El Dorado Chemical Company
Human Health and Ecological Groundwater Risk Assessment

August 8, 2007

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Prepared for:

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List of Acronyms

ADEQ	Arkansas Department of Environmental Quality
ADNH	Arkansas Department of Natural Heritage
AOI	Area of Interest
ATSDR	Agency for Toxic Substances and Disease Control
bgs	Below Ground Surface
CAO	Consent Administrative Order
CAST	Center for Advancement Spatial Technologies
CDC	Center for Disease Control
CL	Clay
cm/sec	Centimeters per second
COPC	Constituents of Potential Concern
Cr	Chromium
CTE	Central Tendency Exposure
DI	Daily Intake
DGEU	Downgradient Exposure Unit
ECMW	El Dorado Chemical Monitoring Well
EDCC	El Dorado Chemical Company
EMS	Environmental Management Systems
EPC	Exposure Point Concentration
ER	Environmental Risk
ERA	Ecological Risk Assessment
EU	Exposure Unit
GCP	Gulf Coastal Plain
GGH	Grubbs, Garner, & Hoskyns
GMWP	Groundwater Monitoring Work Plan
gpd	Gallons per day
GWU	Ground Water Unit
HEAST	Health Effects assessment Summary Table
HHRA	Human Health Risk Assessment
HI	Hazard Index
HNO_3	Nitric Acid
HQ	Hazard Quotient
IE	Table E.6
IEUBK	Integrated Exposure Uptake Biokinetic
km^2	Square kilometers
KT	Kaltenbach Thuring
LOAEL	Lowest Observed Adverse Effect Level
MDL	Method Detection Level
MGEU	Midgradient Exposure Unit
mi^2	square miles
mg/kg	Milligram per kilogram
mg/L	Milligram per Liter
mg/m^3	Milligram per cubic meter
MRL	Minimum Risk Level
MSL	Mean Sea Level
MW	Monitoring Well
NCEA	National Center for Environmental Assessment
NH_3	Ammonia

List of Acronyms (cont.)

NOAEL	No Observed Adverse Effect Level
OOW	Ozark Ordinance Works
PEU	Production Exposure Unit
Pop/Comm	Population and Community Demographics
POR	Period of Record
ppm	Parts per million
RA	Risk Assessment
RAGS	Risk Assessment Guidance for Superfund
RAP	Remedial Action Plan
RBA	Relative Bioavailability
RBC	Risk Based Concentration
RfD	Reference Dose, reference dose per day
RME	Reasonable Maximum Exposure
SC	Silt
SIC	Industrial Classification
SSTT	Site Specific Toxicity Test
TBV	Toxicity Benchmark Value
TDS	Total Dissolved Solids
TMDL	Total Daily Maximum Load
TNT	Tri-nitro-toluene
UCL	Upper Confidence Level
UGEU	Upgradient Exposure Unit
USEPA	Untied States Environmental Protection Agency
UTA	Unnamed Tributary A
UTB	Unnamed Tributary B
UTC	Unnamed Tributary C
VOC	Volatile Organic Carbon
ug/L	microgram per liter

EXECUTIVE SUMMARY

A. Overview of Critical Findings

The El Dorado Chemical Company (EDCC) risk assessment (RA) determined that there are no current receptors for site groundwater, therefore there are no current risks associated with the groundwater.

Since there are no current receptors, the following risk assessment was completed with the focus of identifying appropriate end-points that could be developed to protect hypothetical future receptors. Based on this approach, the receptor for the human health risk is the potential offsite residential user. As proposed herein an appropriate monitoring/remedial action end-point is to monitor the groundwater at the EDCC property boundary to verify that the EDCC chemicals of potential concern (COPC's) do not exceed established monitoring endpoints and/or migrate offsite.

The hypothetical ecological risk receptors are identified as aquatic communities that might be exposed in site surface water tributaries should the groundwater become surface water and terrestrial vertebrate which might consume groundwater which has the potential to become surface water. This assessment based on the hypothetical exposure demonstrates that even should exposure occur, it is not likely that the ecological receptors (community level) would be at risk.

Prior to the completion of this risk assessment EDCC implemented activities to recover potentially contaminated groundwater. This process included the development and implementation of two (2) groundwater recovery wells. These recovery wells have been in operation since November 2006. Although, not discussed in this RA, the results of the groundwater recovery is reflected by data collected during December 2006 and the first six-months of 2007 (EDCC, personal communication).

The continued operation of these recovery wells, along with other site improvements, should be reflected in midgradient and downgradient wells with time. The on-going groundwater recovery efforts will be combined with continued monitoring to track groundwater COPC's and prevent the potential exposure scenario detailed within the RA.

The following observations summarize the critical issues related to the human health and ecological risk assessments (ERA) for groundwater potentially impacted by industrial activity at EDCC.

1. This human health and ecological risk assessment has determined there are no documented completed receptor pathways regarding groundwater at the EDCC site. The absence of documented completed exposure pathways signifies no on or offsite human health or ecological risks associated with groundwater at the EDCC site. As such, only hypothetical exposures were evaluated.

2. This risk assessment has been conducted to comply with requirements of Consent Administrative Order (CAO) LIS #06-153.

3. The purpose of this assessment is to identify if human health and ecological risks exist, and if so, ensure they are addressed in the Remedial Action Plan (RAP) for potentially impacted groundwater at EDCC.

4. The risk assessment is focused on risk associated with groundwater and the list of constituents included in the assessment was based on the semiannual sampling parameters required by the CAO. The constituents addressed in the risk assessment included: nitrate, sulfate, ammonia, total dissolved solids (TDS), pH, total and dissolved lead, total and dissolved chromium, and total and dissolved vanadium.

5. The risk assessment was based on available groundwater monitoring data from 2001 to 2006 and quality assurance of the database was completed prior to conducting statistical analysis.

6. Selection of COPC was based on the statistical analysis of the data. The statistical analysis revealed that statistically significant differences existed between the upgradient well group and selected downgradient wells for ammonia, total chromium, total lead, nitrate, sulfate, pH, and TDS.

7. Groundwater at the EDCC facility was delineated into four primary areas to evaluate hypothetical exposure. The exposure areas (or units) were based on the historical groundwater monitoring well data and grouping of well locations. The groundwater units include the following: Upgradient Unit, Production Unit, Midgradient Unit, and Downgradient Unit.

8. Currently, none of the groundwater units actually present a completed exposure pathway with EDCC site groundwater and on-site/offsite receptors (either human or ecological).

9. The potential exposure pathways judged to be of potential concern to human health included groundwater ingestion and inhalation due to hypothetical use by offsite residents at the EDCC property boundary. This pathway would only be completed should the potentially contaminated groundwater migrate offsite, which has not been documented. The 2001-2006 groundwater data does not implicate offsite migration. In addition, the interim measures implemented by EDCC (groundwater recovery wells) are likely to further reduce the potential for the pathway to be completed. Therefore, although the potential pathway is evaluated to assess the potential risk, this hypothetical exposure is considered very unlikely to occur and the risks should be viewed as very conservative given the above conditions.

10. Based on the hypothetical exposure, the human health risk assessment (HHRA) identified ammonia as the constituent that may need to be addressed in the RAP.

11. Based on the hypothetical exposure, a preliminary groundwater target for ammonia is presented based on the potential risk associated with offsite residents should they be exposed to potentially contaminated groundwater. The target for ammonia is 0.55 mg/L at the property boundary.

12. Although there is no current completed exposure pathway, monitoring the groundwater at the property line to document that the groundwater has not migrated and that any ammonia target concentration based on the hypothetical exposure would provide appropriate monitoring and /or remedial action.

13. There is no documentation of a connection between groundwater and surface waters at the site. Data from other studies shows no impairment of the site surface waters when compared to an upstream reference condition, supporting the conclusion of no significant nexus with groundwater. Nevertheless, the

ecological risk was assessed as though groundwater and surface waters are connected or that there may be a future nexus.

14. The ERA identified nitrate and ammonia as constituents that could pose risk based on hypothetical exposure should groundwater become surface water. However, since no connection between groundwater and surface water exist, the hypothetical risk is considered acceptable. All other COPCs, except lead, were determined to not present an ecological risk.

15. The risks associated with lead could not be addressed effectively due to the elevated method detection level (MDL) of the monitoring data. Therefore, future lead monitoring should include an MDL consistent with the toxicity benchmark values (TBV) utilized in the ERA.

16. Groundwater recovery wells have already been installed by EDCC and levels of COPC's are anticipated to remain stable and/or decrease over time.

17. Using an adaptive management approach, groundwater ammonia will be evaluated over time to determine if preliminary targets and remediation goals to be determined in the RAP are being attained.

B. Purpose

This document presents the results of the human health and ERAs for groundwater potentially impacted by industrial activity at EDCC.

The protection of human health and the environment is the primary goal of regulatory requirements for cleanup and corrective action. A risk assessment can contribute significantly to strategy development, risk management, and evaluation of corrective action needs. The purpose of this document is to identify human health and ecological risks to be addressed in the RAP for potentially impacted groundwater at EDCC. The objectives of the risk assessment include:

a) Identification of the COPC related to site activities,
b) Determination of whether concentrations of COPC occur at concentrations that possibly pose unacceptable risk to human receptors,

c) Determination of whether concentrations of COPC occur at concentrations that possibly pose unacceptable risk to ecological receptors, and
d) Identify risks to be addressed in the RAP and establish preliminary monitoring and/or remediation endpoints based on available and current data.

C. Facility Information

EDCC manufactures basic agricultural chemicals, including sulfuric acid, nitric acid, low-density and high-density ammonium nitrate prills used in fertilizers and explosives, and industrial grade ammonium nitrate solution. Ammonia used to produce nitric acid and ammonium nitrate is received at the plant site via underground pipeline owned by SCA. Elemental sulfur used to produce sulfuric acid is received in trucks from Lion Oil Company. The facility is located at 4500 North West Avenue in El Dorado, Union County, Arkansas. The Plant is located on a total area of approximately 1,300 acres and the manufacturing area covers approximately 150 acres.

D. Geology and Hydrogeology

The EDCC facility is located west of the Mississippi Embayment in the Gulf Coastal Plain ecoregion. Sediments in Union County are within the Claiborne Group and characterized by a thick sequence of unconsolidated, relatively young sediments that are fluvial-deltaic in origin and Tertiary in age. In some areas of Union County younger unconsolidated alluvial and terrace deposits that are Quaternary in age overlay the Tertiary sediments.

The Claiborne Group hydrogeologic formations consist of, in ascending order, the Cane River Formation, Sparta Sand, Cook Mountain Formation, and Cockfield Formation. Within the Claiborne Group, two units crop out in Union County, the Cook Mountain Formation and the Cockfield Formation. The Cook Mountain is overlain by the Cockfield Formation. The Cook Mountain is uniformly underlain by the Sparta Formation. The Cook Mountain is 50 to 200 feet thick and is composed of clay and silty clay containing minor amounts of localized very fine to silty sand. These clays serve as a confining unit between the more permeable overlying Cockfield Formation and the underlying aquifer.

The Cockfield Formation, locally referred to as the “lignite sand”, is generally characterized by fine sand, interbedded silty clay and lignite becoming more massive and containing less silt and clay with depth. Previous site investigations determined that the Cockfield Formation at the EDCC site consists of interbedded sand, silty sand, silt and clay, with more clay in the northern area of the property and more sand to the south.

E. Ecological Setting

The City of El Dorado and Union County, Arkansas are situated within what is known as the Gulf Coastal Plain ecoregion. The facility is located atop a watershed divide and storm waters are drained to both the north and south into unnamed tributaries of Flat Creek. Terrestrial habitats and species composition on the EDCC manufacturing area have not been surveyed. The industrial nature of the existing production groundwater unit precludes the existence of a high-quality terrestrial habitat. The surrounding undeveloped areas within the EDCC facility are vegetated, relatively undisturbed, and provide habitat for terrestrial flora and fauna.

The aquatic habitats have been evaluated in connection with previous surface water quality investigations. None of these investigations have documented a groundwater connection (e.g. nexus) to surface water. Flows in the unnamed tributaries that drain the EDCC facility reflect the dependence on the discharge from NPDES permitted discharges. The small watersheds of the unnamed tributaries to Flat creek limit the development of the aquatic biotic communities. The previous investigations have documented that the fish community reflects limited development related only to sustainable habitat (i.e., summer low flow conditions). In addition, there has been no unique, threatened or endangered species identified in any of the previous investigations.

Information provided by the Arkansas Department of Natural Heritage (ADNH) confirms that there are no rare plants and/or animals, outstanding natural communities, natural or scenic rivers, or other elements of special concern near the EDCC facility. ADNH confirmed that none of these elements occur within a mile of the facility. Additionally, no natural community or other special elements were noted to exist within five miles of the EDCC facility.

F. Previous Investigations

Previous hydrogeologic investigations have been completed at the EDCC facility and have focused on shallow groundwater conditions at separate locations within the facility. In general, these investigations confirm the information provided in this risk assessment regarding shallow groundwater as given in the preceding discussion of regional geologic and hydrogeologic settings. These previous subsurface investigations provide information that characterizes the shallow saturated zone, groundwater flow, and contaminants of potential concern in the shallow groundwater.

EDCC has also completed other surface water quality studies. The previous surface water quality investigations support the conclusion there is no nexus between groundwater and surface water at the site.

G. Groundwater Data and Chemicals of Potential Concern

A database of groundwater data for each of the constituents listed in the CAO from 2001 to 2006 was compiled and analyzed. Groundwater data collected from 22 monitoring wells (3 upgradient and 19 downgradient) were compiled in the database. Statistical analysis of the groundwater data was completed using the computer programs Excel® and Systat® (or Sigmastat®). Upgradient (background) wells were grouped (ECMW1-ECMW3) for analysis while each downgradient well was analyzed individually. The analysis revealed that statistically significant differences existed between the upgradient well group and selected downgradient wells for ammonia, total chromium, total lead, nitrate, sulfate, pH, and TDS. Since at least some downgradient wells had elevated levels for these constituents each of these constituents were retained as COPC. Total lead was retained as a COPC however, the MDL for lead was in excess of the ecological screening level, so quantitative evaluation of ecological risk will be limited.

None of the monitoring wells revealed statistically significant differences for dissolved chromium, dissolved lead, dissolved vanadium or total vanadium. Therefore, each of these constituents was removed from the list of COPC resulting in ammonia, total chromium, total lead, nitrate, sulfate, pH and TDS remaining for further risk assessment.

H. Groundwater Units

Based on the historical groundwater data, the EDCC facility can be delineated into four units that have similar groundwater characteristics. These areas can be delineated by relative density of industrial activities and includes the following associated areas or units: Upgradient Unit, Production Unit, Midgradient Unit, and Downgradient Unit. Point concentrations were developed for each COPC for each groundwater unit. Statistical analysis was completed for the El Dorado Chemical Monitoring Wells (ECMW) data in each groundwater unit in order to develop 95% upper confidence levels (UCL) for the arithmetic mean of the data. The resulting 95% UCL for each constituent will be used as point concentrations for assessment of risk related to potential exposure to groundwater and surface water.

Groundwater Area (Units)	Description	Well #'s
Upgradient Unit	Wells upgradient of facility influences, representing natural background groundwater quality.	ECMW 1-3
Production Unit	Wells located in the most concentrated area of industrial activities at the facility and generally representing the highest potential groundwater contamination.	ECMW 4-11
Midgradient Unit	Wells located near the wastewater treatment ponds and representing a lower level of industrial activity.	ECMW 14-16
Downgradient Unit	Wells near the property line of the facility, Downgradient of industrial activities, and representative of the groundwater quality that could potentially be leaving the site.	ECMW 17-22

I. Human Health Risk Assessment

The exposure assessment provides an evaluation of exposure pathways that could lead to human contact with site-related contaminants from the groundwater should the site groundwater migrate offsite, identifies COPC's in the groundwater, and describes the methods used to evaluate potential exposure from each pathway that is considered to be of possible significance. The COPC's evaluated in this HHRA include ammonia, total chromium, total lead, and nitrate. Although pH, sulfate, and TDS were identified as COPC's, sufficient information regarding human health affects related to these compounds is not available. Therefore, pH, sulfide, and TDS were not included in the HHRA.

I.1 Site Conceptual Model

A site conceptual model is included in the risk assessment report that shows the potential exposure pathways and exposure scenarios. Study of the site has determined that there are no current completed exposure pathways. At present, the facility is used for industrial operations under the direct control of EDCC. Because of the heavy industrial nature of the site, it is considered very probable that this land use will not change in the future. Available information and the historical groundwater data indicates that site related contaminants have not migrated to offsite locations and currently the potential for exposure to offsite residential populations does not exist. The recent addition of interim control measures implemented by EDCC (groundwater recovery wells) will further reduce the potential for offsite migration and therefore further reduce any potential for offsite exposure. However, human health risks can be assessed hypothetically for potential exposure to offsite residential populations should the site groundwater migrate offsite and be used by residents.

I.2 Potential Exposure Scenarios

At present, there are no on-site wells in the shallow aquifer that are used as a source of drinking water, so exposure of workers to groundwater is not currently of concern. It is not considered likely that any onsite drinking water wells will ever be installed in the shallow aquifer in the future and EDCC will restrict access to groundwater at the site. Therefore, the production groundwater unit is not of concern in this risk assessment. Offsite groundwater wells are not installed in the shallow aquifer and installation of drinking water wells at offsite locations in the shallow aquifer is not likely in the future due to the availability of municipal water provided by the City of El Dorado and availability of groundwater from the deeper Sparta aquifer. Though offsite groundwater wells do not exist and are not anticipated to be installed in the future, the potential was assumed to exist hypothetically for the assessment of risks. Thus, potential exposure is limited to hypothetical offsite receptors. Therefore, the pathways evaluated for risk evaluation include the following:

1. Ingestion of groundwater by offsite residents, and
2. Inhalation due to groundwater use by offsite residents.

The groundwater units that will be evaluated to represent the hypothetical offsite point concentrations are the Midgradient Unit and the Downgradient Unit.

Other exposure pathways are judged to be sufficiently minor that further evaluation is not warranted.

I.3 Point Concentrations

Because of the assumption of random exposure over an exposure area, risk from a chemical is related to the arithmetic mean concentration of that chemical averaged over the entire groundwater unit. Since the true arithmetic mean concentration cannot be calculated with certainty from a limited number of measurements, the USEPA recommends that the 95th percentile upper confidence limit (UCL) of the arithmetic mean at each hypothetical point be used when calculating exposure and estimating the potential risk at that location (USEPA, 1992). The point concentrations of nitrate, ammonia, total lead, and total chromium in the groundwater to be used in the risk assessment evaluation are shown in the Table E-1.

Table E-1. Groundwater point concentrations based on 95th percentile UCL.

Groundwater Assessment Units	Nitrate (mg/L)	Ammonia (mg/L)	Total Lead (mg/L)	Total Chromium (mg/L)
Upgradient Unit (background)	1.48	0.549	0.020	0.021
Midgradient Unit	39.2	3.64	0.021	0.020
Downgradient Unit	33.6	1.50	0.032	0.063

Point concentration for volatile compounds in indoor air of offsite residential buildings due to water use are based on groundwater concentrations. Ammonia is the only volatile compound of potential concern. The calculations utilized to determine the point concentration of ammonia due to water use are based on volatilization from water used in showers and are shown in the Table E-2.

Table E-2. Ammonia point concentrations for inhalation (based on 95th percentile UCL groundwater concentrations).

Groundwater Assessment Units	Acute Ammonia Air Concentration (based on water use)		Chronic Ammonia Air Concentration (based on water use)	
	(mg/m^3)	(ppm)	(mg/m^3)	(ppm)
Upgradient Unit (background)	1.1	1.6	0.030	0.043
Midgradient Unit	7.3	11	0.18	0.27
Downgradient Unit	3.0	4.3	0.077	0.11

I.4 Toxicity Assessment

The basic objective of a toxicity assessment is to identify what adverse health effects a chemical causes, and how the appearance of these adverse effects depends on exposure level. Nitrate, ammonia, and chromium were evaluated based on the non-cancer health effects associated with point concentrations at the site. In characterizing the non-cancer effects of a chemical, the key parameter is the threshold dose at which an adverse effect first becomes evident. Doses below the threshold are considered to be safe, while doses above the threshold are likely to cause an effect.

The threshold dose is typically estimated from toxicological data (derived from studies of humans and/or animals) by finding the highest dose that does not produce an observable adverse effect, and the lowest dose which does produce an effect. Non-cancer risk evaluations are based on a value referred to as the Reference Dose (RfD). The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. The point concentrations for nitrate and chromium were compared to RfD values.

However, the point concentrations for ammonia were compared to both an acute and a chronic minimum risk level (MRL) associated with inhalation exposure. The toxicity values (e.g., RfD, MRL, etc.) for nitrate, chromium VI, (the most toxic form of chromium) and ammonia are shown in the Table E-3.

Table E-3. Toxicity values for evaluation of human health risks.

Toxicity Parameter	**Ammonia**	**Chromium VI**	**Nitrate**	**Source**
RfDo (mg/kg-day)	NA	0.003	1.6	Region 6 HHMSSL 2007 and IRIS
Tap Water (mg/L)	0.210	0.110	58	Region 3 RBC
Acute Inhalation MRL (ppm)	1.7	NA	NA	ATSDR Tox. Profile Ammonia
Chronic Inhalation MRL (ppm)	0.1	NA	NA	ATSDR Tox. Profile Ammonia

NA – Not Applicable
MRL – Minimum Risk Level

Since there are no USEPA-approved RfD values for lead, it is not possible to evaluate the non-cancer toxic risks of lead by calculation of a Hazard Index. An alternative approach is to estimate the likely effect of lead exposure on the concentration of lead in the blood of children using the Integrated Exposure Uptake Biokinetic (IEUBK) model. The IEUBK model can be used in a risk assessment to assess potential chronic exposures of children receptors to lead.

I.5 Risk Characterization

For most chemicals, the potential for non-cancer effects is evaluated by comparing the estimated daily intake of the chemical over a specific time period with the RfD for that chemical derived for a similar exposed period. If the Hazard Quotient (HQ) for a chemical is equal to or less than one (1), it is believed that there is no appreciable risk that non-cancer health effects will occur. Non-cancer effects from residential water consumption has been evaluated using the following equations from USEPA Risk Assessment Guidance for Superfund (RAGS):

Residential Water – Non-cancer Effects

$$THI = \frac{EF \times ED \times C \times \left[\left({}^{1}\!/_{RfDo} \right) \times IRw + \left({}^{1}\!/_{RfDi} \right) \times K \times IRa \right]}{BW \times AT \times 365 day/yr}$$

where:

C = chemical concentration in water (mg/L)
THI = Target Hazard Index (unitless)
RfDo = oral chronic reference dose (mg/kg-day), chemical specific value
RfDi = inhalation chronic reference dose (mg/kg-day), chemical specific value
BW = adult body weight (kg), default value 70
AT = averaging time (yr), default value 30
EF = exposure frequency (days/yr), default value 350
ED = exposure duration (yr), default value 30
IRa = daily indoor inhalation rate (m3/day), default value 15
IRw = daily water ingestion rate (L/day), default value 2
K = volatilization factor (unitless), default value 0.5

I.5.a. Nitrate and Chromium

The risks associated with nitrate and chromium VI for residential water consumption are summarized in the Table E-4. Since the risk from chromium VI resulted in a hazard index less than 1.0 for each of the groundwater units, chromium VI was not retained as a COPC. The risks from nitrate resulted in a hazard index of less than 1.0 for each groundwater unit assessed. Therefore, no appreciable risk to offsite receptors is associated with nitrate.

Table E-4. Calculated Hazard Index for Nitrate and Chromium VI.

Groundwater unit	Parameter	Concentration (mg/L)	Hazard Index
Upgradient Unit	Nitrate	1.5	0.025
	Cr VI	0.0035	0.032
Midgradient Unit	Nitrate	39.2	0.67
	Cr VI	0.0033	0.030
Downgradient Unit	Nitrate	35.6	0.61
	Cr VI	0.0105	0.096

Nitrate RfDo = 1.6 mg/kg-day
Cr VI RfDo = 0.003 mg/kg-day
C (mg/L) = concentration represents 95^{th} percentile upper confidence limit
Cr VI concentration is based on ratio of 1/6 for Cr VI/Total Cr

I.5.b. Ammonia

The hypothetical point concentration for ammonia was calculated for both acute and chronic exposure based on residential water use in a shower should the site groundwater migrate to and be used by an offsite residential well. Table E-2 summarizes the results of the inhalation exposure for each groundwater unit. The inhalation exposure calculated for the upgradient unit (background) is below both the acute and chronic MRLs. The inhalation exposure calculated for the production unit, Midgradient Unit and Downgradient Unit exceed both the acute and chronic

MRLs. However there are no currently completed exposure pathways for offsite groundwater, eliminating the current potential human health risks associated with ammonia in the groundwater.

I.5.c. Lead

The IEUBK model was used in the risk assessment to assess potential chronic exposures of children receptors to lead in groundwater. The groundwater concentration was set at the 32 µg/L, which is the 95th percentile UCL concentration for the downgradient area and was the highest 95th percentile UCL concentration of any of the areas of concern. The modeling performed for the risk assessment produced a probability function that predicted the likelihood of elevated blood lead concentrations in hypothetical future child offsite residents. In the case of potential exposure to lead, using available data and certain assumptions, the estimate of the percentage of child residents expected to have blood lead concentration levels in excess of the 10 ug/dL criterion established by Center for Disease Control (CDC) was less than five percent. Since the risk from lead was determined to be less than the five percent, lead was not retained as a COPC.

I.6 Preliminary Groundwater Targets

Based on the risk estimates for offsite residents, only ammonia poses any level of risk for which groundwater should be monitored to achieve reasonable targets.

I.6.a. Ammonia

An appropriate groundwater target for ammonia at the EDCC property boundary would be 0.55 mg/L, which would be equivalent to approximately the upgradient concentration of ammonia in groundwater. This target is above the tap water concentration of 0.21 mg/L established in the USEPA Region 3 Risk based Concentrations (RBC). However, since the upgradient concentration of ammonia is already greater than the tap water level, the target provides a goal that is potentially attainable. In addition, the upgradient groundwater concentration of ammonia meets the acute and chronic MRLs.

J. Ecological Risk Assessment

This ERA was performed in accordance with current United States Environmental Protection Agency (USEPA) guidance for ERA (USEPA 1992, 1997a, 1998). The initial screening level evaluation concluded that risks from site-related contaminants could be excluded from the ecological receptors as long as surface connections were prevented via groundwater controls and /or the COPC's are not present in concentrations which present ecological risks.

There has been no documentation of EDCC site groundwater connections to the surface waters through spring seeps and/or surface upwelling. Recent interim action by EDCC (groundwater recovery wells) provide groundwater controls that further reduces the probability that the groundwater will become surface waters in the future. However, other site regulatory requirements related to surface water discharges (both non-contact and storm waters) have required documentation of the condition of unnamed receiving streams into which EDCC discharges. These unnamed tributaries traverse the groundwater units identified in Section H. above. This report utilizes the historical data to evaluate the potential ecological risk for the site as may be impacted by groundwater should it become surface waters in the future.

J.1 Baseline ERA Site Conceptual Model

The site conceptual model (SCM) for the baseline ERA noted that there is no documented connection between the contaminated groundwater and the ecological endpoints considered, thus no completed exposure pathways. However, potential hypothetical pathways were included in the theoretical approach taken in developing the ERA; this site model is very similar to the site model that was developed for the HHRA.

J.2 Exposure Pathways and Receptors

Receptors identified for this assessment include aquatic receptors (fish and benthic macroinvertebrates), and wildlife receptors (avian and mammalian). The following identifies which potential pathways are of concern at this site and which were selected for quantitative evaluation. The potential pathways are believed to be hypothetical only, therefore any risk calculations based on these pathways should be considered improbable and very conservative.

Aquatic Receptors

The main pathway of exposure for all aquatic receptors is direct contact with surface water only in the event that groundwater seeps into the surface water. The aquatic receptors are those biotic communities that are maintained in the unnamed tributaries of Flat Creek. Although the surface waters traverse the groundwater units, there is no documented nexus between groundwater and surface water at the EDCC site despite over 60 years of industrial activity on the site. Therefore, the ERA is completed based on the hypothetical scenario that, in spite of the groundwater controls, the site ground water develops a surface water connection. Nevertheless, this potential pathway was evaluated qualitatively for fish and benthic macro invertebrates.

Wildlife Receptors

The main pathway of exposure for all wildlife receptors is direct contact with surface water only in the event that groundwater becomes surface water. The following potential exposure pathways were considered in the ERA:

- Wildlife receptors (birds, mammals) may be exposed by ingestion of surface water, contaminated by potential groundwater intrusion (which has not been documented) and this pathway was evaluated quantitatively.
- Wildlife receptors (birds, mammals) may also be exposed by ingestion of food web items and or sediment/soil. However, since the baseline ERA was completed based on groundwater data, and since these exposure pathways are not complete, they were not explored as part of this baseline ERA.
- Inhalation exposure may be possible for all terrestrial receptors. However, this pathway is generally very minor, and was not evaluated.

Terrestrial Plants and Soil Invertebrates

The primary exposure pathway for both terrestrial plants and soil invertebrates is direct contact with contaminated groundwater. No data was available for plants or soil contaminant levels, therefore this pathway was not evaluated.

J.3 Assessment and Measurement Endpoints

Although there are no documented exposure pathways, the assessment and measurement endpoints are used to interpret potential ecological risks for the EDCC site. These measurement endpoints can be divided into three basic categories of approach, as follows:

- Hazard Quotients (HQs)
- Site-specific toxicity tests (SSTTs)
- Observations of population and community demographics (Pop/Comm. Dem.)

A HQ is the ratio of the estimated exposure of a receptor at the site to a "benchmark" exposure that is believed to be without significant risk of unacceptable adverse effect:

HQ = Exposure / Benchmark

Exposure may be expressed in a variety of ways, including concentration in an environmental medium (water, sediment, soil, diet), concentration in the tissues of an exposed receptor, or amount of chemical ingested by a receptor. In all cases, the benchmark toxicity value must be of the same type as the exposure estimate.

If the value of an HQ is less than or equal to 1.0, risk of unacceptable adverse effects in the exposed individual is judged to be acceptable. If the HQ exceeds 1.0, the risk of adverse effect in the exposed individual is of potential concern. When interpreting HQ results for ecological receptors, it is important to remember that the assessment endpoint is usually based on the sustainability of exposed populations, and risks to some individuals in a population may be acceptable if the population is expected to remain healthy and stable.

J.4 COPC Selection

Because the toxicity of COPCs in surface water to aquatic receptors is usually dependent on the length of exposure, the HQ was calculated both for short-term (acute) and long-term (chronic) exposure conditions for COPC with chronic HQ in excess of 1.0. For those COPC with chronic HQ ≤1, only chronic HQ were calculated (acute HQ’s were not calculated). In cases where the acute and chronic benchmarks are hardness-dependent, toxicity benchmarks were calculated for each sample based on the average ecoregion hardness (31 *mg/L).*

The detailed calculations of HQ values for each COPC in each sample are presented, along with graphs which summarize the distributions of HQ values for samples collected at each monitoring well (i.e., groundwater unit). A summary of the HQ's > 1.0 are presented in Table E-5.

Table E-5. Summary of aquatic life HQ>1.0.

	Groundwater Unit			
COPC	**Upgradient Unit**	**Production Unit**	**Midgradient Unit**	**Downgradient Unit**
Ammonia Acute	--	1.11	--	--
Ammonia Chronic	--	23.87	1.42	--
Total Chromium Acute	--	--	--	--
Total Chromium Chronic	--	--	--	--
Total Lead Acute	1.11	1.11	1.17	1.78
Total Lead Chronic	28.57	28.57	30.00	45.71
Nitrate	--	7.39	--	--
Sulfate	--	3.92	--	--
TDS	--	5.55	1.05	1.20

The population-level risk in each groundwater unit was classified into one of three risk categories based on the fraction of the HQ distribution above a value of 1.0. These results are summarized in report Table 6.4. Each COPC was then assigned a category (A,B,C) based on their HQ. (Table E.6)

Based on the aquatic life benchmarks, only, total chromium was assigned to risk category C for all groundwater units. Total chromium was treated as hexavalent chromium which is the more toxic form of the metal. According to USEPA Region 6 risk assessment screening levels, chromium can be assumed to speciate at a 1:6 ratio of hexavalent to trivalent chromium. When treated in this fashion total chromium HQ were all ≤ 1.0 placing it in the category C designation. Therefore, risks to the population from chromium in all the groundwater units are expected to be minimal and are assumed to be acceptable.

Based on chronic benchmark several inorganic COPCs (including ammonia, nitrate, sulfate, and TDS) are initially assigned to risk category A from one or more of the groundwater units.

Lead is assigned to a Category B. The lead HQ's were largely based on non-detect values which were elevated above the TBV. In addition, risks in the upgradient unit (i.e. reference areas) are approximately the same as in all other groundwater units potentially impacted should aquatic receptors be exposed to the site groundwater.

In the case of sulfate and TDS, available toxicity data indicates that lowest observed adverse effect level (LOAEL's) are much higher than the bench marks (conservative no observed adverse effect level (NOAEL)) used by ADEQ, it is concluded that the chronic toxicity benchmarks for these chemicals are probably overly-conservative for application at this site and that chronic risks from these inorganic COPCs in surface water are not likely to be of population level concern to aquatic receptors. Therefore sulfate and TDS are assigned to the B category.

Table E.6. Summary of conclusions drawn concerning risk to aquatic receptors.

Risk Category	Distribution of HQ values	Preliminary Conclusion	COPC	Groundwater Unit
A	Greater than 20% of HQs based on detects exceed 1.	Risks to the population at this location are possible.	Ammonia	Production & Midgradient
			Nitrate	Production
B	There are at least 20% of the HQs greater than 1, but these are partly or entirely based on non-detects or the TBV were unavailable or unreliable. The method detection limit was inadequate to quantify risk.	Risk to the population at this location cannot be determined, but at background and believed minimal.	Total Lead Sulfate and TDS	All Units Production Production, Midgradient and Downgradient
C	Greater than 80% of all HQs (based on non- detects and detects) are below 1.	Risks to the population at this location are expected to be minimal and are assumed to be acceptable.	Ammonia	Downgradient
			Total Chromium	ALL
			Nitrate	Upgradient, Midgradient,& Downgradient
			Total Vanadium	ALL
			Sulfate	Upgradient, Midgradient,& Downgradient
			TDS	Upgradient, Midgradient, & Downgradient

One way to help reduce the uncertainty associated with HQ values based on TBV is to perform direct toxicity testing using site-specific media, in this case, groundwater samples. Tests of this type have not been performed on site groundwaters. However, the analytical chemistry of groundwater monitoring has demonstrated that the pH of the groundwaters from all units are well below 6 SU. It is anticipated that should toxicity tests be performed, the toxicity tests would demonstrate a significant difference in the groundwater and lab control water exposures. The low pH would present toxicity to routine test organisms and limit the ability of the test to measure potential toxicity from other COPC. However, since no surface waters on the EDCC property are known to flow from springs only, it is unlikely that exposure to such low pH could occur.

J.5 Evaluation of Aquatic Community Bioassessments

Groundwater quality is not typically associated with surface aquatic ecosystem health. However, the potential effects of chemical stressors in groundwater on surface water biotic communities can be assessed hypothetically by direct observation of the density and diversity of species present in the receiving streams. Observations on the benthic and fish community structure in surface water on the EDCC site are available from numerous studies not associated with the groundwater investigations.

Each of the reports concluded that the existing beneficial fishery uses were being maintained and that the benthic communities did not appear significantly different at any site location in comparison to the upstream reference location community.

J.6 Weight of Evidence Conclusions

Three lines of evidence are available to evaluate risks from groundwaters which may be transformed to surface waters. The findings from these lines of evidence are summarized below in Table E-7.

Table E-7 Summary of lines of evidence for risk associated with groundwater as surface water

Line of Evidence	Findings
HQ Calculations	Based on COPC concentrations and TBV, risks to biotic stream organisms from COPC in surface water do not appear to be of population-level concern except possibly for ammonia and nitrate in the Production Unit groundwater.
Direct Toxicity Testing	There is no toxicity data related to the groundwater from any of the EDCC groundwater units.
Population Observations	No evidence of adverse effect on the aquatic communities in the unnamed tributaries that drain the EDCC facility.
and related site Conditions	No pathway for groundwater to enter surface water is known to exist at the EDCC site.

In summary, based on a weight of evidence approach, it is concluded that groundwaters are not of population-level concern to surface water biotic communities from any of the groundwater units.

J.7 Risks to Wildlife Receptors

It is not feasible to evaluate exposures and risks for each avian and mammalian species potentially present within the site. For this reason, specific wildlife species (Table E.8) have been identified as surrogates (representative species) for the purpose of estimation of exposure and risk to groups of species within similar feeding guilds at this site.

Table E.8. Summary of wildlife potential receptors.

Surrogate Species	Feeding Guild	Exposure Pathways Evaluated [A]
White-footed Mouse	Mammalian omnivore	Ingestion of surface water.
Eastern Cottontail rabbit	Mammalian herbivore	Ingestion of surface water.
White-tailed deer		
American Robin	Avian insectivore	Ingestion of surface water.

A= Pathways evaluated are theoretical and are not documented to exist

The basic equation used for calculation of an HQ value for exposure of a terrestrial wildlife receptor to a chemical by ingestion of an environmental medium is:

$$HQ = C * IR * DF * RBA / BW * TBV$$

where:

HQ = HQ for exposure of receptor
C = Concentration of chemical (mg/L)
IRC = Intake rate of medium (1/day)
BW = Body weight of receptor (kg)
DF = Dietary fraction of medium derived from site (%)
RBA = Relative bioavailability of chemical in medium (%)
TBV = Toxicity reference value for chemical (mg/L)

Table E.9 Summary table for Wildlife HQ presents the HQ’s for each wildlife receptor for each COPC at each reach.

Table E.9. Summary of Wildlife HQ.

	Common Robin		White Footed Mouse		Eastern Cottontail		White-tailed Deer	
	Benchmark	Maximum HQ*	Benchmark	Maximum HQ*	Benchmark	Maximum HQ*	Benchmark	Maximum HQ*
	(TBV)		(TBV)		(TBV)		(TBV)	
Ammonia	22	0.40	22	0.88	22	0.27	22	0.18
Total Chromium	36.32	0.00	56.29	0.00	56.29	0.00	56.29	0.00
Total Lead	82.08	0.00	48.56	0.00	48.56	0.00	48.56	0.00
Nitrate	6061	0.01	6061	0.02	6061	0.01	6061	0.00
Sulfate	125	0.56	125	1.25	125	0.38	125	0.26
TDS	475	0.79	475	1.77	475	0.54	475	0.36

* Maximum HQ taken from either Upgradient, Production, Midgradient, or Downgradient Unit.

Only the White-footed mouse presented HQ in excess of 1.0 for sulfate and TDS; however, because sulfate and TDS have no accepted TBV, actual ecological risk is unlikely to exist.

Based on this line of evidence, it is concluded that risks from site-related COPC in groundwater, are not of population-level concern to wildlife receptors either in the riparian area along the unnamed tributaries north and south of the EDCC facility or within the Production groundwater unit, even in the event that the groundwater developed a direct surface connection allowing exposures, that to date, have not been documented even after 60+ years of site industrial activities. Therefore, no ecological risk from groundwater exists at the EDCC site for potential wildlife receptors

J.8 Uncertainties

Quantitative evaluation of ecological risks is generally limited by uncertainty regarding a number of important data. This is usually circumvented by making estimates based on whatever limited data are available, or by making assumptions based on professional judgment when no reliable data are available. These estimates and/or assumptions often overestimate the actual risk in order to account for the uncertainty. Because of these assumptions and estimates, the results of the risk calculations are themselves uncertain, and it is important for risk managers and the public to keep this in mind when interpreting the results of a risk assessment. The following sources of uncertainty were addressed in the EDCC baseline groundwater ERA:

- Representativeness of Samples Collected
- Accuracy of Analytical Measurements
- Exposure Pathways Not Evaluated

- Chemicals Not Detected
- Exposure Area Concentration Values
- Representativeness of Receptors Evaluated
- Extrapolation of Toxicity Data Between Receptors
- Uncertainties in Risk Characterization
- Estimation of Population-Level Impacts

The sources of uncertainty in this baseline ERA, along with a qualitative estimate of the direction and magnitude of the likely errors attributable to the uncertainty have been considered. Based on all of these considerations, the HQ and HI values calculated and presented in this ERA section should be viewed as having reasonable uncertainty. Because of the inherent conservatism in the derivation of many of the exposure estimates and toxicity benchmarks, these HQ and HI values should generally be viewed as being more likely to be high than low, and should be interpreted in a weight-of-evidence approach based on other types of available information.

J.9 ERA Status

In summary, the ERA demonstrates that there is no ecological risk to EDCC site aquatic and terrestrial receptors from site groundwater COPCs even under a hypothetical exposure scenario, and applying conservation hazard assumptions. In fact, the ERA failed to demonstrate a groundwater nexus with surface waters and exposure pathways do not currently exist for the EDCC site groundwater, therefore there is no existing ecological risk to site biota due to EDCC groundwater. In addition, the recent interim actions implemented by EDCC (groundwater recovery wells) will further reduce the potential for completion of the exposure pathways.

1.0 INTRODUCTION

This document presents the results of the human health and environmental risk assessment (ERA) for groundwater potentially impacted by industrial activity at El Dorado Chemical Company (EDCC). The risk assessment is being completed in accordance the requirements of Consent Administrative Order (CAO) LIS No. 06-153 for the purpose of providing information needed to guide development of the Remedial Action Plan (RAP) related to potential groundwater contamination.

1.1 Purpose and Objectives

The protection of human health and the environment is the primary goal of regulatory requirements for cleanup and corrective action. A risk assessment can contribute significantly to strategy development, risk management, and evaluation of corrective action needs. The purpose of this document is to identify human health and ecological risks to be addressed in the RAP for potentially impacted groundwater at EDCC. The objectives of the risk assessment include:

e) Identification of COPC related to site activities,
f) Determination of whether concentrations of COPC occur at concentrations that possibly pose unacceptable risk to human receptors,
g) Determination of whether concentrations of COPC occur at concentrations that possibly pose unacceptable risk to ecological receptors, and
h) Identify risks to be addressed in the RAP and establish preliminary monitoring and/or remediation endpoints based on available and current data.

As stated above, information from the risk assessment will be used to assist EDCC in the development of the RAP, which will include selecting remediation strategies and establishing preliminary monitoring and/or remediation endpoints. During implementation of the RAP, there may be a need to implement procedures for the systematic evaluation and enhancement of site remediation processes to ensure that human health and the environment are being protected over the long term at minimum risk and cost. The need to review and update the RAP may arise based on additional groundwater monitoring data, revised site information, scientific advances, regulatory changes, evaluation of remediation technologies, or other site specific information that becomes available as remediation strategies are implemented. This will allow for consideration to be given to the reevaluation of remediation goals and a way that potentially inapplicable or unattainable goals can be updated.

1.2 Scope of Risk Assessment

There has been no documented human exposure to the site groundwater, and there is no anticipated exposure within the facility, and there has been no documented nexus (connection) of groundwater to surface water (e.g. there is no risk). Therefore, risk associated with EDCC site groundwater is limited to potential human health exposure as presented at the EDCC facility perimeter. Despite this limited potential for exposure (and ultimately risk associated with that exposure) this risk assessment has been prepared following the USEPA risk assessment guidance documents referenced in Appendix E of ADEQ's Brownfields Program User's Guide, June, 2004.

1.3 Report Organization

This report is organized into six sections and includes multiple appendices that contain supporting material. The remaining sections of this report present the available data and the components of the human health and ERA.

Section 2 presents the site description and setting, including a brief history of industrial activity at the site, a description of the current industrial operations, and demographic information for both the City of El Dorado and Union County. This section also provides a description of the site geology, hydrogeology, and ecological setting.

Section 3 provides a summary of previous site investigations conducted at the site to characterize the subsurface and groundwater conditions.

Section 4 provides the evaluation of groundwater data to identify the chemicals of potential concern (COPC).

Section 5 and Section 6 present the human health risk assessment (HHRA) and ERA, respectively. These sections include an identification of COPC, site conceptual models, exposure assessments, toxicity assessments, and risk characterizations.

Section 7 provides information regarding references and data sources. This section also discusses significant assumptions and data gaps associated with the risk assessment.

The attached appendices provide detailed data upon which individual report sections are based.

2.0 SITE DESCRIPTION AND SETTING

2.1 Site Location

The EDCC facility is located at 4500 North West Avenue in El Dorado, Union County, Arkansas Sections 5, 6, 7, 8, and 9, Township 17 South, Range 15 West and Sections 1 and 12, Township 17 South, Range 16 West. A location map for the facility is provided in Figure 2.1. The facility is located on a total area of approximately 1,300 acres and the manufacturing area covers approximately 150 acres. The facility is situated atop a watershed divide and based on the USGS topographic map for El Dorado, Arkansas, the elevation of the site is approximately 190 to 200 feet above mean sea level. The nearest surface waters are the north (UTC) and south (UTB) branches of an unnamed tributary to Flat Creek (Figure 2.1). These two unnamed tributaries join with other unnamed tributaries downstream of the facility and ultimately flow into Flat Creek, the first named stream or a USGS 7.5' quad. Process water, sanitary wastewater, and storm water discharged from the facility flow into the unnamed tributaries of Flat Creek, then to Flat Creek, then to Haynes Creek, then to Smackover Creek, and then to the Ouachita River. The Ouachita River is located approximately 10 miles northeast of the site. There has been no documented connection (nexus) to the potentially contaminated groundwater and the surface water features.

2.2 Site History

On October 9, 1941, the War Department notified US Representative Oren Harris of El Dorado that a plant to produce anhydrous ammonia and ammonium nitrate had been approved for a site near El Dorado, and would be called the Ozark Ordnance Works (OOW). Anhydrous ammonia and ammonium nitrate produced at this new facility be used in the manufacture of explosives to support the war effort. The OOW would be a government-owned facility operated by Lion Oil Refining Company. Lion Chemical Company signed a contract to operate the OOW facility on November 18, 1941. A petition was filed with the United States district court, El Dorado division in December 1941, condemning 3,250.41 acres of land situated in Union County, Arkansas, and naming J. P. Pickering, et al. as land owners.

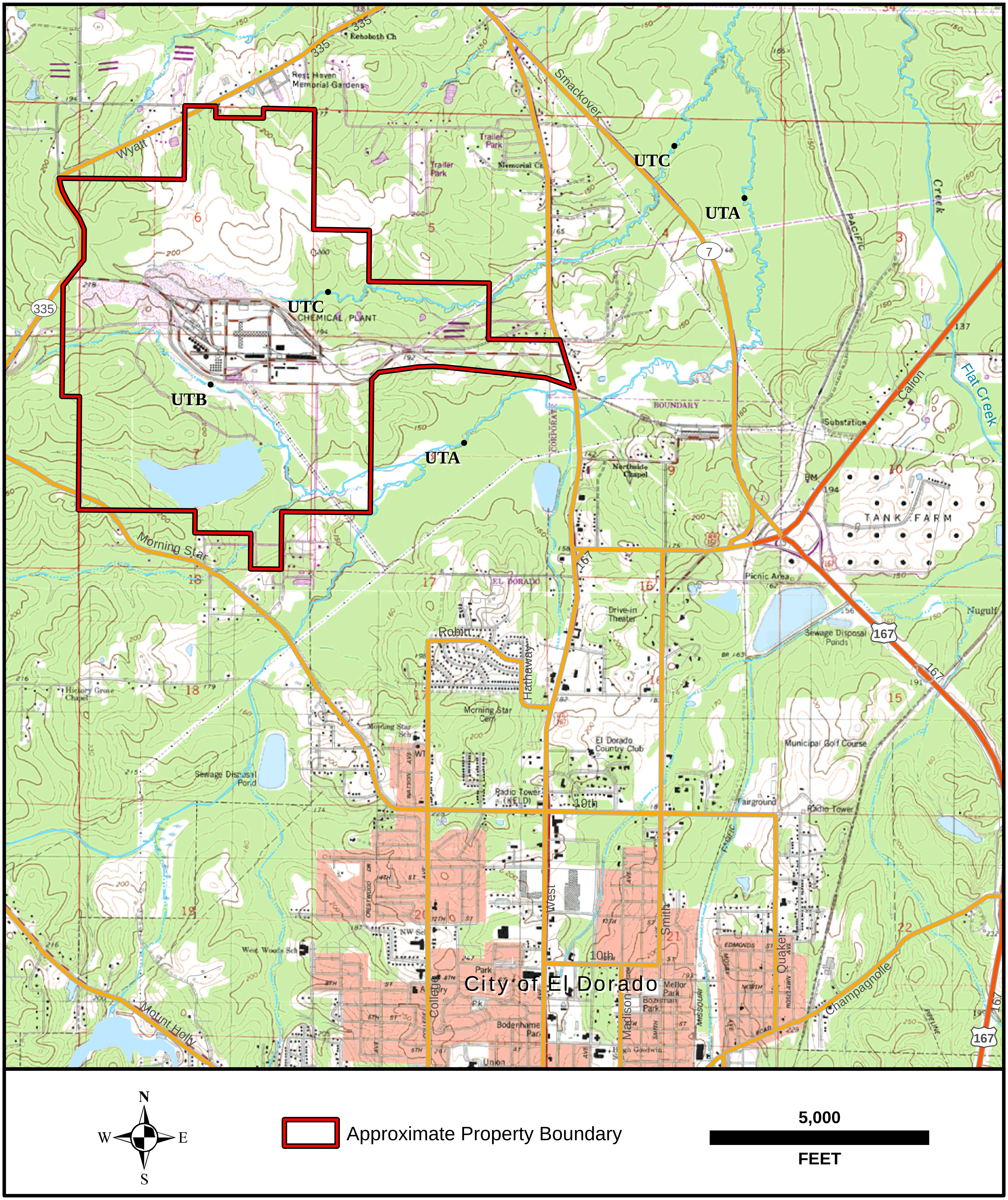


Figure 2.1. El Dorado Chemical Company approximate property boundary with relation to the City of El Dorado.

The United States of America was subsequently given possession of the land. Temporary administration buildings were completed and an access road from Highway 7 was paved shortly thereafter. A spur railroad was also completed to the site. Production operations began on May 13, 1943, or 18 months after the operating contract was signed by Lion Chemical Corp. During war operations, about 700 employees were needed to staff the facility. Contracted output of the plant was set at 300 tons of ammonia to be converted to 300 tons of ammonium nitrate solution per day. By 1944 other TNT plants in the United States had been built and the government began phasing out ammonium nitrate operations. On March 15, 1946, the War Assets Corporation announced that the OOW was surplus to the government needs and would be offered for sale or lease. The Lion Chemical Corp was granted a lease of OOW with options to purchase the facility to conduct nitrogen fertilizer manufacturing operations for commercial use.

By May 16, 1946, Lion Chemical had taken over all operations at the plant. Lion purchased the plant in March 1948 and made improvements and additions at a cost of over $10 million in the 1940s and diversified the products. Nine 30-ton anhydrous ammonia tanks were added and an ammonium prilling plant was built and placed in operation in 1947. Lion merged with Monsanto Chemical Company in 1955 and the plant continued to operate under Monsanto's Inorganic Chemical Division until July 29, 1983, when it was sold to the EDCC with backing from LSB Industries. LSB Industries bought the El Dorado chemical operation in November 1984 and the plant operates under the name of EDCC.

2.3 Facility Description

EDCC manufactures basic agricultural chemicals, including sulfuric acid, nitric acid, low-density and high-density ammonium nitrate prills used in fertilizers, and industrial grade ammonium nitrate solution. A brief description of the production units and various processes at the EDCC facility is provided in the subsections below. Ammonia used to produce nitric acid and ammonium nitrate is received at the plant site via underground pipeline owned by SCA. Elemental sulfur used to produce sulfuric acid is received in trucks from Lion Oil Company. Other principal raw materials used in the EDCC production process include water and natural gas. Water is supplied by on-site underground wells owned by EDCC that range in depth from 530 feet to 670 feet below ground surface. Fresh water from the Ouachita River is also provided for industrial use by underground pipeline from the Union County Water Conservation Board. Natural gas is supplied to the facility via underground pipeline. Aerial photographs of the EDCC facility are included in Appendix A. Major production processes at the facility are discussed in the following subsections. The following

Standard Industrial Classification Codes are applicable to the EDCC facility:

Division D: Manufacturing
Major Group 28: Chemicals and Allied Products
SIC Code 2873: Nitrogenous Fertilizers
SIC Code 2819: Industrial Inorganic Chemicals, Not Elsewhere Classified

Division F: Wholesale Trade
Major Group 51: Wholesale Trade-non-durable Goods

2.3.1 East and West Regular Nitric Acid Plants

The East and West Regular Nitric Acid Plants produce weak nitric acid (HNO_3) at concentrations ranging from 53% to 57%. These nitric acid plants employ the DuPont single (high) pressure process designed and built in 1962 by C&I Girdler. Ammonia (NH_3) is used as a raw material in the process and is received at the facility through the SCA pipeline. Liquid ammonia is supplied to the nitric acid plant from intermediate storage.

2.3.2 DM Weatherly Nitric Acid Plant (DMW Plant)

The DMW Plant produces weak nitric acid at a concentration of 62% by the oxidation of ammonia in the presence of a catalyst in a similar process to the East and West Nitric Acid Plants. This nitric acid plant was originally installed at the American Cyanamid Company facility at Hannibal, Missouri and was relocated to the EDCC location in 1990. Liquid ammonia used as a raw material in the process and is supplied to the DMW Plant from intermediate storage.

2.3.3 Hoescht-UHDE Direct Strong Nitric Acid Plant (DSN Plant)

The DSN Plant produces strong nitric acid (≥ 98% strength) directly from ammonia oxidation utilizing technology developed by Hoescht-UHDE in the 1970's. This process is unique in that concentrated nitric acid is produced from the dehydration of weak (56-65%) nitric acid. The technology takes advantage of low and high pressures and low temperatures at appropriate points in the process for optimum efficiency. The DSN Plant is more technically complicated than traditional nitric acid plants. However, this process produces concentrated nitric acid without the dehydration step.

2.3.4 Sulfuric Acid Plant

The Sulfuric Acid Plant was originally constructed in 1949 when Lion Oil Company operated the facility and is a single absorption contact process of the Chemico design. The raw material used to initiate the sulfuric acid manufacturing process is elemental (Bright) molten sulfur. The elemental sulfur is delivered to EDCC by rail car or tank truck. The sulfur is unloaded into a heated pit and pumped to a 2,000 ton heated sulfur storage tank.

2.3.5 Ammonium Nitrate Plant

The E2 Ammonium Nitrate Plant has been in operation at EDCC since the 1950s. It was modified in the early 1980s to allow for the production of either high density ammonium nitrate (fertilizer grade) or low density ammonium nitrate (industrial grade). Both grades require the reaction of weak nitric acid with ammonia to produce an ammonium nitrate solution. Prior to being prilled, the ammonium nitrate is concentrated to strength greater than 99% for high density prills and 97% for low density prills.

2.3.6 KT Ammonium Nitrate Plant (KT Plant)

The Kaltenbach Thuring Ammonium Nitrate Plant (KT Plant) manufactures low-density ammonium nitrate for industrial blasting customers. This plant was originally installed at American Cyanamid Corporation in Hannibal, Missouri and was purchased and relocated to EDCC in 1989. Weak nitric acid from one of the weak nitric acid plants and anhydrous ammonia are heated and fed to the neutralizer (reaction vessel).

2.3.7 E2 Plant Solution Reactor

A 35% E2 solution is created by reacting weak nitric acid with magnesium oxide through agitation. Approximately 0.5% of the magnesium nitrate is contained in the final ammonium nitrate product. The solution reactor has the capability of producing seven batches of E2 solution a day while the Ammonium Nitrate Plant is running at its maximum rate.

2.4 Demographics and Land Use

2.4.1 History of City of El Dorado

The City of El Dorado was founded in 1843 and became the county seat for Union County the next year. In 1851, the town was incorporated and was one square mile in area. Cotton growers came up the Ouachita River by steamboat and cleared land for plantations. By the 1850s, the area had become home to a number of cotton farms and plantations. The community remained an isolated farming community from its founding until the late nineteenth century. The arrival of railroads by the late 1800s allowed business interests to more readily access native timber resources and develop a lumber industry. Economically, the community remained dependent on agriculture and lumber into the 1920s, limiting its growth. In January 1921 the Busey No. 1 well was completed by Dr. Samuel T. Busey, a physician and oil speculator, at a site located one mile southwest of El Dorado. The success of this well resulted in an influx of speculators into the area, and changed El Dorado from an isolated agricultural city of approximately 4,000 residents to the oil capital of Arkansas. By 1923, El Dorado boasted fifty-nine oil contracting companies, thirteen oil distributors and refiners, and twenty-two oil production companies. The city was flooded with so many people that no bed space was available for them, leading to whole neighborhoods of tents and hastily constructed shacks to be erected throughout the city. The city's population reached a high of nearly 30,000 in 1925 during the boom before dropping to 16,241 by 1930 and rising to 25,000 by 1960. Oil production, after plummeting by the early 1930s, recovered later in the decade. During World War II, the city was the site of several chemical and munitions plants, most of which closed shortly after the war. The oil industry began to decline again by the late 1960s, causing a devastating impact on the economy of El Dorado. In 2004, the downtown area was declared a national historic district. Oil, chemical, and timber interests continue to play a powerful role in the local economy.

2.4.2 Union County Demographics

Union County has a total area of 2,733 km² (1,055 mi²), 2,691 km² (1,039 mi²) of the county's surface is land and 42 km² (16 mi²) of it is water (1.55%). As of the U.S. census of 2000, there were 45,629 people, resulting in a population density of 17/km² (44/mi²). The U.S. census of 2000 reported 20,676 housing units and 17,989 occupied households in the county. The occupied households consisted of 12,646 family households and 5,337 non-family households. The average household size was 2.48 and the average family size was 3.00. Of the 17,989 households, 36.5% had individuals under the age of 18 and 28.1% had individuals 65 years and over.

The racial makeup of the county was 66.1% White, 32.0% Black or African American, 0.2% American Indian and Alaskan Native, 0.4% Asian, 0.5% from other races, 0.8% from two or more races, and 1.1% of the population was Hispanic or Latino. The population was made of 47.8% male and 52.2% female and the median age was 37.7 years. Age distribution of the population was 74.1% age 18 and over, 70.1% age 21 and over, 18.5% age 62 and over, and 16.1% age 65 and older.

A U.S. Census Bureau Profile of General Demographic Characteristics summary for Union County, Arkansas is provided in Appendix C.

2.4.3 El Dorado Demographics

The City of El Dorado has a total area of 42.3 km² (16.3 mi²), 42.1 km² (16.3 mi²) of the city's surface is land and 0.1 km² (0.1 mi²) of it (0.31%) is water. As of the census of 2000, there were 21,530 people, resulting in a population density of 510.9/km² (1,323.3/mi²). The U.S. census of 2000 reported 9,891 total housing units and 8,686 occupied households in the city. The occupied households consisted of 5,734 family households and 2,952 non-family households. The average household size was 2.40 and the average family size was 2.99. Of the 8,686 households, 35.2% had individuals under the age of 18 and 30.0% had individuals 65 years and over.

The racial makeup of the city was 53.7% White, 44.2% Black or African American, 0.2% American Indian or Native Alaskan, 0.7% Asian, 0.4% from other races, 0.9% from two or more races, and 1.0% of the population was Hispanic or Latino. The population was made of 46.2% male and 53.8% female and the median age was 37.6 years. Age distribution of the population was 73.7% age 18 and over, 69.8% age 21 and over, 20.5% age 62 and over, and 18.3% age 65 and older.

A U.S. Census Bureau Profile of General Demographic Characteristics summary for El Dorado, Arkansas is provided in Appendix C.

2.5 Geology and Hydrogeology

The EDCC facility is located west of the Mississippi Embayment in the Gulf Coastal Plain Geostratigraphic Region. Sediments in Union County are within the Claiborne Group and characterized by a thick sequence of unconsolidated, relatively young sediments that are fluvial-deltaic in origin and Tertiary in age. In some areas of Union County younger unconsolidated alluvial and terrace deposits that are Quaternary in age overlay the Tertiary sediments.

The Claiborne Group body of sediments is several thousand feet thick at El Dorado and are prism-shaped, with the thickest portion being much thicker to the southeast and thinning out to a feather edge against the highlands about 70 miles to the northwest. These sediments consist of sand, silt, clay and limestone, occurring in more or less well-sorted and well-defined beds. The beds dip in a general southeasterly direction and generally thicken in this direction such that lower beds have a greater angle of dip than to the upper ones. The beds have been folded and are broken by faults in some places. A graben structure (a down-thrown faulted block of sediments) is located approximately seven miles south of the EDCC facility. The fault planes which form the graben strike northwest-southeast.

The Claiborne Group hydrogeologic formations consist of, in ascending order, the Cane River Formation, Sparta Sand, Cook Mountain Formation, and Cockfield Formation. These formations are generally composed of interbedded sequences of sand and clay. Sand beds in the Cockfield Formation and Sparta Sand contain most of the fresh groundwater in Union County. Geologic units below the Sparta Sand contain saline water. The Cane River and Cook Mountain Formations are regional confining units.

Within the Claiborne Group, two units crop out in Union County, the Cook Mountain Formation and the Cockfield Formation. The Cook Mountain is overlain by the Cockfield Formation. The Cook Mountain is uniformly underlain by the Sparta Formation. The Cook Mountain is 50 to 200 feet thick and is composed of clay and silty clay containing minor amounts of localized very fine to silty sand. These clays serve as a confining unit between the more permeable overlying Cockfield Formation and the underlying aquifer. The Cockfield Formation, locally referred to as the “lignite sand”, is generally characterized by fine sand, interbedded silty clay and lignite becoming more massive and containing less silt and clay with depth. Previous site investigations summarized in Section 3 determined that the Cockfield Formation at the EDCC site consists of interbedded sand, silty sand, silt and clay, with more clay in the northern area of the property and more sand to the south.

Quaternary alluvial and terrace deposits are present primarily in the bottomlands of the Ouachita River and its major tributaries in the northern and eastern parts of the county. The nearest outcrops of the Sparta Sand are about 4 miles west and 3 miles northwest of the northwest corner of Union County, in Columbia and Ouachita Counties, respectively.

Broom, et. al. (1984) have characterized the regional hydrogeology in a study of salt water contamination of groundwater in Union County, Arkansas and the regional hydrogeologic description in this report is based largely on their work. Additionally, two studies (Fitzpatrick, et. al., 1990 and McWreath,. et. al., 1991) which simulated the response to pumping stresses in the Sparta aquifer are also referenced in the regional hydrogeologic setting. This section describes principal aquifers used for potable water supplies near the EDCC facility; including the Cockfield aquifer, the Greensand aquifer, and the El Dorado aquifer. Both the Greensand aquifer and the El Dorado aquifer are commonly referred to as the Sparta aquifer.

2.5.1 Cockfield Aquifer

The Tertiary-aged Cockfield Formation (part of the Claiborne Group) is exposed over most of' Union County. The formation includes sands, silts, and carbonaceous (calcitic) clays with minor amounts of interbedded lignite and gypsum. In some areas the formation contains lenticular beds of lignitic sands (Broom, et. al., 1984; and McWreath, et. al., 1991). The average thickness of the Cockfield Formation is approximately 200 feet in Union County. Overlying this formation is a thin veneer of Quaternary-aged alluvial sediments along the Ouachita River and its tributaries.

An investigation of site conditions was conducted in 2004 by Environmental Management Systems (EMS, 2004) to characterize the shallow stratigraphy of the Cockfield and define the top of the confining clay unit (Cook Mountain Formation). The geologic investigation report is included in Appendix X, and describes the sediments of the Cockfield as grey to orange sands, silts, and clays. Thickness of the Cockfield Formation generally increases from north to south at the site, ranging from 14 feet (MW-3) to 76 feet (MW-22).

Recharge to the Cockfield aquifer is local and groundwater occurs under unconfined conditions. Some semi-confined conditions have been found to exist where overlying sediments have high clay content. The configuration of the water table within the Cockfield Formation generally reflects local topography with flow being towards existing surface drainage features. Water levels in wells range in depth from near land surface in low-lying areas to as much as 50 feet deep at elevated locations.

Coefficient of vertical permeability values in the formation ranging from 1.0 x 10^{-3} cm/sec for sandy materials to 5.0 x 10^{-8} cm/sec for the more clayey sediments. This wide range reflects the varying clay content of the sediments. In general the aquifer's horizontal hydraulic conductivity is greater than the aquifer's vertical hydraulic conductivity and locally perched groundwater is typically found where clay content is high. Further, clay horizons can generate semi-confined conditions when the clayey material overlies more permeable zones and hydrostatic head is driven by recharge areas at higher elevations.

The Cockfield aquifer was the primary source of groundwater for both domestic and industrial use prior to the 1920s but domestic use of this source has continued to decline since this time; owing to the development of rural water supply systems that reduced demand on the Cockfield aquifer (Broom, et. al., 1984).

2.5.2 Cook Mountain Formation

Underlying Cockfield Formation is the Cook Mountain Formation in most areas except where erosion has removed overlying Cockfield sediments to expose the Cook Mountain Formation. Low permeability clays and silty clays with lesser amounts of very fine sands characterize the Cook Mountain Formation. This formation functions as a lower confining unit (aquitard) for the Cockfield aquifer and an upper confining unit and underlying aquifer known as the Sparta.

The thickness of the confining Cook Mountain ranges from approximately 50 feet to 200 feet across the region. In a Phase I Subsurface Investigation Report for the EDCC facility prepared by Woodward-Clyde (1996), the thickness of this confining unit in the vicinity of the EDCC site was estimated to be 200 feet. The Geologic Investigation performed by EMS (2004) defined the top of the Cook Mountain Formation at the site to range from 180 to 90 MSL, dipping from north to south. Results of a calibrated regional finite-difference model performed by Hays, et. al. (1998) estimated vertical hydraulic conductivity of the Cook Mountain confining unit to range from 1.06 x 10^{-6} cm/sec to 3.18 x 10^{-9} cm/sec.

2.5.3 Sparta Formation

The Sparta Formation is Tertiary in age and a primary source of groundwater for industrial, municipal, and agricultural uses in southern Arkansas and northern Louisiana. In Union County, withdrawals from the aquifer increased since development related to the beginning of an oil boom in the early 1920's until the 1960's, resulting in water level declines of over 250 feet in El Dorado. Additionally, the chloride concentration within the aquifer has continued to increase. In 1996, the

Arkansas Soil and Water Conservation Commission designated five counties in Southern Arkansas, including Union County, as a “Critical Ground-Water Area”.

In Union County, the Sparta Formation has three separate zones based on lithologic character and water production capacities. These zones include the uppermost Greensand aquifer, followed by the Sparta Formation confining bed, and the bottom most El Dorado aquifer. Within this sequence, the El Dorado aquifer is the most heavily used for water supply.

2.5.3.1 Greensand Aquifer

The upper portion of the Sparta Formation is a fine-grained to very fine-grained glauconitic sand containing lesser amounts of silts and clays known as the Greensand aquifer. This aquifer is situated between the overlying Cook Mountain confining unit, and an underlying clay-rich horizon of the Sparta Sand which acts as a lower confining unit. Groundwater in the Greensand exists under confined conditions. The structural top of the aquifer in the vicinity of El Dorado ranges from mean sea level (msl) to 50 feet below msl and its thickness here is approximately 200 feet (Leidy and Taylor, 1992). Regional flow direction within the aquifer is south-southeast (Broom, et. al., 1984).

The El Dorado aquifer is more productive than the Greensand aquifer and has a significantly greater potable water supply demand. Recharge to the Greensand aquifer is via precipitation and from streams flowing across outcrop areas. To a lesser extent, the aquifer can receive recharge from leakage across confining beds when the vertical hydraulic gradient is toward the aquifer.

2.5.3.2 Sparta Sand Confining Bed

Although the Sparta aquifer is commonly regarded as a single aquifer, Broom, et. Al. (1984) noted that in Union County a 50 to 150 foot thick largely marine clay horizon existing within the middle portion of the Sparta Formation acts as a confining unit. Both vertical and horizontal hydraulic conductivity is therefore low in comparison to the overlying and underlying sediments because the clay horizon serves as a confining layer between the upper and lower Sparta Formation, such that they act as separate aquifers.

2.6 Ecological Setting

2.6.1 Landscape Setting

The City of El Dorado and Union County, Arkansas are part of the Gulf Coastal Plain (GCP) ecoregion. An ecoregion is generally described as a relatively large area that contains geographically distinct natural community assemblages, where communities share a large majority of their species, dynamics, and environmental conditions, and the communities also function together as a single, large-scale conservation unit. The ecoregion encompasses an area of approximately 26,250,000 acres or 40,970 square miles, and includes parts of Arkansas, Louisiana, Oklahoma, and Texas. The region extends south approximately from Little Rock, Arkansas to south of Shreveport, Louisiana, southwest to Houston, Texas and northwest to outside the Dallas Fort Worth, Texas area. Ecoregions that border the GCP include the Lower West Gulf Coast Plain to the south, the Gulf Coast Prairies and Marshes to the southeast, the Crosstimbers and Southern Tallgrass Prairie to the West, the Ouachita Mountains to the north, and the Mississippi River Alluvial Plain to the East. A map depicting the GCP and surrounding ecoregions is provided in Figure 2.2.

As described by ADEQ’s Regulation No. 2, the Arkansas Water Quality Standards, (ADEQ, 2000) Union County, El Dorado and the EDCC facility are situated within the Gulf Coastal Plain Aquatic Ecoregion as describer by Omermik J.M, (1987).

2.6.2 Topography

The topography of the Gulf Coastal Plain Aquatic Ecoregion (GCPAE) ranges generally from flat to rolling hills, with occasional ravines and erosion terraces. Although there are sections of the GCPAE with steep terrain ranging from 150 to 300 feet above sea level, the terrain of the EDCC facility and surrounding facility boundary ranges from 200 to 150MSL elevation. The EDCC facility is located on a watershed divide with storm flow directed from the centroid of the facility to both the north and south into unnamed tributaries with very small watersheds (both less than 2 square miles).

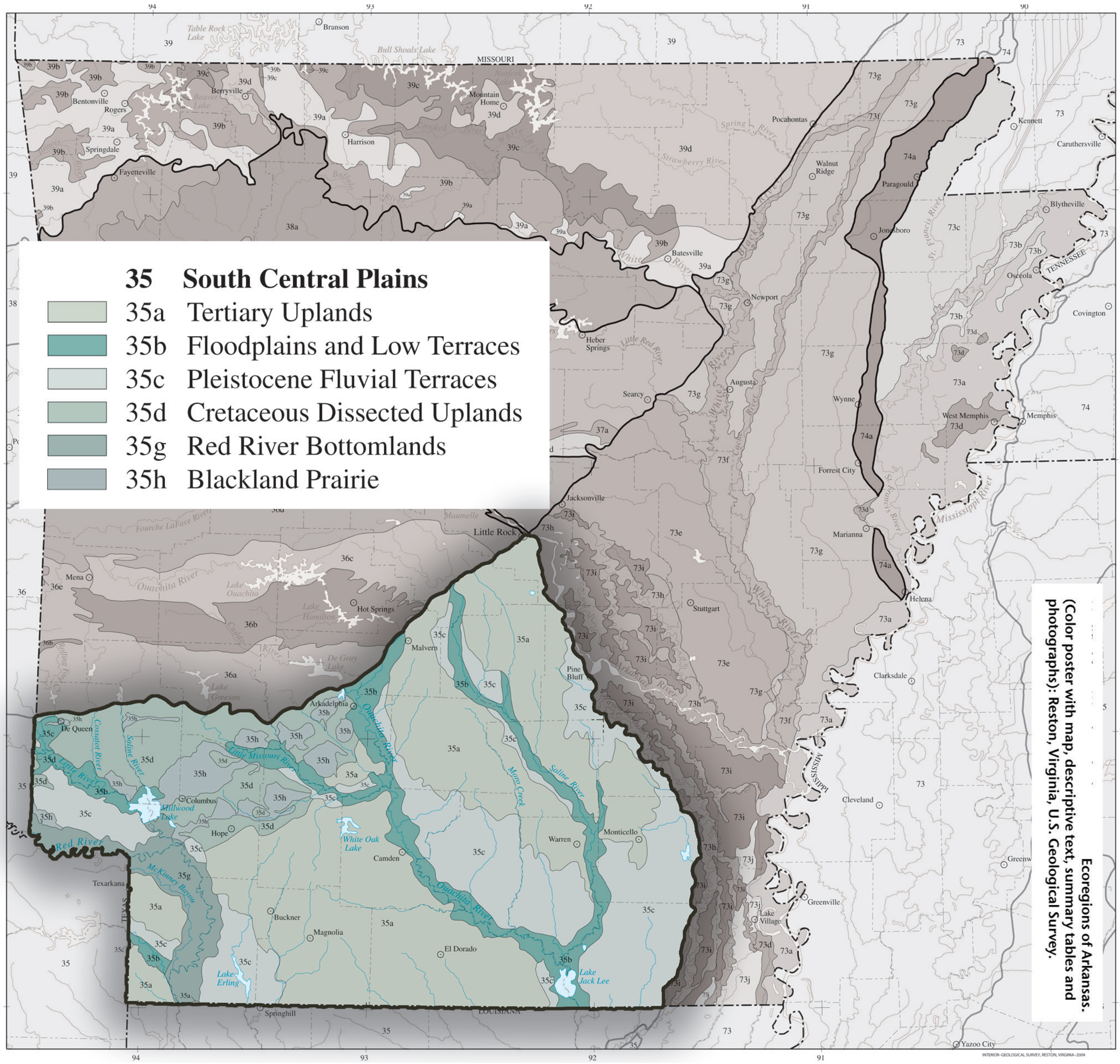


Figure 2.2. South Central Plains, (Gulf Coastal) ecoregions.

2.6.3 Climatology

On the broad scale, the GCP climate is transitional, between subtropical humid areas of the south and gulf, and the continental climates of the Great Plains and Midwest. South or southwesterly winds contribute to hot, humid summers and mild winters. Spring and fall are typically mild and winter temperatures average from 50° - 63° F in the afternoons to 39°- 50° F in the early mornings; with approximately 30 to 40 days of freezing temperatures in the winter. In warmer months the temperature varies less, with afternoon temperatures averaging between 85° - 95° F and morning temperatures averaging 68° -75° F.

Figure 2.3 depicts the monthly average, monthly maximum and monthly minimum temperatures for El Dorado as recorded at the El Dorado airport for the period from 1976 through 2007. The monthly maximum temperatures exceed 90°F (approximated 95°F) during July and August and approximate 90°F for June and September. The minimum temperatures approximate 30°F during January and December, which are the coldest months. Over the 30 year period there is a steady increase to the summer time maximums from January, then steadily decreasing till December minimums.

Precipitation occurs throughout the year, though most rainfall occurs in the spring and fall. Thunderstorms and extreme weather can occur throughout the year, though they are more prevalent in the spring and fall in the northern part of the ecoregion, and in the spring and summer in the southern part of the ecoregion. El Dorado, Arkansas receives approximately 46 - 52 inches of precipitation a year with approximately 100 days receiving measurable rainfall. The 2-year, 24 hour storm event is approximately 4.5 inches, while the 10-year 24 hour event is greater than 7 inches. May averages the greatest precipitation (over 5 inches), closely followed by December and March. August and September are typically the driest months with three (3) inches or less per month (Figure 2.4).

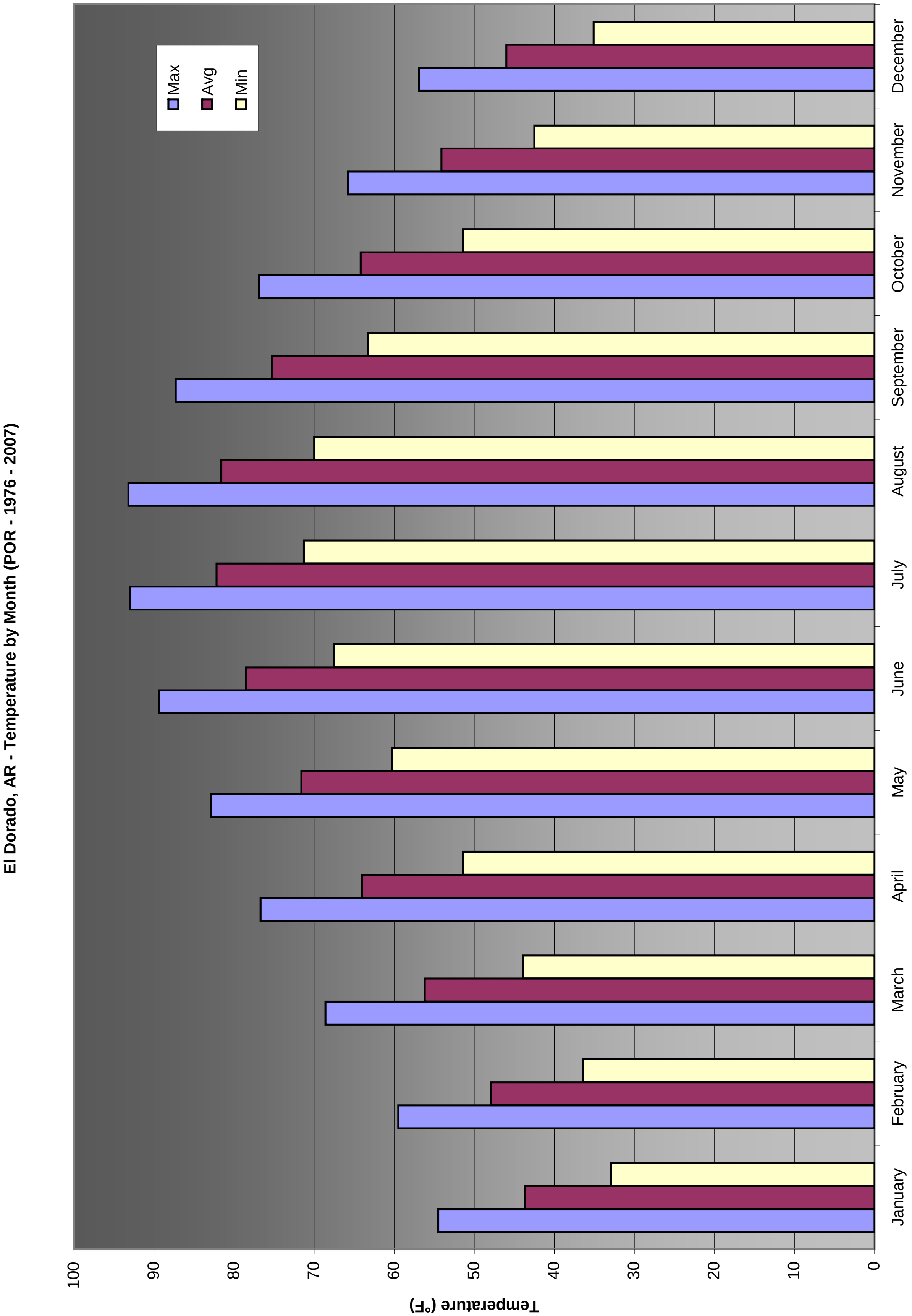


Figure 2.3. Monthly temperatures history for El Dorado, Arkansas.

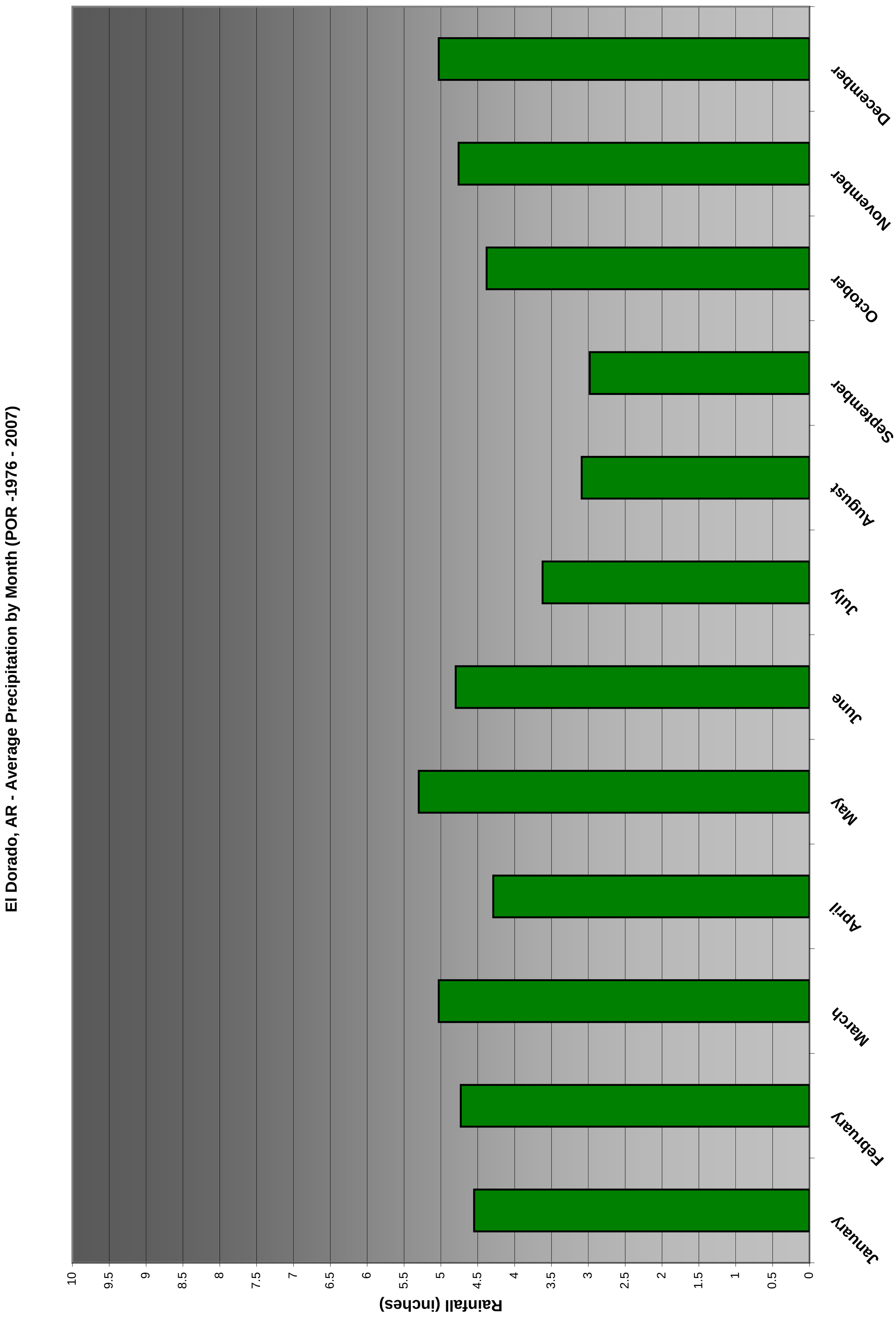


Figure 2.4. Normal monthly precipitation history for El Dorado, Arkansas.

2.6.4 Terrestrial Systems & Processes

Habitats and species composition on the EDCC facility have not been surveyed. The industrial nature of the existing production area limits the existence of a high-quality terrestrial habitat. Although surrounding undeveloped (e.g. non-industrial) areas within the EDCC property boundary are vegetated, the areas have been harvested and replanted with loblolly pine plantations, or are scrub/scrub early successional vegetation. There are no native terrestrial ecosystems within the EDCC property boundary.

Other non-industrial uses include grazing and pasture. Habitat fragmentation caused by industrial activity, urban growth, and suburban development also occurs throughout the region. Stressors to terrestrial ecosystems in the region are caused by habitat destruction or conversion (i.e., grazing and agriculture), habitat fragmentation, and alteration of natural fire regimes. Improper forestry practices, development, conversion and agriculture, and fire suppression are stressor sources. Fragmentation and loss commonly occurs as conversion, including grazing and agriculture. Habitat alteration and incompatible land use include incompatible agricultural and commercial use as well as development. Invasive fire-intolerant species include exotics such as lespedeza, cedars, and kudzu.

Various degrees of disturbances have occurred throughout the ecoregion based upon land use. Biodiversity in many areas has been disturbed by clearing for timber, agriculture, grazing, or mineral extraction. Aside from areas permanently developed to accommodate population growth trends and associated commercial activities, many previously disturbed areas have been or are in the process of improving, although suppression of a natural fire regime continues persist as a stressor.

2.6.5 Aquatic Systems

As described in Section 2.6.2, the EDCC facility is located atop a watershed divide and storm flow feeds two (2) small unnamed tributaries, one on the north and one on the south. Both unnamed tributaries are part of the Flat Creek watershed and generally flow from west to east to Flat Creek which flows to Salt Creek, then to Smackover Creek, then to the Ouachita River. In the unnamed tributaries, storm flows provide the wetted stream habitat in the northern tributary while the southern tributary receives flow from the primary NPDES discharge Outfall 001 as well as storm flows.

Aquatic systems near the EDCC facility are low slope and sheet, and surface fed. The biotic communities of the unnamed tributaries, Flat Creek, Salt Creek have been described in numerous studies completed to document the existing fish communities. (FTN, 1991, ADEQ, 1998, and GBMc, 2006). These investigations have documented the presence of an established fish and benthic invertebrate communities typical of Gulf coastal fisheries as would be supported by streams of the respective watersheds.

Detailed habitat characterizations were also completed as part of those investigations and documented that stream substrates typically consist of hard pack clay, sand, and silt, depending on the location within the watershed. Depending on the specific location, the unnamed tributaries may be free flowing or stagnated by beaver dams.

Primary stressors to these aquatic systems are caused by non-point source discharges and incompatible land use practices that lead to sedimentation. There are limited point source discharges into the Flat Creek watershed including the primary discharge from EDCC.

2.6.6 Significant Ecological Receptors

The Arkansas Department of Natural Heritage (ADNH) was consulted regarding the presence of any threatened and/or endangered species, rare plants and animals, outstanding natural communities, natural or scenic rivers, or other elements of special concern near the EDCC facility. ADNH documented that none of these elements occur within a mile of the facility. Additionally, no natural community or other special elements were noted to exist within five miles of the facility. The ADNH list for union County is provided in Appendix A.

3.0 SUMMARY OF PREVIOUS INVESTIGATIONS

Previous hydrogeologic investigations have been completed at the EDCC facility which has focused on shallow groundwater conditions at separate locations within the facility. In general, these investigations confirm the information provided in this work plan regarding shallow groundwater as given in the preceding discussion of regional geologic and hydrogeologic settings. These previous subsurface investigations are summarized in this section.

3.1 McClelland Engineers – 1980 Investigation

McClelland Engineers completed an investigation in the west-central portion of the EDCC property in December, 1980 (McClelland Engineers, 1980). Investigation objectives were as follows:

- Determine general soil stratigraphy at the site in relation to groundwater characteristics
- Establish the thickness and character of the existing soil strata
- Establish the permeability of significant strata
- Install wells for long-term monitoring of groundwater quality

The study concluded that the west-central portion of the site was underlain by Claiborne Group deposits. The upper 10 – 15 feet of soils were found to consist of reworked alluvial deposits and underlying beds were largely in their unaltered original depositional form. Cover soil in the area ranged from 2 to 2.5 feet in thickness and was reported to consist primarily of gray and tan sandy clay with 6 to 37 percent sand.

Stratigraphy at the site was found to be moderately variable with cross-bedding. Significant variation in strata was noted to exist in four widely spaced borings around the area of the closed Class III landfill. Borings for monitoring well installations were completed to depths ranging from 20 to 40 feet.

Groundwater in the borings was reportedly encountered at depths ranging ranging from 7.5 to 21 feet below ground surface (bgs). Water was observed to rapidly rise in each boring and the noted rise amount was 3.5 feet in Boring C-2 (completed to 10 feet bgs) to 16.5 feet in Boring B-C (completed to 40 feet bgs). This observation was noted by McClelland indicating a 'perched' condition and not a major groundwater aquifer. Reported vertical permeability values for the cover in the area ranged from 1.0 x 10^{-6} to 1.0 x 10^{-7} cm/sec. Vertical permeability of the natural clays believed by McClelland to underlie the cover soils was reported to range from 5.0 x 10^{-7} to 1.0 x 10^{-8} cm/sec.

3.2 McClelland Engineers -1981(a) Investigation

McClelland Engineers completed an investigation in the Lake Kildeer area in June, 1981. Lake Kildeer is located at the southern boundary of the EDCC facility. The objectives of the investigation were to:

- Determine general subsurface stratigraphy and definition of the first aquifer
- Determine the degree of contamination, if any, of the first aquifer and soils resulting from seepage losses from the impoundment
- Estimate the seepage losses based on groundwater seepage analysis and a water balance for existing and proposed reservoir levels

The study concluded that the site is underlain by deposits of the Claiborne Group. Twelve borings were completed with depths ranging from 18 to 100 feet below grade and piezometers were installed in six of the borings . Six monitoring wells were also installed, at Borings 1, 2, 2A, 3, 4 and 5. According to the June 1981 investigation report:

- Piezometer F and Monitoring Well 1 (MW -1) were completed in a former borrow area located adjacent to the north end of the lake
- Piezometer A was completed near the northeast comer of the lake
- Piezometer E was completed north of the northern end of the dam
- Piezometer D and MW-2, MW-2A, and MW-5 were completed east and downstream of the dam
- Piezometer C was completed south of the southern end of the dam
- MW-3 was completed east of the accessory dike on the southern side of the lake
- MW-4 was completed near the end of the western end of the accessory dike on the southern side of the lake
- Piezometer B was completed near the western end of the accessory dike on the southern side of the lake

Soils recovered from the borings were divided into three strata as follows:

> “STRATUM I: Stiff to very stiff tan and gray sandy clay (CL) was encountered at or near the ground surface over a portion of the site to depths of up to approximately 15 ft. The permeability of this stratum is estimated to be in the order of 1.0 x 10^{-7} cm/sec.
>
> STRATUM II: Medium dense to dense gray clayey sand and silty sand (SC and SM) was encountered beneath Stratum I or at the ground surface over most of the site to depths of up to approximately 50 ft. The thickness of this stratum is greatest on the south side of the Impoundment Pond and beneath the embankment (approximately 30 to 50 ft.) and least on the north and west sides of the pond (approximately 0 to 20 ft). Measured permeability values were found to vary widely over the range of 1.3 x 10^{-4} to 5.8 X 10^{-7} cm/sec.
>
> STRATUM III: Laminated stiff to very stiff gray silty clay (CL and CH) and light gray fine sand (SM was encountered as the basal unit beneath Strata I and II). This stratum was encountered generally below EL 160 to 170 on the northwest sides of the impoundment,

below EL 130 on the south side and below EL 90 to 100 in the valley bottom below the dam. Measured permeabilities range from 9.5 x 10^{-5} to 7.0 X 10^{-9} cm/sec. Vertical permeabilities are substantially less than horizontal permeabilities in this laminated zone."

