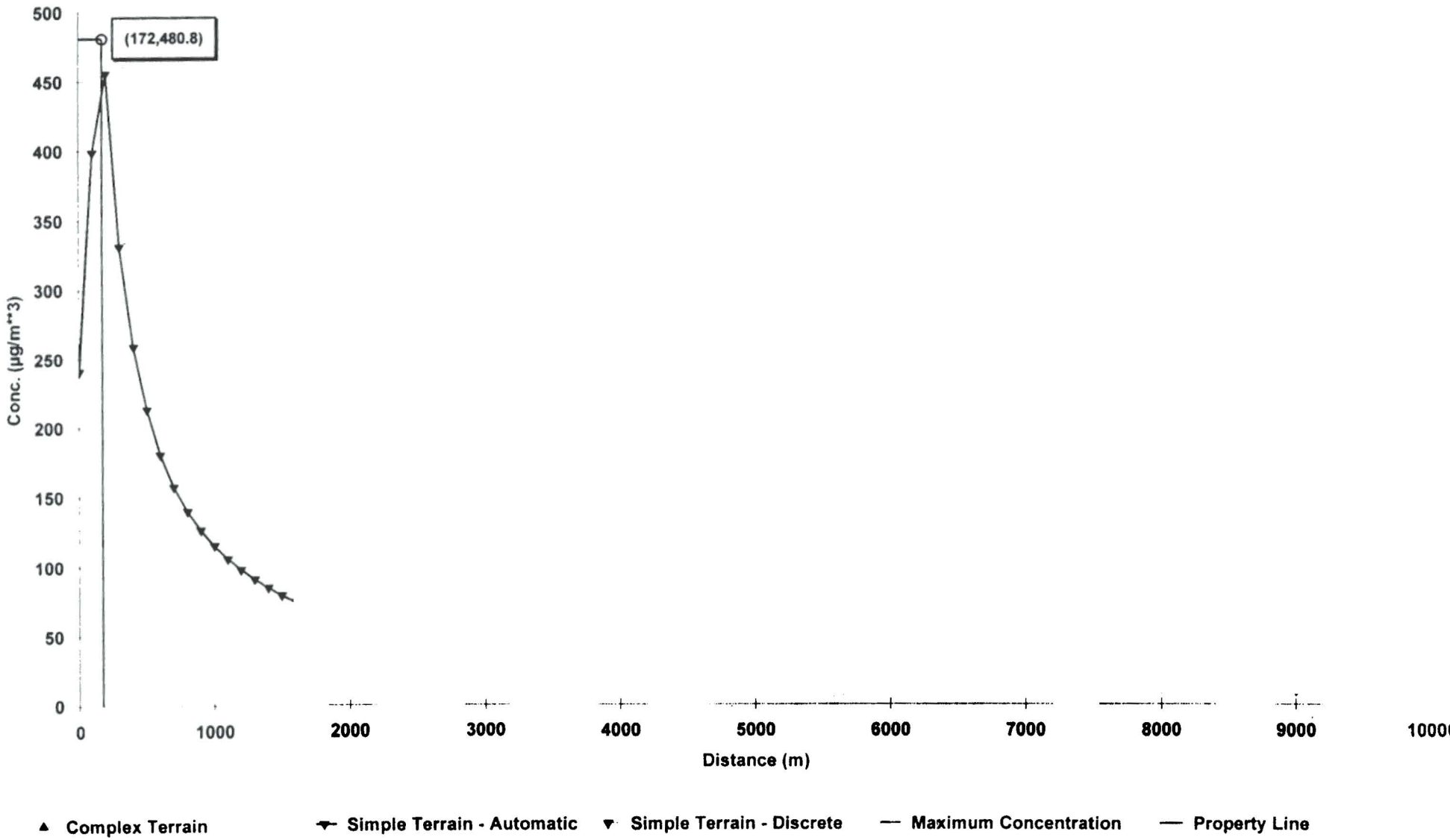
CEDAR 10 ACRE SITE