The report did not clearly identify whether each of the above-described strata should be treated as one or more water bearing zones. Wells and piezometers had screens set in Stratum II and in Stratum III. From the report it appears that MW-2A was screened in shallow fill material and it was noted that regional groundwater flow in the uppermost aquifer was towards the south-southeast. The report also concluded that results of chemical analysis indicate the presence of "little, if any contamination of either the soil or groundwater…".

McClelland also performed a seepage analysis and water balance to determine seepage losses from Lake Kildeer and found this to range from 300 gallons per day (gpd) with a lake surface elevation of 165 feet above mean sea level (msl) to 700 gpd with a lake water surface elevation of 175 feet above msl. The report also noted that considerably higher or lower seepage loss quantities may be possible.

3.3 McClelland Engineers -1981(b) Investigation

McClelland Engineers completed an investigation of the Lake Lee area in November, 1981. Lake Lee is located within the central portion of the EDCC facility property and directly south of the manufacturing process area. The purpose of this investigation was to address potential contamination of the "uppermost aquifer" due to construction of the collection pond (Lake Lee).

Four borings were completed to depths ranging from 40 to 60 feet. Boring locations were selected to provide three downgradient (Borings 1, 2 and 3) and one upgradient (Boring 4) locations. It is not clear from the report whether monitoring wells were installed but it is noted that water samples were collected from each boring by facility employees immediately upon encountering water. These water samples were tested for pH, sulfate, nitrate-nitrogen and ammonia-nitrogen. A variable head aquifer test was also performed on Boring 3.

The report concluded Clairborne Group deposits exist below Lake Lee below 162 to 164 feet above msl within the pond area and below 147 feet above msl downgradient of the Lake Lee. Fill and/or alluvium was noted as existing above these deposits. Deposits encountered in the borings were divided by McClelland into four strata as follows:

> "Stratum I: Fill consisting of very stiff to firm tan gray and brown sandy clay (CL) with some gravel encountered at the ground surface to depths of 5 to 17 feet (generally to EL 166 to 170 within the pond area). The mass permeability of this stratum is in the order of 7 x 10^{-7} to 5 x 10^{-8} cm/sec.
>
> Stratum II: Soft to stiff gray with tan sandy clay (CL) was encountered beneath the fill to depths of approximately 15 to 20 ft. This stratum contains some silty sand pockets and seams and consequently possesses a horizontal permeability in the order of 5.0 x 10^{-6} to 1 X 10^{-5} cm/sec. This stratum represents geologically recent alluvial deposition.
>
> Stratum III: Very stiff brown and dark gray clay (CL to CH) with light gray silt and fine sand partings and seams was encountered beneath the alluvial zone to the completion depths of 40 ft. in Borings 1, 2 and 4 and to a depth of 49 ft. in Boring 3.
>
> Numerous sand seams and layers were encountered below depths of 35 ft. in Boring 3 and 32.5 ft. in Boring 4. The mass vertical permeability of this stratum is in the order of 5 x 10^{-8} to 1 X 10^{-7} cm/sec. In the deeper zone more frequent sand seams are encountered and the mass vertical permeability could approach 1 x 10^{-5} and 1 x 10^{-4} cm/sec.
>
> Stratum IV: Dense light fine sand (SN to SP) with occasional clayey seams was encountered beneath Stratum III in Boring 3 at a depth of 49 ft. The coefficient of permeability is estimated to be 1.0 x 10^{-3} cm/sec for this sand stratum."

Static groundwater levels in the four borings ranged from 4 feet bgs grade in Boring 3 to 24.5 feet bgs in Boring 1. Groundwater flow direction was found to approximate the southeast sloping surface topography. It was concluded that the water bearing zone encountered during this investigation did not represent the uppermost aquifer. McClelland interpreted the uppermost aquifer as existing within Stratum IV sands encountered below 115 msl.

This report made no apparent conclusive determination regarding the potential for contaminated soil or groundwater to exist within the Lake Lee investigation area.

3.4 Grubbs, Garner & Hoskyn - 1992 Investigation

In September 1992, Grubbs, Garner & Hoskyn (GGH) completed an investigation of the on site Class III Landfill to define site stratigraphy and determine groundwater depth and movement in the study area. Three borings were completed to depths ranging from 20 to 25 feet bgs and monitoring wells were installed in each of the three borings.

According to information provided in a January 1996 Phase I Subsurface Investigation report prepared by Woodward-Clyde Consultants, EDCC personnel stated that the GGH Report has the designations for Monitoring Well 1 and Monitoring Well 3 reversed from EDCC's understanding of the monitoring well designations. Therefore, this section of this report follows the monitoring well designation understood by EDCC (i.e., Monitoring Well 1 is located east of Landfill Area 1 and Monitoring Well 3 is located south of Landfill Area 5). For excerpts of the report that are in direct quotes, the GGH report is recited as written, but will insert the EDCC designations in parentheses.

The Class III Landfill site was found to be underlain by Claiborne Group deposits and GGH projected that the base of the Cockfield and the top of the Cook Mountain Formation would be encountered at a depth of about 100 feet bgs. GGH summarized the stratigraphy encountered in borings at the site as follows:

> "Stratum I: Loose to medium-dense brown, tan and gray clayey silt and silty fine sand to fine sandy silt was encountered at the ground surface to depths of 2 to 4 ft.
>
> Stratum II: Stiff to very stiff gray and yellowish tan clay and sandy clay with silty sand seams was encountered beneath Stratum I to depths of 13 to 20 ft. The more clayey portions of this stratum were found to possess vertical hydraulic conductivities in the range of 3 x 10^{-9} to 5 x 10^{-9} cm/sec. Due to the presence of intermittent sand seams, horizontal hydraulic conductivities are substantially greater than these recorded vertical conductivities.
>
> Stratum III: Medium dense to dense tan and gray silty fine sand was encountered beneath Stratum II in Monitoring Wells 2 and 3 (EDCC Well 1) to the boring completion depths. Grain size analyses indicated hydraulic conductivities ranging from 4 x 10^{-4} to 8 x 10^{-4} cm/sec. Review of this and previous studies indicate that this sand stratum is present over most of the existing and old landfill sites.

Stratum IV: Very stiff, dark brown clay was encountered beneath Stratum III in Monitoring Well 1 (EDCC Well 3) to the boring completion depth. A coefficient of permeability of 5×10^{-9} cm/sec was obtained. This clay stratum was also encountered in Boring 3 of the previous study. Apparently, this predominantly clay unit is confined to the northeastern portion of the existing landfill."

A potentiometric surface map prepared by GGH indicated shallow groundwater flow to be generally towards the southeast beneath the preexisting Monsanto landfill and generally towards the south beneath the closed Class III Landfill, and towards the valley of an unnamed tributary that crosses the EDCC property on the south side of the Production Area.

3.5 Woodward-Clyde - 1996 Phase I Subsurface Investigation

In compliance with the terms of CAO LIS 95-070, EDCC arranged for Woodward-Clyde to conduct a Phase I investigation in accordance with a Groundwater Monitoring Work Plan (GMWP) dated September 19, 1995, and approved by the Water Division of the ADEQ on October 12, 1995. The GMWP proposed to define groundwater quality beneath the EDCC facility by conducting a phased investigation approach, with Phase I involving preliminary delineation of shallow groundwater elevation and quality at 35 locations throughout the facility using direct-push technology and groundwater sampling and analysis.

Unfiltered groundwater samples were collected at all thirty-five well point locations, (Figure provided in Appendix A) All water samples were analyzed for total lead, total chromium, nitrate-nitrogen, and sulfate. A majority of the recovered groundwater samples were found to be turbid, and contained a significant layer of sediment upon settling. It was noted in the Phase I report that sample turbidity could contribute to sample matrix interferences for total metals and/or increased total metals results.

Well point locations are summarized below:

Well Point Number	Targeted Area of Potential Concern
1, 2, 3, 4	Background, along northern property boundary
9, 11, 21, 35	Lake Kildeer Downgradient Area
5, 6, 7, 19, 22	Lake Lee/Lake Kildeer Buffer Area
23, 24, 25, 26	Lake Lee Area
8, 10, 12, 13, 14, 15, 16, 17, 18	Lake Kildeer Area
20, 27, 28, 29	Nitrate truck and train loading areas
30, 31, 32, 33, 34	Acid concentrator units, acid loading areas

A summary of the well point investigation program including the installation depths at each location. Is provided in

Appendix A.

Groundwater was confirmed to exist at each of the 35 well point locations. Using the approximate groundwater elevations obtained during the water level survey, a contour map depicting a generalized groundwater flow direction was developed and indicated the general direction of groundwater flow over most of the EDCC site to be towards the east-southeast. The map suggested that groundwater flow is locally affected by ground surface topography, especially in the northeast portion of the site, where local groundwater flow direction appears to be toward the southwest. The contour map also indicated that Lake Lee and Lake Kildeer locally affect groundwater flow direction in their respective vicinities.

Analytical results indicated that lead and chromium were present in the groundwater at relatively similar concentrations throughout the EDCC site. The groundwater data obtained from the four upgradient locations that were installed along the northern property line (WP-I through WP-4) indicated that lead and chromium concentrations were consistent with concentrations found throughout much of the EDCC site. Several well point locations were also found to exhibit elevated concentrations of nitrate and sulfate.

3.6 Woodward-Clyde - 1996 Phase II Subsurface Investigation

Phase II activities were executed by Woodward-Clyde in February 1996 and included installation of eighteen new groundwater wells, sampling of four existing groundwater monitoring wells, and abandonment of eighteen existing piezometers/monitoring wells previously installed at the EDCC facility. The wells were located and installed at various points around the EDCC facility (Appendix A).

Static groundwater elevations were measured for each well location and used to develop a potentiometric surface map that indicates an east-southeasterly groundwater flow direction as is consistent with previous site investigations.

Groundwater samples were collected and analyzed for lead (total and dissolved), chromium (total and dissolved), nitrate and sulfate. The Phase II groundwater data generally indicated lower concentrations and lower frequency of detection of lead and chromium than data obtained during the Phase I Subsurface Investigation. Reduced Phase II lead and chromium sample concentrations were believed to be associated with decreased turbidity in groundwater samples obtained from the Phase II monitoring wells. Both nitrate and sulfate concentrations and frequency of detection were similar for the Phase I and II data, although maximum sulfate concentrations measured during the Phase II investigation were lower.

3.7 Environmental Management Systems - 2004 Geologic Investigation

Environmental Management Systems (EMS) performed additional study of the geologic and hydrogeologic conditions of the EDCC site in January 2004. The objectives of the investigation were to (1) further characterize the shallow site stratigraphy with borings that penetrated through to the confining clay unit (Cook Mountain Formation), and (2) further define groundwater flow and quality.

A total of eleven borings were advanced and four monitoring wells installed. Soil conductivity was logged for each boring to aid definition of the top of the Cook Mountain Formation. Data obtained from this investigation was compiled with boring information from previous work by EMS and others to refine the site geological characterization. The top of the Cook Mountain was defined as ranging from 180 to 90 MSL, dipping from north to south across the site. Groundwater depths were recorded and water samples collected for analyses. Consistent with prior measurements, the groundwater flow direction was noted as from northwest to southeast with the exception of localized areas where shallow perched groundwater likely exists. Analytical results indicated that ammonia, nitrate, chromium and lead were below detection levels in the four new monitoring wells (MW-19, MW-20, MW21, MW-22).

4.0 EVALUATION OF GROUNDWATER DATA AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC)

The risk assessment is being completed in accordance the requirements of CAO LIS No. 06-153 for the purpose of providing information needed to guide development of the RAP related to potential groundwater impacts. Pollutants for evaluation are listed specifically in the CAO, and are, ammonia, dissolved chromium, total chromium, dissolved lead, total lead, nitrate, pH, sulfate, total dissolved solids (TDS), dissolved vanadium and total vanadium. Each of these chemicals was evaluated qualitatively and quantitatively for their inclusion as COPC in regards to human health risk and ecological risk. Existing groundwater data was utilized for assessment of risks in this Risk Assessment.

4.1 Groundwater Monitoring

Groundwater monitoring at the EDCC site has been completed historically by Environmental Management Services, Inc. (EMS) of Baton Rouge, Louisiana. Their 2006 Groundwater Report dated March 29, 2007 was used as the source of groundwater monitoring data for the risk assessments. The monitoring presented in the EMS 2006 report was completed following quality assurance protocols which included trip blanks, field blanks, and duplicate sample collections and analysis. In-situ parameters and water surface depth were recorded at each well during each monitoring event. Data from this report utilized in the risk assessment spans a period of record from 2001-2006.

4.2 Data Quality

A database of groundwater data for each of the constituents listed in the CAO from 2001 to 2006 was compiled and analyzed. Groundwater data collected from 22 monitoring wells (3 upgradient and 19 Downgradient) were compiled in the database. Quality assurance for the creation of the database was maintained through checking data entries for a minimum of 10% of the data entry. Data entries were checked again for accuracy after any significant data sorting, rearranging or transfer to other programs.

All analytical concentrations below the method detection levels (MDL) were set equal to the MDL for conservative use in statistical analysis. The MDL for each constituent were checked against screening values to assess if constituents had been analyzed to the levels necessary for comparison to risk based thresholds. Table 4.1 presents a summary of that comparison.

Table 4.1. Summary of MDL's and risk based screening thresholds.

Constituent in Water	Lab MDL (mg/L)	95%UCL above MDL in each area	Human Health Screening Value (mg/L)	Lowest Ecological Screening Value (mg/L)
ammonia	0.50	*	0.21	2.56[3]
dissolved chromium	0.02		n/a[1]	n/a
total chromium	0.02		0.11[2]	0.011
dissolved lead	0.015		n/a[1]	n/a
total lead	0.015	*	IEUBK model	0.0007
nitrate	0.50	*	10	42.6
pH	n/a[1]	n/a	n/a[1]	6-9 (range)
sulfate	2.0	*	n/a[1]	n/a
TDS	2.0	*	250	n/a
dissolved vanadium	0.02		n/a[1]	n/a
total vanadium	0.02		0.037	0.012[4]

[1] No data available or defer to total metal.

[2] Value for Chromium VI

[3] Value at pH of 5.00 s.u.

[4] USEPA Region 5 value, three other references cite values of 0.019 or 0.02.

4.3 Statistical Analysis of Data

Statistical analysis of the groundwater data was completed using the computer programs Excel® and Systat® (or Sigmastat®). Upgradient (background) wells were grouped (ECMW1-ECMW3) for analysis while each Downgradient well was analyzed individually. Statistical analysis began with an assessment of data distribution. The distribution of data for each constituent at each well was first graphed as a histogram to visually asses the basic distribution. A Shapiro-Wilk's test for normality was then completed on the data from each well. The upgradient well group was found to not fit a normal distribution. Therefore, since each downgradient well would be compared to the upgradient well grouping, non-parametric analysis methods were utilized. A Kruskal-Wallis test was completed using post-hoc testing (Dunn's method) for multiple group comparison to determine if statistically significant differences (at the $\alpha=0.05$ level) exit between constituents in the upgradient wells and constituents in each of the downgradient wells. The analysis revealed that statistically significant differences existed between the upgradient well group and selected downgradient wells for ammonia, total chromium, total lead, nitrate, sulfate, pH, and TDS. Since at least some downgradient wells had elevated levels for these constituents each of these constituents were retained as COPC. Total lead was retained as a COPC, however, the MDL for lead was in excess of the ecological screening level, so quantitative evaluation of ecological risk will be limited. None of the monitoring wells revealed statistically significant differences for dissolved chromium, dissolved lead, dissolved vanadium or total vanadium. Therefore, each of these constituents was considered for removal from the list of COPC. Note dissolved and total vanadium at El Dorado Chemical monitoring well (ECMW) 18 was elevated above the MDL but was found to not be in excess of background levels at an alpha of 0.05.

Constituents being considered from removal as COPC's were further evaluated as to their:

1. frequency of detection (how often are they detected above the MDL),
2. their potential source (anthropogenic versus naturally occurring, most organic chemicals are not naturally occurring) and
3. their necessity as essential nutrients (is it required in the human diet for good health).

Table 4.2 provides the result of the evaluation.

Table 4.2. Evaluation of constituents found only at background levels.

Constituent	Infrequently above MDL	Naturally Occurring	Essential Nutrient	Statistically Above Background levels
Dissolved Chromium	Yes	Yes	No	No
Dissolved Lead	Yes	Yes	No	No
Dissolved Vanadium	Yes	Yes	No	No
Total Vanadium	Yes	Yes	No	No

Dissolved chromium, dissolved lead, dissolved vanadium and total vanadium each meet the criteria for being similar to natural background levels; therefore they will be removed from the list of COPC and from further risk assessment. Note total chromium and total lead are retained as COPC.

4.4 Development of Point Concentrations

Groundwater at the EDCC facility can be delineated into four primary groundwater areas (units) to represent potential exposure. These units are delineated mostly by density of industrial activities and the groundwater characteristics, and are described in Table 4.3. Figure 4.1 provides a view of the physical location of each groundwater unit.

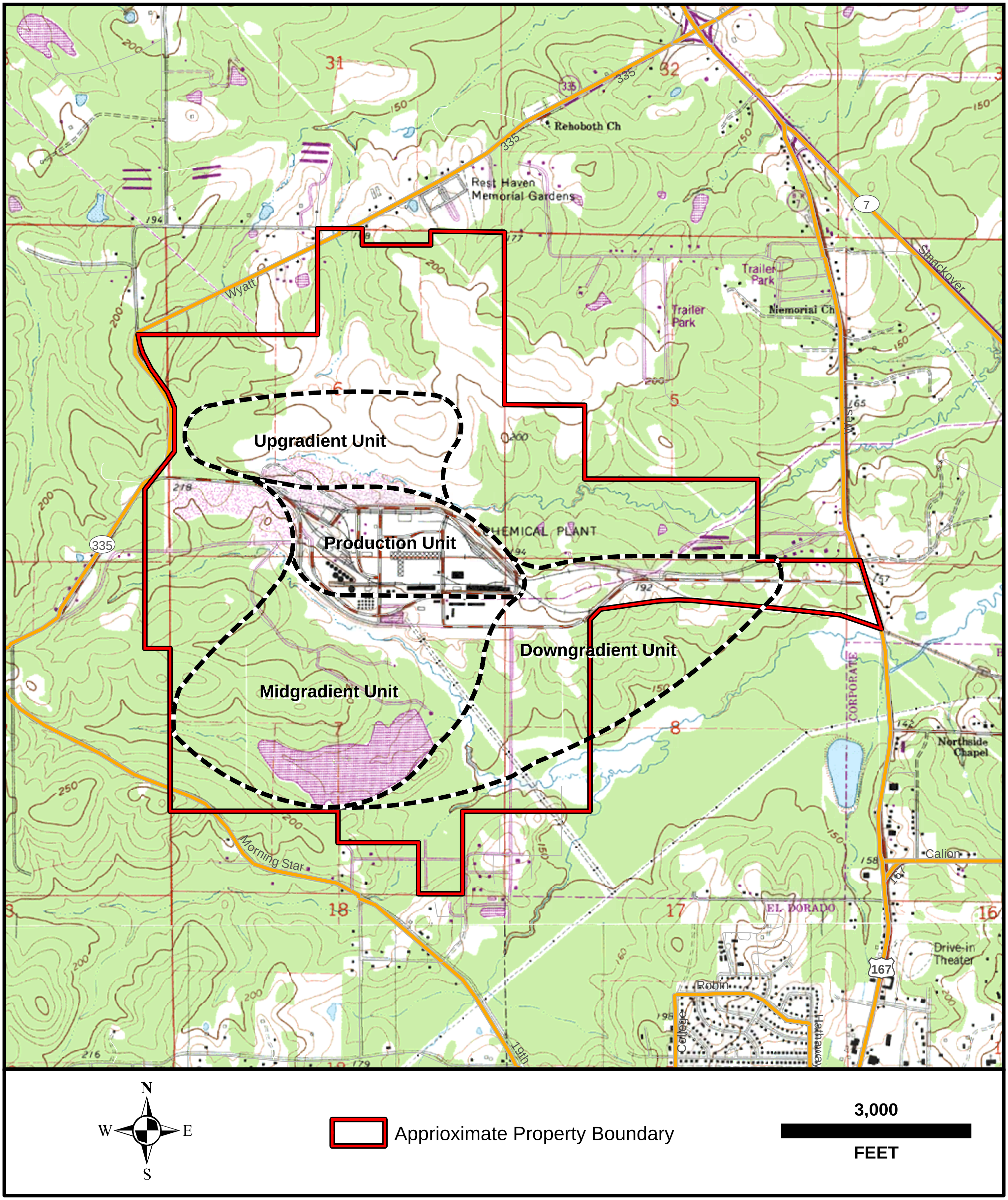


Figure 4.1. Topography showing unit descriptors and the approximate property boundary of EDCC.

Table 4.3. Groundwater units for which point concentrations were developed.

Groundwater Area (Units)	Description	Well #'s*
Upgradient Unit	Wells upgradient of facility influences, representing natural background groundwater quality.	ECMW 1-3
Production Unit	Wells located in the most concentrated area of industrial activities at the facility and generally representing the highest potential groundwater contamination.	ECMW 4-11
Midgradient Unit	Wells located near the wastewater treatment ponds and representing a lower level of industrial activity.	ECMW 14-16
Downgradient Unit	Wells near the property line of the facility, Downgradient of industrial activities, and representative of the groundwater quality that could potentially be leaving the site.	ECMW 17-22

*Well locations are depicted in Figure 4.2

Point concentrations were developed for each COPC for each groundwater unit. Data from wells ECMW 12 and ECMW 13 were not utilized in the analysis as they were in between adjacent units and generally represented COPC concentrations near detection for the CPOCs. Statistical analysis was completed for the combined ECMW data in each groundwater unit in order to develop 95% UCL for the arithmetic mean of the data. The data distribution of each groundwater unit was evaluated for normality and each units data set was found to not meet the assumptions of normality. Therefore, a distribution-free statistical method was used to calculate the 95%UCL for each groundwater unit. The equation used is presented below.

$X + Z_{1-\alpha/2}(s / \sqrt{n}))$ (Gilbert, 1987)

Where: X = mean

Z = Values of probability (p) corresponding to Zp for a normal curve

α = probability level

s = standard deviation

n = number of data points in sample

The resulting 95%UCL for each constituent will be used as point concentrations for groundwater and surface water exposure in this report and are provided in Appendix B.

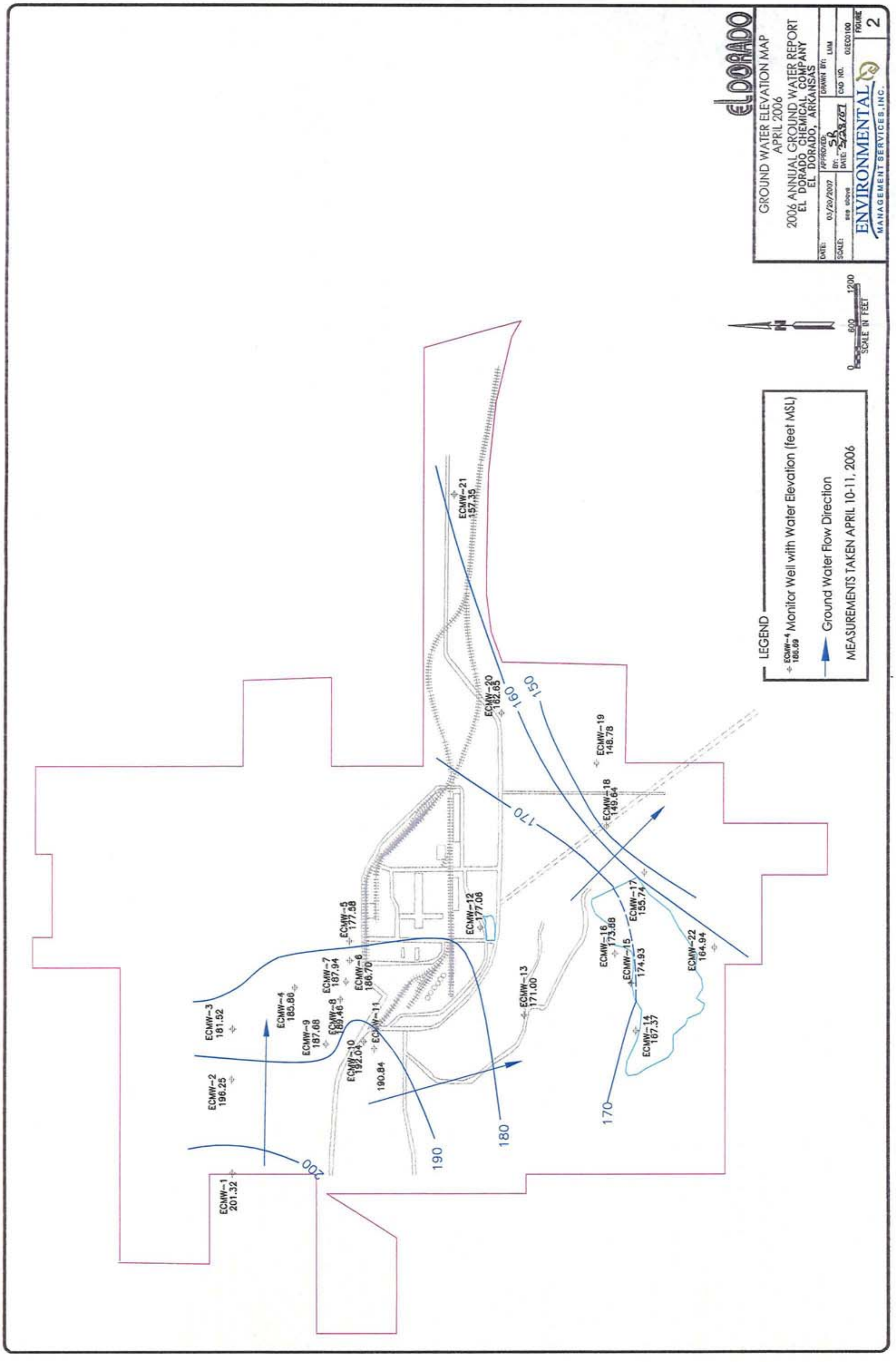


Figure 4.2. Groundwater monitoring well locations.

4.5 Screening to Benchmarks and Risk Thresholds

The remaining COPC's (ammonia, total chromium, total lead, nitrate, pH, sulfate, and TDS) were compared against both human health and ecological -risk toxicity benchmark values (TBV), for each groundwater unit. This was accomplished by comparing the maximum value in a groundwater unit to the TBV. In all cases, the maximum values in at least one groundwater unit was in excess of the TBV, so each COPC was retained for risk assessment.

5.0 HUMAN HEALTH RISK ASSESSMENT

5.1 Overview

Exposure is the process by which humans come into contact with chemicals in the environment. In general, humans can be exposed to chemicals in a variety of environmental media (e.g., soil, water, air, food), and these exposures can occur through several pathways (e.g., ingestion, dermal contact, inhalation). The exposure assessment provides an evaluation of potential exposure pathways that could lead to human contact with site-related contaminants from the groundwater at this site should the groundwater migrate offsite and be utilized in residential wells , identifies COPC in the groundwater, and describes the methods used to evaluate exposure from each potential pathway that is considered possible.

There is no documented evidence to indicate that the site groundwater has migrated offsite. In addition, recent interim actions by EDCC to install and operate groundwater recovery wells further reduces the potential for the hypothetical exposure to occur.

The COPCs evaluated in this HHRA included ammonia, total chromium, total lead, and nitrate. Although pH, sulfate, and TDS were identified as COPCs, sufficient information regarding human health affects related to these compounds is not available. Therefore, pH, sulfide, and TDS were not included in the HHRA.

5.2 Site Conceptual Model

The EDCC facility is used for industrial operations under the direct control of EDCC and because of the heavy industrial nature of the site, it is considered very probable that this land use will not change in the future. EDCC maintains strict control of the site and will restrict access to groundwater at the site. Figure 5.1 presents a site conceptual model showing the potential exposure pathways. Exposure scenarios that may be complete and potentially significant are shown in Figure 5.1 by boxes containing a circle. If sufficient data are available to support evaluation, the pathway is indicated by a solid black circle. An open circle indicates a pathway that is potentially significant but which lacks sufficient information to allow meaningful evaluation. Pathways that may be complete but which are likely to contribute only occasional or minor exposures are shown by boxes with an "X". Incomplete pathways (i.e., those which are not documented to occur) are shown by open boxes. The following sections present a more detailed description of site-related contamination, migration pathways, and exposure scenarios selected for evaluation at the site.

5.2.1 Exposed Populations

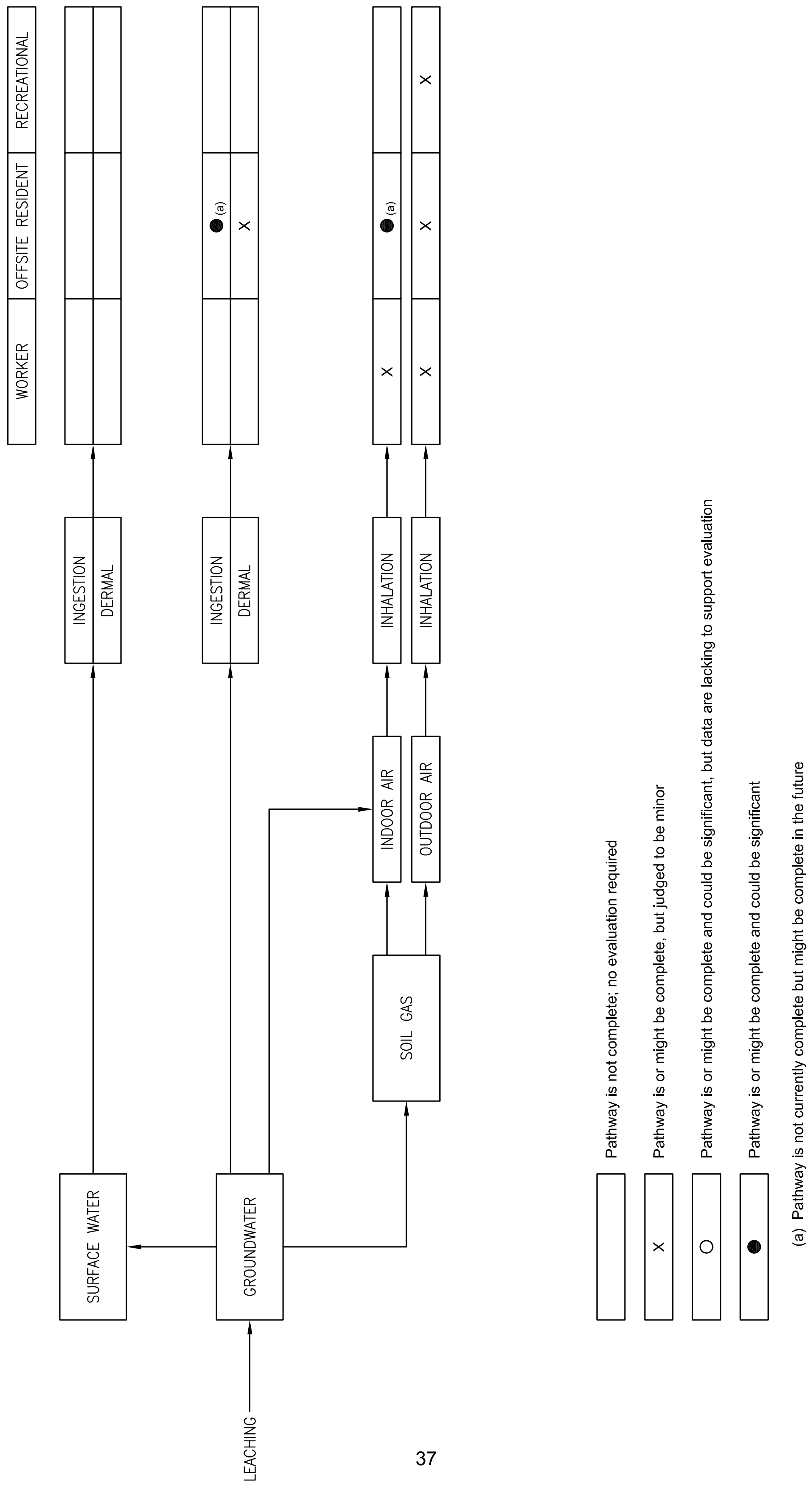
At present, the facility is used for industrial operations under the direct control of EDCC. Because of the heavy industrial nature of the site, it is considered very probable that this land use will not change in the future. Available information indicates that site related contaminants have not migrated to offsite locations and currently the potential for exposure to offsite residential populations does not exist.

5.2.2 Potential On-Site Exposure Scenarios

At present, there are no onsite wells in the shallow aquifer that are used as a source of drinking water and EDCC maintains strict control of the site and will restrict access to groundwater at the site, therefore onsite exposure of workers to groundwater is not of concern. Considering the lack of current and future onsite exposure, the production unit is not considered further in the HHRA.

Exposure to Surface Water

There is no information available to indicate that groundwater is hydraulically connected to surface water (e.g., springs, seeps, etc.).



2042.080.102

EDCC RISK ASSESSMENT
SITE CONCEPTUAL MODEL FOR HUMAN EXPOSURE
EL DORADO CHEMICAL COMPANY
EL DORADO, ARKANSAS

Approved by:	MSR	GBMc STRATEGIC ENVIRONMENTAL SERVICES 219 Brown Lane Bryant, AR 72022	Project No.:	2042-07-080
Checked by:	GLP		Date:	JULY 31, 2007
Drawn by:	RW		Scale:	---

Figure 5.1. Site conceptual model showing exposure pathways.

5.2.3 Potential Offsite Residential Exposure Scenarios

Ingestion of Groundwater

Available information indicates that site related contaminants have not migrated to offsite locations and groundwater wells for residential use are not installed in the shallow aquifer at offsite locations. Offsite groundwater wells are not installed in the shallow aquifer and installation of drinking water wells at offsite locations in the shallow aquifer is not likely in the future due to the availability of municipal water provided by the City of El Dorado and availability of groundwater from the Sparta aquifer. Therefore, the potential for exposure to offsite residential populations does not exist. The exposure scenarios for offsite residents are not currently completed pathways. Although offsite groundwater wells are not currently installed or expected to be installed in the shallow aquifer, this hypothetical exposure pathway was evaluated to characterize the level of concern that would exist in the event that COPCs migrated offsite and offsite groundwater wells were installed in the shallow aquifer for use by a residential population.

Inhalation of Volatile Compounds Released from Indoor Use of Groundwater

If groundwater from the shallow aquifer were ever to be used for indoor purposes at offsite residential locations, volatile compounds present in the water could be released from the water into indoor air, leading to inhalation exposure of residents. As noted above, even though the shallow groundwater is not currently used for any indoor purposes, this hypothetical pathway was evaluated to characterize the level of concern that would exist if offsite groundwater wells were ever installed by a residential population.

Inhalation of Volatile Compounds from Soil Gas

Subsurface groundwater that is contaminated with volatile compounds may release those compounds into soil gas, and the volatile compounds may diffuse laterally and upward through pores in the soil and be released at the surface. If the surface is not covered by a building, the volatile compounds enter outdoor air where they are diluted and dispersed by wind. Therefore, inhalation of volatile compounds in outdoor air is not considered to be an important exposure route. However, if the volatile compounds approach the surface at a location near a building, the soil gas may be drawn into the building and the concentration in the building may tend to build up. Inhalation of volatile compounds in indoor air volatilized from soil gas emanating from groundwater is considered a complete pathway for indoor residents offsite.

Ammonia is the only potential COPC volatile compound at the site. Guidance documents for vapor intrusion modeling indicate that a chemical is considered to be sufficiently volatile if its Henry's law constant is 1 x 10^{-5} atm-m^3/mole or greater. The ASTDR toxicological profile for ammonia indicates that the Henry's law constant for ammonia ranges from 7.3 x 10^{-6} to 1.6 x 10^{-5}, which is on the borderline of being considered sufficiently volatile and therefore vapor intrusion may not be a concern. In addition, guidance documents for modeling vapor intrusion provide necessary input variables (e.g., chemical and physical parameters) only for volatile organic compounds (VOCs). The input variables necessary to complete the vapor intrusion model include diffusion coefficients that are not available for ammonia. Therefore, inhalation of ammonia due to diffusion laterally and upward through pores in the soil and being released to the surface has not been addressed in this risk assessment. However, due to the assimilation of ammonia by aerobic nitrifying microbes in the soil, further consideration of volatized ammonia is not required.

5.2.4 Summary of Pathways of Principal Concern

Based on the evaluations above, the pathways listed in Table 5.1 are judged to be of potential concern to warrant risk evaluation. Other exposure pathways are judged to be sufficiently minor that further evaluation is not warranted.

Table 5.1. Potential pathways of concern.

Exposed Population	Exposure Medium	Exposure Route
Offsite Residents	Groundwater	Ingestion of water
		Inhalation due to water use

5.3 Quantification Of Potential Exposure

5.3.1 Selection of Potential Exposure Points

An exposure point (also referred to as an exposure unit or exposure area) is an area where a receptor (e.g., resident) may be exposed to one or more environmental media. Selection of the bounds of an exposure point is based mainly on a consideration of the likely activity patterns of the exposed receptors; that is, an exposure point is an area within which a receptor is likely to spend most of their time and to move about more or less at random.

At present, there are no known offsite residences that are located above an area of groundwater contaminated by the site. In addition, the historical groundwater data does not indicate that the site groundwater has migrated offsite. One approach for evaluating potential exposure and risk would be to use groundwater fate and transport models to predict the concentration of contaminants at some time in the future, assuming that groundwater plumes are migrating toward offsite locations. However, this requires detailed data on groundwater flow, soil characteristics in the saturated zone, and chemical and biological degradation processes operating in the aquifer. At present, existing data are not sufficient to provide these inputs, so quantitative modeling of future groundwater concentration values at offsite locations was not attempted. Rather, as a screening level approach, risks were evaluated based on conservative assumptions to evaluate allowable concentrations of COPCs at the property boundary. As stated previously, because of the heavy industrial nature of the site, it is considered very probable that this land use will not change in the future.

5.3.2 Point Concentrations (PCs)

Approach for Groundwater

Because of the assumption of random exposure over a groundwater unit area, risk from a chemical is related to the arithmetic mean concentration of that chemical averaged over the entire groundwater unit. Since the true arithmetic mean concentration cannot be calculated with certainty from a limited number of measurements, the USEPA recommends that the 95th percentile upper confidence limit (UCL) of the arithmetic mean at each point concentration be used when calculating exposure and risk at that location (USEPA, 1992). If the 95% UCL exceeds the highest detected concentration, the highest detected value is used instead (USEPA, 1989). Additional information regarding the calculation of point concentrations for the site is provided in the description of statistical methods used for the risk assessment. Table 5.2 provides the point concentrations of nitrate, ammonia, lead, and total chromium in the groundwater to be used in the risk assessment evaluation.

Table 5.2. Groundwater point concentrations based on 95th percentile UCL.

Groundwater Unit	Nitrate (mg/L)	Ammonia (mg/L)	Lead (mg/L)	Total Chromium (mg/L)
Upgradient Unit (background)	1.48	0.549	0.020	0.021
Midgradient Unit	39.2	3.64	0.021	0.020
Downgradient Unit	33.6	1.50	0.032	0.063

Approach for Volatile Compounds Released from Water

Exposure point concentration for volatile compounds in indoor air of offsite residential buildings due to water use are based on groundwater concentrations at the Midgradient Unit and Downgradient Unit. The groundwater concentrations at the Upgradient Unit were also evaluated for comparison purposes. Ammonia is the only volatile compound of concern. The calculations utilized to determine the exposure point concentration of ammonia due to water use are based on volatilization from water used in showers.

Acute Exposure

Equations have been developed for estimating indoor air levels in the shower and bathroom for chemicals volatilized from use of water in the shower (ATSDR 2004b). The maximum concentration of a volatile compound in the bathroom can be estimated for a 10 minute shower and for the 20 minute period in the bathroom following a shower using the following equation:

C air max = (k) (Fw) (Ts) (Cw) / Va

Where:
C air max = maximum concentration in air during the shower and after period in bathroom,
k = fraction of chemical that evaporates from water while showering (assumed to be 0.25),
Fw = flow rate of water through shower head in L/minute (assumed to be 8 liters/minute),
Ts = duration of shower in minutes (assumed to be 10 minutes),
Va = volume of shower and bathroom in liters, (assumed to be 10,000 liters, the approximate size of a small bathroom), and
Cw = concentration of water in mg/L

The following example shows how units cancel to arrive at mg volatile compound per cubic meter of air, and then convert to part per million (ppm) in air.

C air max = (k) (Fw) (Ts) (Cw) / Va
C air max = (%) (L/min) (min) (mg volatile compound/L) / L
C air max = mg/L air
C air max = mg/L x 1000 L /m3
C air max = mg/m3
C air max = mg/m3 x 1.44 ppm/mg/m3
C air max = ppm

Chronic Exposure

To evaluate chronic exposure, it is necessary to also include the additional ammonia exposure that occurs the remainder of the day indoors. The exposure for a volatile compound can be estimated assuming a reasonable situation where someone stays at home most of the day. Typically men breathe about 23 cubic meters of air each day and women breathe about 21 cubic meters of air each day. Assuming that some time is spent away from the home each day, 20 m^3/day has been used as an average upper-end exposure situation, therefore, the volatile compound exposure can be estimated using the following formula:

Daily Dose Indoor Air Exposure = (concentration indoors in ug/m^3) x (20 m^3/day) x (1mg/1000ug)

An estimate of chronic exposure can be made by using results from actual indoor air measurements or estimates from published information. ATSDR toxicological profile for ammonia indicates that the average ambient ammonia concentrations in air for the United States can be estimated to be 3.3 ug/L (equivalent to 2.3 ug/m^3).

Daily Dose Indoor Air Exposure = (2.3 ug/m^3) x (20 m^3/day) x (1 mg/1000 ug)
Daily Dose Indoor Air Exposure = 0.046 mg/day

The daily dose from water use is calculated using the following equation with the assumption of an adult breathing rate of 1 m^3/hr.

Daily Dose Water Use = shower exposure + bathroom exposure
Daily Dose Water Use = [C air max (mg/m^3) x (1 shower/day) x (10 min/60 min/hr) x (1 m^3/hr)] + [C air max (mg/m^3) x (1 shower/day) x (20 min/60 min/hr) x (1 m^3/hr)]

The chronic exposure is estimated based on the sum of the indoor air exposure and the exposure due to water use. From the total daily dose, a daily air concentration can be calculated.

Total Daily Dose = Daily Dose Indoor Air Exposure + Daily Dose Water Use

Daily Air Concentration = Total Daily Dose ÷ 20 mg/m^3

Table 5.3. Ammonia point concentrations for inhalation (based on 95th percentile UCL groundwater concentrations).

Groundwater Unit	Acute Ammonia Air Concentration (based on water use)		Chronic Ammonia Air Concentration (based on water use)	
	(mg/m^3)	(ppm)	(mg/m^3)	(ppm)
Upgradient Unit (background)	1.1	1.6	0.030	0.043
Midgradient Unit	7.3	11	0.18	0.27
Downgradient Unit	3.0	4.3	0.077	0.11

5.3.3 Human Exposure Parameters

For every exposure pathway of potential concern, it is expected that there will be differences between different individuals in the level of exposure at a specific location due to differences in intake rates, body weights, exposure frequencies and exposure durations. Thus, there is normally a wide range of average daily intakes between different members of an exposed population. Because of this, all daily intake calculations must specify what part of the range of doses is being estimated. Typically, attention is focused on intakes that are "average" or are otherwise near the central portion of the range, and on intakes that are near the upper end of the range (e.g., the 95th percentile). These two exposure estimates are referred to as Central Tendency Exposure (CTE) and Reasonable Maximum Exposure (RME), respectively.

This variability in exposure between different members of the population should not be confused with the uncertainty that is often encountered in attempting to estimate either CTE or RME daily chemical intake levels. This uncertainty arises because there are usually insufficient data to accurately define the true distribution of key variables and to accurately identify key exposure parameters such as typical and upper bound intake rates, exposure frequencies and exposure durations. Thus, intake calculations should always be viewed as estimates that have an associated degree of uncertainty, both for CTE and RME values.

The USEPA has collected a wide variety of data and has performed a number of studies to help establish default values for most exposure parameters. The chief sources of these standard default values are the following documents:

1. Risk Assessment Guidance for Superfund (RAGS). Volume I. Human Health Evaluation Manual (Part A*)*. USEPA 1989.
2. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors". USEPA 1991a.

Whenever possible, these parameters were derived from USEPA guidance. In some cases, no data or guidance was available, and the exposure parameters were selected based on professional judgment.

5.4 Toxicity Assessment

5.4.1 Overview

The basic objective of a toxicity assessment is to identify what adverse health effects a chemical causes, and how the appearance of these adverse effects depends on exposure level. In addition, the toxic effects of a chemical frequently depend on the route of exposure and the duration of exposure. Thus, a full description of the toxic effects of a chemical includes a listing of what adverse health effects the chemical may cause, and how the occurrence of these effects depends upon dose, route, and duration of exposure.

Non-cancer Effects

Nitrate, ammonia, and chromium were evaluated based on the non-cancer health effects associated with point concentrations. In characterizing the non-cancer effects of a chemical, the key parameter is the threshold dose at which an adverse effect first becomes evident. Doses below the threshold are considered to be safe, while doses above the threshold are likely to cause an effect.

The threshold dose is typically estimated from toxicological data (derived from studies of humans and/or animals) by finding the highest dose that does not produce an observable adverse effect, and the lowest dose which does produce an effect. These are referred to as the "No-observed-adverse-effect-level" (NOAEL) and the “Lowest-observed-adverse-effect-lever” (LOAEL), respectively. The threshold is presumed to lie in the interval between the NOAEL and the LOAEL. However, in order to be conservative (protective), non-cancer risk evaluations are not based directly on the threshold exposure level, but on a value referred to as the RfD. The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

The RfD is derived from the NOAEL (or the LOAEL if a reliable NOAEL is not available) by dividing by an "uncertainty factor". If the data are from studies in humans, and if the observations are considered to be very reliable, the uncertainty factor may be as small as 1.0. However, the uncertainty factor is normally at least 10, and can be much higher if the data are limited. The effect of dividing the NOAEL or the LOAEL by an uncertainty factor is to ensure that the RfD is not higher than the threshold level for adverse effects. Thus, there is always a "margin of safety" built into an RfD, and doses equal to or less than the RfD are nearly certain to be without any risk of adverse effect. Doses higher than the RfD may carry some risk, but because of the margin of safety, a dose above the RfD does not mean that an effect will necessarily occur.

Ammonia was evaluated based on the non-cancer health effects associated with the inhalation point concentrations developed based on groundwater data. The point concentrations were compared to both an acute and a chronic MRL associated with inhalation exposure (ATSDR 2004).

An MRL of 1.7 ppm has been derived for acute-duration inhalation exposure (14 days or less) to ammonia. This acute MRL of 1.7 ppm is based on a lowest-observed-adverse-effect level (LOAEL) of 50 ppm for mild irritation to the eyes, nose, and throat in humans exposed to ammonia as a gas for 2 hours. The LOAEL was divided by an uncertainty factor of 30 (10 to protect sensitive individuals and 3 for the use of a minimal LOAEL).

An MRL of 0.1 ppm has been derived for chronic-duration inhalation exposure (365 days or more) to ammonia. This MRL supersedes the previous chronic inhalation MRL of 0.3 ppm derived in the 2002 draft for public comment version of this profile. The MRL is based on a NOAEL of 9.2 ppm for sense of smell, prevalence of respiratory symptoms (cough, bronchitis, wheeze, dyspnea, and others), eye and throat irritation, and lung function parameters (FVC, FEV1, FEV1/FVC, FEF50, and FEF75) in humans exposed for an average of 12.2 years in a soda ash plant; no LOAEL was determined. The MRL was calculated by adjusting the mean exposure concentration of 9.2 ppm for continuous exposure (8/24 hours x 5/7 days) and dividing by an uncertainty factor of 10 to protect sensitive individuals. A modifying factor of 3 was added for the lack of reproductive and developmental studies.

Blood Lead Concentration

Since there are no USEPA-approved RfD values for lead, it is not possible to evaluate the non-cancer toxic risks of lead by calculation of a Hazard Index. An alternative approach is to estimate the likely effect of lead exposure on the concentration of lead in the blood of children using the Integrated Exposure Uptake Biokinetic (IEUBK) model. The IEUBK model can be used in a risk assessment to assess potential chronic exposures of children receptors to lead.

5.4.2 Toxicity Values

Toxicity values that have been established by USEPA are listed in an online database referred to as "IRIS" (Integrated Risk Information System) and are also available in the USEPA Region 6 Human Health Medium-Specific Screening Levels. Other toxicity values are listed in USEPA Region 3 Risk Based Compliance, or the Health Effects Assessment Summary Tables (HEAST), or are available as interim recommendations from USEPA's Superfund Technical Assistance Center operated by the National Center for Environmental Assessment (NCEA). Table 5.4 summarizes the toxicity values used for evaluation of human health risks from COPCs at this site.

Table 5.4. Toxicity values for evaluation of human health risks.

Toxicity Parameter	Ammonia	Chromium VI	Nitrate	Source
RfDo (mg/kg-day)	NA	0.003	1.6	Region 6 HHMSSL 2007 and IRIS
Tap Water (mg/L)	0.210	0.110	58	Region 3 RBC
Acute Inhalation MRL (ppm)	1.7	NA	NA	ATSDR Tox. Profile Ammonia
Chronic Inhalation MRL (ppm)	0.1	NA	NA	ATSDR Tox. Profile Ammonia

NA – Not Applicable
MRL – Minimum Risk Level

5.5 Risk Characterization

5.5.1 Basic Methods

Non-cancer Risk

For most chemicals, the potential for non-cancer effects is evaluated by comparing the estimated daily intake of the chemical over a specific time period with the RfD for that chemical derived for a similar exposed period. This comparison results in a non-cancer HQ, as follows (USEPA 1989):

HQ = DI/RfD

where:

HQ	Hazard Quotient
DI	Daily Intake (mg/kg-day)
RfD	Reference Dose (mg/kg-day)

If the HQ for a chemical is equal to or less than one (1), it is believed that there is no appreciable risk that non-cancer health effects will occur. If an HQ exceeds 1, there is some possibility that non-cancer effects may occur, although an HQ above 1 does not indicate an effect will definitely occur. This is because of the margin of safety inherent in the derivation of RfD values. However, the larger the HQ value, the more likely it is that an adverse effect may occur.

If an individual is exposed to more than one chemical, a screening-level estimate of the total non-cancer risk is derived simply by summing the HQ values for that individual. This total is referred to as the Hazard Index (HI). If the HI value is less than 1, non-cancer risks are not expected from any chemical, alone or in combination with others. If the screening level HI exceeds 1, it may be appropriate to perform a follow-up evaluation in which HQ values are added only if they affect the same target tissue or organ system (e.g., the liver, the respiratory system, etc.). This is because chemicals which do not cause toxicity in the same tissues or systems are not likely to cause additive effects.

5.5.2 Risk Estimates For Offsite Residents

5.5.2.1 Risks from Groundwater Consumption – Nitrate and Chromium VI

Non-cancer effects from residential water consumption has been evaluated using the following equations from USEPA RAGS:

Residential Water – Non-cancer Effects

$$THI = \frac{EF \times ED \times C \times \left[\left(1/_{RfDo} \right) \times IRw + \left(1/_{RfDi} \right) \times K \times IRa \right]}{BW \times AT \times 365 day/yr}$$

where:

C = chemical concentration in water (mg/L)
THI = Target Hazard Index (unitless)
RfDo = oral chronic reference dose (mg/kg-day), chemical specific value
RfDi = inhalation chronic reference dose (mg/kg-day), chemical specific value
BW = adult body weight (kg), default value 70
AT = averaging time (yr), default value 30
EF = exposure frequency (days/yr), default value 350
ED = exposure duration (yr), default value 30
IRa = daily indoor inhalation rate (m3/day), default value 15
IRw = daily water ingestion rate (L/day), default value 2
K = volatilization factor (unitless), default value 0.5

The risks associated with nitrate and chromium VI for offsite residential water consumption are summarized in Table 5.5. Since offsite data are not available, the 95th percentile UCL concentrations at the Midgradient Unit and Downgradient Unit were used as conservative estimate for the offsite concentration of the COPC in groundwater. The risk from chromium VI resulted in a hazard index less than 1.0 for both the Midgradient Unit and Downgradient Unit exposure areas. The results indicate that the hazard index for nitrate is less than 1.0 for both the Midgradient Unit and Downgradient Unit exposure areas. Thus, there are no offsite human health risks associated with ingestion of nitrate or chromium in groundwater from EDCC.

Table 5.5. Calculated Hazard Index for Nitrate and Chromium VI

Groundwater Unit	Parameter	Concentration (mg/L)	Hazard Index
Upgradient Unit	Nitrate	1.5	0.025
	Chromium VI	0.0035	0.032
Midgradient Unit	Nitrate	39.2	0.67
	Chromium VI	0.0033	0.030
Downgradient Unit	Nitrate	35.6	0.61
	Chromium VI	0.0105	0.096

Nitrate RfDo = 1.6 mg/kg-day
Cr VI RfDo = 0.003 mg/kg-day
C (mg/L) = concentration represents 95th percentile upper confidence limit
Cr VI concentration is based on ratio of 1/6 for Cr VI/Total Cr

5.5.2.2 Risks from Inhalation of Ammonia

The point concentration for ammonia was calculated for both acute and chronic exposure based on residential water use in a shower. Table 5.3 summarizes the results of the inhalation exposure for each area of concern. The inhalation exposure calculated for the upgradient unit (background) is below both the acute and chronic MRLs. The inhalation exposure calculated for the Midgradient Unit and Downgradient Unit exceed both the acute and chronic MRLs. However, there is no documented offsite residential use of groundwater, thus no offsite inhalation risk for ammonia.

5.5.2.3 Risks from Lead

The IEUBK model was used in the risk assessment to assess potential chronic exposures of children receptors to lead in groundwater. Model default parameters were used for all exposure pathways except the air concentration, soil concentration, and groundwater concentration. The groundwater concentration was set at the 32 μg/m^3, which is the 95th percentile UCL concentration for the Downgradient Unit and was the highest 95th percentile UCL concentration of any of the areas of concern. The air concentration was set at 0.0151 μg/m^3, which is the 95th percentile UCL of the Arkansas statewide ambient air concentration (USEPA 1996). The soil concentration was set at 100 μg/g, which is approximately five times higher than the background soil concentration for lead in the State of Arkansas (USEPA 2005)

The modeling performed for the risk assessment produced a probability function that predicted the likelihood of elevated blood lead concentrations in offsite child residents. IEUBK model input and output information are included in Appendix C. In the case of potential exposure to lead, using available data and certain assumptions, the estimate of the percentage of child residents expected to have blood lead concentration levels in excess of the 10 ug/dL criterion established by Center for Disease Control (CDC) was less than five percent. The USEPA recommends that exposure to lead should not exceed a level such that a typical child would have greater than 5 percent chance of exceeding 10 µg of lead per deciliter (dL) of blood.

5.5.3 Preliminary Groundwater Targets

Based on the risk estimates for offsite residents, the following targets for each of the COPCs may be applicable at the property boundary of the site to ensure protection of human health.

Nitrate

The risk from nitrate resulted in a hazard index less than 1.0 for both the Midgradient Unit and Downgradient Unit exposure areas. Based on the available information and assumptions made in the risk assessment, the existing concentrations of nitrate in the groundwater do not exceed acceptable risk. Therefore, a target has not been established for nitrate and if the concentration of nitrate remains stable one will not be necessary.

Ammonia

The inhalation exposure calculated based on the ammonia concentration in groundwater for the Upgradient Unit (background) meets both the acute and chronic MRLs. The analysis of the Midgradient Unit and Downgradient Unit indicate that both the acute and chronic MRLs are not met for hypothetical offsite resident, based on the conservative assumption that offsite groundwater concentration of ammonia are equivalent to the Midgradient Unit or Downgradient Unit. An appropriate groundwater target for groundwater at the property boundary of the site would be 0.55 mg/L, which would be equivalent to approximately the Upgradient Unit (background) concentration of ammonia in groundwater. This target is above the tap water concentration of 0.21 mg/L established in the USEPA Region 3 RBC. However, since the Upgradient Unit concentration of ammonia is already greater than the tap water level, the target provides a goal that is potentially attainable. Also, as previously discussed, the evaluation of inhalation based on the groundwater concentrations in the Upgradient Unit result in point concentrations that meet the acute and chronic MRLs.

Chromium VI

Since offsite data are not available, the 95th percentile UCL concentrations at the Midgradient Unit and Downgradient Unit were used as conservative assumptions for the offsite concentration of the COPC in groundwater. The risk from chromium VI resulted in a hazard index less than 1.0 for both the Midgradient Unit and Downgradient Unit exposure areas. Based on the available information and assumptions made in the risk assessment, the existing concentrations of chromium VI in the groundwater do not exceed acceptable risk. Therefore, a target has not been established for chromium and if the concentration of chromium remains stable one will not be necessary.

Lead

The modeling performed for the risk assessment produced a probability function that predicted the likelihood of elevated blood lead concentrations in offsite child residents. Since offsite data are not available, the 95th percentile UCL concentration at the Downgradient Unit was used as a conservative assumption for the offsite concentration of the COPC in groundwater. The estimate of the percentage of child residents expected to have blood lead concentration levels in excess of the 10 ug/dL criterion established by CDC was less than five percent. Based on the available information and assumptions made in the risk assessment, the existing concentration of lead in the groundwater does not exceed acceptable risk. Therefore, a target has not been established for lead and if the concentration of lead remains stable none will be necessary.

5.6 Uncertainties

Evaluation of the risks to humans from environmental contamination is frequently limited by uncertainty regarding a number of key data items, including concentration levels in the environment, the true level of human contact with contaminated media, and the true dose-response curves for non-cancer and cancer effects in humans. This uncertainty is usually addressed by making assumptions or estimates for uncertain parameters based on whatever limited data are available. Because of these assumptions and estimates, the results of risk calculations are themselves uncertain, and it is important for risk managers and the public to keep this in mind when interpreting the results of a risk assessment. The following sections review the main sources of uncertainty in the risk calculations performed at this site.

5.6.1 Uncertainties in Exposure Estimation

As described above, the risk assessment process begins with estimation of human exposure to potentially toxic chemicals in environmental media. There are multiple sources of uncertainty in these exposure estimates, as discussed below.

Uncertainties from Exposure Pathways Not Evaluated

Humans may be exposed to site-related chemicals by a number of pathways, but not all of these pathways were evaluated in this risk assessment. In most cases, this is because the contribution of the pathway omitted is believed to be minor compared to one or more other pathways that were evaluated. In these cases, omission of the minor pathways will result in a small underestimation of exposure and risk, but the magnitude of this underestimation is not expected to be significant. In the case of dermal exposure, the magnitude of the underestimation is generally presumed to be small, but this may vary between different chemicals and different exposure pathways (dermal contact with soil, sediment or water), and might become significant in some cases. If so, that would result in an underestimation of risk.

Uncertainties in Point Concentrations

In all exposure calculations, the desired input parameter is the true mean concentration of a contaminant within a medium, averaged over the area where random exposure occurs. However, because the true mean cannot be calculated based on a limited set of measurements, the USEPA recommends that the exposure estimate be based on the 95% upper confidence limit of the mean. This approach helps ensure that exposure and risk estimates are more likely to be high than low.

When data are plentiful and inter-sample variability is not large, the EPC may approach the mean of the data. However, when data are sparse or are highly variable, the EPC may be far greater than the simple mean of the available data. Such EPCs (substantially higher than the mean) reflect the substantial uncertainty that exists when data are sparse or highly variable, and in general are likely to result in an overestimate of risk.

In some cases, no direct measures of concentration in a medium were obtained, so the concentration values (and the EPCs) had to be estimated by mathematical modeling. This includes the concentration of ammonia in indoor air due to release from indoor uses of water. In general, mathematical modeling of point concentrations is a source of many additional uncertainties, and point estimates derived in this way often have low reliability.

In the case of potential future offsite exposure of residents to groundwater, no attempt was made to perform mathematical modeling of future offsite groundwater concentrations, and values were simply assumed to be equal to current onsite concentrations. This assumption does not account for the usual decrease (attenuation) in the concentration of contaminants in a groundwater plume as it migrates away from its source, nor does it account for source reduction actions performed at the site.

Uncertainties in Human Exposure Parameters

Accurate calculation of risk values requires accurate estimates of the level of human exposure that is occurring. However, because human activity patterns are so variable, data on the average and intake rates are limited for some of the pathways considered in this assessment. In general, when exposure data were limited or absent, the exposure parameters were chosen in a way that was intended to be conservative. Therefore, the values selected are thought to be more likely to overestimate than underestimate actual exposure and risk.

5.6.2 Uncertainties In Toxicity Values

Toxicity information for many chemicals is often limited. Consequently, there are varying degrees of uncertainty associated with toxicity values (i.e., cancer slope factors, RfDs). For example, uncertainties can arise from the following sources:

In general, uncertainty in toxicity factors is one of the largest sources of uncertainty in risk estimates at a site. Because of the conservative methods USEPA uses in dealing with the uncertainties, it is much more likely that the uncertainty will result in an overestimation rather than an underestimation of risk.

5.6.3 Uncertainties In Risk Estimates

A number of limitations are associated with the risk characterization approach for carcinogens and non-carcinogens.

First, because risk estimates for a chemical are derived by combining uncertain estimates of exposure and toxicity, the risk estimates for each chemical are more uncertain than either the exposure estimate or the toxicity estimate alone. However, even if the risk estimates for individual chemicals were quite certain, there is considerable uncertainty in how to combine risk estimates across different chemicals. In some cases, the effects caused by one chemical do not influence the effects caused by other chemicals. In other cases, the effects of one chemical may interact with effects of other chemicals, causing responses that are approximately additive, greater than additive (synergistic), or less than additive (antagonistic). In most cases, available toxicity data are not sufficient to define what type of interaction is expected, so USEPA generally assumes effects are additive for non-carcinogens that act on the same target tissue and for carcinogens (all target tissues).

Because documented cases of synergistic interactions between chemicals are relatively uncommon, this approach is likely to be conservative for most chemicals.

However, it should be noted that risk estimates for different chemicals are based on toxicity values (slope factors and RfDs) that often have differing degrees of confidence and uncertainty (both quantitative and qualitative). Thus, summing HQ values and cancer risk estimates across different chemicals tends to commingle risks that are relatively certain with risks that are highly uncertain, and this makes interpretation of the combined risk estimates more difficult.

For non-carcinogens, summing HQ values across different chemicals is properly applied only to compounds that induce the same effect by the same mechanism of action. Consequently, summation of HQ values for compounds that are not expected to include the same type of effects or that do not act by the same mechanisms could overestimate the potential for effects.

6.0 ECOLOGICAL RISK ASSESSMENT

6.1 Introduction

6.1.1 Purpose

To date, there has been no documented occurrences of groundwater connection to surface water even after over 60 years of industrial activity on the current site. In addition there is no information to indicate that there is nexus (connection) between groundwater and surface water. Therefore, there are no completed aquatic pathways to result in exposure; therefore, there is no documented risk. Recent actions by EDCC to install and operate groundwater recovery wells, further reduces the potential for the exposures pathways to develop in the future.

Although there is no existing nexus and/or exposure, it is possible that a connection could develop; therefore, the ERA is completed as though the receptors are exposed to the COPC in the site groundwater. This document is a baseline ERA for the EDCC site located in El Dorado, AR. (Figure 6.1).

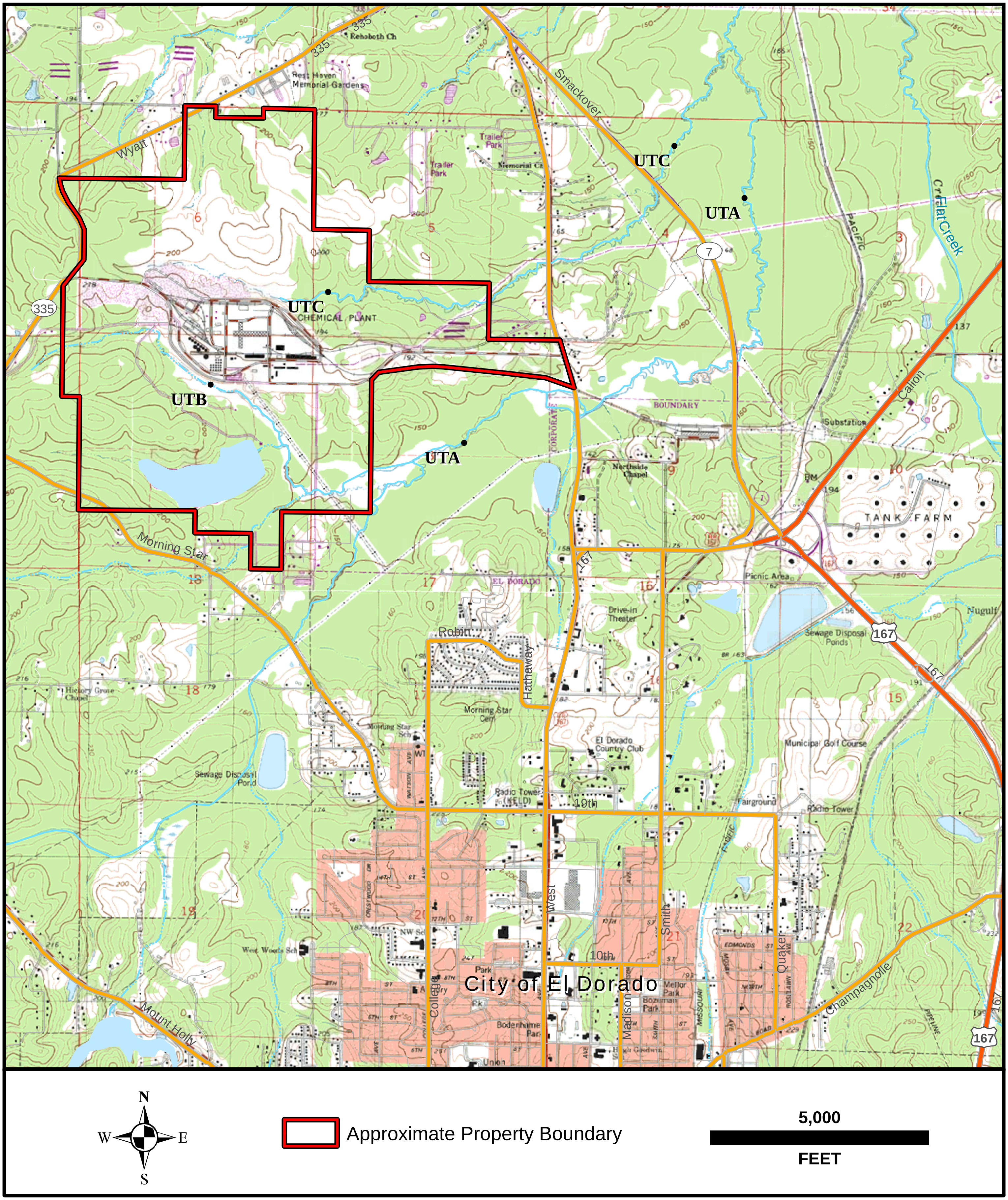


Figure 6.1. El Dorado Chemical Company approximate property boundary with relation to the City of El Dorado.

The purpose of the ERA is to describe the likelihood, nature, and extent of adverse effects to ecological receptors resulting from exposure to contaminants released through the site groundwaters to surrounding areas as a result of past, present or future site activities. This information, along with other relevant information, is used by risk managers to make decisions whether remedial actions are needed to protect the environment from site-related releases of groundwater. If remediation is warranted, an investigation is performed to evaluate the relative merits of a range of alternative remedial actions which might be undertaken to achieve risk management goals at the site.

An evaluation of potential risks to human receptors from site-related groundwater contamination was presented previously in Section 4.0 of this report.

6.1.2 Approach

This ERA was performed in accordance with current United States Environmental Protection Agency (USEPA) guidance for ERAs (USEPA 1992, 1997, 1998). The general sequence of an ERA is illustrated in Figure 6.2 (USEPA 1997). The eight steps depicted in Figure 6.2 are not intended to represent a linear sequence of mandatory tasks. Rather, some tasks may proceed in parallel, some tasks may be performed in a phased or iterative fashion, and some tasks may be judged to be unnecessary at certain sites. The format of this risk assessment is based on that of an ERA completed by USEPA Region 8 (USEPA Region 8, 2004).

At the EDCC site, the ERA process has been initiated by performing a screening-level assessment as a portion of this baseline assessment. The screening level assessment was intended to support identification and refinement of COPCs.

Risks from site-related contaminants could be reasonably excluded from the ecological receptors as long as surface connections were prevented via groundwater controls and /or the COPC's are not present in concentrations which present ecological risks.

There has been no documentation of surface water connections to the groundwater through spring seeps and/or surface upwelling. However, other site regulatory requirements related to surface water discharges (both non-contact and storm waters) have required documentation of the condition of unnamed receiving streams into which the EDCC discharges (See Section 5.6.4). These efforts included collection of additional abiotic and biotic samples, site-specific toxicity testing of discharged surface waters, and an analysis of the aquatic habitat and benthic communities in site surface waters. This report utilizes the historical data to evaluate the potential ecological risk for the site as may be hypothetically impacted by groundwater should it become surface waters.

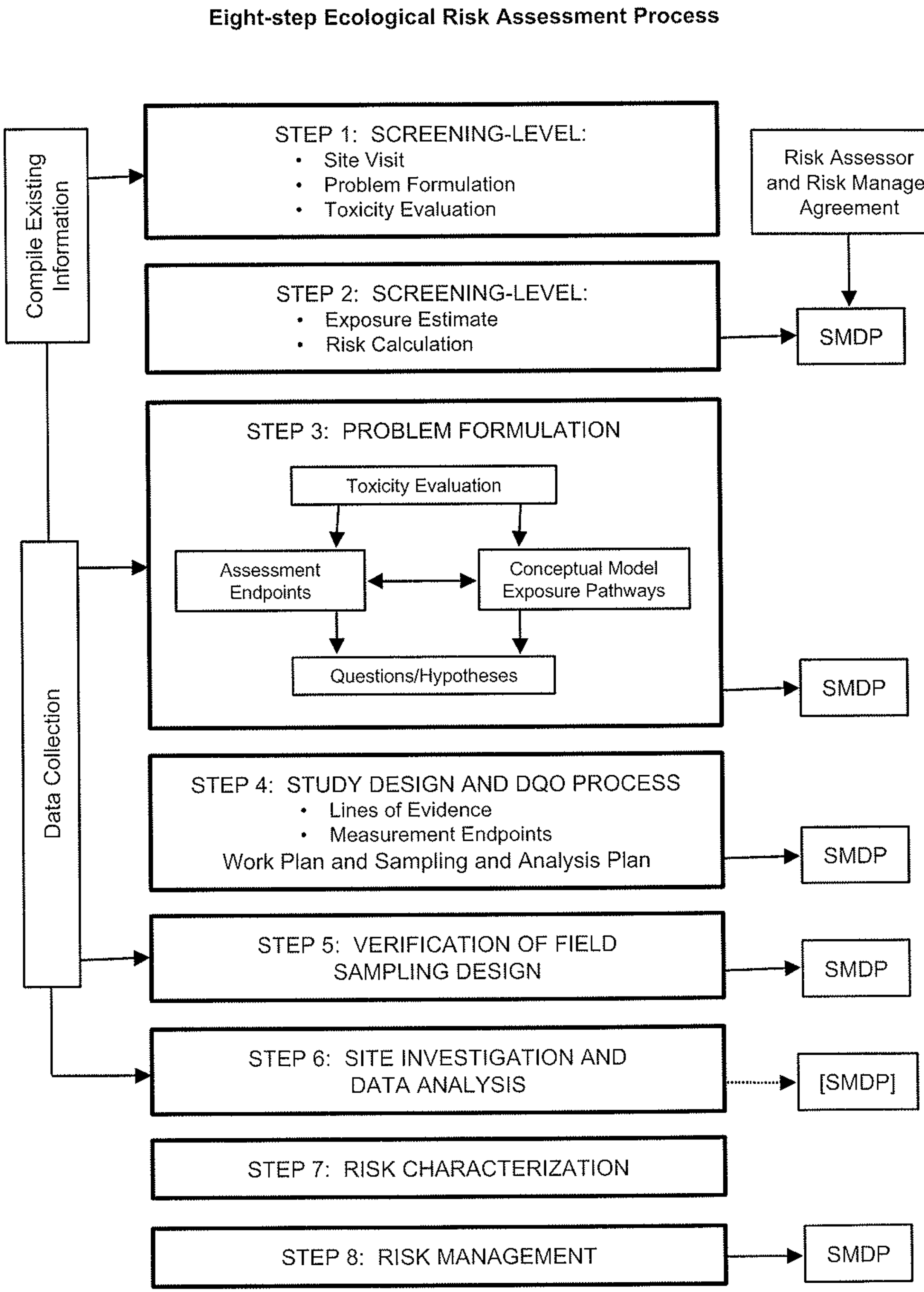


Figure 6.2. Eco-risk process flow diagram from EPA's Ecological Risk Assessment Guidance for Superfund (USEPA, 1997)

6.1.3 Site Location

EDCC is located in Union County, Arkansas, just north of the City of El Dorado (Figure 6.1). The active production facility area is located just west of AR. Hwy. 7B and covers an area of approximately 1300 acres. The facility is located atop a minor watershed divide with storm water runoff to both the north and south into unnamed tributaries to Flat Creek in the Ouachita River watershed. The flow in the unnamed tributary is storm flow dependencies and are ephemeral in nature. The UTB also flows in relation to the NPDES permitted discharge. The facility is surrounded by undeveloped areas predominantly new growth forest with some forest cleared for pasture to the north.

6.1.4 Site Description

The site is described in Section 2.0. For convenience in site investigation activities, potential source areas of contamination in groundwater have been grouped in to four groundwater units based on the historical groundwater data. These are:

- the Upgradient Groundwater Unit (UGGU),
- the Production Groundwater Unit (PGU);
- the Midgradient Groundwater Unit (MGGU);
- the Downgradient Groundwater Unit (DGGU).

Figure 6.3 illustrates the approximate boundaries of each of the four (4) AOI and their proximity to one another and any association with areas of potential ecological concern. The boundaries of each unit are loosely tied to the groundwater potentiometeric contours that have been used to identify similar groundwater complexes.

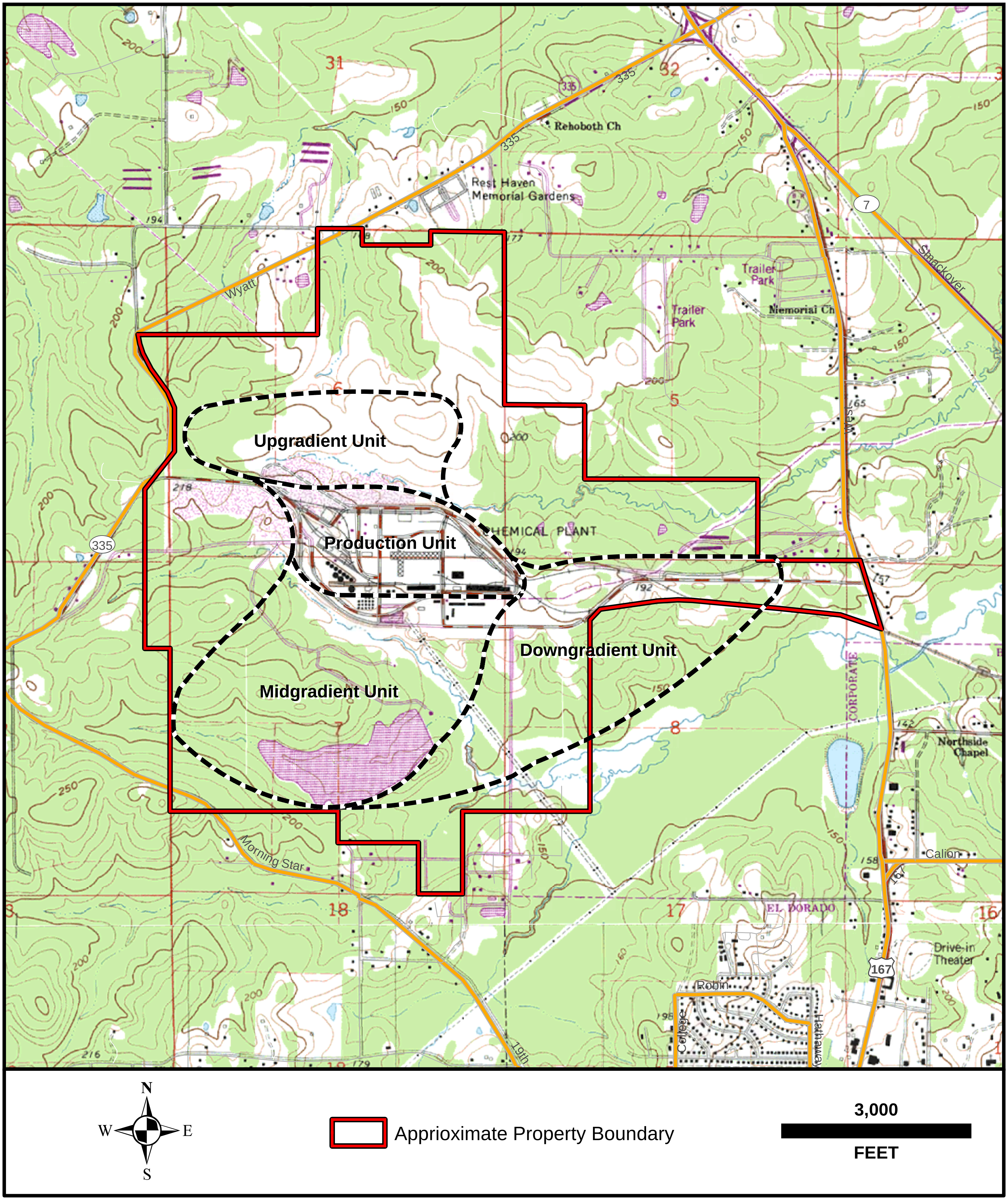


Figure 6.3. Topography showing unit descriptors and the approximate property boundary of EDCC.

6.1.5 Environmental Setting

Figure 6.4 illustrates the existing land uses of each of the groundwater units. The land use data is developed from 2001 landuse data from the Center for Advanced Spatial Technologies (CAST).

6.1.5.1 Upgradient Groundwater Unit (UGGU)

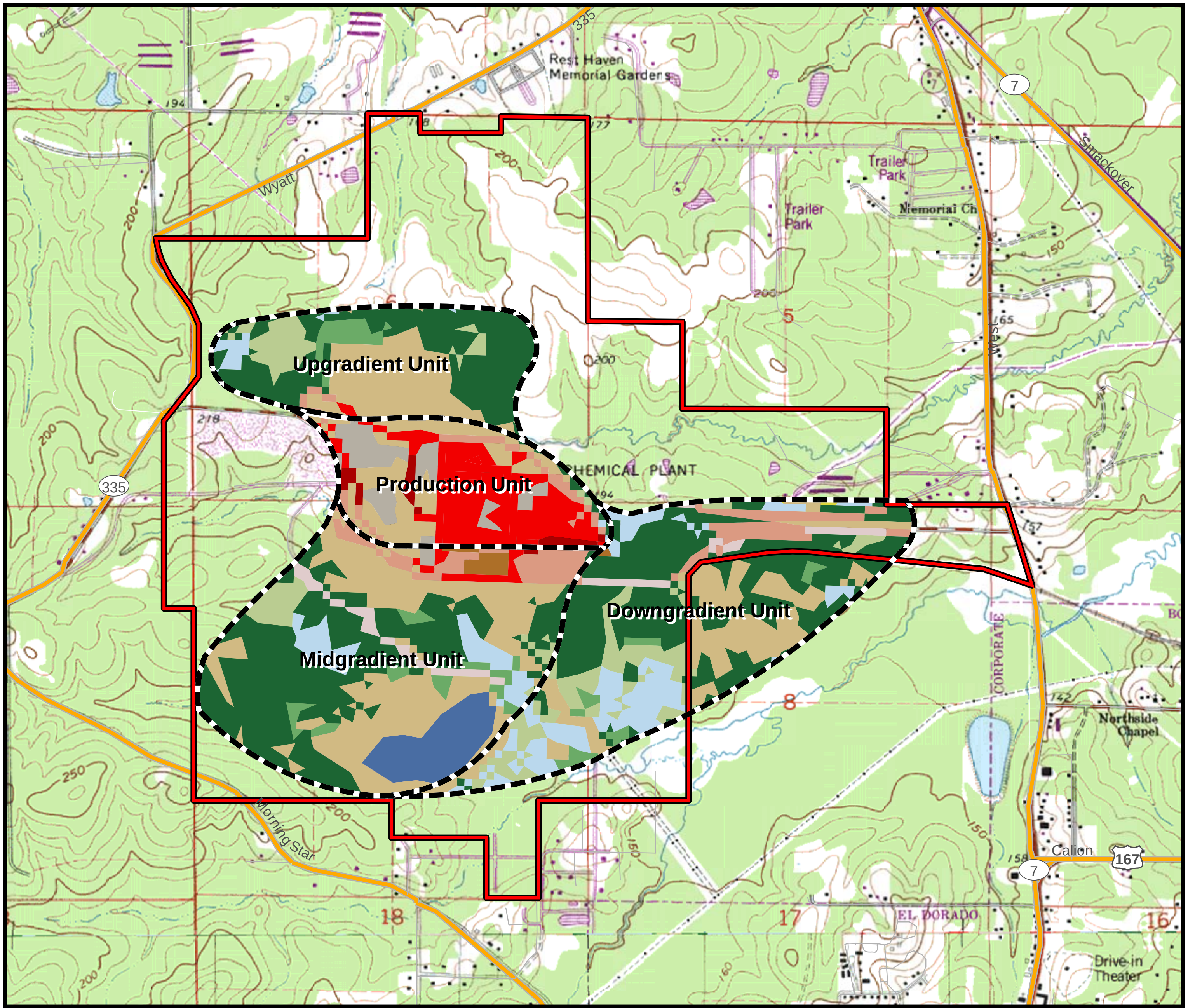
The UGGU comprises approximately 132 acres within the EDCC facility (approximately 16%). The UGGU is dominated by pine forest and mixed pine deciduous forest (approximately 63%) and sub-dominant land use being shrub/scrub grasslands. There is little industrial development within this operational unit. Although the UGGU contains habitat suitable for ecological receptors, there has been no documentation of surface water connection to the groundwater. In addition, the previous groundwater investigations have identified this unit as Upgradient and represents the background condition utilized in the ERA.

As in other operational units, there is no existing surface connection with groundwaters and little potential for uncontrolled release should any connection develop. Any potential groundwater release within the Upgradient Unit would be controlled into the existing waste water treatment/spill control as regulated through the NPDES permit.

6.1.5.2 Production Groundwater Unit (PGU)

The PGU comprises approximately 122 acres within the EDCC facility (15%). The area within the PGU is dominated by facilities developed for production. The PGU of the facility contains no permanent water bodies, has little or no vegetation, other than mowed road shoulders and administrative office lawn, contains little habitat suitable for ecological receptors.

In addition there is no existing surface connection with groundwaters and little potential for uncontrolled release should any connection develop. Any potential groundwater release within the production unit would be controlled and routed into the existing waste water treatment/spill control as regulated through the NPDES permit. For these reasons (e.g., lack of habitat to support receptors and existing regulatory controls), ecological risks within the PGU is limited to hypothetical scenarios only. Despite the low risk potential to ecological receptors, the risk was estimated as discussed in Section 6.6.



Upgradient Unit		
Vegetation Description	*Acres*	*%*
Developed, Low Intensity	1.55	1.18%
Developed, Medium Intensity	0.80	0.61%
Barren Land	0.05	0.04%
Deciduous Forest	7.02	5.35%
Evergreen Forest	62.69	47.72%
Mixed Forest	13.86	10.55%
Scrub/Shrub	41.29	31.43%
Woody Wetlands	4.09	3.11%
Totals	131.36	100.00%

Midgradient Unit		
Vegetation Description	*Acres*	*%*
Open Water	26.45	8.78%
Developed, Open Space	8.27	2.75%
Developed, Low Intensity	17.74	5.89%
Developed, Medium Intensity	4.98	1.65%
Developed, High Intensity	0.50	0.17%
Barren Land	1.18	0.39%
Deciduous Forest	9.96	3.31%
Evergreen Forest	110.28	36.62%
Mixed Forest	9.83	3.27%
Scrub/Shrub	90.30	29.99%
Cultivated Crops	4.44	1.48%
Woody Wetlands	17.16	5.70%
Totals	301.11	100.00%

Downgradient Unit		
Vegetation Description	*Acres*	*%*
Developed, Open Space	7.05	2.62%
Developed, Low Intensity	17.14	6.38%
Deciduous Forest	7.01	2.61%
Evergreen Forest	110.31	41.03%
Mixed Forest	32.87	12.23%
Scrub/Shrub	53.61	19.94%
Pasture/Hay	0.41	0.15%
Cultivated Crops	0.40	0.15%
Woody Wetlands	40.05	14.90%
Totals	268.86	100.00%

Production Unit		
Vegetation Description	*Acres*	*%*
Developed, Low Intensity	9.15	7.49%
Developed, Medium Intensity	51.11	41.86%
Developed, High Intensity	6.34	5.20%
Barren Land	19.88	16.28%
Evergreen Forest	2.53	2.08%
Mixed Forest	0.45	0.37%
Scrub/Shrub	32.19	26.37%
Woody Wetlands	0.43	0.36%
Totals	122.08	100.00%

Land Use Description

- 🟦 Open Water
- ▨ Developed, Open Space
- ▨ Developed, Low Intensity
- 🟥 Developed, Medium Intensity
- 🟥 Developed, High Intensity
- ▨ Barren Land
- 🟩 Deciduous Forest
- 🟩 Evergreen Forest
- 🟩 Mixed Forest
- 🟫 Scrub/Shrub
- 🟨 Pasture/Hay
- 🟫 Cultivated Crops
- 🟦 Woody Wetlands

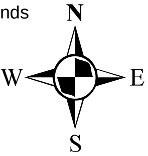


Figure 6.4. El Dorado Chemical Company land use designations for each unit descriptor.

6.1.5.3 Midgradient Groundwater Unit (MGGU)

The MGGU comprises approximately 301 acres within the EDCC facility (representing approximately 37 % of the facility) The MGGU is dominated by forest and shrub/scrub habitats (70%). In addition, the primary treatment pond (Lake Kildeer) is within this AOI. Although there are ecological receptors within this AOI, there is no documentation to support a nexus with the underlining contaminated groundwater. The historical groundwater investigations (see section 3.0) have not identified any connection with Lake Kildeer.

In addition, no surface release in the form of springs and/or seeps have been identified or documented as part of any other historical surface water or groundwater investigations. However, the potential for surface exposure is assumed to exist and the ecological risk due to the contaminated groundwater will be determined in the following sections (See Section 6.6).

6.1.5.4 Downgradient Groundwater Unit (DGGU)

The DGGU comprises approximately 261 acres within the EDCC facility (representing approximately 33 % of the facility). The habitat within the DGGU is co-dominated by loblolly pine forest (approximately 37%) and shrub/scrub perennial vegetation (approximately 31%) along the riparian right of way of the unnamed tributary to Flat Creek. The unnamed tributaries to Flat Creek are designated as supporting a seasonal warm water fishery, including the necessary aquatic organisms to support that fishery (ADEQ, 2003). The DGGU is representative of the Eastern property boundary of EDCC, and thence consistent with risks potentially moving offsite.

There are areas of limited development in the northern pat of the DGGU. Although there are ecological receptors within this AOI, there is no documentation to support a nexus with the underlining contaminated groundwater. The historical groundwater investigations (see section 3.0) have not identified any connection with the unnamed tributary or other wetland areas within the DGGU.

In addition, no surface release in the form of springs and/or seeps have been identified or documented as part of any of the historical surface water or groundwater investigations. However, the potential for surface exposure is assumed to exist and the potential ecological risk due to the contaminated groundwater is presented in Section 6.6.

6.2 Nature And Extent Of Contamination

For the purposes of this assessment, areas of potential ecological exposure have been evaluated within each of the groundwater units and along the unnamed tributaries to Flat Creek, including locations that are not believed to be impacted by site-related releases and that serve as reference areas for the site. These reaches and reference areas are listed below (Table 6.1) and are shown previously in Figure 6.3 and 6.4.

Table 6.1 Groundwater Unit Descriptions

Groundwater Units and Reference areas	Description
Upgradient Groundwater Unit	North and west of Production facility. Wells number ECMW 1-3 representing background conditions.
Production Groundwater Unit	Industrial Area of Facility ECMW 4-11
Midgradient Groundwater Unit	Groundwater unit south of production unit including Lake Kildeer and including well numbers ECMW, 14-16..
Downgradient Groundwater Unit	Groundwater unit to southeast of production facility, identified by Wells ECMW 17-22.
Unnamed Tributary B 001 to Flat Creek	Unnamed tributary, originating west of facility flowing to southeast, receiving discharge from Outfall 001
Unnamed tributary A to Flat Creek	Unnamed tributary, originating south and west of EDCC facility, flowing to east and draining southern facing slopes of watershed.

Appendix B provides summary statistics (detection frequency, average, minimum, maximum) for each analyte in each medium in each exposure area.

6.3. Problem Formulation

Problem formulation is a systematic planning step that identifies the major concerns and issues to be considered in the ERA, and a description of the basic approach that will be used to characterize the potential risks that may exist (USEPA 1997). Problem formulation usually begins by development of a conceptual site model that identifies sources of chemical release to the environment, evaluates the fate and transport of chemicals in the environment, and identifies exposure pathways of potential concern for ecological receptors. Based on the conceptual site model, assessment endpoints, measurement endpoints, and testable hypotheses are identified that form the basis of the ERA. As discussed in USEPA guidance (USEPA 1997), problem formulation is an iterative process, undergoing refinement as new information and findings become available.

6.3.1 Screening-Level Assessment

Although not completed independently of this baseline ERA, the data utilized in the ERA was initially screened to determine: 1) data quality, 2) identify data gaps that would prevent the completion of the baseline ERA, and 3) verify if COPC were presented at concentrations that would require development of risk endpoints.

6.3.1.1 Sources of Contamination

At the time of the baseline ERA, the source of potential concern was the potentially contaminated groundwaters, which had been identified during preliminary groundwater monitoring efforts required by the ADEQ. Preliminary investigations to identify elevated levels of chemicals in groundwater have been completed as summarized in Section 3.0. The area of potential ecological concern was groundwaters within the facility property boundaries.

6.3.1.2 Ecological Receptors of Potential Concern

Initially, ecological receptors were not evaluated as part of the preliminary data assessment. It was not until the baseline assessment that individual ecological receptors were evaluated. These included aquatic life receptors, (fish and invertebrate communities that reside in the unnamed tributaries of Flat Creek and wildlife receptors in the riparian zones of the unnamed tributaries to Flat Creek and in the undeveloped landscape of the EDCC site.

6.3.1.3 Exposure Pathways Evaluated

Exposure pathways that were evaluated in the assessment included:

- Direct contact of aquatic receptors with surface water contaminated by groundwater seeps and or springs,
- Direct contact of benthic macro invertebrates with sediment contaminated by groundwater seeps and /or springs,

- Direct contact of terrestrial plants that may uptake contaminated groundwaters, and
- Ingestion by wildlife receptors of surface water and soils contaminated by groundwater.

6.3.1.4 Summary of Risk Findings

Although there is no documented nexus between existing groundwater and surface water feature (therefore, there is no existing completed pathway), the ERA was completed based the hypothetical potential that a future connection could develop.

Based on the preliminary risk characterization, all of the exposure pathways with the exception of direct contact with aquatic receptors and ingestion by wildlife could be excluded, and further evaluation was recommended for these pathways. However, in many cases, the available information on the nature and extent of contamination was limited, and the preliminary assessment identified a number of data areas where additional information could improve the reliability of the risk assessment. These areas include: documentation of any actual surface connection between the groundwater and surface waters, sediment concentrations of COPC, soil concentrations of COPC, and sediment toxicity of the receiving streams into which any groundwater might discharge. These data gaps should be considered in the final assessment of the ultimate remedy.

6.3.2 Baseline ERA Site Conceptual Model

Figure 6.5 presents the site conceptual model (SCM) for the baseline ERA. It should be noted that there is no documented connection between the contaminated groundwater and the ecological endpoints considered. However, no pathways could be excluded as a result of the theoretical approach taken in developing the preliminary ERA. This site model is very similar to the site model that was developed for the HHRA.

As indicated in the SCM, although there are a number of exposure pathways by which ecological receptors may come into contact with site-related groundwater, exposure pathways are not likely to be of equal concern. For the purposes of this ERA, each exposure pathway has been classified as follows:

- The pathway is considered to be of potential concern, and data exist to support a quantitative risk evaluation. These cases are indicated by boxes containing a solid circle (●). These pathways are the primary focus of this risk assessment.

- The pathway is considered to be of potential concern, but the pathway is incomplete or available data are too limited to support a reliable quantitative risk evaluation. These cases are shown by boxes with an open circle (○).
- The risk posed by the pathway is likely to be minor, either on an absolute basis and/or in comparison to other exposure pathways that affect the same receptor. These cases are indicated by boxes with an "X". Because these pathways are judged to be of minor concern, they are not evaluated quantitatively in the ERA.

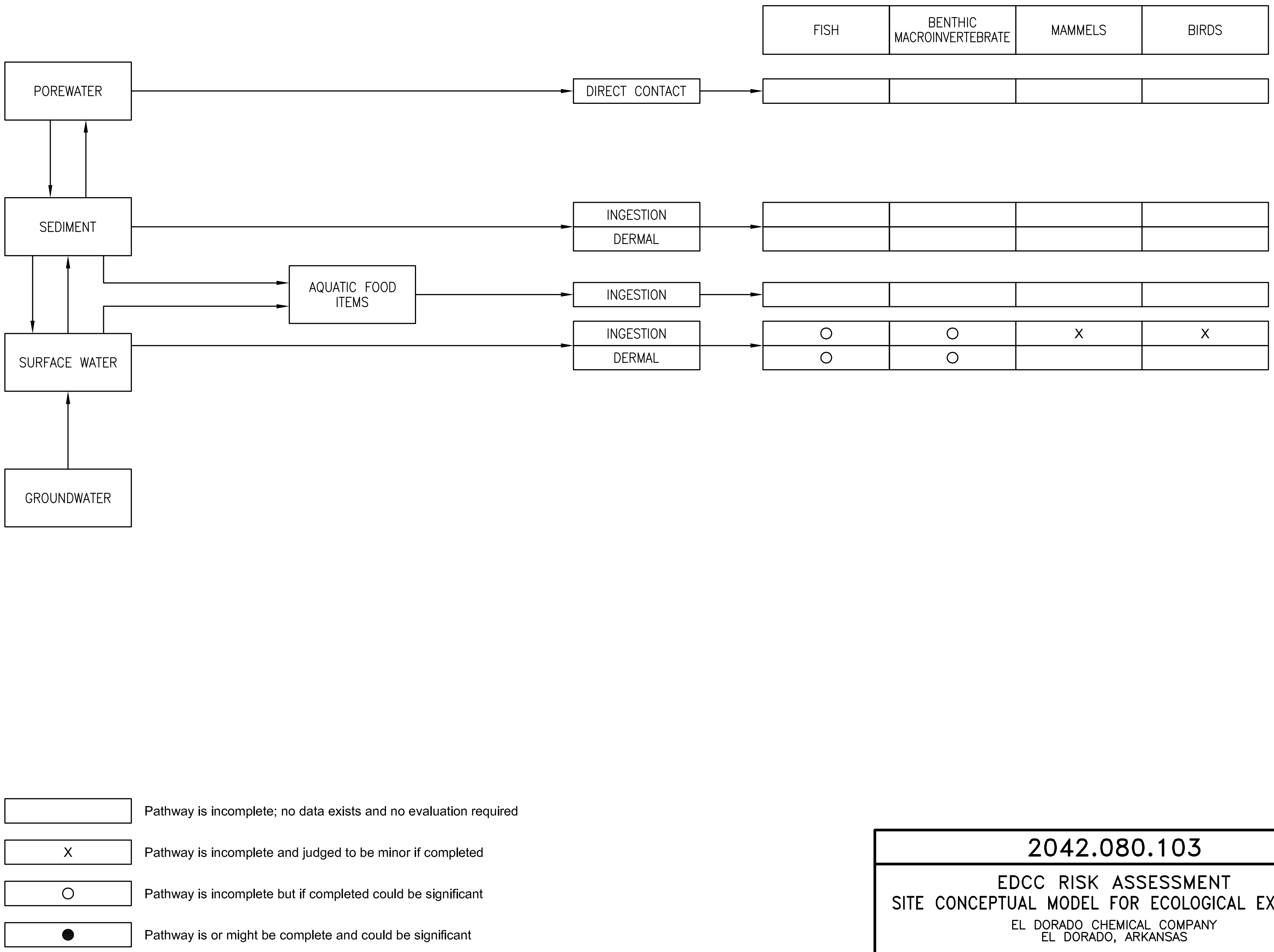
The following section provides a discussion of these exposure pathways.

6.3.2.1 Exposure Pathways and Receptors

Receptors identified for this assessment include aquatic receptors (fish and benthic macro invertebrates), and wildlife receptors (avian and mammalian). These receptors may be potentially exposed to chemical contamination via exposure to groundwater (Figure 6.5), including direct contact via surface water, sediment, or sediment porewater, or indirectly via aquatic food items, surface soil, and terrestrial food items. The following identifies which pathways are of chief concern at this site and which were selected for quantitative evaluation.

Aquatic Receptors

- The main pathway of exposure for all aquatic receptors is direct contact with surface water only in the event that groundwater seeps into the surface water. This pathway was evaluated qualitatively for fish and benthic macro invertebrates, collectively as aquatic receptors.
- Direct contact with sediment and porewater is a potentially significant pathway for benthic macroinvertebrates (less so for fish) in the case that groundwater seeps enter the subsurface ecosystem. Data is not available to allow an assessment of risks from direct contact with sediment and porewater, and such assessment is beyond the scope of the CAO and is not explored in this ERA.



		FISH	BENTHIC MACROINVERTEBRATE	MAMMELS	BIRDS
POREWATER	DIRECT CONTACT				
SEDIMENT	INGESTION				
	DERMAL				
AQUATIC FOOD ITEMS	INGESTION				
SURFACE WATER	INGESTION	○	○	X	X
	DERMAL	○	○		

	Pathway is incomplete; no data exists and no evaluation required
X	Pathway is incomplete and judged to be minor if completed
○	Pathway is incomplete but if completed could be significant
●	Pathway is or might be complete and could be significant

Figure 6.5. Site conceptual model for eco-risk.

2042.080.103

EDCC RISK ASSESSMENT
SITE CONCEPTUAL MODEL FOR ECOLOGICAL EXPOSURE
EL DORADO CHEMICAL COMPANY
EL DORADO, ARKANSAS

Approved by:	MSR	GBMc STRATEGIC ENVIRONMENTAL SERVICES 219 Brown Lane Bryant, AR 72022	Project No.:	2042-07-080
Checked by:	GLP		Date:	JULY 31, 2007
Drawn by:	RW		Scale:	---

Wildlife Receptors

- Wildlife receptors (birds, mammals) may be exposed by ingestion of surface water, contaminated by potential groundwater intrusion (which has not been documented) and this pathway was evaluated quantitatively.
- Wildlife receptors (birds, mammals) may be exposed by ingestion of food web items and or sediment/soil. However, these exposure pathways are beyond the scope of the CAO and are not explored as part of this ERA.
- Inhalation exposure may be possible for all terrestrial receptors. However, this pathway is generally very minor, and was not evaluated.

Terrestrial Plants and Soil Invertebrates

- The primary exposure pathway for both terrestrial plants and soil invertebrates is direct contact with contaminated groundwaters. No data was available for plants or soil contaminant levels. Therefore this pathway is beyond the scope of the CAO and this pathway was not evaluated as part of this ERA

6.3.2.2 Selection of Wildlife Indicator Species

It is not feasible to evaluate exposures and risks for each avian and mammalian species potentially present at the site. For this reason, specific wildlife species are identified as surrogates (representative species) for the purpose of estimating exposure and risk. The surrogate species are wildlife species present at the site that are representative of other species with similar dietary preferences and feeding guilds. Selection criteria for wildlife surrogate species include trophic level, feeding habits, and the availability of life history information. The species identified as surrogate species at this site include:

American robin *(Turdus migratorius). Widely distributed over the US*. Large population increase during winter southern migrations. The American robin represents avian insectivorous passerine species that feed primarily on soil invertebrates. (Martin, Zim and Nelson, 1951).

White Footed Mouse (*Peromyscus leucopus*). Commonly found in the lower regions of Arkansas, the white footed mouse represents insectivorous mammalian species that nests on the ground and feed on seeds, nuts and insects. The home range is small (½ to 1.5 acres). Opportunistic nester. (Burt and Grossenheider, 1976).

Eastern Cottontail Rabbit (*Sylvilagus floridanus*). The Eastern Cottontail rabbit is a vegetarian with small home range 3-20 acres depending on available food and shelter. Inhabits a wide variety of vegetation types but prefers heavy cover with herbaceous vegetation.

White Tailed Deer *(Odocoileus virginianus*). The White-tailed deer is a recreationally important species in southern Arkansas. The deer is a vegetarian and consumes a wide variety of plants. The species is very adaptable and tolerates human activity well. Exposure profiles are presented for each of these representative species in Appendix D.

6.4 Management Goals

Management goals are descriptions of the basic objectives which the risk manager at a site wishes to achieve. The overall management goal identified for ecological health at the EDCC site is as follows (USEPA 1999b):

Ensure adequate protection of ecological systems within the impacted areas of the EDCC site by protecting them from the deleterious effects of acute and chronic exposures to site-related contaminants of concern.

"Adequate protection" is generally defined as protection of growth, reproduction, and survival of local populations. That is, the focus is on ensuring sustainability of the local population, rather than on protection of every individual in the population. In order to provide greater specificity regarding this general goal and to identify specific measurable ecological values to be protected, the following list of sub-goals was derived:

- Ensure adequate protection of terrestrial soil organisms and plant communities by protecting them from the deleterious effects of chronic exposures to site-related contaminants of concern within the groundwater.
- Ensure adequate protection of aquatic life in the unnamed tributaries of Flat Creek from the deleterious effects of chronic exposures to site-related contaminants of concern in the event that the groundwater

should enter in to the surface water ecosystems.

- Ensure adequate protection of aquatic and terrestrial mammal and bird populations by protecting them from the deleterious effects of chronic exposures to site-related contaminants of concern in the event that the groundwater should enter in to the surface terrestrial ecosystems.

6.5 Assessment and Measurement Endpoints

Assessment endpoints are explicit statements of the characteristics of the ecological system that are to be protected. Assessment endpoints are either measured directly or are evaluated through indirect measures. Measurement endpoints represent quantifiable ecological characteristics that can be measured, interpreted, and related to the valued ecological components chosen as the assessment endpoints (USEPA 1992, 1997a).

Assessment and measurement endpoints are used to interpret potential ecological risks for the EDCC site. These measurement endpoints can be divided into three basic categories of approach, as follows:

- Hazard Quotients (HQs)
- Site-specific toxicity tests (SSTTs)
- Observations of population and community demographics (bioassessment.)

Each of these three basic approaches is described below.

6.5.1 Method 1: Hazard Quotients

Basic Equation

A HQ is the ratio of the estimated exposure of a receptor at the site to a "benchmark" exposure that is believed to be without significant risk of unacceptable adverse effect:

HQ = Exposure / Benchmark

Exposure may be expressed in a variety of ways, including:

- Concentration in an environmental medium (water, sediment, soil, diet)
- Concentration in the tissues of an exposed receptor
- Amount of chemical ingested by a receptor

In all cases, the benchmark toxicity value must be of the same type as the exposure estimate.

Interpretation of HQ Values

If the value of an HQ is less than or equal to 1, risk of unacceptable adverse effects in the exposed individual is judged to be acceptable. If the HQ exceeds 1, the risk of adverse effect in the exposed individual is of potential concern. When interpreting HQ results for ecological receptors, it is important to remember that the assessment endpoint is usually based on the sustainability of exposed populations, and risks to some individuals in a population may be acceptable if the population is expected to remain healthy and stable. In these cases, population risk is best characterized by quantifying the fraction of all receptors that have HQ values greater than 1, and by the magnitude of the exceedences. Clearly, if all HQs for individuals in a population of receptors are below 1, it is believed that no unacceptable effects will occur in the exposed population. Conversely, if many or all of the individual receptors have HQs that are above 1, then unacceptable effects on the exposed population are likely, especially if the HQ values are large. If only a small portion of the exposed population has HQ values that exceed 1, some individuals may be impacted, but population-level effects are not likely to occur. As the fraction of the population with HQ values above 1 increases, and as the magnitude of the exceedences increases, risk that a population-level effect will occur also increases.

The fraction of the population that must have HQ values below a value of 1 in order for the population to remain stable depends on the species being evaluated and on the toxicological endpoint underlying the toxicity benchmark (USEPA 2001c). Reliable characterization of the impact of a chemical stressor on an exposed population risks requires knowledge of population size, birth rates, and death rates, as well as immigration and emigration rates. Because this type of detailed knowledge of population dynamics is generally not available on a site-specific basis, extrapolation from a distribution of individual risks to a characterization of population-level risks is generally uncertain. For the purposes of this assessment, it is assumed that if at least 80% of the individuals in a population have an HQ≤1, risks to the population will be minimal. Conversely, it is assumed that if more than 20% of the individuals in a population have HQ values above 1, then there is a potential risk to that population. It should be emphasized that this is a screening level assumption based on professional judgment, and that actual risks to populations are expected to gradually transition from "acceptable" to "unacceptable" as the frequency and magnitude of HQ values above 1 increases.

In cases where a substantial fraction of the available concentration data are below the limit of detection, and the limit of detection is above the level corresponding to an HQ of 1, it is usually not possible to estimate the fraction or magnitude of individual HQ values above 1, since HQ values for non-detects might be either above or below a level of 1. Based on this approach, risks to a sub-population of receptors residing in an exposure area were classified into one of three categories, as shown below (Table 6.2).

Table 6.2. Summary of Risk Categories.

Risk Category	Distribution of HQ values	Preliminary Conclusion
A	Greater than 20% of HQs based on detects exceed 1.	Risks to the population at this location are possible.
B	There are at least 20% of the HQs greater than 1, but these are partly or entirely based on non-detects or the TBV is not available or unreliable. The method detection limit was inadequate to quantify risk.	Risk to the population at this location cannot be determined.
C	Greater than 80% of all HQs (based on non-detects and detects) are below 1.	Risks to the population at this location are expected to be minimal and are assumed to be acceptable.

6.5.2 Selection of Chemicals of Potential Concern for the HQ Approach

An HQ value may be derived for any chemical for which adequate exposure and toxicity data are available. However, it is usually helpful to restrict the number of chemicals evaluated quantitatively to a subset of all chemicals for which data exist. These are referred to as COPCs. The general procedure used in this risk assessment to select COPCs for quantitative evaluation by the HQ approach is presented in Section 4.0

In most cases, HQ values are not based on site-specific toxicity data, and do not account for site-specific factors that may either increase or decrease the toxicity of the metals compared to what is observed in the laboratory. Therefore, HQ values should be interpreted as estimates rather than highly precise predictions and should be viewed as part of the weight-of-evidence along with the results of site-specific toxicity testing and direct observations on the structure and function of the aquatic community (see below).

6.5.3 Method 2: Site-Specific Toxicity Tests

Site-specific toxicity tests measure the response of receptors that are exposed to site media. This may be done either in the field or in the laboratory using media collected on the site. The chief advantage of this approach is that site-specific conditions which can influence toxicity are usually accounted for. A potential disadvantage is that, if toxic effects are observed to occur when test organisms are exposed to site media, it is usually not possible to specify which chemical or combination of chemicals is responsible for the effect. Rather, the results of the toxicity testing reflect the combined effect of the mixture of chemicals present in the site medium. In addition, it is often difficult to test the full range of environmental conditions which may occur at the site across time and space, either in the field or in the laboratory, so these studies are not always adequate to identify the boundary between exposures that are acceptable and those that are not.

6.5.4 Community Bioassessment

A third approach for evaluating impacts of environmental contamination on ecological receptors is to make direct observations on the receptors in the field (bioassessment), seeking to determine whether any receptor population has unusual numbers of individuals (either lower or higher than expected), or whether the diversity (number of different species) of a particular category of receptors (e.g., fish, benthic organisms, birds) is different than expected. The chief advantage of this approach is that direct observation of community status does not require making the numerous assumptions and estimates needed in the HQ approach. However, there are also a number of important limitations to this approach. The most important of these is that both the abundance and diversity of an ecological population depend on many site-specific factors (habitat suitability, availability of food, predator pressure, natural population cycles, meteorological conditions, etc.), and it is often difficult to know what the expected (non-impacted) abundance and diversity of an ecological population should be in a particular area. This problem is generally approached by seeking an appropriate "reference area" (either the site itself before the impact occurred, or some similar site that has not been impacted), and comparing the observed abundance and diversity in the reference area to that for the site. However, it is sometimes quite difficult to locate reference areas that are truly a good match for all of the important habitat variables at the site, so comparisons based on this approach do not always establish firm cause-and-effect conclusions regarding the impact of environmental contamination on a receptor population. In the case of the EDCC site the communities (aquatic and terrestrial) may be effected by contaminate sources other than groundwater (i.e. storm water, soils, etc.). Therefore, it is difficult to determine direct associations between potential groundwater impacts and community affects. One aspect of the EDCC site condition that should be stressed is the absence of known surface conduits for groundwater. If groundwater does not enter surface water bodies it cannot pose ecological risk.

6.5.5 Weight of Evidence Evaluation

As noted above, each of the measurement endpoints has advantages but also has limitations. For this reason, conclusions based on only one method of evaluation may be misleading. Therefore, the best approach for deriving reliable conclusions is to combine the findings across all of the methods for which data are available, taking the relative strengths and weaknesses of each method into account. If the methods all yield similar conclusions, confidence in the conclusion is greatly increased. If different methods yield different conclusions, then a careful review must be performed to identify the basis of the discrepancy, and to decide which approach provides the most reliable information.

6.6 Risk Assessment

6.6.1 Hazard Quotient Approach

As discussed in Section 4.0, site-related contaminants are of potential concern in the EDCC groundwater. These groundwaters typically have no ecological receptors while contained in the aquifer and to date there is no evidence or information to document that the groundwaters have escaped containment. However, should the groundwaters become surface flows through seeps and/or springs ecological receptors may be exposed to contaminants through several potential pathways. Based on the site conceptual model (Figure 6.5), the following exposure pathways have been selected for quantitative evaluation by the HQ approach:

- Direct contact with chemicals dissolved or suspended in surface water. This pathway is most applicable to fish, but is also applicable to benthic organisms that reside in the uppermost portion of the sediment substrate.

These HQ-based evaluations are described below.

6.6.2 Risks to the Aquatic Receptors from Direct Contact of Groundwater as Surface Water

6.6.2.1 Exposure Assessment

An HQ value is calculated for each groundwater unit for each chemical. In accord with USEPA guidance, non-detects were evaluated conservatively as equal to the detection limit. The concentration of a metal in surface water may be expressed either as total recoverable or as "dissolved" (that which passes through a fine-pore filter). There is general consensus that toxicity to aquatic receptors is dominated by the level of dissolved chemicals (Prothro 1993), since chemicals that are adsorbed onto particulate mater may be less toxic that the dissolved forms. However, at this site, data for metals in surface water are based on total recoverable. In some cases the difference between total recoverable and dissolved may be small, but calculating risks to aquatic receptors based on total recoverable could lead to an overestimate of actual risks.

6.6.2.2 Toxicity Assessment

TBV for the protection of aquatic life from direct contact with contaminants in surface water are available from several sources. Each of the sources evaluated in deriving surface water benchmarks is described briefly in Appendix D. The selected TBVs for all chemicals analyzed in surface water are shown in Table 6.3.

Table 6.3. Aquatic life TBV's used in development of HQ's.

Toxicity Benchmark Values (TBV)			
	Chronic (mg/L)	**Acute (mg/L)**	**Source**
Ammonia	2.56	54.99	USEPA-AWQC
Total Chromium	0.011	0.016	AR-WQC
Total Lead	0.0007	0.018	AR-WQC
Nitrate	42.6	--	SETAC
Sulfate	--	125	[1]AR-SSWQC
TDS	--	475	[1]AR-SSWQC

[1]. Arkansas site specific water quality criterion for tributary to Flat Creek. Based on bioassessment and historical 99th percentile effluent values. Assumed to represent a NOEC but not toxicity based.

6.6.2.3 COPC Selection

Surface water COPCs for aquatic receptors were selected using the procedure described in Section 4, and based on all available groundwater data from the individual groundwater units. Point concentrations for each chemical (95% UCL) were compared to their respective chronic and/or acute benchmark values (Table 6.3). Note that toxicity benchmarks for a number of inorganic chemicals (metals) in surface water are hardness dependent. For simplicity, the toxicity benchmarks used in the COPC screen were calculated based on the ecoregion specific hardness default value utilized by ADEQ in the development of NPDES permitting and is based on the Gulf Coastal ecoregion least disturbed streams (31 *mg/L).* The results of the COPC selection procedure for exposure of aquatic receptors to surface water are detailed in Appendix B and the chemicals that were selected for quantitative evaluation are presented below (Table 6.4).

Because the toxicity of COPCs in surface water to aquatic receptors is usually dependent on the length of exposure, the HQ was calculated both for short-tern (acute) and long-term (chronic) exposure conditions for COPC with chronic HQ in excess of 1.0. For those COPC with chronic HQ ≤1, acute HQ were not calculated. In cases where the acute and chronic benchmarks are hardness-dependent, toxicity benchmarks were calculated for each sample based on the hardness of that sample. If a sample hardness was not reported or could not be estimated, the HQ was calculated based on the average ecoregion hardness (31 *mg/L).*

The detailed calculations of HQ values for each COPC in each sample are presented in Appendix D. A summary of the HQ's are presented in Table 6.4.

Table 6.4. Summary of aquatic life HQ>1.0.

COPC	**Groundwater unit**			
	Upgradient GU	**Production GU**	**Midgradient GU**	**Downgradient GU**
Ammonia-Acute	--	1.11	--	--
Ammonia-Chronic	--	23.87	1.42	--
Total Chromium-Acute	--	--	--	--
Total Chromium-Chronic	--	--	--	--
Total Lead-Acute	1.11	1.11	1.17	1.78
Total Lead-Chronic	28.57	28.57	30.00	45.71
Nitrate	--	7.39	--	--
Sulfate	--	3.92	--	--
TDS	--	5.55	1.05	1.20

As discussed in Section 6.5, the population-level risk in each groundwater unit was classified into one of three risk categories based on the fraction of the HQ distribution above a value of 1. These results are summarized in Table 6.5. The following conclusions are based on the summary presented in Table 6.5 and supported by Appendix D:

Based on the aquatic life benchmarks, only, total chromium was assigned to risk category C for all groundwater units. Total chromium was treated as hexavalent chromium which is the more toxic form of the metal. According to USEPA Region 6 risk assessment screening levels, chromium can be assumed to speciate at a 1:6 ratio of hexavalent to trivalent chromium. When treated in this fashion total chromium HQ were all ≤ 1.0 placing it in the category C designation. Therefore, risks to the population from chromium in all the groundwater units are expected to be minimal and are assumed to be acceptable.

Based on chronic benchmark several inorganic COPC's (including ammonia, nitrate, sulfate, and TDS) are initially assigned to risk category A from one or more of the groundwater units.

Lead is assigned to a Category B, as its HQ's were largely based on non-detect values which were evaluated above the TBV. In addition, risks in the upgradient unit (i.e. reference areas) are approximately the same as in area potentially impacted should aquatic receptors be exposed to the site groundwater.

In the case of sulfate and TDS actual toxicity data indicates that LOAEL's are much higher than the bench marks (conservative NOAEL) used by ADEQ, it is concluded that the chronic toxicity benchmarks for these chemicals are probably overly-conservative for application at this site and that chronic risks from these inorganic COPCs in surface water are not likely to be of population level concern to aquatic receptors. Therefore sulfate and TDS are assigned to the B category but could meet requirements for placement in Category C.

Table 6.5. Summary of conclusions drawn concerning risk to aquatic receptors.

Risk Category	Distribution of HQ values	Preliminary Conclusion	COPC	Groundwater Unit
A	Greater than 20% of HQs based on detects exceed 1.	Risks to the population at this location are possible.	Ammonia	Production & Midgradient
			Nitrate	Production
B	There are at least 20% of the HQs greater than 1, but these are partly or entirely based on non-detects or the TBV were unavailable or unreliable. The method detection limit was inadequate to quantify risk.	Risk to the population at this location cannot be determined.	Total Lead Sulfate TDS	All Units Production Production, Midgradient and Downgradient
C	Greater than 80% of all HQs (based on non- detects and detects) are below 1.	Risks to the population at this location are expected to be minimal and are assumed to be acceptable.	Ammonia	Downgradient
			Total Chromium	ALL
			Nitrate	Upgradient, Midgradient,& Downgradient
			Total Vanadium	ALL
			Sulfate	Upgradient, Midgradient,& Downgradient
			TDS	Upgradient, Midgradient, & Downgradient

6.6.3 Risks to Benthic Macroinvertebrates from Direct Contact with Groundwaters

6.6.3.1 Exposure Assessment

Benthic macroinvertebrates that spend some or most of their life cycle within the sediment substrate are exposed to chemicals through direct contact with sediment. However, any contact with the groundwater COPCs would occur only as the groundwater became surface flows. This exposure has not been documented in the historical groundwater assessments and or monitoring and therefore the potential exposure to aquatic invertebrate community is addressed as part of the aquatic life hazard assessment.

In addition, concentrations of chemicals in groundwater are usually not as time-variable as concentrations in surface water, concentrations may fluctuate as contaminated groundwaters are added or removed to surface water flow. In addition, data has demonstrated variability in concentrations at any specific groundwater unit. Therefore, exposure due to sediment concentration is usually best characterized as a distribution of individual values. However, there are no measurements of sediment concentration available from any groundwater unit therefore risk to benthic macroinvertebrates were considered as part of the aquatic life hazard assessment.

6.6.3.2 Evaluation of Site-Specific Toxicity Tests

One way to help reduce the uncertainty associated with HQ values based on TBV is to perform direct toxicity testing using site-specific media, in this case, groundwater samples. Tests of this type have not been performed on site groundwaters. However, the analytical chemistry of groundwater monitoring has demonstrated that the pH of the groundwaters from all units are well below 6 SU. It is anticipated that should toxicity tests be performed, the toxicity tests would demonstrate a significant difference in the groundwater and lab control water exposures. The low pH would present toxicity to routine test organisms and limit the ability of the test to measure potential toxicity from other COPC. However, no groundwater outlet to the surface is known to exist on the EDCC property, an any pathway by which groundwater (seeps, etc) would find a surface outlet would likely require exposure with multiple soil horizons allowing the pH to be buffered prior to discharge. Therefore, risks from pH are believed to be minimal.

6.6.4 Evaluation of Aquatic Community Bioassessments

Although the pathway does not currently exist, assuming to a connection from the current groundwater to the surface flows, the potential effects of chemical stressors in groundwater on surface water biotic communities can be assessed by direct observation of the density and diversity of species present in the receiving streams.

Observations on the benthic and fish community structure are available from numerous surface water quality studies not associated with the groundwater investigations. These include a 1991 water quality study (FTN, 1991), several TMDL studies (ADEQ, 1998, FTN, 2002 and FTN, 2003) addressing loadings of chloride, sulfate, TDS and ammonia. The most recent report includes aquatic life investigation of the unnamed tributaries to Flat Creek that drains the EDCC facility, and Flat and Salt Creek in Union County (GBMc, 2006). Depending on the individual project objective, each report provided data related to the surface waters associated with the EDCC facility. The 1991, 1998 and 2006 reports evaluated both bentic and fish community health by applying several community metrics to determine the biological condition of the biotic communities. For each sample, a biological condition score was derived from the available benthic metrics based on Rapid Bioassessment Protocols (RBP) for rivers and streams as described in (USEPA 1989). Each of the reports concluded that the existing beneficial fisheries uses were being maintained and that the benthic communities did not appear significantly different at any site location in comparison to the upstream reference location. The studies found that primary conditions as related to watershed size and volume of flows resulting from point source discharges had a greater influence on the biotic communities than did water quality.

6.6.5 Weight of Evidence Evaluation

6.6.5.1 Risks from Groundwater Entering Surface Waters

Three lines of evidence are available to evaluate risks from groundwaters which may be transformed to surface waters. The findings from these lines of evidence are summarized below in Table 6.6.

Table 6.6 Summary of lines of evidence for risk associated with groundwater as surface water

Line of Evidence	Findings
HQ Calculations	Based on COPC concentrations and TBV, risks to biotic stream organisms from COPC in surface water do not appear to be of population-level concern except possibly for ammonia and nitrate in the Production Unit groundwater and ammonia in the midgradient unit.
Direct Toxicity Testing	There is no toxicity data related to the groundwater from any of the EDCC groundwater units.
Population Observations	No evidence of adverse effect in the unnamed tributaries that drain EDCC facility related to the surface discharge of any groundwaters.
and related site Conditions	No Pathway for groundwater to enter surface water is known to exist at the EDCC site.

In summary, based on a weight of evidence approach, it is concluded that groundwaters are not of population-level concern to surface water biotic communities from any of the groundwater units even if groundwater were known to occur as surface water, which it does not.

6.6.6 Overall Conclusion Regarding Risks to Aquatic Receptors

The weight of evidence combined across all observations indicates that risks to aquatic receptors from site-related groundwater chemicals are low at all groundwater units, except potentially for risks to aquatic life from ammonia or nitrate should organisms be directly exposed to the Production Unit groundwater. However, as no conduits are known to exist by which groundwater would enter surface waters, therefore, ecological risks associated with groundwater are believed to be virtually nonexistent and at acceptable levels.

6.7 Risks To Wildlife Receptors

6.7.1 Overview

This section presents an assessment of the populations of wildlife receptors that reside within or near the EDCC facility. Wildlife receptors include a wide variety of mammals and birds that span a variety of sizes and feeding guilds. Exposure of wildlife receptors **may** occur through ingestion of contaminated surface water while drinking, ingestion of contaminated soil or sediment while feeding, and ingestion of contaminated food web items **should** the groundwater become mixed with surface waters. No data for soil, sediment or food web items exist. Therefore, for this assessment, only the ingestion of contaminated groundwater (while drinking) was explored.

As discussed in Section 6.3.2, it is not feasible to evaluate exposures and risks for each avian and mammalian species potentially present within the site. For this reason, specific wildlife species (Table 6.7) have been identified as surrogates (representative species) for the purpose of estimation of exposure and risk to groups of species within similar feeding guilds at this site.

Table 6.7. Summary of wildlife potential receptors.

Surrogate Species	Feeding Guild	Exposure Pathways Evaluated [A]
White-footed Mouse	Mammalian omnivore	Ingestion of surface water.
Eastern Cottontail rabbit	Mammalian herbivoure	Ingestion of surface water.
White-tailed deer		
American Robin	Avian insectivore	Ingestion of surface water.

A= Pathways evaluated are theoretical and are not documented to exist

6.7.2 Hazard Index Approach

The basic equation used for calculation of an HQ value for exposure of a terrestrial wildlife receptor to a chemical by ingestion of an environmental medium is:

$$HQ = C * IR * DF * RBA / BW * TBV$$

where:

HQ = HQ for exposure of receptor
C = Concentration of chemical in medium (mg/L)
IR = Intake rate of medium (L/day)
BW = Body weight of receptor (kg)
DF = Dietary fraction of medium derived from site (%)
RBA = Relative bioavailability of chemical in medium (%)
TBV = Toxicity benchmark value for chemical (mg/L)

Because all receptors are exposed to more than one environmental medium, the total Hazard Index (total HI) for a receptor from a specific chemical is calculated as the sum of HQs for that chemical across all exposure pathways:

If the total HI is below 1, it is believed that no unacceptable effects will occur in the exposed population from the chemical of concern. If the total HI is above 1, then unacceptable effects may occur, with the likelihood and/or severity effect tending to increase as the value of the HI becomes larger. In this risk assessment there is only one exposure pathway for each chemical, therefore the HI=HQ.

6.7.3 Exposure Assessment

Wildlife receptors are generally mobile, and hence may be exposed to a range of different concentration values in water, soil, and food web items as they move throughout their home range. As described previously, for the purposes of this assessment, the groundwater has been divided into 4 operable units based on groundwater surface elevations and the analytical chemistry that is characteristic of each. Exposure of wildlife receptors for each COPC in each groundwater unit was based on the 95% upper confidence limit (UCL) of the mean concentration or on the maximum concentration, whichever was lower.

6.7.4 COPC Selection

The COPC selection procedure for exposure of wildlife receptors at this site was performed using medium-specific concentration-based benchmarks in water. The values employed were derived by Sample et al. (1996) for several different types of mammalian and avian receptors. For COPC selection, the lowest LOAEL concentration-based TBVs for mammals and avian receptors were employed. These concentration-based benchmarks are presented in Appendix C. The 95% UCL for each COPC were compared to their respective concentration-based TBV, and HQ calculated. Chemicals that were selected for quantitative evaluation in one or more media are presented below.

6.7.5 Toxicity

Sample et at (1996) provide a summary of available data on the toxicity of chemicals in wildlife receptors. Based on these studies, Sample et al. (1996) identified avian and mammalian dose-based TBVs for each chemical for which data are adequate. Those TBV's were utilized for ammonia, total chromium, total lead and nitrate. No TBV's were available for sulfate or TDS. The minimum LOAEL for water ingestion was utilized as the TBV in calculation of each HQ.

6.7.6 Relative Bioavailability

The TBVs calculated by Sample et al. (1996) are expressed in units of ingested dose. However, the value of the TBV depends on how much of the ingested dose is actually absorbed, which in turn depends on the properties of both the chemical and the exposure medium. Ideally, toxicity studies would be available that establish empiric TBVs for all site media of concern (water, food, soil, sediment). However, most laboratory tests use either food or water as the exposure medium, and essentially no studies use soil or sediment. Therefore, in cases where a TBV is based on a study in which the oral absorption fraction is different that what would be expected for a site medium, it is necessary to adjust the TBV to account for the difference in absorption.

The ratio of absorption from the study medium compared to absorption from site medium is referred to as the relative bioavailability (RBA). For inorganic COPCs, available data on cadmium and manganese suggest that absorption from the diet is about half that from water (IRIS 2002). Based on this data bioavailability for water ingestion was assumed to be 100%.

6.7.7 Risk Calculation

6.7.7.1 Wildlife Intake Factors

Exposure parameters and dietary intake factors for each receptor for each medium were taken from toxicological bench marks for wildlife (Samples, 1996). The exposure parameters selected for each wildlife receptor are detailed in Appendix D, and are summarized in Table 6.8.

Table 6.8. Wildlife exposure parameters

	Intake Rate	Body Weight	Dietary Fraction	Bioavailability
Receptors	**(L/d)**	**(kg)**	**(%)**	**(%)**
American Robin	0.011	0.077	1	1
White Footed Mouse	0.007	0.022	1	1
Eastern Cottontail	0.116	1.2	1	1
White-tailed Deer	3.7	56.5	1	1

In all cases, the fraction of the total dietary intake that comes from within the exposure reach was assumed to be 100%. This assumption was conservative, but used because each of the groundwater unit is relatively large, and most wildlife receptors being evaluated could potentially to derive nearly all of their food from within the exposure reach (with the exception of the PGU which likely provides much less than 100% dietary intake exposure). If any receptors were to derive a significant portion of their diet from areas outside of the area being evaluated, estimated doses and risks could be lower than predicted.

6.7.7.2 Calculation of Total Hazard Indices

Table 6.9 present’s the HQ’s for each wildlife receptor for each COPC at each reach. Detailed calculations are provided in Appendix D.

Table 6.9. Summary of maximum HQ for each wildlife receptor.

COPC	Common Robin		White Footed Mouse		Eastern Cottontail		White-tailed Deer	
	Benchmark	Maximum HQ*	Benchmark	Maximum HQ*	Benchmark	Maximum HQ*	Benchmark	Maximum HQ*
	(TBV)		(TBV)		(TBV)		(TBV)	
Ammonia	22	0.40	22	0.88	22	0.27	22	0.18
Total Chromium	36.32	0.00	56.29	0.00	56.29	0.00	56.29	0.00
Total Lead	82.08	0.00	48.56	0.00	48.56	0.00	48.56	0.00
Nitrate	6061	0.01	6061	0.02	6061	0.01	6061	0.00
Sulfate	125	0.56	125	1.25	125	0.38	125	0.26
TDS	475	0.79	475	1.77	475	0.54	475	0.36

* Maximum HQ taken from either Upgradient, Production, Midgradient, or Downgradient stations.
**TBV based on aquatic receptors. No TBV available for sulfate and TDS for wildlife.

The HQ developed for each receptor as summarized in Table 6.9 demonstrates that:

American Robin. As shown in Table 6.9, risks to passerine birds (as represented by the American robin) appear to be below a level of concern for all chemicals at all groundwater units. Thus, site-related risks to the robin appear to be negligible.

White-footed Mouse As shown in Table 6.9, risks to mammalian omnivores (as represented by the white-footed mouse) were found to exceed 1.0, (1.25 and 1.77) for sulfate and TDS, respectively, in the PGU. HQ are below (1.0) and any level for potential concern for all remaining COPCs within any of the groundwater units, including the Production Unit.

Eastern Cottontail Rabbit As shown in Table 6.9, risks to the mammalian vegetarian (as represented by the rabbit) appear to be below a level of concern for all chemicals in all groundwater units.

White tailed deer As shown in Table 6.9, risks to the large bodied ruminant (as represented by the white tailed deer) appear to be below a level of concern for all COPC in all groundwater units.

Considering that only the White-footed mouse presented HQ in excess of 1.0, and these only slightly elevated and then for sulfate and TDS which have no accepted TBV, actual eco-risk is believed minimal and acceptable.

6.7.7.3 Evaluation of Site-Specific Toxicity Tests

No site-specific toxicity tests for wildlife receptors are available for the EDCC site.

6.7.7.4 Evaluation of Wildlife Surveys

No wildlife evaluations are available for the EDCC site.

6.7.7.5 Weight of Evidence

Only one line of evidence (the HQ approach) is available to evaluate risks to wildlife receptors from COPC in the groundwater units. This approach considers TBVs, intake rates, dietary fraction, body weights and bioavailability quotients in the determination of the HQ. The findings from this line of evidence are summarized below:

Line of Evidence	Findings
HQ calculations for the COPC concentrations measured in groundwater.	ALL HQ values are below a level of concern for wildlife, even if the groundwater were to become available for wildlife consumption and exposure. No TBV exist for sulfate or TDS so risks are considered minimal and acceptable.

-

6.7.7.6 Wildlife Exposure Summary

Based on this line of evidence, it is concluded that risks from site-related chemicals in groundwater, are not of population-level concern to wildlife receptors either in the riparian area along the unnamed tributaries north and south of the EDCC facility or within the Production Unit groundwater, even in the event that the groundwater developed a direct surface connection allowing exposures, that to date, have not been documented.

6.8 Summary of Ecological Risks

Based on the information developed as part of the ERA:

1. There is no known connection between groundwater and surface water on the EDCC site,
2. The ground water recovery wells further reduces the potential for the groundwater to

become site surface water in the future,

3. The weight of evidence indicates that the ecological risk to aquatic receptors from groundwater is minimal to population based communities and acceptable at EDCC.
4. The existing information demonstrates that there has been no adverse effects to existing surface waters when compared to upstream condition, and
5. The baseline assessment related to wildlife ecological risk demonstrates that none of the COPC identified from the EDCC groundwater units presents a significant risk to the wildlife of the EDCC facility even if it were to be exposed to site groundwater.

6.9 Uncertainties

Quantitative evaluation of ecological risks is generally limited by uncertainty regarding a number of important data. This lack of knowledge is usually circumvented by making estimates based on whatever limited data are available, or by making assumptions based on professional judgment when no reliable data are available. Because of these assumptions and estimates, the results of the risk calculations are themselves uncertain, and it is important for risk managers and the public to keep this in mind when interpreting the results of a risk assessment. The following text summarizes the key sources of uncertainty influencing the results of this baseline EDCC groundwater ERA.

6.9.1 Uncertainty In The Nature And Extent Of Contamination

6.9.1.1 Representativeness of Samples Collected

Concentration levels of COPCs in environmental media are often quite variable as a function of location, and may also vary significantly as a function of time. Thus, samples collected during a field sampling program may or may not fully characterize the spatial and temporal variability in actual concentration levels. At the EDCC facility, all of the field samples were collected in accordance with sampling and analysis plans that specifically sought to ensure that samples were representative. However, in some locations, the number of samples collected was relatively small. Thus, without the collection of sufficient numbers of samples over both space and time, some uncertainty remains as to whether the samples collected provide an accurate representation of the distribution of concentration values actually present.

6.9.1.2 Accuracy of Analytical Measurements

Laboratory analysis of environmental samples is subject to a number of technical difficulties, and values reported by the laboratory may not always be exactly correct. However, all data used in this risk assessment had sufficient accompanying quality assurance data to ensure that results were within acceptable bounds for accuracy and precision. The magnitude of analytical error is usually small compared to other sources of uncertainty, although the relative uncertainty increases for results that are near the detection limit.

6.9.2 Uncertainty in Exposure Assessment

6.9.2.1 Exposure Pathways Not Evaluated

Exposure pathways selected for quantitative evaluation in this ERA do not include all potential exposure pathways for all ecological receptors. Exposure pathways that were not evaluated in this ERA included:

- Ingestion of prey items and sediments by benthic invertebrates
- Ingestion of sediment, and prey items by fish
- Direct contact of fish with contaminated sediments
- Dermal exposure of wildlife to soil, sediment, and surface water
- Ingestion of terrestrial food items by wildlife receptors

As discussed previously, most of these exposure pathways are likely to be minor compared to other pathways that were evaluated, and the magnitude of the underestimation is not likely to be significant in most cases.

Based on the lack of data on the toxicity of contaminants in food chain items on aquatic invertebrate receptors, quantitative prediction of hazard using the traditional HQ and HI approach is not yet possible. To the extent that dietary exposures tend to be less important than water exposures in at least some species, failure to quantify the hazard from the ingestion pathway may not lead to a substantial underestimation of total hazard. However, the food pathway may be more important than the water pathway for some contaminants and/or some receptor species. Therefore, the inability to quantify hazard from solids (non-water) ingestion exposures is a potential source of uncertainty that may tend to underestimate impacts of contamination on aquatic macro invertebrate receptors.

Although omission of pathways can lead to an underestimation of total risk to the exposed receptors, this baseline ERA over-compensated (conservative estimation) the potential risk. This conservative approach is a result of the assumption that the groundwaters were actually evaluated as surface waters and available. It is important to note that there has been no documentation that surface exposure has ever existed, currently exists, or are anticipated to occur in the future.

6.9.2.2 Chemicals Not Detected

The COPCs addressed by this RA were stipulated in the CAO and based on the preliminary groundwater assessments. Any chemical that was not stipulated in the CAO was not evaluated in exposures of receptors. Also, in some cases, the analytical detection limit was too high to expect the chemical would be detected even if it were present at a level of concern. Omission of these chemicals could result in an underestimation of risk. However, the magnitude of the error is likely to be low in most cases. This is because if the chemical were actually site-related or if it were present at a level of substantial health concern, it likely would have occurred at levels above the detection limit at least a few times and included in the list of COPC, as was lead. Thus, while the hazard from unknown COPC it is probably not large enough to cause a substantial underestimation of risk. In addition, COPC detected below the MDL were treated as equal to the MDL providing a generous level of conservation in the 95% UCL used in HQ calculations.

6.9.2.3 Exposure Area Concentration Values

For exposures that are based on the average concentration across many samples rather than exposures that are based on individual samples (this is the case for most wildlife species), the desired input parameter is the true mean concentration of a contaminant within a medium, averaged over the area where exposure occurs. In this assessment, rather than using the sample mean, exposure was based on the 95% UCL of the mean, or the maximum value (which ever was lower). This approach is much more likely to overestimate than underestimate true risk, and this is a source of conservatism in the risk estimates.

6.9.2.4 Wildlife Exposure Factors

The intake (ingestion) rates for food, soil, water, and sediment used to estimate exposure of wildlife at the site are derived from literature reports of intake rates, average body sizes, dietary compositions, consumption rates, and metabolic rates by receptors at other locations or from measurements of laboratory-raised organisms. These values may or may not serve as appropriate models for site-specific intake rates of wild receptors at this site. Moreover, the actual dietary composition of an organism will vary daily and seasonally. These uncertainties could either under- or overestimate the actual exposures of wildlife to COPCs in water, sediment, soil, and diet.

6.9.2.5 Absorption from Ingested Doses

The toxicity of an ingested chemical depends on how much of the chemical is absorbed from the gastrointestinal tract into the body. However, the actual extent of chemical absorption from ingested media (soil, sediment, food, and water) is usually not known. The hazard from an ingested dose is estimated by comparing the dose to an ingested dose that is believed to be safe, based on tests in a laboratory setting. Thus, if the absorption is the same in the laboratory test and the exposure in the field, then the prediction of hazard will be accurate. However, if the absorption of chemical from the site medium is different (usually lower) than occurred in the laboratory study, then the hazard estimate will be incorrect (usually too high). In this assessment, estimates of wildlife exposure due to water ingestion conservatively assume a relative bioavailability of 100% for all chemicals. This assumption is expected to overestimate contaminant doses to wildlife, since absorption efficiencies for many chemicals are lower in site media than in most laboratory studies.

6.10 Uncertainties in Effects (Toxicity) Assessment

6.10.1 Representativeness of Receptors Evaluated

Risk characterizations for aquatic receptors are based on a generalized set of species found in freshwater aquatic communities. However, not all of these species are likely to occur at this site. Thus, HQ values above lE+00 may reflect risks to species that are absent at the site, and risks to species that are actually present at the site may be lower.

Risks to wildlife are assessed for a small subset of the species likely to be present in the areas surrounding the EDCC. The representative wildlife species used for quantitative evaluation at this site was selected to represent a range of taxonomic groups and life history types of species likely to occur in the area. These species may not, however, represent the full range of sensitivities present. The species selected may be either more or less sensitive to contaminant exposures than typical species located within the area.

6.10.2 Absence of Toxicity Data for Same Chemicals

As discussed in Section 4, no reliable toxicity benchmark could be located for a number of chemicals that were detected in one or more samples of site media. The inability to evaluate hazard from these chemicals could result in an underestimation of risk, but the magnitude of the error is likely to be low. This is because absence of a toxicity benchmark for a chemical is often due to the fact that toxicological concern over that chemical is low. That is, chemicals that lack benchmarks are often considered to be relatively less hazardous that those for which benchmarks do exist.

6.10.3 Extrapolation of Toxicity Data Between Receptors

Toxicity data are not available for all of the species of potential concern at the site. Thus, it is sometimes necessary to estimate toxicity values for a receptor by extrapolating toxicity data across similar species. This extrapolation may either overestimate or underestimate the risk to the actual receptor, depending on whether the actual receptor is less sensitive or more sensitive that the species for which data are available. The direction of the error introduced by this extrapolation is unknown, but could be significant in some cases.

6.10.3.1 Extrapolation of Toxicity Data Across Dose or Duration

In some cases, TBV data are available only for high dose exposures, and extrapolation to low doses (similar to those that actually occur at the site) is a source of uncertainty. Likewise, some TBVs are based on relatively short-term exposures, and extrapolation to long-term conditions is uncertain, especially for chemicals that tend to build up in the exposed organism. When such extrapolations are necessary, it is customary to include an "uncertainty factor" in the derivation of the benchmark to account for the extrapolation. In general, the "uncertainty factor" is likely to be somewhat too large, so the benchmarks derived in this way are often conservative (overly protective).

6.10.3.2 Extrapolation of Toxicity Data from Laboratory to Field Conditions

Even when data are available for a species of concern at the site, the data are usually generated under laboratory conditions and extrapolation of those data to free-living receptors in the field is uncertain. In some cases, site-specific factors may tend to modify (often decrease) the toxicity of chemicals in surface water, sediments, and soil. For example, metals in surface water may be bound to soluble organic materials that reduce the tendency for the metal to bind to respiratory structures offish or benthic organisms. Similarly, the presence of organic matter in soil, along with other substances, may have a significant influence on actual toxicity, Thus, risks based on literature-derived toxicity factors may sometimes overestimate risk from site media.

6.11 Uncertainties in Risk Characterization

Most TBV are derived from studies of the adverse effects of a single contaminant. However, exposures to ecological receptors usually involve multiple contaminants, raising the possibility that synergistic or antagonistic interactions might occur. However, data are not adequate to permit any quantitative adjustment in toxicity values or risk calculations based on inter-contaminant interactions. In accordance with USEPA guidance, effects from different COPCs are not added unless reliable data are available to indicate that the two (or more) chemicals act on the same target tissue by the same mode of action. At this site, HQ values for each COPC were not added across different chemicals, If any of the other COPCs at the site act by a similar mode of action, total risks could be higher than estimated.

6.12 Estimation of Population-Level Impacts

Assessment endpoints for the receptors at this site are based on the sustainability of exposed populations, and risks to some individuals in a population may be acceptable if the population is expected to remain healthy and stable. However, even if it is possible to accurately characterize the distribution of risks or effects across the members of the exposed population, estimating the impact of those effects on the population is generally difficult and uncertain. For this ERA, it was assumed that if more than 80% of the population was below a level of concern, then population-level effects were not likely. Conversely, it was assumed that if more than 20% of the individuals in a population had HQ values above IE+00, then impacts on population sustainability might occur. However, the relationship between adverse effects on individuals and effects on the population is complex, depending on the demographic and life history characteristics of the receptor being considered as well as the nature, magnitude and frequency of the chemical stresses and associated adverse effects. Thus, the actual distribution of HQ values that will lead to population-level adverse effects will vary from receptor to receptor, and use of a single criterion (80% below IE+00) may not be appropriate in all cases.

6.13 Summary of Uncertainties

The above sections have summarized the various sources of uncertainty in this baseline ERA, along with a qualitative estimate of the direction and magnitude of the likely errors attributable to the uncertainty. Based on all of these considerations, the HQ and HI values calculated and presented in this ERA section should be viewed as having a level of uncertainty. Because of the inherent conservatism in the derivation of many of the exposure estimates and toxicity benchmarks, these HQ and HI values should generally be viewed as being more likely to be high than low, and should be interpreted in a weight-of-evidence approach based on other types of available information as well.

7.0 REFERENCES

ADEQ, 1998. TMD investigation of water quality impairment to unnamed tributary to Flat Creek, Union county, Arkansas. WQ-98-04-1. Published by Arkansas Department of Environmental Quality. April 1998. 42pp.

ADEQ, 2001. Regulation 2: Regulation Establishing Water Quality Standards for Surface waters of the State of Arkansas. July 2001

ATSDR 2004a. Toxicological Profile for Ammonia, U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, September 2004.

ATSDR 2004b. Jet Gas Spill Site, Lowell, Henry County, Iowa, U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, October 2004.

Broom 1984. Broom, M.E., T.F. Kraemer and W.V. Bush. A Reconnaissance Study of Saltwater Contamination in the El Dorado Aquifer, Union County, Arkansas. U.S. Geological Survey, Water-Resources Investigations Report 84-4012, 1984.

Burt W. H. and R. P. Grossenheider, 1979. Roger Troy Peterson field guides: Mammals, The Easton Press. Norwalk, CT.289 pp.

EDCC, 2007. Communication with facility personnel regarding recent monitoring data from recovery wells.

Environmental Management Systems, 2004. Geologic Investigation Report, May 2004. Report prepared for El Dorado Chemical Company. El dorado, Arkansas.

Fitzpatrick 1990. Fitzpatrick, D.J., J.M. Kilpatrick and H. McWreath. Geohydrologic Characteristics and Simulated Response to Pumping Stresses in the Sparta Aquifer in East-Central Arkansas. U.S. Geological Survey, Water-Resources Investigations Report 88-4201, 1990.

FTN, 1991. Surface water quality study for El Dorado Chemical Company. Prepared by FTN Associates for El Dorado Chemical Company.

FTN, 2002. TMDLs for chloride sulfate TDS and ammonia in the ELCC Tributary , Arkansas (Reachs 08040201-706 and 806). October 8, 2003. Prepared for USEPA Region VI.

FTN, 2003. TMDLs for chloride sulfate TDS and ammonia in Flat and Salt Creek, Arkansas (Reach 08040201-606). December 16, 2002. Prepared for USEPA Region VI.
GBMc and Associates, 2006. El Dorado Chemical Company Section 2.306 Site specific water quality Study for chloride, sulfate and TDS.59pp + appendices.

Gilbert, 1987. Methods for Environmental Pollution Monitoring.

Grubbs, Garner, and Hoskyn. Subsurface Investigation, Class III Landfill, September 1992.

Martin, A.C., H.S. Zim, and A.L. Nelson, 1951. American Wildlife and Plants. Dover

Puiblications NY, NY.500pages.

McClelland Engineers (1980) Subsurface Investigation Well Installation and Water Sampling. Existing Waste Disposal Area, Monsanto Chemical Company, El Dorado, Arkansas, 5 p. plus attachments, December, 1980.

McClelland Engineers, 1981(a). Ground Work Study Impoundment Pond Area, Monsanto Agricultural Products Company, El Dorado, Arkansas. 10p. plus attachments, June 1981.

McClelland Engineers, 1981(b). Groundwater Study Lake Lee, Monsanto Agricultural Products Company, El Dorado, Arkansas. 8p. plus attachments, November 1981.

McWreath 1991. McWreath, H.C., J.D. Nelson and D.J. Fitzpatrick. Simulated Response to Pumping Stresses in the Sparta Aquifer, Northern Louisiana and Southern Arkansas. U.S. Geological Survey, Water Resources Technical Report No. 51, 1991.

Hays, Phillip D.; Lovelace, John K.; Reed, Thomas B., Simulated response to pumping stress in the Sparta aquifer of southeastern Arkansas and north-central Louisiana, 1998-2027

Omernik, J.M. 1987, Ecoregions of the United States. Supplemental to the annals of the association of American geographers, Vol 77, No1

Sample et.al. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. ES/ER/TM-86/R3. Health Sciences Research Division. Oak Ridge, TN

USEPA. 1989. Rapid Bioassessment Protocols for use in Streams and Rivers. USEPA/440/4-89/001. Office of Water, U.S. Environmental Protection Agency, Washington DC.

USEPA 1989. Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part A), Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, USEPA 540/1-89/002, December 1989.

USEPA 1991a. Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals), Publication 9285.7-01B, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, USEPA 540/R-92/003, December 1991.

USEPA 1991b. Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual, Supplemental Guidance, “Standard Default Exposure Factors”, OSWER Directive 9285.6-03, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, March 1991.

USEPA 1994. *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities*, Memorandum to Regional Administrators 1 - 10, OSWER Directive 9355.4-12, U.S. Environmental Protection Agency, August 1994.

USEPA 1996. Modeled Ambient Concentrations, Technology Transfer Network National Air Toxics Assessment, http://www.epa.gov/ttn/atw/nata/tablconc.html, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, 1996.

USEPA. 1997. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. Interim final. USEPA 540-R-97-006. U.S. Environmental Protection Agency.

USEPA. 1998. Guidelines for Ecological Risk Assessment. USEPA/630/R-95/002F. U.S. Environmental Protection Agency, Washington, DC.

USEPA 1998a. Printed Wiring Board Cleaner Technologies Substitutes Assessment: Making Holes Conductive, Volume 1, U.S. Environmental Protection Agency, USEPA 744-R-98-004a, August 1998.

USEPA 1998b. Toxicological Review of Trivalent Chromium, Integrated Risk Information System, U.S. Environmental Protection Agency, August 1998.

USEPA 1998c. Toxicological Review of Hexavalent Chromium, Integrated Risk Information System, U.S. Environmental Protection Agency, August 1998.

USEPA 2001a. Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments), Publication 9285.7-47, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, December 2001.

USEPA 2001b. User's Guide for the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK), Environmental Protection and Remedial Response, U.S. Environmental Protection Agency, May 2001.

USEPA 2002. Calculating Upper Confidence Limits for Point Concentrations at Hazardous Waste Sites, OSWER 9285.6-10, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, December 2002.

USEPA Region 8, 2003. Baseline Ecological Risk Assessment for the Ogden Railyard Site Ogden, Utah, U.S. Environmental Protection Agency Region 8, January 2003.

USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Revised February 2004.

USEPA 2005. Guidance for Developing Ecological Soil Screening Levels, OSWER Directive 9285.7-55, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Revised February 2005.

USEPA Region 6, 2007. Region 6 Human Health Medium Specific Screening Levels 2007, U.S. Environmental Protection Agency Region 6, May 2007.

USEPA Region 8, 1994. Evaluating and Identifying Contaminants of Concern for Human Health, Region 8 Superfund Technical Guidance, U.S. Environmental Protection Agency Region 8, September 1994.

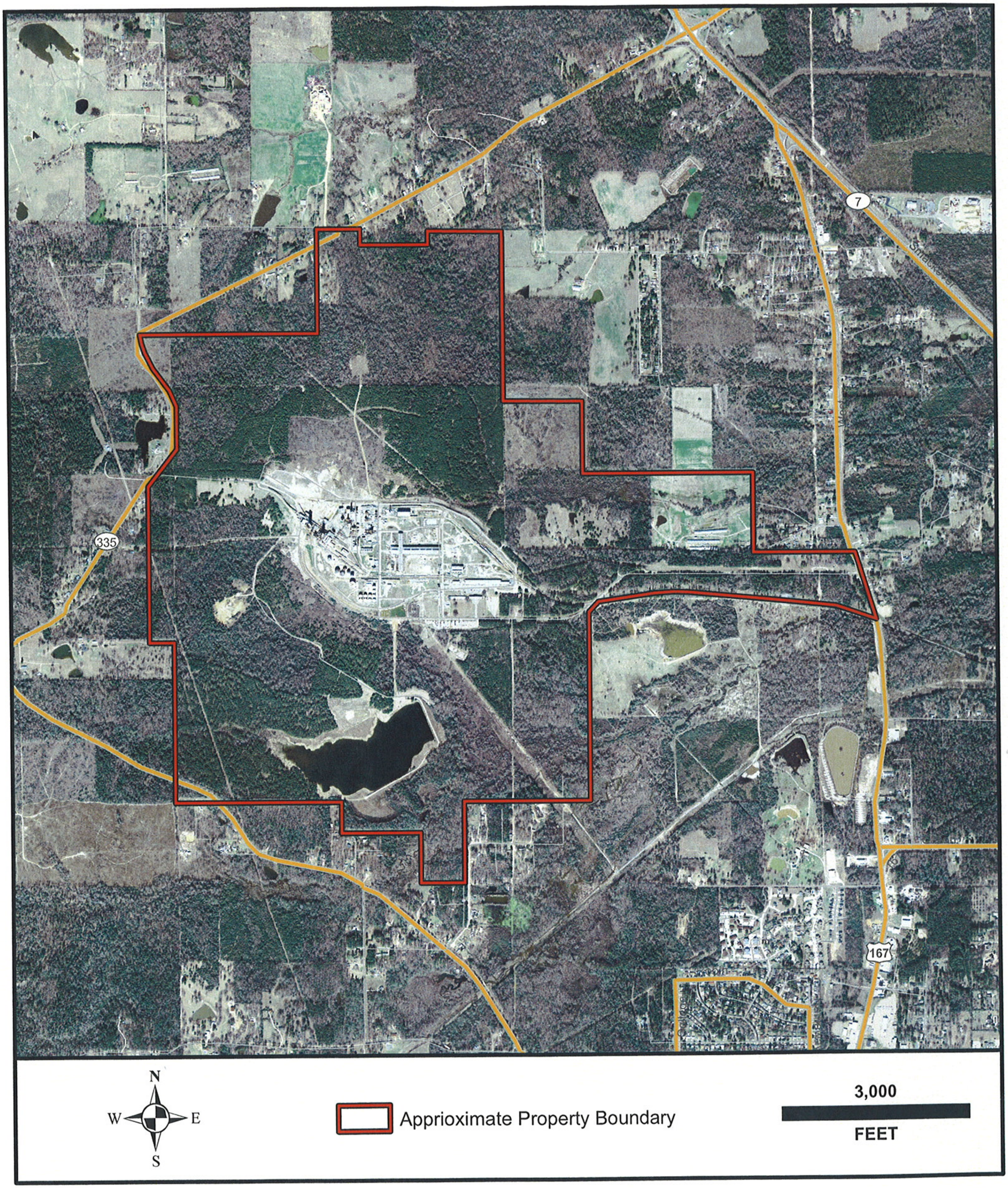
USEPA Region 8, 2003. Baseline Human Health Risk Assessment for the Ogden Railyard Site Ogden, Utah, U.S. Environmental Protection Agency Region 8, January 2003.

Woods and Others, 2004. Ecoregions of Arkansas. (Color poster with map, descriptive text, summary tables and photographs): Reston, Virginia, U.S. Geological Survey.

Appendix A

Site Description Materials
And Old Reports

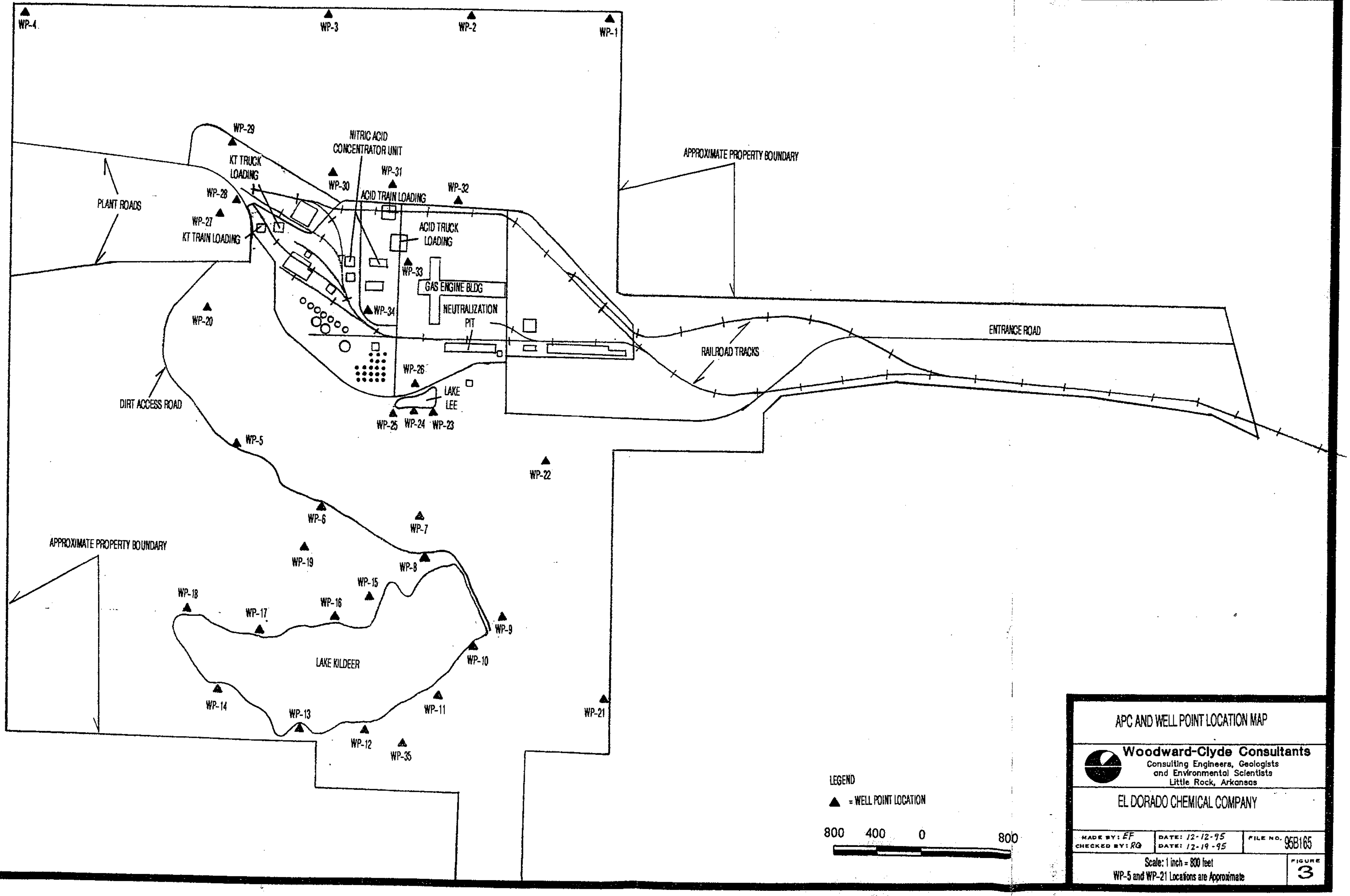
Aerial Photograph of EDCC



Aerial photography showing the approximate property boundary of El Dorado Chemical Company.

July 23, 2007

1996 Well Point Locations



APC AND WELL POINT LOCATION MAP

Woodward-Clyde Consultants
Consulting Engineers, Geologists
and Environmental Scientists
Little Rock, Arkansas

EL DORADO CHEMICAL COMPANY

MADE BY: EF
CHECKED BY: RQ
DATE: 12-12-95
DATE: 12-19-95
FILE NO. 95B165

Scale: 1 inch = 800 feet
WP-5 and WP-21 Locations are Approximate

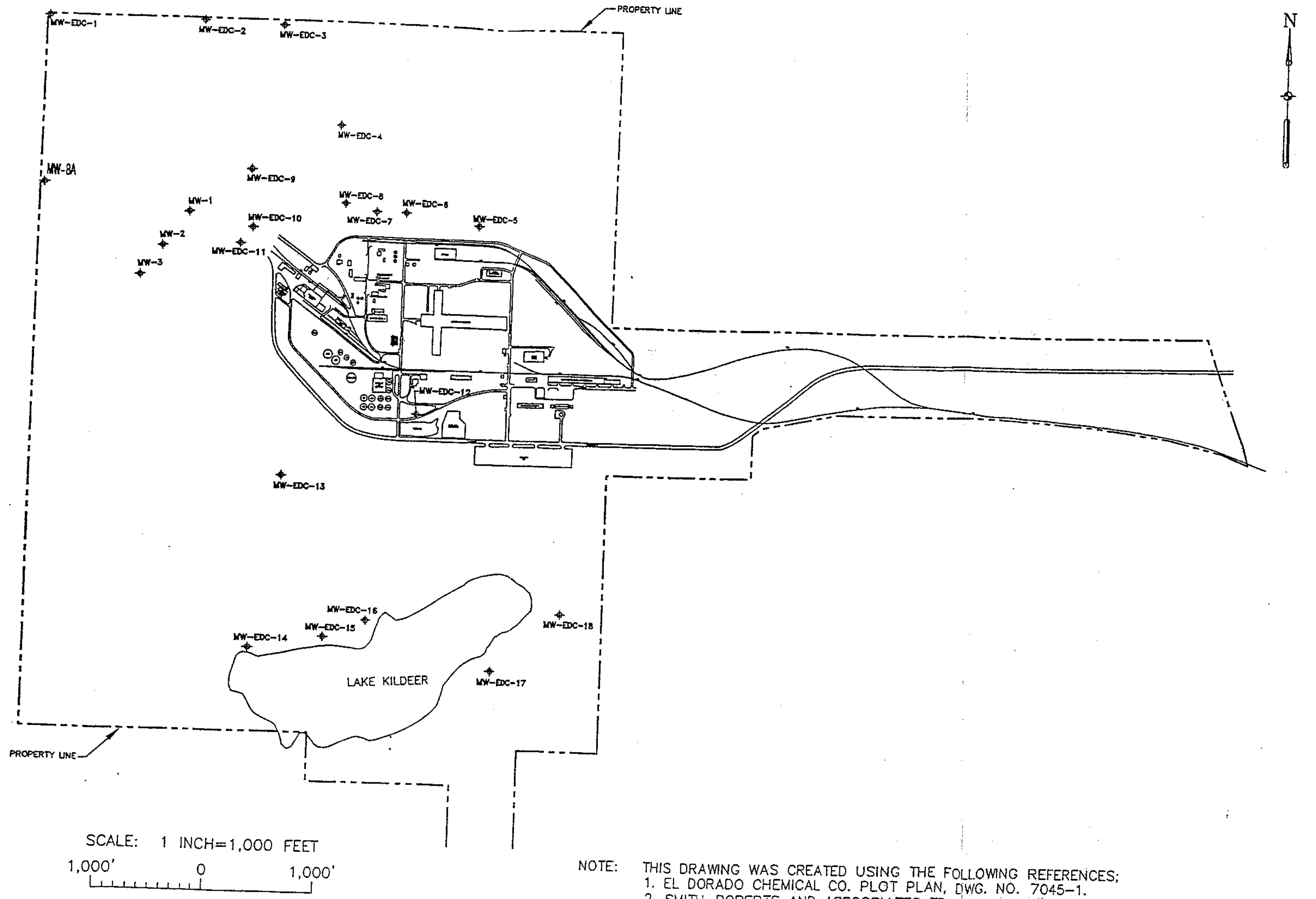
FIGURE 3

1996 Well Point Data Summary

Table 2
Summary of Well Point Data
Phase I Hydropunch Investigation
El Dorado Chemical Company
November 1995

Well Point No.	Total Depth (ft.)	Depth to Water (ft.)	Ground Elevation (ft. MSL)	Groundwater Elevation (ft. MSL)
WP-1	34.5	15.2	206.7	191.5
WP-2	27.0	4.7	190.6	185.9
WP-3	24.0	1.7	181.9	180.2
WP-4	27.5	3.5	210.8	207.3
WP-5	32.0	1.5	200.9	199.4
WP-6	23.0	17.3	201.8	184.5
WP-7	27.0	2.4	171.2	168.8
WP-8	30.5	13.0	182.3	169.3
WP-9	21.0	14.7	168.5	153.8
WP-10	18.0	14.5	174.8	160.3
WP-11	19.5	12.3	176.7	164.4
WP-12	12.0	4.5	173.1	168.6
WP-13	12.0	4.2	175.2	171.0
WP-14	12.0	0.5	172.9	172.4
WP-15	12.0	3.5	175.4	171.9
WP-16	12.0	5.5	178.4	172.9
WP-17	12.0	7.7	176.0	168.3
WP-18	12.0	7.6	173.9	166.3
WP-19	27.0	21.6	212.1	190.5
WP-20	20.0	7.1	172.6	165.5
WP-21	24.0	4.9	149.7	144.8
WP-22	22.0	11.2	166.4	155.2
WP-23	21.0	6.1	163.2	157.1
WP-24	21.0	7.9	161.8	153.9
WP-25	21.0	11.2	163.9	152.7
WP-26	21.0	6.6	182.0	175.4
WP-27	26.0	3.0	199.9	196.9
WP-28	23.0	14.7	202.8	188.1
WP-29	25.0	8.9	196.3	187.4
WP-30	24.0	10.5	194.5	184.0
WP-31	22.0	4.8	188.2	183.4
WP-32	30.0	17.2	195.8	178.6
WP-33	24.0	7.9	198.0	190.1
WP-34	15.0	17.0	199.0	182.0
WP-35	12.0	0.5	162.2	161.7

1996 Phase II Well Locations



NOTE: THIS DRAWING WAS CREATED USING THE FOLLOWING REFERENCES;
1. EL DORADO CHEMICAL CO. PLOT PLAN, DWG. NO. 7045-1.
2. SMITH-ROBERTS AND ASSOSSIATES TRACT LOCATION MAP (QUAD), SC31,663C DWG. NO. SHT.4.
3. BALL AND PAULUS SURVEYORS, INC. JOB NO. 181F-95, MONITORING WELLS.

REV	DESCRIPTION OF REVISION	BY	DATE
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EL DORADO
CHEMICAL COMPANY

Woodward-Clyde Consultants
Engineering & sciences applied to the earth & its environment
900 S. Shacleford, Suite 412
Little Rock, Arkansas 72211

SCALE 1"=1,000'
DESIGNED
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CHECKED EF
PEER REVIEWED
DATE 04/01/96

SITE MAP AND MONITORING WELL LOCATIONS

REVISION △
PROJECT 95B165
DRAWING 5

K:\CAD-GIS\ELDORADO\95B16504 Thu May 02 09:36:02 1996

Geologic Investigation Report (EMS, 2004)

GEOLOGIC INVESTIGATION REPORT

Prepared For:

ELDORADO

El Dorado Chemical Company

Prepared By:

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.

12241 Industriplex Blvd, Suite B
Baton Rouge, Louisiana
(225) 751-5386

May 2004

DRAFT

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TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

This Report documents the approach used to conduct an investigation to further characterize the geology and hydrogeology of the El Dorado Chemical Company (EDC) facility in El Dorado Arkansas. The field activities included advancement and logging of eleven (11) borings and the installation of four (4) monitor wells. A map of the site is presented as Figure 1.

1.1 OBJECTIVES

The objectives of this investigation were to:

- Further characterize the shallow site stratigraphy with borings that penetrate through to the confining clay unit (Cook Mountain Clay); and
- Install additional wells to further define ground water flow and quality.

1.2 SCOPE

This report includes the following:

- Short description of drilling activities;
- Soil boring and well construction logs;
- Maps illustrating surveyed locations of new borings and wells;
- Geologic cross-sections; and
- An updated discussion on site geologic and ground water conditions.

2.0 FIELD ACTIVITIES

The field investigation procedures are described in the following sections. Field activities included soil sampling and logging; monitor well installation and sampling; and plugging and abandonment of soil borings.

2.1 SOIL SAMPLING

Techniques used to characterize the soil conditions during this investigation included soil conductivity profiling; and soil collection for physical description and conductivity profile correlation. The field operation consisted of drilling and logging eleven (11) soil borings. The methodology used for soil sample collection consisted of Geoprobe collection devices and probes operated by EMS and an ATV Mud Rotary Drilling Rig operated by Diversified Drilling Services, Inc. (Diversified) of El Dorado, Arkansas. Figure 1 depicts the location of the borings. A summary of soil boring information is provided in Table 1.

2.1.1 Geoprobe Sampling Equipment and Procedures

The Geoprobe portion of the investigation was conducted from January 6, 2004 through January 14, 2004. A soil conductivity log was obtained at all boring locations using the Geoprobe® developed Direct Image Soil Conductivity Logging System. Logging was accomplished by driving a rugged conductivity probe containing an isolated electrical array. As the probe is advanced, the array gathers electrical data and transmits the data through a communication cable that is fed from the probe through 1.25-inch drive rods into a microprocessor. A laptop computer operating the Direct Image software and connected to the microprocessor displays the changes in soil conductivity with depth in the form of an onscreen graph as the probe is advanced. At the conclusion of logging, the data was stored as a .DAT file in the computer and can be imported to existing spreadsheet software for processing and presentation. The soil conductivity logs were used to determine the depth of the Cook Mountain Formation and assist in the correlation of geologic units. The soil conductivity logs are presented on the boring logs in Appendix A.

As shown on Table 1, Soil Borings SB-01, SB-02, SB-03 and SB-10 were completed using the Geoprobe rig. Borings SB-04 and SB-07 were drilled and sampled until refusal and were completed using Diversified's ATV Rig. The Geoprobe® Model 66 DT (posi-track mounted) direct-push sampling system was used to collect soil samples for site characterization. All sampling equipment was thoroughly cleaned prior to mobilization to the site.

Soil samples were collected using a Geoprobe Macro-core 48-inch long, 2-inch diameter soil sampling probe equipped with a disposable 1.5-inch diameter clear PVC sample collection tube within the probe. Soil samples were collected continuously, from ground surface to the termination depth of each boring. Upon completion of each 4-foot soil "push", the sample collection tube was retrieved and split open, and the soil visually described and logged by the field geologist in accordance with the Unified Soil Classification System. All soil descriptions and other pertinent observations were recorded on dedicated soil boring logs for each location. The soil boring logs are presented in Appendix A. The soil cores collected were not discarded and are stored on site.

2.1.2 Mud Rotary Sampling Procedures

Soil Borings SB-04, SB-05, SB-07 SB-08, SB-09, SB-11 and SB-12 were completed using Diversified's ATV Mud Rotary Drilling Rig. Because these borings were conductivity logged, samples were only collected at the termination depth of these borings. Cuttings were logged during drilling. Soil samples were obtained by either Shelby tube or split-spoon sampling devices in accordance with ASTM Methods D1587 and D1586. Soil samples were visually classified in accordance with the Unified Soil Classification System as provided in ASTM D2488 and descriptions recorded on boring logs (see Appendix B).

2.2 WELL INSTALLATION

Monitor wells MW-19, MW-20, MW-21 and MW-22 were installed during this investigation. MW-21 was installed using the Geoprobe, the others using Mud Rotary drilling. The field procedures for the well installations are provided in the following sections.

2.2.1 Geoprobe

Monitor Well MW-21 was installed using the Geoprobe's direct-push capability driving 1.5-inch inside-diameter probe rod equipped with an expendable stainless-steel drive point. Once the desired depth was reached, the well was installed within the probe rod and the rod extracted, leaving the temporary well and expendable drive point in place. Pre-packed screens were used for this well. Additional filter pack was placed above the pre-pack screens to ensure that there was at least two feet above the top of the screen. Above the filter pack, a grout seal was installed. The grout mixture consists of a mixture of bentonite, Portland cement and water in accordance with applicable Arkansas (Arkansas Water Well Construction Commission Rules and Regulations) and U.S. Environmental Protection Agency (*Environmental Investigations Standard Operating Procedures and Quality Assurance Manual,* USEPA, Region IV, Science and Ecosystem Support Division, November 2001) guidelines. A rubber well plug was placed in the well and the PVC casing placed in a locked protective casing. Well construction details are presented in Appendix B. MW-21 was developed by pumping it with a submersible pump.

2.2.2 Mud Rotary

A hollow stem auger was used to set 2-inch monitor well MW-20. Mud rotary procedures were used to install MW-19, MW-21 and MW-22. Monitor wells were constructed of 2-inch PVC well materials. Prior to well installation, the borings were enlarged with an 8-inch nominal diameter drill. Well materials consisted of 2-inch PVC slotted well screen with a slot opening of 0.01 inches. Total well depths, screen lengths and other specifications for each well are provided on Table 2. Above the well screen, PVC flush threaded well casing was installed such that approximately 2 feet of casing extends above ground surface.

A filter pack composed of 20/40 graded silica sand was emplaced from the bottom up using the tremie method. The quantity of sand used was documented. The filter pack extended from the base of the borehole to 4 to 6 feet above the top of the well screen. The depth of the filter pack was measured and recorded on a well construction diagram. After measuring the filter pack depth, bentonite pellets were manually placed in the borehole to a thickness of 3 to 5 feet and allowed to hydrate overnight to provide a seal above the filter pack.

Subsequent to bentonite hydration, a cement/bentonite grout slurry was trimmed into the remaining borehole annulus, from the bottom up to minimize voids and bridging. Subsequent to grout curing and settling, additional grout mixture was emplaced to fill the annular space to the ground surface. A rubber well plug was placed in the well and the well placed in a locked protective casing.

A well construction diagram was prepared by the supervising geologist for each well which includes pertinent information on well construction materials (quantities and depths). The wells were developed by pumping them with a submersible pump.

2.3 MONITOR WELL SAMPLING

MW-19, MW-20, MW-21 and MW-22 were sampled in January 2004. Depth-to-water measurements were collected from each well using an electronic water level indicator. Depth-to-water measurements were subtracted from their respective top-of-casing elevations to calculate ground water elevations referenced to Mean Sea Level (MSL) at each well.

The depth-to-water measurements were used to calculate the volume of water within each well and determine the amount to be purged prior to sampling. Three well volumes were removed from each well or until the well became dry using either a disposable bailer or a Redi-Flo electric pump. When a pump was used, dedicated polyethylene tubing was used for each well to minimize the potential for cross-contamination. Field indicator parameters (pH, conductivity and temperature) were recorded after removal of each well volume. Field meters used to measure field data were calibrated each day during sampling. Purge water was containerized for proper disposal.

Ground water samples were collected using new, clean, dedicated, disposable polyethylene bailers. Ground water samples were placed into laboratory-provided containers with the appropriate preservatives. The containers were packed in ice-chests and shipped to the laboratory under chain-of-custody. Analytical results indicate that no constituents of concern for this site (ammonia, nitrate, chromium and lead) were detected in the samples.

2.4 BORING ABANDONMENT

Borehole abandonment was accomplished in accordance with applicable Arkansas (Arkansas Water Well Construction Commission Rules and Regulations) and U.S. Environmental Protection Agency (*Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, USEPA, Region IV, Science and Ecosystem Support Division, November 2001) guidelines. Borings were abandoned by pumping grout down the open borehole using a tremie pipe from the bottom up. The solution used to abandon each borehole consisted of Portland Type I cement in 80lb. bags mixed with not more than 5-8% sodium bentonite powder by weight, and not more than 5 gallons of water per bag of cement.

2.5 SURVEYING

The location and ground elevation and/or top of casing of each boring or well installed were surveyed to provide accurate location data. Surveying was accomplished throughout the project to establish a surveyed location of other borings, wells, site topography, and other points of interest as necessary.

3.0 GEOLOGIC INVESTIGATION RESULTS

3.1 REGIONAL GEOLOGY

The regional shallow geology consists of the Claiborne Group, with two units that crop out in Union County: the Cockfield Formation and the Cook Mountain Formation. The Cockfield Formation, locally referred to as the "lignite sand", is generally characterized by fine sand, interbedded silty clay and lignite becoming more massive and containing less silt and clay with depth. Beneath the Cockfield Formation lies the Cook Mountain Formation. The Cook Mountain is 50 to 200 feet thick and is composed of clay and silty clay containing minor amounts of localized very fine to silty sand. These clays serve as a confining unit between the more permeable overlying Cockfield Formation and the underlying aquifer. The Cook Mountain is uniformly underlain by the Sparta Formation. Most of the borings drilled at the site do not extend into the upper part of the Cook Mountain Formation; therefore, the Cockfield Formation is not fully defined. The purpose of this additional investigation was to further define this unit.

3.2 SITE GEOLOGY

Site boring logs indicate the subsurface geology consists of interbedded sands, silts and clays of the Cockfield Formation which is underlain by the interbedded clays and fine sands of the Cook Mountain Formation. The sediments of the Cockfield are characterized as grey to orange sands silts and clays. The sediments of the Cook Mountain Formation consist of very hard, dark gray clays with some interbedded sands. Seven Cross Sections (locations shown on Figure 2) are presented on Figures 3 through 9. Sections A through D were presented in the 2001 Annual Ground Water Report and have been modified to add borings logged during this investigation.

The Cook Mountain is defined on all cross sections. The top of the Cook Mountain Formation exists across the site at elevations ranging from 180 to 90 MSL, dipping from North to South (see Sections C, D and E).

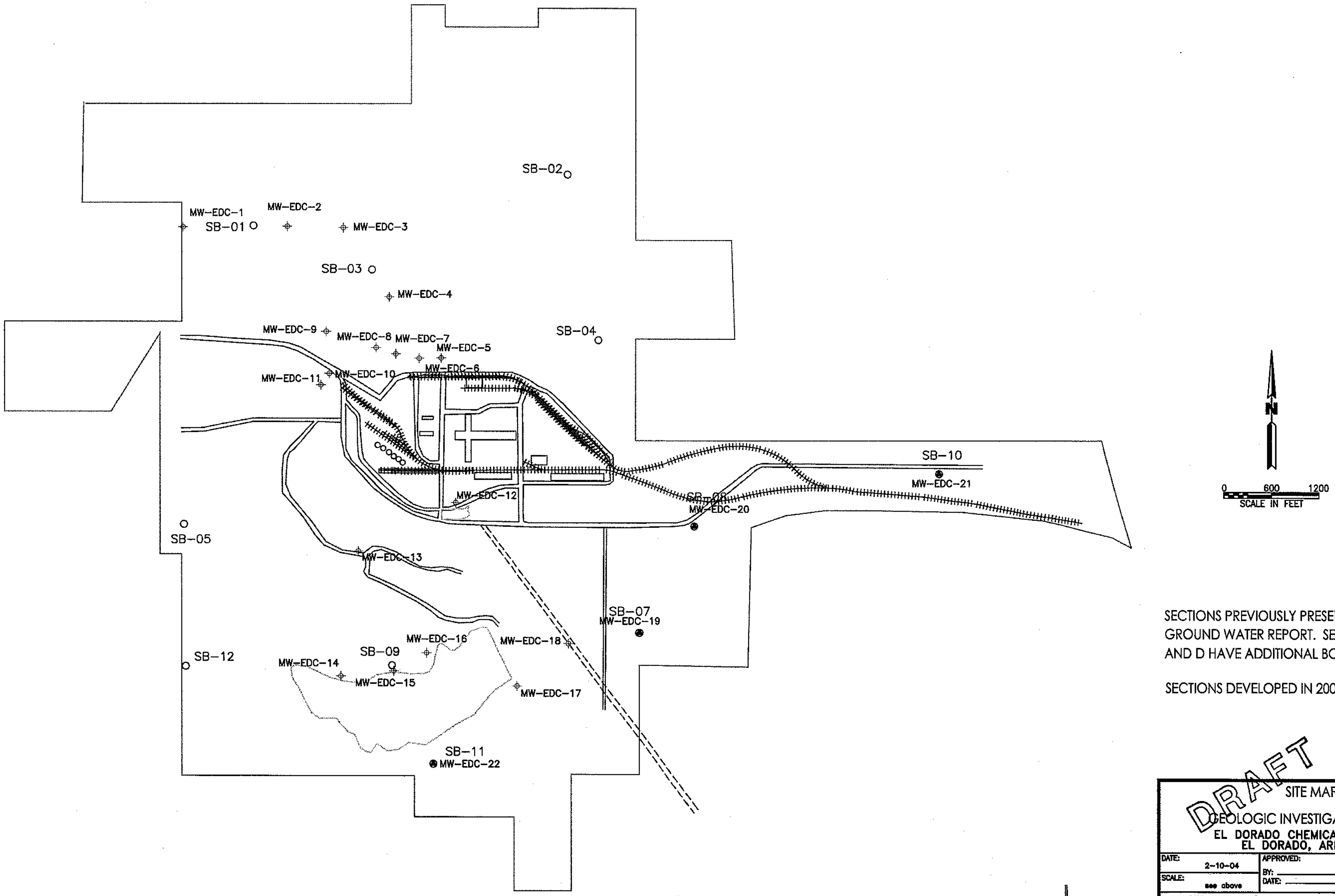
TABLES

TABLE 1
SOIL BORING DETAILS
GEOLOGIC INVESTIGATION REPORT
EL DORADO CHEMICAL COMPANY
EL DORADO ARKANSAS

Boring ID	Date	East	North	Ground Surface Elevation	Conductivity Depth	Drilling and Sampling Depth	Drilling Method
				feet MSL	feet below ground surface		
SB-01	1/11/2004	1846.897	10915.590	208.57	30	32	Geoprobe
SB-02	1/10/2004	5829.665	11562.880	214.41	40	40	Geoprobe
SB-03	1/11/2004	3353.219	10364.750	198.39	30	28	Geoprobe
SB-04	1/11/2004	6232.138	9480.964	174.99	34	31	Mud Rotary
SB-05	1/20/2004	968.180	7157.142	219.47	58	60	Mud Rotary
SB-07/ MW-19	1/11/2004	6741.293	5800.273	147.92	34	59	Mud Rotary
SB-08 /MW-20	1/7/2004	7446.361	7138.067	190.39	52	52	Mud Rotary
SB-09	1/22/2004	3610.846	5385.754	180.48	33	173	Mud Rotary
SB-10 /MW-21	1/6/2004	10545.773	7797.167	173.40	32	32	Geoprobe
SB-11 /MW-22	1/21/2004	4134.481	4154.273	170.79	30	77	Mud Rotary
SB-12	1/20/2004	987.621	5373.757	184.33	38	65	Mud Rotary

TABLE 2
WELL CONSTRUCTION DETAILS
GEOLOGIC INVESTIGATION REPORT
EL DORADO CHEMICAL COMPANY
EL DORADO ARKANSAS

Well	Date	Top of Casing Elevation	Depth	Sceen Length	Slot Size	Diameter	Materials
		feet msl	below ground	feet	inches	inches	
MW-19	1/20/2004	150.41	59	10	0.01	2	PVC
MW-20	1/19/2004	192.77	52	10	0.01	2	PVC
MW-21	1/6/2004	176.29	32	10	0.01	1	PVC
MW-22	1/22/2004	173.55	77	10	0.01	2	PVC



SECTIONS PREVIOUSLY PRESENTED IN 2001 GROUND WATER REPORT. SECTIONS A, B AND D HAVE ADDITIONAL BORINGS.

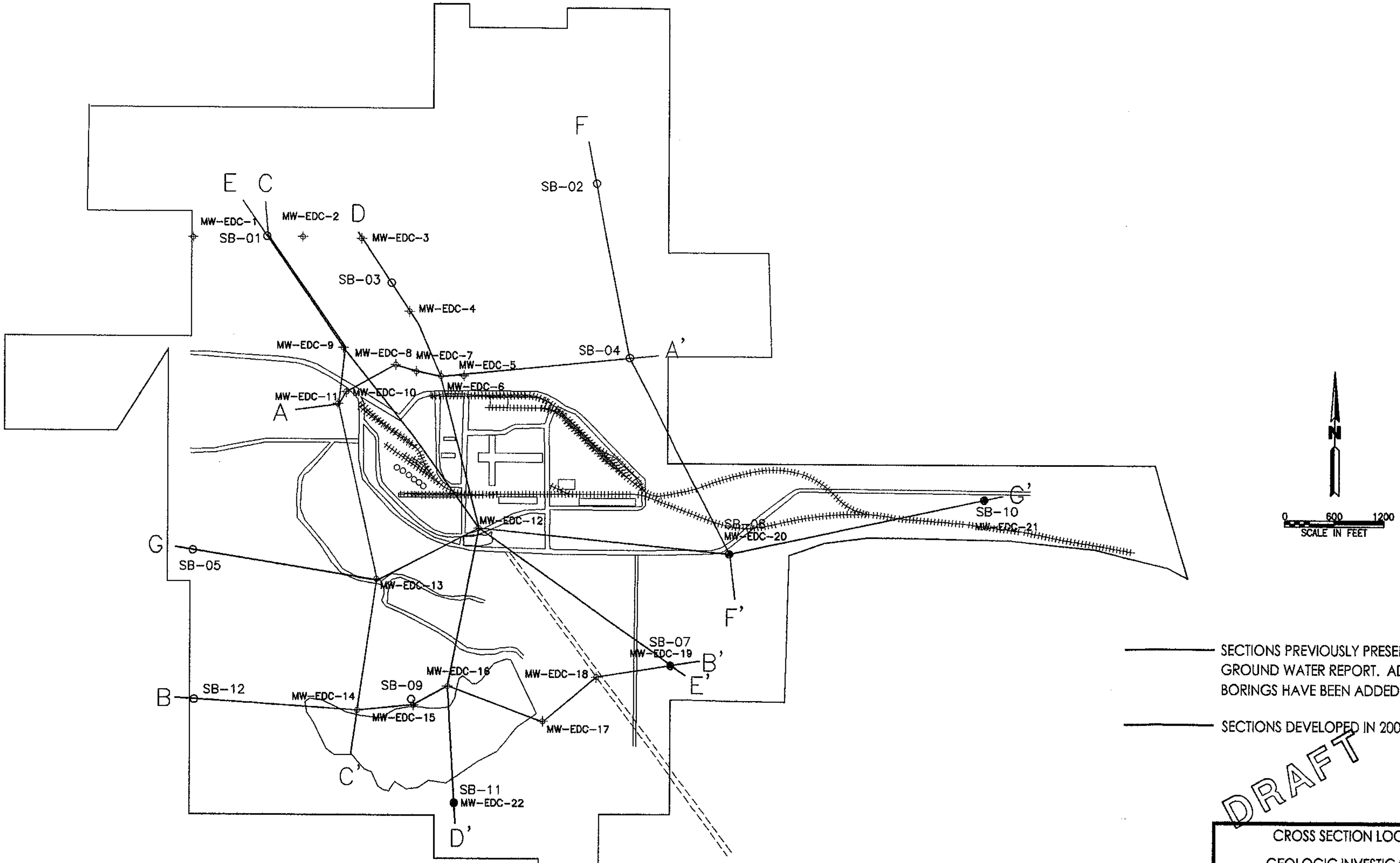
SECTIONS DEVELOPED IN 2004

SITE MAP
GEOLOGIC INVESTIGATION REPORT
EL DORADO CHEMICAL COMPANY
EL DORADO, ARKANSAS

DATE: 2-10-04	APPROVED: BY: ________ DATE: ________	DRAWN BY: LMM
SCALE: see above		CAD NO. 03EC200

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.

FIGURE
1



SECTIONS PREVIOUSLY PRESENTED IN 2001 GROUND WATER REPORT. ADDITIONAL BORINGS HAVE BEEN ADDED.

SECTIONS DEVELOPED IN 2004

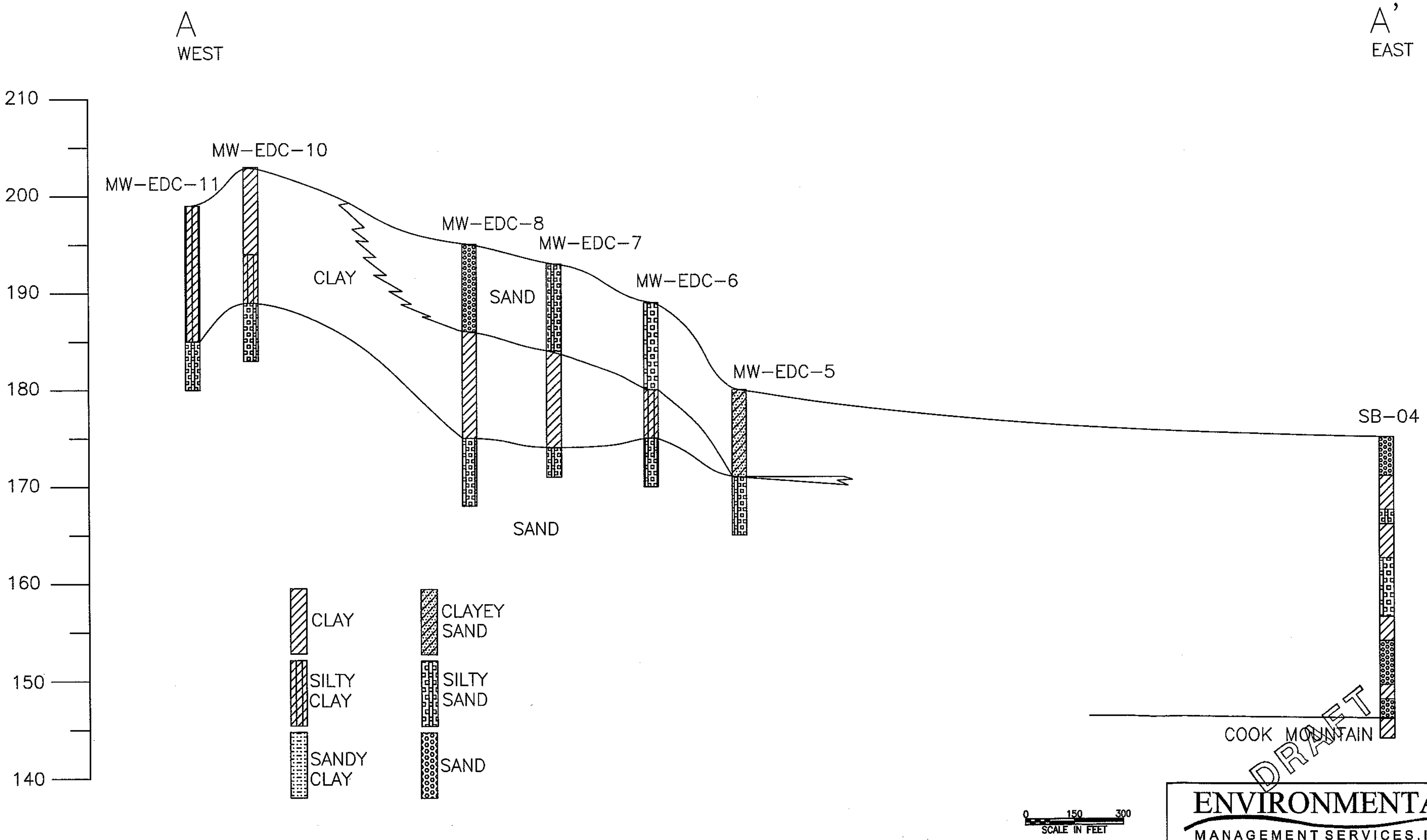
CROSS SECTION LOCATION MAP

GEOLOGIC INVESTIGATION REPORT
EL DORADO CHEMICAL COMPANY
EL DORADO, ARKANSAS

DATE: 2-10-04
SCALE: see above
APPROVED:
BY: ____________
DATE: ____________
DRAWN BY: LMM
CAD NO. 03EC200

ENVIRONMENTAL MANAGEMENT SERVICES, INC.

FIGURE 2

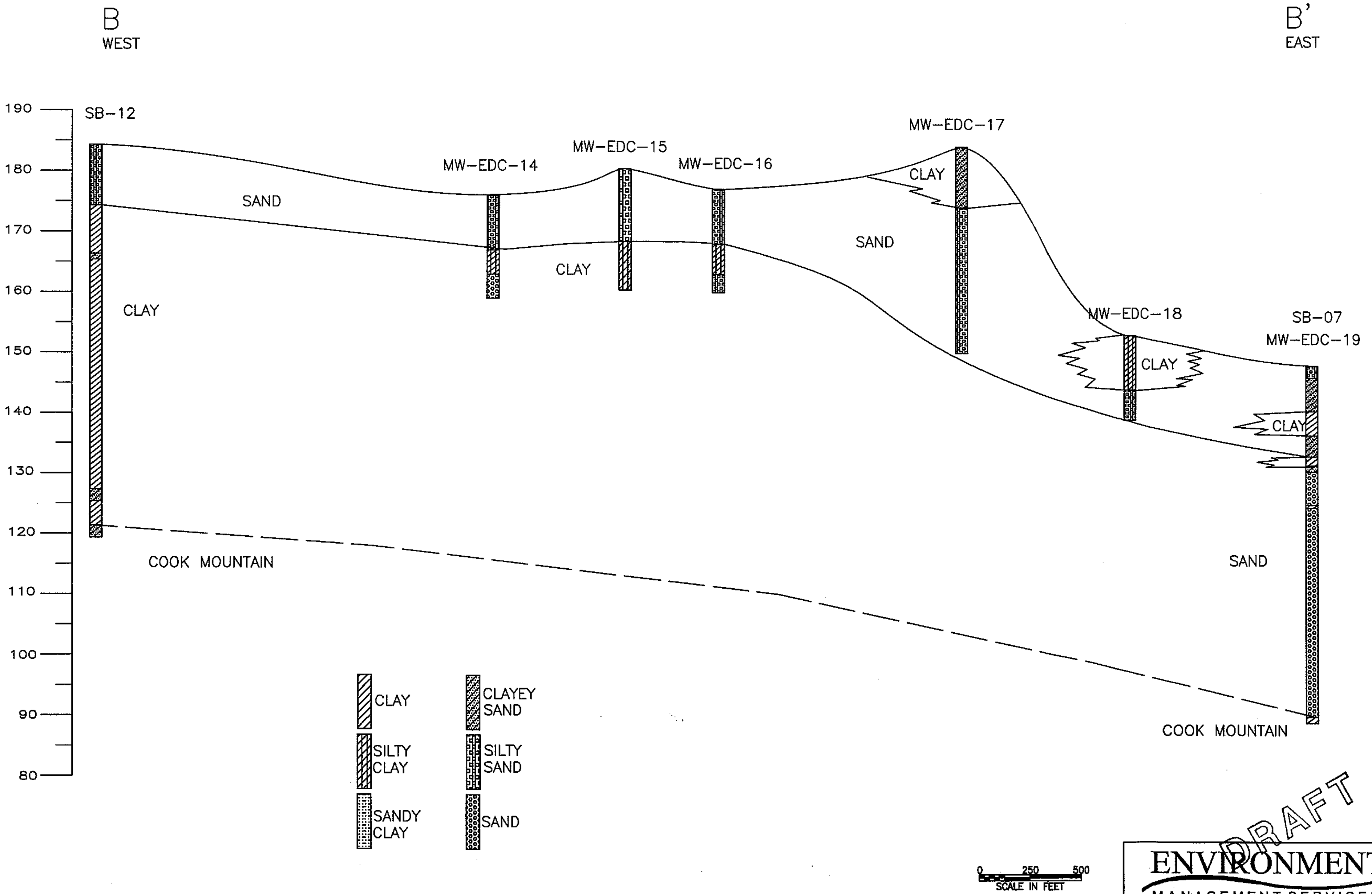


ENVIRONMENTAL
MANAGEMENT SERVICES, INC.

PROJECT NO: 03EC200
filename
DRAFTED BY: LMM DATE: 03/15/04
APPROVED:
BY: DATE:

CROSS SECTION A - A'
GEOLOGIC INVESTIGATION REPORT
EL DORADO CHEMICAL COMPANY
EL DORADO, ARKANSAS

3

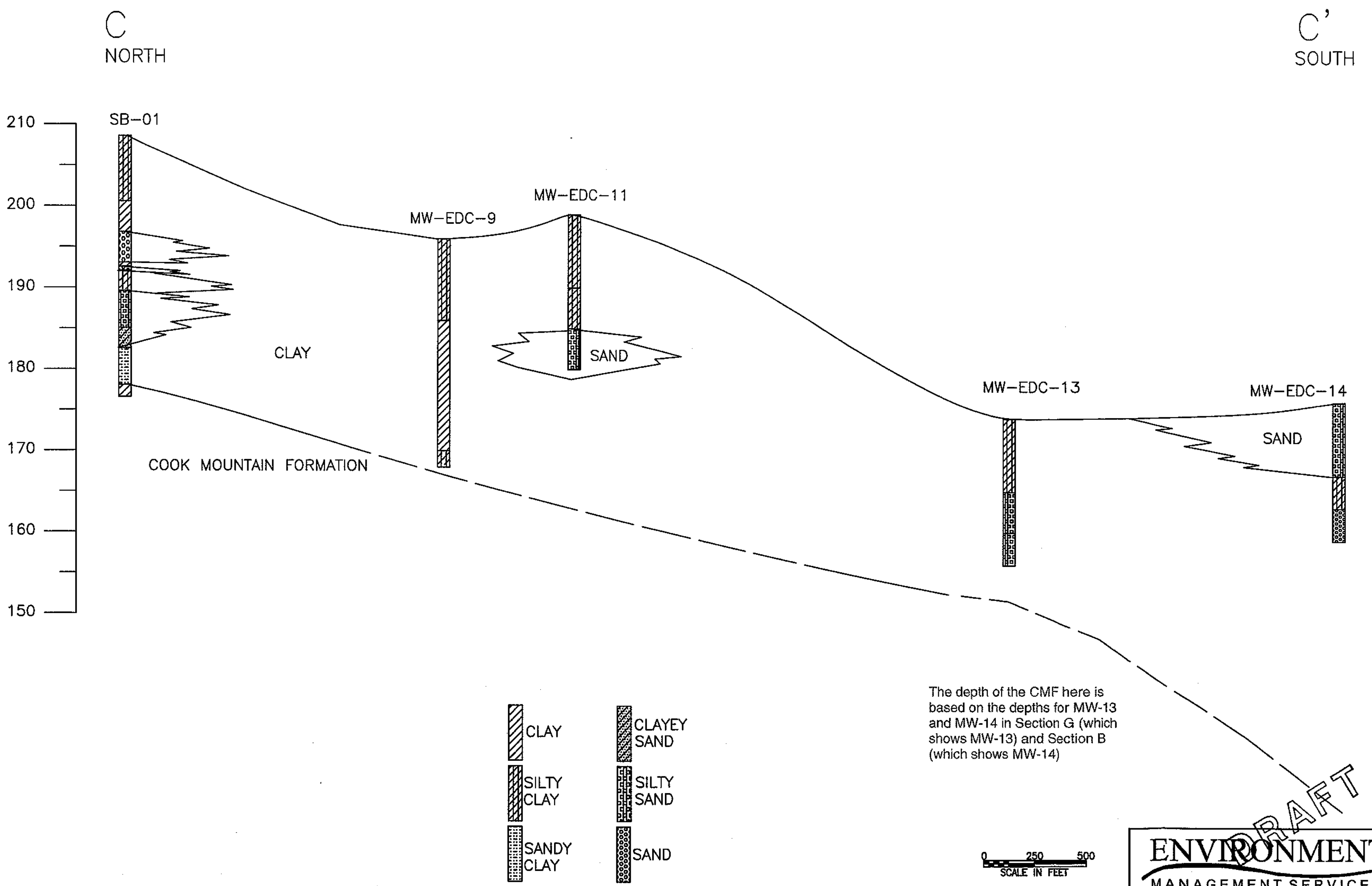


ENVIRONMENTAL
MANAGEMENT SERVICES, INC.

PROJECT NO: 03EC200
filename
DRAFTED BY: LMM DATE: 03/15/04
APPROVED:
BY: DATE:

CROSS SECTION B - B'
GEOLOGIC INVESTIGATION REPORT
EL DORADO CHEMICAL COMPANY
EL DORADO, ARKANSAS

4



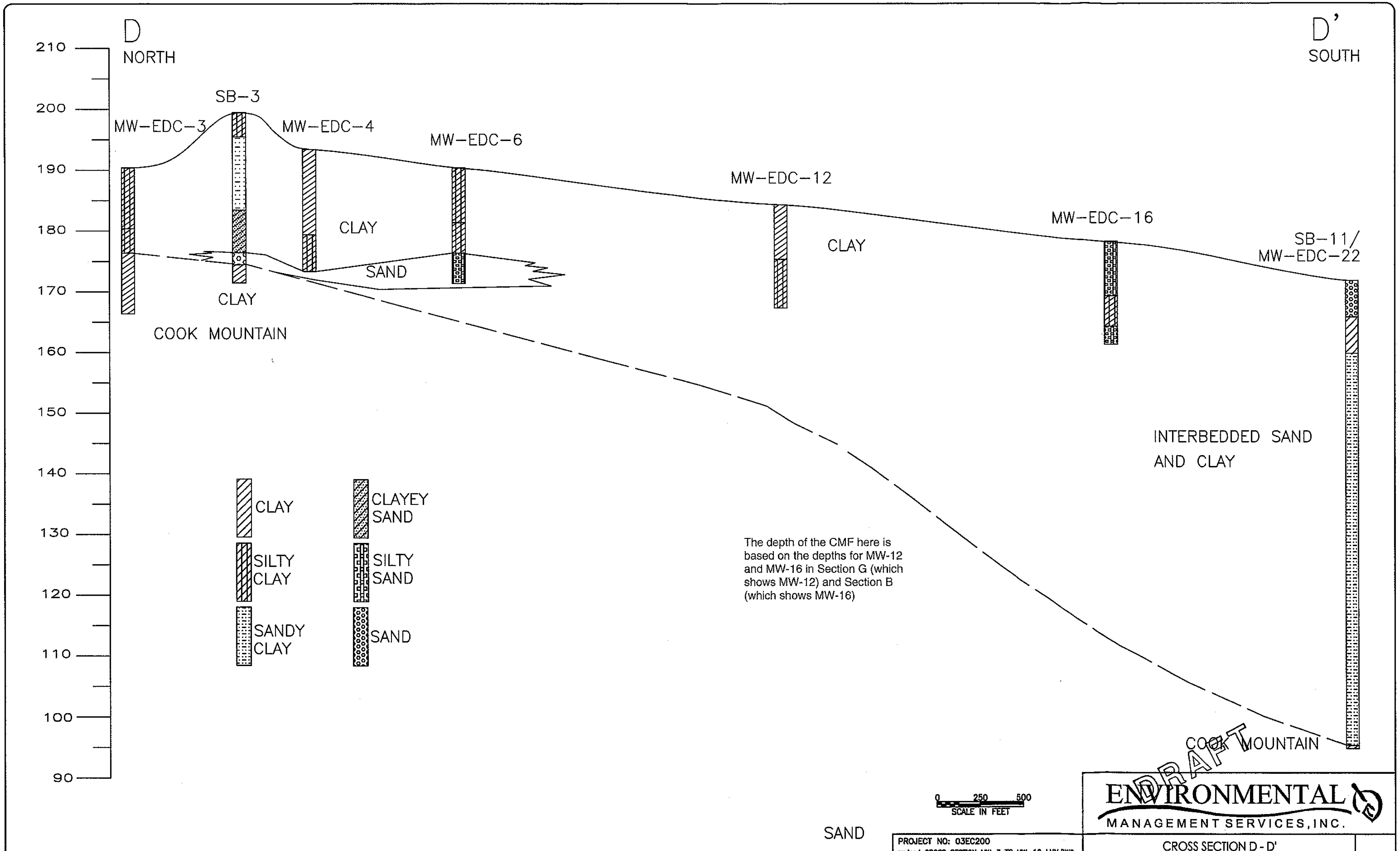
The depth of the CMF here is based on the depths for MW-13 and MW-14 in Section G (which shows MW-13) and Section B (which shows MW-14)

PROJECT NO: 2EC0100
C.DWG
DRAFTED BY: KK/LM DATE: 03/21/04
APPROVED:
BY: DATE:

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.

CROSS SECTION C - C'
GEOLOGIC INVESTIGATION REPORT
EL DORADO CHEMICAL COMPANY
EL DORADO, ARKANSAS

5



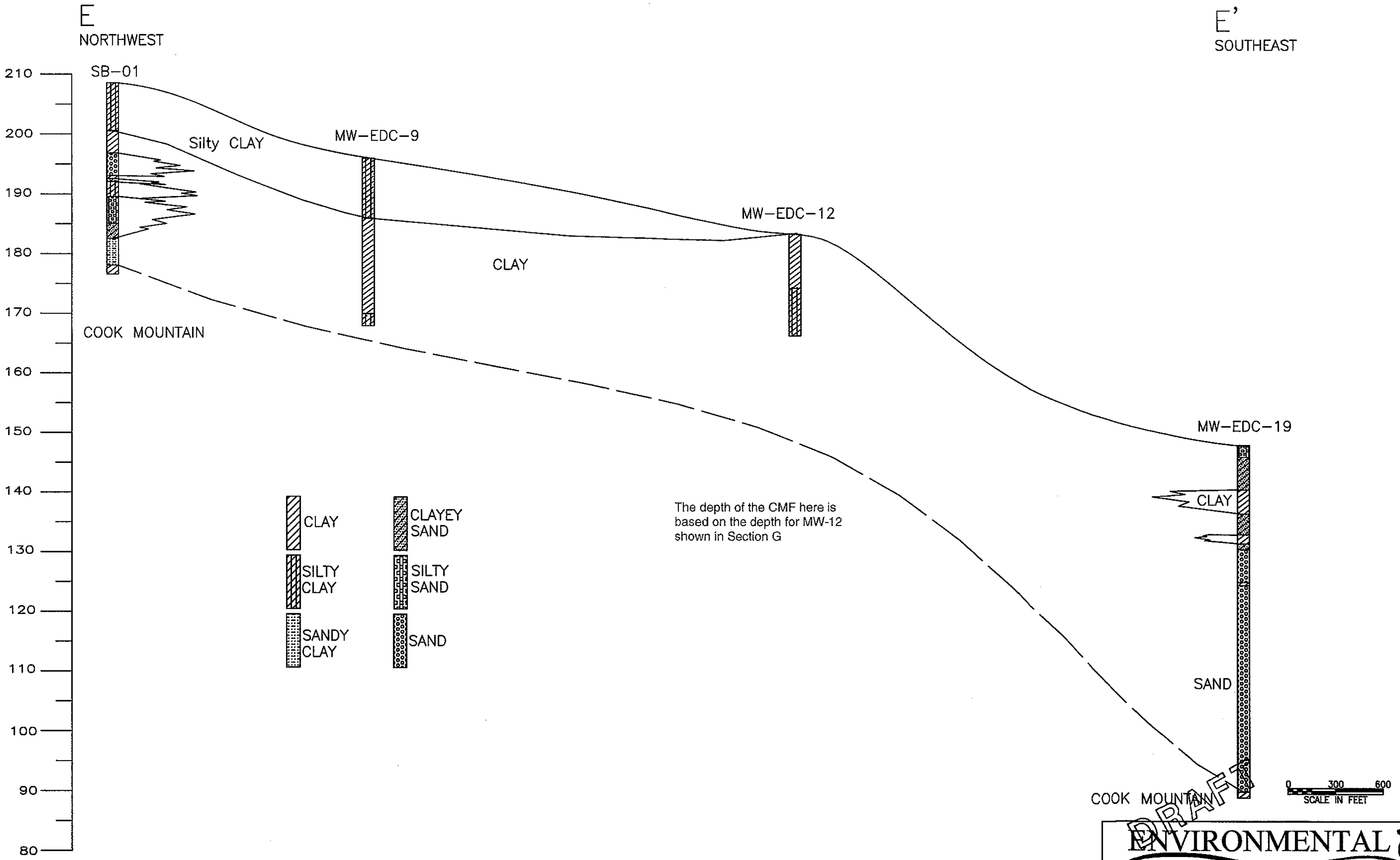
The depth of the CMF here is based on the depths for MW-12 and MW-16 in Section G (which shows MW-12) and Section B (which shows MW-16)

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.

PROJECT NO: 03EC200
revised CROSS SECTION MW-3 TO MW-16 LMM.DWG
DRAFTED BY: LMM DATE: 03/12/04
APPROVED:
BY: DATE:

CROSS SECTION D - D'
GEOLOGIC INVESTIGATION REPORT
EL DORADO CHEMICAL COMPANY
EL DORADO, ARKANSAS

6



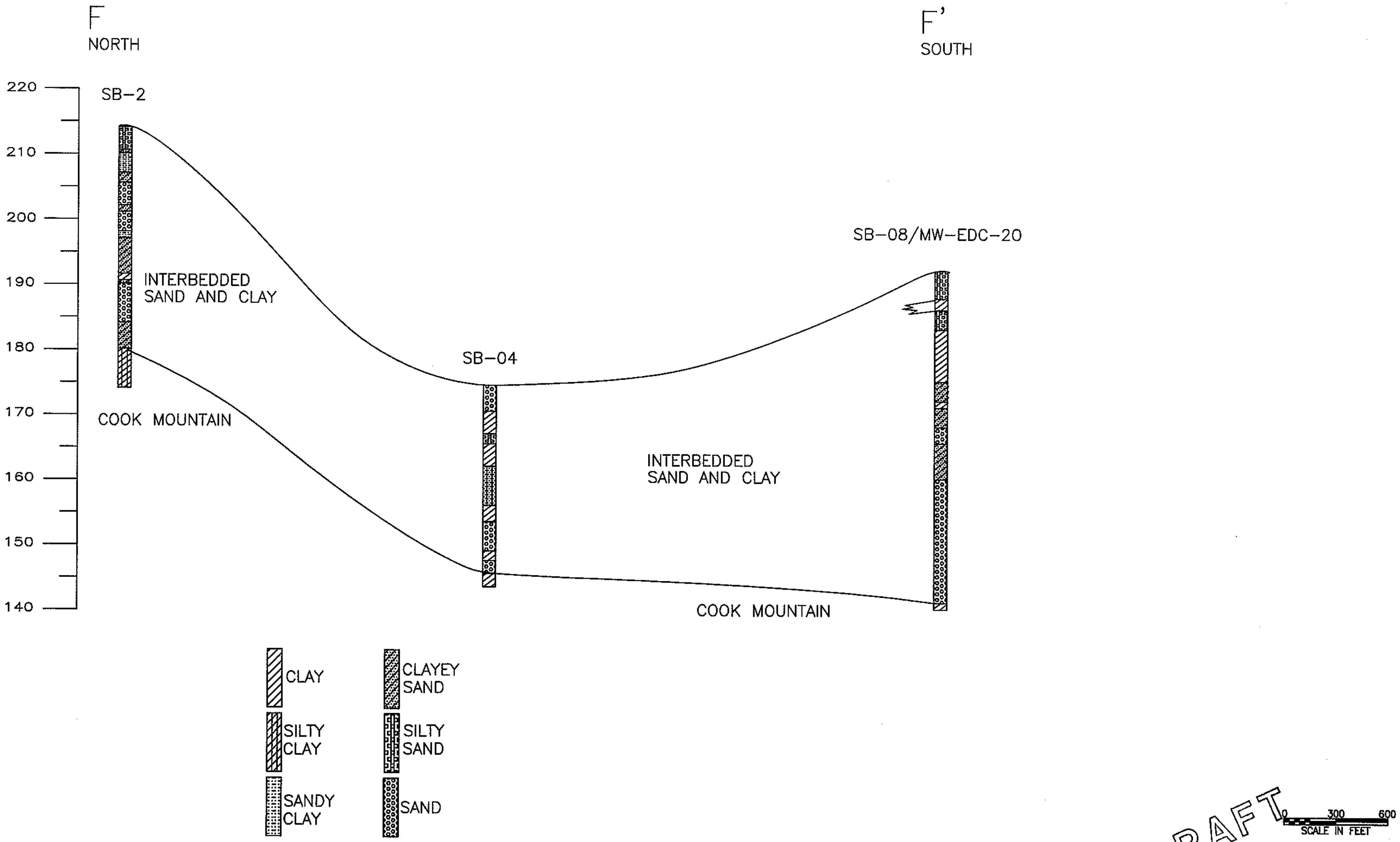
The depth of the CMF here is based on the depth for MW-12 shown in Section G

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.

PROJECT NO: 03EC200
filename
DRAFTED BY: LMM DATE: 03/15/04
APPROVED:
BY: DATE:

CROSS SECTION E - E'
GEOLOGIC INVESTIGATION REPORT
EL DORADO CHEMICAL COMPANY
EL DORADO, ARKANSAS

7

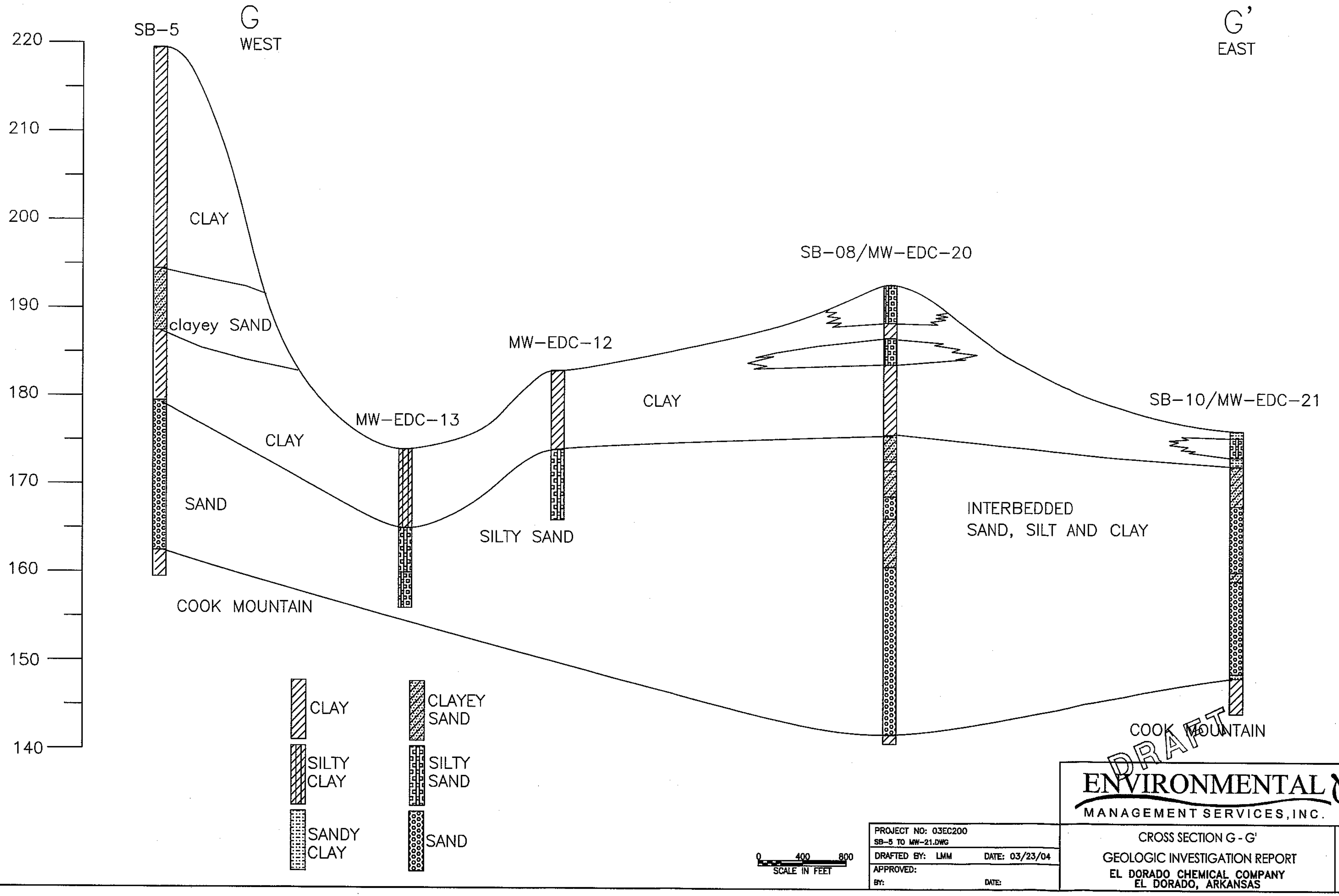


ENVIRONMENTAL
MANAGEMENT SERVICES, INC.

PROJECT NO: 03EC200
filename
DRAFTED BY: LMM DATE: 03/15/04
APPROVED:
BY: DATE:

CROSS SECTION F - F'
GEOLOGIC INVESTIGATION REPORT
EL DORADO CHEMICAL COMPANY
EL DORADO, ARKANSAS

8



PROJECT NO: 03EC200
SB–5 TO MW–21.DWG

DRAFTED BY: LMM DATE: 03/23/04

APPROVED:

BY: DATE:

ENVIRONMENTAL MANAGEMENT SERVICES, INC.

CROSS SECTION G - G'

GEOLOGIC INVESTIGATION REPORT

EL DORADO CHEMICAL COMPANY
EL DORADO, ARKANSAS

9

APPENDIX A

BORING AND CONDUCTIVITY LOGS

Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-11-04
Northing: 10915.59
Easting: 1846.90
Grd. Elev: 208.57
Total Depth (ft. bls) 32.0
Geologist: SMF
Drill Method: GeoProbe
Driller: JG
Checked By:

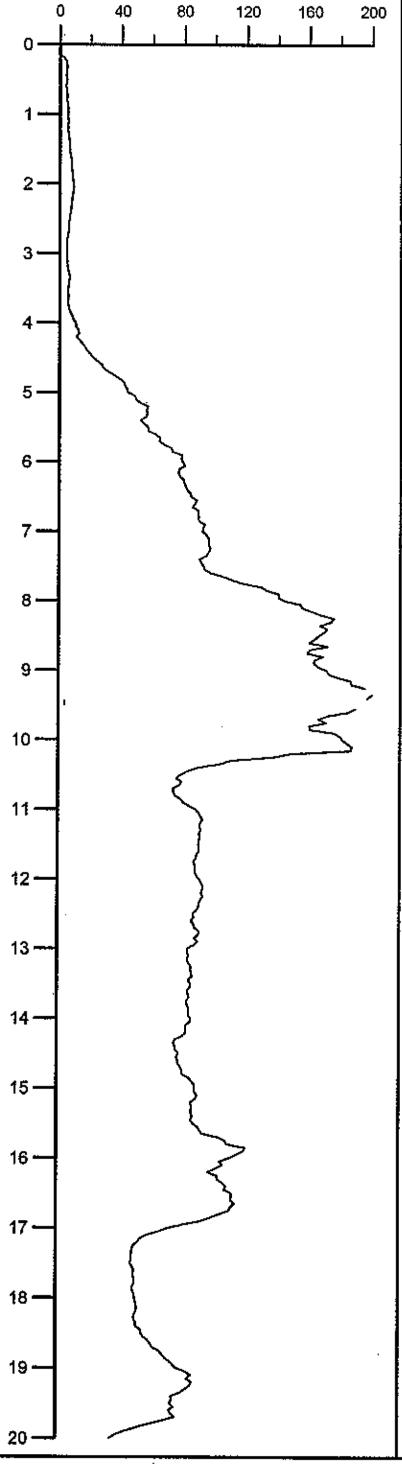
Page: 1 of 2

Boring No.: SB-01

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE			SAMPLE	
Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
0		Ground Surface		
0–8	▨	Hard light gray and orange silty CLAY (CL)	☒	
8–11.8	▨	Very stiff light gray CLAY (CH) with orange seams	☒	
11.8–15.5	░	Dense to very dense light gray fine SAND (SP) with clay	☒	
15.5–16	▨	Stiff light brown CLAY (CH)		
16–16.5	░	Dense light gray SAND (SP)	☒	
16.5–19		Very dense light gray clayey SILT (ML)		
19–20	░	Very dense light gray SAND (SP)		

Soil Conductivity (mS/m)
Probe Log



Well Completion
Details

Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-11-04

Northing: 10915.59
Easting: 1846.90
Grd. Elev: 208.57
Total Depth (ft. bls) 32.0

Geologist: SMF
Drill Method: GeoProbe
Driller: JG
Checked By:

Page: 2 of 2

Boring No.: SB-01

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE | SAMPLE

Depth (ft.) | Symbol | Description / Unified Soil Classification | Lab Sample No. | PID (ppm)

Dense light gray silty SAND (SM) with some black grains

Firm to dense light gray and light brown clayey SAND (SC)

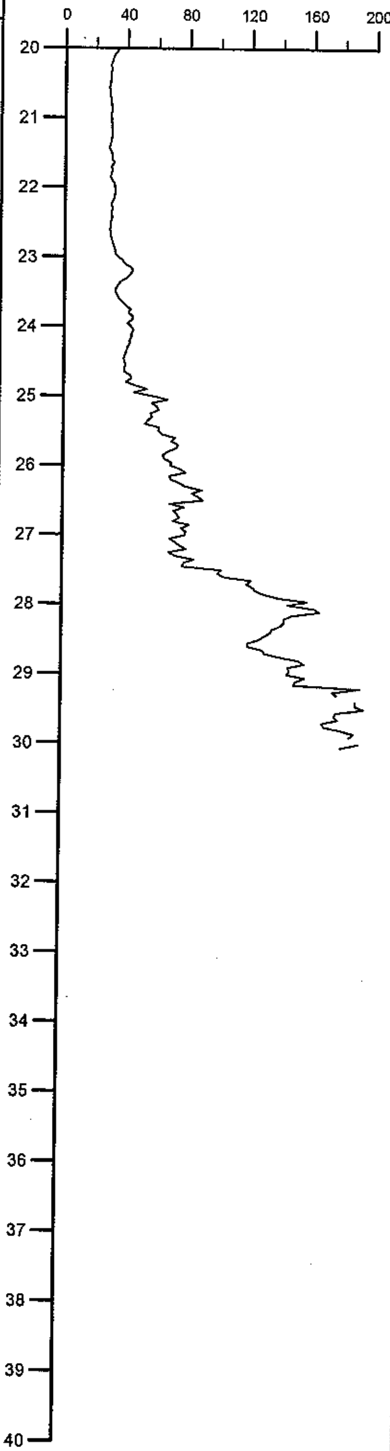
Medium light gray and orange fine sandy CLAY (CL)

Cook Mountian Formation

Very stiff to hard dark gray CLAY (CH) with light gray silt seams

Total Depth 32'

Soil Conductivity (mS/m) Probe Log



Well Completion Details

Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-10-04

Northing: 11562.88
Easting: 5829.66
Grd. Elev: 214.41
Total Depth (ft. bls) 40.0

Geologist: SMF
Drill Method: GeoProbe
Driller: JG
Checked By:

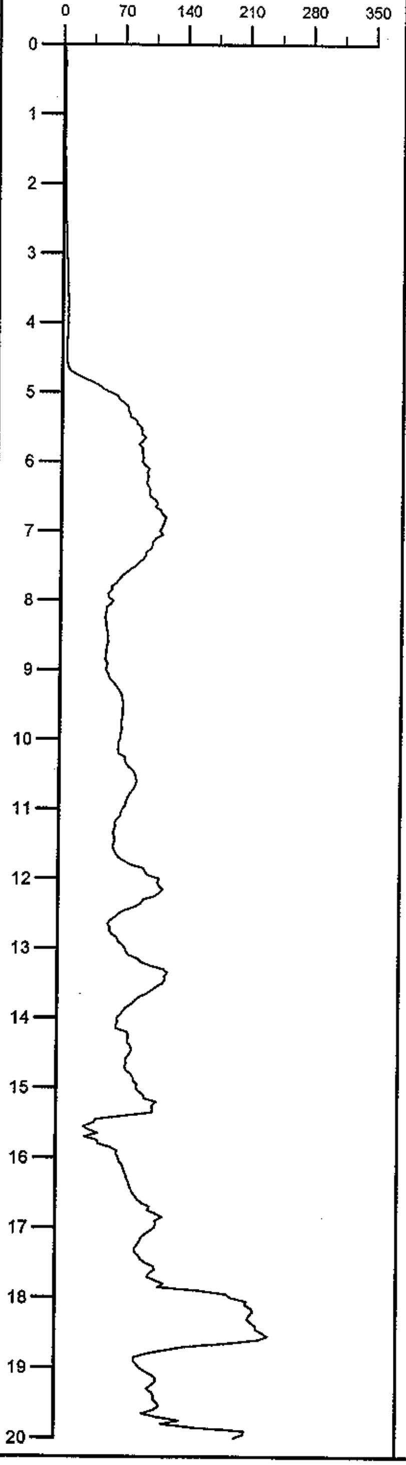
Page: 1 of 2

Boring No.: SB-02

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE			SAMPLE	
Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
0		Ground Surface		
		Loose brown silty SAND (SM)		
		Dense brown clayey SAND (SC)		
		Very stiff dark gray and orange sandy CLAY (CL)		
		Very dense orange and light brown clayey SAND (SC)		
		Very dense light brown fine SAND (SP) with clay		
		Very dense light gray and orange clayey SAND (SC)		
		Very dense light gray SAND (SP) with clay		
		Very stiff dark gray sandy CLAY (CL)		
		Very dense orange and light gray clayey SAND (SC)		
		Stiff light gray sandy CLAY (CL)		
		Very dense orange and light gray clayey SAND (SC)		
20				

Soil Conductivity (mS/m) Probe Log



Well Completion Details

Project No.: 03EC200
Northing: 11562.88
Geologist: SMF
Project: El Dorado Chem
Easting: 5829.66
Drill Method: GeoProbe
Location: ElDorado, AR
Grd. Elev: 214.41
Driller: JG
Date: 1-10-04
Total Depth (ft. bls) 40.0
Checked By:

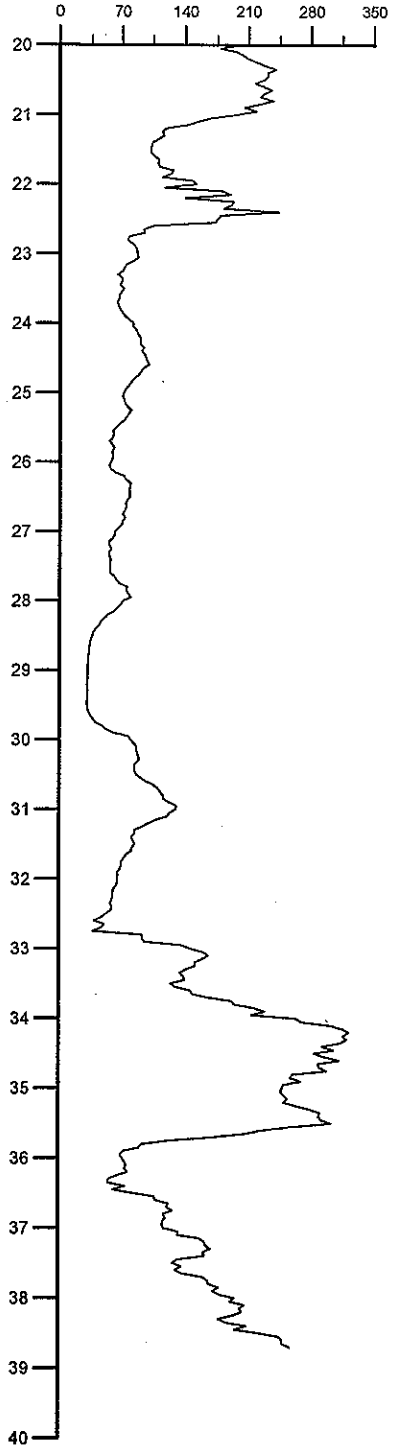
Page: 2 of 2

Boring No.: SB-02

ENVIRONMENTAL MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE			SAMPLE	
Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
20		Stiff light gray and orange sandy CLAY (CL) *(Continued)*		
21		Dense light gray clayey SAND (SC)		
22		Hard dark gray silty CLAY (CL)		
23		Dense light gray clayey SAND (SC)		
24		Dense light gray SAND (SP) with clay		
30		Dense light brown clayey SAND (SC)		
34		Very stiff orange silty sandy CLAY (CL)		
36		Cook Mountian Formation Very stiff dark gray silty CLAY (CL) with light gray silt seams, and lignite Total Depth 40'		
40				

Soil Conductivity (mS/m) Probe Log



Well Completion Details

Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-11-04

Northing: 10364.75
Easting: 3353.22
Grd. Elev: 198.39
Total Depth (ft. bls) 28.0

Geologist: SMF
Drill Method: GeoProbe
Driller: JG
Checked By:

Page: 1 of 2

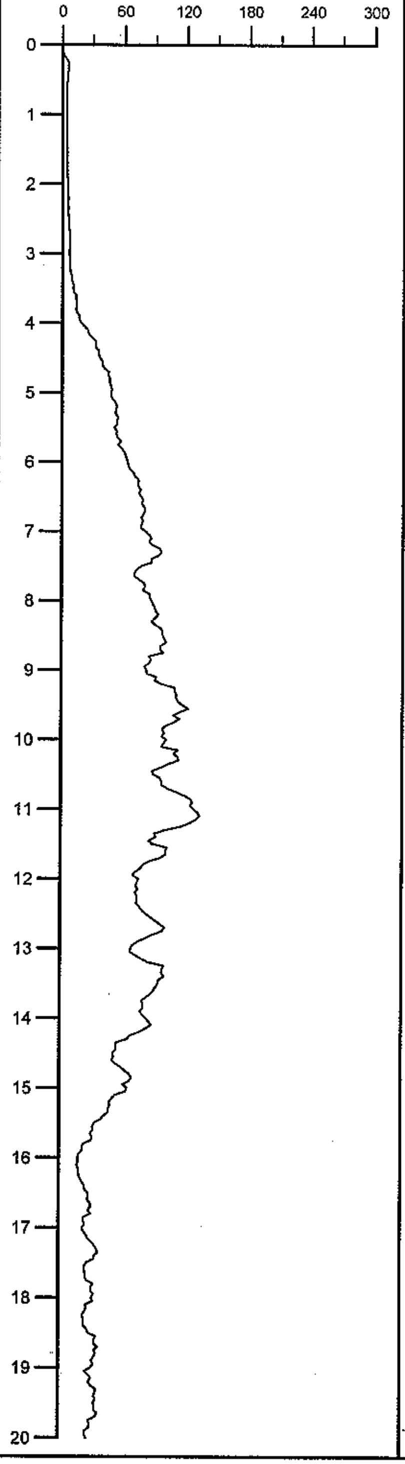
Boring No.: SB-03

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE | SAMPLE

Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
0		Ground Surface		
0	▨	Very soft light gray and orange silty CLAY (CL)	☒	
4	▧	Very stiff light gray fine sandy CLAY (CL-CH) with light gray silt seams	☒ ☒	
12	▨	Very stiff light gray fine sandy CLAY (CL) with light gray silt seams	☒	
16	▨	Loose light gray clayey SAND (SC) with 1" clay seams	☒	
20				

Soil Conductivity (mS/m)
Probe Log



Well Completion
Details

Project No.: 03EC200
Northing: 10364.75
Geologist: SMF
Project: El Dorado Chem
Easting: 3353.22
Drill Method: GeoProbe
Location: ElDorado, AR
Grd. Elev: 198.39
Driller: JG
Date: 1-11-04
Total Depth (ft. bls) 28.0
Checked By:

Page: 2 of 2

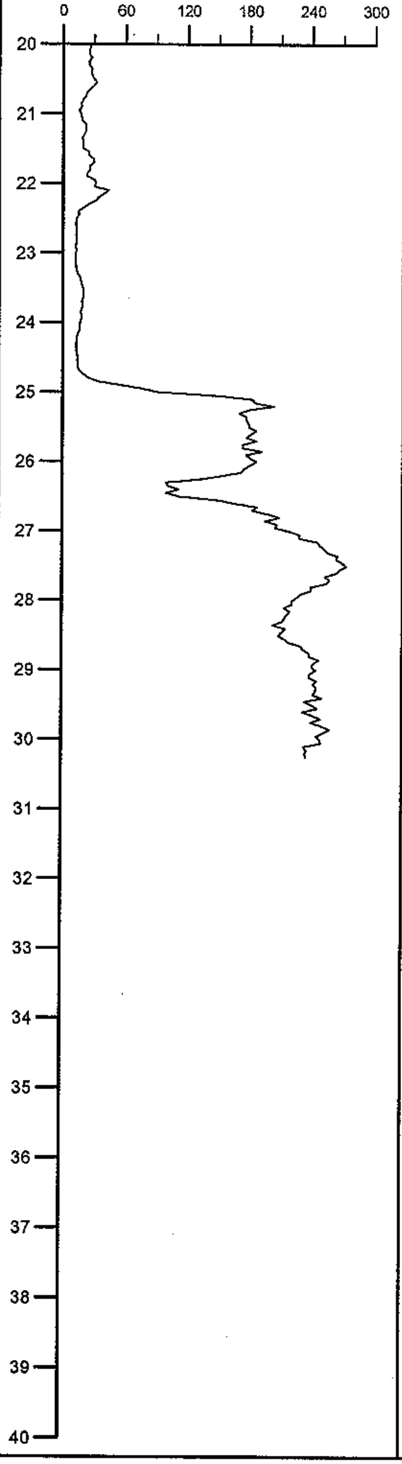
Boring No.: SB-03

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE

Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
20 21 22	▨	Loose light gray clayey SAND (SC) with 1" clay seams *(Continued)*	☒	
23 24	░	Loose light gray SAND (SP)	☒	
25 26 27	▩	Cook Mountian Formation Very stiff dark brown CLAY (CH) with sand and silt seams	☒	
28		Total Depth 28'		
29 30 31 32 33 34 35 36 37 38 39 40				

Soil Conductivity (mS/m) Probe Log



Well Completion Details

Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-11-04

Northing: 9480.96
Easting: 6232.14
Grd. Elev: 174.99
Total Depth (ft. bls) 31.0

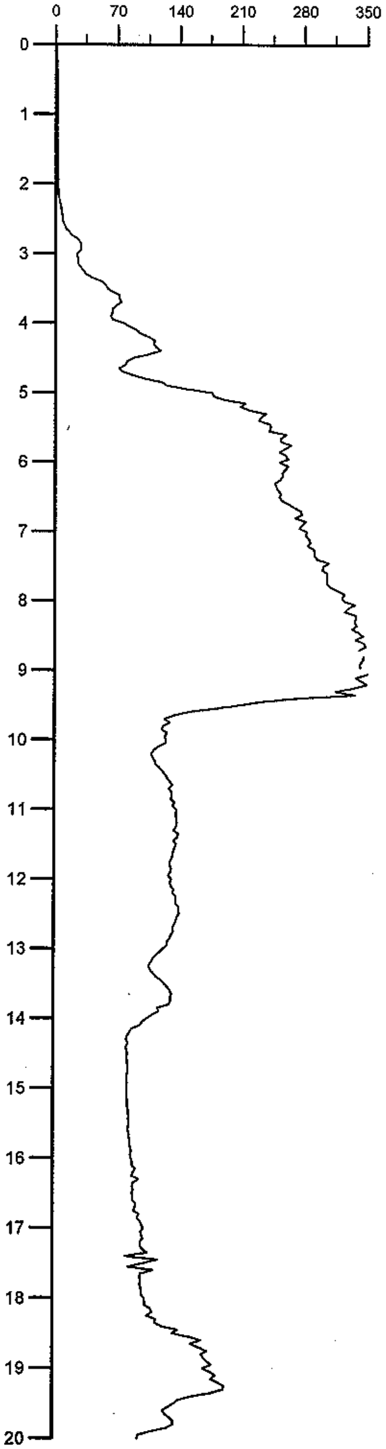
Geologist: SMF
Drill Method: Mud Rotary
Driller: Diversified
Checked By:

Page: 1 of 2

Boring No.: SB-04

ENVIRONMENTAL MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE			SAMPLE		Soil Conductivity (mS/m) Probe Log	Well Completion Details
Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)		
0		Ground Surface				
		Loose light gray fine SAND (SP)				
4		Very stiff light brown CLAY (CH) with fine sand seams 6' to 7.5'				
		Light gray silty SAND (SP)				
		Very stiff light gray CLAY (CH)				
14		Very dense to hard light brown clayey sandy SILT (ML) GeoProbe refusal at 16'				
		Stiff dark brown CLAY (CL)				



Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-11-04
Northing: 9480.96
Easting: 6232.14
Grd. Elev: 174.99
Total Depth (ft. bls) 31.0
Geologist: SMF
Drill Method: Mud Rotary
Driller: Diversified
Checked By:

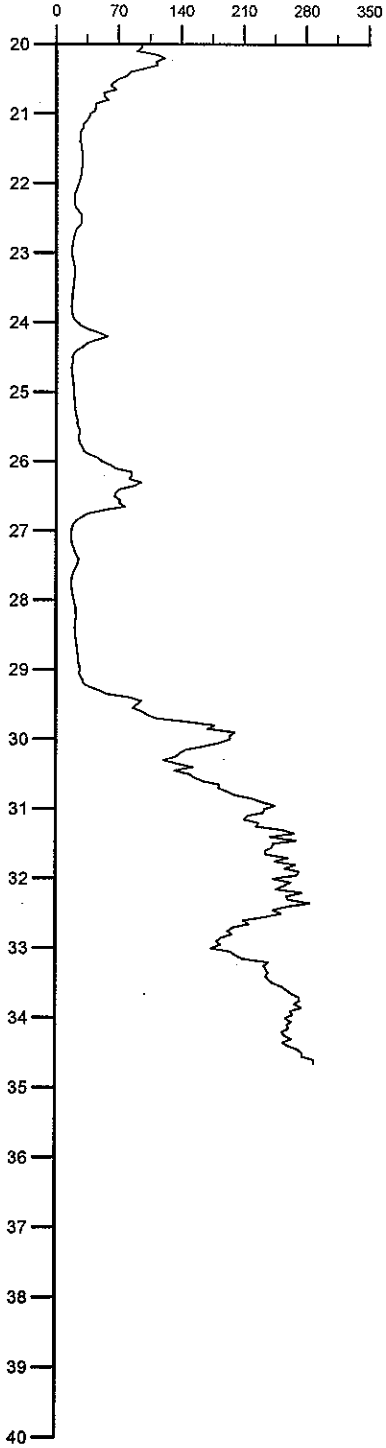
Page: 2 of 2

Boring No.: SB-04

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE			SAMPLE	
Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
20	▨	Stiff dark brown CLAY (CL) *(Continued)*		
21	░	Dense dark gray SAND (SP)		
26	▨	Light gray and brown sandy CLAY (CL) laminated		
27	░	Dark gray SAND (SP)		
29	▨	Cook Moutian Formation Very stiff dark brown clay (CL) with light gray sand laminations	☒	
31		Total Depth 31'		

Soil Conductivity (mS/m)
Probe Log



Well Completion
Details

Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-20-04

Northing: 7157.14
Easting: 968.18
Grd. Elev: 219.47
Total Depth (ft. bls) 60.0

Geologist: SMF
Drill Method: Mud Rotary
Driller: Diversified
Checked By:

Page: 1 of 4

Boring No.: SB-05

ENVIRONMENTAL
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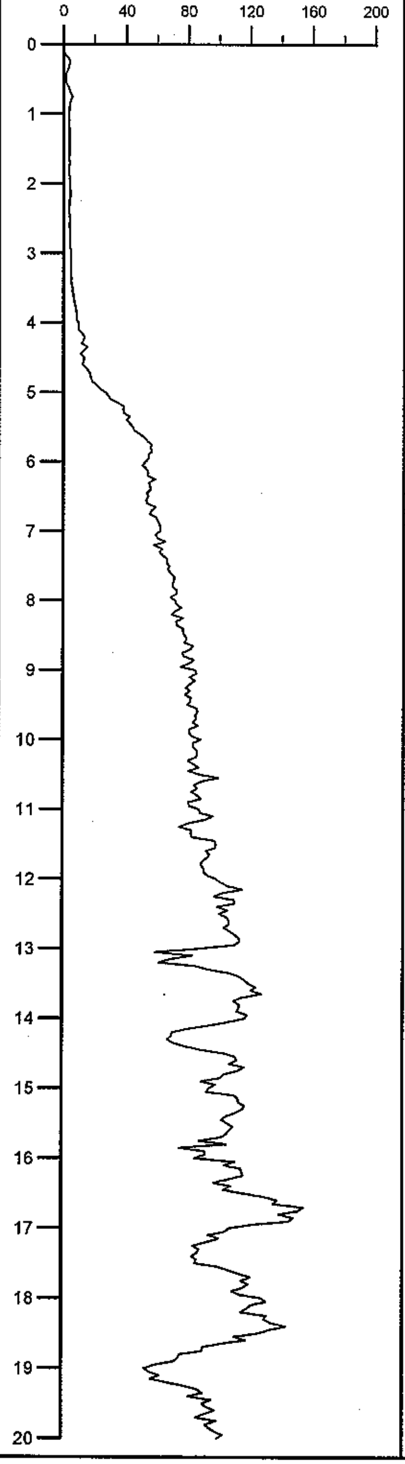
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE			SAMPLE	
Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
		Ground Surface		
0 – 8.5	▨	Stiff light gray silty CLAY (CL) with orange stains		
8.5 – 19	▨	Very stiff brown CLAY (CH) with light gray fine sand seams		
19 – 20	▨	Very stiff brown clay (CL-CH) interbedded with light gray and orange fine sand		

Soil Conductivity (mS/m)
Probe Log



Well Completion
Details

Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-20-04

Northing: 7157.14
Easting: 968.18
Grd. Elev: 219.47
Total Depth (ft. bls) 60.0

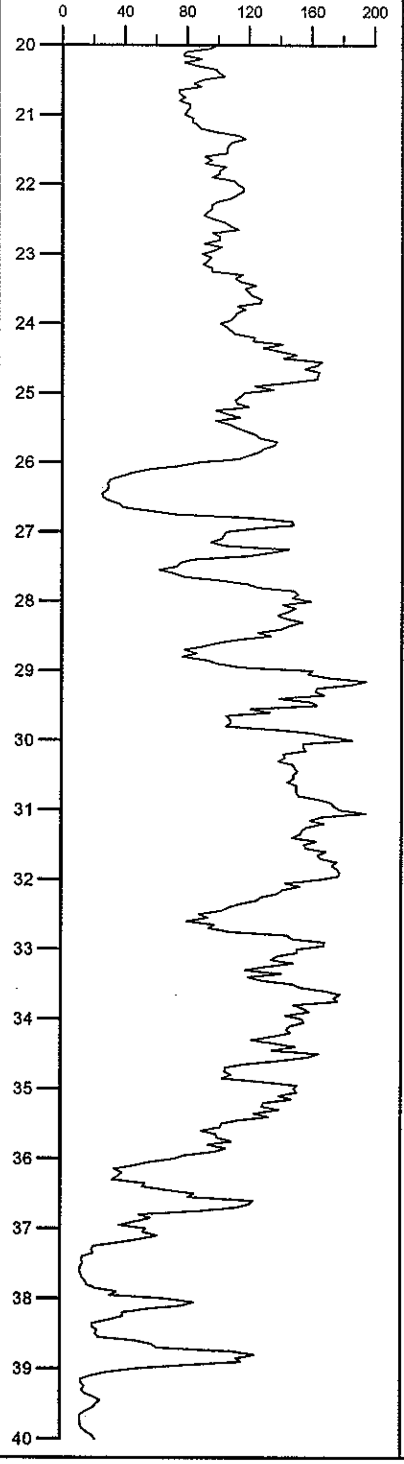
Geologist: SMF
Drill Method: Mud Rotary
Driller: Diversified
Checked By:

Page: 2 of 4

Boring No.: SB-05

ENVIRONMENTAL MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE			SAMPLE		Soil Conductivity (mS/m) Probe Log	Well Completion Details
Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)		
20	▨	Very stiff dark gray CLAY (CH) with fine sand seams				
25	▨	Very stiff dark gray clayey fine sandy CLAY (CL)				
32	▨	Very stiff dark gray CLAY (CH) with light gray fine sand seams				
38	░	Very dense dark gray fine SAND				
40						



CONDUCTIVITY AND WELL 03EC200.GPJ ENV MANAGEMENT.GDT 3/5/04

Project No.:	03EC200	Northing:	7157.14	Geologist:	SMF
Project:	El Dorado Chem	Easting:	968.18	Drill Method:	Mud Rotary
Location:	ElDorado, AR	Grd. Elev:	219.47	Driller:	Diversified
Date:	1-20-04	Total Depth (ft. bls)	60.0	Checked By:	

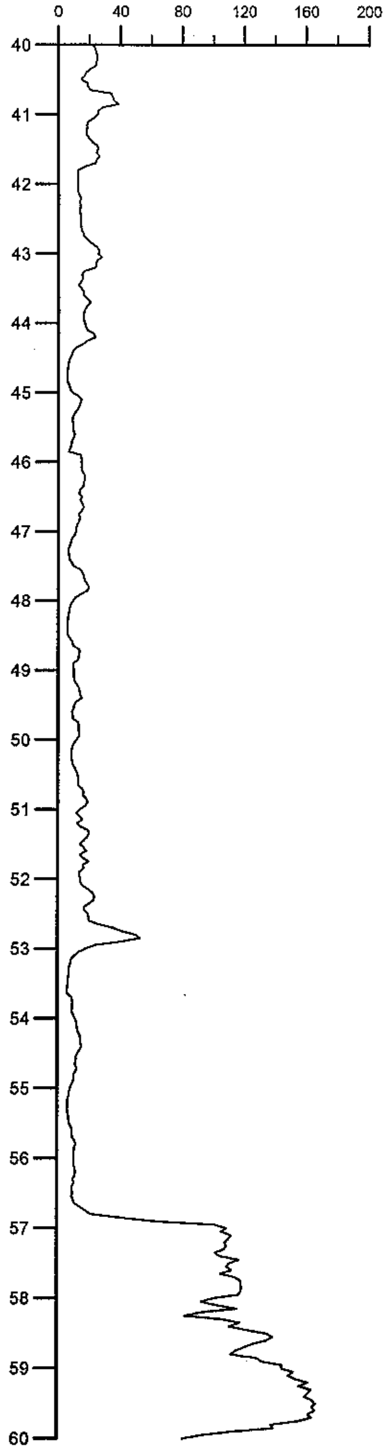
Page: 3 of 4

Boring No.: SB-05

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE			SAMPLE	
Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
40		(SP) with clay seams		
41				
42				
43				
44				
45		Very dense dark gray fine SAND (SP) with clay seams		
46				
47				
48				
49				
50		Very dense dark gray fine SAND (SP) with clay seams, and lignite		
51				
52				
53				
54				
55		Very dense dark gray fine SAND (SP) with clay seams		
56				
57			☒	
58		Cook Mountian Formation Very stiff interbedded light gray fine sand (SP), and dark brown CLAY (CL) Total Depth 60'		
59				
60				

Soil Conductivity (mS/m)
Probe Log



Well Completion Details

Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-20-04

Northing: 7157.14
Easting: 968.18
Grd. Elev: 219.47
Total Depth (ft. bls) 60.0

Geologist: SMF
Drill Method: Mud Rotary
Driller: Diversified
Checked By:

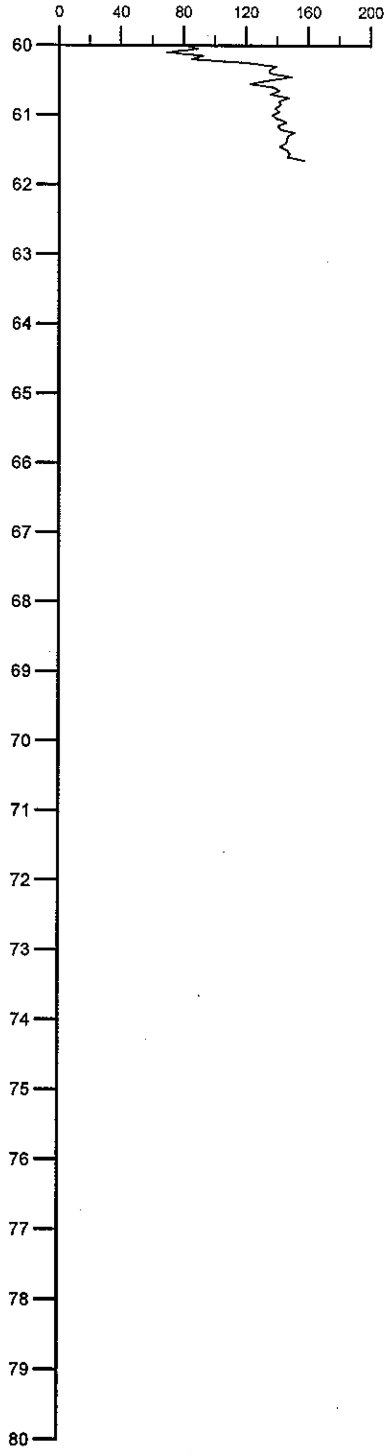
Page: 4 of 4

Boring No.: SB-05

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE			SAMPLE	
Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
60				
61				
62				
63				
64				
65				
66				
67				
68				
69				
70				
71				
72				
73				
74				
75				
76				
77				
78				
79				
80				

Soil Conductivity (mS/m)
Probe Log



Well Completion
Details

Project No.: 03EC200
Northing: 5800.30
Geologist: SMF
Project: El Dorado Chem
Easting: 6741.46
Drill Method: Mud Rotary
Location: ElDorado, AR
Grd. Elev: 147.92
Driller: Diversified
Date: 1-11-04
Total Depth (ft. bls) 59.0
Checked By:

Page: 1 of 3

Boring No.: SB-07/MW-19

ENVIRONMENTAL
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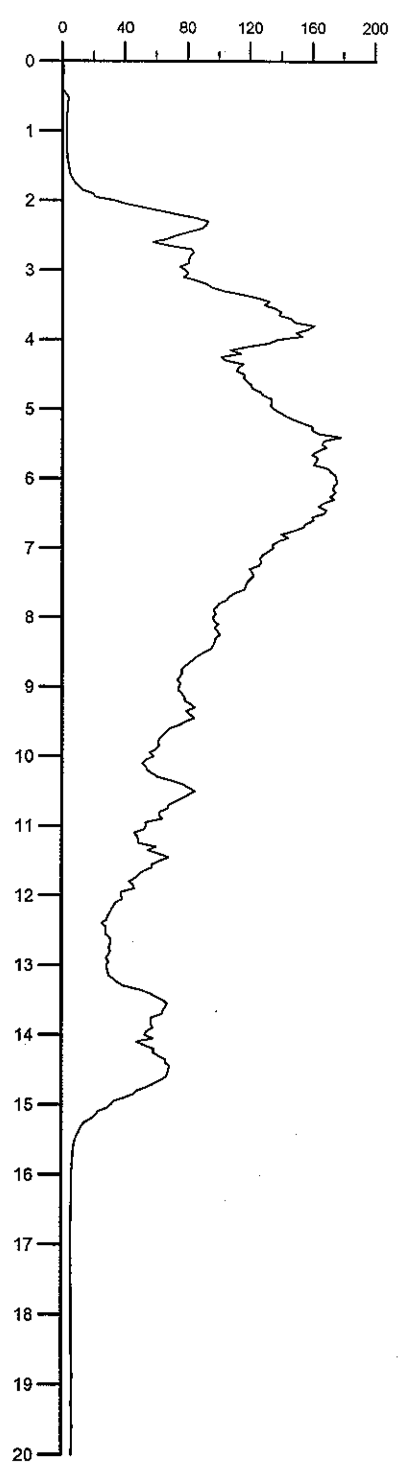
600 N. 26TH AVE
HATTIESBURG, MS 39401

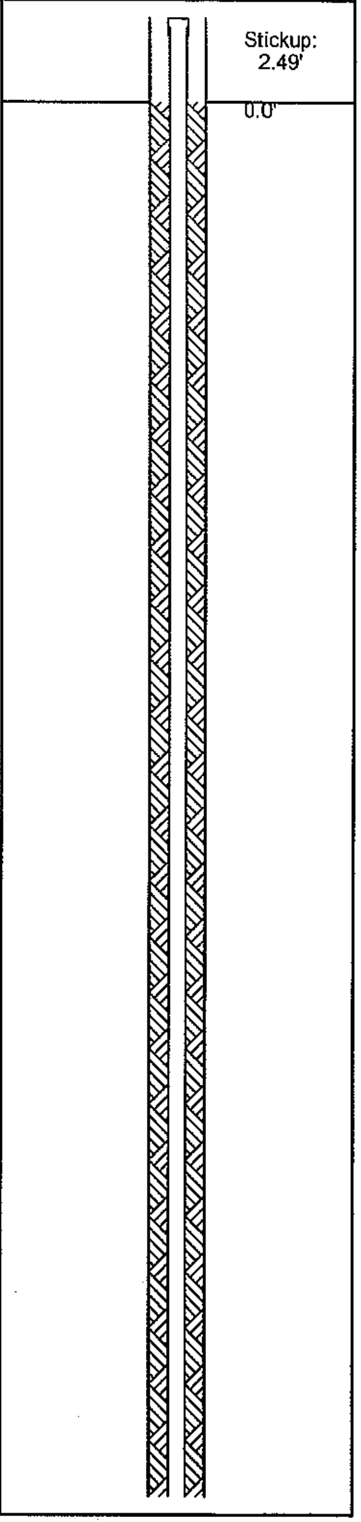
SUBSURFACE PROFILE — SAMPLE

Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
0		Ground Surface		
		Firm light gray silty fine SAND (SM)		
		Stiff light gray fine sandy, silty, CLAY (CL)		
		Medium light gray fine sandy CLAY (CL) light gray and orange, and very sandy 10' to 11.5'		
		Dense light gray and orange clayey fine SAND (SC) with gravel at 14'		
		Very stiff dark gray fine sandy CLAY (CL)		
		Firm dark gray and yellowish brown cayey SAND (SC)		
		Dense gray fine sand (SP)		

Soil Conductivity (mS/m)
Probe Log



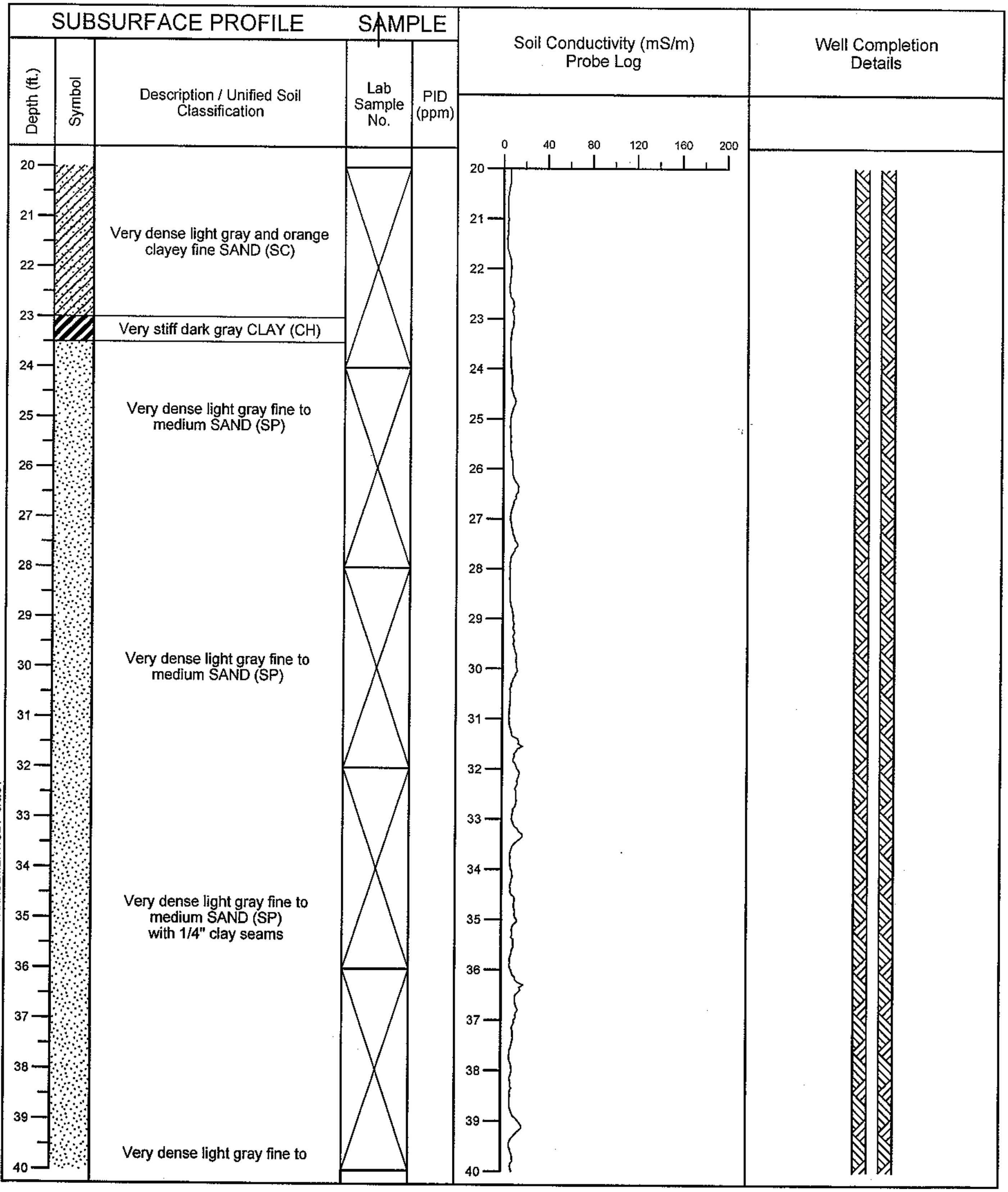
Well Completion
Details



Project No.:	03EC200	Northing:	5800.30	Geologist:	SMF
Project:	El Dorado Chem	Easting:	6741.46	Drill Method:	Mud Rotary
Location:	ElDorado, AR	Grd. Elev:	147.92	Driller:	Diversified
Date:	1-11-04	Total Depth (ft. bls)	59.0	Checked By:	

Boring No.: SB-07/MW-19

ENVIRONMENTAL MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401



Very dense light gray and orange clayey fine SAND (SC)

Very stiff dark gray CLAY (CH)

Very dense light gray fine to medium SAND (SP)

Very dense light gray fine to medium SAND (SP)

Very dense light gray fine to medium SAND (SP) with 1/4" clay seams

Very dense light gray fine to

Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-11-04

Northing: 5800.30
Easting: 6741.46
Grd. Elev: 147.92
Total Depth (ft. bls) 59.0

Geologist: SMF
Drill Method: Mud Rotary
Driller: Diversified
Checked By:

Page: 3 of 3

Boring No.: SB-07/MW-19

ENVIRONMENTAL
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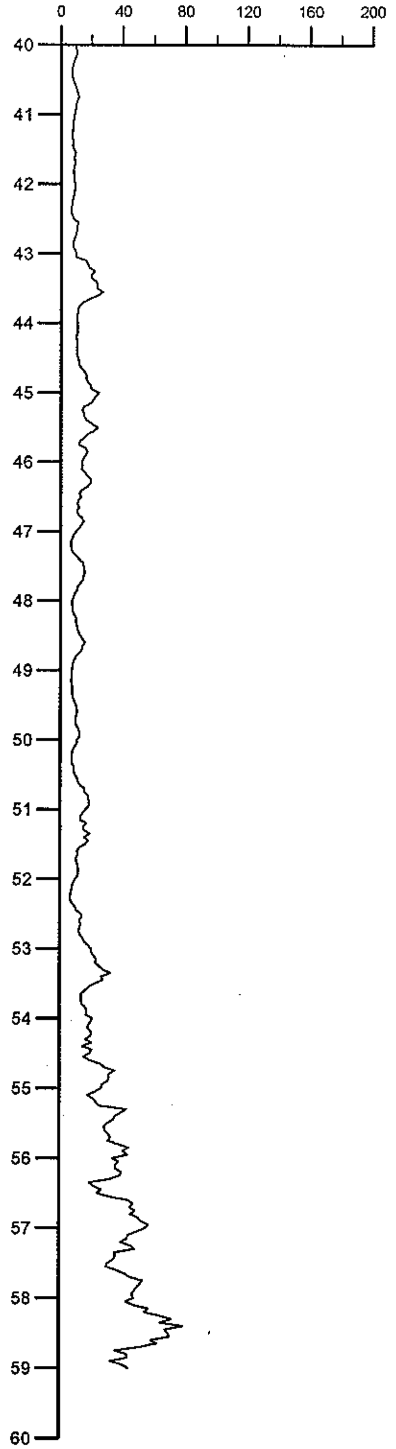
600 N. 26TH AVE
HATTIESBURG, MS 39401

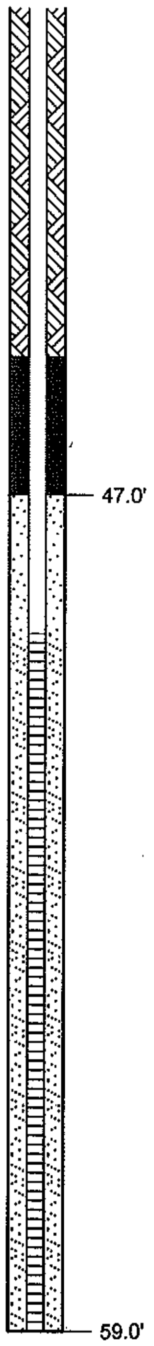
SUBSURFACE PROFILE

Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
40		medium SAND (SP) with 1" clay seams	☒	
42		Geo Probe refusal at 42'		
45		Very dense light gray fine to medium SAND (SP) with 1" clay seams		
50		Very dense light gray fine to medium SAND (SP) with 1" clay seams	☒	
55		Very dense light gray fine to medium SAND (SP) with 1" clay seams	☒	
58	▨	Cook Mountian Formation Interbedded fine SAND (SP) and very stiff dark brown CLAY (CL)	☒	
59		Total Depth 59'		
60				

Soil Conductivity (mS/m)
Probe Log



Well Completion
Details



Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-07-04

Northing: 7137.84
Easting: 7446.47
Grd. Elev: 192.77
Total Depth (ft. bls) 52.0

Geologist: SMF
Drill Method: GeoProbe
Driller: JG
Checked By:

Page: 1 of 3

Boring No.: SB-08/MW-20

ENVIRONMENTAL MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
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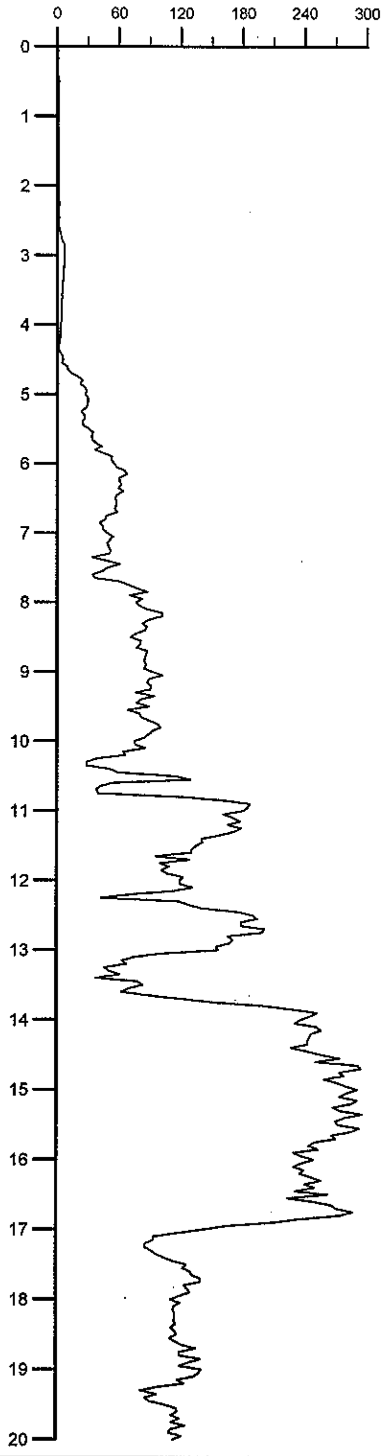
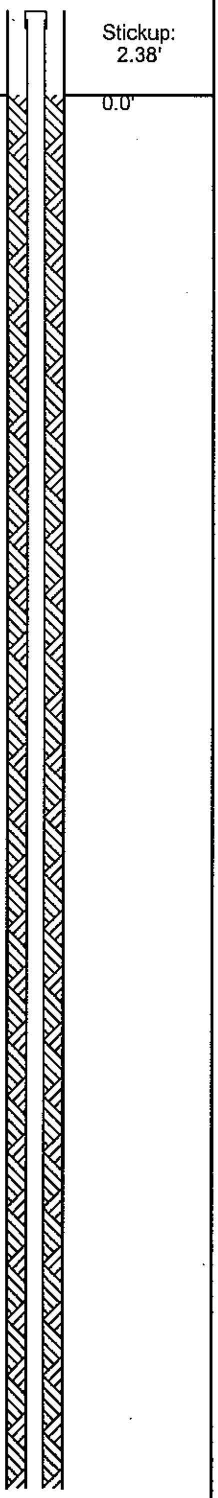
SUBSURFACE PROFILE			SAMPLE	
Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
0		Ground Surface		
		Firm light brown silty fine SAND (SM)		
		Dense orange clayey silty SAND (SC-SM)		
		Stiff grayish brown, light gray, and orange fine sandy CLAY (CL)		
		Dense light gray silty clayey fine SAND (SC-SM)		
		Very stiff grayish brown clay (CL) with light gray fine sand and silt laminations		
		Very stiff to hard grayish brown CLAY (CH) with light gray silt seams		
		Medium light brown and light gray fine sandy CLAY (CL) orange stains 19' to 20'		
20				

Soil Conductivity (mS/m) Probe Log



Well Completion Details



Project No.: 03EC200
Northing: 7137.84
Geologist: SMF
Project: El Dorado Chem
Easting: 7446.47
Drill Method: GeoProbe
Location: ElDorado, AR
Grd. Elev: 192.77
Driller: JG
Date: 1-07-04
Total Depth (ft. bls) 52.0
Checked By:

Page: 2 of 3

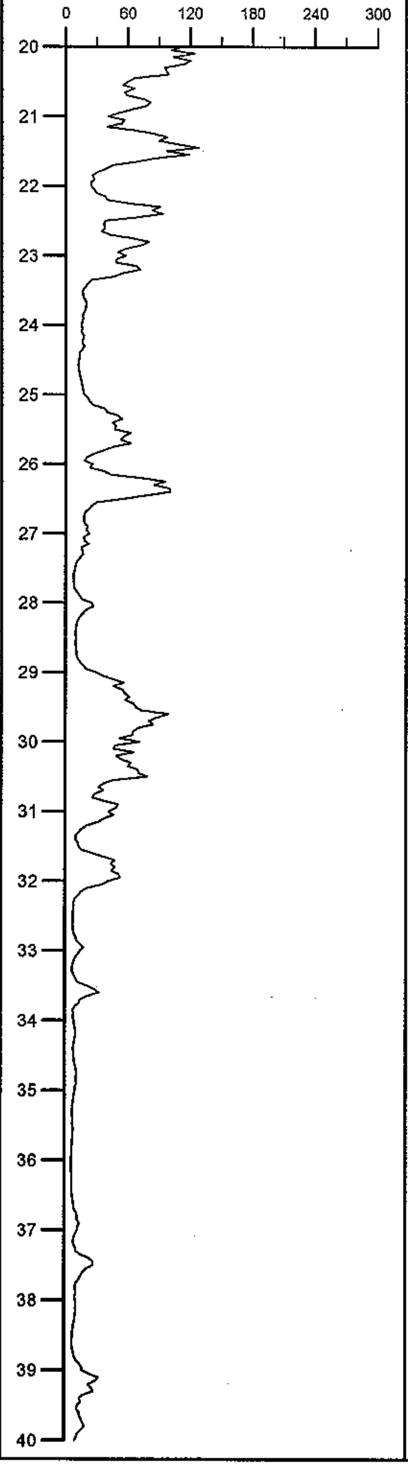
Boring No.: SB-08/MW-20

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

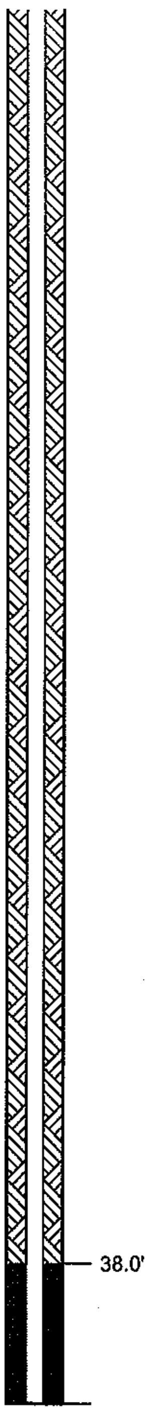
SUBSURFACE PROFILE / SAMPLE

Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
20		Stiff gray CLAY (CH)		
21				
22		Very dense light gray and light brown clayey fine SAND (SC) clay in 1/8" seams		
23				
24				
25		Very dense light gray fine SAND (SP)		
26				
27		Very dense light gray clayey fine SAND (SC) clay in 1/8" seams		
28				
29				
30		Very dense light gray fine SAND (SP-SC) with clay		
31				
32				
33				
34				
35		Very dense light gray fine SAND (SP) clay laminations 33' to 34'		
36				
37				
38				
39				
40		Very dense light gray fine SAND		

Soil Conductivity (mS/m) Probe Log



Well Completion Details



Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-07-04

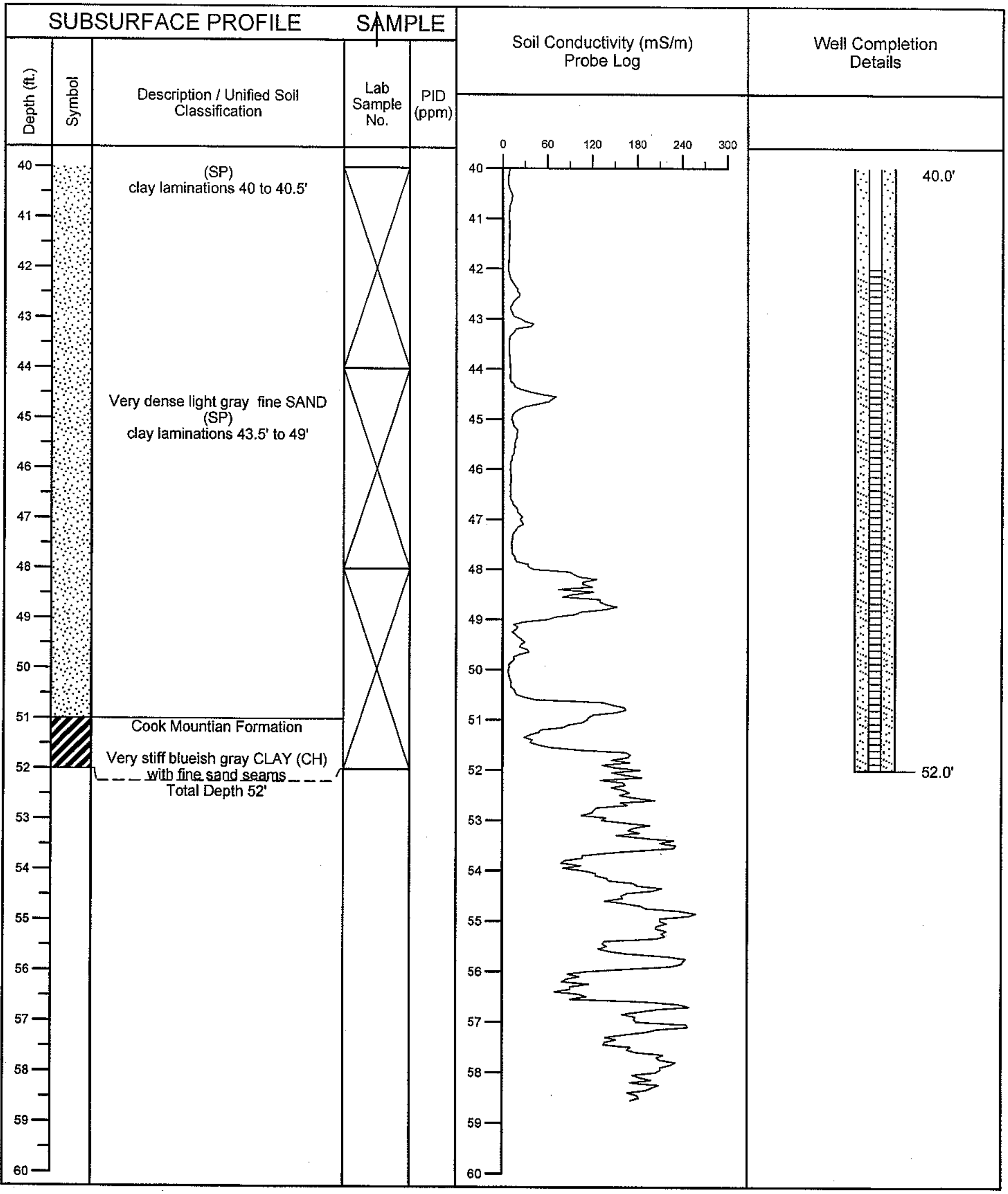
Northing: 7137.84
Easting: 7446.47
Grd. Elev: 192.77
Total Depth (ft. bls) 52.0

Geologist: SMF
Drill Method: GeoProbe
Driller: JG
Checked By:

Page: 3 of 3

Boring No.: SB-08/MW-20

ENVIRONMENTAL MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401



(SP)
clay laminations 40 to 40.5'

Very dense light gray fine SAND (SP)
clay laminations 43.5' to 49'

Cook Mountian Formation

Very stiff blueish gray CLAY (CH) with fine sand seams

Total Depth 52'

Project No.:	03EC200	Northing:	5385.75	Geologist:	SMF
Project:	El Dorado Chem	Easting:	3610.85	Drill Method:	Mud Rotary
Location:	ElDorado, AR	Grd. Elev:	180.48	Driller:	Diversified
Date:	1-22-04	Total Depth (ft. bls)	173.0	Checked By:	

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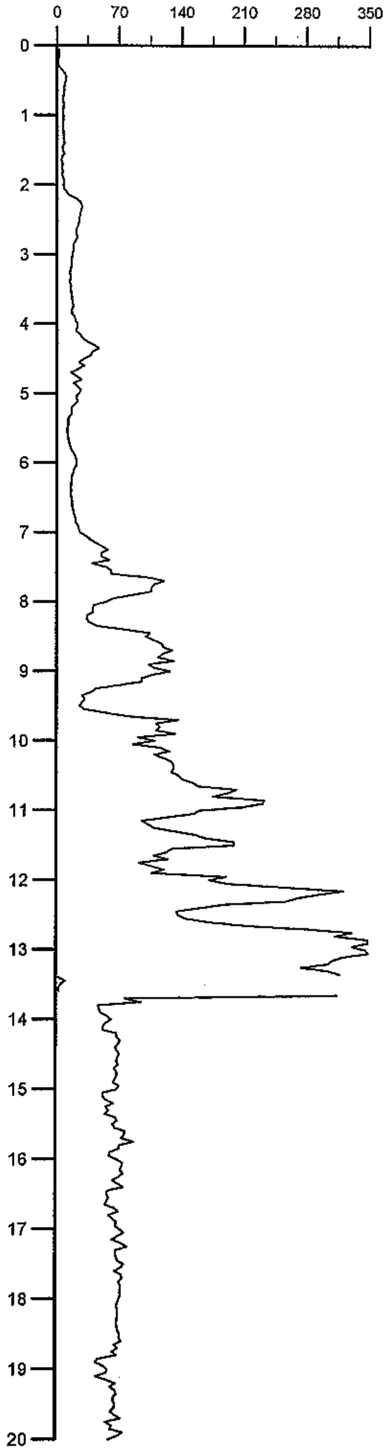
Boring No.: SB-09

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE			SAMPLE		Soil Conductivity (mS/m) Probe Log	Well Completion Details
Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)		
		Ground Surface				
0	░	Dense light gray SAND (SP)				
	▨	Very stiff dark gray silty CLAY (CL)				
8	░	Dense light gray SAND (SP)				
9	▨	Very stiff dark gray silty CLAY (CL)				
	▨	Very stiff dark gray CLAY (CH)				
14	▨	Light gray and orange sandy CLAY (CL)				
20						



Project No.:	03EC200	Northing:	5385.75	Geologist:	SMF
Project:	El Dorado Chem	Easting:	3610.85	Drill Method:	Mud Rotary
Location:	ElDorado, AR	Grd. Elev:	180.48	Driller:	Diversified
Date:	1-22-04	Total Depth (ft. bls)	173.0	Checked By:	

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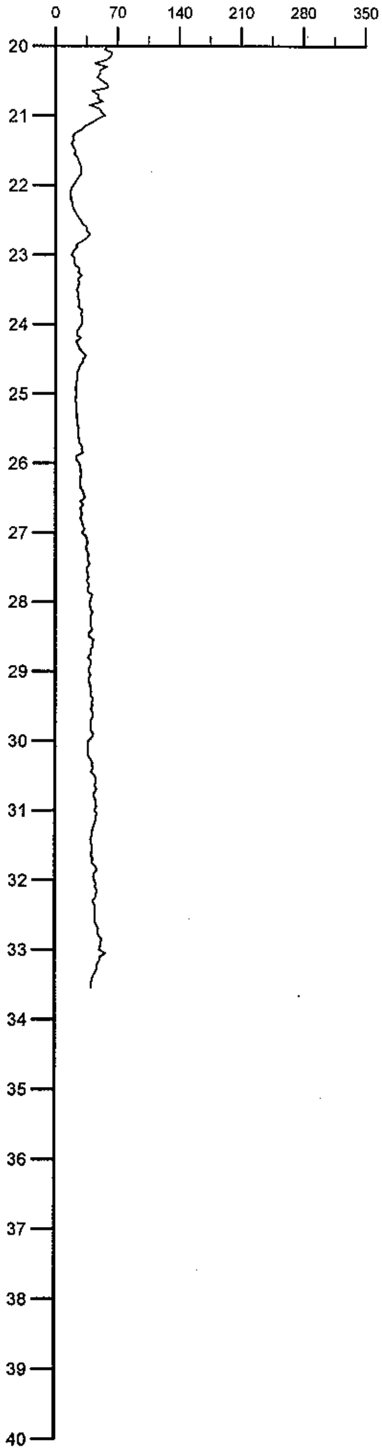
Boring No.: SB-09

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE			SAMPLE	
Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
20	▨			
21	▨			
22	▨	Light gray and orange sandy CLAY (CL) *(Continued)*		
23	▨			
24	▨			
25	░			
26	░			
27	░			
28	░			
29	░			
30	░	Very dense light gray Sand (SP) with 1" clay seams		
31	░			
32	░			
33	░			
34	░			
35	░	Very dense light gray Sand (SP) with 1" clay seams		
36	░			
37	░			
38	░			
39	░			
40	░	Very dense light gray Sand (SP)		

Soil Conductivity (mS/m)
Probe Log



Well Completion
Details

Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-22-04

Northing: 5385.75
Easting: 3610.85
Grd. Elev: 180.48
Total Depth (ft. bls) 173.0

Geologist: SMF
Drill Method: Mud Rotary
Driller: Diversified
Checked By:

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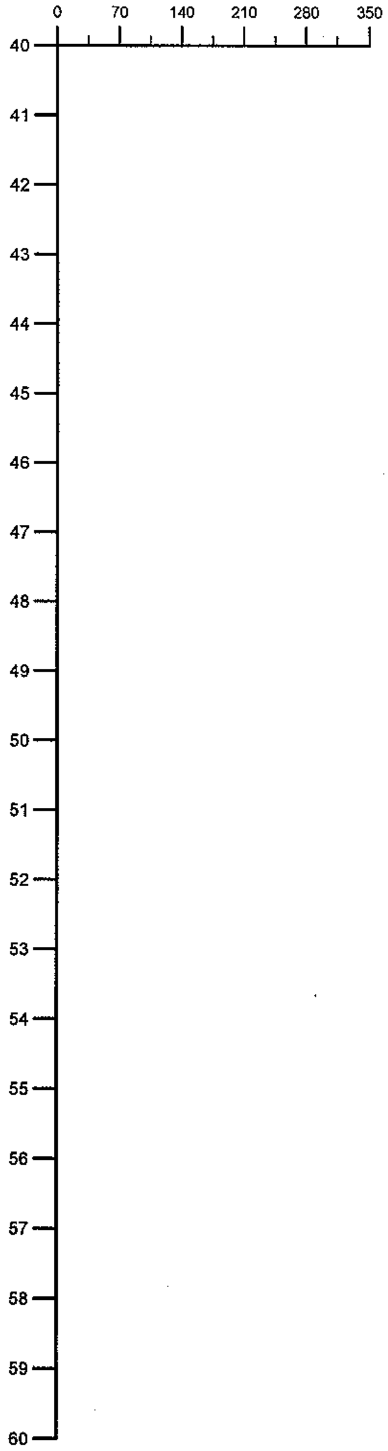
Boring No.: SB-09

ENVIRONMENTAL MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE			SAMPLE	
Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
40		with 1" clay seams		
41				
42				
43				
44				
45		Very dense light gray Sand (SP) with 1" clay seams		
46				
47				
48				
49				
50		Very dense light gray Sand (SP) with 1" clay seams		
51				
52				
53				
54				
55		Very dense light gray Sand (SP) with 1" clay seams		
56				
57				
58				
59				
60		Very dense light gray Sand (SP)		

Soil Conductivity (mS/m) Probe Log



Well Completion Details

Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-22-04

Northing: 5385.75
Easting: 3610.85
Grd. Elev: 180.48
Total Depth (ft. bls) 173.0

Geologist: SMF
Drill Method: Mud Rotary
Driller: Diversified
Checked By:

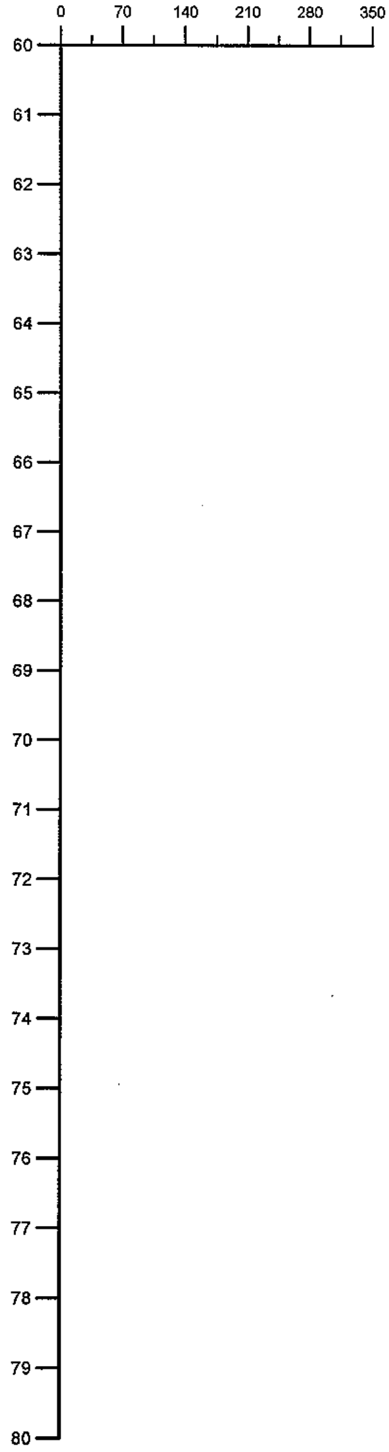
Page: 4 of 9

Boring No.: SB-09

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE			SAMPLE	
Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
60		with 1" clay seams		
65		Very dense light gray Sand (SP) with 1" clay seams		
70		Very dense light gray Sand (SP) with 1" clay seams		
75		Very dense light gray Sand (SP) with 1" clay seams		
80		Very dense light gray Sand (SP)		

Soil Conductivity (mS/m) Probe Log



Well Completion Details

Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-22-04

Northing: 5385.75
Easting: 3610.85
Grd. Elev: 180.48
Total Depth (ft. bls) 173.0

Geologist: SMF
Drill Method: Mud Rotary
Driller: Diversified
Checked By:

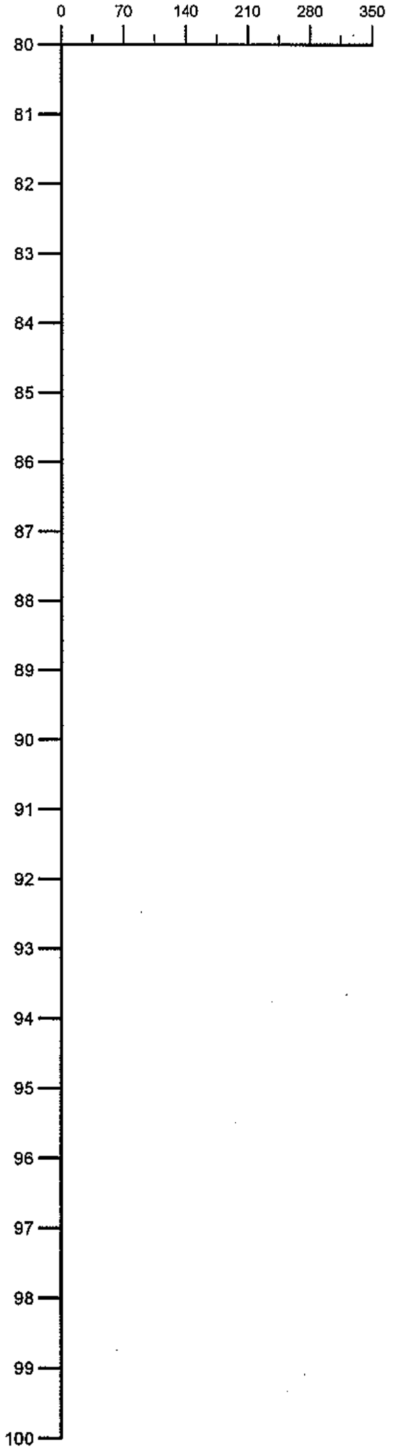
Page: 5 of 9

Boring No.: SB-09

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE			SAMPLE	
Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
80		with 1" clay seams		
81				
82				
83				
84				
85		Very dense light gray Sand (SP) with 1" clay seams		
86				
87				
88				
89				
90		Very dense light gray Sand (SP) with 1" clay seams		
91				
92				
93				
94				
95		Very dense light gray Sand (SP) with 1" clay seams		
96				
97				
98				
99				
100		Very dense light gray Sand (SP)		

Soil Conductivity (mS/m) Probe Log



Well Completion Details

Project No.:	03EC200	Northing:	5385.75	Geologist:	SMF
Project:	El Dorado Chem	Easting:	3610.85	Drill Method:	Mud Rotary
Location:	ElDorado, AR	Grd. Elev:	180.48	Driller:	Diversified
Date:	1-22-04	Total Depth (ft. bls)	173.0	Checked By:	

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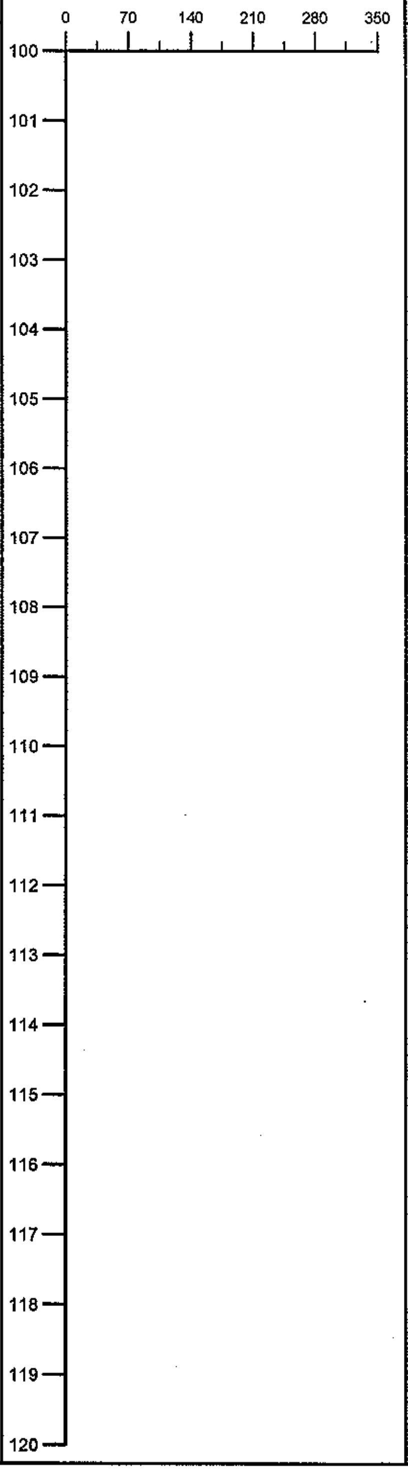
Boring No.: SB-09

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE / SAMPLE

Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
100	░	with 1" clay seams		
101	░			
102	░			
103	░			
104	░			
105	░	Very dense light gray Sand (SP) with 1" clay seams		
106	░			
107	░			
108	░		☒	
109	░		☒	
110	░	Very dense light gray Sand (SP) with 1" clay seams		
111	░			
112	░			
113	░			
114	░			
115	░	Very dense light gray Sand (SP) with 1" clay seams		
116	░			
117	░			
118	░		☒	
119	░		☒	
120	░	Very dense light gray Sand (SP)		

Soil Conductivity (mS/m) Probe Log



Well Completion Details

Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-22-04

Northing: 5385.75
Easting: 3610.85
Grd. Elev: 180.48
Total Depth (ft. bls) 173.0

Geologist: SMF
Drill Method: Mud Rotary
Driller: Diversified
Checked By:

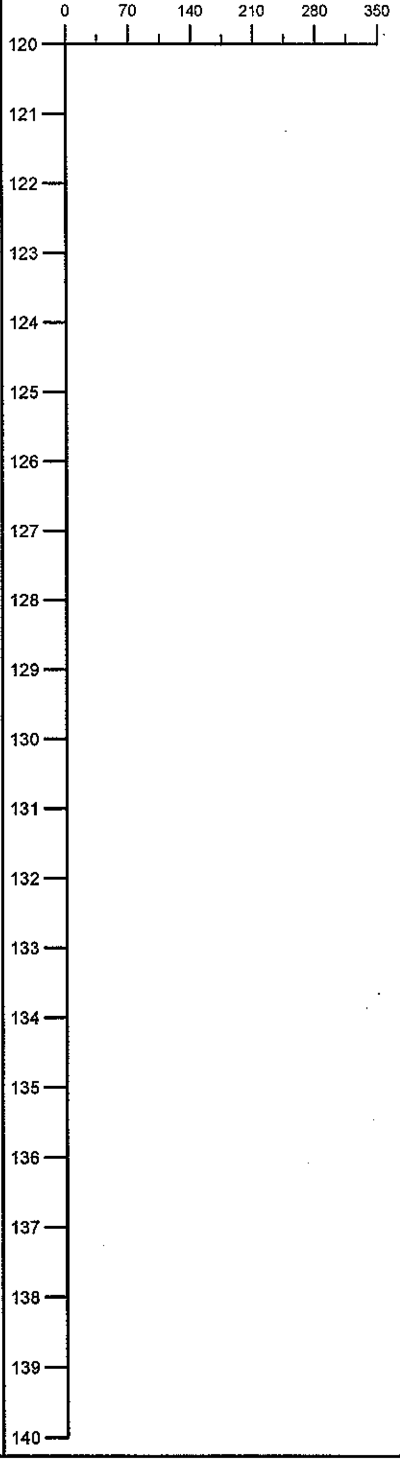
Page: 7 of 9

Boring No.: SB-09

ENVIRONMENTAL MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE			SAMPLE	
Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
120		with 1" clay seams		
121				
122				
123				
124				
125		Very dense light gray Sand (SP) with 1" clay seams		
126				
127				
128				
129				
130		Very dense light gray Sand (SP) with 1" clay seams		
131				
132				
133				
134				
135		Very dense light gray Sand (SP) with 1" clay seams		
136				
137				
138				
139				
140		Very dense light gray Sand (SP)		

Soil Conductivity (mS/m)
Probe Log



Well Completion Details

Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-22-04

Northing: 5385.75
Easting: 3610.85
Grd. Elev: 180.48
Total Depth (ft. bls) 173.0

Geologist: SMF
Drill Method: Mud Rotary
Driller: Diversified
Checked By:

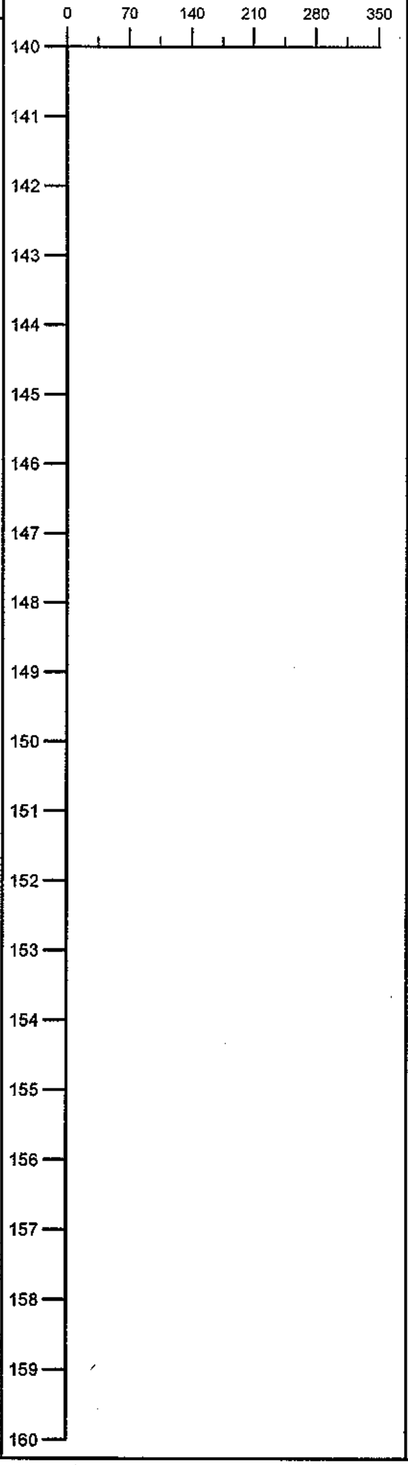
Page: 8 of 9

Boring No.: SB-09

ENVIRONMENTAL MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE			SAMPLE	
Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
140		with 1" clay seams		
141				
142				
143				
144				
145		Very dense light gray Sand (SP) with 1" clay seams		
146				
147				
148			☒	
149				
150		Very dense light gray Sand (SP) with 1" clay seams		
151				
152				
153				
154				
155		Very dense light gray Sand (SP) with 1" clay seams		
156				
157				
158				
159				
160		Very dense light gray Sand (SP)		

Soil Conductivity (mS/m)
Probe Log



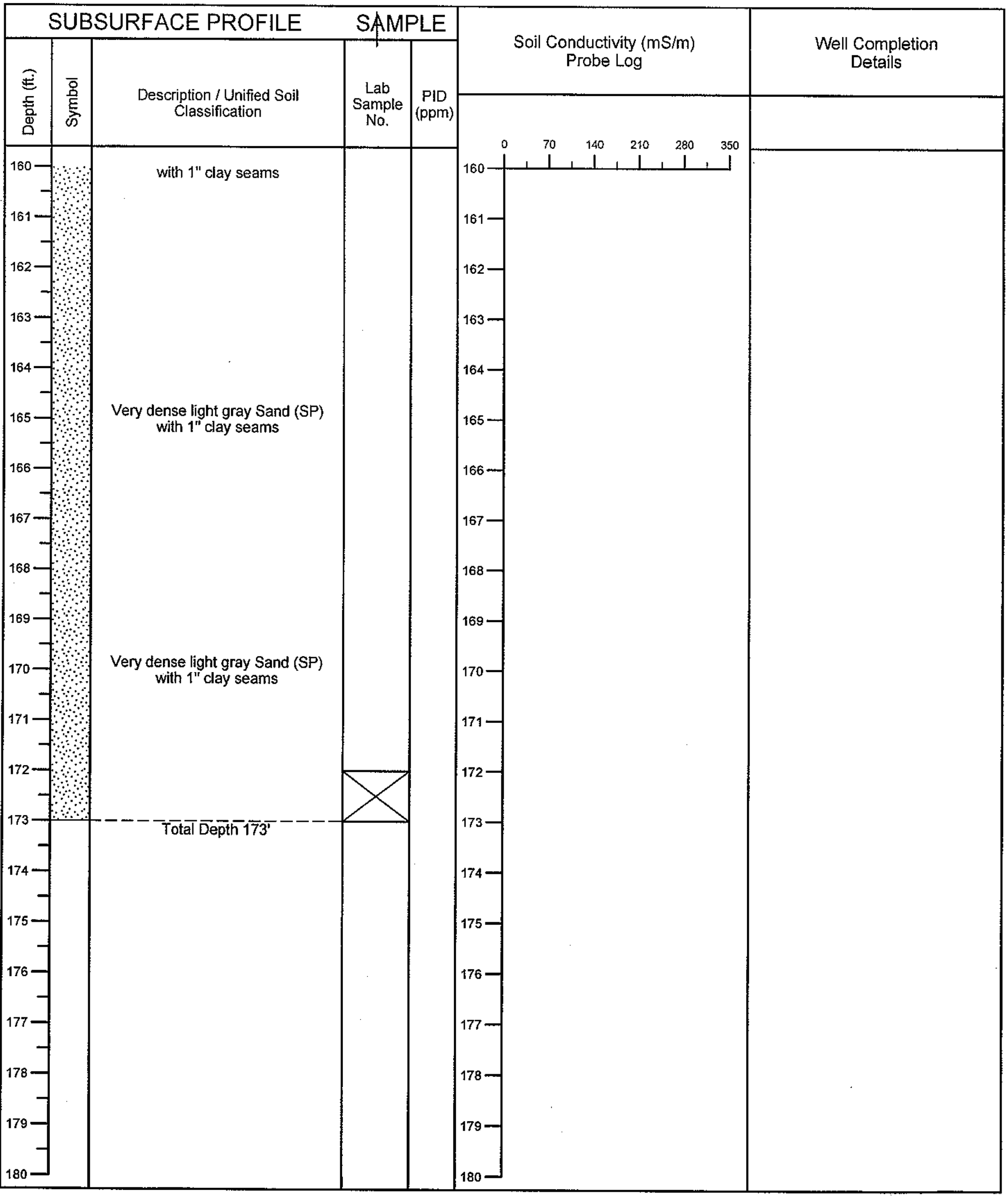
Well Completion Details

Project No.: 03EC200
Northing: 5385.75
Geologist: SMF
Project: El Dorado Chem
Easting: 3610.85
Drill Method: Mud Rotary
Location: ElDorado, AR
Grd. Elev: 180.48
Driller: Diversified
Date: 1-22-04
Total Depth (ft. bls) 173.0
Checked By:

Page: 9 of 9

Boring No.: SB-09

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401



with 1" clay seams

Very dense light gray Sand (SP) with 1" clay seams

Very dense light gray Sand (SP) with 1" clay seams

Total Depth 173'

Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-06-04

Northing: 7797.15
Easting: 10546.00
Grd. Elev: 176.29
Total Depth (ft. bls) 32.0

Geologist: SMF
Drill Method: GeoProbe
Driller: JG
Checked By:

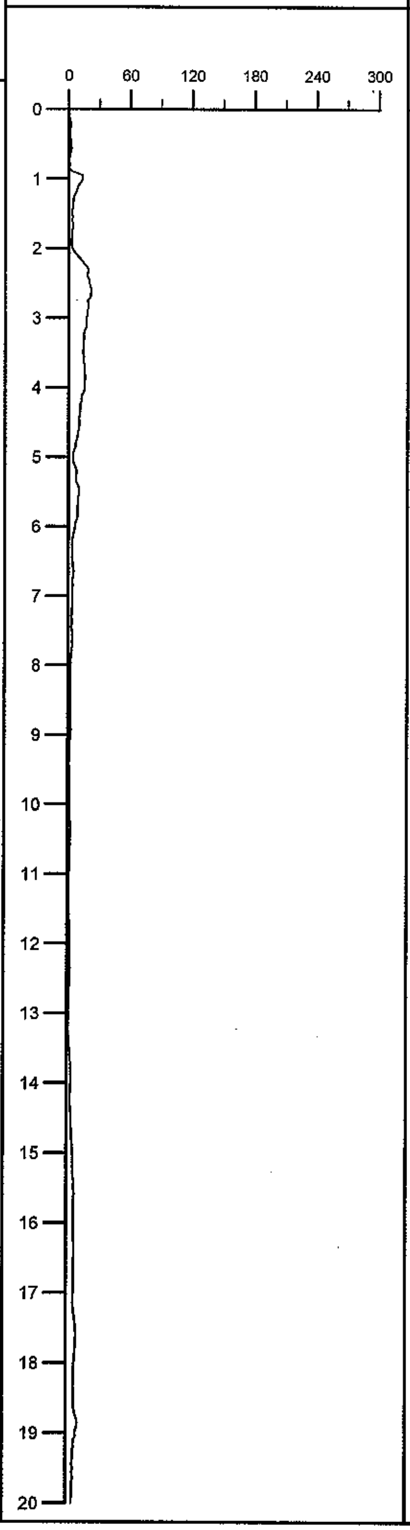
Page: 1 of 2

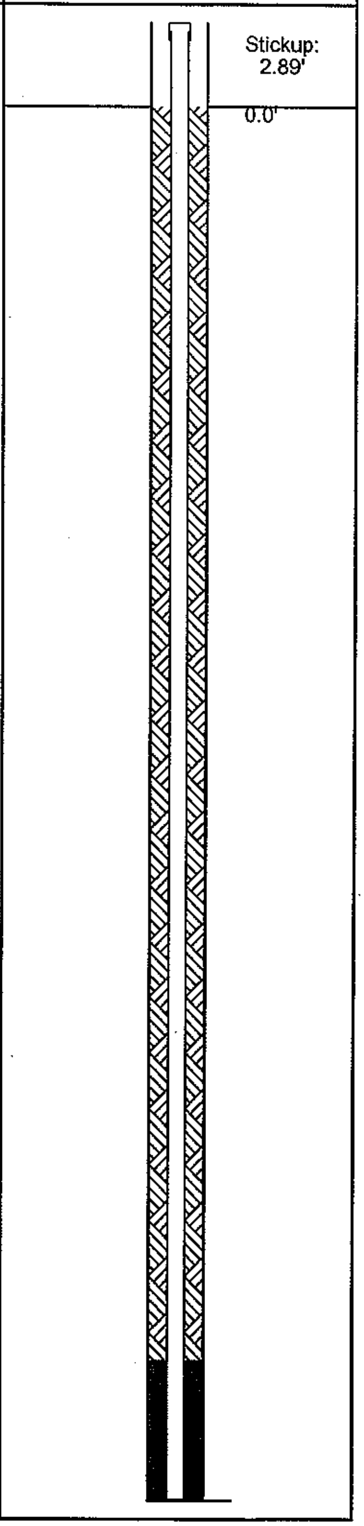
Boring No.: SB-10/MW-21

ENVIRONMENTAL MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE

Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
		Ground Surface		
0	▨	Stiff light gray sandy CLAY (CL)		
1		Loose light gray silty SAND (SM)		
3	▨	Very stiff yellowish brown sandy CLAY (CL)		
4	▨	Dense orange and light gray clayey SAND (SC) with light gray clay lenses		
8.5		Firm light brown medium SAND (SP)		
16	▨	Dense light brown and light gray clayey SAND (SC)		
17		Frim light gray and orange SAND		



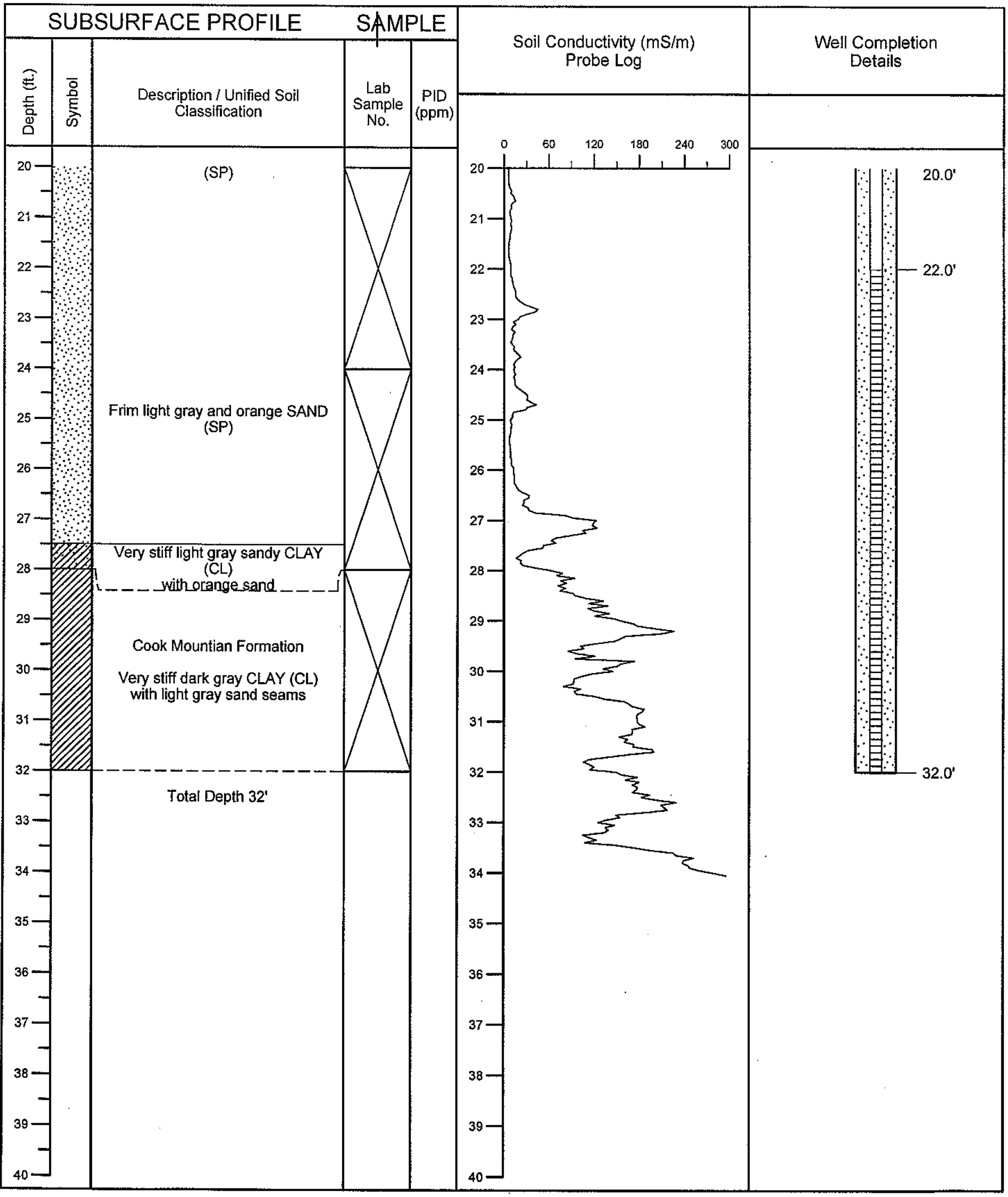


Project No.:	03EC200	Northing:	7797.15	Geologist:	SMF
Project:	El Dorado Chem	Easting:	10546.00	Drill Method:	GeoProbe
Location:	ElDorado, AR	Grd. Elev:	176.29	Driller:	JG
Date:	1-06-04	Total Depth (ft. bls)	32.0	Checked By:	

Page: 2 of 2

Boring No.: SB-10/MW-21

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401



Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-21-04

Northing: 4154.50
Easting: 4135.10
Grd. Elev: 170.79
Total Depth (ft. bls) 77.0

Geologist: SMF
Drill Method: Mud Rotary
Driller: Diversified
Checked By:

Page: 1 of 4

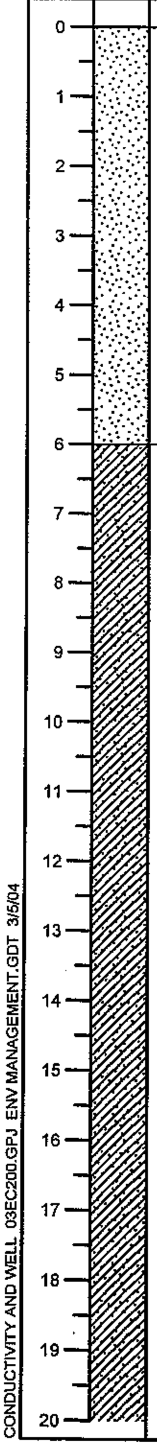
Boring No.: SB-11/MW-22

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE

SAMPLE

Depth (ft.) | Symbol | Description / Unified Soil Classification | Lab Sample No. | PID (ppm)

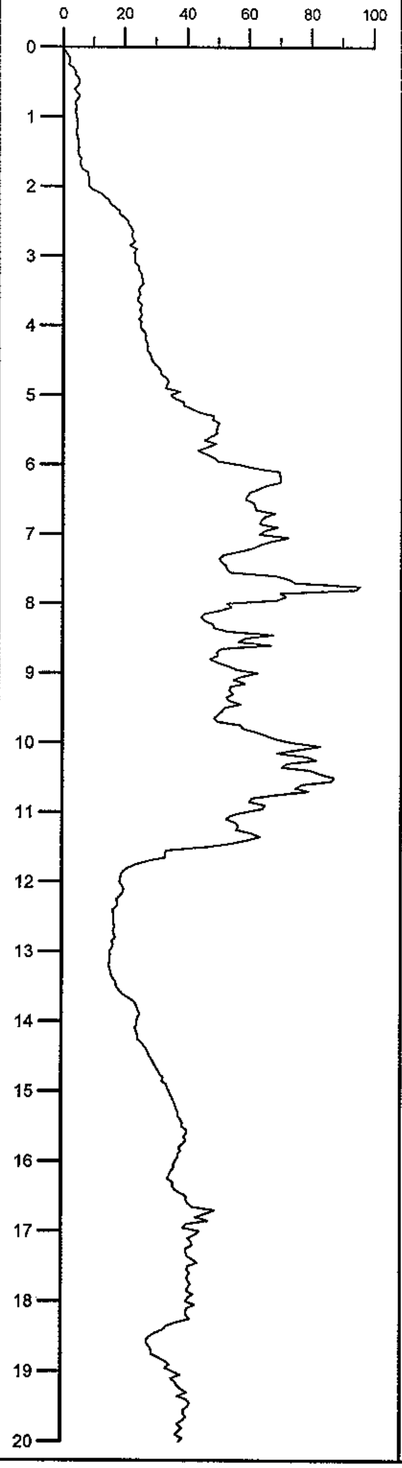


Ground Surface

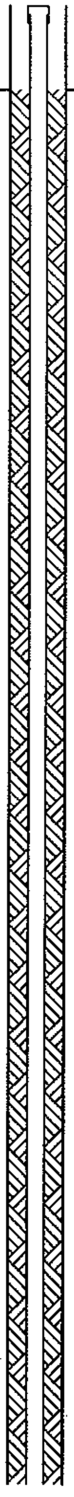
Very dense light gray fine SAND (SP) with 1" clay seams

Interbedded light gray SAND (SP), and gray stiff CLAY (CL)

Soil Conductivity (mS/m)
Probe Log



Well Completion Details



Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-21-04

Northing: 4154.50
Easting: 4135.10
Grd. Elev: 170.79
Total Depth (ft. bls) 77.0

Geologist: SMF
Drill Method: Mud Rotary
Driller: Diversified
Checked By:

Page: 2 of 4

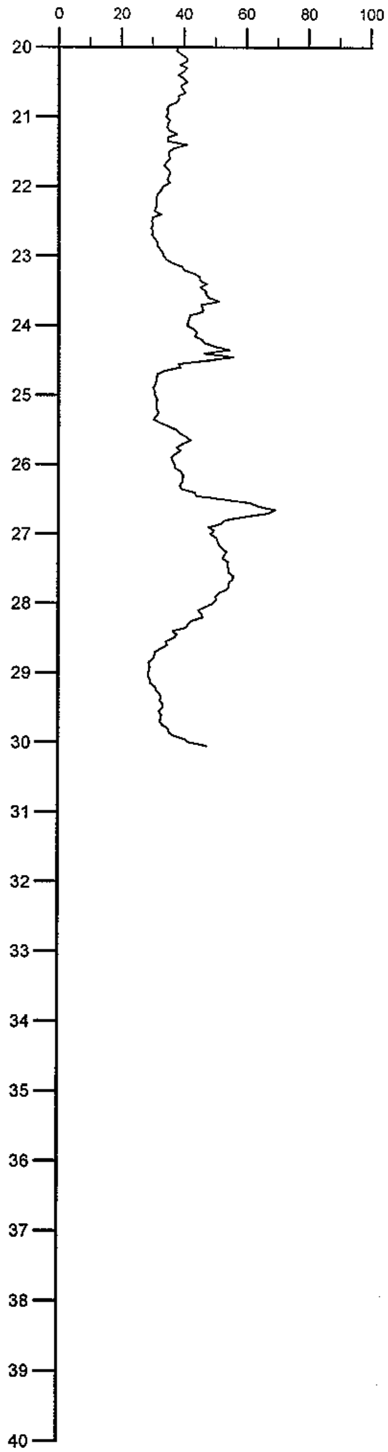
Boring No.: SB-11/MW-22

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE

Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
20	▨			
21	▨			
22	▨			
23	▨			
24	▨			
25	▨			
26	▨			
27	▨			
28	▨			
29	▨			
30	▨	Interbedded light gray SAND (SP), and gray stiff CLAY (CL) *(Continued)*		
31	▨			
32	▨			
33	▨			
34	▨			
35	▨			
36	▨			
37	▨			
38	▨			
39	▨			
40	▨			

Soil Conductivity (mS/m)
Probe Log



Well Completion
Details

CONDUCTIVITY AND WELL 03EC200.GPJ ENV MANAGEMENT.GDT 3/5/04

Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-21-04

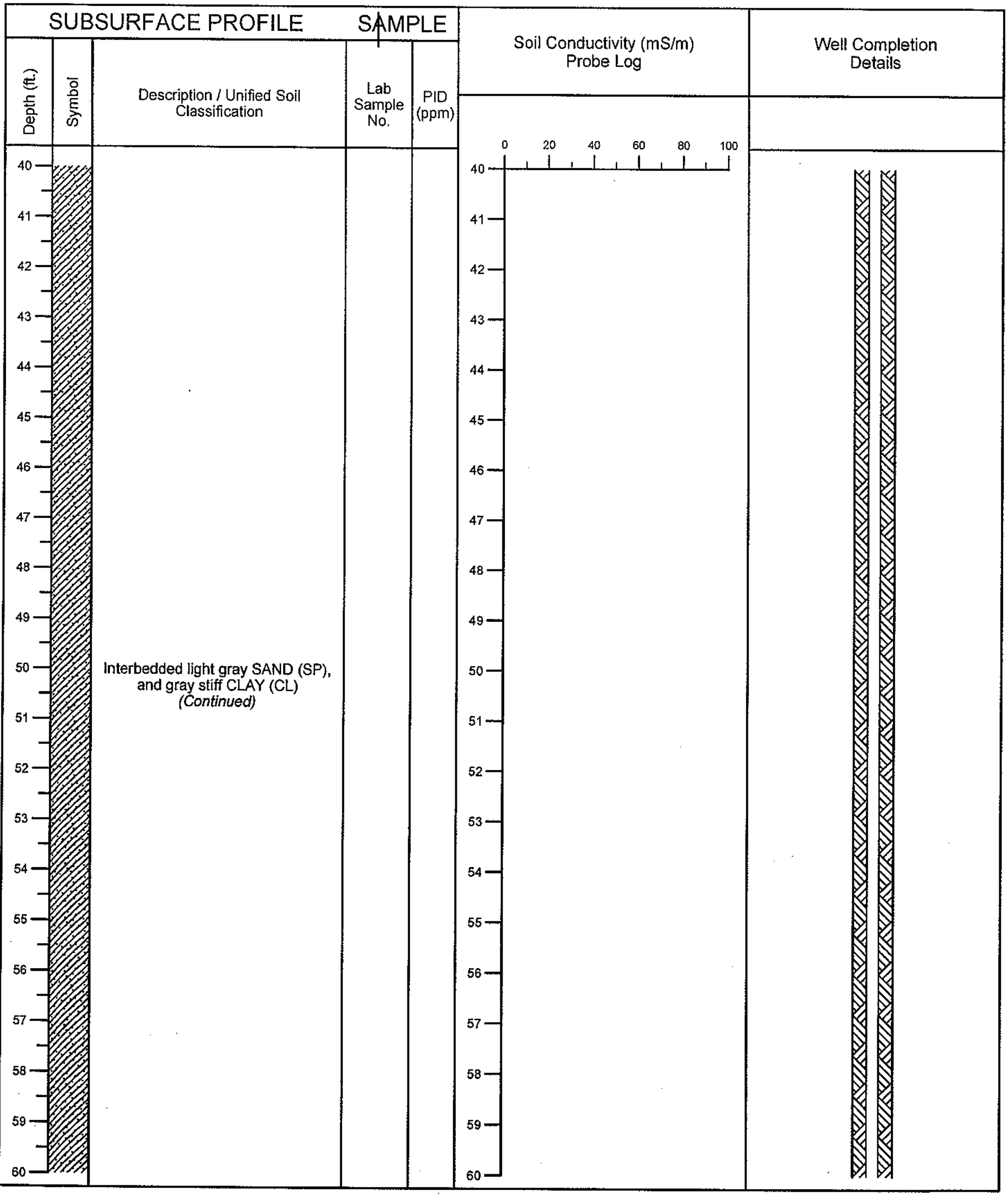
Northing: 4154.50
Easting: 4135.10
Grd. Elev: 170.79
Total Depth (ft. bls) 77.0

Geologist: SMF
Drill Method: Mud Rotary
Driller: Diversified
Checked By:

Page: 3 of 4

Boring No.: SB-11/MW-22

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401



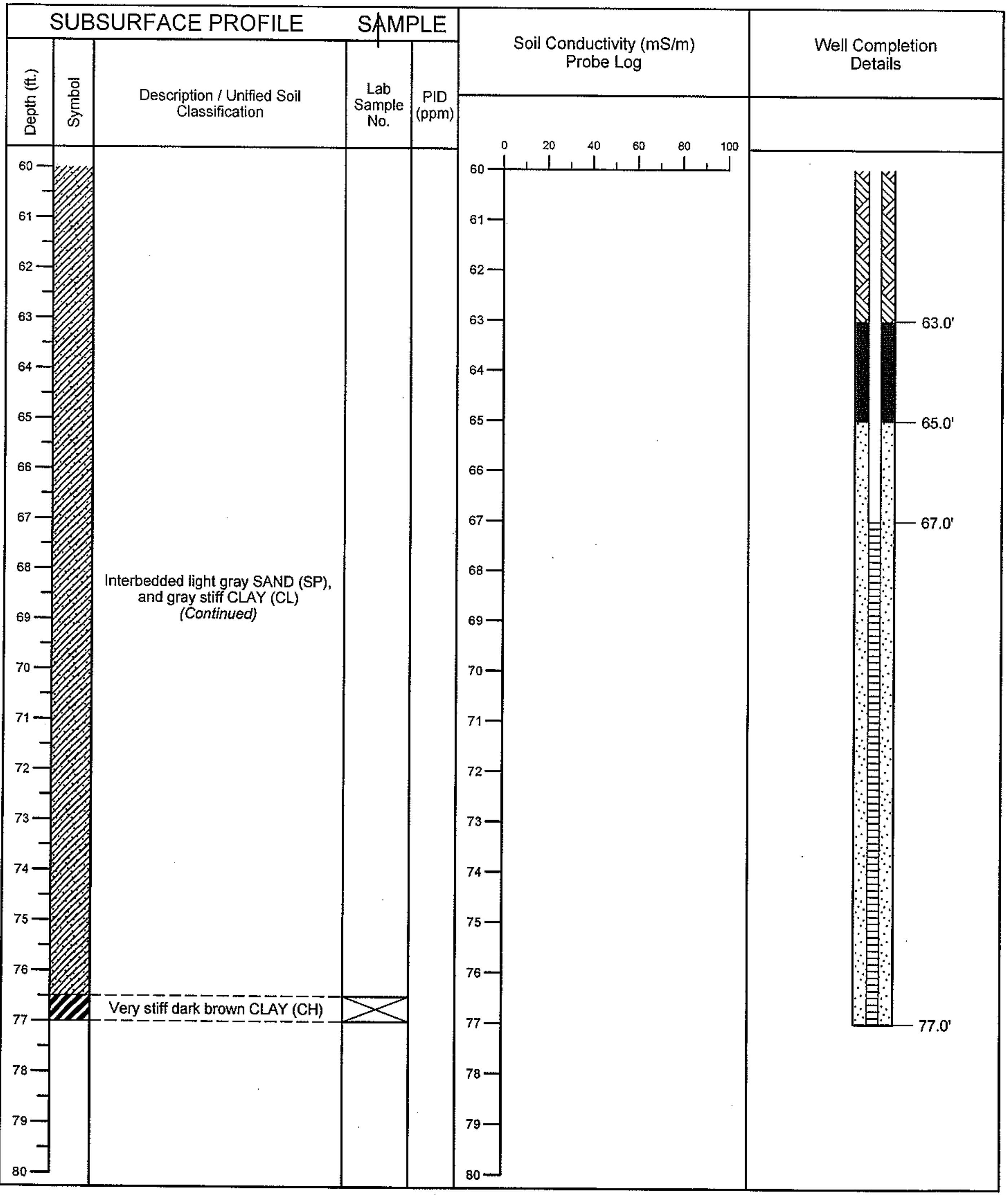
Interbedded light gray SAND (SP), and gray stiff CLAY (CL)
(Continued)

Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-21-04
Northing: 4154.50
Easting: 4135.10
Grd. Elev: 170.79
Total Depth (ft. bls) 77.0
Geologist: SMF
Drill Method: Mud Rotary
Driller: Diversified
Checked By:

Page: 4 of 4

Boring No.: SB-11/MW-22

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401



Interbedded light gray SAND (SP), and gray stiff CLAY (CL) *(Continued)*

Very stiff dark brown CLAY (CH)

Project No.:	03EC200	Northing:	5373.76	Geologist:	SMF
Project:	El Dorado Chem	Easting:	987.62	Drill Method:	Mud Rotary
Location:	ElDorado, AR	Grd. Elev:	184.33	Driller:	Diversified
Date:	1-20-04	Total Depth (ft. bls)	65.0	Checked By:	

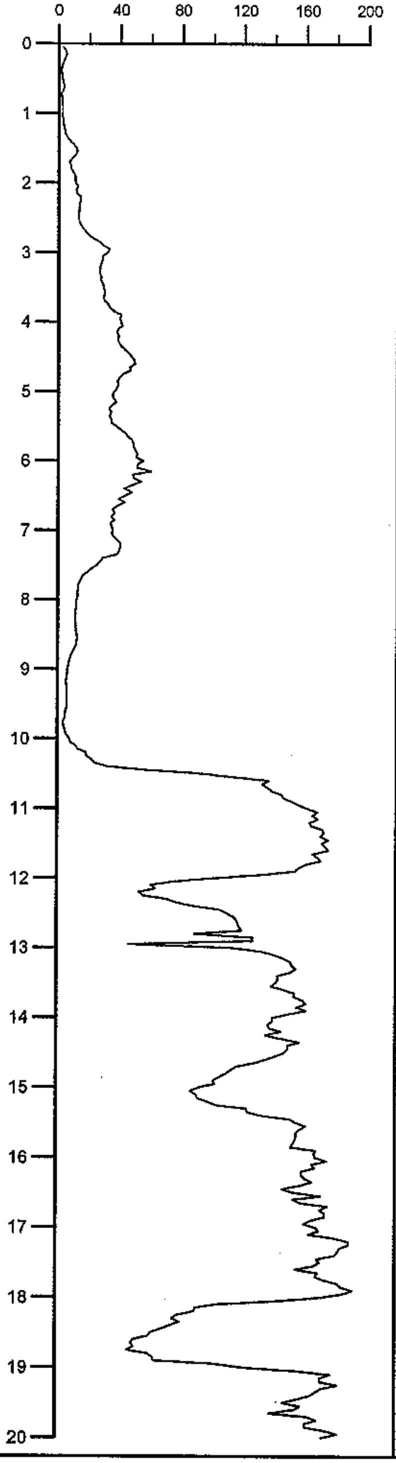
Page: 1 of 4

Boring No.: SB-12

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE			SAMPLE	
Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
		Ground Surface		
0		Dense light gray silty SAND (SP)		
10		Very stiff dark gray CLAY (CH)		
18		Gray clayey SAND (SC)		
19		Very stiff dark gray CLAY (CH)		

Soil Conductivity (mS/m)
Probe Log



Well Completion
Details

Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-20-04

Northing: 5373.76
Easting: 987.62
Grd. Elev: 184.33
Total Depth (ft. bls) 65.0

Geologist: SMF
Drill Method: Mud Rotary
Driller: Diversified
Checked By:

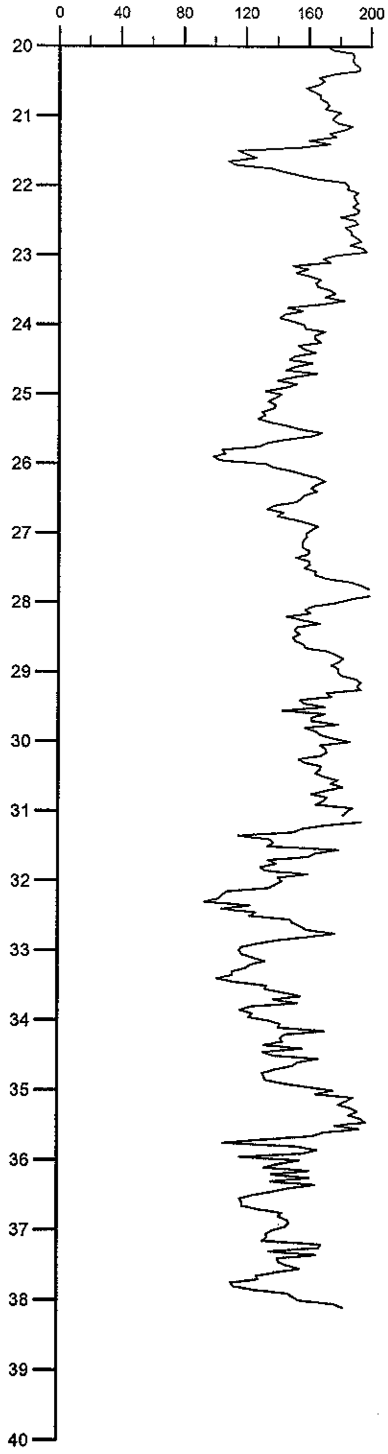
Page: 2 of 4

Boring No.: SB-12

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE			SAMPLE	
Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
20	▨			
21	▨			
22	▨			
23	▨			
24	▨			
25	▨			
26	▨			
27	▨			
28	▨			
29	▨			
30	▨	Very stiff dark gray CLAY (CH) *(Continued)*		
31	▨			
32	▨			
33	▨			
34	▨			
35	▨			
36	▨			
37	▨			
38	▨			
39	▨			
40	▨			

Soil Conductivity (mS/m)
Probe Log



Well Completion
Details

Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-20-04

Northing: 5373.76
Easting: 987.62
Grd. Elev: 184.33
Total Depth (ft. bls) 65.0

Geologist: SMF
Drill Method: Mud Rotary
Driller: Diversified
Checked By:

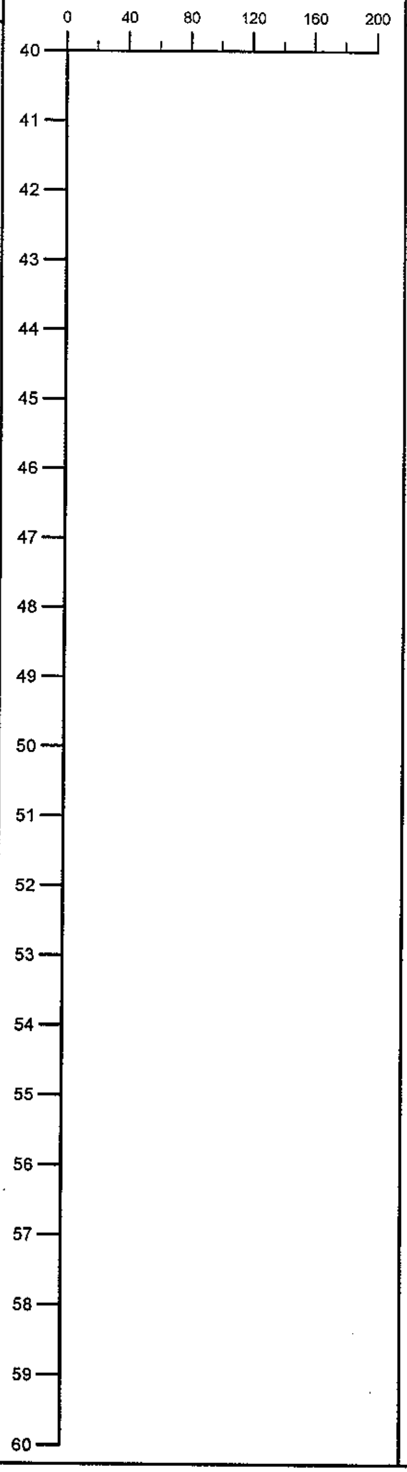
Page: 3 of 4

Boring No.: SB-12

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE			SAMPLE	
Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
40	▨	Very stiff dark gray CLAY (CH) *(Continued)*		
57	▨	Gray fine SAND (SC) with clay lenses		
59	▨	Very stiff dark gray CLAY (CH)		
60				

Soil Conductivity (mS/m) Probe Log



Well Completion Details

Project No.: 03EC200
Project: El Dorado Chem
Location: ElDorado, AR
Date: 1-20-04

Northing: 5373.76
Easting: 987.62
Grd. Elev: 184.33
Total Depth (ft. bls) 65.0

Geologist: SMF
Drill Method: Mud Rotary
Driller: Diversified
Checked By:

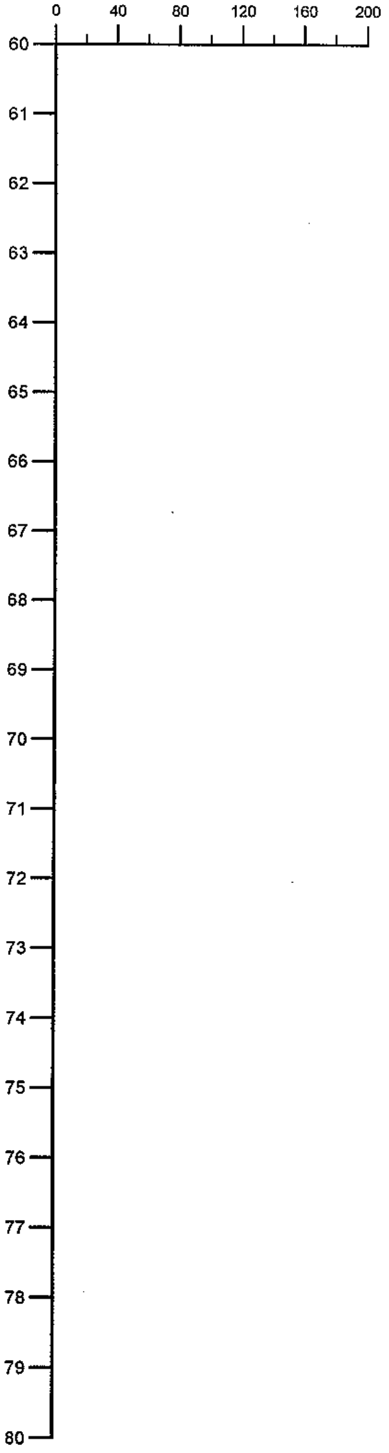
Page: 4 of 4

Boring No.: SB-12

ENVIRONMENTAL MANAGEMENT SERVICES, INC.
600 N. 26TH AVE
HATTIESBURG, MS 39401

SUBSURFACE PROFILE			SAMPLE	
Depth (ft.)	Symbol	Description / Unified Soil Classification	Lab Sample No.	PID (ppm)
60	▨			
61	▨	Very stiff dark gray CLAY (CH) *(Continued)*		
62	▨			
63	▨	Cook Mountian Formation	☒	
64	▨	Interbedded fine SAND (SP) and very stiff CLAY (CL)		
65		Total Depth 65'		
66				
67				
68				
69				
70				
71				
72				
73				
74				
75				
76				
77				
78				
79				
80				

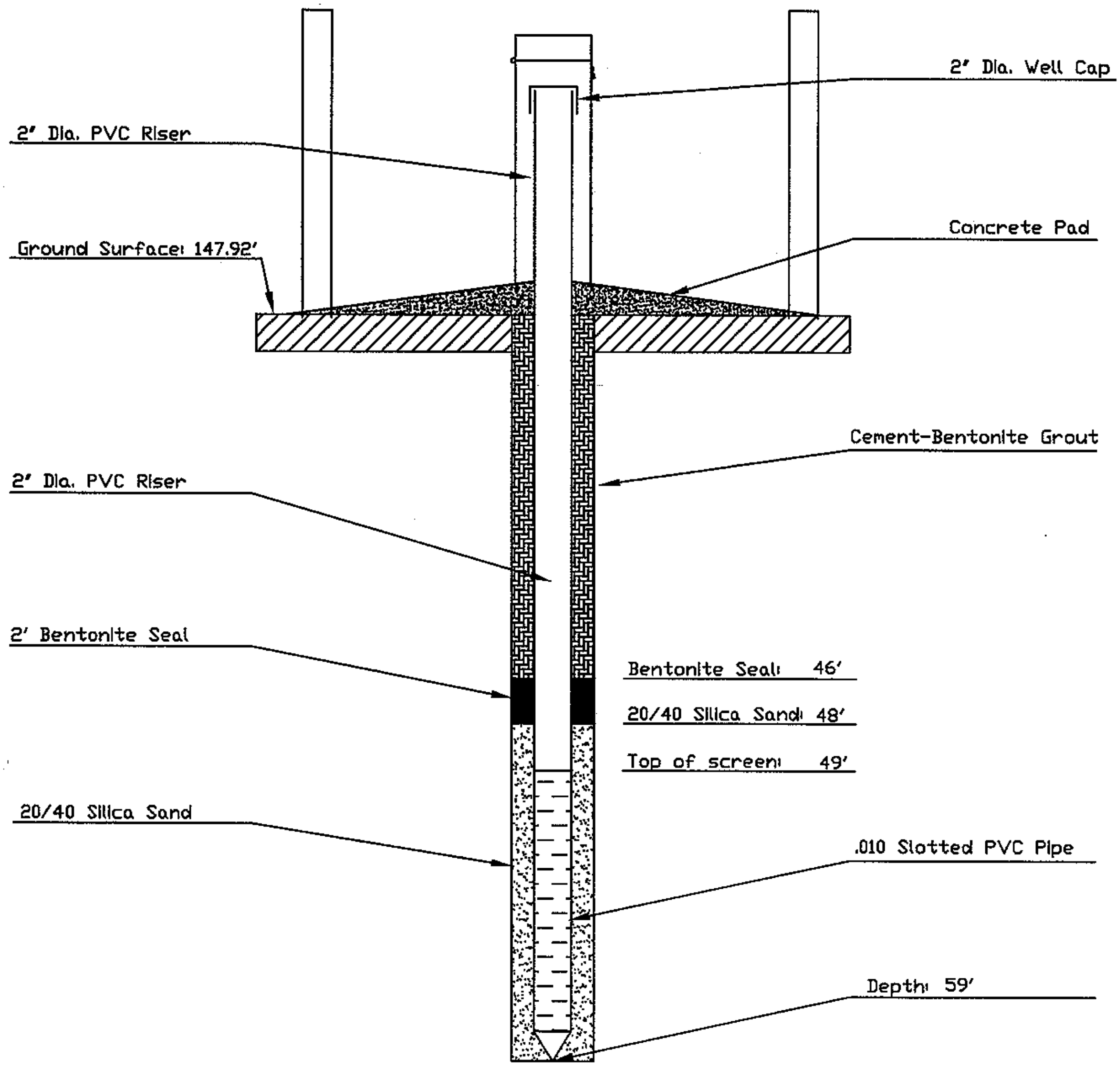
Soil Conductivity (mS/m) Probe Log



Well Completion Details

APPENDIX B

WELL CONSTRUCTION LOGS



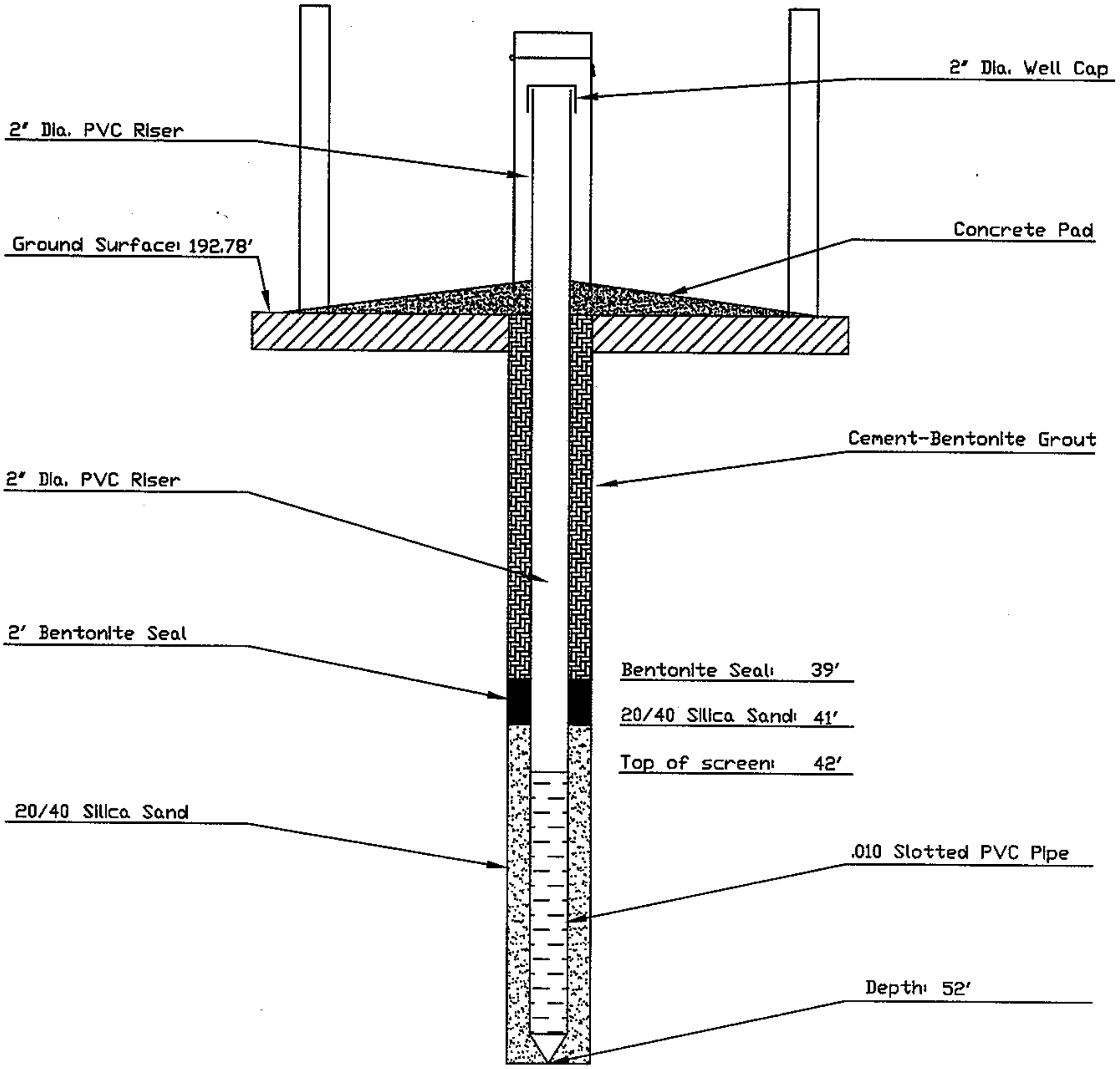
WELL DETAIL EDC-MW-19

GEOLOGIC INVESTIGATION REPORT
EL DORADO CHEMICAL COMPANY
03EC0200

DATE:	APPROVED:	DRAWN BY: SMF
SCALE: NTS	BY: ______ DATE: ______	CAD NO.

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.

1



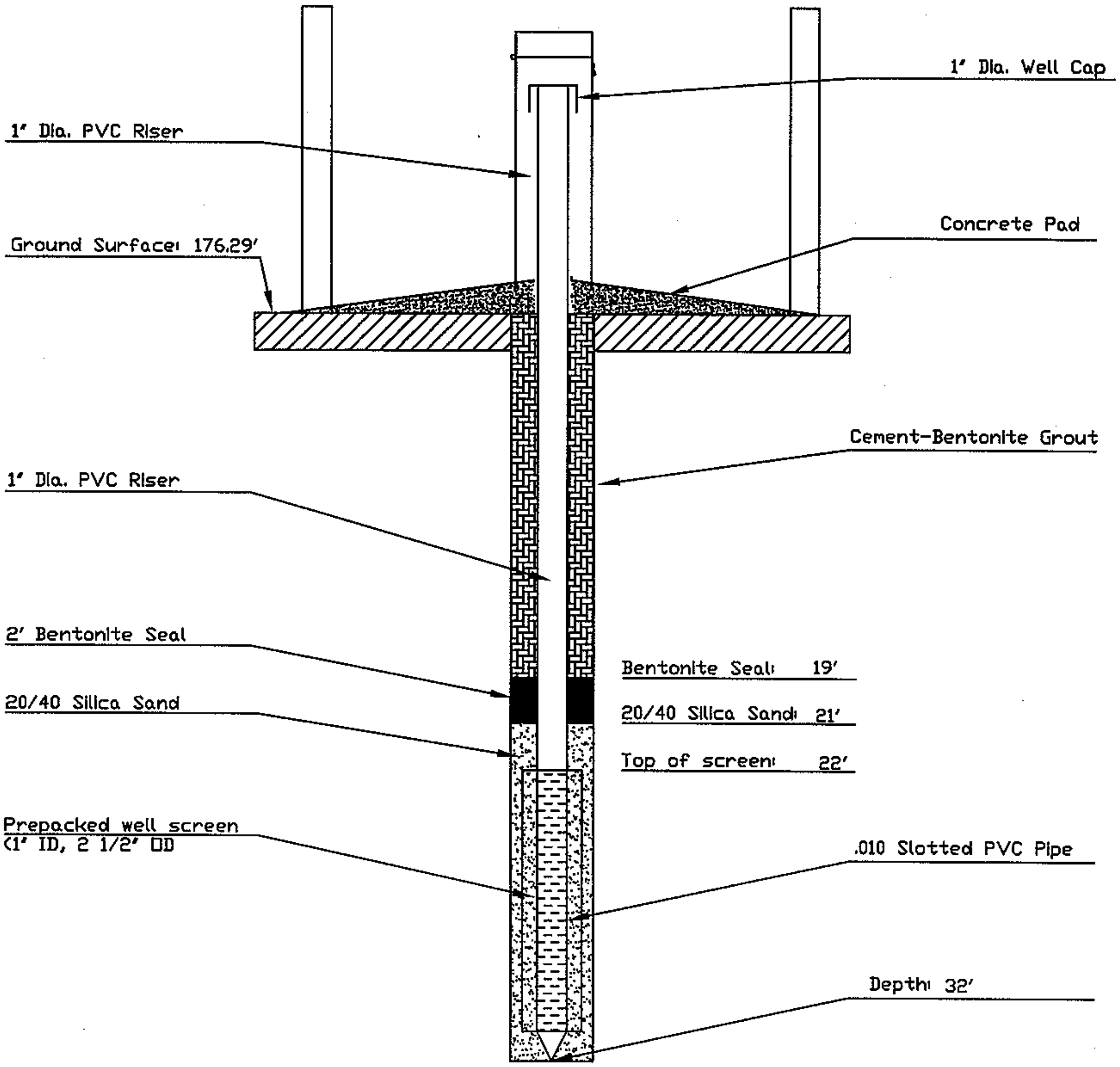
WELL DETAIL EDC-MW-20

GEOLOGIC INVESTIGATION REPORT
EL DORADO CHEMICAL COMPANY
03EC0200

DATE:	APPROVED:	DRAWN BY:
SCALE:	BY: DATE:	CAD NO.

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.

2

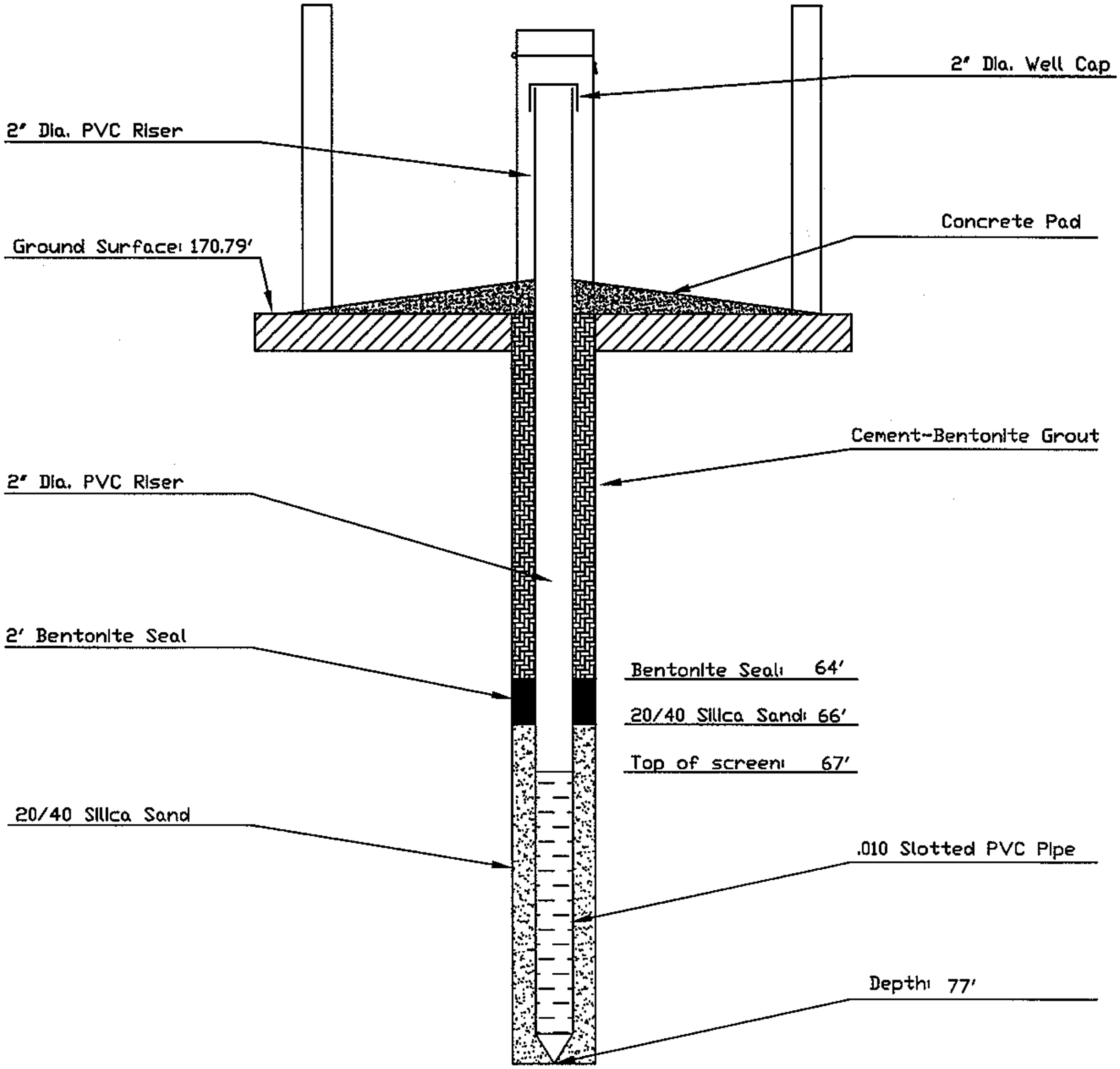


WELL DETAIL EDC-MW-21

GEOLOGIC INVESTIGATION REPORT
EL DORADO CHEMICAL COMPANY
03EC0200

DATE:	APPROVED:	DRAWN BY:
SCALE:	BY: ______ DATE: ______	CAD NO.

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.



WELL DETAIL EDC-MW-22

GEOLOGIC INVESTIGATION REPORT
EL DORADO CHEMICAL COMPANY
03EC0200

DATE:
APPROVED:
BY: ____________
DATE: ____________
DRAWN BY:
SCALE:
CAD NO.

ENVIRONMENTAL
MANAGEMENT SERVICES, INC.

4

Appendix B

Groundwater Data and Statistical Analysis

Groundwater Data

MasterID	GroupID	MasterDate	ammonia Conc	dissolved chrom Conc	total chrom Conc	dissolved lead Conc	total lead Conc	nitrate Conc	ph Conc	sulfate Conc	tds Conc	dissolve vanadium Conc	total vanadium Conc
ECMW-01	UG	5/29/2001	0.5		0.02		0.04	1.83	5.1	3.67	42		
ECMW-01	UG	11/1/2001	0.5		0.02		0.04	2.74	4.8	3.34	43		
ECMW-01	UG	6/3/2002	0.5	0.02	0.02	0.02	0.02	2.01	5.5	4.66	83		
ECMW-01	UG	10/30/2002	0.66	0.02	0.02	0.015	0.015	1.56	5.6	4.63	44		
ECMW-01	UG	12/10/2002	0.5	0.02	0.02	0.015	0.015	1.8	6.1	6.73	108		
ECMW-01	UG	5/20/2003	0.5	0.02	0.02	0.015	0.015	2.4	4.77	3.79	46		
ECMW-01	UG	7/24/2003	0.5	0.02	0.02	0.015	0.015	2.55	7.10	5.05	59		
ECMW-01	UG	9/24/2003	0.5	0.02	0.02	0.015	0.015	3.18	5.26	6.52	68		
ECMW-01	UG	11/19/2003	0.5	0.02	0.02	0.015	0.015	1.47	5.11	5.85	64		
ECMW-01	UG	1/28/2004	0.56	0.02	0.02	0.015	0.015	1.6	5.25	6.19	53		
ECMW-01	UG	3/16/2004	0.5	0.02	0.02	0.015	0.015	2.73	5.59	4.22	56		
ECMW-01	UG	5/18/2004	0.5	0.02	0.02	0.015	0.015	4.79	5.51	6.57	35		
ECMW-01	UG	7/13/2004	0.5	0.02	0.02	0.015	0.015	3.68	6.16	3.88	80		
ECMW-01	UG	9/14/2004	0.76	0.02	0.02	0.015	0.015	4.26	5.65	3.48	53		0.02
ECMW-01	UG	11/16/2004	0.5	0.02	0.02	0.015	0.015	3.81	5.11	3.9	58	0.02	0.02
ECMW-01	UG	1/25/2005	0.5	0.02	0.02	0.015	0.015	2.88	5.43	6.69	86	0.02	0.02
ECMW-01	UG	5/24/2005	0.55	0.02	0.02	0.015	0.015	2.45	5.73	4.39	52	0.02	0.02
ECMW-01	UG	10/18/2005							3.61			0.02	0.02
ECMW-01	UG	4/11/2006							4.73			0.02	0.02
ECMW-01	UG	11/1/2006							4.98				0.02
ECMW-02	UG	5/29/2001	0.5		0.032		0.04	0.5	5.4	19.6	340		
ECMW-02	UG	11/1/2001	0.5		0.02		0.04	0.5	5.3	22.9	300		
ECMW-02	UG	6/3/2002	0.5	0.02	0.02	0.02	0.02	0.5	6	20	396		
ECMW-02	UG	10/30/2002	0.5	0.02	0.02	0.015	0.015	0.5	6.1	25.7	517		
ECMW-02	UG	12/10/2002	0.5	0.02	0.02	0.015	0.015	0.5	6.7	24	305		
ECMW-02	UG	5/20/2003	0.5	0.02	0.02	0.015	0.015	0.5	5.31	22.1	309		
ECMW-02	UG	7/24/2003	0.5	0.02	0.02	0.015	0.015	0.5	7.26	22.9	370		
ECMW-02	UG	9/24/2003	0.5	0.02	0.02	0.015	0.015	0.5	5.50	24.9	380		
ECMW-02	UG	11/19/2003	0.5	0.02	0.02	0.015	0.015	0.5	5.42	28.2	360		
ECMW-02	UG	1/28/2004	0.5	0.02	0.02	0.015	0.015	0.5	5.2	25.3	490		
ECMW-02	UG	3/16/2004	0.5	0.02	0.02	0.015	0.015	0.5	5.47	20.9	311		
ECMW-02	UG	5/18/2004	0.5	0.02	0.02	0.015	0.015	0.5	5.4	24	298		
ECMW-02	UG	7/13/2004	0.5	0.02	0.02	0.015	0.015	0.5	5.68	22.4	330		
ECMW-02	UG	9/14/2004	0.5	0.02	0.02	0.015	0.015	0.5	5.44	24.3	340		0.02
ECMW-02	UG	11/16/2004	0.5	0.02	0.02	0.015	0.015	0.5	6.12	21.5	320	0.02	0.02
ECMW-02	UG	1/25/2005	0.5	0.02	0.02	0.015	0.015	0.5	5.38	20.8	300	0.02	0.02
ECMW-02	UG	5/24/2005	0.79	0.02	0.02	0.015	0.015	0.5	5.87	22.9	290	0.02	0.02
ECMW-02	UG	10/18/2005						0.5	5.15			0.02	0.02
ECMW-02	UG	4/11/2006						0.5	5.56			0.02	0.02
ECMW-02	UG	11/1/2006							5.2				0.02
ECMW-03	UG	5/29/2001	0.5		0.02		0.04	0.5	6.2	10.6	180		
ECMW-03	UG	11/1/2001	0.5		0.02		0.04	0.5	5.4	22.5	240		
ECMW-03	UG	6/3/2002	0.5	0.02	0.02	0.02	0.02	0.5	6.4	11.4	228		
ECMW-03	UG	10/30/2002	0.5	0.02	0.02	0.015	0.015	0.5	6.5	21.6	295		
ECMW-03	UG	12/10/2002	0.5	0.02	0.02	0.015	0.015	0.5	6.0	16.4	242		
ECMW-03	UG	5/20/2003	0.5	0.02	0.02	0.015	0.015	0.5	6.05	12.5	207		
ECMW-03	UG	7/24/2003	0.5	0.02	0.02	0.015	0.015	0.5	6.23	11.8	210		
ECMW-03	UG	9/24/2003	0.5	0.02	0.02	0.015	0.015	0.5	5.97	27.7	250		
ECMW-03	UG	11/19/2003	0.5	0.02	0.02	0.015	0.015	0.5	5.81	23.5	220		
ECMW-03	UG	1/28/2004	0.5	0.02	0.02	0.015	0.015	0.5	5.59	26.9	270		
ECMW-03	UG	3/16/2004	0.5	0.02	0.02	0.015	0.015	0.5	5.94	11.2	188		
ECMW-03	UG	5/18/2004	0.5	0.02	0.02	0.015	0.015	0.5	5.86	9.75	176		
ECMW-03	UG	7/13/2004	0.5	0.02	0.02	0.015	0.015	0.5	5.92	13	260		
ECMW-03	UG	9/14/2004	0.5	0.02	0.02	0.015	0.015	0.5	5.74	18.3	220		0.02
ECMW-03	UG	11/16/2004	0.5	0.02	0.02	0.015	0.015	0.5	5.96	18.8	260	0.02	0.02
ECMW-03	UG	1/25/2005	0.5	0.02	0.02	0.015	0.015	0.5	6.33	15.8	240	0.02	0.02
ECMW-03	UG	5/24/2005	0.98	0.02	0.02	0.015	0.015	0.5	6.05	11.8	200	0.02	0.02
ECMW-03	UG	10/18/2005						0.5	6.04			0.02	0.02
ECMW-03	UG	4/12/2006						0.5	6.39			0.02	0.02
ECMW-03	UG	11/1/2006							5.37				0.02
ECMW-04	DG4	8/8/2001	0.66		0.02		0.04	0.5	4.1	925	5100		
ECMW-04	DG4	10/30/2001	0.5		0.04		0.06	0.5	4.3	936	5200		
ECMW-04	DG4	6/3/2002	0.5	0.02	0.02	0.02	0.02	0.5	5.2	979	4862		
ECMW-04	DG4	10/30/2002	0.5	0.02	0.02	0.015	0.02	0.62	4.8	756	4240		
ECMW-04	DG4	12/10/2002	0.5	0.02	0.02	0.015	0.015	2.4	4.4	976	5360		
ECMW-04	DG4	5/20/2003	0.5	0.02	0.02	0.015	0.015	0.5	4.33	936	4800		
ECMW-04	DG4	7/24/2003	0.5	0.02	0.02	0.015	0.015	0.5	9.08	978	5300		
ECMW-04	DG4	9/24/2003	0.5	0.02	0.02	0.015	0.015	2.42	4.78	989	5200		
ECMW-04	DG4	11/19/2003	0.5	0.02	0.02	0.015	0.015	2.05	4.13	848	5300		
ECMW-04	DG4	1/28/2004	0.5	0.02	0.02	0.015	0.015	6.39	3.88	1040	5200		
ECMW-04	DG4	3/16/2004	0.5	0.02	0.02	0.015	0.015	0.5	4.1	919	5204		
ECMW-04	DG4	5/19/2004	0.5	0.02	0.02	0.015	0.015	1.45	4.05	1040	5300		
ECMW-04	DG4	7/13/2004	0.5	0.02	0.02	0.015	0.015	0.5	4.35	973	5500		
ECMW-04	DG4	9/14/2004	0.68	0.02	0.02	0.015	0.015	0.5	4.44	943	5200		0.02
ECMW-04	DG4	11/16/2004	0.5	0.02	0.02	0.015	0.015	0.5	4.26	874	4600	0.02	0.02
ECMW-04	DG4	1/25/2005	0.64	0.02	0.02	0.015	0.015	8.5	4.63	805	4700	0.02	0.02
ECMW-04	DG4	5/24/2005	2.14	0.02	0.02	0.015	0.015	0.997	4.77	1020	4700	0.02	0.02
ECMW-04	DG4	10/18/2005						0.517	4.06			0.02	0.02
ECMW-04	DG4	4/12/2006						0.5	4.12			0.02	0.02
ECMW-04	DG4	11/1/2006	0.5		0.02		0.015	0.5	3.69				0.02
ECMW-05	DG5	8/8/2001	0.5		0.02		0.04	3.54	4.6	657	1000		
ECMW-05	DG5	10/30/2001	0.5		0.02		0.04	3.27	4.7	526	980		
ECMW-05	DG5	6/3/2002	0.5	0.02	0.02	0.02	0.02	3.35	6.3	650	934		
ECMW-05	DG5	10/30/2002	0.5	0.02	0.02	0.015	0.015	3.66	5.4	582	929		
ECMW-05	DG5	12/10/2002	0.5	0.02	0.02	0.015	0.015	3.26	5.2	489	901		

Groundwater Data			ammonia	dissolved chrom	total chrom	dissolved lead	total lead	nitrate	ph	sulfate	tds	dissolve vanadium	total vanadium
MasterID	GroupID	MasterDate	Conc	Conc	Conc	Conc	Conc	Conc	Conc	Conc	Conc	Conc	Conc
ECMW-05	DG5	5/20/2003	0.5	0.02	0.02	0.015	0.015	3.6	4.75	654	845		
ECMW-05	DG5	7/24/2003	0.5	0.02	0.02	0.015	0.015	3.47	6.85	546	950		
ECMW-05	DG5	9/24/2003	0.5	0.02	0.02	0.015	0.015	3.53	4.82	560	950		
ECMW-05	DG5	11/19/2003	0.5	0.02	0.02	0.015	0.015	2.4	4.79	416	780		
ECMW-05	DG5	1/28/2004	0.5	0.02	0.02	0.015	0.015	3.19	5.03	476	740		
ECMW-05	DG5	3/16/2004	0.5	0.02	0.02	0.015	0.015	3.6	5.13	472	780		
ECMW-05	DG5	5/19/2004	0.5	0.02	0.02	0.015	0.015	3.41	5.85	455	860		
ECMW-05	DG5	7/13/2004	0.5	0.02	0.02	0.015	0.015	3.75	4.96	511	910		
ECMW-05	DG5	9/14/2004	0.59	0.02	0.02	0.015	0.015	3.75	6.7	515	700		0.02
ECMW-05	DG5	11/16/2004	0.5	0.02	0.02	0.015	0.015	3.33	5.28	502	850	0.02	0.02
ECMW-05	DG5	1/25/2005	0.5	0.02	0.02	0.015	0.015	3.18	6.36	461	870	0.02	0.02
ECMW-05	DG5	5/24/2005	3.62	0.02	0.02	0.015	0.015	3.21	6.42	547	820	0.02	0.02
ECMW-05	DG5	10/19/2005							4.96			0.02	0.02
ECMW-05	DG5	4/12/2006							4.39			0.02	0.02
ECMW-05	DG5	11/1/2006							4.42				0.02
ECMW-06	DG6	8/8/2001	0.5		0.02		0.04	298	4.3	18.3	2100		
ECMW-06	DG6	10/30/2001	0.5		0.02		0.04	326	4.3	15.7	2700		
ECMW-06	DG6	6/3/2002	0.5	0.02	0.02	0.02	0.02	459	6.1	12.1	290		
ECMW-06	DG6	10/30/2002	0.51	0.02	0.02	0.015	0.015	661	5	8.13	3840		
ECMW-06	DG6	12/10/2002	0.5	0.02	0.02	0.015	0.015	588	4.6	7.15	3360		
ECMW-06	DG6	5/21/2003	0.5	0.02	0.02	0.015	0.015	608	4.3	17	4020		
ECMW-06	DG6	7/24/2003	1.09	0.02	0.02	0.015	0.015	681	7.41	15	4600		
ECMW-06	DG6	9/24/2003	4.88	0.02	0.02	0.015	0.015	857	4.28	9.35	5100		
ECMW-06	DG6	11/19/2003	5.72	0.02	0.02	0.015	0.015	865	4.53	10.7	4700		
ECMW-06	DG6	1/28/2004	12.3	0.02	0.02	0.015	0.015	835	4.36	17.2	5300		
ECMW-06	DG6	3/16/2004	13	0.02	0.02	0.015	0.015	826	4.4	17.2	5106		
ECMW-06	DG6	5/19/2004	21.4	0.02	0.02	0.015	0.015	915	5.04	13.4	5800		
ECMW-06	DG6	7/13/2004	17.5	0.02	0.02	0.015	0.015	868	4.74	11.7	6100		
ECMW-06	DG6	9/14/2004	20	0.02	0.02	0.015	0.015	1130	5.51	3.84	6300		0.02
ECMW-06	DG6	11/16/2004	37.6	0.02	0.02	0.015	0.015	1140	4.59	4.4	7100	0.02	0.02
ECMW-06	DG6	1/25/2005	43.1	0.02	0.02	0.015	0.015	1130	5.36	3.14	6600	0.02	0.02
ECMW-06	DG6	5/24/2005	68.2	0.02	0.02	0.015	0.015	1410	4.57	5.19	6700	0.02	0.02
ECMW-06	DG6	10/18/2005	110					1350	4.43			0.02	0.02
ECMW-06	DG6	4/11/2006	154					1680	4.45			0.02	0.02
ECMW-06	DG6	11/1/2006	170					2390	3.94				0.02
ECMW-07	DG7	8/8/2001	184		0.02		0.04	336	9.7	316	1300		
ECMW-07	DG7	10/30/2001	0.5		0.02		0.04	186	3.5	322	1056		
ECMW-07	DG7	6/3/2002	190	0.02	0.02	0.02	0.031	358	4.4	363	1324		
ECMW-07	DG7	10/30/2002	167	0.02	0.02	0.016	0.017	294	4.2	345	1080		
ECMW-07	DG7	12/10/2002	149	0.02	0.02	0.015	0.015	344	3.7	275	1316		
ECMW-07	DG7	5/21/2003	244	0.02	0.02	0.017	0.02	563	3.66	298	1850		
ECMW-07	DG7	7/24/2003	95.1	0.02	0.02	0.015	0.015	141	7.05	378	1400		
ECMW-07	DG7	9/24/2003	116	0.02	0.02	0.018	0.02	953	3.84	341	1700		
ECMW-07	DG7	11/19/2003	124	0.02	0.02	0.015	0.015	152	4.03	476	1500		
ECMW-07	DG7	1/28/2004	147	0.02	0.02	0.015	0.018	300	3.99	644	1300		
ECMW-07	DG7	3/16/2004	190	0.02	0.02	0.017	0.018	310	3.98	496	1280		
ECMW-07	DG7	5/19/2004	204	0.02	0.02	0.015	0.015	337	3.95	524	1500		
ECMW-07	DG7	7/13/2004	73.4	0.02	0.02	0.015	0.015	150	3.99	498	1600		
ECMW-07	DG7	9/14/2004	25.9	0.02	0.02	0.015	0.015	76	4.45	142	1000		0.02
ECMW-07	DG7	11/16/2004	219	0.02	0.02	0.015	0.015	370	3.97	428	1700	0.02	0.02
ECMW-07	DG7	1/25/2005	281	0.02	0.02	0.015	0.016	480	4.08	312	1700	0.02	0.02
ECMW-07	DG7	5/24/2005	323	0.02	0.02	0.017	0.022	595	4.21	349	1400	0.02	0.02
ECMW-07	DG7	10/18/2005	14.3			0.015	0.015	91.6	3.9			0.02	0.02
ECMW-07	DG7	4/11/2006	267			0.015	0.017	516	4.36			0.02	0.02
ECMW-07	DG7	11/1/2006	57.4				0.015	105	3.34				0.02
ECMW-08	DG8	10/30/2001	0.94		0.02		0.04	1030	3.9	81.1	5000		
ECMW-08	DG8	6/3/2002	551	0.02	0.02	0.02	0.02	1200	5.4	77.8	4246		
ECMW-08	DG8	10/30/2002	406	0.02	0.02	0.015	0.015	1330	4.4	151	4560		
ECMW-08	DG8	12/10/2002	220	0.02	0.02	0.015	0.015	1080	4	46.2	5120		
ECMW-08	DG8	5/21/2003	214	0.02	0.02	0.019	0.019	1250	3.99	209	4200		
ECMW-08	DG8	7/24/2003	179	0.02	0.02	0.015	0.015	472	6.04	904	3700		
ECMW-08	DG8	9/23/2003	157.5	0.02	0.02	0.015	0.015	524	3.93	870	3400		
ECMW-08	DG8	11/19/2003	206	0.02	0.02	0.015	0.015	464	4.99	738	3200		
ECMW-08	DG8	1/28/2004	45.7	0.02	0.02	0.015	0.015	142	4.29	854	1800		
ECMW-08	DG8	3/16/2004	88	0.02	0.02	0.015	0.015	203	4.18	805	2221		
ECMW-08	DG8	5/19/2004	120	0.02	0.02	0.015	0.015	298	4.07	789	2500		
ECMW-08	DG8	7/13/2004	120	0.02	0.02	0.015	0.015	354	4.48	767	2600		
ECMW-08	DG8	9/14/2004	107	0.02	0.02	0.015	0.015	392	3.99	743	2400		0.02
ECMW-08	DG8	11/16/2004	82.1	0.02	0.02	0.015	0.015	304	4.01	808	2800	0.02	0.02
ECMW-08	DG8	1/25/2005	48.9	0.02	0.02	0.015	0.015	126	4.09	1200	2700	0.02	0.02
ECMW-08	DG8	5/24/2005	79.6	0.02	0.02	0.015	0.015	225	6.12	1220	2700	0.02	0.02
ECMW-08	DG8	10/18/2005	84.8					246	4.03			0.02	0.02
ECMW-08	DG8	4/11/2006	53.5					194	3.78			0.02	0.02
ECMW-08	DG8	11/1/2006	74.5					224	3.44				0.02
ECMW-09	DG9	6/27/2001	0.5		0.02		0.04	28.8	5.4	520	1600		
ECMW-09	DG9	10/30/2001	0.5		0.02		0.04	26.7	5.5	514	2600		
ECMW-09	DG9	6/3/2002	0.5	0.02	0.02	0.02	0.02	24.4	6	639	1597		
ECMW-09	DG9	10/30/2002	18.8	0.02	0.02	0.015	0.015	59	6	655	1630		
ECMW-09	DG9	12/10/2002	0.5	0.02	0.02	0.015	0.015	31.5	5.2	556	1680		
ECMW-09	DG9	5/21/2003	0.5	0.02	0.02	0.015	0.015	26.3	5.33	568	1600		
ECMW-09	DG9	7/24/2003	0.5	0.02	0.02	0.015	0.015	28.4	7.05	547	1500		
ECMW-09	DG9	9/23/2003	0.5	0.02	0.02	0.015	0.015	146	5.24	531	1500		
ECMW-09	DG9	11/19/2003	0.5	0.02	0.02	0.015	0.015	28	5.72	532	1600		
ECMW-09	DG9	1/28/2004	0.5	0.02	0.02	0.015	0.015	29.2	5.53	575	1500		
ECMW-09	DG9	3/16/2004	0.5	0.02	0.02	0.015	0.015	30.6	5.88	528	1524		

Groundwater Data

			ammonia	dissolved chrom	total chrom	dissolved lead	total lead	nitrate	ph	sulfate	tds	dissolve vanadium	total vanadium
MasterID	GroupID	MasterDate	Conc	Conc	Conc	Conc	Conc	Conc	Conc	Conc	Conc	Conc	Conc
ECMW-09	DG9	5/19/2004	0.5	0.02	0.02	0.015	0.015	27.4	5.47	517	1600		
ECMW-09	DG9	7/13/2004	0.5	0.02	0.02	0.015	0.015	24.6	6.87	588	1600		
ECMW-09	DG9	9/14/2004	1.14	0.02	0.02	0.015	0.015	25.3	5.04	548	1500		0.02
ECMW-09	DG9	11/16/2004	0.7	0.02	0.02	0.015	0.015	24	5.67	549	580	0.02	0.02
ECMW-09	DG9	1/25/2005	0.5	0.02	0.02	0.015	0.015	26.3	5.57	518	1600	0.02	0.02
ECMW-09	DG9	5/24/2005	0.5	0.02	0.015	0.015	0.018	27.4	5.77	600	1600	0.02	0.02
ECMW-09	DG9	10/18/2005						29.9	5.64			0.02	0.02
ECMW-09	DG9	4/11/2006						29.5	5.83			0.02	0.02
ECMW-09	DG9	11/1/2006						40.2	5				0.02
ECMW-10	DG10	6/27/2001	0.5		0.025		0.04	156	4.4	100	1300		
ECMW-10	DG10	10/30/2001	0.5		0.04		0.04	153	3.9	134	1400		
ECMW-10	DG10	6/3/2002	0.5	0.02	0.02	0.02	0.02	138	5.3	84.9	1122		
ECMW-10	DG10	10/30/2002	1.84	0.02	0.02	0.015	0.015	137	5.6	140	968		
ECMW-10	DG10	12/10/2002	0.5	0.02	0.02	0.015	0.015	70.4	4.5	52.2	1120		
ECMW-10	DG10	5/21/2003	0.5	0.02	0.02	0.015	0.015	148	4.08	96	1140		
ECMW-10	DG10	7/24/2003	0.5	0.02	0.02	0.015	0.015	118	5.56	108	1000		
ECMW-10	DG10	9/23/2003	0.5	0.02	0.02	0.015	0.015	147	4.18	127	1000		
ECMW-10	DG10	11/19/2003	0.5	0.02	0.02	0.015	0.015	119	4.38	104	970		
ECMW-10	DG10	1/28/2004	0.5	0.02	0.02	0.015	0.015	126	4.6	129	1000		
ECMW-10	DG10	3/16/2004	0.5	0.02	0.02	0.015	0.015	135	5.01	128	1078		
ECMW-10	DG10	5/18/2004	0.5	0.02	0.02	0.015	0.015	123	5.07	139	1055		
ECMW-10	DG10	7/13/2004	0.5	0.02	0.02	0.015	0.015	114	4.54	112	920		
ECMW-10	DG10	9/14/2004	0.77	0.02	0.02	0.015	0.015	123	4.7	137	1000		0.02
ECMW-10	DG10	11/16/2004	0.5	0.02	0.02	0.015	0.015	94.4	4.79	71.1	800	0.02	0.02
ECMW-10	DG10	1/25/2005	0.5	0.02	0.02	0.015	0.015	115	4.63	114	1000	0.02	0.02
ECMW-10	DG10	5/25/2005	1.45	0.02	0.02	0.015	0.015	120	4.93	142	990	0.02	0.02
ECMW-10	DG10	10/18/2005						97.7	4.3			0.02	0.02
ECMW-10	DG10	4/11/2006						97.5	4.4			0.02	0.02
ECMW-10	DG10	11/1/2006					0.015	71	3.83				0.02
ECMW-11	DG11	8/8/2001	4.21		0.02		0.04	7.99	4.3	611	1100		
ECMW-11	DG11	10/30/2001	0.5		0.02		0.04	21.9	4	334	610		
ECMW-11	DG11	6/3/2002	3.9	0.02	0.02	0.02	0.02	6.46	5.4	565	897		
ECMW-11	DG11	10/30/2002	18	0.02	0.02	0.015	0.015	9.22	4.8	362	625		
ECMW-11	DG11	12/10/2002	10.73	0.02	0.02	0.015	0.015	6.12	4.5	414	809		
ECMW-11	DG11	5/21/2003	7.84	0.02	0.02	0.015	0.015	6.02	4.45	333	576		
ECMW-11	DG11	7/24/2003	25.6	0.02	0.02	0.015	0.015	6.68	6.66	278	540		
ECMW-11	DG11	9/23/2003	5.25	0.02	0.02	0.015	0.015	4.24	4.29	397	660		
ECMW-11	DG11	11/19/2003	14.3	0.02	0.02	0.015	0.015	6.26	4.61	289	570		
ECMW-11	DG11	1/28/2004	19.6	0.02	0.02	0.015	0.015	6.72	5.04	303	520		
ECMW-11	DG11	3/16/2004	15	0.02	0.02	0.015	0.015	8.79	5	262	511		
ECMW-11	DG11	5/18/2004	19.9	0.02	0.02	0.015	0.015	13.5	5.17	228	452		
ECMW-11	DG11	7/13/2004	17.4	0.02	0.02	0.015	0.015	13.6	4.53	222	480		
ECMW-11	DG11	9/14/2004	14.5	0.02	0.02	0.015	0.015	9.85	4.61	247	480		0.02
ECMW-11	DG11	11/17/2004	19.1	0.02	0.02	0.015	0.015	11.1	4.86	209	450	0.02	0.02
ECMW-11	DG11	1/25/2005							4.64	3.58	410		
ECMW-11	DG11	5/25/2005	20.6	0.02	0.02	0.015	0.015	1.12	5.05			0.02	0.02
ECMW-11	DG11	10/18/2005	10.6					2.02	4.42			0.02	0.02
ECMW-11	DG11	4/11/2006	10.9					6.01	4.63			0.02	0.02
ECMW-11	DG11	11/1/2006	4.88					1.43	4.06				
ECMW-12	DG12	6/27/2001	2.2		0.02		0.04	0.5	5.9	13	330		
ECMW-12	DG12	6/4/2002	0.9	0.02	0.02	0.02	0.02	0.5	6	4.85	510		
ECMW-12	DG12	10/30/2002	4.2	0.02	0.02	0.015	0.015	0.5	6.1	21.6	382		
ECMW-12	DG12	12/10/2002	2.3	0.02	0.02	0.015	0.015	0.5	5.8	12.5	424		
ECMW-12	DG12	5/21/2003	1.89	0.02	0.02	0.015	0.015	0.5	5.71	5.31	307		
ECMW-12	DG12	7/24/2003	1.74	0.02	0.02	0.015	0.015	0.5	4.76	18.7	380		
ECMW-12	DG12	9/24/2003	1.43	0.02	0.02	0.015	0.015	0.5	5.45	26	440		
ECMW-12	DG12	11/19/2003	1.83	0.02	0.02	0.015	0.015	0.5	5.79	30.6	460		
ECMW-12	DG12	1/28/2004	1.87	0.02	0.02	0.015	0.015	0.5	6.44	6.76	320		
ECMW-12	DG12	3/16/2004	2.2	0.02	0.02	0.015	0.015	0.5	5.96	4.04	252		
ECMW-12	DG12	5/19/2004	1.94	0.02	0.02	0.015	0.015	0.5	5.8	5.11	360		
ECMW-12	DG12	7/13/2004	1.2	0.02	0.02	0.015	0.015	0.5	6.78	7.18	220		
ECMW-12	DG12	9/15/2004	2.38	0.02	0.02	0.015	0.015	0.5	5.8	23	440		0.02
ECMW-12	DG12	11/16/2004	1.55	0.02	0.02	0.015	0.015	0.5	5.73	18.5	340	0.02	0.02
ECMW-12	DG12	1/26/2005	1.98	0.02	0.02	0.015	0.015	0.5	5.91	4.88	360	0.02	0.02
ECMW-12	DG12	5/25/2005	1.02	0.02	0.02	0.015	0.015	0.5	5.96	11.2	370	0.02	0.02
ECMW-12	DG12	10/20/2005	1.06						5.3			0.02	0.02
ECMW-12	DG12	4/11/2006	1.58						6.12			0.02	0.02
ECMW-12	DG12	11/1/2006	1.37						5.3				0.02
ECMW-13	DG13	6/5/2001	0.5		0.02		0.04	0.5	5.6	538	1400		
ECMW-13	DG13	10/30/2001	0.5		0.02		0.04	0.5	5.3	606	1300		
ECMW-13	DG13	6/4/2002	0.5	0.02	0.02	0.02	0.02	0.5	5.7	372	718		
ECMW-13	DG13	10/30/2002	1.28	0.02	0.02	0.015	0.015	0.5	6.1	538	1030		
ECMW-13	DG13	12/10/2002	0.5	0.02	0.02	0.015	0.015	0.5	5.5	598	1320		
ECMW-13	DG13	5/20/2003	0.5	0.02	0.02	0.015	0.015	0.5	5.51	697	1330		
ECMW-13	DG13	7/23/2003	0.5	0.02	0.02	0.015	0.015	0.5	6.05	358	820		
ECMW-13	DG13	9/24/2003	0.71	0.02	0.02	0.015	0.015	0.5	4.7	458	920		
ECMW-13	DG13	11/19/2003	0.5	0.02	0.02	0.015	0.015	0.62	4.91	310	680		
ECMW-13	DG13	1/28/2004	0.5	0.02	0.02	0.015	0.015	0.5	5.02	656	1100		
ECMW-13	DG13	3/16/2004	0.5	0.02	0.02	0.015	0.015	0.5	5.19	550	1175		
ECMW-13	DG13	5/18/2004	0.5	0.02	0.02	0.015	0.015	0.5	5.27	296	647		
ECMW-13	DG13	7/13/2004	0.5	0.02	0.02	0.015	0.015	0.5	6.02	510	1100		
ECMW-13	DG13	9/14/2004	0.51	0.02	0.02	0.015	0.015	0.5	5.03	416	940		0.02
ECMW-13	DG13	11/16/2004	0.5	0.02	0.02	0.015	0.015	0.5	4.83	250	1500	0.02	0.02
ECMW-13	DG13	1/26/2005	0.5	0.02	0.02	0.015	0.015	0.72	4.86	564	1200	0.02	0.02
ECMW-13	DG13	5/25/2005	0.54	0.02	0.02	0.015	0.015	0.5	5.07	302	580	0.02	0.02

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MasterID	GroupID	MasterDate	ammonia Conc	dissolved chrom Conc	total chrom Conc	dissolved lead Conc	total lead Conc	nitrate Conc	ph Conc	sulfate Conc	tds Conc	dissolve vanadium Conc	total vanadium Conc
ECMW-13	DG13	10/19/2005	0.5					[redacted]	4.19			0.02	0.02
ECMW-13	DG13	4/12/2006						[redacted]	4.97			0.02	0.02
ECMW-13	DG13	11/2/2006			0.02	0.015		0.5	4.71				0.02
ECMW-14	DG14	8/8/2001	0.5		0.02		0.04	75	4.3	175	1000		
ECMW-14	DG14	10/30/2001	0.5		0.02		0.04	25.2	4.5	211	790		
ECMW-14	DG14	6/4/2002	0.5	0.02	0.02	0.02	0.02	26.5	5.6	187	675		
ECMW-14	DG14	10/30/2002	5.32	0.02	0.02	0.015	0.015	17	6.3	288	669		
ECMW-14	DG14	12/10/2002	0.5	0.02	0.02	0.015	0.015	23.4	5.3	230	709		
ECMW-14	DG14	5/20/2003	0.5	0.02	0.02	0.015	0.015	44.9	4.85	227	865		
ECMW-14	DG14	7/23/2003	0.5	0.02	0.02	0.015	0.015	23.1	4.62	221	750		
ECMW-14	DG14	9/23/2003	0.5	0.02	0.02	0.015	0.015	20.3	5	275	700		
ECMW-14	DG14	11/19/2003	0.5	0.02	0.02	0.015	0.015	16.1	4.92	227	740		
ECMW-14	DG14	1/28/2004	0.5	0.02	0.022	0.015	0.028	24.5	5.19	262	710		
ECMW-14	DG14	3/16/2004	0.5	0.02	0.02	0.015	0.015	33.4	5.34	211	792		
ECMW-14	DG14	5/18/2004	0.5	0.02	0.02	0.015	0.015	32.6	5.23	234	784		
ECMW-14	DG14	7/13/2004	0.5	0.02	0.02	0.015	0.015	47.3	5.05	226	820		
ECMW-14	DG14	9/14/2004	0.5	0.02	0.02	0.015	0.015	57.7	4.72	232	900		0.02
ECMW-14	DG14	11/16/2004	0.5	0.02	0.02	0.015	0.015	21.7	4.88	168	660	0.02	0.02
ECMW-14	DG14	1/26/2005	0.5	0.02	0.02	0.015	0.015	62.4	4.89	204	930	0.02	0.02
ECMW-14	DG14	5/25/2005	0.5	0.02	0.02	0.015	0.015	31	5.06	204	700	0.02	0.02
ECMW-14	DG14	10/19/2005		0.02				36	4.96			0.02	0.02
ECMW-14	DG14	4/12/2006						48.2	4.72			0.02	0.02
ECMW-14	DG14	11/2/2006						13.6	4.15				0.02
ECMW-15	DG15	8/8/2001	0.5		0.02		0.04	19.1	4.3	7.8	140		
ECMW-15	DG15	10/30/2001	0.5		0.02		0.04	12.6	4.3	10.2	110		
ECMW-15	DG15	6/4/2002	0.5	0.02	0.02	0.02	0.02	10.7	5.4	11.1	100		
ECMW-15	DG15	10/30/2002	1.16	0.02	0.02	0.015	0.015	18.2	5.4	9.22	120		
ECMW-15	DG15	12/10/2002	0.5	0.02	0.02	0.015	0.015	12.2	5.8	10.8	120		
ECMW-15	DG15	5/20/2003	0.5	0.02	0.02	0.015	0.015	9.45	4.75	13	66		
ECMW-15	DG15	7/23/2003	0.5	0.02	0.02	0.015	0.015	7.63	4.77	12.8	100		
ECMW-15	DG15	9/23/2003	0.5	0.02	0.02	0.015	0.015	9.62	4.49	11.8	180		
ECMW-15	DG15	11/19/2003	0.5	0.02	0.02	0.015	0.015	9.81	4.89	12.6	100		
ECMW-15	DG15	1/28/2004	3.96	0.02	0.02	0.015	0.015	4.52	5.56	18.6	81		
ECMW-15	DG15	3/16/2004	0.5	0.02	0.02	0.015	0.015	7.66	5.68	13.9	97		
ECMW-15	DG15	5/18/2004	0.5	0.02	0.02	0.015	0.015	6.82	5.75	15.2	83		
ECMW-15	DG15	7/13/2004	0.5	0.02	0.02	0.015	0.015	9.52	5.39	11	110		
ECMW-15	DG15	9/14/2004	0.61	0.02	0.02	0.015	0.015	8.22	4.67	13.2	100		0.02
ECMW-15	DG15	11/16/2004	0.5	0.02	0.02	0.015	0.015	7.42	4.92	11.8	110	0.02	0.02
ECMW-15	DG15	1/25/2005	0.5	0.02	0.02	0.015	0.015	7.62	4.68	11.8	110	0.02	0.02
ECMW-15	DG15	5/25/2005	0.5	0.02	0.02	0.015	0.015	5.79	4.94	16.1	79	0.02	0.02
ECMW-15	DG15	10/19/2005						5.63	4.77			0.02	0.02
ECMW-15	DG15	4/11/2006						1.6	4.95			0.02	0.02
ECMW-15	DG15	11/2/2006						2.54	4.17				0.02
ECMW-16	DG16	6/5/2001	4.61		0.02		0.04	134	4.3	5.09	1100		
ECMW-16	DG16	10/30/2001	0.5		0.02		0.04	58.4	3.9	6.44	330		
ECMW-16	DG16	6/4/2002	6.2	0.02	0.02	0.02	0.02	72.5	5	7.19	396		
ECMW-16	DG16	10/30/2002	11.6	0.02	0.02	0.015	0.015	72	5	9.21	263		
ECMW-16	DG16	12/10/2002	2.99	0.02	0.02	0.015	0.015	89.4	5.9	5.64	595		
ECMW-16	DG16	5/20/2003	3.69	0.02	0.02	0.015	0.015	90.8	4.42	6.55	555		
ECMW-16	DG16	7/23/2003	6.45	0.02	0.02	0.015	0.015	72.3	4.81	7.15	430		
ECMW-16	DG16	9/23/2003	5.97	0.02	0.02	0.015	0.015	72.8	4.31	7.09	400		
ECMW-16	DG16	11/19/2003	8.61	0.02	0.02	0.015	0.015	44.3	4.99	9.78	230		
ECMW-16	DG16	1/28/2004	5.66	0.02	0.02	0.015	0.015	59	5.61	9.84	280		
ECMW-16	DG16	3/16/2004	8.39	0.02	0.02	0.015	0.015	34.8	5.83	11.2	180		
ECMW-16	DG16	5/18/2004	11.5	0.02	0.02	0.015	0.015	31.9	5.95	13.3	167		
ECMW-16	DG16	7/13/2004	9.35	0.02	0.02	0.015	0.015	40.2	5.5	7.7	160		
ECMW-16	DG16	9/14/2004	8.57	0.02	0.02	0.015	0.015	47.1	4.49	7.83	190		0.02
ECMW-16	DG16	11/16/2004	6.87	0.02	0.02	0.015	0.015	38.2	5.08	8.11	310	0.02	0.02
ECMW-16	DG16	1/25/2005	4.15	0.02	0.02	0.015	0.015	43.1	4.54	8.13	310	0.02	0.02
ECMW-16	DG16	5/25/2005	7.62	0.02	0.02	0.015	0.015	26.8	4.62	10.2	110	0.02	0.02
ECMW-16	DG16	10/19/2005	6.28					17	4.66			0.02	0.02
ECMW-16	DG16	4/11/2006	2.01					17	4.79			0.02	0.02
ECMW-16	DG16	11/2/2006	2.16					24.8	4.27				0.02
ECMW-17	DG17	6/5/2001	1.16		0.02		0.04	54.2	4.4	87.1	600		
ECMW-17	DG17	10/30/2001	0.5		0.02		0.04	106	4.1	11.5	760		
ECMW-17	DG17	6/4/2002	0.5	0.02	0.02	0.02	0.02	83.4	5.1	8.04	603		
ECMW-17	DG17	10/30/2002	2.36	0.02	0.02	0.015	0.015	92	5.1	9.53	540		
ECMW-17	DG17	12/10/2002	1.22	0.02	0.02	0.015	0.015	101	5.6	28.2	751		
ECMW-17	DG17	5/20/2003	0.5	0.02	0.02	0.015	0.015	83.6	4.54	17.1	603		
ECMW-17	DG17	7/23/2003	0.58	0.02	0.02	0.015	0.015	74.7	4.74	9.31	548		
ECMW-17	DG17	9/23/2003	0.5	0.02	0.02	0.015	0.015	64.3	5.25	6.98	400		
ECMW-17	DG17	11/19/2003	0.55	0.02	0.02	0.015	0.015	77.3	5.28	11.8	530		
ECMW-17	DG17	1/28/2004	0.5	0.02	0.02	0.015	0.015	81.3	6.54	42.8	560		
ECMW-17	DG17	3/16/2004	8.14	0.02	0.02	0.015	0.015	129	6.62	64	983		
ECMW-17	DG17	5/18/2004	8.05	0.02	0.02	0.015	0.015	134	6.73	60.1	944		
ECMW-17	DG17	7/13/2004	0.5	0.02	0.02	0.015	0.015	67.6	6.57	6.54	460		
ECMW-17	DG17	9/14/2004	1.42	0.02	0.02	0.015	0.015	78.4	4.4	3.14	570		0.02
ECMW-17	DG17	11/16/2004	9.55	0.02	0.02	0.015	0.015	219	5.41	54.8	1800	0.02	0.02
ECMW-17	DG17	1/26/2005	1.79	0.02	0.02	0.015	0.015	53.3	4.54	12.2	360	0.02	0.02
ECMW-17	DG17	5/25/2005	0.5	0.02	0.02	0.015	0.015	58.4	4.86	19.1	390	0.02	0.02
ECMW-17	DG17	10/20/2005	0.67					48.9	5.74			0.02	0.02
ECMW-17	DG17	4/11/2006	1.15					66.6	3.35			0.02	0.02
ECMW-17	DG17	11/2/2006	4.81					47.6	3.56				0.02
ECMW-18	DG18	10/30/2001	0.5		0.05		0.04	0.5	5.4	3.74	300		
ECMW-18	DG18	6/4/2002	0.5	0.137	0.147	0.02	0.115	0.5	6.2	8.38	796		

Groundwater Data

			ammonia	dissolved chrom	total chrom	dissolved lead	total lead	nitrate	ph	sulfate	tds	dissolve vanadium	total vanadium
MasterID	GroupID	MasterDate	Conc	Conc	Conc	Conc	Conc	Conc	Conc	Conc	Conc	Conc	Conc
ECMW-18	DG18	10/30/2002	0.43	0.02	0.02	0.015	0.018	0.5	6.3	3.22	258		
ECMW-18	DG18	12/10/2002	0.5	0.02	0.02	0.015	0.015	0.5	6.4	5.01	495		
ECMW-18	DG18	5/21/2003	0.59	0.02	0.02	0.015	0.029	0.5	6.01	7.08	786		
ECMW-18	DG18	7/23/2003	0.5	0.02	0.047	0.015	0.029	113	5.38	115	2000		
ECMW-18	DG18	9/24/2003	5.79	0.026	0.036	0.015	0.025	0.5	5.54	3.81	590		
ECMW-18	DG18	11/19/2003	0.5	0.02	0.02	0.015	0.015	0.5	5.9	9.68	300		
ECMW-18	DG18	1/28/2004							6.17				
ECMW-18	DG18	3/16/2004	0.5	0.021	0.027	0.015	0.021	0.5	6.4	7.01	666		
ECMW-18	DG18	5/19/2004	0.5	0.02	0.088	0.015	0.063	0.5	6.43	5.63	720		
ECMW-18	DG18	7/13/2004	0.5	0.02	0.043	0.015	0.033	0.5	6.05	5.68	1100		
ECMW-18	DG18	9/15/2004	0.56	0.05	0.12	0.038	0.109	0.5	5.89	3.88	1200		0.213
ECMW-18	DG18	11/17/2004	0.5	0.02	0.027	0.015	0.03	0.5	5.96	4.61	1100	0.02	0.045
ECMW-18	DG18	1/26/2005	0.5	0.022	0.055	0.015	0.056	0.5	5.9	5.13	1000	0.031	0.099
ECMW-18	DG18	5/25/2005	0.5	0.02	0.032	0.015	0.018	0.5	6.04	5.18	700	0.03	0.048
ECMW-18	DG18	10/19/2005		0.052	0.02	0.015	0.015		5.82			0.081	0.02
ECMW-18	DG18	4/12/2006		0.065	0.02	0.016	0.015		1.34			0.02	0.02
ECMW-18	DG18	11/2/2006			0.02		0.015		5.23				0.02
ECMW-19	DG19	1/28/2004	0.64	0.077	0.077	0.045	0.122	0.5	6.73	8.32	1400		
ECMW-19	DG19	3/16/2004	0.5	0.02	0.02	0.015	0.019	0.5	6.49	6.38	238		
ECMW-19	DG19	5/19/2004	0.5	0.02	0.02	0.015	0.015	0.5	6.19	9.05	220		
ECMW-19	DG19	7/13/2004	0.5	0.02	0.02	0.015	0.015	0.5	6.37	6.85	180		
ECMW-19	DG19	9/15/2004	0.54	0.02	0.02	0.015	0.015	0.5	6.23	4.11	120		0.02
ECMW-19	DG19	11/17/2004	0.5	0.02	0.02	0.015	0.015	0.5	6.02	4.63	130	0.02	0.02
ECMW-19	DG19	1/26/2005	0.5	0.02	0.02	0.015	0.015	0.5	5.82	3.67	100	0.02	0.02
ECMW-19	DG19	5/25/2005	0.5	0.02	0.02	0.015	0.015	0.5	5.88	4.56	120	0.02	0.02
ECMW-19	DG19	10/19/2005	0.5	0.02	0.02	0.015	0.015	0.5	6.27			0.02	0.02
ECMW-19	DG19	4/12/2006	0.5	0.02	0.02	0.015	0.015	0.5	6.1			0.02	0.02
ECMW-19	DG19	11/2/2006	0.5		0.02		0.015	0.5	5.51				0.02
ECMW-20	DG20	1/28/2004	0.5	0.02	0.034	0.015	0.024	0.5	5.93	11.4	730		
ECMW-20	DG20	3/16/2004	0.5	0.02	0.02	0.015	0.015	0.5	6.51	15.9	186		
ECMW-20	DG20	5/19/2004	0.5	0.02	0.02	0.015	0.015	0.5	6.23	10.6	140		
ECMW-20	DG20	7/13/2004	0.5	0.02	0.02	0.015	0.015	0.5	5.8	17.2	130		
ECMW-20	DG20	9/15/2004	0.86	0.02	0.02	0.015	0.015	0.5	5.61	17.2	120		0.02
ECMW-20	DG20	11/17/2004	0.5	0.02	0.02	0.015	0.015	0.5	5.36	13.5	160	0.02	0.02
ECMW-20	DG20	1/26/2005	0.5	0.02	0.02	0.015	0.017	0.5	6.02	13.8	160	0.02	0.02
ECMW-20	DG20	5/26/2005	0.5	0.02	0.02	0.015	0.015	1.86	6.03	7.72	85	0.02	0.02
ECMW-20	DG20	10/20/2005	0.5	0.02	0.02	0.015	0.015	0.5	6.2			0.02	0.02
ECMW-20	DG20	4/12/2006	3.58	0.02	0.02	0.015	0.015	6.29				0.02	0.02
ECMW-20	DG20	11/2/2006	0.5		0.02		0.015	1.21					0.02
ECMW-21	DG21	1/28/2004	0.5	0.02	0.837	0.015	0.169	1.63	5.56	8.17	82		
ECMW-21	DG21	3/16/2004	0.5	0.02	0.028	0.015	0.015	0.54	6.34	3.62	130		
ECMW-21	DG21	5/19/2004	0.5	0.02	0.07	0.015	0.029	2.15	6.75	4.59	110		
ECMW-21	DG21	7/13/2004	0.5	0.02	0.056	0.015	0.032	2.5	6.39	3.74	103		
ECMW-21	DG21	9/15/2004	0.81	0.02	0.029	0.015	0.015	4.65	5.47	4.15	150		0.02
ECMW-21	DG21	11/17/2004	0.5	0.02	0.047	0.015	0.015	2.97	5.96	3.14	110	0.02	0.02
ECMW-21	DG21	1/26/2005	4.06	0.02	0.044	0.015	0.02	3.23	5.37	2.88	77	0.02	0.02
ECMW-21	DG21	5/26/2005	0.5	0.02	0.265	0.015	0.063	3.17	5.69	3.64	76	0.02	0.092
ECMW-21	DG21	10/20/2005	0.5	0.02	0.02	0.015	0.015	4.16	4.17			0.02	0.02
ECMW-21	DG21	4/12/2006	0.5	0.02	0.02	0.015	0.015	3.19				0.02	0.02
ECMW-21	DG21	11/2/2006	0.5		0.02		0.015	2.23					0.02
ECMW-22	DG22	1/28/2004	0.61	0.02	0.021	0.015	0.021	0.53	7.68	6.62	540		
ECMW-22	DG22	3/16/2004	0.5	0.02	0.02	0.015	0.015	0.66	6.65	2.88	1		
ECMW-22	DG22	5/18/2004	0.5	0.02	0.02	0.015	0.015	0.95	6.76	3.74	136		
ECMW-22	DG22	7/13/2004	0.5	0.02	0.02	0.015	0.015	0.5	6.74	3.8	140		
ECMW-22	DG22	9/14/2004	0.7	0.02	0.02	0.015	0.015	0.5	5.84	2.94	170		0.02
ECMW-22	DG22	11/16/2004	0.5	0.02	0.02	0.015	0.015	0.5	6.95	2.51	180	0.02	0.02
ECMW-22	DG22	1/26/2005	0.5	0.02	0.02	0.015	0.015	1.09	5.79	3.56	140	0.02	0.02
ECMW-22	DG22	5/25/2005	0.5	0.02	0.02	0.015	0.015	1.12	6.46	3.61	130	0.02	0.02
ECMW-22	DG22	10/19/2005	0.5	0.02	0.02	0.015	0.056	0.5	6.21			0.02	0.02
ECMW-22	DG22	4/11/2006	0.5	0.02	0.02	0.015	0.015	2.56	6.22			0.02	0.02
ECMW-22	DG22	11/2/2006	0.5		0.02		0.015	1.07	5.37				0.02

Groundwater Data

Exposure Unit Statistics

MasterID	GroupID	MasterDate	ammonia Conc	dissolved chrom Conc	total chrom Conc	dissolved lead Conc	total lead Conc	nitrate Conc	ph Conc	sulfate Conc	tds Conc	dissolve vanadium Conc	total vanadium Conc
Production Unit-Stats													
Average			46.913	0.020	0.020	0.015	0.018	252.171	4.827	435.645	2326.851	0.020	0.020
Min			0.500	0.020	0.015	0.015	0.015	0.500	3.340	3.140	290.000	0.020	0.020
Max			551.000	0.020	0.040	0.020	0.060	2390.000	9.700	1220.000	7100.000	0.020	0.020
Stdev			87.858	0.000	0.003	0.001	0.008	400.401	0.951	319.310	1831.250	0.000	0.000
Median			1.140	0.020	0.020	0.015	0.015	76.000	4.600	458.000	1500.000	0.020	0.020
95%CI			14.203	#NUM!	0.000	0.000	0.001	63.034	0.148	54.064	310.058	#NUM!	#NUM!
n			147.000	119.000	135.000	121.000	139.000	155.000	159.000	134.000	134.000	39.000	54.000
95-Upper-dist-free			61.116	#NUM!	0.021	0.016	0.020	315.205	4.975	489.709	2636.909	#NUM!	#NUM!
95-Lower-dist-free			32.711	#NUM!	0.020	0.015	0.017	189.136	4.679	381.581	2016.793	#NUM!	#NUM!
t-value			1.655	1.658	1.656	1.658	1.656	1.655	1.655	1.656	1.656	1.686	1.674
95%UCL-normal			58.909	0.020	0.021	0.016	0.020	305.391	4.951	481.335	2588.885	0.020	0.020
95%UCL-lognormal													
Midgradient Area													
Average			2.764	0.020	0.020	0.015	0.018	32.383	4.952	81.046	411.882	0.020	0.020
Min			0.500	0.020	0.020	0.015	0.015	1.600	3.900	5.090	66.000	0.020	0.020
Max			11.600	0.020	0.022	0.020	0.040	134.000	6.300	288.000	1100.000	0.020	0.020
Stdev			3.295	0.000	0.000	0.001	0.008	26.936	0.516	102.637	314.874	0.000	0.000
Median			0.500	0.020	0.020	0.015	0.015	24.650	4.905	12.600	310.000	0.020	0.020
95%CI			0.879	#NUM!	0.000	0.000	0.002	6.816	0.131	28.169	86.417	0.000	#NUM!
n			54.000	46.000	51.000	45.000	51.000	60.000	60.000	51.000	51.000	15.000	21.000
95-Upper-dist-free			3.642	#NUM!	0.020	0.016	0.021	39.198	5.083	109.215	498.300	0.020	#NUM!
95-Lower-dist-free			1.885	#NUM!	0.020	0.015	0.016	25.567	4.822	52.878	325.465	0.020	#NUM!
t-value			1.674	1.679	1.676	1.680	1.676	1.671	1.671	1.676	1.676	1.761	1.725
95%UCL-normal			3.514	0.020	0.020	0.016	0.020	38.194	5.063	105.133	485.775	0.020	0.020
95%UCL-lognormal													
Downgradient													
Average			1.109	0.024	0.042	0.016	0.026	24.049	5.753	13.496	467.297	0.023	0.029
Min			0.430	0.020	0.020	0.015	0.015	0.500	1.340	2.510	1.000	0.020	0.020
Max			9.550	0.137	0.837	0.045	0.169	219.000	7.680	115.000	2000.000	0.081	0.213
Stdev			1.770	0.017	0.097	0.005	0.027	43.107	0.922	20.513	422.926	0.011	0.034
Median			0.500	0.020	0.020	0.015	0.015	0.660	5.930	6.735	330.000	0.020	0.020
95%CI			0.390	0.004	0.021	0.001	0.006	9.506	0.203	5.026	103.615	0.004	0.010
n			79.000	71.000	79.000	71.000	79.000	79.000	79.000	64.000	64.000	30.000	42.000
95-Upper-dist-free			1.499	0.028	0.063	0.017	0.032	33.555	5.956	18.522	570.912	0.027	0.040
95-Lower-dist-free			0.719	0.020	0.021	0.015	0.020	14.543	5.549	8.471	363.682	0.019	0.019
t-value			1.665	1.667	1.665	1.667	1.665	1.665	1.665	1.669	1.669	1.699	1.683
95%UCL-normal			1.441	0.027	0.060	0.017	0.031	32.122	5.925	17.777	555.551	0.026	0.038
95%UCL-lognormal													
Upgradient													
Average			0.525	0.020	0.020	0.015	0.018	1.177	5.672	14.892	213.176	0.020	0.020
Min			0.500	0.020	0.020	0.015	0.015	0.500	3.610	3.340	35.000	0.020	0.020
Max			0.980	0.020	0.032	0.020	0.040	4.790	7.260	28.200	517.000	0.020	0.020
Stdev			0.087	0.000	0.002	0.001	0.008	1.154	0.589	8.428	127.451	0.000	0.000
Median			0.500	0.020	0.020	0.015	0.015	0.500	5.595	15.800	228.000	0.020	0.020
95%CI			0.024	#NUM!	0.000	0.000	0.002	0.305	0.149	2.313	34.979	0.000	#NUM!
n			51.000	45.000	51.000	45.000	51.000	55.000	60.000	51.000	51.000	15.000	21.000
95-Upper-dist-free			0.549	#NUM!	0.021	0.016	0.020	1.482	5.821	17.205	248.155	0.020	#NUM!
95-Lower-dist-free			0.502	#NUM!	0.020	0.015	0.016	0.872	5.523	12.579	178.198	0.020	#NUM!
t-value			1.676	1.680	1.676	1.680	1.676	1.674	1.671	1.676	1.676	1.761	1.725
95%UCL-normal			0.546	0.020	0.021	0.016	0.020	1.437	5.799	16.870	243.086	0.020	0.020
95%UCL-lognormal													

Appendix C

Calculations and Benchmark Values (RfDs, etc)

U.S Census Bureau
Profile for City of El Dorado, Arkansas

Table DP-1. Profile of General Demographic Characteristics: 2000

Geographic area: El Dorado city, Arkansas

[For information on confidentiality protection, nonsampling error, and definitions, see text]

Subject	Number	Percent
Total population	**21,530**	**100.0**
SEX AND AGE		
Male	9,937	46.2
Female	11,593	53.8
Under 5 years	1,520	7.1
5 to 9 years	1,567	7.3
10 to 14 years	1,598	7.4
15 to 19 years	1,544	7.2
20 to 24 years	1,238	5.8
25 to 34 years	2,583	12.0
35 to 44 years	3,004	14.0
45 to 54 years	2,705	12.6
55 to 59 years	986	4.6
60 to 64 years	848	3.9
65 to 74 years	1,703	7.9
75 to 84 years	1,569	7.3
85 years and over	665	3.1
Median age (years)	37.6	(X)
18 years and over	15,874	73.7
Male	6,994	32.5
Female	8,880	41.2
21 years and over	15,033	69.8
62 years and over	4,409	20.5
65 years and over	3,937	18.3
Male	1,408	6.5
Female	2,529	11.7
RACE		
One race	21,345	99.1
White	11,552	53.7
Black or African American	9,512	44.2
American Indian and Alaska Native	43	0.2
Asian	152	0.7
Asian Indian	55	0.3
Chinese	22	0.1
Filipino	40	0.2
Japanese	11	0.1
Korean	2	-
Vietnamese	12	0.1
Other Asian[1]	10	-
Native Hawaiian and Other Pacific Islander	3	-
Native Hawaiian	1	-
Guamanian or Chamorro	-	-
Samoan	-	-
Other Pacific Islander[2]	2	-
Some other race	83	0.4
Two or more races	185	0.9
Race alone or in combination with one or more other races:[3]		
White	11,678	54.2
Black or African American	9,628	44.7
American Indian and Alaska Native	122	0.6
Asian	193	0.9
Native Hawaiian and Other Pacific Islander	17	0.1
Some other race	111	0.5

Subject	Number	Percent
HISPANIC OR LATINO AND RACE		
Total population	**21,530**	**100.0**
Hispanic or Latino (of any race)	224	1.0
Mexican	127	0.6
Puerto Rican	16	0.1
Cuban	12	0.1
Other Hispanic or Latino	69	0.3
Not Hispanic or Latino	21,306	99.0
White alone	11,441	53.1
RELATIONSHIP		
Total population	**21,530**	**100.0**
In households	20,861	96.9
Householder	8,686	40.3
Spouse	3,728	17.3
Child	6,249	29.0
Own child under 18 years	4,793	22.3
Other relatives	1,411	6.6
Under 18 years	731	3.4
Nonrelatives	787	3.7
Unmarried partner	379	1.8
In group quarters	669	3.1
Institutionalized population	557	2.6
Noninstitutionalized population	112	0.5
HOUSEHOLD BY TYPE		
Total households	**8,686**	**100.0**
Family households (families)	5,734	66.0
With own children under 18 years	2,670	30.7
Married-couple family	3,728	42.9
With own children under 18 years	1,493	17.2
Female householder, no husband present	1,659	19.1
With own children under 18 years	981	11.3
Nonfamily households	2,952	34.0
Householder living alone	2,665	30.7
Householder 65 years and over	1,178	13.6
Households with individuals under 18 years	3,055	35.2
Households with individuals 65 years and over	2,608	30.0
Average household size	2.40	(X)
Average family size	2.99	(X)
HOUSING OCCUPANCY		
Total housing units	**9,891**	**100.0**
Occupied housing units	8,686	87.8
Vacant housing units	1,205	12.2
For seasonal, recreational, or occasional use	38	0.4
Homeowner vacancy rate (percent)	3.1	(X)
Rental vacancy rate (percent)	11.3	(X)
HOUSING TENURE		
Occupied housing units	**8,686**	**100.0**
Owner-occupied housing units	5,273	60.7
Renter-occupied housing units	3,413	39.3
Average household size of owner-occupied units	2.42	(X)
Average household size of renter-occupied units	2.38	(X)

- Represents zero or rounds to zero. (X) Not applicable.

[1] Other Asian alone, or two or more Asian categories.

[2] Other Pacific Islander alone, or two or more Native Hawaiian and Other Pacific Islander categories.

[3] In combination with one or more of the other races listed. The six numbers may add to more than the total population and the six percentages may add to more than 100 percent because individuals may report more than one race.

Source: U.S. Census Bureau, Census 2000.

Table DP-2. Profile of Selected Social Characteristics: 2000

Geographic area: El Dorado city, Arkansas

[Data based on a sample. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see text]

Subject	Number	Percent
SCHOOL ENROLLMENT		
Population 3 years and over enrolled in school	**5,152**	**100.0**
Nursery school, preschool	363	7.0
Kindergarten	269	5.2
Elementary school (grades 1-8)	2,630	51.0
High school (grades 9-12)	1,312	25.5
College or graduate school	578	11.2
EDUCATIONAL ATTAINMENT		
Population 25 years and over	**13,973**	**100.0**
Less than 9th grade	1,253	9.0
9th to 12th grade, no diploma	2,454	17.6
High school graduate (includes equivalency)	4,349	31.1
Some college, no degree	2,782	19.9
Associate degree	538	3.9
Bachelor's degree	1,797	12.9
Graduate or professional degree	800	5.7
Percent high school graduate or higher	73.5	(X)
Percent bachelor's degree or higher	18.6	(X)
MARITAL STATUS		
Population 15 years and over	**16,764**	**100.0**
Never married	4,155	24.8
Now married, except separated	8,283	49.4
Separated	575	3.4
Widowed	1,637	9.8
Female	1,406	8.4
Divorced	2,114	12.6
Female	1,267	7.6
GRANDPARENTS AS CAREGIVERS		
Grandparent living in household with one or more own grandchildren under 18 years	**582**	**100.0**
Grandparent responsible for grandchildren	278	47.8
VETERAN STATUS		
Civilian population 18 years and over	**15,802**	**100.0**
Civilian veterans	2,042	12.9
DISABILITY STATUS OF THE CIVILIAN NONINSTITUTIONALIZED POPULATION		
Population 5 to 20 years	**5,098**	**100.0**
With a disability	553	10.8
Population 21 to 64 years	**10,904**	**100.0**
With a disability	2,952	27.1
Percent employed	45.0	(X)
No disability	7,952	72.9
Percent employed	75.5	(X)
Population 65 years and over	**3,557**	**100.0**
With a disability	1,902	53.5
RESIDENCE IN 1995		
Population 5 years and over	**20,028**	**100.0**
Same house in 1995	11,194	55.9
Different house in the U.S. in 1995	8,410	42.0
Same county	5,585	27.9
Different county	2,825	14.1
Same state	1,313	6.6
Different state	1,512	7.5
Elsewhere in 1995	424	2.1

Subject	Number	Percent
NATIVITY AND PLACE OF BIRTH		
Total population	**21,404**	**100.0**
Native	21,071	98.4
Born in United States	20,943	97.8
State of residence	15,725	73.5
Different state	5,218	24.4
Born outside United States	128	0.6
Foreign born	333	1.6
Entered 1990 to March 2000	202	0.9
Naturalized citizen	58	0.3
Not a citizen	275	1.3
REGION OF BIRTH OF FOREIGN BORN		
Total (excluding born at sea)	**333**	**100.0**
Europe	63	18.9
Asia	125	37.5
Africa	9	2.7
Oceania	-	-
Latin America	129	38.7
Northern America	7	2.1
LANGUAGE SPOKEN AT HOME		
Population 5 years and over	**20,028**	**100.0**
English only	19,440	97.1
Language other than English	588	2.9
Speak English less than "very well"	231	1.2
Spanish	371	1.9
Speak English less than "very well"	116	0.6
Other Indo-European languages	131	0.7
Speak English less than "very well"	44	0.2
Asian and Pacific Island languages	77	0.4
Speak English less than "very well"	71	0.4
ANCESTRY (single or multiple)		
Total population	**21,404**	**100.0**
Total ancestries reported	*16,992*	*79.4*
Arab	29	0.1
Czech[1]	28	0.1
Danish	28	0.1
Dutch	115	0.5
English	1,363	6.4
French (except Basque)[1]	244	1.1
French Canadian[1]	53	0.2
German	750	3.5
Greek	4	-
Hungarian	-	-
Irish[1]	1,371	6.4
Italian	138	0.6
Lithuanian	6	-
Norwegian	43	0.2
Polish	25	0.1
Portuguese	-	-
Russian	-	-
Scotch-Irish	497	2.3
Scottish	203	0.9
Slovak	-	-
Subsaharan African	141	0.7
Swedish	33	0.2
Swiss	49	0.2
Ukrainian	-	-
United States or American	2,569	12.0
Welsh	42	0.2
West Indian (excluding Hispanic groups)	-	-
Other ancestries	9,261	43.3

-Represents zero or rounds to zero. (X) Not applicable.

[1] The data represent a combination of two ancestries shown separately in Summary File 3. Czech includes Czechoslovakian. French includes Alsatian. French Canadian includes Acadian/Cajun. Irish includes Celtic.

Source: U.S. Bureau of the Census, Census 2000.

Table DP-3. Profile of Selected Economic Characteristics: 2000

Geographic area: El Dorado city, Arkansas

[Data based on a sample. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see text]

Subject	Number	Percent
EMPLOYMENT STATUS		
Population 16 years and over	**16,458**	**100.0**
In labor force	9,081	55.2
Civilian labor force	9,068	55.1
Employed	8,278	50.3
Unemployed	790	4.8
Percent of civilian labor force	8.7	(X)
Armed Forces	13	0.1
Not in labor force	7,377	44.8
Females 16 years and over	**9,225**	**100.0**
In labor force	4,456	48.3
Civilian labor force	4,456	48.3
Employed	4,071	44.1
Own children under 6 years	**1,631**	**100.0**
All parents in family in labor force	1,056	64.7
COMMUTING TO WORK		
Workers 16 years and over	**8,121**	**100.0**
Car, truck, or van - - drove alone	6,646	81.8
Car, truck, or van - - carpooled	1,042	12.8
Public transportation (including taxicab)	12	0.1
Walked	219	2.7
Other means	107	1.3
Worked at home	95	1.2
Mean travel time to work (minutes)[1]	14.3	(X)
Employed civilian population 16 years and over	**8,278**	**100.0**
OCCUPATION		
Management, professional, and related occupations	2,384	28.8
Service occupations	1,261	15.2
Sales and office occupations	1,980	23.9
Farming, fishing, and forestry occupations	82	1.0
Construction, extraction, and maintenance occupations	674	8.1
Production, transportation, and material moving occupations	1,897	22.9
INDUSTRY		
Agriculture, forestry, fishing and hunting, and mining	279	3.4
Construction	426	5.1
Manufacturing	1,961	23.7
Wholesale trade	200	2.4
Retail trade	953	11.5
Transportation and warehousing, and utilities	303	3.7
Information	109	1.3
Finance, insurance, real estate, and rental and leasing	436	5.3
Professional, scientific, management, administrative, and waste management services	603	7.3
Educational, health and social services	1,930	23.3
Arts, entertainment, recreation, accommodation and food services	382	4.6
Other services (except public administration)	444	5.4
Public administration	252	3.0
CLASS OF WORKER		
Private wage and salary workers	6,587	79.6
Government workers	1,215	14.7
Self-employed workers in own not incorporated business	433	5.2
Unpaid family workers	43	0.5

Subject	Number	Percent
INCOME IN 1999		
Households	**8,696**	**100.0**
Less than $10,000	1,773	20.4
$10,000 to $14,999	926	10.6
$15,000 to $24,999	1,393	16.0
$25,000 to $34,999	1,129	13.0
$35,000 to $49,999	1,352	15.5
$50,000 to $74,999	1,104	12.7
$75,000 to $99,999	526	6.0
$100,000 to $149,999	261	3.0
$150,000 to $199,999	107	1.2
$200,000 or more	125	1.4
Median household income (dollars)	27,045	(X)
With earnings	6,198	71.3
Mean earnings (dollars)[1]	39,487	(X)
With Social Security income	2,958	34.0
Mean Social Security income (dollars)[1]	11,085	(X)
With Supplemental Security Income	678	7.8
Mean Supplemental Security Income (dollars)[1]	5,488	(X)
With public assistance income	315	3.6
Mean public assistance income (dollars)[1]	1,901	(X)
With retirement income	1,405	16.2
Mean retirement income (dollars)[1]	15,626	(X)
Families	**5,839**	**100.0**
Less than $10,000	833	14.3
$10,000 to $14,999	495	8.5
$15,000 to $24,999	838	14.4
$25,000 to $34,999	769	13.2
$35,000 to $49,999	1,095	18.8
$50,000 to $74,999	937	16.0
$75,000 to $99,999	435	7.4
$100,000 to $149,999	240	4.1
$150,000 to $199,999	78	1.3
$200,000 or more	119	2.0
Median family income (dollars)	34,753	(X)
Per capita income (dollars)[1]	16,332	(X)
Median earnings (dollars):		
Male full-time, year-round workers	30,876	(X)
Female full-time, year-round workers	19,211	(X)

Subject	Number below poverty level	Percent below poverty level
POVERTY STATUS IN 1999		
Families	**1,166**	**20.0**
With related children under 18 years	928	29.8
With related children under 5 years	467	38.7
Families with female householder, no husband present	**808**	**47.9**
With related children under 18 years	697	58.0
With related children under 5 years	366	72.2
Individuals	**5,127**	**24.6**
18 years and over	3,132	20.4
65 years and over	490	13.8
Related children under 18 years	1,965	36.3
Related children 5 to 17 years	1,409	34.6
Unrelated individuals 15 years and over	1,220	34.8

-Represents zero or rounds to zero. (X) Not applicable.

[1] If the denominator of a mean value or per capita value is less than 30, then that value is calculated using a rounded aggregate in the numerator. See text.

Source: U.S. Bureau of the Census, Census 2000.

Table DP-4. Profile of Selected Housing Characteristics: 2000

Geographic area: El Dorado city, Arkansas

[Data based on a sample. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see text]

Subject	Number	Percent
Total housing units	**9,915**	**100.0**
UNITS IN STRUCTURE		
1-unit, detached	7,277	73.4
1-unit, attached	159	1.6
2 units	295	3.0
3 or 4 units	514	5.2
5 to 9 units	542	5.5
10 to 19 units	171	1.7
20 or more units	183	1.8
Mobile home	774	7.8
Boat, RV, van, etc	-	-
YEAR STRUCTURE BUILT		
1999 to March 2000	85	0.9
1995 to 1998	231	2.3
1990 to 1994	225	2.3
1980 to 1989	894	9.0
1970 to 1979	1,626	16.4
1960 to 1969	2,080	21.0
1940 to 1959	3,525	35.6
1939 or earlier	1,249	12.6
ROOMS		
1 room	55	0.6
2 rooms	299	3.0
3 rooms	920	9.3
4 rooms	1,949	19.7
5 rooms	2,720	27.4
6 rooms	2,101	21.2
7 rooms	872	8.8
8 rooms	520	5.2
9 or more rooms	479	4.8
Median (rooms)	5.1	(X)
Occupied housing units	**8,703**	**100.0**
YEAR HOUSEHOLDER MOVED INTO UNIT		
1999 to March 2000	1,881	21.6
1995 to 1998	2,131	24.5
1990 to 1994	1,255	14.4
1980 to 1989	945	10.9
1970 to 1979	887	10.2
1969 or earlier	1,604	18.4
VEHICLES AVAILABLE		
None	1,279	14.7
1	3,604	41.4
2	2,877	33.1
3 or more	943	10.8
HOUSE HEATING FUEL		
Utility gas	6,412	73.7
Bottled, tank, or LP gas	121	1.4
Electricity	2,118	24.3
Fuel oil, kerosene, etc	-	-
Coal or coke	8	0.1
Wood	25	0.3
Solar energy	-	-
Other fuel	-	-
No fuel used	19	0.2
SELECTED CHARACTERISTICS		
Lacking complete plumbing facilities	92	1.1
Lacking complete kitchen facilities	71	0.8
No telephone service	542	6.2
OCCUPANTS PER ROOM		
Occupied housing units	**8,703**	**100.0**
1.00 or less	8,311	95.5
1.01 to 1.50	246	2.8
1.51 or more	146	1.7
Specified owner-occupied units	**4,619**	**100.0**
VALUE		
Less than $50,000	2,013	43.6
$50,000 to $99,999	1,845	39.9
$100,000 to $149,999	322	7.0
$150,000 to $199,999	218	4.7
$200,000 to $299,999	151	3.3
$300,000 to $499,999	40	0.9
$500,000 to $999,999	24	0.5
$1,000,000 or more	6	0.1
Median (dollars)	55,400	(X)
MORTGAGE STATUS AND SELECTED MONTHLY OWNER COSTS		
With a mortgage	2,274	49.2
Less than $300	83	1.8
$300 to $499	360	7.8
$500 to $699	764	16.5
$700 to $999	624	13.5
$1,000 to $1,499	227	4.9
$1,500 to $1,999	136	2.9
$2,000 or more	80	1.7
Median (dollars)	674	(X)
Not mortgaged	2,345	50.8
Median (dollars)	261	(X)
SELECTED MONTHLY OWNER COSTS AS A PERCENTAGE OF HOUSEHOLD INCOME IN 1999		
Less than 15.0 percent	2,202	47.7
15.0 to 19.9 percent	726	15.7
20.0 to 24.9 percent	471	10.2
25.0 to 29.9 percent	247	5.3
30.0 to 34.9 percent	183	4.0
35.0 percent or more	704	15.2
Not computed	86	1.9
Specified renter-occupied units	**3,430**	**100.0**
GROSS RENT		
Less than $200	309	9.0
$200 to $299	442	12.9
$300 to $499	1,504	43.8
$500 to $749	792	23.1
$750 to $999	77	2.2
$1,000 to $1,499	37	1.1
$1,500 or more	-	-
No cash rent	269	7.8
Median (dollars)	406	(X)
GROSS RENT AS A PERCENTAGE OF HOUSEHOLD INCOME IN 1999		
Less than 15.0 percent	763	22.2
15.0 to 19.9 percent	424	12.4
20.0 to 24.9 percent	337	9.8
25.0 to 29.9 percent	222	6.5
30.0 to 34.9 percent	204	5.9
35.0 percent or more	1,089	31.7
Not computed	391	11.4

-Represents zero or rounds to zero. (X) Not applicable.

Source: U.S. Bureau of the Census, Census 2000.

U.S. Census Bureau
Profile for Union County Arkansas

Table DP-1. Profile of General Demographic Characteristics: 2000

Geographic area: Union County, Arkansas

[For information on confidentiality protection, nonsampling error, and definitions, see text]

Subject	Number	Percent
Total population	**45,629**	**100.0**
SEX AND AGE		
Male	21,814	47.8
Female	23,815	52.2
Under 5 years	2,942	6.4
5 to 9 years	3,219	7.1
10 to 14 years	3,461	7.6
15 to 19 years	3,459	7.6
20 to 24 years	2,527	5.5
25 to 34 years	5,401	11.8
35 to 44 years	6,897	15.1
45 to 54 years	6,103	13.4
55 to 59 years	2,303	5.0
60 to 64 years	1,967	4.3
65 to 74 years	3,548	7.8
75 to 84 years	2,718	6.0
85 years and over	1,084	2.4
Median age (years)	37.7	(X)
18 years and over	33,797	74.1
Male	15,627	34.2
Female	18,170	39.8
21 years and over	31,989	70.1
62 years and over	8,445	18.5
65 years and over	7,350	16.1
Male	2,782	6.1
Female	4,568	10.0
RACE		
One race	45,277	99.2
White	30,182	66.1
Black or African American	14,587	32.0
American Indian and Alaska Native	109	0.2
Asian	182	0.4
Asian Indian	56	0.1
Chinese	40	0.1
Filipino	44	0.1
Japanese	13	-
Korean	5	-
Vietnamese	13	-
Other Asian [1]	11	-
Native Hawaiian and Other Pacific Islander	5	-
Native Hawaiian	2	-
Guamanian or Chamorro	1	-
Samoan	-	-
Other Pacific Islander [2]	2	-
Some other race	212	0.5
Two or more races	352	0.8
***Race alone or in combination with one or more other races:* [3]**		
White	30,453	66.7
Black or African American	14,757	32.3
American Indian and Alaska Native	294	0.6
Asian	255	0.6
Native Hawaiian and Other Pacific Islander	30	0.1
Some other race	262	0.6

Subject	Number	Percent
HISPANIC OR LATINO AND RACE		
Total population	**45,629**	**100.0**
Hispanic or Latino (of any race)	520	1.1
Mexican	331	0.7
Puerto Rican	27	0.1
Cuban	17	-
Other Hispanic or Latino	145	0.3
Not Hispanic or Latino	45,109	98.9
White alone	29,950	65.6
RELATIONSHIP		
Total population	**45,629**	**100.0**
In households	44,646	97.8
Householder	17,989	39.4
Spouse	9,221	20.2
Child	13,334	29.2
Own child under 18 years	10,220	22.4
Other relatives	2,750	6.0
Under 18 years	1,408	3.1
Nonrelatives	1,352	3.0
Unmarried partner	629	1.4
In group quarters	983	2.2
Institutionalized population	871	1.9
Noninstitutionalized population	112	0.2
HOUSEHOLD BY TYPE		
Total households	**17,989**	**100.0**
Family households (families)	12,652	70.3
With own children under 18 years	5,789	32.2
Married-couple family	9,221	51.3
With own children under 18 years	3,859	21.5
Female householder, no husband present	2,740	15.2
With own children under 18 years	1,564	8.7
Nonfamily households	5,337	29.7
Householder living alone	4,842	26.9
Householder 65 years and over	2,181	12.1
Households with individuals under 18 years	6,566	36.5
Households with individuals 65 years and over	5,061	28.1
Average household size	2.48	(X)
Average family size	3.00	(X)
HOUSING OCCUPANCY		
Total housing units	**20,676**	**100.0**
Occupied housing units	17,989	87.0
Vacant housing units	2,687	13.0
For seasonal, recreational, or occasional use	420	2.0
Homeowner vacancy rate (percent)	2.3	(X)
Rental vacancy rate (percent)	11.8	(X)
HOUSING TENURE		
Occupied housing units	**17,989**	**100.0**
Owner-occupied housing units	13,110	72.9
Renter-occupied housing units	4,879	27.1
Average household size of owner-occupied units	2.51	(X)
Average household size of renter-occupied units	2.39	(X)

- Represents zero or rounds to zero. (X) Not applicable.

[1] Other Asian alone, or two or more Asian categories.

[2] Other Pacific Islander alone, or two or more Native Hawaiian and Other Pacific Islander categories.

[3] In combination with one or more of the other races listed. The six numbers may add to more than the total population and the six percentages may add to more than 100 percent because individuals may report more than one race.

Source: U.S. Census Bureau, Census 2000.

Table DP-2. Profile of Selected Social Characteristics: 2000

Geographic area: Union County, Arkansas

[Data based on a sample. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see text]

Subject	Number	Percent
SCHOOL ENROLLMENT		
Population 3 years and over enrolled in school	**11,194**	**100.0**
Nursery school, preschool	661	5.9
Kindergarten	643	5.7
Elementary school (grades 1-8)	5,582	49.9
High school (grades 9-12)	2,881	25.7
College or graduate school	1,427	12.7
EDUCATIONAL ATTAINMENT		
Population 25 years and over	**29,986**	**100.0**
Less than 9th grade	2,544	8.5
9th to 12th grade, no diploma	5,099	17.0
High school graduate (includes equivalency)	10,648	35.5
Some college, no degree	5,976	19.9
Associate degree	1,252	4.2
Bachelor's degree	3,191	10.6
Graduate or professional degree	1,276	4.3
Percent high school graduate or higher	74.5	(X)
Percent bachelor's degree or higher	14.9	(X)
MARITAL STATUS		
Population 15 years and over	**36,034**	**100.0**
Never married	7,897	21.9
Now married, except separated	19,736	54.8
Separated	971	2.7
Widowed	3,322	9.2
Female	2,828	7.8
Divorced	4,108	11.4
Female	2,272	6.3
GRANDPARENTS AS CAREGIVERS		
Grandparent living in household with one or more own grandchildren under 18 years	**1,217**	**100.0**
Grandparent responsible for grandchildren	640	52.6
VETERAN STATUS		
Civilian population 18 years and over	**33,789**	**100.0**
Civilian veterans	4,305	12.7
DISABILITY STATUS OF THE CIVILIAN NONINSTITUTIONALIZED POPULATION		
Population 5 to 20 years	**10,830**	**100.0**
With a disability	1,035	9.6
Population 21 to 64 years	**24,362**	**100.0**
With a disability	5,935	24.4
Percent employed	46.4	(X)
No disability	18,427	75.6
Percent employed	75.5	(X)
Population 65 years and over	**6,749**	**100.0**
With a disability	3,609	53.5
RESIDENCE IN 1995		
Population 5 years and over	**42,828**	**100.0**
Same house in 1995	25,940	60.6
Different house in the U.S. in 1995	16,398	38.3
Same county	11,258	26.3
Different county	5,140	12.0
Same state	2,426	5.7
Different state	2,714	6.3
Elsewhere in 1995	490	1.1

Subject	Number	Percent
NATIVITY AND PLACE OF BIRTH		
Total population	**45,629**	**100.0**
Native	45,094	98.8
Born in United States	44,895	98.4
State of residence	34,135	74.8
Different state	10,760	23.6
Born outside United States	199	0.4
Foreign born	535	1.2
Entered 1990 to March 2000	265	0.6
Naturalized citizen	161	0.4
Not a citizen	374	0.8
REGION OF BIRTH OF FOREIGN BORN		
Total (excluding born at sea)	**535**	**100.0**
Europe	118	22.1
Asia	156	29.2
Africa	17	3.2
Oceania	-	-
Latin America	231	43.2
Northern America	13	2.4
LANGUAGE SPOKEN AT HOME		
Population 5 years and over	**42,828**	**100.0**
English only	41,754	97.5
Language other than English	1,074	2.5
Speak English less than "very well"	414	1.0
Spanish	702	1.6
Speak English less than "very well"	244	0.6
Other Indo-European languages	234	0.5
Speak English less than "very well"	73	0.2
Asian and Pacific Island languages	113	0.3
Speak English less than "very well"	94	0.2
ANCESTRY (single or multiple)		
Total population	**45,629**	**100.0**
Total ancestries reported	*34,946*	*76.6*
Arab	43	0.1
Czech[1]	34	0.1
Danish	58	0.1
Dutch	395	0.9
English	2,968	6.5
French (except Basque)[1]	737	1.6
French Canadian[1]	125	0.3
German	1,943	4.3
Greek	18	-
Hungarian	11	-
Irish[1]	3,712	8.1
Italian	296	0.6
Lithuanian	6	-
Norwegian	92	0.2
Polish	92	0.2
Portuguese	2	-
Russian	2	-
Scotch-Irish	887	1.9
Scottish	421	0.9
Slovak	1	-
Subsaharan African	362	0.8
Swedish	130	0.3
Swiss	57	0.1
Ukrainian	-	-
United States or American	6,575	14.4
Welsh	107	0.2
West Indian (excluding Hispanic groups)	2	-
Other ancestries	15,870	34.8

-Represents zero or rounds to zero. (X) Not applicable.

[1] The data represent a combination of two ancestries shown separately in Summary File 3. Czech includes Czechoslovakian. French includes Alsatian. French Canadian includes Acadian/Cajun. Irish includes Celtic.

Source: U.S. Bureau of the Census, Census 2000.

Table DP-3. Profile of Selected Economic Characteristics: 2000

Geographic area: Union County, Arkansas

[Data based on a sample. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see text]

Subject	Number	Percent
EMPLOYMENT STATUS		
Population 16 years and over	**35,344**	**100.0**
In labor force	20,064	56.8
Civilian labor force	20,037	56.7
Employed	18,655	52.8
Unemployed	1,382	3.9
Percent of civilian labor force	6.9	(X)
Armed Forces	27	0.1
Not in labor force	15,280	43.2
Females 16 years and over	**18,991**	**100.0**
In labor force	9,388	49.4
Civilian labor force	9,388	49.4
Employed	8,734	46.0
Own children under 6 years	**3,266**	**100.0**
All parents in family in labor force	1,973	60.4
COMMUTING TO WORK		
Workers 16 years and over	**18,271**	**100.0**
Car, truck, or van - - drove alone	15,226	83.3
Car, truck, or van - - carpooled	2,206	12.1
Public transportation (including taxicab)	23	0.1
Walked	346	1.9
Other means	177	1.0
Worked at home	293	1.6
Mean travel time to work (minutes)[1]	18.0	(X)
Employed civilian population 16 years and over	**18,655**	**100.0**
OCCUPATION		
Management, professional, and related occupations	4,780	25.6
Service occupations	2,491	13.4
Sales and office occupations	4,448	23.8
Farming, fishing, and forestry occupations	267	1.4
Construction, extraction, and maintenance occupations	2,102	11.3
Production, transportation, and material moving occupations	4,567	24.5
INDUSTRY		
Agriculture, forestry, fishing and hunting, and mining	845	4.5
Construction	1,391	7.5
Manufacturing	4,607	24.7
Wholesale trade	522	2.8
Retail trade	2,093	11.2
Transportation and warehousing, and utilities	854	4.6
Information	210	1.1
Finance, insurance, real estate, and rental and leasing	825	4.4
Professional, scientific, management, administrative, and waste management services	1,063	5.7
Educational, health and social services	3,827	20.5
Arts, entertainment, recreation, accommodation and food services	734	3.9
Other services (except public administration)	1,043	5.6
Public administration	641	3.4
CLASS OF WORKER		
Private wage and salary workers	14,818	79.4
Government workers	2,583	13.8
Self-employed workers in own not incorporated business	1,186	6.4
Unpaid family workers	68	0.4

Subject	Number	Percent
INCOME IN 1999		
Households	**17,994**	**100.0**
Less than $10,000	2,930	16.3
$10,000 to $14,999	1,720	9.6
$15,000 to $24,999	2,951	16.4
$25,000 to $34,999	2,680	14.9
$35,000 to $49,999	2,832	15.7
$50,000 to $74,999	2,812	15.6
$75,000 to $99,999	1,106	6.1
$100,000 to $149,999	577	3.2
$150,000 to $199,999	176	1.0
$200,000 or more	210	1.2
Median household income (dollars)	29,809	(X)
With earnings	13,292	73.9
Mean earnings (dollars)[1]	41,220	(X)
With Social Security income	5,913	32.9
Mean Social Security income (dollars)[1]	10,845	(X)
With Supplemental Security Income	1,294	7.2
Mean Supplemental Security Income (dollars)[1]	5,405	(X)
With public assistance income	468	2.6
Mean public assistance income (dollars)[1]	2,004	(X)
With retirement income	2,842	15.8
Mean retirement income (dollars)[1]	14,806	(X)
Families	**12,791**	**100.0**
Less than $10,000	1,257	9.8
$10,000 to $14,999	957	7.5
$15,000 to $24,999	1,935	15.1
$25,000 to $34,999	1,926	15.1
$35,000 to $49,999	2,373	18.6
$50,000 to $74,999	2,514	19.7
$75,000 to $99,999	953	7.5
$100,000 to $149,999	540	4.2
$150,000 to $199,999	146	1.1
$200,000 or more	190	1.5
Median family income (dollars)	36,805	(X)
Per capita income (dollars)[1]	16,063	(X)
Median earnings (dollars):		
Male full-time, year-round workers	31,868	(X)
Female full-time, year-round workers	19,740	(X)

Subject	Number below poverty level	Percent below poverty level
POVERTY STATUS IN 1999		
Families	**1,876**	**14.7**
With related children under 18 years	1,418	21.4
With related children under 5 years	664	27.9
Families with female householder, no husband present	**1,107**	**40.0**
With related children under 18 years	964	49.6
With related children under 5 years	475	61.8
Individuals	**8,361**	**18.7**
18 years and over	5,323	16.1
65 years and over	967	14.3
Related children under 18 years	2,987	25.8
Related children 5 to 17 years	2,198	24.9
Unrelated individuals 15 years and over	2,046	32.2

-Represents zero or rounds to zero. (X) Not applicable.

[1] If the denominator of a mean value or per capita value is less than 30, then that value is calculated using a rounded aggregate in the numerator. See text.

Source: U.S. Bureau of the Census, Census 2000.

Table DP-4. Profile of Selected Housing Characteristics: 2000

Geographic area: Union County, Arkansas

[Data based on a sample. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see text]

Subject	Number	Percent
Total housing units	**20,676**	**100.0**
UNITS IN STRUCTURE		
1-unit, detached	14,431	69.8
1-unit, attached	213	1.0
2 units	317	1.5
3 or 4 units	544	2.6
5 to 9 units	559	2.7
10 to 19 units	178	0.9
20 or more units	191	0.9
Mobile home	4,207	20.3
Boat, RV, van, etc	36	0.2
YEAR STRUCTURE BUILT		
1999 to March 2000	364	1.8
1995 to 1998	1,204	5.8
1990 to 1994	1,067	5.2
1980 to 1989	3,152	15.2
1970 to 1979	3,675	17.8
1960 to 1969	3,497	16.9
1940 to 1959	5,629	27.2
1939 or earlier	2,088	10.1
ROOMS		
1 room	112	0.5
2 rooms	464	2.2
3 rooms	1,384	6.7
4 rooms	3,969	19.2
5 rooms	6,390	30.9
6 rooms	4,490	21.7
7 rooms	2,022	9.8
8 rooms	1,101	5.3
9 or more rooms	744	3.6
Median (rooms)	5.2	(X)
Occupied housing units	**17,989**	**100.0**
YEAR HOUSEHOLDER MOVED INTO UNIT		
1999 to March 2000	3,197	17.8
1995 to 1998	4,426	24.6
1990 to 1994	2,684	14.9
1980 to 1989	2,755	15.3
1970 to 1979	1,970	11.0
1969 or earlier	2,957	16.4
VEHICLES AVAILABLE		
None	1,906	10.6
1	6,504	36.2
2	6,671	37.1
3 or more	2,908	16.2
HOUSE HEATING FUEL		
Utility gas	11,041	61.4
Bottled, tank, or LP gas	1,546	8.6
Electricity	5,029	28.0
Fuel oil, kerosene, etc	6	-
Coal or coke	8	-
Wood	306	1.7
Solar energy	-	-
Other fuel	22	0.1
No fuel used	31	0.2
SELECTED CHARACTERISTICS		
Lacking complete plumbing facilities	172	1.0
Lacking complete kitchen facilities	100	0.6
No telephone service	1,072	6.0

Subject	Number	Percent
OCCUPANTS PER ROOM		
Occupied housing units	**17,989**	**100.0**
1.00 or less	17,344	96.4
1.01 to 1.50	424	2.4
1.51 or more	221	1.2
Specified owner-occupied units	**9,011**	**100.0**
VALUE		
Less than $50,000	4,003	44.4
$50,000 to $99,999	3,443	38.2
$100,000 to $149,999	822	9.1
$150,000 to $199,999	435	4.8
$200,000 to $299,999	190	2.1
$300,000 to $499,999	76	0.8
$500,000 to $999,999	34	0.4
$1,000,000 or more	8	0.1
Median (dollars)	55,400	(X)
MORTGAGE STATUS AND SELECTED MONTHLY OWNER COSTS		
With a mortgage	4,414	49.0
Less than $300	122	1.4
$300 to $499	696	7.7
$500 to $699	1,434	15.9
$700 to $999	1,184	13.1
$1,000 to $1,499	614	6.8
$1,500 to $1,999	214	2.4
$2,000 or more	150	1.7
Median (dollars)	692	(X)
Not mortgaged	4,597	51.0
Median (dollars)	255	(X)
SELECTED MONTHLY OWNER COSTS AS A PERCENTAGE OF HOUSEHOLD INCOME IN 1999		
Less than 15.0 percent	4,282	47.5
15.0 to 19.9 percent	1,414	15.7
20.0 to 24.9 percent	918	10.2
25.0 to 29.9 percent	555	6.2
30.0 to 34.9 percent	368	4.1
35.0 percent or more	1,327	14.7
Not computed	147	1.6
Specified renter-occupied units	**4,780**	**100.0**
GROSS RENT		
Less than $200	356	7.4
$200 to $299	576	12.1
$300 to $499	2,012	42.1
$500 to $749	1,017	21.3
$750 to $999	106	2.2
$1,000 to $1,499	48	1.0
$1,500 or more	-	-
No cash rent	665	13.9
Median (dollars)	408	(X)
GROSS RENT AS A PERCENTAGE OF HOUSEHOLD INCOME IN 1999		
Less than 15.0 percent	987	20.6
15.0 to 19.9 percent	573	12.0
20.0 to 24.9 percent	488	10.2
25.0 to 29.9 percent	293	6.1
30.0 to 34.9 percent	262	5.5
35.0 percent or more	1,364	28.5
Not computed	813	17.0

-Represents zero or rounds to zero. (X) Not applicable.

Source: U.S. Bureau of the Census, Census 2000.

IEUBK Model Results and Inputs for Lead Analysis

1996 Modeled Ambient Concentration for Arkansas

EPA strongly cautions that these modeling results should not be used to draw conclusions about local concentrations or risk. The results are most meaningful when viewed at the state or national level; for smaller areas, the modeling becomes less certain. In addition, these results represent conditions in *1996* rather than current conditions.

- The modeled estimates presented here are not a direct indicator of risk because they do not factor in the extent to which people are exposed to these pollutants or the widely varying toxic potential of different substances. EPA uses these ambient concentration estimates in combination with exposure modeling and health effects information to estimate risk.
- The emissions used in this assessment do not reflect potentially significant emission reductions that have taken effect since 1996, including those from: 1) mobile source regulations which are being phased in over time; 2) many of the air toxics regulations EPA has issued for major industrial sources; 3) State or industry initiatives; and 4) any facility closures.
- Methods of estimating emissions, as well as simplified modeling assumptions, may introduce significant uncertainties into each component of the assessment.
  For a discussion of limitations, please see http://www.epa.gov/ttn/atw/nata/natsalim2.html
- Because of these uncertainties, EPA will not use the results of this assessment to determine source-specific contributions or to set regulatory requirements. However, EPA expects to use these results to inform decisions about the priorities of the air toxics program as well as to guide the collection of additional data that could lead to regulatory decisions.
- Note that based on the persistence and bioaccumulation potential of lead, mercury, PCBs (polychlorinated biphenyls), hexachlorobenzene, 7-PAH (polycyclic aromatic hydrocarbons), POM (polycyclic organic matter) and cadmium, ingestion rather than inhalation may contribute substantially to exposures of concern, and this assessment does not address pollutant levels that may be ingested from food, water, or soil.

KEY-- *** onroad and nonroad concentrations include a model-estimated background concentration

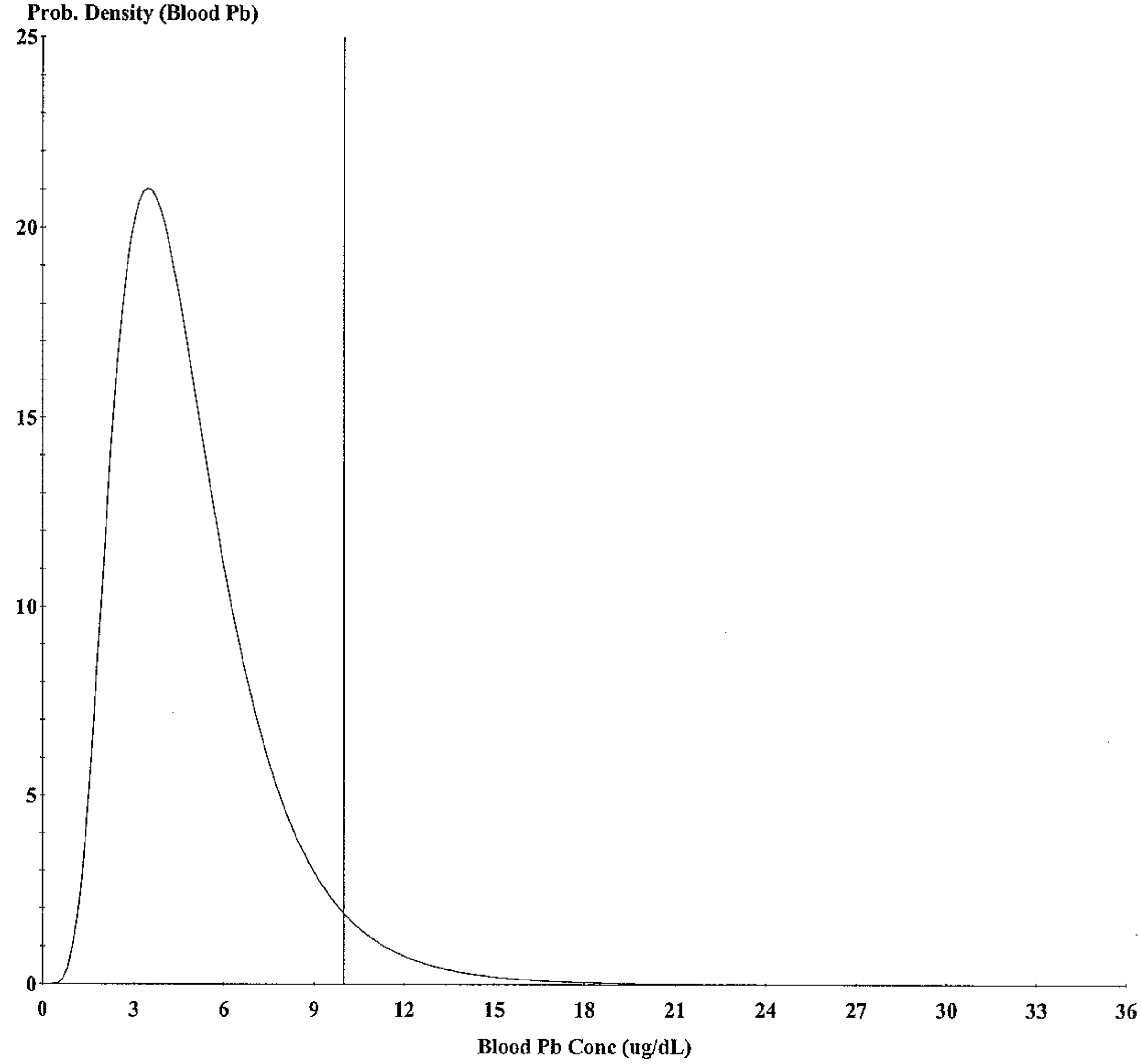
Estimated Annual Average Ambient Concentrations (µg/m³) for Arkansas

					Percentile Distribution of Ambient Concentrations Across Census Tracts								Contribution to Average from ...				
State	County	FIPS	Urban or Rural	Pollutant	5th	10th	25th	Median	Average	75th	90th	95th	Major	Area and Other	Onroad Mobile	Nonroad Mobile	Estimated Background
Arkansas	Statewide	N/A	N/A	Acetaldehyde	5.19E-02	6.10E-02	8.97E-02	1.88E-01	2.73E-01	3.65E-01	6.35E-01	8.19E-01	3.34E-03	5.01E-02	1.67E-01	5.24E-02	0.00E+00
Arkansas	Statewide	N/A	N/A	Acrolein	1.31E-02	1.74E-02	2.61E-02	4.58E-02	5.51E-02	7.47E-02	1.09E-01	1.23E-01	1.08E-04	2.81E-02	1.96E-02	7.27E-03	0.00E+00
Arkansas	Statewide	N/A	N/A	Acrylonitrile	1.12E-05	1.61E-05	3.55E-05	9.38E-05	2.38E-04	1.98E-04	4.04E-04	5.17E-04	7.94E-05	1.59E-04	0.00E+00	0.00E+00	0.00E+00
Arkansas	Statewide	N/A	N/A	Arsenic Compounds	9.26E-06	1.36E-05	2.88E-05	4.87E-05	1.17E-04	8.95E-05	1.62E-04	3.16E-04	6.60E-06	1.10E-04	1.65E-07	3.66E-07	0.00E+00
Arkansas	Statewide	N/A	N/A	Benzene	5.37E-01	5.49E-01	5.87E-01	7.15E-01	8.33E-01	9.64E-01	1.33E+00	1.62E+00	1.24E-03	7.06E-02	2.35E-01	4.66E-02	4.80E-01
Arkansas	Statewide	N/A	N/A	Beryllium Compounds	2.16E-07	3.00E-07	7.32E-07	2.21E-06	4.71E-06	6.80E-06	1.25E-05	1.61E-05	3.48E-07	4.36E-06	0.00E+00	2.89E-09	0.00E+00
Arkansas	Statewide	N/A	N/A	1,3-Butadiene	3.91E-03	5.34E-03	8.71E-03	2.08E-02	3.57E-02	5.10E-02	8.24E-02	1.14E-01	7.97E-05	8.56E-03	2.19E-02	5.13E-03	0.00E+00
Arkansas	Statewide	N/A	N/A	Cadmium Compounds	8.51E-07	1.39E-06	4.16E-06	1.22E-05	7.95E-05	3.75E-05	7.69E-05	2.07E-04	3.22E-05	4.72E-05	0.00E+00	4.03E-08	0.00E+00
Arkansas	Statewide	N/A	N/A	Carbon Tetrachloride	8.80E-01	8.80E-01	8.80E-01	8.80E-01	8.80E-01	8.80E-01	8.80E-01	8.81E-01	1.88E-04	8.22E-05	0.00E+00	0.00E+00	8.80E-01
Arkansas	Statewide	N/A	N/A	Chloroform	8.31E-02	8.31E-02	8.31E-02	8.34E-02	8.37E-02	8.38E-02	8.43E-02	8.47E-02	1.36E-04	5.69E-04	0.00E+00	0.00E+00	8.30E-02
Arkansas	Statewide	N/A	N/A	Chromium Compounds	9.65E-06	1.60E-05	5.11E-05	3.03E-04	3.18E-03	2.66E-03	8.50E-03	1.34E-02	4.64E-04	2.69E-03	1.12E-05	1.47E-05	0.00E+00
Arkansas	Statewide	N/A	N/A	Coke Oven Emissions	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arkansas	Statewide	N/A	N/A	1,3-Dichloropropene	1.72E-03	2.31E-03	4.00E-03	1.35E-02	2.66E-02	4.31E-02	7.13E-02	8.61E-02	0.00E+00	2.66E-02	0.00E+00	0.00E+00	0.00E+00
Arkansas	Statewide	N/A	N/A	Diesel Particulate Matter	3.06E-01	3.31E-01	4.26E-01	6.34E-01	7.67E-01	9.01E-01	1.27E+00	1.68E+00	0.00E+00	0.00E+00	2.61E-01	5.07E-01	***
Arkansas	Statewide	N/A	N/A	Ethylene Dibromide	7.70E-03	7.70E-03	7.70E-03	7.70E-03	7.71E-03	7.70E-03	7.70E-03	7.70E-03	1.19E-05	4.36E-07	0.00E+00	0.00E+00	7.70E-03
Arkansas	Statewide	N/A	N/A	Ethylene Dichloride	6.10E-02	6.10E-02	6.10E-02	6.10E-02	6.15E-02	6.11E-02	6.11E-02	6.25E-02	4.90E-04	3.09E-05	0.00E+00	0.00E+00	6.10E-02
Arkansas	Statewide	N/A	N/A	Ethylene Oxide	1.82E-05	2.84E-05	6.74E-05	2.73E-04	1.17E-03	1.25E-03	3.85E-03	5.55E-03	0.00E+00	1.17E-03	0.00E+00	0.00E+00	0.00E+00
Arkansas	Statewide	N/A	N/A	Formaldehyde	3.35E-01	3.52E-01	4.00E-01	5.21E-01	6.02E-01	7.30E-01	9.38E-01	1.10E+00	3.84E-03	1.45E-01	1.30E-01	7.33E-02	2.50E-01
Arkansas	Statewide	N/A	N/A	Hexachlorobenzene	9.30E-05	9.30E-05	9.30E-05	9.31E-05	9.32E-05	9.31E-05	9.33E-05	9.35E-05	0.00E+00	1.96E-07	0.00E+00	0.00E+00	9.30E-05
Arkansas	Statewide	N/A	N/A	Hydrazine	1.43E-11	3.94E-11	2.70E-10	4.74E-09	1.04E-06	7.77E-08	5.42E-07	1.37E-06	1.32E-07	9.06E-07	0.00E+00	0.00E+00	0.00E+00
Arkansas	Statewide	N/A	N/A	Lead Compounds	2.20E-05	3.73E-05	1.52E-04	6.70E-04	3.64E-03	3.19E-03	8.93E-03	1.51E-02	1.06E-03	1.84E-03	1.57E-05	7.17E-04	0.00E+00
Arkansas	Statewide	N/A	N/A	Manganese Compounds	4.56E-05	7.98E-05	2.66E-04	9.34E-04	2.40E-03	2.92E-03	5.92E-03	8.92E-03	1.74E-04	2.21E-03	4.54E-06	1.62E-05	0.00E+00
Arkansas	Statewide	N/A	N/A	Mercury Compounds	1.51E-03	1.51E-03	1.51E-03	1.54E-03	1.59E-03	1.60E-03	1.70E-03	1.76E-03	2.70E-06	8.24E-05	1.48E-07	3.57E-06	1.50E-03
Arkansas	Statewide	N/A	N/A	Methylene Chloride	1.54E-01	1.55E-01	1.62E-01	1.90E-01	3.16E-01	2.87E-01	4.68E-01	7.20E-01	7.40E-02	9.22E-02	0.00E+00	0.00E+00	1.50E-01
Arkansas	Statewide	N/A	N/A	Nickel Compounds	1.42E-05	2.60E-05	7.92E-05	3.08E-04	1.96E-03	9.40E-04	2.47E-03	8.10E-03	1.90E-05	1.91E-03	8.64E-06	1.89E-05	0.00E+00
Arkansas	Statewide	N/A	N/A	Perchloroethylene	1.41E-01	1.42E-01	1.45E-01	1.62E-01	2.00E-01	2.31E-01	3.18E-01	3.79E-01	6.42E-03	5.32E-02	0.00E+00	0.00E+00	1.40E-01
Arkansas	Statewide	N/A	N/A	Polychlorinated Biphenyls	3.80E-04	3.80E-04	3.80E-04	3.80E-04	3.80E-04	3.80E-04	3.80E-04	3.80E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.80E-04
Arkansas	Statewide	N/A	N/A	Polycyclic Organic Matter	2.91E-03	3.76E-03	6.05E-03	1.44E-02	2.33E-02	3.62E-02	5.54E-02	6.54E-02	1.30E-04	2.30E-02	7.95E-05	2.16E-05	0.00E+00
Arkansas	Statewide	N/A	N/A	7-PAH	2.71E-04	3.86E-04	6.12E-04	1.18E-03	1.56E-03	2.34E-03	3.10E-03	3.70E-03	5.31E-08	1.52E-03	3.53E-05	6.74E-06	0.00E+00
Arkansas	Statewide	N/A	N/A	Propylene Dichloride	5.83E-07	8.45E-07	2.08E-06	5.95E-06	1.52E-05	1.36E-05	3.33E-05	4.70E-05	2.94E-06	1.22E-05	0.00E+00	0.00E+00	0.00E+00
Arkansas	Statewide	N/A	N/A	Quinoline	4.29E-10	1.40E-09	5.96E-09	4.24E-08	4.54E-07	2.79E-07	1.48E-06	2.51E-06	0.00E+00	4.54E-07	0.00E+00	0.00E+00	0.00E+00
Arkansas	Statewide	N/A	N/A	1,1,2,2-Tetrachloroethane	3.37E-06	4.61E-06	1.36E-05	3.80E-05	9.54E-05	8.55E-05	1.70E-04	2.22E-04	2.69E-05	6.85E-05	0.00E+00	0.00E+00	0.00E+00
Arkansas	Statewide	N/A	N/A	Trichloroethylene	8.13E-02	8.14E-02	8.21E-02	8.76E-02	1.03E-01	1.03E-01	1.36E-01	1.63E-01	9.32E-03	1.23E-02	0.00E+00	0.00E+00	8.10E-02
Arkansas	Statewide	N/A	N/A	Vinyl Chloride	8.46E-06	1.30E-05	4.02E-05	1.29E-04	3.95E-04	3.67E-04	8.94E-04	1.41E-03	6.62E-05	3.28E-04	0.00E+00	0.00E+00	0.00E+00
Arkansas	All Urban Counties	N/A	U	Acetaldehyde	8.16E-02	1.17E-01	2.00E-01	3.38E-01	3.99E-01	5.52E-01	8.16E-01	8.84E-01	5.09E-03	5.72E-02	2.57E-01	7.99E-02	0.00E+00
Arkansas	All Urban Counties	N/A	U	Acrolein	1.71E-02	2.13E-02	3.35E-02	6.10E-02	6.41E-02	8.90E-02	1.16E-01	1.25E-01	1.92E-04	2.31E-02	2.96E-02	1.12E-02	0.00E+00

Table 2.3. Mean Reported Soil Metal Background Concentrations (mg/kg dry weight) by State*

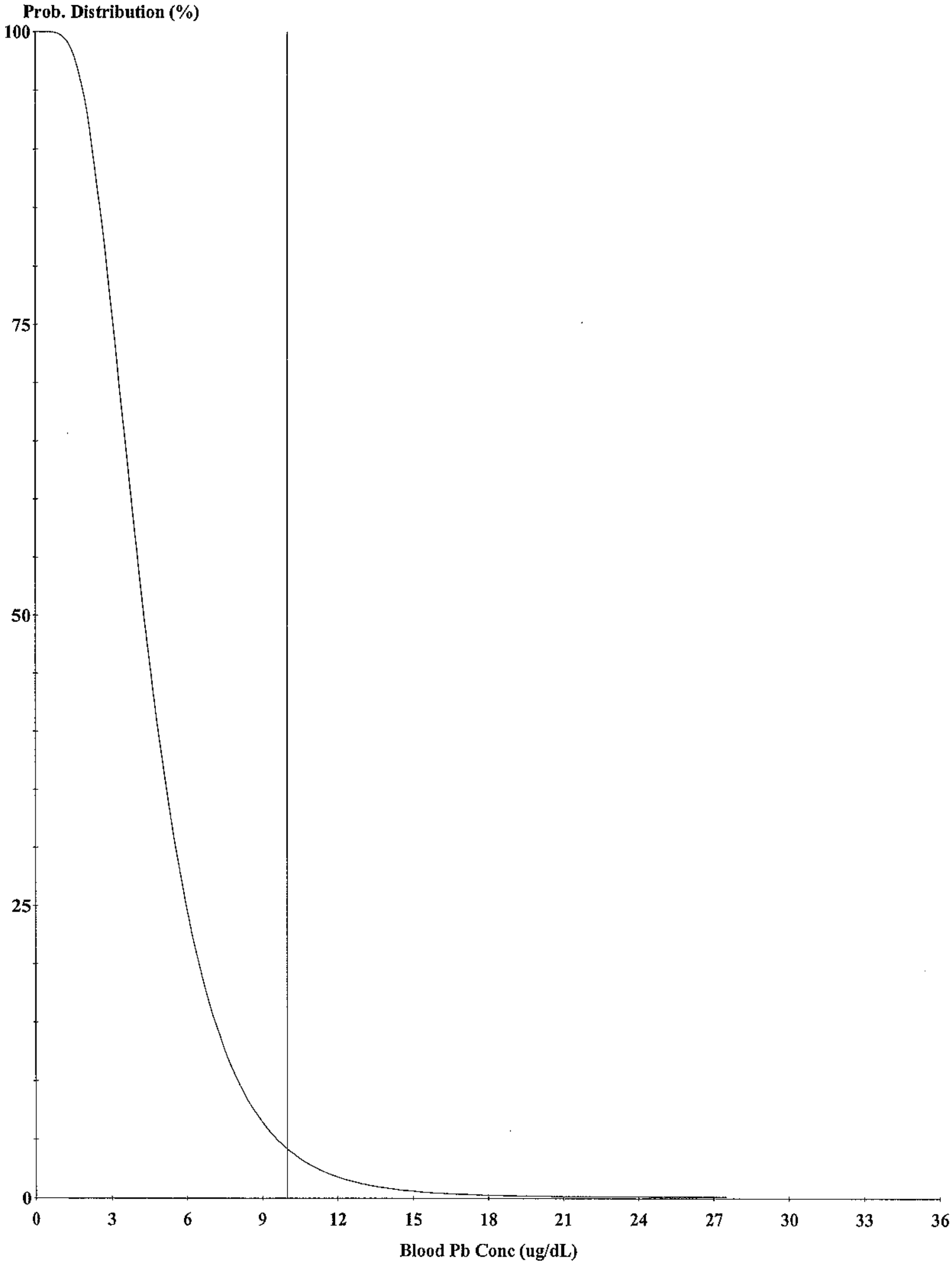
	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Manganese	Nickel	Lead	Selenium	Silver	Vanadium	Zinc
Alabama	23100	3.6	4.7	200	0.6		30.6	4.4	9.6	11950	420	11	9.3	0.3		38	26
Arkansas	33429	1.2	9.7	336	0.9		53.1	12	17	19857	731	18	21	0.7		52	39
Arizona	32933	1.4	9.6	364	1.0	0.4	37.3	9.9	23	20787	447	23	16	0.4	0.5	42	51
California	75633	0.8	5.1	598	1.1	0.4	119.9	14	39	36867	640	48	26	0.2	0.8	118	113
Colorado	61557	1.1	6.7	662	1.4		41.7	6.8	21	23048	343	13	31	0.4		74	87
Connecticut	85000		4.1	400	0.5		40.0	7.5	15	17500	450	13	5.0	0.8		60	40
Delaware	22500	1.0	1.4	400	0.5		30.0	3.3	5.0	7500	85	6.0	15	0.3		20	23
Florida	9944	0.9	3.0	48	0.6	0.1	15.4	1.6	5.6	3705	86	8.5	12	0.3	0.5	11	12
Georgia	38250	1.0	5.0	232	0.6		32.4	6.9	21	16976	252	17	19	0.4		43	47
Iowa	64667	1.0	7.3	617	1.3		64.7	11	31	23278	603	26	19	0.4		97	57
Idaho	58500	1.0	6.4	757	1.1		52.1	12	28	32000	580	22	22	0.3		90	83
Illinois	48714	1.1	7.1	551	0.7		48.4	9.8	24	19159	646	19	39	0.5		62	67
Indiana	50000	1.0	7.5	500	0.7		46.8	10	27	21364	518	18	18	0.4		74	56
Kansas	61818	1.1	6.8	694	1.0		49.0	8.9	25	18788	452	17	32	0.4		77	67
Kentucky	54123	1.0	7.8	349	1.1		79.8	11	17	30432	483	23	16	0.5		66	35
Louisiana	42188	1.0	7.6	441	0.6		60.8	8.6	33	19688	470	33	16	0.7		76	55
Massachusetts	34083	1.0	8.6	203	1.3	0.2	39.5	7.8	16	19000	439	13	13	1.9		87	54
Maryland	39167	1.2	3.8	393	1.3		47.9	7.5	20	28571	291	13	22	0.2		63	39
Maine	65385	1.0	9.4	319	1.6		71.2	10	28	45385	581	30	19	0.7		98	80
Michigan	10964	1.3	4.2	127	0.7	0.9	13.8	4.6	12	10520	230	12	9.2	0.3	0.5	44	33
Minnesota	49457	1.0	5.5	571	0.7	0.3	25.4	7.2	20	19581	583	14	9.9	0.3		72	38
Missouri	42094	1.0	10	499	1.0		50.0	12	19	24733	940	20	23	0.5		72	53
Mississippi	45368	1.0	8.8	390	0.9		53.2	12	20	19684	471	21	18	0.5		68	45
Montana	70938	1.1	8.8	739	1.1		63.3	7.5	29	27766	366	20	14	0.4		101	69
Nebraska	59474	1.0	5.5	711	1.1		32.5	5.9	15	16000	306	15	16	0.4		62	54
North Carolina	60105	1.0	4.8	356	0.6		64.8	15	34	37053	563	24	17	0.4		107	56
North Dakota	62857	1.0	7.0	682	0.9		53.2	6.9	23	25357	530	20	13	0.4		83	64
New Hampshire	66667		4.4	500	2.3	0.6	18.4	5.3	12	33333	633	10	28	0.3		57	23
New Jersey	10075	1.4	7.0	54	0.3	0.3	13.9	1.7	14	11632	221	3.8	35	0.9		30	22
New Mexico	54423	1.0	5.9	727	1.0		55.5	8.8	21	20898	367	28	18	0.3		72	44
Nevada	66078	1.0	9.0	822	1.3		36.8	8.4	25	22725	481	15	25	0.3		78	69
New York	58800	1.0	6.4	666	1.4	0.2	66.9	9.1	36	38900	418	21	20	0.3		132	82
Ohio	54615		12	469	1.0		55.0	13	28	27308	550	25	23	0.6		88	69
Oklahoma	39200	1.0	7.0	430	1.1		46.0	7.1	16	19320	465	15	18	0.3		50	50
Oregon	94412	1.2	5.1	682	0.9		121.6	16	53	50147	725	23	15	0.3		168	70
Pennsylvania	63438	1.0	13	366	1.4		52.8	15	37	36063	609	24	23	0.5		80	81
Rhode Island	100000		3.5	500	0.5		50.0	10	15	30000	500	15	15	0.9		70	30
South Carolina	39143		3.9	151	1.4		21.4	3.5	16	12500	87.1	7.8	5.0	0.3		45	25
South Dakota	74333	1.3	8.5	1043	1.4		58.7	7.7	29	25667	1013	28	16	0.5		108	75
Tennessee	31894	0.7	16	193	0.8	0.2	40.3	14	17	28479	1112	18	23	0.6	1.2	49	57
Texas	41958	1.1	6.4	404	0.9		39.6	5.3	15	16328	303	12	14	0.3		52	39
Utah	45638	1.1	8.0	493	0.9		45.6	6.6	26	18830	371	13	35	0.3		70	96
Virginia	60438	1.2	5.1	436	0.9		54.3	9.7	33	27750	441	17	36	0.4		77	233
Vermont	56667		3.6	333	1.7		66.7	12	18	30000	800	25	20	0.4		70	43
Washington	66834	1.0	4.5	606	0.9	0.8	49.9	18	31	42635	760	23	14	0.3	0.7	160	78
Wisconsin	48000	1.0	4.4	543	2.0		40.3	7.7	12	15667	365	14	12	0.3		48	44
West Virginia	67000	1.3	8.6	360	1.0		46.0	14	22	28500	770	23	17	0.5		65	60
Wyoming	56125	1.1	6.5	756	0.7		47.9	8.3	21	25250	416	16	17	0.5		84	57

* Summary of background soil concentration data provided as Attachment 1-4.



Cutoff = 10.000 ug/dl
Geo Mean = 4.500
GSD = 1.600
% Above = 4.466
% Below = 95.534

Age Range = 0 to 84 months
Time Step = Every 4 Hours
Run Mode = Research



Cutoff = 10.000 ug/dl
Geo Mean = 4.500
GSD = 1.600
% Above = 4.466

Age Range = 0 to 84 months
Time Step = Every 4 Hours
Run Mode = Research

```
             LEAD MODEL FOR WINDOWS Version 1.0

==================================================================================
Model Version: 1.0 Build 263
User Name:
Date:
Site Name:
Operable Unit:
Run Mode: Research
==================================================================================
The time step used in this model run: 1 - Every 4 Hours (6 times a day).

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Age         Time         Ventilation          Lung           Outdoor Air
          Outdoors          Rate           Absorption          Pb Conc
          (hours)        (m^3/day)            (%)           (ug Pb/m^3)
----------------------------------------------------------------------
.5-1       1.000            2.000            32.000            0.015
1-2        2.000            3.000            32.000            0.015
2-3        3.000            5.000            32.000            0.015
3-4        4.000            5.000            32.000            0.015
4-5        4.000            5.000            32.000            0.015
5-6        4.000            7.000            32.000            0.015
6-7        4.000            7.000            32.000            0.015

****** Diet ******

Age       Diet Intake(ug/day)
-----------------------------------
.5-1       5.530
1-2        5.780
2-3        6.490
3-4        6.240
4-5        6.010
5-6        6.340
6-7        7.000

****** Drinking Water ******

Water Consumption:
Age       Water (L/day)
-----------------------------------
.5-1       0.200
1-2        0.500
2-3        0.520
3-4        0.530
4-5        0.550
5-6        0.580
6-7        0.590

Drinking Water Concentration: 32.000 ug Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 71.510 ug/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Age            Soil (ug Pb/g)       House Dust (ug Pb/g)
-------------------------------------------------------
.5-1               100.000              71.510
1-2                100.000              71.510
2-3                100.000              71.510
```

```
3-4              100.000              71.510
4-5              100.000              71.510
5-6              100.000              71.510
6-7              100.000              71.510

****** Alternate Intake ******

Age      Alternate (ug Pb/day)
--------------------------------
.5-1     0.000
1-2      0.000
2-3      0.000
3-4      0.000
4-5      0.000
5-6      0.000
6-7      0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 2.500 ug Pb/dL

*************************************
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
*************************************

Year         Air               Diet              Alternate     Water
           (ug/day)          (ug/day)            (ug/day)     (ug/day)
-----------------------------------------------------------------------
.5-1        0.003             2.539               0.000        2.938
1-2         0.005             2.581               0.000        7.144
2-3         0.009             2.931               0.000        7.516
3-4         0.010             2.857               0.000        7.765
4-5         0.010             2.792               0.000        8.177
5-6         0.014             2.964               0.000        8.676
6-7         0.014             3.285               0.000        8.860

 Year       Soil+Dust          Total              Blood
            (ug/day)          (ug/day)           (ug/dL)
-----------------------------------------------------------
.5-1         1.975             7.455               4.0
1-2          3.050            12.780               5.2
2-3          3.085            13.542               5.0
3-4          3.128            13.760               4.8
4-5          2.351            13.330               4.5
5-6          2.129            13.783               4.2
6-7          2.018            14.177               4.0
```

Appendix D

Ecological Risk
HQ Calculations and TBV's

HQ's for Aquatic Life and Wildlife

Aquatic Life
Hazard Quotients (HQ)

Chemical: **Ammonia**

Exposure Unit	EPC (95%UCL)	Benchmark	Chroinc HQ
Upgradient	0.549	2.18	0.25
Production	61.1	2.18	28.03
Kildeer	3.64	2.18	1.67
Downgradient	1.5	2.18	0.69

Chemical: **Ammonia (Site Specific at pH=6.0)**

Exposure Unit	EPC (95%UCL)	Chronic BM	Acute BM	Chronic HQ	Acute HQ
Upgradient	0.549	2.56	54.99	0.21	0.01
Production	61.1	2.56	54.99	23.87	1.11
Kildeer	3.64	2.56	54.99	1.42	0.07
Downgradient	1.5	2.56	54.99	0.59	0.03

Chemical: **Total Chromium**

Exposure Unit	EPC (95%UCL)	Benchmark	Chroinc HQ	
Upgradient	0.021	0.011	1.91	**
Production	0.021	0.011	1.91	**
Kildeer	0.02	0.011	1.82	**
Downgradient	0.063	0.011	5.73	**

Chemical: ****Chromium VI (1:6 ratio, IV:III) (& AR WQC at Hdns= 31)**

Exposure Unit	EPC (95%UCL)	Chronic BM	Acute BM	Chronic HQ	Acute HQ
Upgradient	0.004	0.011	0.016	0.32	0.22
Production	0.004	0.011	0.016	0.32	0.22
Kildeer	0.003	0.011	0.016	0.30	0.21
Downgradient	0.011	0.011	0.016	0.95	0.66

Chemical: **Total Lead**

Exposure Unit	EPC (95%UCL)	Benchmark	Chroinc HQ
Upgradient	0.02	0.0025	8.00
Production	0.02	0.0025	8.00
Kildeer	0.021	0.0025	8.40
Downgradient	0.032	0.0025	12.80

Chemical: **Total Lead (AR WQC at Hdns=31)**

Exposure Unit	EPC (95%UCL)	Chronic BM	Acute BM	Chronic HQ	Acute HQ
Upgradient	0.02	0.0007	0.018	28.57	1.11
Production	0.02	0.0007	0.018	28.57	1.11
Kildeer	0.021	0.0007	0.018	30.00	1.17
Downgradient	0.032	0.0007	0.018	45.71	1.78

Chemical: **Nitrate***

Exposure Unit	EPC (95%UCL)	Benchmark	Chroinc HQ
Upgradient	1.48	42.6	0.03
Production	315	42.6	7.39
Kildeer	39.2	42.6	0.92
Downgradient	33.6	42.6	0.79

*Benchmark from SETC Vol19 #12 pp2918 sub-lethal LOEC to C.dubia

Chemical: **Sulfate**

Exposure Unit	EPC (95%UCL)	Benchmark	Chroinc HQ
Upgradient	17.2	30	0.57
Production	490	30	16.33
Kildeer	109	30	3.63
Downgradient	18.5	30	0.62

Chemical: **Sulfate (new ADEQ commission approved WQS from 4G)**

Exposure Unit	EPC (95%UCL)	Benchmark	Chroinc HQ
Upgradient	17.2	125	0.14
Production	490	125	3.92
Kildeer	109	125	0.87
Downgradient	18.5	125	0.15

Chemical: **TDS**

Exposure Unit	EPC (95%UCL)	Benchmark	Chroinc HQ
Upgradient	248	250	0.99
Production	2637	250	10.55
Kildeer	498	250	1.99
Downgradient	571	250	2.28

Chemical: **TDS (new ADEQ commission approved WQS from 4G)**

Exposure Unit	EPC (95%UCL)	Benchmark	Chroinc HQ
Upgradient	248	475	0.52
Production	2637	475	5.55
Kildeer	498	475	1.05
Downgradient	571	475	1.20

Wildlife - Common Robin
Hazard Quotients (HQ)

Chemical: **Ammonia**

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	0.549	22	0.011	0.077	1	1	0.00
Production	61.1	22	0.011	0.077	1	1	0.40
Kildeer	3.64	22	0.011	0.077	1	1	0.02
Downgradient	1.5	22	0.011	0.077	1	1	0.01

Ammonia Benchmark from ATSDR=min NOAEL

Chemical: **Total Chromium**

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	0.021	36.32	0.011	0.077	1	1	0.00
Production	0.021	36.32	0.011	0.077	1	1	0.00
Kildeer	0.02	36.32	0.011	0.077	1	1	0.00
Downgradient	0.063	36.32	0.011	0.077	1	1	0.00

Chemical: **Total Lead**

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	0.02	82.08	0.011	0.077	1	1	0.00
Production	0.02	82.08	0.011	0.077	1	1	0.00
Kildeer	0.021	82.08	0.011	0.077	1	1	0.00
Downgradient	0.032	82.08	0.011	0.077	1	1	0.00

Chemical: **Nitrate***

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	1.48	6061	0.011	0.077	1	1	0.00
Production	315	6061	0.011	0.077	1	1	0.01
Kildeer	39.2	6061	0.011	0.077	1	1	0.00
Downgradient	33.6	6061	0.011	0.077	1	1	0.00

*Benchmark from SETC Vol19 #12 pp2918 sub-lethal LOEC to C.dubia

Chemical: **Sulfate**

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	17.2	125	0.011	0.077	1	1	0.02
Production	490	125	0.011	0.077	1	1	0.56
Kildeer	109	125	0.011	0.077	1	1	0.12
Downgradient	18.5	125	0.011	0.077	1	1	0.02

Chemical: **TDS**

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	248	475	0.011	0.077	1	1	0.07
Production	2637	475	0.011	0.077	1	1	0.79
Kildeer	498	475	0.011	0.077	1	1	0.15
Downgradient	571	475	0.011	0.077	1	1	0.17

Wildlife - White Footed Mouse
Hazard Quotients (HQ)

Chemical: **Ammonia**

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	0.549	22	0.007	0.022	1	1	0.01
Production	61.1	22	0.007	0.022	1	1	0.88
Kildeer	3.64	22	0.007	0.022	1	1	0.05
Downgradient	1.5	22	0.007	0.022	1	1	0.02

Ammonia Benchmark from ATSDR=min NOAEL

Chemical: **Total Chromium**

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	0.021	56.29	0.007	0.022	1	1	0.00
Production	0.021	56.29	0.007	0.022	1	1	0.00
Kildeer	0.02	56.29	0.007	0.022	1	1	0.00
Downgradient	0.063	56.29	0.007	0.022	1	1	0.00

Chemical: **Total Lead**

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	0.02	48.56	0.007	0.022	1	1	0.00
Production	0.02	48.56	0.007	0.022	1	1	0.00
Kildeer	0.021	48.56	0.007	0.022	1	1	0.00
Downgradient	0.032	48.56	0.007	0.022	1	1	0.00

Chemical: **Nitrate***

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	1.48	6061	0.007	0.022	1	1	0.00
Production	315	6061	0.007	0.022	1	1	0.02
Kildeer	39.2	6061	0.007	0.022	1	1	0.00
Downgradient	33.6	6061	0.007	0.022	1	1	0.00

*Benchmark from SETC Vol19 #12 pp2918 sub-lethal LOEC to C.dubia

Chemical: **Sulfate**

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	17.2	125	0.007	0.022	1	1	0.04
Production	490	125	0.007	0.022	1	1	1.25
Kildeer	109	125	0.007	0.022	1	1	0.28
Downgradient	18.5	125	0.007	0.022	1	1	0.05

Chemical: **TDS**

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	248	475	0.007	0.022	1	1	0.17
Production	2637	475	0.007	0.022	1	1	1.77
Kildeer	498	475	0.007	0.022	1	1	0.33
Downgradient	571	475	0.007	0.022	1	1	0.38

Wildlife - Eastern Cottontail
Hazard Quotients (HQ)

Chemical: **Ammonia**

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	0.549	22	0.116	1.2	1	1	0.00
Production	61.1	22	0.116	1.2	1	1	0.27
Kildeer	3.64	22	0.116	1.2	1	1	0.02
Downgradient	1.5	22	0.116	1.2	1	1	0.01

Ammonia Benchmark from ATSDR=min NOAEL

Chemical: **Total Chromium**

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	0.021	56.29	0.116	1.2	1	1	0.00
Production	0.021	56.29	0.116	1.2	1	1	0.00
Kildeer	0.02	56.29	0.116	1.2	1	1	0.00
Downgradient	0.063	56.29	0.116	1.2	1	1	0.00

Chemical: **Total Lead**

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	0.02	48.56	0.116	1.2	1	1	0.00
Production	0.02	48.56	0.116	1.2	1	1	0.00
Kildeer	0.021	48.56	0.116	1.2	1	1	0.00
Downgradient	0.032	48.56	0.116	1.2	1	1	0.00

Chemical: **Nitrate***

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	1.48	6061	0.116	1.2	1	1	0.00
Production	315	6061	0.116	1.2	1	1	0.01
Kildeer	39.2	6061	0.116	1.2	1	1	0.00
Downgradient	33.6	6061	0.116	1.2	1	1	0.00

*Benchmark from SETC Vol19 #12 pp2918 sub-lethal LOEC to C.dubia

Chemical: **Sulfate**

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	17.2	125	0.116	1.2	1	1	0.01
Production	490	125	0.116	1.2	1	1	0.38
Kildeer	109	125	0.116	1.2	1	1	0.08
Downgradient	18.5	125	0.116	1.2	1	1	0.01

Chemical: **TDS**

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	248	475	0.116	1.2	1	1	0.05
Production	2637	475	0.116	1.2	1	1	0.54
Kildeer	498	475	0.116	1.2	1	1	0.10
Downgradient	571	475	0.116	1.2	1	1	0.12

Wildlife - White-tailed Deer
Hazard Quotients (HQ)

Chemical: **Ammonia**

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	0.549	22	3.7	56.5	1	1	0.00
Production	61.1	22	3.7	56.5	1	1	0.18
Kildeer	3.64	22	3.7	56.5	1	1	0.01
Downgradient	1.5	22	3.7	56.5	1	1	0.00

Ammonia Benchmark from ATSDR=min NOAEL

Chemical: **Total Chromium**

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	0.021	56.29	3.7	56.5	1	1	0.00
Production	0.021	56.29	3.7	56.5	1	1	0.00
Kildeer	0.02	56.29	3.7	56.5	1	1	0.00
Downgradient	0.063	56.29	3.7	56.5	1	1	0.00

Chemical: **Total Lead**

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	0.02	48.56	3.7	56.5	1	1	0.00
Production	0.02	48.56	3.7	56.5	1	1	0.00
Kildeer	0.021	48.56	3.7	56.5	1	1	0.00
Downgradient	0.032	48.56	3.7	56.5	1	1	0.00

Chemical: **Nitrate***

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	1.48	6061	3.7	56.5	1	1	0.00
Production	315	6061	3.7	56.5	1	1	0.00
Kildeer	39.2	6061	3.7	56.5	1	1	0.00
Downgradient	33.6	6061	3.7	56.5	1	1	0.00

*Benchmark from SETC Vol19 #12 pp2918 sub-lethal LOEC to C.dubia

Chemical: **Sulfate**

Exposure Unit	EPC (95%UCL)	Benchmark (TRV)	Intake Rate (L/d)	Body Weight (kg)	Dietary Fraction (%)	Bioavailability (%)	HQ
Upgradient	17.2	125	3.7	56.5	1	1	0.01
Production	490	125	3.7	56.5	1	1	0.26
Kildeer	109	125	3.7	56.5	1	1	0.06
Downgradient	18.5	125	3.7	56.5	1	1	0.01

Chemical: **TDS**

Exposure Unit	(95%UCL)	(TRV)	(L/d)	(kg)	Fraction (%)	(%)	HQ
Upgradient	248	475	3.7	56.5	1	1	0.03
Production	2637	475	3.7	56.5	1	1	0.36
Kildeer	498	475	3.7	56.5	1	1	0.07
Downgradient	571	475	3.7	56.5	1	1	0.08

Sources of Aquatic TBV's

AR-WQS (Metals)

Arkansas Toxicity Screen

(Evaluated as Dissolved)

Toxic Pollutant	Instream Standard. The instream standard for most metals are hardness dependent			Stream Concentrations (ug/L). For Source 1, input total concentration as single value or geometric mean in "total" column(s). For additional source, "unhide" columns. If multiple datum, can input actual coefficient of variation (cv), or use default (0.6)						Calculated Instream Waste Concentration (IWC). This value multiplies the source concentration (Cd) by the 95th %tile, IWC = ((Cd x 95%tile) x Qd + Cb x Qb) / (Qd + Qb)			Criteria Exceeded. Compares each IWC with corresponding instream standard		
ARWQS for Metals	Instream Standard (ug/L)			Waste Stream Source 1, ug/L				Background Source, ug/L		Stream IWC, ug/L			Acute	Chronic	H. Health
	Acute	Chronic	H.Health	total	dissolved	cv	95th%tile	total	dissolved	Acute	Chronic	H. Health			
ARKANSAS STANDARDS															
Cadmium	1.03927	0.432909	1.00E+101	0.00	0.00	0.60	2.13	0.00	0.00	0.00	0.00	0.00			
Chromium (III)	210.276	68.21146	1.00E+101	0.00	0.00	0.60	2.13	0.00	0.00	0.00	0.00	0.00			
Chromium (VI)	15.712	10.582	1.00E+101		0.00	0.60	2.13		0.00	0.00	0.00	0.00			
Copper	5.6445	4.17252	1.00E+101	0.00	0.00	0.60	2.13	0.00	0.00	0.00	0.00	0.00			
Lead	17.6788	0.688919	1.00E+101	0.00	0.00	0.60	2.13	0.00	0.00	0.00	0.00	0.00			
Mercury	2.04	0.012	1.00E+101	0.00	0.00	0.60	2.13	0.00	0.00	0.00	0.00	0.00			
Nickel	525.501	58.36105	1.00E+101	0.00	0.00	0.60	2.13	0.00	0.00	0.00	0.00	0.00			
Selenium	20	5	1.00E+101	0.00	0.00	0.60	2.13	0.00	0.00	0.00	0.00	0.00			
Silver*	0.46022	########	1.00E+101	0.00	0.00	0.60	2.13	0.00	0.00	0.00	0.00	0.00			
Zinc	42.4264	38.74177	1.00E+101	0.00	0.00	0.60	2.13	0.00	0.00	0.00	0.00	0.00			
Cyanide	22.4	5.2	1.00E+101	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Beryllium*	#######	########	0.076	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
PCBs*	#######	0.014	0.0004	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Aldrin*	3	########	1.00E+101	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Dieldrin	2.5	0.0019	0.0012	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
DDT (& metabolites)*	1.1	0.001	1.00E+101	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Endrin	0.18	0.0023	1.00E+101	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Toxaphene	0.73	0.0002	0.0063	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Chlordane	2.4	0.0043	0.005	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Endosulfan*	0.22	0.056	1.00E+101	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Heptachlor*	0.52	0.0038	1.00E+101	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Hexachlorocyclohexane	2	0.08	1.00E+101	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Pentachlorophenol*	9.07025	5.725901	1.00E+101	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Chlorpyrifos	0.083	0.041	1.00E+101	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Dioxin (2,3,7,8 TCDD)*	#######	########	0.000001	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Alpha Hexachlorocyclohexane	#######	########	0.0373	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
*Refer also to Gold Book Criteria															
GOLD BOOK CRITERIA SCREEN															
Acrolein	#######	########	780	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Acrylonitrile	#######	########	6.6	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Aldrin	#######	########	0.0014	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Anthracene	#######	########	110000	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Antimony, Total	#######	########	4300	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Arsenic, Total	3.60E+02	1.90E+02	1.4	0.00	0.00	0.60	2.13	0.00	0.00	0.00	0.00	0.00			
Benzene	#######	########	710	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Benzidine	#######	########	0.0054	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Benzo(a)anthracene	#######	########	0.31	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Benzo(a)pyrene	#######	########	0.31	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Benzo(k)fluoranthene	#######	########	0.31	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Benzofluoranthene 3,4	#######	########	0.31	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Beryllium, Total	1.30E+02	5.30E+00	1.00E+101	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
BHC-I	#######	########	0.13	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
BHC-II	#######	########	0.46	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
BHC-III	2.00E+00	########	0.63	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Bromoform	#######	########	3600	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Carbon tetrachloride	3.52E+04	########	44	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Chlorobenzene	#######	########	21000	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Chlorodibromomethane	#######	########	340	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Chloroethyl ether-bis 2	#######	########	14	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Chloroform	#######	########	4700	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Chloroisopropyl ether-bis 2	#######	########	170000	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Chrysene	#######	########	0.31	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
DDD 4,4'	#######	########	0.0084	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
DDE 4,4'	#######	########	0.0059	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
DDT 4,4	#######	########	0.0059	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Di-n-butyl phthalate	#######	########	12000	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Dibenzo(a,h)anthracene	#######	########	0.31	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Dichloroethylene (1,1)	#######	########	32	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Dichlorobenzene (1,2)	1.12E+03	7.63E+02	17000	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Dichlorobenzene (1,3)	1.12E+03	7.63E+02	17000	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Dichlorobenzene (1,4)	1.12E+03	7.63E+02	17000	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Dichlorobenzidine	#######	########	0.77	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Dichlorobromomethane	#######	########	220	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Dichloroethane (1,2)	1.18E+05	2.00E+04	990	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Dichlorophenol 2,4	2.02E+03	3.65E+02	1.00E+101	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Dichloropropane 1,2	2.30E+04	5.70E+03	1.00E+101	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Dichloropropylene (1,3 2,3)	6.06E+03	2.44E+02	1700	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Diethyl phthalate	#######	########	120000	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Dimethyl phthalate	#######	########	2900000	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Dinitrophenol 2,4	#######	########	14000	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Dinitrotoluene 2,4	#######	########	91	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Diphenylhydrazine	#######	########	5.4	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Endosulfan I	#######	########	2	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Endosulfan II	#######	########	2	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Endosulfan sulfate	#######	########	2	0.00		0.60	2.13	0.00		0.00	0.00	0.00			
Endrin aldehyde	[illegible]	[illegible]	[illegible]	0.00		0.60	2.13	0.00		0.00	0.00	0.00			

Ethylbenzene	#######	########	29000	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Ethylhexyl phthalate-bis	#######	########	59	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Fluoranthene	#######	########	370	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Heptachlor	#######	########	0.0021	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Heptachlor epoxide	5.20E-01	3.80E-03	0.0011	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Hexachlorobenzene	#######	########	0.0077	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Hexachlorobutadiene	#######	########	500	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Hexachlorocyclopentadiene	#######	########	17000	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Hexachloroethane	#######	########	89	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Indeno(1,2,3-cd)pyrene	#######	########	0.31	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Isophorone	1.17E+05	########	6000	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Methyl bromide	#######	########	4000	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Methylene chloride	#######	########	16000	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Nitrobenzene	#######	########	1900	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Nitrosodimethylamine-N	#######	########	81	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Nitrosodiphenylamine-N	#######	########	160	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
PCB's	2.00E+00	########	1.00E+101	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Pentachlorophenol	#######	########	82	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Phenol	#######	########	4600000	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Phenols	#######	########	4600000	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Pyrene	#######	########	11000	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Silver, Total	#######	1.20E-01	1.00E+101	0.00 0.00	0.60	2.13	0.00 0.00	0.00	0.00	0.00		
Dioxin (2,3,7,8 TCDD)	1.00E-02	1.00E-05	1.40E-08	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Tetrachloroethane (1,1,2,2)	#######	########	110	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Tetrachloroethylene	#######	########	88.5	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Thallium, Total	#######	########	6.3	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Toluene	#######	########	200000	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Trichloroethane 1,1,2	#######	########	420	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Trichloroethylene	#######	########	810	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Trichlorophenol 2,4,6	#######	########	65	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Vinyl Chloride	#######	########	5250	0.00	0.60	2.13	0.00	0.00	0.00	0.00		
Ammonia	36.09	3.08	1.00E+101	0.00	0.60	2.13	0.00	0.00	0.00	0.00		

Basis for Screen	(cfs)	
Flow:	streams	lakes
Source 1	0.87	
Source 2	0.00	
Background:		
7Q10	0.00	
Critical	0.00	
LTA (for Human Health)	4.00	2.80
ZID (for Acute)	0.00	
MZ (for Chronic)	0.00	

(ALL FLOWS IN THE SAME UNITS=cfs)

Variables:

Coeffiecent of variation (default)	0.60
z for the 95th%tile occurrence	1.645
Hardness, mg/L	31.0
TSS, mg/L	0.1
S for Stream, L for Lake or Reservoir	S
Dia. of discharge pipe, ft (for lakes, only)	
pH (for pentachlorophenol)	7.00
Metals:	
T for total, D for dissolved	D

TOTAL TO DISSOLVED CORRECTION FACTORS AND PARITIONING COEFFICIENTS

Metal	Correction Factors		Partitioning Coefficients			
			Stream		Lake	
	acute	chronic	Kpo	alpha	Kpo	alpha
Arsenic			4.80E+05	-0.73	4.80E+05	-0.73
Cadmium	0.993	0.958	4.00E+06	-1.13	3.52E+06	-0.92
Chromium(III)	0.316	0.860	3.36E+06	-0.93	2.17E+06	-0.27
Chromium(VI)	0.982	0.962				
Copper	0.960	0.960	1.04E+06	-0.74	2.85E+06	-0.9
Lead	0.962	0.962	2.80E+06	-0.8	2.04E+06	-0.53
Mercury	0.850		2.90E+06	-1.14	1.97E+06	-1.17
Nickel	0.998	0.997	4.90E+05	-0.57	2.21E+06	-0.76
Selenium						
Silver	0.850		2.40E+06	-1.03	2.40E+06	-1.03
Zinc	0.978	0.986	1.25E+06	-0.7	3.34E+06	-0.68

Ecoregion and Stream Specific Values for Hardness & TSS:

	Hardness	TSS 15th%tile
Gulf Coastal	31	5.5
Ouachita Mtns.	31	2
Arkansas River Valley	25	3
Boston Mountain	25	1.3
Ozark Highlands	148	2.5
Delta	81	8
Streams:		
Arkansas River	125	-----
Ft. Smith to Dardenelle Dam		12
Dardenelle Dame to Terry L&D		10.5
Terry L&D to L&D No. 5		8.3
L&D No. 5 to Mouth		9
Red River	211	33
Ouachita River	28	-----
Above Caddo River		2
Below Caddo River		5.5
White River	116	-----
Above Beaver Lake		2.5
Bull Shoals to Black River		3.3
Black River to Mouth		18.5
St. Francis River	103	18

SETAC and ECOTOX (Nitrate)

SETAC PRESS

Environmental Toxicology and Chemistry, Vol. 19, No. 12, pp. 2918–2922, 2000

ACUTE AND CHRONIC TOXICITY OF NITRATE TO FATHEAD MINNOWS (*PIMEPHALES PROMELAS*), *CERIODAPHNIA DUBIA*, AND *DAPHNIA MAGNA*

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Abstract—Increasing concentrations of nitrate in surface water and groundwater are becoming a worldwide concern, yet little information has been published on toxicity of nitrate to common organisms used for toxicity testing. The acute and chronic toxicity of nitrate (NO_3-N) to *Ceriodaphnia dubia, Daphnia magna,* and *Pimephales promelas* was investigated in 48-h to 17-d laboratory exposures. The 48-h median lethal concentration (LC50) of nitrate to *C. dubia* and *D. magna* neonates was 374 mg/L NO_3-N and 462 mg/L NO_3-N. The no-observed-effect concentration (NOEC) and the lowest-observed-effect concentration (LOEC) for neonate production in *C. dubia* were 21.3 and 42.6 mg/L NO_3-N, respectively. The NOEC and LOEC values for neonate production in *D. magna* were 358 and 717 mg/L NO_3-N, respectively. The 96-h LC50 for larval fathead minnows (*P. promelas*) was 1,341 mg/L NO_3-N. The NOEC and LOEC for 7-d larval and 11-d embryo–larval growth tests were 358 and 717 mg/L NO_3-N, respectively. Additional exposure of breeding *P. promelas* and their fertilized eggs to nitrate did not increase susceptibility further. The LC50 values for all species tested were above ambient concentrations of nitrate reported for surface water. However, the LOEC for *C. dubia* was within the range of concentrations that could be found in streams draining areas under extensive agricultural cultivation.

Keywords—Nitrate Acute toxicity Chronic toxicity *Ceriodaphnia*

INTRODUCTION

Increasing concentrations of nitrate in groundwater and surface waters are becoming a worldwide concern. Nitrate naturally enters groundwater and surface water via runoff from decomposition of vegetation, natural geological deposits, soil nitrogen, and atmospheric deposition [1,2]. Anthropogenic inputs include septic tank drainage, feedlots, and soil leaching from irrigation and fertilizers [3]. During the period from 1950 to 1970 fertilizer use in the United States doubled from 20 million to 40 million tons per year [4]. The percentage of nitrogen in fertilizers also increased from 6.1 to 20.4% [2]. By the mid-1980s fertilizer consumption reached a high of 41 to 53 million tons [5]. Concentrations of NO_3-N above 3 mg/L in groundwater are considered elevated because of human activity [2]. The United States federal maximum contaminant level for drinking water is 10 mg/L NO_3-N [6]. Concentrations in groundwater entering streams draining the Central Sands region of Wisconsin, USA, can exceed 10 mg/L [7]. Currently, no safe levels have been established for aquatic life.

The potential toxicity of nitrate to aquatic organisms has probably been ignored because other commonly occurring forms of nitrogen such as ammonia and nitrite are more toxic. These nitrogen-containing compounds are interrelated through the process of nitrification. Ammonia is converted into nitrate through a two-step process with nitrite produced as an intermediate product [8]. Nitrite is toxic through the conversion of hemoglobin to methemoglobin, a form incapable of carrying oxygen, resulting in anoxia [9]. Exposure of fish to acutely toxic concentrations of ammonia causes increased gill ventilation, hyperexcitability, convulsions, and death [8]. Toxic effects of nitrate on warm-blooded animals are well studied and may be related to in vivo conversion of nitrate to nitrite [10,11]. Neonatal stages and newborn individuals are especially susceptible because nitrate may be converted to nitrite under anaerobic conditions in the gut [12].

Comparatively few studies have been conducted on the effects of nitrate to aquatic organisms, particularly to different life history stages. No information has been published on the acute and chronic toxicity of nitrate to *Pimephales promelas* and *Ceriodaphnia dubia,* species commonly used for aquatic toxicity testing [13]. Toxic effects of nitrate to *Daphnia magna,* another widely used organism for toxicity testing, have been reported previously [14–16]. The acute toxicity of nitrate to several species of fish generally falls between 100 and 1,000 mg/L NO_3-N [17–19]. Limited data are available on longer-term effects of nitrate to fish. Recent studies have raised concerns about nitrate toxicity in aquatic insects [13,20] and amphibians [21–23] because ambient concentrations in surface water often exceed effect levels.

The objectives of this study were to determine the acute and chronic toxicity of nitrate to *P. promelas, C. dubia* and *D. magna,* and determine if early life stages of *P. promelas* are more susceptible to nitrate toxicity than are older individuals.

MATERIALS AND METHODS

Acute toxicity

Ceriodaphnia dubia (< 24 h old) and *D. magna* (< 48 h old) were exposed to a geometric series of five concentrations of reagent grade $NaNO_3$ (lot 960785, Fisher Scientific, Fairlawn, NJ, USA) ranging from 150 to 2,500 mg/L NO_3-N in 48-h static renewal tests. Organisms were cultured in-house and neonates were selected for testing following procedures described by Weber and Peltier [24]. Four replicates each containing five organisms were assigned to the treatments and control. Polystyrene cups (30 ml) filled to 20 ml served as test chambers. Test solutions were renewed daily with a stock so-

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U.S. Environmental Protection Agency

ECOTOX: Aquatic Report

USEPA/ORD/NHEERL - Mid-Continent Ecology Division

E-mail: ecotox.support@epa.gov

Telephone: 218-529-5225

It is recommended that users consult the original scientific paper to ensure an understanding of the context of the data retrieved from the ECOTOX database.
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*** AQUATIC TEST #: 198257 ***

CHEMICAL

	GRADE	PURITY	FORM.	RADIOLABEL	CAS #
TEST	**NR**	**NR**	**NR**	**NR**	**14797558**

NAME: **Nitrate**
COMMENT: **EXCRETION**

TEST CONDITIONS

STUDY TYPE:	**NR**
MEDIA:	**FW**
LOCATION:	**LAB**
CONTROL:	**NR**
EXPOSURE TYPE:	**S**
APPLICATION FREQ.:	**1 X**
EXPOSURE DUR.:	**164 day(s)**
STAND DUR. (D):	**164 day(s)**

SPECIES

SPECIES # (NAME):	**89 Micropterus salmoides (Largemouth bass)**
AGE:	**NR NR**
LIFE STAGE:	**not reported, unknown**
COMMENT:	**3 IN**

PUBLICATION

REFERENCE #:	**8606 Knepp, G.L., and G.F. Arkin, 1973**

EXP. DESIGN: **200 CATFISH ADDED AT D 103 TO RAISE CHEM CONC//**

TEST CONCENTRATION

CHEM ANAL. METHOD: **measured**
UNIT OF MEASURE: **ppm** parts per million

Ecotox MAX FW

TYPE	VALUE		RANGE		STANDARD CONC (ug/L)	ION
T	**NR**	**170**	TO	**400**	(170000-400000) ug/L	NR
NR	**NR**	**NR**	TO	**NR**		NR

EFFECT RESULTS

EFFECT:	**Growth**
TREND:	**INC**
RESPONSE SITE:	**NR**
% EFFECT:	**NR**
EFFECT MEASUREMENT:	

Length

ENDPOINT

ENDPOINT:	**Not Reported**
ENDPOINT ASSIGN.:	
SIGNIFICANCE:	**NR**
LEVEL:	**NR**
BCF Value **(T)**:	**NR (NR to NR)**
BCF Value **(NR)**:	**NR (NR to NR)**

EE Comment:

*** AQUATIC TEST #: 198257 *** (continued)

WATER QUALITY	**VALUE**	**RANGE**			**(UNIT)**
TEMPERATURE:	**NR**	**NR**	TO	**NR**	**NR**
pH:	**NR**	**NR**	TO	**NR**	
HARDNESS:	**NR**	**NR**	TO	**NR**	**NR**
SALINITY:	**NR**	**NR**	TO	**NR**	**NR**
ALKALINITY:	**NR**	**NR**	TO	**NR**	**NR**
CONDUCTIVITY:	**NR**	**NR**	TO	**NR**	**NR**
DISSOLVED OXYGEN:	**NR**	**NR**	TO	**NR**	**NR**
ORGANIC CARBON (**NR**):	**NR**	**NR**	TO	**NR**	**NR**

COMMENTS

OTHER EFFECTS:

GENERAL COMMENTS:

FIELD DATA

HABITAT CODE:

HABITAT DESC.:

SUBSTRATE CODE:

SUBSTRATE DESC.:

GEOG. LOCATION:

GEOG. CODE:	DEPTH:
LATITUDE:	APPLIC TYPE:
LONGITUDE:	APPLIC RATE:
HALF LIFE: **(to)**	APPLIC DATE(SEASON): **()**

NA = Not Applicable
NC = Not Coded
NR = Not Reported

Last updated on Friday, July 20th, 2007
URL: http://cfpub.epa.gov/ecotox/report.cfm

USEPA Region 5 ESLs

U.S. EPA, Region 5, RCRA

Ecological Screening Levels

August 22, 2003

Chemical	CAS No.	Air mg/m^3	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
Acenaphthene	83-32-9		**38**[a]	6.71[r]	6.82 e+5
Acenaphthylene	208-96-8		4.84 e+3[b]	5.87[r]	6.82 e+5
Acetone	67-64-1	959	**1700**[a, c, z]	**9.9**[z]	2500[w]
Acetonitrile	75-05-8	17.1	**12 e+3**[d, z]	**56**[z]	1370[w]
Acetophenone	98-86-2		-----	-----	3 e+5
Acetylaminofluorene [2-]	53-96-3		535[b]	15.3	596
Acrolein	107-02-8	0.578	**0.19**[c, z]	**1.52 e-3**[z]	5270[w]
Acrylonitrile	107-13-1	0.797	**66**[a]	**1.2**	23.9[w]
Aldrin	309-00-2		**1.7 e-2**[a, z]	2[t]	3.32[x]
Allyl chloride	107-05-1	1.22		-----	13.4
Aminobiphenyl [4-]	92-67-1			-----	3.05
Aniline	62-53-3		**4.1**[d]	**0.31**	56.8[w]
Anthracene	120-12-7		**0.035**[f]	**57.2**[u]	1.48 e+6
Antimony (Total)	7440-36-0		**80**[c]		142
Aramite	140-57-8		3.09[g]	1.11 e-3	1.66 e+5
Arsenic (Total)	7440-38-2		**148**[f]	**9790**[u]	5700
Azobenzene [p-(dimethylamino)]	60-11-7		1.65[b]	318	40
Barium (Total)	7440-39-3		**220**[d, z]		1040
Benzene	71-43-2	9.76	114[f]	142	255
Benzo[a]anthracene	56-55-3		**0.025**[c, z]	**108**[u]	5210

Chemical	CAS No.	Air mg/m^3	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
Benzo[a]pyrene	50-32-8		0.014[h]	**150**[u]	1520
Benzo[b]fluoranthene	205-99-2		9.07[b]	1.04 e+4	5.98 e+4
Benzo[ghi]perylene	191-24-2		7.64[b]	170[t]	1.19 e+5
Benzo[k]fluoranthene	207-8-9		-----	240[t]	1.48 e+5
Benzyl alcohol	100-51-6		**8.6**[h, z]	**1.04**[z]	6.58 e+4
Beryllium (Total)	7440-41-7		**3.6**[d, k, z]		1060
BHC [alpha-]	319-84-6		12.4[b]	6[t]	99.4
BHC [beta-]	319-85-7		0.495[b]	5[t]	3.98[x]
BHC [delta-]	319-86-8		667[g]	7.15 e+4	9940
BHC [gamma-]	58-89-9		**0.026**[a]	**2.37**[u]	5[x]
Bromodichloromethane	75-27-4			-----	540
Bromoform	75-25-2	9.11	**230**[d, z]	**492**[z]	1.59 e+4
Bromophenyl phenyl ether [4-]	101-55-3		1.5[h]	1550	
Butylamine [N-Nitrosodi-n-]	924-16-3		-----	-----	267
Butylbenzyl phthalate	85-68-7		**23**[d, z]	**1970**[z]	239
Cadmium (Total)	7440-43-9		**0.15**[i, j, k]	**990**[u]	2.22
Carbon disulfide	75-15-0	3.67	**15**[d, z]	**23.9**[z]	94.1
Carbon tetrachloride	56-23-5	1.41	**240**[d]	**1450**	2980
Chlordane	57-74-9		**4.3 e-3**[j]	**3.24**[u, z]	224[x]
Chlorethyl ether [bis(2-]	111-44-4		**19 e+3**[l]	**3520**	2.37 e+4[w]

Chemical	CAS No.	Air mg/m^3	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
Chloro-1-methylethyl)ether [bis(2-]	108-60-1		-----	-----	1.99 e+4
Chloroaniline [p-]	106-47-8		232[g]	146	1100
Chlorobenzene	108-90-7	120	**47[a]**	**291**	1.31 e+4
Chlorobenzilate	510-15-6		7.16[g]	860	5050
Chloroethane	75-0-3	20	-----	-----	
Chloroform	67-66-3	1.34	**140[d]**	**121**	1190
Chloronaphthalene [2-]	91-58-7		0.396[b]	417	12.2
Chlorophenol [2-]	95-57-8		**24[a]**	**31.9**	243
Chlorophenyl phenyl ether [4-]	7005-72-3			-----	
Chloroprene	126-99-8	4.16 E-2		-----	2.9
Chromium^{+3} (Total)	7440-47-3		42[j, k]	**4.34 e+4[u]**	400[y]
Chrysene	218-1-9		-----	**166[u]**	4730
Cobalt (Total)	7440-48-4		**24[d]**	5.00 e+4[t]	140
Copper (Total)	7440-50-8		**1.58[j, k, z]**	**3.16 e+4[u]**	**5400**
Cresol [4,6-dinitro-o-]	534-52-1		**23[m]**	**104**	144
Cresol [m-]	108-39-4		**62[d]**	**52.4**	3490
Cresol [o-]	95-48-7		**67[c]**	**55.4**	4.04 e+4
Cresol [p-chloro-m-]	59-50-7		34.8[g]	388	7950
Cresol [p-]	106-44-5		**25[a]**	**20.2**	1.63 e+5
Cyanide	57-12-5		5.2[a]	0.1[t]	1330[w]

Chemical	CAS No.	Air mg/m^3	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
DDD [4,4'-]	72-54-8		-----	**4.88**[u, z]	758
DDE [4,4'-]	72-55-9		4.51 e-9[e]	**3.16**[u]	596
DDT [4,4'-]	50-29-3		**1.1 e-5**[a, z]	**4.16**[u]	**3.5**[z]
Di-n-butyl phthalate	84-74-2		**9.7**[a]	**1114**	150
Di-n-octyl phthalate	117-84-0		30[f]	4.06 e+4	7.09 e+5
Diallate	2303-16-4		-----	-----	452[w]
Dibenzofuran	132-64-9		**4**[a, z]	**449**[z]	
Dibenz[a,h]anthracene	53-70-3		-----	**33**[u]	1.84 e+4
Dibromo-3-chloropropane [1,2-]	96-12-8	0.32	-----	-----	35.2
Dibromochloromethane	124-48-1		-----	-----	2050
Dibromoethane [1,2-]	106-93-4	176	-----	-----	1230
Dichloro-2-butene [trans-1,4-]	110-57-6	4.03		-----	
Dichlorobenzene [m-]	541-73-1	273	**38**[a, z]	**1315**[z]	3.77 e+4
Dichlorobenzene [o-]	95-50-1	270	**14**[h]	**294**	2960
Dichlorobenzene [p-]	106-46-7	275	**9.4**[d, z]	**318**[z]	546
Dichlorobenzidine [3,3'-]	91-94-1		**4.5**[a, z]	**127**	646
Dichlorodifluoromethane	75-71-8	1550		-----	3.95 e+4
Dichloroethane [1,1-]	75-34-3	1240	47[h]	0.575	2.01 e+4
Dichloroethane [1,2-]	107-6-2	29.7	**910**[h]	**260**	2.12 e+4
Dichloroethene [1,1-]	75-35-4	0.303	**65**[a, z]	**19.4**[z]	8280

Chemical	CAS No.	Air mg/m^3	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
Dichloroethylene [trans-1,2-]	156-60-5	29.1	**970**[d]	**654**	784
Dichlorophenol [2,4-]	120-83-2		**11**[d, z]	**81.7**[z]	8.75 e+4
Dichlorophenol [2,6-]	87-65-0			-----	1170
Dichloropropane [1,2-]	78-87-5	70.6	**360**[a, z]	**333**[z]	3.27 e+4
Dichloropropene [cis-1,3-]	10061-1-5	5.89	-----	-----	398
Dichloropropene [trans-1,3-]	10061-2-6	5.89	-----	-----	398
Dieldrin	60-57-1		**7.1 e-5**[a]	**1.9**[u, z]	2.38
Diethyl O-2-pyrazinyl phosphorothioate [O,O-]	297-97-2			-----	799
Diethyl phthalate	84-66-2		**110**[a]	**295**	2.48 e+4
Dimethoate	60-51-5		-----	-----	218
Dimethyl phthalate	131-11-3		-----	-----	7.34 e+5
Dimethylbenzidine [3,3'-]	119-93-7			-----	104
Dimethylbenz[a]anthracene [7,12-]	57-97-6		0.548[b]	6.64 e+4	1.63 e+4
Dimethylphenethylamine [alpha,alpha-]	122-9-8			-----	300
Dimethylphenol [2,4-]	105-67-9		100[b]	304	10[x]
Dinitrobenzene [m-]	99-65-0		**22**[d]	**8.61**	655
Dinitrophenol [2,4-]	51-28-5		**19**[a]	**6.21**	60.9
Dinitrotoluene [2,4-]	121-14-2		**44**[d, z]	**14.4**[z]	1280
Dinitrotoluene [2,6-]	606-20-2		**81**[d]	**39.8**	32.8

Chemical	CAS No.	Air mg/m³	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
Dinoseb	88-85-7		**0.48[a]**	**14.5**	21.8
Dioxane [1,4-]	123-91-1	367	**22 e+3[a]**	**119**	2050[w]
Diphenylamine	122-39-4		412[b]	34.6	1010
Disulfoton	298-4-4		4.02 e-2[c]	324	19.9
D [2,4-]	94-75-7		**220[a]**	**1273**	27.2
Endosulfan I	959-98-8		**0.056[j]**	**3.26**	119
Endosulfan II	33213-65-9		**0.056[j]**	**1.94**	119
Endosulfan sulfate	1031-7-8		2.22[b]	34.6	35.8
Endrin	72-20-8		**0.036[a]**	**2.22[u, z]**	10.1
Endrin aldehyde	7421-93-4		0.15[b]	**480[z]**	10.5
Ethyl methacrylate	97-63-2	356		-----	3 e+4
Ethyl methane sulfonate	62-50-0			-----	
Ethylbenzene	100-41-4	304	**14[o, z]**	**175**	5160
Famphur	52-85-7			-----	49.7
Fluoranthene	206-44-0		**1.9[f, z]**	**423[u]**	1.22 e+5
Fluorene	86-73-7		**19[d]**	**77.4[u]**	1.22 e+5
Heptachlor	76-44-8		**3.8 e-3[j]**	0.6[r]	5.98
Heptachlor epoxide	1024-57-3		**3.8 e-3[j]**	**2.47[u]**	152
Hexachlorobenzene	118-74-1		**3 e-4[a]**	20[t]	199
Hexachlorobutadiene	87-68-3		**0.053[a, z]**	**26.5[z]**	39.8

Chemical	CAS No.	Air mg/m^3	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
Hexachlorocyclopentadiene	77-47-4		77[b]	901	755
Hexachloroethane	67-72-1		**8**[a, z]	**584**[z]	596
Hexachlorophene	70-30-4		0.228[c]	2.31 e+5	199
Hexachloropropene	1888-71-7		-----	-----	
Hexanone [2-]	591-78-6	105	**99**[h, z]	**58.2**[z]	1.26 e+4
Indeno (1,2,3-cd) pyrene	193-39-5		4.31[b]	200[t]	1.09 e+5
Isobutyl alcohol	78-83-1	32.8	-----	-----	2.08 e+4[w]
Isodrin	465-73-6		3.09 e-2[e]	55.2	3.32[x]
Isophorone	78-59-1		**920**[d]	**432**	1.39 e+5
Isosafrole	120-58-1			-----	9940
Kepone	143-50-0		0.132[c]	3.31	32.7
Lead (Total)	7439-92-1		**1.17**[j, k, z]	**3.58 e+4**[u]	53.7
Mercury (Total)	7439-97-6		1.3 e-3[a]	174[r]	100[y]
Methacrylonitrile	126-98-7	3.38		-----	57[w]
Methane [bis(2-chloroethoxy)]	111-91-1		-----	-----	302[w]
Methapyrilene	91-80-5			-----	2780[w]
Methoxychlor	72-43-5		**0.019**[h]	**13.6**	19.9
Methyl bromide	74-83-9	26.5	**16**[d]	**1.37**	235[w]
Methyl chloride	74-87-3	2.63		-----	1.04 e+4[w]
Methyl ethyl ketone	78-93-3	642	**2200**[a, z]	**42.4**[z]	8.96 e+4[w]

Chemical	CAS No.	Air mg/m³	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
Methyl iodide	74-88-4	11.7		-----	1230
Methyl mercury	22967-92-6		2.46 e-3[c]	0.01	1.58
Methyl methacrylate	80-62-6	87.1	2800[g]	168	9.84 e+5[w]
Methyl methanesulfanate	66-27-3			-----	315[w]
Methyl parathion	298-0-0			-----	0.292
Methyl-2-pentanone [4-]	108-10-1	45.9	**170**[h, z]	**25.1**[z]	4.43 e+5
Methylcholanthrene [3-]	56-49-5		8.91 e-2[b]	8.19 e+6	77.9
Methylene bromide	74-95-3	344		-----	6.5 e+4[w]
Methylene chloride	75-9-2	4780	**940**[a]	**159**[z]	4050[w]
Methylnaphthalene [2-]	91-57-6		330[b]	20.2[r]	3240
Naphthalene	91-20-3	80.1	**13**[a, z]	**176**[u]	99.4
Naphthoquinone [1,4-]	130-15-4		-----	-----	1670
Naphthylamine [1-]	134-32-7		-----	-----	9340
Naphthylamine [2-]	91-59-8			-----	3030
Nickel (Total)	7440-2-0		**28.9**[j, k, z]	**2.27 e+4**[u]	1.36 e+4
Nitroaniline [m-]	99-9-2			-----	3160
Nitroaniline [o-]	88-74-4			-----	7.41 e+4
Nitroaniline [p-]	100-1-6			-----	2.19 e+4
Nitrobenzene	98-95-3		**220**[a, z]	**145**[z]	1310
Nitrophenol [o-]	88-75-5		-----	-----	1600

Chemical	CAS No.	Air mg/m^3	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
Nitrophenol [p-]	100-2-7		**60**[a]	**13.3**	5120
Nitroquinoline-1-oxide [4-]	56-57-5			-----	122
Nitrosodiethylamine [N-]	55-18-5		768[g]	22.8	69.3[w]
Nitrosodimethylamine [N-]	62-75-9			-----	0.0321[w]
Nitrosodiphenylamine [N-]	86-30-6		-----	-----	545
Nitrosomethylethylamine [N-]	10595-95-6			-----	1.66[w]
Nitrosomorpholine [N-]	59-89-2			-----	70.6[w]
Nitrosopiperidine [N-]	100-75-4			-----	6.65[w]
Nitrosopyrrolidine [N-]	930-55-2			-----	12.6[w]
Parathion	56-38-2		**0.013**[a, d]	**0.757**	0.34[y]
Pentachlorobenzene	608-93-5		**0.019**[a, z]	**24**[z]	497
Pentachloroethane	76-1-7	0.68	56.4[g]	689	1.07 e+4
Pentachloronitrobenzene	82-68-8		-----	-----	7090
Pentachlorophenol	87-86-5		**4.0**[j, p, z]	**2.3 e+4**[z]	119
Phenacetin	62-44-2		-----	-----	1.17 e+4
Phenanthrene	85-1-8		**3.6**[f]	**204**[u]	4.57 e+4
Phenol	108-95-2	4.31	**180**[c]	**49.1**	1.2 e+5
Phenylenediamine [p-]	106-50-3			-----	6160[w]
Phorate	298-02-2		3.62[g]	0.861	0.496
Phthalate [bis(2-ethylhexyl)]	117-81-7		**0.3**[q, z]	182[r]	925

Chemical	CAS No.	Air mg/m^3	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
Picoline [2-]	109-6-8	140	-----	-----	9900[w]
Polychlorinated biphenyls	1336-36-3		**1.2 e-4**[a, z]	**59.8**[u]	0.332
Polychlorinated dibenzo-p-dioxins	PCDD-S		2.78 e-7[b]	**0.011**	1.99 e-4
Polychlorinated dibenzofurans	51207-31-9		-----	-----	0.0386
Pronamide	23950-58-5		-----	-----	13.6[x]
Propionitrile	107-12-0	1.87	-----	-----	49.8[w]
Propylamine [N-nitrosodi-n-]	621-64-7			-----	544
Pyrene	129-0-0		0.3[g]	**195**[u]	7.85 e+4
Pyridine	110-86-1	13.7	2380[g]	106	1030[w]
Safrole	94-59-7		-----	-----	404
Selenium (Total)	7782-49-2		5[j]		27.6
Silver (Total)	7440-22-4		**0.12**[f, z]	500[t]	4040
Silvex	93-72-1		**30**[a, z]	**675**[z]	109[x]
Styrene	100-42-5	0.946	**32**[d, z]	**254**[z]	4690
Sulfide	18496-25-8				3.58
Tetrachlorobenzene [1,2,4,5-]	95-94-3		**3**[a, z]	**1252**[z]	2020
Tetrachlorodibenzo-p-dioxin [2,3,7,8-]	1746-1-6		**3 e-9**[a, z]	**1.2 e-4**[z]	1.99 e-4
Tetrachloroethane [1,1,1,2-]	630-20-6	22.5	-----	-----	2.25 e+5
Tetrachloroethane [1,1,2,2-]	79-34-5	353	**380**[a]	**850**	127
Tetrachloroethene	127-18-4	69	**45**[a]	**990**	9920

Chemical	CAS No.	Air mg/m^3	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
Tetrachlorophenol [2,3,4,6-]	58-90-2		**1.2**[a, z]	**129**[z]	199
Tetraethyl dithiopyrophosphate	3689-24-5		13.9[b]	560	596
Thallium (Total)	7440-28-0		**10**[a]		56.9
Tin (Total)	7440-31-5		**180**[d]		7620
Toluene	108-88-3	1040	253[f]	**1220**[z]	5450
Toluidine [5-nitro-o-]	99-55-8			-----	8730
Toluidine [o-]	95-53-4			-----	2970[w]
Toxaphene	8001-35-2		**1.4 e-4**[a, z]	**0.077**[z]	119
Trichlorobenzene [1,2,4-]	120-82-1		**30**[a, z]	**5062**[z]	1.11 e+4
Trichloroethane [1,1,1-]	71-55-6	4170	**76**[d, z]	**213**[z]	2.98 e+4
Trichloroethane [1,1,2-]	79-0-5	11.6	**500**[a, z]	**518**[z]	2.86 e+4
Trichloroethylene	79-1-6	1220	**47**[h, z]	**112**[z]	1.24 e+4
Trichlorofluoromethane	75-69-4	5150		-----	1.64 e+4
Trichlorophenol [2,4,5-]	95-95-4			-----	1.41 e+4
Trichlorophenol [2,4,6-]	88-6-2		**4.9**[d]	**208**	9940
Trichloropropane [1,2,3-]	96-18-4	3.32	-----	-----	3360
Trichlorphenoxyacetic acid [2,4,5-]	93-76-5		686[g]	5.87 e+4	596
Triethyl phosphorothioate [O,O,O-]	126-68-1		58.2[b]	189	818
Trinitrobenzene [Sym-]	99-35-4			-----	376[w]
Vanadium (Total)	7440-62-2		**12**[a, z]		1590

Chemical	CAS No.	Air mg/m^3	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
Vinyl acetate	108-5-4	359	248[g]	13	1.27 e+4[w]
Vinyl chloride	75-1-4	0.221	**930**[a]	**202**	646
Xylenes (total)	1330-20-7	135	**27**[d, z]	**433**[z]	1 e+4[x]
Zinc (Total)	7440-66-6		**65.7**[j, k, z]	**1.21 e+5**[u]	6620[y]

[a] = Michigan water quality standards, Rule 57 water quality values, July 23, 2003. Available at: http://www.michigan.gov/deq/0,1607,7-135-3313_3686_3728-11383--,00.html. The water ESL data for acenaphthene, BHC (gamma), cyanide and parathion are Michigan (final chronic value or FCV) Tier I criteria. Likewise, water ESL data for dieldrin, dioxin, DDT, endrin, hexachlorobenzene, hexachlorobutadiene, mercury, PCB's and toxaphene represent wildlife values (see Notes at end of these footnotes for dioxin, DDT, mercury and PCB's). All of the remaining data are Tier II values.

[b] = Water Ecological Screening Level (ESL) based on exposure to a mink (*Mustela vison*).

[c] = Indiana water quality standards, Title 327, Article 2, of the Indiana Administrative Code, Feb. 4, 2002. Available at: http://www.ai.org/legislative/iac/t03270/a00020.pdf The water ESL for toxaphene is from the Indiana chronic aquatic criterion for all waters outside of mixing zones (see Table 1 under Rule 1 of 327 IAC 2-1-6 Minimum Surface Water Quality Standards at the above Internet site). The remaining water ESL data are either wildlife values (for dioxin, DDT, mercury and PCB's) or Tier II values for the Indiana Great Lakes Basin (see Great Lakes Basin Criteria and Values Table as developed under Rule 1.5 of 327 IAC Article 2 as referenced above).

[d] = Ohio water quality standards, Chapter 3745-1 of the Ohio Administrative Code, Dec. 30, 2002. Available at: http://www.epa.state.oh.us/dsw/rules/3745-1.html The water ESL data for endrin and parathion are Ohio aquatic life Tier I criteria from the Outside Mixing Zone Average (OMZA). Wildlife values are available for dioxin, DDT, mercury and PCB's. All of the remaining data are Ohio aquatic life Tier II values from the OMZA. See Ohio summary tables for water quality criteria and values along with reference on the development of Tier I criteria and Tier II values.

[e] = Water ESL based on exposure to a belted kingfisher (*Ceryle alcyon*).

[f] = Minnesota water quality standards, Rule 7052.0100, Subpart 2 (water ESL data for arsenic & benzene represents aquatic life chronic standards and dioxin, DDT, mercury and PCB's represents wildlife values), April 13, 2000. Rule 7050.0222, Subpart 2, Feb. 12, 2003. Available at: http://www.revisor.leg.state.mn.us/arule/7050/0100.html and http://www.revisor.leg.state.mn.us/arule/7052/0222.html

[g] = Region 5, RCRA Interim Criteria, based on Aquire database with acceptable review codes and endpoints (life cycle). Must have eight or more acceptable studies (i.e., chronic and/or acute).

[h] = GLWQI Tier II value as presented in: Suter, G.W. II and Tsao, C.L. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota, 1996 Revision. ES/ER/TM-96/R2. Available at: http://www.esd.ornl.gov/programs/ecorisk/ecorisk.html

[i] = U.S. EPA 2001 Update of Ambient Water Quality Criteria for Cadmium (EPA 822-R-01-001).

[j] = U.S. EPA National Recommended Water Quality Criteria: 2002 (EPA 822-R-02-047)

[k] = For hardness-dependent metals (beryllium, cadmium, chromium^{+3}, copper, lead, nickel and zinc), freshwater chronic criteria are based on soft water with a total hardness of 50 mg/L as $CaCO_3$. Soft water is common within Region 5 and this water ESL may be recalculated when site specific water hardness is less than 50 mg/L.

[l] = U.S. EPA Ambient Water Quality for Chloroalkyl Ethers (EPA 440/5-80-030). No definitive data available concerning chronic toxicity. The water ESL is based on no adverse effects for a chronic toxicity embryo-larval test of the fathead minnow.

[m] = U.S. EPA Ambient Water Quality for Nitrophenols (EPA 440/5-80-063). The acute value of 230 ug/l was adjusted with an uncertainty factor of ten for 2,4-dinitrophenol and 4,6-dinitro-o-cresol since no chronic criteria are available.

[n] = Wisconsin Surface Water Quality Criteria and Secondary Values for Toxic Substances, NR 105.07(1)(b), Sept.1, 1997. Available at: http://www.legis.state.wi.us/rsb/code/nr/nr100.html

[o] = Illinois water quality standards, Title 35, Part 302.208, Dec. 20, 2002. Available at: http://www.ipcb.state.il.us/SLR/IPCBandIEPAEnvironmentalRegulations-Title35.asp

[p] = The criterion for pentachlorophenol is pH dependent and is based on a pH of 6.5.

[q] = U.S. EPA Ambient Water Quality for Phthalate Esters (EPA 440/5-80-067). A chronic value of 3 ug/L that resulted in significant reproductive impairment was adjusted with an uncertainity factor of ten.

[r] = Environment Canada. September 1994. Interim Sediment Quality Assessment Values. Ecosystem Conservation Directorate. Evaluation and Interpretation Branch.

[s] = Unless noted otherwise, all Sediment ESLs were derived using equilibrium partitioning (EqP) equation and the corresponding water ESL. Note: Sediment ESL = K_{oc} x Water ESL x 0.01.

[t] = Ontario Ministry of the Environment. August 1993. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario.

[u] = Consensus based threshold effect concentrations (TEC) as presented in MacDonald et. al. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch Environ Contam Toxicol 39:20-31 (see Table 2). The TEC for mercury had a high incidence of toxicity and was not used. These values do not consider bioaccumulation nor biomagnification.

[v] = Unless noted otherwise, all Soil ESLs are based on exposure to a masked shrew (*Sorex cinerus*).

[w] = Soil ESL is based on exposure to a meadow vole (*Microtus pennsylvanicus*).

[x] = Soil ESL is based on exposure to a plant.

[y] = Soil ESL is based on exposure to soil invertebrates (e.g., earthworms).

[z] = New ESL data is lower than the previous table.

Notes: New ESL data are displayed in bold font and a dashed line (e.g., -----) is used to show when data was deleted from the previous table (i.e., supporting data was inadequate). All six states in EPA Region 5 have the same water ESL's for dioxin, DDT, mercury and PCB's which are based on a wildlife value. A summary report will be created on the development of soil benchmarks including equations, criteria and references. Likewise, a report will be prepared on the development of water benchmarks that are based on mink and belted kingfisher exposure.

USEPA Region 3 BTAG

EPA Region III BTAG
FRESHWATER SCREENING BENCHMARKS
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CAS#	Analyte	Screening Value (ug/l)	Ref	End Note	Bioaccumulative[q]	B
					Class of Compound	
71-55-6	1,1,1-Trichloroethane	11	a	1	Volatile	
79-34-5	1,1,2,2-Tetrachloroethane	610	a	1	Volatile	
127-18-4	1,1,2,2-Tetrachloroethylene (PCE)	111	b	2	Volatile	
79-00-5	1,1,2-Trichloroethane	1200	a	1	Volatile	
79-01-6	1,1,2-Trichloroethene (TCE)	21	b	2		
92-52-4	1,1-Biphenyl	14	c	1	PAH	
75-34-3	1,1-Dichloroethane	47	c	1	Volatile	
75-35-4	1,1-Dichloroethene (1,1-Dichloroethylene)	25	a	1	Volatile	
75-35-4	1,1-Dichloroethylene	25	a	1	Volatile	
634-66-2	1,2,3,4-Tetrachlorobenzene	1.8	b	2	Other Semi-Volatile	B
87-61-6	1,2,3-Trichlorobenzene	8	b	2	Other Semi-Volatile	
95-94-3	1,2,4,5-Tetrachlorobenzene	3	d	3	Other Semi-Volatile	B
120-82-1	1,2,4-Trichlorobenzene	24	b	2	Volatile	B
95-63-6	1,2,4-Trimethylbenzene	33	e,f	4	Volatile	B
95-50-1	1,2-Dichlorobenzene	0.7	b	2	Volatile	B
107-06-2	1,2-Dichloroethane	100	b	2	Volatile	
540-59-0	1,2-Dichloroethene (1,2-Dichloroethylene)	590	a	1	Volatile	
540-59-0	1,2-Dichloroethylene	590	a	1	Volatile	
156-60-5	1,2-Trans-Dichloroethylene	970	g	5	Volatile	
108-67-8	1,3,5-Trimethylbenzene	71	h,i	6	Volatile	
541-73-1	1,3-Dichlorobenzene	150	b	2	Volatile	B
542-75-6	1,3-Dichloropropene (1,3-Dichloropropylene)	0.055	a	1	Volatile	
542-75-6	1,3-Dichloropropylene	0.055	a	1	Volatile	
106-46-7	1,4-Dichlorobenzene	26	b	2	Volatile	B
99-08-1	1-Methyl-3-nitrobenzene	750	h,i	6	Other Semi-Volatile	
99-99-0	1-Methyl-4-nitrobenzene (4-Nitrotoluene)	1900	h,i	6	Other Semi-Volatile	
90-12-0	1-Methylnaphthalene	2.1	a	1	PAH	
71-41-0	1-Pentanol	110	a	1	Volatile	
10222-01-2	2,2-Dibromo-3-nitrilopropionamide	20	e,f	4,7	Other Semi-Volatile	
58-90-2	2,3,4,6-Tetrachlorophenol	1.2	d	3	Other Semi-Volatile	
1746-01-6	2,3,7,8-TCDD-Dioxin	3.1E-09	j	8	Dioxin/Furans	B
51207-31-9	2,3,7,8-TCDF		k	9	Dioxin/Furans	B
93-72-1	2,4,5-TP (Silvex)	30	d	3	Volatile	
93-76-5	2,4,5-Trichlorphenoxyacetic acid	686	l,m	10	Phenoxycaceticacid Herbicide	
88-06-2	2,4,6-Trichlorophenol	4.9	g	5	Other Semi-Volatile	
118-96-7	2,4,6-Trinitrotoluene (TNT)	100	h,i	6	Other Semi-Volatile	
120-83-2	2,4-Dichlorophenol	11	g	5	Other Semi-Volatile	
121-14-2	2,4-Dinitrotoluene	44	g	5	Other Semi-Volatile	
606-20-2	2,6-Dinitrotoluene	81	g	5	Other Semi-Volatile	
35572-78-2	2-Amino-4,6-dinitrotoluene	1480	h,i	6	Other Semi-Volatile	
78-93-3	2-Butanone	14000	a	1	Volatile	
95-57-8	2-Chlorophenol	24	d	3	Other Semi-Volatile	
591-78-6	2-Hexanone	99	a	1	Volatile	
91-57-6	2-Methylnaphthalene	4.7	e,f	4	PAH	
95-48-7	2-Methylphenol	13	a	1	Other Semi-Volatile	
88-75-5	2-Nitrophenol	1920	h,i	6	Other Semi-Volatile	
111-13-7	2-Octanone	8.3	a	1	Other Semi-Volatile	

EPA Region III BTAG
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CAS#	Analyte	Screening Value (ug/l)	Ref	End Note	Bioaccumulative[q]	B
					Class of Compound	
67-63-0	2-Propanol	7.5	a	1	Volatile	
91-94-1	3,3'- Dichlorobenzidine	4.5	d	3	Other Semi-Volatile	
99-08-1	3-Nitrotoluene (1-Methyl-3-nitrobenzene)	750	h,i	6	Other Semi-Volatile	
106-68-3	3-Octanone	3571	a	11	Volatile	
101-55-3	4-Bromophenyl phenyl ether	1.5	c	1	Other Semi-Volatile	B
106-47-8	4-Chloroaniline	232	l,m	10	Other Semi-Volatile	
7005-72-3	4-Chlorophenyl- phenyl ether				Other Semi-Volatile	B
99-87-6	4-Isopropyltoluene (Cymene)	85	h,i	6	Other Semi-Volatile	
108-10-1	4-Methyl-2-pentanone	170	a	1	Volatile	
106-44-5	4-Methylphenol	543	h,i	6	Other Semi-Volatile	
100-02-7	4-Nitrophenol	60	a	12	Other Semi-Volatile	
99-99-0	4-Nitrotoluene	1900	h,i	6	Other Semi-Volatile	
83-32-9	Acenaphthene	5.8	b	2	PAH	B
208-96-8	Acenapthylene				PAH	B
67-64-1	Acetone	1500	a	1	Volatile	
75-05-8	Acetonitrile	12000	g	5	Volatile	
309-00-2	Aldrin	3	n	13	Organochlorine Pesticide	B
7429-90-5	Aluminum	87	n	13	Inorganic/Metal	
7664-41-7	Ammonia (un-ionized)	19	b	2	Inorganic	
62-53-3	Aniline	2.2	b	2	Other Semi-Volatile	
120-12-7	Anthracene	0.012	b	2	PAH	B
7440-36-0	Antimony	30	a	1	Inorganic/Metal	
140-57-8	Aramite	3.09	l,m	10	Other Semi-Volatile	
12674-11-2	Aroclor 1016 (total PCBs)	0.000074	j	8	Other Pesticide/PCB	B
11104-28-2	Aroclor 1221 (total PCBs)	0.000074	j	8	Other Pesticide/PCB	B
11141-16-5	Aroclor 1232 (total PCBs)	0.000074	j	8	Other Pesticide/PCB	B
53469-21-9	Aroclor 1242 (total PCBs)	0.000074	j	8	Other Pesticide/PCB	B
12672-29-6	Aroclor 1248 (total PCBs)	0.000074	j	8	Other Pesticide/PCB	B
11097-69-1	Aroclor 1254 (total PCBs)	0.000074	j	8	Other Pesticide/PCB	B
11096-82-5	Aroclor 1260 (total PCBs)	0.000074	j	8	Other Pesticide/PCB	B
7440-38-2	Arsenic	5	b	2	Inorganic/Metal	B
22569-72-8	Arsenic III	55	a	14	Inorganic/Metal	
17428-41-0	Arsenic V	3.1	a	1	Inorganic/Metal	
1912-24-9	Atrazine	1.8	b	2	Triazine Herbicide	
86-50-0	Azinophosmethyl (Guthion)	0.01	n	13	Organophosphorus Pesticide	
7440-39-3	Barium	4	a	1	Inorganic/Metal	
71-43-2	Benzene	370	b	2	Volatile	
92-87-5	Benzidine	3.9	a	1	Other Semi-Volatile	
56-55-3	Benzo(a)anthracene	0.018	b	2	PAH	B
50-32-8	Benzo(a)pyrene	0.015	b	2	PAH	B
205-99-2	Benzo(b)fluoranthene				PAH	B
191-24-2	Benzo(g,h,i)perylene				PAH	B
207-08-9	Benzo(k)fluoranthene				PAH	B
65-85-0	Benzoic Acid	42	a	1	Other Semi-Volatile	
100-51-6	Benzyl alcohol	8.6	a	1	Other Semi-Volatile	
7440-41-7	Beryllium	0.66	a	1	Inorganic/Metal	
	BHC (non Lindane)	2.2	a	1	Organochlorine Pesticide	

EPA Region III BTAG
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CAS#	Analyte	Screening Value (ug/l)	Ref	End Note	Bioaccumulative[q]	B
					Class of Compound	
319-84-6	BHC, alpha				Organochlorine Pesticide	B
319-85-7	BHC, beta				Organochlorine Pesticide	B
319-86-8	BHC, delta	141	h,i	6	Organochlorine Pesticide	B
58-89-9	BHC, gamma (Lindane)	0.01	b	2	Organochlorine Pesticide	B
92-52-4	Biphenyl (1,1-Biphenyl)	14	c	1	Other Semi-Volatile	
117-81-7	bis (2-ethylhexyl) phthalate	16	b	2	Other Semi-Volatile	
7440-42-8	Boron	1.6	a	1	Inorganic/Metal	
75-25-2	Bromoform	320	c	1	Volatile	
74-83-9	Bromomethane				Volatile	
85-68-7	Butyl benzyl phthalate	19	c	1	Other Semi-Volatile	
7440-43-9	Cadmium (hardness=100)	0.25	n	15	Inorganic/Metal	B
7440-70-2	Calcium	116000	a	16	Inorganic/Metal	
63-25-2	Carbaryl (Sevin)	0.2	b	2	Other Pesticide/PCB	
1563-66-2	Carbofuran	1.8	b	2	N-Methylcarbamate herbicide	
75-15-0	Carbon disulfide	0.92	a	1	Volatile	
56-23-5	Carbon tetrachloride	13.3	b	2	Volatile	
57-74-9	Chlordane	0.0022	n	13	Organochlorine Pesticide	B
16887-00-6	Chloride	230000	n	13	Inorganic/Metal	
7782-50-5	Chlorine (TRC)	11	n	13	Inorganic/Metal	
108-90-7	Chlorobenzene	1.3	b	2	Volatile	
510-15-6	Chlorobenzilate	7.16	l,m	10	Other Pesticide/PCB	
67-66-3	Chloroform	1.8	b	2	Volatile	
2921-88-2	Chloropyrifos	0.0035	b	2	Organophosphorus Pesticide	B
16065-83-1	Chromium III (hardness=100)	74	n	15	Inorganic/Metal	
7440-47-3	Chromium Total (hardness=100)	85	n		Inorganic/Metal	
18540-29-9	Chromium VI (hardness=100)	11	n		Inorganic/Metal	B
218-01-9	Chrysene				PAH	B
7440-48-4	Cobalt	23	a	1	Inorganic/Metal	
7440-50-8	Copper (hardness=100)	9	n	13,15	Inorganic/Metal	B
98-82-8	Cumene	2.6	e,f	4	Volatile	
57-12-5	Cyanide, free	5	b	2	Inorganic/Metal	
99-87-6	Cymene	85	h,i	6	Volatile	
72-54-8	DDD (p,p')	0.011	a	1	Organochlorine Pesticide	B
72-55-9	DDE				Organochlorine Pesticide	B
50-29-3	DDT (4,4' DDT)	0.0005	n	13	Organochlorine Pesticide	B
	DDT (op + pp)				Organochlorine Pesticide	B
	DDT, Total				Organochlorine Pesticide	B
	DDT/DDE/DDD (total)	0.000011	j	8	Organochlorine Pesticide	B
124-18-5	Decane	49	a	1	Other Semi-Volatile	
8065-48-3	Demeton	0.1	n	13	Other Semi-Volatile	
117-81-7	Di(2-ethylhexyl)phthalate (Bis(2-ethylhexyl) phthalate)	16	b	2	Other Semi-Volatile	
333-41-5	Diazinon	0.043	a	1	Other Pesticide/PCB	B
53-70-3	Dibenzo(a,h)anthracene				PAH	B
132-64-9	Dibenzofuran	3.7	a	1	Other Semi-Volatile	
3252-43-5	Dibromoacetonitrile	20	e,f	4,7	Other Semi-Volatile	
25321-22-6	Dichlorobenzene (mixed isomers)	5	e,f	4,17	Volatile	
75-09-2	Dichloromethane	98.1	b	2	Volatile	

EPA Region III BTAG
FRESHWATER SCREENING BENCHMARKS
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CAS#	Analyte	Screening Value (ug/l)	Ref	End Note	Bioaccumulative[q]	B
					Class of Compound	
SEQ NO-35-8	Dichlorophenols, total	0.2	b	2	Other Semi-Volatile	
542-75-6	Dichloropropene (1,3-Dichloropropylene)	0.055	a	1	Volatile	
115-32-2	Dicofol (Kelthane)				Other Pesticide/PCB	B
60-57-1	Dieldrin	0.056	n	13	Organochlorine Pesticide	B
84-66-2	Diethylphthalate	210	a	1	Other Semi-Volatile	
60-51-5	Dimethoate	6.2	b	2	Other Pesticide/PCB	
84-74-2	Di-n-butyl phthalate	19	b	2	Other Semi-Volatile	
117-84-0	Di-n-octyl phthalate	22	h,i	6	Other Semi-Volatile	
88-85-7	Dinoseb	0.05	b	2	Other Pesticide/PCB	
117-84-0	Dioctylphthalate (Di-n-octyl phthalate)	22	h,i	6	Other Semi-Volatile	
298-04-4	Disulfoton				Pesticide	B
115-29-7	Endosulfan (alpha and beta)	0.02	b	2	Organochlorine Pesticide	B
959-98-8	Endosulfan I (a-endosulfan)	0.051	c	1	Organochlorine Pesticide	B
33213-65-9	Endosulfan II (b-endosulfan)	0.051	c	1	Organochlorine Pesticide	B
72-20-8	Endrin	0.036	n	13	Organochlorine Pesticide	B
100-41-4	Ethylbenzene	90	b	2	Volatile	
107-06-2	Ethylene dichloride (1,2-Dichloroethane)	100	b	2	Volatile	
107-21-1	Ethylene glycol	192000	b	2	Other Semi-Volatile	
206-44-0	Fluoranthene	0.04	b	2	PAH	B
86-73-7	Fluorene	3	b	2	PAH	B
16984-48-8	Fluoride (hardness = 100)	2119.4	e,f	4,15	Inorganic	
7782-41-4	Fluorine	1080	a	12	Inorganic	
86-50-0	Guthion	0.01	n	13	Other Pesticide/PCB	
319-86-8	HCH, d- (BHC, delta)	141	h,i	6	Organochlorine Pesticide	
58-89-9	HCH, gamma (Lindane) (BHC, gamma)	0.01	b	2	Organochlorine Pesticide	
76-44-8	Heptachlor	0.0019	n	13	Organochlorine Pesticide	B
	Heptachlor & Heptachlor epoxide				Organochlorine Pesticide	B
1024-57-3	Heptachlor epoxide	0.0019	n	13	Organochlorine Pesticide	B
118-74-1	Hexachlorobenzene	0.0003	d	18	Other Semi-Volatile	B
87-68-3	Hexachlorobutadiene	1.3	b	2	Volatile	B
608-73-1	Hexachlorocyclohexanes (HCH, BHC)	0.01	b	2	Organochlorine Pesticide	B
77-47-4	Hexachlorocyclopentadiene				Organochlorine Pesticide	B
67-72-1	Hexachloroethane	12	c	1	Volatile	B
110-54-3	Hexane	0.58	a	1	Volatile	
2691-41-0	HMX (Octogen)	150	h,i	6	Other Pesticide/PCB	
302-01-2	Hydrazine (hardness <50)	5	e,f	4	Volatile	
302-01-2	Hydrazine (hardness =>50)	10	e,f	4	Volatile	
123-31-9	Hydroquinone	2.2	e,f	4	Other Semi-Volatile	
193-39-5	Indeno(1,2,3-c,d)pyrene				PAH	B
7439-89-6	Iron	300	b	2	Inorganic/Metal	
29761-21-5	Isodecyl diphenyl phosphate	1.7	e,f	4	Other Semi-Volatile	
98-82-8	Isopropylbenzene (Cumene)	2.6	e,f	4		
	Isothiazolones, total	1	e,f	4	Other Semi-Volatile	
7439-92-1	Lead (hardness=100)	2.5	n	13,15	Inorganic/Metal	B
58-89-9	Lindane (BHC,gamma)	0.01	b	2	Organochlorine Pesticide	
	Linear alkyl benzene sulfates (LAS)	40	e,f	4,19	Other Semi-Volatile	
7439-93-2	Lithium	14	a	1	Inorganic/Metal	

EPA Region III BTAG
FRESHWATER SCREENING BENCHMARKS
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CAS#	Analyte	Screening Value (ug/l)	Ref	End Note	Bioaccumulative[q]	B
					Class of Compound	
7439-95-4	Magnesium	82000	a	16	Inorganic/Metal	
121-75-5	Malathion	0.097	c	1	Other Pesticide/PCB	
7439-96-5	Manganese	120	a	1	Inorganic/Metal	
7439-97-6	Mercury	0.026	b	2	Inorganic/Metal	
72-43-5	Methoxychlor	0.019	c	1	Organochlorine Pesticide	B
78-93-3	Methyl ethyl ketone (2-Butanone)	14000	a	1	Volatile	
111-13-7	Methyl hexyl ketone (2-Octanone)	8.3	a	1	Volatile	
108-10-1	Methyl isobutyl ketone (4-Methyl-2-pentanone)	170	a	1	Volatile	
80-62-6	Methyl methacrylate	2800	l,m	10	Volatile	
1634-04-4	Methyl tert-butyl ether (MTBE)	11070	h,i	6	Other Semi-Volatile	
6317-18-6	Methylene bisthiocyanate	1	e,f	4	Other Semi-Volatile	
75-09-2	Methylene chloride (Dichloromethane)	98.1	b	2	Volatile	
22967-92-6	Methylmercury	0.004	b	2	Volatile	B
2385-85-5	Mirex	0.001	n	13	Chlorinated Pesticides	B
7439-98-7	Molybdenum	73	b	2	Inorganic/Metal	
108-90-7	Monochlorobenzene (Chlorobenzene)	1.3	b	2		
	Monochlorophenols, total	7	b	2	Other Semi-Volatile	
91-20-3	Naphthalene	1.1	b	2	PAH	
84-74-2	n-Butylphthalate (Di-n-butyl phthalate)	19	b	2	Other Semi-Volatile	
7440-02-0	Nickel (hardness=100)	52	n	13,15	Inorganic/Metal	B
139-13-9	Nitrilotriacetic acid	5000	e,f	4,20		
	Nitrite (cold water)	20	e,f	4	Anion	
	Nitrite (warm water)	100	e,f	4	Anion	
55-63-0	Nitroglycerine	138	h,i	6	Other Semi-Volatile	
55-18-5	N-Nitrosodiethylamine	768	l,m	10	Other Semi-Volatile	
62-75-9	N-Nitrosodimethylamine	117	o	21	Other Semi-Volatile	
86-30-6	N-Nitrosodiphenylamine	210	a	1	Other Semi-Volatile	
95-48-7	o-Cresol (2-Methylphenol)	13	a	1	Other Semi-Volatile	
56-38-2	Parathion	0.013	n	13	PAH	
	Parathion and methyl parathion	0.008	e,f	4	Organophosphorus Pesticide	
1336-36-3	PCBs, total	0.000074	j	8	Other Pesticide/PCB	
106-44-5	p-Cresol (4-Methylphenol)	543	h,i	6	Other Semi-Volatile	
608-93-5	Pentachlorobenzene	6	b	2	Other Semi-Volatile	B
76-01-7	Pentachloroethane	56.4	l,m	10	Other Semi-Volatile	
87-86-5	Pentachlorophenol (pH = 7.8)	0.5	b	2	Other Semi-Volatile	B
78-11-5	PETN (Pentaerythrite-tetranitrate)	85000	h,i	6	Other Semi-Volatile	
	pH	6.5-9	b	2	Inorganic	
85-01-8	Phenanthrene	0.4	b	2	PAH	B
108-95-2	Phenol	4	b	2	Other Semi-Volatile	B
100-42-5	Phenylethylene	72	b	2	Other Semi-Volatile	
298-02-2	Phorate	3.62	l,m	10		
7723-14-0	Phosphorus		p	22	Inorganic/Metal	
51207-31-9	Polychlorinated dibenzofurans		k	9	Dioxins/Furans	
	Polychlorinated dibenzo-p-dioxins (PCDD-S)		k	9	Dioxins/Furans	
7440-09-7	Potassium	53000	a	16	Inorganic/Metal	
103-65-1	Propyl benzene	128	h,i	6	Volatile	
129-00-0	Pyrene	0.025	b	2	PAH	B

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FRESHWATER SCREENING BENCHMARKS
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CAS#	Analyte	Screening Value (ug/l)	Ref	End Note	Bioaccumulative[q]	B
					Class of Compound	
110-86-1	Pyridine	2380	l,m	10	Volatile	
	Quaternary ammonium compounds, total	10	e,f	4	Inorganic	
121-82-4	RDX (Cyclonite)	360	h,i	6	Explosive	
7782-49-2	Selenium	1	b	2	Inorganic/Metal	B
7440-22-4	Silver (hardness = 100)	3.2	n	13,15	Inorganic/Metal	B
7440-23-5	Sodium	680000	a	16	Inorganic/Metal	
7440-24-6	Strontium	1500	a	1	Inorganic/Metal	
100-42-5	Styrene (Phenylethylene)	72	b	2	Volatile	
7783-06-4	Sulfide (Hydrogen Sulfide)	2	n	13	Anion	
	Sulfite	200	e,f	4	Anion	
95-94-3	Tetrachlorobenzene (1,2,4,5-Tetrachlorobenzene)	3	d	3	Other Semi-Volatile	
79-34-5	Tetrachloroethane (1,1,2,2-Tetrachloroethane)	610	a	1	Volatile	
127-18-4	Tetrachloroethene (1,1,2,2-Tetrachloroethylene)	111	b	2	Volatile	
127-18-4	Tetrachloroethylene (1,1,2,2-Tetrachloroethylene)	111	b	2	Volatile	
56-23-5	Tetrachloromethane (Carbon tetrachloride)	13.3	b	2	Volatile	
	Tetrachlorophenols, total	1	b	2	Other Semi-Volatile	
7440-28-0	Thallium	0.8	b	2	Inorganic/Metal	
7440-31-5	Tin	73	a	1	Inorganic/Metal	
108-88-3	Toluene	2	b	2	Volatile	
8001-35-2	Toxaphene	0.0002	n	13	Organochlorine Pesticide	B
156-60-5	trans-1,2-Dichloroethylene (1,2-trans-Dichloroethylene)	970	g	5	Volatile	
75-25-2	Tribromomethane (Bromoform)	320	c	1	Volatile	
688-73-3	Tributyltin	0.008	b	2	Inorganic/Metal	B
12002-48-1	Trichlorobenzene (mixed isomers)	5	e,f	4,23	Other Semi-Volatile	
79-00-5	Trichloroethane (1,1,2-Trichloroethane)	1200	a	1	Volatile	
79-01-6	Trichloroethene (Trichloroethylene)	21	b	2	Volatile	
79-01-6	Trichloroethylene	21	b	2	Volatile	
67-66-3	Trichloromethane (Chloroform)	1.8	b	2	Volatile	
25167-82-2	Trichlorophenols, total	18	b	2	Other Semi-Volatile	
1582-09-8	Trifluralin	0.2	b	2		
115-86-6	Triphenyl phosphate	4	e,f	4	Other Semi-Volatile	
7440-61-1	Uranium (hardness = 100)	2.6	a	1	Inorganic/Metal	
7440-62-2	Vanadium	20	a	1	Inorganic/Metal	
1314-62-1	Vanadium pentoxide	15	h,i	6	Inorganic/Metal	
108-05-4	Vinyl acetate	16	a	1	Volatile	
100-42-5	Vinyl benzene (Pheylethylene)	72	b	2	Volatile	
75-01-4	Vinyl chloride	930	d	3	Volatile	
75-35-4	Vinylidene chloride (1,1-Dichloroethylene)	25	a	1	Volatile	
108-38-3	Xylene, m-	1.8	c	1	Volatile	
1330-20-7	Xylenes (total)	13	a	1	Volatile	
7440-66-6	Zinc (hardness = 100)	120	n	15	Inorganic/Metal	B
7440-67-7	Zirconium	17	a	1	Inorganic/Metal	

Note: Values are expressed in terms of dissolved analyte in the water column except for those indicated with endnote 2 which are expressed in terms of total concentration.

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LITERATURE CITED

[a] Suter, G.W. II, and Tsao, C.L. 1996. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision. ES/ER/TM-96/R2. Available at: http://www.esd.ornl.gov/programs/ecorisk/documents/tm96r2.pdf

[b] CCME (Canadian Council of Ministers of the Environment). 2003. Canadian Environmental Quality Guidelines: Summary Table December 2003. Canadian Council of Ministers of the Environment, Winnipeg, Manitoba. Available at: http://www.ccme.ca/publications/ceqg_rcqe.html.

[c] U.S. EPA. OSWER (Office of Solid Waste and Emergency Response). 1996. Eco Update: Ecotox thresholds. Washington, D.C. EPA 540/F-95/038. Available at: http://www.epa.gov/oswer/riskassessment/pdf/eco_updt.pdf

[d] Michigan DEQ (Department of Environmental Quality). 2002. Rule 57: Water Quality Values. Available at: http://www.deq.state.mi.us/documents/deq-swq-gleas-r57inter.xls

[e] NY DEC (New York State Department of Environmental Conservation), Division of Water. 1993. Technical and Operational Guidance Series (1.1.1). Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations. Available at: http://www.dec.state.ny.us/website/dow/togs/togs111.pdf

[f] NYCRR (New York Compilation of Codes, Rules, and Regulations). 1999. Title 6, Part 706. Available at: http://www.dec.state.ny.us/website/regs/part706.html

[g] Ohio EPA, Division of Surface Water. 2002. Ohio Administrative Code (OAC) 3745-1-07: Water Use Designations and Statewide Criteria. Available at: http://www.epa.state.oh.us/dsw/rules/3745-1.html and http://www.epa.state.oh.us/dsw/wqs/criteria.html

[h] TNRCC (Texas Natural Resource Conservation Commission), Toxicology and Risk Assessment Section. December 2001. Guidance for Conducting Ecological Risk Assessments at Remediation Sites in Texas. Available at:http://www.tceq.state.tx.us/comm_exec/forms_pubs/pubs/rg/rg-263_189521.pdf

[i] TNRCC (Texas Natural Resources Conservation Commission). 2000. Texas Surface Water Quality Standards. Texas Administrative Code (TAC), Title 30, Chapter 307. Effective August 17, 2000. Available at: http://www.tceq.state.tx.us/permitting/water_quality/wq_assessment/standards/WQ_standards_1997.html

[j] U.S. EPA 1995. Final Water Quality Guidance for the Great Lakes System. 40CFR Parts 9, 122, 123, 131 and 132. March 23, 1995, 15366-15425. Available at: http://www.epa.gov/npdes/regulations/greatlakes_fedregstr.pdf

[k] Van den Berg, M., Birnbaum, L., Bosveld, A.T.C., Brunstrom, B., Cook, P., Feeley, M., Giesy, J.P., Hanberg, A., Hasegawa, R., Kennedy, S.W., Kubiak, T., Larsen, J.C., Rolaf van Leeuwen, F.X., Liem, A.K.D., Nolt, C., Peterson, R.E., Poellinger, L., Safe, S., Schrenk, D., Tillitt, D., Tysklind, M., Younes, M., Waern, F., and Zacharewski, T. 1998. Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environmental Health Perspectives. 106 (12): 775-792. Available at: http://ehp.niehs.nih.gov/members/1998/106p775-792vandenberg/vandenberg-full.html

[l] U.S. EPA Region 5. 2003. Region 5 EDQL for all media. Available at: http://www.epa.gov/reg5rcra/ca/ESL.pdf.

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[n] U.S. EPA. 2004. National Recommended Water Quality Criteria: 2004. Available at: http://www.epa.gov/waterscience/criteria/wqcriteria.html

[o] Oregon DEQ (Department of Environmental Quality). 1998. Guidance for Ecological Risk Assessment: Level II Screening Benchmark Values. Updated December 2001. Oregon Dept. Env. Qual., Portland. SLV-2. Available at: http://www.deq.state.or.us/wmc/documents/eco-2slv.pdf

[p] U.S. EPA. Ecoregional Nutrient Criteria. Available at: http:/www.epa.gov/waterscience/criteria/nutrient/ecoregions.

[q] U.S. EPA. 2000. Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment. Available at: http://www.epa.gov/waterscience/cs/biotesting/bioaccum.pdf

ENDNOTES

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LITERATURE CITED

[a] Suter, G.W. II, and Tsao, C.L. 1996. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision. ES/ER/TM-96/R2. Available at: http://www.esd.ornl.gov/programs/ecorisk/documents/tm96r2.pdf

[b] CCME (Canadian Council of Ministers of the Environment). 2003. Canadian Environmental Quality Guidelines: Summary Table December 2003. Canadian Council of Ministers of the Environment, Winnipeg, Manitoba. Available at: http://www.ec.gc.ca/ceqg-rcqe/English/ceqg/water/default.cfm#pro.

[c] U.S. EPA. OSWER (Office of Solid Waste and Emergency Response). 1996. Eco Update: Ecotox thresholds. Washington, D.C. EPA 540/F-95/038. Available at: http://www.epa.gov/oswer/riskassessment/pdf/eco_updt.pdf

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USEPA-AWQC

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Office of Science and Technology
(4304T)

2006

National Recommended Water Quality Criteria

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY TOXIC POLLUTANTS

			Freshwater		Saltwater		Human Health For Consumption of:		
	Priority Pollutant	CAS Number	CMC (µg/L)	CCC (µg/L)	CMC (µg/L)	CCC (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)	FR Cite/ Source
1	Antimony	7440360					5.6 B	640 B	65FR66443
2	Arsenic	7440382	340 A,D,K	150 A,D,K	69 A,D,bb	36 A,D,bb	0.018 C,M,S	0.14 C,M,S	65FR31682 57FR60848
3	Beryllium	7440417					Z		65FR31682
4	Cadmium	7440439	2.0 D,E,K,bb	0.25 D,E,K,bb	40 D,bb	8.8 D,bb	Z		EPA-822-R-01-001 65FR31682
5a	Chromium (III)	16065831	570 D,E,K	74 D,E,K			Z Total		EPA820/B-96-001 65FR31682
5b	Chromium (VI)	18540299	16 D,K	11 D,K	1,100 D,bb	50 D,bb	Z Total		65FR31682
6	Copper	7440508	13 D,E,K,cc	9.0 D,E,K,cc	4.8 D,cc,ff	3.1 D,cc,ff	1,300 U		65FR31682
7	Lead	7439921	65 D,E,bb,gg	2.5 D,E,bb,gg	210 D,bb	8.1 D,bb			65FR31682
8a 8b	Mercury Methylmercury	7439976 22967926	1.4 D,K,hh	0.77 D,K,hh	1.8 D,ee,hh	0.94 D,ee,hh		0.3 mg/kg J	62FR42160 EPA823-R-01-001
9	Nickel	7440020	470 D,E,K	52 D,E,K	74 D,bb	8.2 D,bb	610 B	4,600 B	65FR31682
10	Selenium	7782492	L,R,T	5.0 T	290 D,bb,dd	71 D,bb,dd	170 Z	4200	62FR42160 65FR31682 65FR66443
11	Silver	7440224	3.2 D,E,G		1.9 D,G				65FR31682

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY TOXIC POLLUTANTS

	Priority Pollutant	CAS Number	Freshwater		Saltwater		Human Health For Consumption of:		FR Cite/ Source
			CMC (µg/L)	CCC (µg/L)	CMC (µg/L)	CCC (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)	
12	Thallium	7440280					0.24	0.47	68FR75510
13	Zinc	7440666	120 D,E,K	120 D,E,K	90 D,bb	81 D,bb	7,400 U	26,000 U	65FR31682 65FR66443
14	Cyanide	57125	22 K,Q	5.2 K,Q	1 Q,bb	1 Q,bb	140 jj	140 jj	EPA820/B-96-001 57FR60848 68FR75510
15	Asbestos	1332214					7 million fibers/L I		57FR60848
16	2,3,7,8-TCDD (Dioxin)	1746016					5.0E-9 C	5.1E-9 C	65FR66443
17	Acrolein	107028					190	290	65FR66443
18	Acrylonitrile	107131					0.051 B,C	0.25 B,C	65FR66443
19	Benzene	71432					2.2 B,C	51 B,C	IRIS 01/19/00 &65FR66443
20	Bromoform	75252					4.3 B,C	140 B,C	65FR66443
21	Carbon Tetrachloride	56235					0.23 B,C	1.6 B,C	65FR66443
22	Chlorobenzene	108907					130 Z,U,	1,600 U	68FR75510
23	Chlorodibromomethane	124481					0.40 B,C	13 B,C	65FR66443
24	Chloroethane	75003							

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			Freshwater		Saltwater		Human Health For Consumption of:		
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25	2-Chloroethylvinyl Ether	110758							
26	Chloroform	67663					5.7 C,P	470 C,P	62FR42160
27	Dichlorobromomethane	75274					0.55 B,C	17 B,C	65FR66443
28	1,1-Dichloroethane	75343							
29	1,2-Dichloroethane	107062					0.38 B,C	37 B,C	65FR66443
30	1,1-Dichloroethylene	75354					330	7,100	68FR75510
31	1,2-Dichloropropane	78875					0.50 B,C	15 B,C	65FR66443
32	1,3-Dichloropropene	542756					0.34 C	21 C	68FR75510
33	Ethylbenzene	100414					530	2,100	68FR75510
34	Methyl Bromide	74839					47 B	1,500 B	65FR66443
35	Methyl Chloride	74873							65FR31682
36	Methylene Chloride	75092					4.6 B,C	590 B,C	65FR66443
37	1,1,2,2-Tetrachloroethane	79345					0.17 B,C	4.0 B,C	65FR66443
38	Tetrachloroethylene	127184					0.69 C	3.3 C	65FR66443
39	Toluene	108883					1,300 Z	15,000	68FR75510
40	1,2-Trans-Dichloroethylene	156605					140 Z	10,000	68FR75510

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY TOXIC POLLUTANTS

			Freshwater		Saltwater		Human Health For Consumption of:		
	Priority Pollutant	CAS Number	CMC (µg/L)	CCC (µg/L)	CMC (µg/L)	CCC (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)	FR Cite/ Source
41	1,1,1-Trichloroethane	71556					Z		65FR31682
42	1,1,2-Trichloroethane	79005					0.59 B,C	16 B,C	65FR66443
43	Trichloroethylene	79016					2.5 C	30 C	65FR66443
44	Vinyl Chloride	75014					0.025 C,kk	2.4 C,kk	68FR75510
45	2-Chlorophenol	95578					81 B,U	150 B,U	65FR66443
46	2,4-Dichlorophenol	120832					77 B,U	290 B,U	65FR66443
47	2,4-Dimethylphenol	105679					380 B	850 B,U	65FR66443
48	2-Methyl-4,6-Dinitrophenol	534521					13	280	65FR66443
49	2,4-Dinitrophenol	51285					69 B	5,300 B	65FR66443
50	2-Nitrophenol	88755							
51	4-Nitrophenol	100027							
52	3-Methyl-4-Chlorophenol	59507					U	U	
53	Pentachlorophenol	87865	19 F,K	15 F,K	13 bb	7.9 bb	0.27 B,C	3.0 B,C,H	65FR31682 65FR66443
54	Phenol	108952					21,000 B,U	1,700,000 B,U	65FR66443
55	2,4,6-Trichlorophenol	88062					1.4 B,C	2.4 B,C,U	65FR66443
56	Acenaphthene	83329					670 B,U	990 B,U	65FR66443

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY TOXIC POLLUTANTS

	Priority Pollutant	CAS Number	Freshwater		Saltwater		Human Health For Consumption of:		FR Cite/ Source
			CMC (µg/L)	CCC (µg/L)	CMC (µg/L)	CCC (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)	
57	Acenaphthylene	208968							
58	Anthracene	120127					8,300 B	40,000 B	65FR66443
59	Benzidine	92875					0.000086 B,C	0.00020 B,C	65FR66443
60	Benzo(a)Anthracene	56553					0.0038 B,C	0.018 B,C	65FR66443
61	Benzo(a)Pyrene	50328					0.0038 B,C	0.018 B,C	65FR66443
62	Benzo(b)Fluoranthene	205992					0.0038 B,C	0.018 B,C	65FR66443
63	Benzo(ghi)Perylene	191242							
64	Benzo(k)Fluoranthene	207089					0.0038 B,C	0.018 B,C	65FR66443
65	Bis(2-Chloroethoxy)Methane	111911							
66	Bis(2-Chloroethyl)Ether	111444					0.030 B,C	0.53 B,C	65FR66443
67	Bis(2-Chloroisopropyl)Ether	108601					1,400 B	65,000 B	65FR66443
68	Bis(2-Ethylhexyl)Phthalate^{X}	117817					1.2 B,C	2.2 B,C	65FR66443
69	4-Bromophenyl Phenyl Ether	101553							
70	Butylbenzyl Phthalate^{W}	85687					1,500 B	1,900 B	65FR66443
71	2-Chloronaphthalene	91587					1,000 B	1,600 B	65FR66443
72	4-Chlorophenyl Phenyl Ether	7005723							

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY TOXIC POLLUTANTS

			Freshwater		Saltwater		Human Health For Consumption of:		
	Priority Pollutant	CAS Number	CMC (μg/L)	CCC (μg/L)	CMC (μg/L)	CCC (μg/L)	Water + Organism (μg/L)	Organism Only (μg/L)	FR Cite/ Source
73	Chrysene	218019					0.0038 B,C	0.018 B,C	65FR66443
74	Dibenzo(a,h)Anthracene	53703					0.0038 B,C	0.018 B,C	65FR66443
75	1,2-Dichlorobenzene	95501					420	1,300	68FR75510
76	1,3-Dichlorobenzene	541731					320	960	65FR66443
77	1,4-Dichlorobenzene	106467					63	190	68FR75510
78	3,3'-Dichlorobenzidine	91941					0.021 B,C	0.028 B,C	65FR66443
79	Diethyl Phthalate^{W}	84662					17,000 B	44,000 B	65FR66443
80	Dimethyl Phthalate^{W}	131113					270,000	1,100,000	65FR66443
81	Di-n-Butyl Phthalate^{W}	84742					2,000 B	4,500 B	65FR66443
82	2,4-Dinitrotoluene	121142					0.11 C	3.4 C	65FR66443
83	2,6-Dinitrotoluene	606202							
84	Di-n-Octyl Phthalate	117840							
85	1,2-Diphenylhydrazine	122667					0.036 B,C	0.20 B,C	65FR66443
86	Fluoranthene	206440					130 B	140 B	65FR66443
87	Fluorene	86737					1,100 B	5,300 B	65FR66443
88	Hexachlorobenzene	118741					0.00028 B,C	0.00029 B,C	65FR66443

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY TOXIC POLLUTANTS

			Freshwater		Saltwater		Human Health For Consumption of:		
	Priority Pollutant	CAS Number	CMC (µg/L)	CCC (µg/L)	CMC (µg/L)	CCC (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)	FR Cite/ Source
89	Hexachlorobutadiene	87683					0.44 B,C	18 B,C	65FR66443
90	Hexachlorocyclopentadiene	77474					40 U	1,100 U	68FR75510
91	Hexachloroethane	67721					1.4 B,C	3.3 B,C	65FR66443
92	Ideno(1,2,3-cd)Pyrene	193395					0.0038 B,C	0.018 B,C	65FR66443
93	Isophorone	78591					35 B,C	960 B,C	65FR66443
94	Naphthalene	91203							
95	Nitrobenzene	98953					17 B	690 B,H,U	65FR66443
96	N-Nitrosodimethylamine	62759					0.00069 B,C	3.0 B,C	65FR66443
97	N-Nitrosodi-n-Propylamine	621647					0.0050 B,C	0.51 B,C	65FR66443
98	N-Nitrosodiphenylamine	86306					3.3 B,C	6.0 B,C	65FR66443
99	Phenanthrene	85018							
100	Pyrene	129000					830 B	4,000 B	65FR66443
101	1,2,4-Trichlorobenzene	120821					35	70	68FR75510
102	Aldrin	309002	3.0 G		1.3 G		0.000049 B,C	0.000050 B,C	65FR31682 65FR66443
103	alpha-BHC	319846					0.0026 B,C	0.0049 B,C	65FR66443
104	beta-BHC	319857					0.0091 B,C	0.017 B,C	65FR66443

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY TOXIC POLLUTANTS

			Freshwater		Saltwater		Human Health For Consumption of:		
	Priority Pollutant	CAS Number	CMC (µg/L)	CCC (µg/L)	CMC (µg/L)	CCC (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)	FR Cite/ Source
105	gamma-BHC (Lindane)	58899	0.95 K		0.16 G		0.98	1.8	65FR31682 68FR75510
106	delta-BHC	319868							
107	Chlordane	57749	2.4 G	0.0043 G,aa	0.09 G	0.004 G,aa	0.00080 B,C	0.00081 B,C	65FR31682 65FR66443
108	4,4'-DDT	50293	1.1 G,ii	0.001 G,aa,ii	0.13 G,ii	0.001 G,aa,ii	0.00022 B,C	0.00022 B,C	65FR31682 65FR66443
109	4,4'-DDE	72559					0.00022 B,C	0.00022 B,C	65FR66443
110	4,4'-DDD	72548					0.00031 B,C	0.00031 B,C	65FR66443
111	Dieldrin	60571	0.24 K	0.056 K,O	0.71 G	0.0019 G,aa	0.000052 B,C	0.000054 B,C	65FR31682 65FR66443
112	alpha-Endosulfan	959988	0.22 G,Y	0.056 G,Y	0.034 G,Y	0.0087 G,Y	62 B	89 B	65FR31682 65FR66443
113	beta-Endosulfan	33213659	0.22 G,Y	0.056 G,Y	0.034 G,Y	0.0087 G,Y	62 B	89 B	65FR31682 65FR66443
114	Endosulfan Sulfate	1031078					62 B	89 B	65FR66443
115	Endrin	72208	0.086 K	0.036 K,O	0.037 G	0.0023 G,aa	0.059	0.060	65FR31682 68FR75510
116	Endrin Aldehyde	7421934					0.29 B	0.30 B,H	65FR66443

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY TOXIC POLLUTANTS

			Freshwater		Saltwater		Human Health For Consumption of:		
	Priority Pollutant	CAS Number	CMC ($\mu g/L$)	CCC ($\mu g/L$)	CMC ($\mu g/L$)	CCC ($\mu g/L$)	Water + Organism ($\mu g/L$)	Organism Only ($\mu g/L$)	FR Cite/ Source
117	Heptachlor	76448	0.52 G	0.0038 G,aa	0.053 G	0.0036 G,aa	0.000079 B,C	0.000079 B,C	65FR31682 65FR66443
118	Heptachlor Epoxide	1024573	0.52 G,V	0.0038 G,V,aa	0.053 G,V	0.0036 G,V,aa	0.000039 B,C	0.000039 B,C	65FR31682 65FR66443
119	Polychlorinated Biphenyls PCBs:			0.014 N,aa		0.03 N,aa	0.000064 B,C,N	0.000064 B,C,N	65FR31682 65FR66443
120	Toxaphene	8001352	0.73	0.002 aa	0.21	0.002 aa	0.00028B,C	0.00028 B,C	65FR31682 65FR66443

Footnotes:

A This recommended water quality criterion was derived from data for arsenic (III), but is applied here to total arsenic, which might imply that arsenic (III) and arsenic (V) are equally toxic to aquatic life and that their toxicities are additive. In the arsenic criteria document (EPA 440/5-84-033, January 1985), Species Mean Acute Values are given for both arsenic (III) and arsenic (V) for five species and the ratios of the SMAVs for each species range from 0.6 to 1.7. Chronic values are available for both arsenic (III) and arsenic (V) for one species; for the fathead minnow, the chronic value for arsenic (V) is 0.29 times the chronic value for arsenic (III). No data are known to be available concerning whether the toxicities of the forms of arsenic to aquatic organisms are additive.

B This criterion has been revised to reflect The Environmental Protection Agency's q1* or RfD, as contained in the Integrated Risk Information System (IRIS) as of May 17, 2002. The fish tissue bioconcentration factor (BCF) from the 1980 Ambient Water Quality Criteria document was retained in each case.

C This criterion is based on carcinogenicity of 10^{-6} risk. Alternate risk levels may be obtained by moving the decimal point (e.g., for a risk level of 10^{-5}, move the decimal point in the recommended criterion one place to the right).

D Freshwater and saltwater criteria for metals are expressed in terms of the dissolved metal in the water column. The recommended water quality criteria value was calculated by using the previous 304(a) aquatic life criteria expressed in terms of total recoverable metal, and multiplying it by a conversion factor (CF). The term "Conversion Factor" (CF) represents the recommended conversion factor for converting a metal criterion expressed as the total recoverable fraction in the water column to a criterion expressed as the dissolved fraction in the water column. (Conversion Factors for saltwater CCCs are not currently available. Conversion factors derived for saltwater CMCs have been used for both saltwater CMCs and CCCs). See "Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria," October 1, 1993, by Martha G. Prothro, Acting Assistant Administrator for

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY TOXIC POLLUTANTS

Water, available from the Water Resource center, USEPA, 401 M St., SW, mail code RC4100, Washington, DC 20460; and 40CFR§131.36(b)(1). Conversion Factors applied in the table can be found in Appendix A to the Preamble- Conversion Factors for Dissolved Metals.

E The freshwater criterion for this metal is expressed as a function of hardness (mg/L) in the water column. The value given here corresponds to a hardness of 100 mg/L. Criteria values for other hardness may be calculated from the following: CMC (dissolved) = exp{m_A [ln(hardness)]+ b_A} (CF), or CCC (dissolved) = exp{m_C [ln (hardness)]+ b_C} (CF) and the parameters specified in Appendix B- Parameters for Calculating Freshwater Dissolved Metals Criteria That Are Hardness-Dependent.

F Freshwater aquatic life values for pentachlorophenol are expressed as a function of pH, and are calculated as follows: CMC = exp(1.005(pH)-4.869); CCC = exp(1.005(pH)-5.134). Values displayed in table correspond to a pH of 7.8.

G This Criterion is based on 304(a) aquatic life criterion issued in 1980, and was issued in one of the following documents: Aldrin/Dieldrin (EPA 440/5-80-019), Chlordane (EPA 440/5-80-027), DDT (EPA 440/5-80-038), Endosulfan (EPA 440/5-80-046), Endrin (EPA 440/5-80-047), Heptachlor (EPA 440/5-80-052), Hexachlorocyclohexane (EPA 440/5-80-054), Silver (EPA 440/5-80-071). The Minimum Data Requirements and derivation procedures were different in the 1980 Guidelines than in the 1985 Guidelines. For example, a "CMC" derived using the 1980 Guidelines was derived to be used as an instantaneous maximum. If assessment is to be done using an averaging period, the values given should be divided by 2 to obtain a value that is more comparable to a CMC derived using the 1985 Guidelines.

H No criterion for protection of human health from consumption of aquatic organisms excluding water was presented in the 1980 criteria document or in the *1986 Quality Criteria for Water*. Nevertheless, sufficient information was presented in the 1980 document to allow the calculation of a criterion, even though the results of such a calculation were not shown in the document.

I This criterion for asbestos is the Maximum Contaminant Level (MCL) developed under the Safe Drinking Water Act (SDWA).

J This fish tissue residue criterion for methylmercury is based on a total fish consumption rate of 0.0175 kg/day.

K This recommended criterion is based on a 304(a) aquatic life criterion that was issued in the *1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water*, (EPA-820-B-96-001, September 1996). This value was derived using the GLI Guidelines (60FR15393-15399, March 23, 1995; 40CFR132 Appendix A); the difference between the 1985 Guidelines and the GLI Guidelines are explained on page iv of the 1995 Updates. None of the decisions concerning the derivation of this criterion were affected by any considerations that are specific to the Great Lakes.

L The CMC = 1/[(f1/CMC1) + (f2/CMC2)] where f1 and f2 are the fractions of total selenium that are treated as selenite and selenate, respectively, and CMC1 and CMC2 are 185.9 μg/l and 12.82 μg/l, respectively.

M EPA is currently reassessing the criteria for arsenic.

N This criterion applies to total pcbs, (e.g., the sum of all congener or all isomer or homolog or Aroclor analyses.)

O The derivation of the CCC for this pollutant (Endrin) did not consider exposure through the diet, which is probably important for aquatic life occupying upper trophic levels.

P Although a new RfD is available in IRIS, the surface water criteria will not be revised until the National Primary Drinking Water Regulations: Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 DBPR) is completed, since public comment on the relative source contribution (RSC) for chloroform is anticipated.

Q This recommended water quality criterion is expressed as μg free cyanide (as CN)/L.

R This value for selenium was announced (61FR58444-58449, November 14, 1996) as a proposed GLI 303(c) aquatic life criterion. EPA is currently working on this criterion and so this value might change substantially in the near future.

S This recommended water quality criterion for arsenic refers to the inorganic form only.

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY TOXIC POLLUTANTS

T This recommended water quality criterion for selenium is expressed in terms of total recoverable metal in the water column. It is scientifically acceptable to use the conversion factor (0.996- CMC or 0.922- CCC) that was used in the GLI to convert this to a value that is expressed in terms of dissolved metal.

U The organoleptic effect criterion is more stringent than the value for priority toxic pollutants.

V This value was derived from data for heptachlor and the criteria document provides insufficient data to estimate the relative toxicities of heptachlor and heptachlor epoxide.

W Although EPA has not published a completed criteria document for butylbenzyl phthalate it is EPA's understanding that sufficient data exist to allow calculation of aquatic criteria. It is anticipated that industry intends to publish in the peer reviewed literature draft aquatic life criteria generated in accordance with EPA Guidelines. EPA will review such criteria for possible issuance as national WQC.

X There is a full set of aquatic life toxicity data that show that DEHP is not toxic to aquatic organisms at or below its solubility limit.

Y This value was derived from data for endosulfan and is most appropriately applied to the sum of alpha-endosulfan and beta-endosulfan.

Z A more stringent MCL has been issued by EPA. Refer to drinking water regulations (40 CFR 141) or Safe Drinking Water Hotline (1-800-426-4791) for values.

aa This criterion is based on a 304(a) aquatic life criterion issued in 1980 or 1986, and was issued in one of the following documents: Aldrin/Dieldrin (EPA 440/5-80-019), Chlordane (EPA 440/5-80-027), DDT (EPA 440/5-80-038), Endrin (EPA 440/5-80-047), Heptachlor (EPA 440/5-80-052), Polychlorinated biphenyls (EPA 440/5-80-068), Toxaphene (EPA 440/5-86-006). This CCC is currently based on the Final Residue Value (FRV) procedure. Since the publication of the Great Lakes Aquatic Life Criteria Guidelines in 1995 (60FR15393-15399, March 23, 1995), the Agency no longer uses the Final Residue Value procedure for deriving CCCs for new or revised 304(a) aquatic life criteria. Therefore, the Agency anticipates that future revisions of this CCC will not be based on the FRV procedure.

bb This water quality criterion is based on a 304(a) aquatic life criterion that was derived using the 1985 Guidelines (*Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, PB85-227049, January 1985) and was issued in one of the following criteria documents: Arsenic (EPA 440/5-84-033), Cadmium (EPA-822-R-01-001), Chromium (EPA 440/5-84-029), Copper (EPA 440/5-84-031), Cyanide (EPA 440/5- 84-028), Lead (EPA 440/5-84-027), Nickel (EPA 440/5-86-004), Pentachlorophenol (EPA 440/5-86-009), Toxaphene, (EPA 440/5-86-006), Zinc (EPA 440/5-87- 003).

cc When the concentration of dissolved organic carbon is elevated, copper is substantially less toxic and use of Water-Effect Ratios might be appropriate.

dd The selenium criteria document (EPA 440/5-87-006, September 1987) provides that if selenium is as toxic to saltwater fishes in the field as it is to freshwater fishes in the field, the status of the fish community should be monitored whenever the concentration of selenium exceeds 5.0 μg/L in salt water because the saltwater CCC does not take into account uptake via the food chain.

ee This recommended water quality criterion was derived on page 43 of the mercury criteria document (EPA 440/5-84-026, January 1985). The saltwater CCC of 0.025 ug/L given on page 23 of the criteria document is based on the Final Residue Value procedure in the 1985 Guidelines. Since the publication of the Great Lakes Aquatic Life Criteria Guidelines in 1995 (60FR15393-15399, March 23, 1995), the Agency no longer uses the Final Residue Value procedure for deriving CCCs for new or revised 304(a) aquatic life criteria.

ff This recommended water quality criterion was derived in *Ambient Water Quality Criteria Saltwater Copper Addendum* (Draft, April 14, 1995) and was promulgated in the Interim final National Toxics Rule (60FR22228-222237, May 4, 1995).

gg EPA is actively working on this criterion and so this recommended water quality criterion may change substantially in the near future.

hh This recommended water quality criterion was derived from data for inorganic mercury (II), but is applied here to total mercury. If a substantial portion of the mercury in the water column is methylmercury, this criterion will probably be under protective. In addition, even though inorganic mercury is converted to methylmercury and methylmercury bioaccumulates to a great extent, this criterion does not account for uptake via the food chain because sufficient data were not available when the criterion was derived.

ii This criterion applies to DDT and its metabolites (i.e., the total concentration of DDT and its metabolites should not exceed this value).

jj This recommended water quality criterion is expressed as total cyanide, even though the IRIS RFD we used to derive the criterion is based on free cyanide. The multiple forms of cyanide that are present in ambient water have significant differences in toxicity due to their differing abilities to liberate the CN-moiety. Some complex cyanides require even more extreme conditions than refluxing with sulfuric acid to liberate the CN-moiety. Thus, these complex cyanides are expected to have little or no 'bioavailability' to humans. If a substantial fraction of the cyanide present in a water body is present in a complexed form (e.g., $Fe_4[Fe(CN)_6]_3$), this criterion may be over conservative.

kk This recommended water quality criterion was derived using the cancer slope factor of 1.4 (LMS exposure from birth).

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR NON PRIORITY POLLUTANTS

			Freshwater		Saltwater		Human Health For Consumption of:		
	Non Priority Pollutant	CAS Number	CMC ($\mu g/L$)	CCC ($\mu g/L$)	CMC ($\mu g/L$)	CCC ($\mu g/L$)	Water + Organism ($\mu g/L$)	Organism Only ($\mu g/L$)	FR Cite/Source
1	Alkalinity	--		20000 F					Gold Book
2	Aluminum pH 6.5 - 9.0	7429905	750 G,I	87 G,I,L					53FR33178
3	Ammonia	7664417	FRESHWATER CRITERIA ARE pH, Temperature and Life-stage DEPENDENT -- SEE DOCUMENT D SALTWATER CRITERIA ARE pH AND TEMPERATURE DEPENDENT						EPA822-R-99-014 EPA440/5-88-004
4	Aesthetic Qualities	--	NARRATIVE STATEMENT-- SEE DOCUMENT						Gold Book
5	Bacteria	--	FOR PRIMARY RECREATION AND SHELLFISH USES -- SEE DOCUMENT						Gold Book
6	Barium	7440393					1,000 A		Gold Book
7	Boron	--	NARRATIVE STATEMENT-- SEE DOCUMENT						Gold Book
8	Chloride	16887006	860000 G	230000 G					53FR19028
9	Chlorine	7782505	19	11	13	7.5	C		Gold Book
10	Chlorophenoxy Herbicide (2,4,5,-TP)	93721					10 A		Gold Book
11	Chlorophenoxy Herbicide (2,4-D)	94757					100 A,C		Gold Book
12	Chloropyrifos	2921882	0.083 G	0.041 G	0.011 G	0.0056 G			Gold Book
13	Color	--	NARRATIVE STATEMENT-- SEE DOCUMENT F						Gold Book

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR NON PRIORITY POLLUTANTS

			Freshwater		Saltwater		Human Health For Consumption of:		
	Non Priority Pollutant	CAS Number	CMC (µg/L)	CCC (µg/L)	CMC (µg/L)	CCC (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)	FR Cite/Source
14	Demeton	8065483		0.1 F		0.1 F			Gold Book
15	Ether, Bis(Chloromethyl)	542881					0.00010 E, H	0.00029 E,H	65FR66443
16	Gases, Total Dissolved	--	NARRATIVE STATEMENT -- SEE DOCUMENT F						Gold Book
17	Guthion	86500		0.01 F		0.01 F			Gold Book
18	Hardness	--	NARRATIVE STATEMENT-- SEE DOCUMENT						Gold Book
19	Hexachlorocyclo-hexane-Technical	319868					0.0123	0.0414	Gold Book
20	Iron	7439896		1000 F			300 A		Gold Book
21	Malathion	121755		0.1 F		0.1 F			Gold Book
22	Manganese	7439965					50 A,O	100 A	Gold Book
23	Methoxychlor	72435		0.03 F		0.03 F	100 A,C		Gold Book
24	Mirex	2385855		0.001 F		0.001 F			Gold Book
25	Nitrates	14797558					10,000 A		Gold Book
26	Nitrosamines	--					0.0008	1.24	Gold Book
27	Dinitrophenols	25550587					69	5300	65FR66443
28	Nonylphenol	1044051	28	6.6	7.0	1.7			71FR9337
29	Nitrosodibutylamine,N	924163					0.0063 A,H	0.22 A,H	65FR66443
30	Nitrosodiethylamine,N	55185					0.0008 A,H	1.24 A,H	Gold Book

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR NON PRIORITY POLLUTANTS

			Freshwater		Saltwater		Human Health For Consumption of:		
	Non Priority Pollutant	CAS Number	CMC ($\mu g/L$)	CCC ($\mu g/L$)	CMC ($\mu g/L$)	CCC ($\mu g/L$)	Water + Organism ($\mu g/L$)	Organism Only ($\mu g/L$)	FR Cite/Source
31	Nitrosopyrrolidine,N	930552					0.016 H	34 H	65FR66443
32	Oil and Grease	--	NARRATIVE STATEMENT -- SEE DOCUMENT F						Gold Book
33	Oxygen, Dissolved Freshwater Oxygen, Dissolved Saltwater	7782447	WARMWATER AND COLDWATER MATRIX -- SEE DOCUMENT N SALTWATER -- SEE DOCUMENT						Gold Book EPA-822R-00-012
34	Diazinon	333415	0.17	0.17	0.82	0.82			71FR9336
35	Parathion	56382	0.065 J	0.013 J					Gold Book
36	Pentachlorobenzene	608935					1.4 E	1.5 E	65FR66443
37	pH	--		6.5 - 9 F		6.5 - 8.5 F,K	5 - 9		Gold Book
38	Phosphorus Elemental	7723140				0.1 F,K			Gold Book
39	Nutrients	--	See EPA's Ecoregional criteria for Total Phosphorus, Total Nitrogen, Chlorophyll *a* and Water Clarity (Secchi depth for lakes; turbidity for streams and rivers) (& Level III Ecoregional criteria)						P
40	Solids Dissolved and Salinity	--					250,000 A		Gold Book
41	Solids Suspended and Turbidity	--	NARRATIVE STATEMENT -- SEE DOCUMENT F						Gold Book
42	Sulfide-Hydrogen Sulfide	7783064		2.0 F		2.0 F			Gold Book
43	Tainting Substances	--	NARRATIVE STATEMENT -- SEE DOCUMENT						Gold Book
44	Temperature	--	SPECIES DEPENDENT CRITERIA -- SEE DOCUMENT M						Gold Book

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR NON PRIORITY POLLUTANTS

			Freshwater		Saltwater		Human Health For Consumption of:		
	Non Priority Pollutant	CAS Number	CMC (μg/L)	CCC (μg/L)	CMC (μg/L)	CCC (μg/L)	Water + Organism (μg/L)	Organism Only (μg/L)	FR Cite/Source
45	Tetrachlorobenzene,1,2,4,5-	95943					0.97 E	1.1 E	65FR66443
46	Tributyltin (TBT)	--	0.46 Q	0.072 Q	0.42 Q	0.0074 Q			EPA 822-F-00-008
47	Trichlorophenol,2,4,5-	95954					1,800 B,E	3,600 B,E	65FR66443

Footnotes:

A This human health criterion is the same as originally published in the Red Book which predates the 1980 methodology and did not utilize the fish ingestion BCF approach. This same criterion value is now published in the Gold Book.

B The organoleptic effect criterion is more stringent than the value presented in the non priority pollutants table.

C A more stringent Maximum Contaminant Level (MCL) has been issued by EPA under the Safe Drinking Water Act. Refer to drinking water regulations 40CFR141 or Safe Drinking Water Hotline (1-800-426-4791) for values.

D According to the procedures described in the *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, except possibly where a very sensitive species is important at a site, freshwater aquatic life should be protected if both conditions specified in Appendix C to the Preamble- Calculation of Freshwater Ammonia Criterion are satisfied.

E This criterion has been revised to reflect EPA's q1* or RfD, as contained in the Integrated Risk Information System (IRIS) as of May 17, 2002. The fish tissue bioconcentration factor (BCF) used to derive the original criterion was retained in each case.

F The derivation of this value is presented in the Red Book (EPA 440/9-76-023, July, 1976).

G This value is based on a 304(a) aquatic life criterion that was derived using the 1985 Guidelines (*Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, PB85-227049, January 1985) and was issued in one of the following criteria documents: Aluminum (EPA 440/5-86-008); Chloride (EPA 440/5-88-001); Chloropyrifos (EPA 440/5-86-005).

H This criterion is based on carcinogenicity of 10^{-6} risk. Alternate risk levels may be obtained by moving the decimal point (e.g., for a risk level of 10^{-5}, move the decimal point in the recommended criterion one place to the right).

I This value for aluminum is expressed in terms of total recoverable metal in the water column.

J This value is based on a 304(a) aquatic life criterion that was issued in the *1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water* (EPA-820-B-96-001). This value was derived using the GLI Guidelines (60FR15393-15399, March 23, 1995; 40CFR132 Appendix A); the differences between the 1985 Guidelines and the GLI Guidelines are explained on page iv of the 1995 Updates. No decision concerning this criterion was affected by any considerations that are specific to the Great Lakes.

K According to page 181 of the Red Book:

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR NON PRIORITY POLLUTANTS

For open ocean waters where the depth is substantially greater than the euphotic zone, the pH should not be changed more than 0.2 units from the naturally occurring variation or any case outside the range of 6.5 to 8.5. For shallow, highly productive coastal and estuarine areas where naturally occurring pH variations approach the lethal limits of some species, changes in pH should be avoided but in any case should not exceed the limits established for fresh water, i.e., 6.5-9.0.

L There are three major reasons why the use of Water-Effect Ratios might be appropriate. (1) The value of 87 μg/l is based on a toxicity test with the striped bass in water with pH= 6.5-6.6 and hardness <10 mg/L. Data in "Aluminum Water-Effect Ratio for the 3M Plant Effluent Discharge, Middleway, West Virginia" (May 1994) indicate that aluminum is substantially less toxic at higher pH and hardness, but the effects of pH and hardness are not well quantified at this time. (2) In tests with the brook trout at low pH and hardness, effects increased with increasing concentrations of total aluminum even though the concentration of dissolved aluminum was constant, indicating that total recoverable is a more appropriate measurement than dissolved, at least when particulate aluminum is primarily aluminum hydroxide particles. In surface waters, however, the total recoverable procedure might measure aluminum associated with clay particles, which might be less toxic than aluminum associated with aluminum hydroxide. (3) EPA is aware of field data indicating that many high quality waters in the U.S. contain more than 87 μg aluminum/L, when either total recoverable or dissolved is measured.

M U.S. EPA. 1973. Water Quality Criteria 1972. EPA-R3-73-033. National Technical Information Service, Springfield, VA.; U.S. EPA. 1977. Temperature Criteria for Freshwater Fish: Protocol and Procedures. EPA-600/3-77-061. National Technical Information Service, Springfield, VA.

N U.S. EPA. 1986. Ambient Water Quality Criteria for Dissolved Oxygen. EPA 440/5-86-003. National Technical Information Service, Springfield, VA.

O This criterion for manganese is not based on toxic effects, but rather is intended to minimize objectionable qualities such as laundry stains and objectionable tastes in beverages.

P Lakes and Reservoirs in Nutrient Ecoregion: II EPA 822-B-00-007, III EPA 822-B-01-008, IV EPA 822-B-01-009, V EPA 822-B-01-010, VI EPA 822-B-00-008 , VII EPA 822-B-00-009, VIII EPA 822-B-01-015, IX EPA 822-B-00-011, XI EPA 822-B-00-012, XII EPA 822-B-00-013, XIII EPA 822-B-00-014, XIV EPA 822-B-01-011; Rivers and Streams in Nutrient Ecoregion: I EPA 822-B-01-012, II EPA 822-B-00-015, III EPA 822-B-00-016, IV EPA 822-B-01-013, V EPA 822-B-01-014, VI EPA 822-B-00-017, VII EPA 822-B-00-018, VIII EPA 822-B-01-015, IX EPA 822-B-00-019, X EPA 822-B-01-016, XI EPA 822-B-00-020, XII EPA 822-B-00-021, XIV EPA 822-B-00-022; and Wetlands in Nutrient Ecoregion XIII EPA 822-B-00-023.

Q EPA announced the availability of a draft updated tributyltin (TBT) document on August 7, 1997 (62FR42554). The Agency has reevaluated this document and anticipates releasing an updated document for public comment in the near future.

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR ORGANOLEPTIC EFFECTS

	Pollutant	CAS Number	Organoleptic Effect Criteria ($\mu g/L$)	FR Cite/Source
1	Acenaphthene	83329	20	Gold Book
2	Monochlorobenzene	108907	20	Gold Book
3	3-Chlorophenol	--	0.1	Gold Book
4	4-Chlorophenol	106489	0.1	Gold Book
5	2,3-Dichlorophenol	--	0.04	Gold Book
6	2,5-Dichlorophenol	--	0.5	Gold Book
7	2,6-Dichlorophenol	--	0.2	Gold Book
8	3,4-Dichlorophenol	--	0.3	Gold Book
9	2,4,5-Trichlorophenol	95954	1	Gold Book
10	2,4,6-Trichloropehnol	88062	2	Gold Book
11	2,3,4,6-Tetrachlorophenol	--	1	Gold Book
12	2-Methyl-4-Chlorophenol	--	1800	Gold Book
13	3-Methyl-4-Chlorophenol	59507	3000	Gold Book
14	3-Methyl-6-Chlorophenol	--	20	Gold Book
15	2-Chlorophenol	95578	0.1	Gold Book
16	Copper	7440508	1000	Gold Book
17	2,4-Dichlorophenol	120832	0.3	Gold Book
18	2,4-Dimethylpehnol	105679	400	Gold Book

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR ORGANOLEPTIC EFFECTS

	Pollutant	CAS Number	Organoleptic Effect Criteria (μg/L)	FR Cite/Source
19	Hexachlorocyclopentadiene	77474	1	Gold Book
20	Nitrobenzene	98953	30	Gold Book
21	Pentachlorophenol	87865	30	Gold Book
22	Phenol	108952	300	Gold Book
23	Zinc	7440666	5000	45 FR79341

General notes:

1. These criteria are based on organoleptic (taste and odor) effects. Because of variations in chemical nomenclature systems, this listing of pollutants does not duplicate the listing in Appendix A of 40 CFR Part 423. Also listed are the Chemical Abstracts Service (CAS) registry numbers, which provide a unique identification for each chemical.

NATIONAL RECOMMENDED WATER QUALITY CRITERIA

Additional Notes:

1. Criteria Maximum Concentration and Criterion Continuous Concentration

The Criteria Maximum Concentration (CMC) is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect. The Criterion Continuous Concentration (CCC) is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect. The CMC and CCC are just two of the six parts of an aquatic life criterion; the other four parts are the acute averaging period, chronic averaging period, acute frequency of allowed exceedence, and chronic frequency of allowed exceedence. Because 304(a) aquatic life criteria are national guidance, they are intended to be protective of the vast majority of the aquatic communities in the United States.

2. Criteria Recommendations for Priority Pollutants, Non Priority Pollutants and Organoleptic Effects

This compilation lists all priority toxic pollutants and some non priority toxic pollutants, and both human health effect and organoleptic effect criteria issued pursuant to CWA §304(a). Blank spaces indicate that EPA has no CWA §304(a) criteria recommendations. For a number of non-priority toxic pollutants not listed, CWA §304(a) "water + organism" human health criteria are not available, but EPA has published MCLs under the SDWA that may be used in establishing water quality standards to protect water supply designated uses. Because of variations in chemical nomenclature systems, this listing of toxic pollutants does not duplicate the listing in Appendix A of 40 CFR Part 423. Also listed are the Chemical Abstracts Service CAS registry numbers, which provide a unique identification for each chemical.

3. Human Health Risk

The human health criteria for the priority and non priority pollutants are based on carcinogenicity of 10^{-6} risk. Alternate risk levels may be obtained by moving the decimal point (e.g., for a risk level of 10^{-5}, move the decimal point in the recommended criterion one place to the right).

4. Water Quality Criteria published pursuant to Section 304(a) or Section 303(c) of the CWA

Many of the values in the compilation were published in the California Toxics Rule. Although such values were published pursuant to Section 303(c) of the CWA, they represent the Agency's most recent calculation of water quality criteria and are thus the Agency's 304(a) criteria.

5. Calculation of Dissolved Metals Criteria

The 304(a) criteria for metals, shown as dissolved metals, are calculated in one of two ways. For freshwater metals criteria that are hardness-dependent, the dissolved metal criteria were calculated using a hardness of 100 mg/l as $CaCO_3$ for illustrative purposes only. Saltwater and freshwater metals' criteria that are not hardness-dependent are calculated by multiplying the total recoverable criteria before rounding by the appropriate conversion factors. The final dissolved metals' criteria in the table are rounded to two significant figures. Information regarding the calculation of hardness dependent conversion factors are included in the footnotes.

6. Maximum Contaminant Levels

The compilation includes footnotes for pollutants with Maximum Contaminant Levels (MCLs) more stringent than the recommended water quality criteria in the compilation. MCLs for these pollutants are not included in the compilation, but can be found in the appropriate drinking water regulations (40 CFR 141.11-16 and 141.60-63), or can be accessed through the Safe Drinking Water Hotline (800-426-4791) or the Internet (http://www.epa.gov/waterscience/drinking/standards/dwstandards.pdf).

7. Organoleptic Effects

The compilation contains 304(a) criteria for pollutants with toxicity-based criteria as well as non-toxicity based criteria. The basis for the non-toxicity based criteria are organoleptic effects (e.g., taste and odor) which would make water and edible aquatic life unpalatable but not toxic to humans. The table includes criteria for organoleptic effects for 23 pollutants. Pollutants with organoleptic effect criteria more stringent than the criteria based on toxicity (e.g., included in both the priority and non-priority pollutant tables) are footnoted as such.

8. Gold Book

The "Gold Book" is Quality Criteria for Water: 1986. EPA 440/5-86-001.

9. Correction of Chemical Abstract Services Number

The Chemical Abstract Services number (CAS) for Bis(2-Chlorisoprpyl) Ether, has been revised in IRIS and in the table. The correct CAS number for this chemical is 108-60-1. The previous CAS number for this pollutant was 39638-32-9.

10. Contaminants with Blanks

EPA has not calculated criteria for contaminants with blanks. However, permit authorities should address these contaminants in NPDES permit actions using the States' existing narrative criteria for toxics.

11. Specific Chemical Calculations

A. Selenium

Aquatic Life

This compilation contains aquatic life criteria for selenium that are the same as those published in the proposed CTR. In the CTR, EPA proposed an acute criterion for selenium based on the criterion proposed for selenium in the Water Quality Guidance for the Great Lakes System (61 FR 58444). The GLI and CTR proposals take into account data showing that selenium's two prevalent oxidation states in water, selenite and selenate, present differing potentials for aquatic toxicity, as well as new data indicating that various forms of selenium are additive. The new approach produces a different selenium acute criterion concentration, or CMC, depending upon the relative proportions of selenite, selenate, and other forms of selenium that are present.

EPA is currently undertaking a reassessment of selenium, and expects the 304(a) criteria for selenium will be revised based on the final reassessment (63FR26186). However, until such time as revised water quality criteria for selenium are published by the Agency, the recommended water quality criteria in this compilation are EPA's current 304(a) criteria.

Appendices

Appendix A - Conversion Factors for Dissolved Metals

Metal	Conversion Factor freshwater CMC	Conversion Factor freshwater CCC	Conversion Factor saltwater CMC	Conversion Factor saltwater CCC[1]
Arsenic	1.000	1.000	1.000	1.000
Cadmium	1.136672-[(ln hardness)(0.041838)]	1.101672-[(ln hardness)(0.041838)]	0.994	0.994
Chromium III	0.316	0.860	--	--
Chromium VI	0.982	0.962	0.993	0.993
Copper	0.960	0.960	0.83	0.83
Lead	1.46203-[(ln hardness)(0.145712)]	1.46203-[(ln hardness)(0.145712)]	0.951	0.951
Mercury	0.85	0.85	0.85	0.85
Nickel	0.998	0.997	0.990	0.990
Selenium	--	--	0.998	0.998
Silver	0.85	--	0.85	--
Zinc	0.978	0.986	0.946	0.946

Appendix B - Parameters for Calculating Freshwater Dissolved Metals Criteria That Are Hardness-Dependent

Chemical	m_A	b_A	m_C	b_C	Freshwater Conversion Factors (CF)	
					CMC	CCC
Cadmium	1.0166	-3.924	0.7409	-4.719	1.136672-[(ln hardness)(0.041838)]	1.101672-[(ln hardness)(0.041838)]
Chromium III	0.8190	3.7256	0.8190	0.6848	0.316	0.860
Copper	0.9422	-1.700	0.8545	-1.702	0.960	0.960
Lead	1.273	-1.460	1.273	-4.705	1.46203-[(ln hardness)(0.145712)]	1.46203-[(ln hardness)(0.145712)]
Nickel	0.8460	2.255	0.8460	0.0584	0.998	0.997
Silver	1.72	-6.59	--	--	0.85	--
Zinc	0.8473	0.884	0.8473	0.884	0.978	0.986

Hardness-dependant metals' criteria may be calculated from the following:
CMC (dissolved) = exp{m_A [ln(hardness)]+ b_A} (CF)
CCC (dissolved) = exp{m_C [ln(hardness)]+ b_C} (CF)

Appendix C - Calculation of Freshwater Ammonia Criterion

1. The one-hour average concentration of total ammonia nitrogen (in mg N/L) does not exceed, more than once every three years on the average, the CMC (acute criterion) calculated using the following equations.

Where salmonid fish are present:

0.275 39.0
CMC = ------------------- + -------------------------

$$1 + 10^{7.204\text{-pH}} \qquad 1 + 10^{\text{pH-}7.204}$$

Or where salmonid fish are not present:

$$\text{CMC} = \frac{0.411}{1 + 10^{7.204\text{-pH}}} + \frac{58.4}{1 + 10^{\text{pH-}7.204}}$$

2A. The thirty-day average concentration of total ammonia nitrogen (in mg N/L) does not exceed, more than once every three years on the average, the CCC (chronic criterion) calculated using the following equations.

When fish early life stages are present:

$$\text{CCC} = \left(\frac{0.0577}{1 + 10^{7.688\text{-pH}}} + \frac{2.487}{1 + 10^{\text{pH-}7.688}} \right) \bullet \quad \text{MIN}\,(2.85,\ 1.45 \cdot 10^{0.028\cdot(25\text{-T})})$$

When fish early life stages are absent:

$$\text{CCC} = \left(\frac{0.0577}{1 + 10^{7.688\text{-pH}}} + \frac{2.487}{1 + 10^{\text{pH-}7.688}} \right) \bullet \quad 1.45 \cdot 10^{0.028\cdot(25\text{-MAX}\,(\text{T},7))}$$

2B. In addition, the highest four-day average within the 30-day period should not exceed 2.5 times the CCC.

Wildlife Exposure Parameters and TBV's

Appendix B

BODY WEIGHTS, FOOD AND WATER CONSUMPTION RATES FOR SELECTED AVIAN AND MAMMALIAN WILDLIFE ENDPOINT SPECIES

Table B.1. Body weights and food and water consumption rates for selected avian and mammalian wildlife endpoint species

Species	Body Weight		Food Intake		Water Intake[a]	
	kg	Citation	kg/d	Citation	L/d	Citation
Mammals						
Short-tailed Shrew *(Blarina brevicauda)*	0.015	Schlesinger and Potter 1974	0.009	Barrett and Stueck 1976 Buckner 1964	0.0033	Chew 1951
Little Brown Bat (*Myotis lucifugus*)	0.0075	Gould 1955	0.0025	Anthony and Kunz 1977	0.0012	
Meadow Vole (*Microtus pennsylvanicus*)	0.044	Reich 1981	0.005	Estimated from Figure 2. in Dark et al. 1983.	0.006	
White-footed Mouse (*Peromyscus leucopus*)	0.022	Green and Miller 1987	0.0034	Green and Miller 1987	0.0066	Oswald et al. 1993
Eastern Cottontail (*Sylvilagus floridanus*)	1.2	Chapman et al. 1980	0.237	Dalke and Sime 1941	0.116	
Mink (*Mustela vison*)	1.0	EPA 1993e	0.137	Bleavins and Aulerich 1981.	0.099	
Red Fox (*Vulpes fulva*)	4.5	Storm et al. 1976[b]	0.45	Sargent 1978[c] Vogtsberger and Barrett 1973	0.38	
White-tailed Deer (*Odocoileus virginianus*)	56.5	Smith 1991	1.74	Mautz et al. 1976	3.7	
Birds						
American Robin (*Turdus migratorius*)	0.077	Dunning 1984	0.093	Skorupa and Hothem 1985 Hazelton et al. 1984	0.0106	

Table B.1. (continued)

Species	Body Weight		Food Intake		Water Intake[a]	
	kg	Citation	kg/d	Citation	L/d	Citation
Osprey (*Pandion haliaetus*)	1.5	EPA 1993d	0.3	EPA 1993d	0.077	EPA 1993d

[a] All values calculated according to Calder and Braun (1983) unless stated otherwise.

[b] Mean for males and females from both Iowa and Illinois.

[c] 0.069 g/g/day for nonbreeding adult times 4.5 kg BW.

Appendix C.1. Selected toxicity data for avian and mammalian wildlife[a]

		LOAEL		NOAEL	Acute or Lethal	
Chemical	Species	Dose or Conc.[b]	Effect	Dose or Conc.[b]	Dose/Conc.[b]	LD_{50} or LC_{50}
Aroclor 1016	ferret			20 ppm (9 mo)		
Aroclor 1016	mink	20 ppm (9 mo)	reproduction		20 ppm	
Aroclor 1221	bobwhite quail		30% mortality		6000 ppm (5 d)	
Aroclor 1221	Japanese quail					>6000 ppm (5 d)
Aroclor 1221	ring-necked pheasant				>4000 ppm (5 d)	
Aroclor 1232	bobwhite quail					3002 ppm (5 d)
Aroclor 1232	Japanese quail					>5000 ppm (5 d)
Aroclor 1232	ring-necked pheasant					3146 ppm (5 d)
Aroclor 1242	ferret	20 ppm (9 mo)	reproduction		20 ppm	
Aroclor 1242	mink	5 ppm (9 mo)	reproduction		10 ppm (9 mo)	
Aroclor 1242	Japanese quail	321.5 ppm (21 d)	reproduction			
Aroclor 1242	Japanese quail	10 ppm (45 d)	reproduction			
Aroclor 1248	screech owl		reproduction	3 ppm (18 mo)		
Aroclor 1248	chicken	10 ppm (8 wk)	reproduction	1 ppm (8 wk)		

Table C.1. (continued)

		LOAEL		NOAEL	Acute or Lethal Dose/Conc.[b]	LD_{50} or LC_{50}
Chemical	Species	Dose or Conc.[b]	Effect	Dose or Conc.[b]		
Cadmium	black duck	4 ppm (4 mo)	offspring behavior			
Cadmium chloride	mallard duck	20 ppm (30-90 d)	pathology			
Cadmium succinate	bobwhite quail					1728 ppm (5 d)
Cadmium succinate	Japanese quail					2693 ppm (5 d)
Cadmium succinate	ring-necked pheasant					1411 ppm (5 d)
Cadmium succinate	mallard duck					>5000 ppm (5 d)
Chlordane	bobwhite quail					331 ppm (5 day)
Chlordane	Japanese quail					350 ppm (5 d)
Chlordane	Japanese quail	25 ppm (8 d)	reproduction			
Chlordane	ring-necked pheasant					430 ppm (5 d)
Chlordane	mallard duck					858 ppm (5 d)
Chlordane	golden eagle				100 mg/kg	10 mg/kg
Chromium (trivalent)	black duck (young)	10 ppm	survival			

Table C.1. (continued)

Chemical	Species	LOAEL		NOAEL	Acute or Lethal	LD_{50} or
		Dose or Conc.[b]	Effect	Dose or Conc.[b]	Dose/Conc.[b]	LC_{50}
DDT	mallard duck	50 ppm (6 mo)				
DDT	mallard duck					1869 ppm (5 d)
DDT	house sparrow				1500 ppm (3 d)	
DDT	white-throated sparrow	5 ppm (11 wk)	behavior; physiology			
DDT	earthworm	5 lb/acre	decreased population			
Di-butyl phthalate	mallard duck		5-d lethal concentration		>5000 ppm	
Di-butyl phthalate	ring dove	10 ppm	thin egg shells			
2,4-Dichlorophenyl-p-nitrophenyl ether	rat	100 ppm (97 wk)	reproduction	10 ppm (3 gen.)		2600 ppm
2,4-Dichlorophenyl-p-nitrophenyl ether	dog			2000 ppm (2 yr)		
Di(2-ethylhexyl)phthalate	ferret	10000 ppm (14 mo)	physiology			
Di(2-ethylhexyl)phthalate	ring dove			10 ppm		
Ferrous sulfate	rat					1187 mg/kg

Table C.1. (continued)

		LOAEL		NOAEL		
Chemical	Species	Dose or Conc.[b]	Effect	Dose or Conc.[b]	Acute or Lethal Dose/Conc.[b]	LD_{50} or LC_{50}
Lead, tetraethyl	mallard duck				6 mg/kg	
Lithium chloride	red-winged blackbird				15000 ppm (4 d)	
Magnesium	Japanese quail	1500 ppm (2 wk)	physiology	1000 ppm (2 wk)		
Mercuric chloride	Japanese quail			2 ppm (1 yr)		
Mercuric chloride	Japanese quail	4 ppm (12 wk)	physiology	2 ppm		
Mercuric chloride	chicken	100 ppm (8 wk)	reproduction			
Mercuric sulfate	chicken	100 ppm (8 wk)	reproduction			
Methyl mercury chloride	mallard duck			5 ppm (3 mo)		
Methyl mercury chloride	chicken	5 ppm (8 wk)	reproduction			
Methyl mercury dicyandiamide	mallard duck	0.5 ppm (1 yr)	reproduction			
Methyl mercury dicyandiamide	black duck	3 ppm (28 wk/yr, 2 yr)	reproduction			
Monosodium methanearsonate	white-footed mouse	1000 ppm (30 d)	physiology			300 mg/kg

Table C.1. (continued)

Chemical	Species	LOAEL Dose or Conc.[b]	LOAEL Effect	NOAEL Dose or Conc.[b]	Acute or Lethal Dose/Conc.[b]	LD_{50} or LC_{50}
Sodium monofluoroacetate	pigeon				4.24 mg/kg	
Sodium monofluoroacetate	house sparrow				3.00 mg/kg	
Sodium monofluoroacetate	kit fox					0.22 mg/kg
Sodium nitrate	Japanese quail				3300 ppm (7 d)	
Sodium nitrate	Japanese quail				660 ppm (15 wk)	
Thallium sulfate	golden eagle					120 mg/kg
Tribromoethanol	mallard duck				150 mg/kg	
Vanadyl sulfate	mallard duck	100 ppm (12 wk)	blood chemistry	10 ppm (12 wk)		
Zinc phosphide	kit fox					93 mg/kg
Zinc phosphide	red fox				10.64 mg/kg/d (3 d)	
Zinc phosphide	grey fox				8.6 mg/kg/d (3 d)	

Appendix D

TABLE 12

Table 12. NOAEL- and LOAEL-based toxicological benchmarks for selected avian and mammalian wildlife species

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)	Estimated Wildlife LOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Acetone	n/a	rat	10	50	Little Brown Bat	26.1	78.4	163.4		130.7	392.1	816.8	
Acetone	n/a	rat	10	50	Short-tailed Shrew	22.0	36.6	99.9		109.9	183.2	499.5	
Acetone	n/a	rat	10	50	White-footed Mouse	20.0	129.2	66.6		99.9	646.1	332.9	
Acetone	n/a	rat	10	50	Meadow Vole	16.8	147.8	123.2		84.0	738.9	615.8	
Acetone	n/a	rat	10	50	Mink	7.7	56.1	77.7	50.460	38.5	280.7	388.5	252.300
Acetone	n/a	rat	10	50	Cottontail Rabbit	7.3	37.2	76.0		36.7	186.0	380.1	
Acetone	n/a	rat	10	50	Red Fox	5.3	52.8	62.5		26.4	264.0	312.7	
Acetone	n/a	rat	10	50	River Otter	4.6	40.7	57.2	33.237	22.9	203.3	285.8	166.187
Acetone	n/a	rat	10	50	Whitetail Deer	2.8	91.1	42.8		14.0	455.5	214.2	
Aldrin	n/a	rat	0.2	1	Little Brown Bat	0.523	1.568	3.267		2.614	7.841	16.335	
Aldrin	n/a	rat	0.2	1	Short-tailed Shrew	0.440	0.733	1.998		2.198	3.663	9.990	
Aldrin	n/a	rat	0.2	1	White-footed Mouse	0.399	2.585	1.331		1.997	12.923	6.657	
Aldrin	n/a	rat	0.2	1	Meadow Vole	0.336	2.956	2.463		1.679	14.779	12.316	
Aldrin	n/a	rat	0.2	1	Mink	0.154	1.123	1.554	1.603e-06	0.769	5.614	7.769	8.013e-06
Aldrin	n/a	rat	0.2	1	Cottontail Rabbit	0.147	0.744	1.520		0.735	3.721	7.602	
Aldrin	n/a	rat	0.2	1	Red Fox	0.106	1.056	1.251		0.528	5.281	6.254	
Aldrin	n/a	rat	0.2	1	River Otter	0.091	0.813	1.143	1.000e-06	0.457	4.065	5.717	5.802e-06
Aldrin	n/a	rat	0.2	1	Whitetail Deer	0.056	1.822	0.857		0.281	9.110	4.284	
Aluminum	$AlCl_3$	mouse	1.93	19.3	Little Brown Bat	2.729	8.188	17.059		27.294	81.883	170.590	
Aluminum	$AlCl_3$	mouse	1.93	19.3	Short-tailed Shrew	2.295	3.825	10.433		22.952	38.253	104.326	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Aluminum	AlCl$_3$	day-old white leghorn chicks		44.5	American Robin					44.5	36.8	323.3	
Aluminum	AlCl$_3$	day-old white leghorn chicks		44.5	Belted Kingfisher					44.5	87.8	411.6	0.380
Aluminum	AlCl$_3$	day-old white leghorn chicks		44.5	American Woodcock					44.5	58.7	440.6	
Aluminum	AlCl$_3$	day-old white leghorn chicks		44.5	Cooper's Hawk					44.5	257.0	574.6	
Aluminum	AlCl$_3$	day-old white leghorn chicks		44.5	Barn Owl					44.5	165.9	592.5	
Aluminum	AlCl$_3$	day-old white leghorn chicks		44.5	Barred Owl					44.5	379.8	678.9	
Aluminum	AlCl$_3$	day-old white leghorn chicks		44.5	Red-tailed Hawk					44.5	459.7	782.9	
Aluminum	AlCl$_3$	day-old white leghorn chicks		44.5	Osprey					44.5	222.5	866.9	0.962
Aluminum	AlCl$_3$	day-old white leghorn chicks		44.5	Great Blue Heron					44.5	253.2	1005.2	1.095
Aluminum	AlCl$_3$	day-old white leghorn chicks		44.5	Wild Turkey					44.5	1483.3	1358.4	
Antimony	antimony potassium tartrate	mouse	0.125	1.25	Little Brown Bat	0.177	0.530	1.105		1.768	5.303	11.049	
Antimony	antimony potassium tartrate	mouse	0.125	1.25	Short-tailed Shrew	0.149	0.248	0.676		1.487	2.478	6.757	
Antimony	antimony potassium tartrate	mouse	0.125	1.25	White-footed Mouse	0.135	0.874	0.450		1.351	8.740	4.503	
Antimony	antimony potassium tartrate	mouse	0.125	1.25	Meadow Vole	0.114	1.000	0.833		1.136	9.996	8.330	
Antimony	antimony potassium tartrate	mouse	0.125	1.25	Mink	0.052	0.380	0.525	0.220	0.520	3.797	5.255	2.204
Antimony	antimony potassium tartrate	mouse	0.125	1.25	Cottontail Rabbit	0.050	0.252	0.514		0.497	2.517	5.142	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Aroclor 1242	n/a	mink	0.069	0.69	Red Fox	0.047	0.474	0.561		0.474	4.737	5.610	
Aroclor 1242	n/a	mink	0.069	0.69	River Otter	0.041	0.365	0.513	4.650e-06	0.410	3.647	5.128	4.650e-05
Aroclor 1242	n/a	mink	0.069	0.69	Whitetail Deer	0.025	0.817	0.384		0.252	8.172	3.843	
Aroclor 1242	n/a	screech owl	0.41		Rough-winged Swallow	0.410	0.543	1.762					
Aroclor 1242	n/a	screech owl	0.41		American Robin	0.410	0.339	2.978					
Aroclor 1242	n/a	screech owl	0.41		Belted Kingfisher	0.410	0.809	3.793	1.074e-05				
Aroclor 1242	n/a	screech owl	0.41		American Woodcock	0.410	0.541	4.059					
Aroclor 1242	n/a	screech owl	0.41		Cooper's Hawk	0.410	2.368	5.294					
Aroclor 1242	n/a	screech owl	0.41		Barn Owl	0.410	1.528	5.459					
Aroclor 1242	n/a	screech owl	0.41		Barred Owl	0.410	3.500	6.255					
Aroclor 1242	n/a	screech owl	0.41		Red-tailed Hawk	0.410	4.235	7.213					
Aroclor 1242	n/a	screech owl	0.41		Osprey	0.410	2.050	7.987	2.721e-05				
Aroclor 1242	n/a	screech owl	0.41		Great Blue Heron	0.410	2.333	9.262	3.097e-05				
Aroclor 1242	n/a	screech owl	0.41		Wild Turkey	0.410	13.667	12.516					
Aroclor 1248	n/a	Rhesus monkey	0.01	0.1	Little Brown Bat	0.051	0.152	0.318		0.508	1.524	3.176	
Aroclor 1248	n/a	Rhesus monkey	0.01	0.1	Short-tailed Shrew	0.043	0.071	0.194		0.427	0.712	1.942	
Aroclor 1248	n/a	Rhesus monkey	0.01	0.1	White-footed Mouse	0.039	0.251	0.129		0.388	2.512	1.294	
Aroclor 1248	n/a	Rhesus monkey	0.01	0.1	Meadow Vole	0.033	0.287	0.239		0.326	2.873	2.394	
Aroclor 1248	n/a	Rhesus monkey	0.01	0.1	Mink	0.015	0.109	0.151	2.982e-07	0.150	1.091	1.510	2.982e-06

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL^a (mg/kg/d)	Test Species LOAEL^a (mg/kg/d)	Endpoint Species^b	Estimated Wildlife NOAEL^c (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL^c (mg/kg/d)	LOAEL-Based Benchmarks		
							Food^d (mg/kg)	Water^e (mg/L)	Piscivore^f (mg/L)		Food^d (mg/kg)	Water^e (mg/L)	Piscivore^f (mg/L)
Aroclor 1254	n/a	ring-necked pheasant	0.18	1.8	Cooper's Hawk	0.180	1.040	2.324		1.800	10.40	23.24	
Aroclor 1254	n/a	ring-necked pheasant	0.18	1.8	Barn Owl	0.180	0.671	2.397		1.800	6.71	23.97	
Aroclor 1254	n/a	ring-necked pheasant	0.18	1.8	Barred Owl	0.180	1.536	2.746		1.800	15.36	27.46	
Aroclor 1254	n/a	ring-necked pheasant	0.18	1.8	Red-tailed Hawk	0.180	1.859	3.167		1.800	18.59	31.67	
Aroclor 1254	n/a	ring-necked pheasant	0.18	1.8	Osprey	0.180	0.900	3.506	4.865e-07	1.800	9.00	35.06	4.865e-06
Aroclor 1254	n/a	ring-necked pheasant	0.18	1.8	Great Blue Heron	0.180	1.024	4.066	5.537e-07	1.800	10.24	40.66	5.537e-06
Aroclor 1254	n/a	ring-necked pheasant	0.18	1.8	Wild Turkey	0.180	6.000	5.495		1.800	60.00	54.95	
Arsenic	Arsenite	mouse	0.126	1.26	Little Brown Bat	0.178	0.535	1.114		1.782	5.346	11.137	
Arsenic	Arsenite	mouse	0.126	1.26	Short-tailed Shrew	0.150	0.250	0.681		1.498	2.497	6.811	
Arsenic	Arsenite	mouse	0.126	1.26	White-footed Mouse	0.136	0.881	0.454		1.362	8.810	4.539	
Arsenic	Arsenite	mouse	0.126	1.26	Meadow Vole	0.114	1.008	0.840		1.145	10.076	8.396	
Arsenic	Arsenite	mouse	0.126	1.26	Mink	0.052	0.383	0.530	0.022	0.524	3.828	5.297	0.216
Arsenic	Arsenite	mouse	0.126	1.26	Cottontail Rabbit	0.050	0.254	0.518		0.501	2.537	5.183	
Arsenic	Arsenite	mouse	0.126	1.26	Red Fox	0.036	0.360	0.426		0.360	3.600	4.264	
Arsenic	Arsenite	mouse	0.126	1.26	River Otter	0.031	0.277	0.390	0.016	0.312	2.772	3.898	0.156
Arsenic	Arsenite	mouse	0.126	1.26	Whitetail Deer	0.019	0.621	0.292		0.191	6.211	2.921	
Arsenic	sodium arsenite	mallard duck	5.14	12.84	Rough-winged Swallow	5.1	6.8	22.1		12.8	17.0	55.2	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Arsenic	paris green (copper acetoarsenite)	brown-headed cowbird	2.46	7.38	Osprey	2.5	12.3	47.9	0.713	7.4	36.9	143.8	2.138
Arsenic	paris green (copper acetoarsenite)	brown-headed cowbird	2.46	7.38	Great Blue Heron	2.5	14.0	55.6	0.811	7.4	42.0	166.7	2.434
Arsenic	paris green (copper acetoarsenite)	brown-headed cowbird	2.46	7.38	Wild Turkey	2.5	82.0	75.1		7.4	246.0	225.3	
Barium	barium chloride	rat	5.1		Little Brown Bat	14.1	42.2	88.0					
Barium	barium chloride	rat	5.1		Short-tailed Shrew	11.8	19.7	53.8					
Barium	barium chloride	rat	5.1		White-footed Mouse	10.8	69.6	35.8					
Barium	barium chloride	rat	5.1		Meadow Vole	9.0	79.6	66.3					
Barium	barium chloride	rat	5.1		Mink	4.1	30.2	41.8					
Barium	barium chloride	rat	5.1		Cottontail Rabbit	4.0	20.0	40.9					
Barium	barium chloride	rat	5.1		Red Fox	2.8	28.4	33.7					
Barium	barium chloride	rat	5.1		River Otter	2.5	21.9	30.8					
Barium	barium chloride	rat	5.1		Whitetail Deer	1.5	49.1	23.1					
Barium	barium hydroxide	rat		19.8	Little Brown Bat					51.8	155.3	323.4	
Barium	barium hydroxide	rat		19.8	Short-tailed Shrew					43.5	72.5	197.8	
Barium	barium hydroxide	rat		19.8	White-footed Mouse					39.5	255.9	131.8	
Barium	barium hydroxide	rat		19.8	Meadow Vole					33.3	292.6	243.8	
Barium	barium hydroxide	rat		19.8	Mink					15.2	111.2	153.8	
Barium	barium hydroxide	rat		19.8	Cottontail Rabbit					14.6	73.7	150.5	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Benzene	n/a	mouse	26.36	263.6	Meadow Vole	24.0	210.8	175.7		239.5	2107.9	1756.6	
Benzene	n/a	mouse	26.36	263.6	Mink	11.0	80.1	110.8	3.162	109.7	800.8	1108.1	31.623
Benzene	n/a	mouse	26.36	263.6	Cottontail Rabbit	10.5	53.1	108.4		104.8	530.7	1084.3	
Benzene	n/a	mouse	26.36	263.6	Red Fox	7.5	75.3	89.2		75.3	753.2	892.0	
Benzene	n/a	mouse	26.36	263.6	River Otter	6.5	58.0	81.5	2.293	65.2	579.8	815.4	22.930
Benzene	n/a	mouse	26.36	263.6	Whitetail Deer	4.0	129.9	61.1		40.0	1299.3	611.0	
Beta-BHC	n/a	rat	0.4	2	Little Brown Bat	1.05	3.14	6.53		5.23	15.68	32.67	
Beta-BHC	n/a	rat	0.4	2	Short-tailed Shrew	0.88	1.47	4.00		4.40	7.33	19.98	
Beta-BHC	n/a	rat	0.4	2	White-footed Mouse	0.80	5.17	2.66		3.99	25.85	13.31	
Beta-BHC	n/a	rat	0.4	2	Meadow Vole	0.67	5.91	4.93		3.36	29.56	24.63	
Beta-BHC	n/a	rat	0.4	2	Mink	0.31	2.25	3.11	0.004	1.54	11.23	15.54	0.021
Beta-BHC	n/a	rat	0.4	2	Cottontail Rabbit	0.29	1.49	3.04		1.47	7.44	15.20	
Beta-BHC	n/a	rat	0.4	2	Red Fox	0.21	2.11	2.50		1.06	10.56	12.51	
Beta-BHC	n/a	rat	0.4	2	River Otter	0.18	1.63	2.29	0.003	0.91	8.13	11.43	0.015
Beta-BHC	n/a	rat	0.4	2	Whitetail Deer	0.11	3.64	1.71		0.56	18.22	8.57	
BHC-mixed isomers	n/a	rat	1.6	3.2	Little Brown Bat	4.18	12.55	26.14		8.36	25.09	52.27	
BHC-mixed isomers	n/a	rat	1.6	3.2	Short-tailed Shrew	3.52	5.86	15.98		7.03	11.72	31.97	
BHC-mixed isomers	n/a	rat	1.6	3.2	White-footed Mouse	3.20	20.68	10.65		6.39	41.35	21.30	
BHC-mixed isomers	n/a	rat	1.6	3.2	Meadow Vole	2.69	23.65	19.70		5.37	47.29	39.41	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Benzo(a)pyrene	n/a	mouse	1	10	Meadow Vole	0.91	8.00	6.66		9.09	79.96	66.64	
Benzo(a)pyrene	n/a	mouse	1	10	Mink	0.42	3.04	4.20	1.034e-05	4.16	30.38	42.04	1.034e-04
Benzo(a)pyrene	n/a	mouse	1	10	Cottontail Rabbit	0.40	2.01	4.11		3.98	20.13	41.13	
Benzo(a)pyrene	n/a	mouse	1	10	Red Fox	0.29	2.86	3.38		2.86	28.57	33.84	
Benzo(a)pyrene	n/a	mouse	1	10	River Otter	0.25	2.20	3.09	6.722e-06	2.47	22.00	30.93	6.722e-05
Benzo(a)pyrene	n/a	mouse	1	10	Whitetail Deer	0.15	4.93	2.32		1.52	49.29	23.18	
Beryllium	beryllium sulfate	rat	0.66		Little Brown Bat	1.73	5.18	10.78					
Beryllium	beryllium sulfate	rat	0.66		Short-tailed Shrew	1.45	2.42	6.59					
Beryllium	beryllium sulfate	rat	0.66		White-footed Mouse	1.32	8.53	4.39					
Beryllium	beryllium sulfate	rat	0.66		Meadow Vole	1.11	9.75	8.13					
Beryllium	beryllium sulfate	rat	0.66		Mink	0.51	3.71	5.13	0.188				
Beryllium	beryllium sulfate	rat	0.66		Cottontail Rabbit	0.49	2.46	5.02					
Beryllium	beryllium sulfate	rat	0.66		Red Fox	0.35	3.49	4.13					
Beryllium	beryllium sulfate	rat	0.66		River Otter	0.30	2.68	3.77	0.136				
Beryllium	beryllium sulfate	rat	0.66		Whitetail Deer	0.19	6.01	2.83					
Bis(2-ethylhexyl)-phthalate	n/a	mouse	18.3	183	Little Brown Bat	25.9	78	162		259	776	1618	
Bis(2-ethylhexyl)-phthalate	n/a	mouse	18.3	183	Short-tailed Shrew	21.8	36	99		218	363	989	
Bis(2-ethylhexyl)-phthalate	n/a	mouse	18.3	183	White-footed Mouse	19.8	128	66		198	1280	659	
Bis(2-ethylhexyl)-phthalate	n/a	mouse	18.3	183	Meadow Vole	16.6	146	122		166	1463	1219	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Boron	boric acid or borax	rat	28	93.6	Little Brown Bat	73.2	220	457		245	734	1529	
Boron	boric acid or borax	rat	28	93.6	Short-tailed Shrew	61.5	103	280		206	343	935	
Boron	boric acid or borax	rat	28	93.6	White-footed Mouse	55.9	362	186		187	1210	623	
Boron	boric acid or borax	rat	28	93.6	Meadow Vole	47.0	414	345		157	1383	1153	
Boron	boric acid or borax	rat	28	93.6	Mink	21.5	157	218		72	525	727	
Boron	boric acid or borax	rat	28	93.6	Cottontail Rabbit	20.6	104	213		69	348	712	
Boron	boric acid or borax	rat	28	93.6	Red Fox	14.8	148	175		49	494	585	
Boron	boric acid or borax	rat	28	93.6	River Otter	12.8	114	160		43	381	535	
Boron	boric acid or borax	rat	28	93.6	Whitetail Deer	7.9	255	120		26	853	401	
Boron	boric acid	mallard duck	28.8	100	Rough-winged Swallow	28.8	38	124		100	133	430	
Boron	boric acid	mallard duck	28.8	100	American Robin	28.8	24	209		100	83	726	
Boron	boric acid	mallard duck	28.8	100	Belted Kingfisher	28.8	57	266		100	197	925	
Boron	boric acid	mallard duck	28.8	100	American Woodcock	28.8	38	285		100	132	990	
Boron	boric acid	mallard duck	28.8	100	Cooper's Hawk	28.8	166	372		100	578	1291	
Boron	boric acid	mallard duck	28.8	100	Barn Owl	28.8	107	383		100	373	1331	
Boron	boric acid	mallard duck	28.8	100	Barred Owl	28.8	246	439		100	854	1526	
Boron	boric acid	mallard duck	28.8	100	Red-tailed Hawk	28.8	298	507		100	1033	1759	
Boron	boric acid	mallard duck	28.8	100	Osprey	28.8	144	561		100	500	1948	
Boron	boric acid	mallard duck	28.8	100	Great Blue Heron	28.8	164	651		100	569	2259	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL^a (mg/kg/d)	Test Species LOAEL^a (mg/kg/d)	Endpoint Species^b	Estimated Wildlife NOAEL^c (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL^c (mg/kg/d)	LOAEL-Based Benchmarks		
							Food^d (mg/kg)	Water^e (mg/L)	Piscivore^f (mg/L)		Food^d (mg/kg)	Water^e (mg/L)	Piscivore^f (mg/L)
Cadmium	cadmium chloride	mallard duck	1.45	20	Great Blue Heron	1.45	8.25	32.76	0.001	20.00	113.81	451.80	0.009
Cadmium	cadmium chloride	mallard duck	1.45	20	Wild Turkey	1.45	48.33	44.26		20.00	666.67	610.53	
Carbon Tetrachloride	n/a	rat	16		Little Brown Bat	41.8	125.5	261.4					
Carbon Tetrachloride	n/a	rat	16		Short-tailed Shrew	35.2	58.6	159.8					
Carbon Tetrachloride	n/a	rat	16		White-footed Mouse	32.0	206.8	106.5					
Carbon Tetrachloride	n/a	rat	16		Meadow Vole	26.9	236.5	197.0					
Carbon Tetrachloride	n/a	rat	16		Mink	12.3	89.8	124.3	1.259				
Carbon Tetrachloride	n/a	rat	16		Cottontail Rabbit	11.8	59.5	121.6					
Carbon Tetrachloride	n/a	rat	16		Red Fox	8.4	84.5	100.1					
Carbon Tetrachloride	n/a	rat	16		River Otter	7.3	65.0	91.5	0.913				
Carbon Tetrachloride	n/a	rat	16		Whitetail Deer	4.5	145.8	68.5					
Chlordane	n/a	mouse	4.6	9.2	Little Brown Bat	6.5	19.5	40.7		13.0	39.0	81.3	
Chlordane	n/a	mouse	4.6	9.2	Short-tailed Shrew	5.5	9.1	24.9		10.9	18.2	49.7	
Chlordane	n/a	mouse	4.6	9.2	White-footed Mouse	5.0	32.2	16.6		9.9	64.3	33.1	
Chlordane	n/a	mouse	4.6	9.2	Meadow Vole	4.2	36.8	30.7		8.4	73.6	61.3	
Chlordane	n/a	mouse	4.6	9.2	Mink	1.9	14.0	19.3	2.942e-05	3.8	27.9	38.7	5.884e-05
Chlordane	n/a	mouse	4.6	9.2	Cottontail Rabbit	1.8	9.3	18.9		3.7	18.5	37.8	
Chlordane	n/a	mouse	4.6	9.2	Red Fox	1.3	13.1	15.6		2.6	26.3	31.1	
Chlordane	n/a	mouse	4.6	9.2	River Otter	1.1	10.1	14.2	1.866e-05	2.3	20.2	28.5	3.732e-05

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks Food[d] (mg/kg)	NOAEL-Based Benchmarks Water[e] (mg/L)	NOAEL-Based Benchmarks Piscivore[f] (mg/L)	Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks Food[d] (mg/kg)	LOAEL-Based Benchmarks Water[e] (mg/L)	LOAEL-Based Benchmarks Piscivore[f] (mg/L)
Chlordecone (kepone)	n/a	rat	0.08	0.4	Mink	0.062	0.449	0.622	1.489e-05	0.308	2.246	3.108	7.445e-05
Chlordecone (kepone)	n/a	rat	0.08	0.4	Cottontail Rabbit	0.059	0.298	0.608		0.294	1.488	3.041	
Chlordecone (kepone)	n/a	rat	0.08	0.4	Red Fox	0.042	0.422	0.500		0.211	2.112	2.502	
Chlordecone (kepone)	n/a	rat	0.08	0.4	River Otter	0.037	0.325	0.457	1.081e-05	0.183	1.626	2.287	5.404e-05
Chlordecone (kepone)	n/a	rat	0.08	0.4	Whitetail Deer	0.022	0.729	0.343		0.112	3.644	1.714	
Chloroform	n/a	rat	15	41	Little Brown Bat	39.2	118	245		107	321	670	
Chloroform	n/a	rat	15	41	Short-tailed Shrew	33.0	55	150		90	150	410	
Chloroform	n/a	rat	15	41	White-footed Mouse	30.0	194	100		82	530	273	
Chloroform	n/a	rat	15	41	Meadow Vole	25.2	222	185		69	606	505	
Chloroform	n/a	rat	15	41	Mink	11.5	84	117	4.741	32	230	319	12.959
Chloroform	n/a	rat	15	41	Cottontail Rabbit	11.0	56	114		30	153	312	
Chloroform	n/a	rat	15	41	Red Fox	7.9	79	94		22	217	256	
Chloroform	n/a	rat	15	41	River Otter	6.9	61	86	3.439	19	167	234	9.399
Chloroform	n/a	rat	15	41	Whitetail Deer	4.2	137	64		12	373	176	
Chromium	Cr^{+3} as Cr_2O_3	rat	2737		Little Brown Bat	7154	21461	44710					
Chromium	Cr^{+3} as Cr_2O_3	rat	2737		Short-tailed Shrew	6015	10026	27343					
Chromium	Cr^{+3} as Cr_2O_3	rat	2737		White-footed Mouse	5466	35370	18221					
Chromium	Cr^{+3} as Cr_2O_3	rat	2737		Meadow Vole	4597	40449	33708					
Chromium	Cr^{+3} as Cr_2O_3	rat	2737		Mink	2105	15366	21265					

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL^a (mg/kg/d)	Test Species LOAEL^a (mg/kg/d)	Endpoint Species^b	Estimated Wildlife NOAEL^c (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL^c (mg/kg/d)	LOAEL-Based Benchmarks		
							Food^d (mg/kg)	Water^e (mg/L)	Piscivore^f (mg/L)		Food^d (mg/kg)	Water^e (mg/L)	Piscivore^f (mg/L)
Chromium	Cr^{+6}	rat	3.28	13.14	Mink	2.52	18.41	25.48	4.947	10.11	73.77	102.09	19.817
Chromium	Cr^{+6}	rat	3.28	13.14	Cottontail Rabbit	2.41	12.20	24.94		9.66	48.89	99.89	
Chromium	Cr^{+6}	rat	3.28	13.14	Red Fox	1.73	17.32	20.51		6.94	69.39	82.17	
Chromium	Cr^{+6}	rat	3.28	13.14	River Otter	1.50	13.33	18.75	3.593	6.01	53.42	75.12	14.394
Chromium	Cr^{+6}	rat	3.28	13.14	Whitetail Deer	0.92	29.88	14.05		3.69	119.70	56.29	
Copper	copper sulfate	mink	11.7	15.4	Little Brown Bat	39.8	119.3	248.5		52.3	157.0	327.1	
Copper	copper sulfate	mink	11.7	15.4	Short-tailed Shrew	33.4	55.7	152.0		44.0	73.3	200.0	
Copper	copper sulfate	mink	11.7	15.4	White-footed Mouse	30.4	196.6	101.3		40.0	258.7	133.3	
Copper	copper sulfate	mink	11.7	15.4	Meadow Vole	25.5	224.8	187.3		33.6	295.9	246.6	
Copper	copper sulfate	mink	11.7	15.4	Mink	11.7	85.4	118.2	0.294	15.4	112.4	155.6	0.387
Copper	copper sulfate	mink	11.7	15.4	Cottontail Rabbit	11.2	56.6	115.6		14.7	74.5	152.2	
Copper	copper sulfate	mink	11.7	15.4	Red Fox	8.0	80.3	95.1		10.6	105.7	125.2	
Copper	copper sulfate	mink	11.7	15.4	River Otter	7.0	61.8	87.0	0.213	9.2	81.4	114.5	0.280
Copper	copper sulfate	mink	11.7	15.4	Whitetail Deer	4.3	138.6	65.2		5.6	182.4	85.8	
Copper	copper oxide	1 day old chicks	47	61.7	Rough-winged Swallow	47.0	62.3	202.0		61.7	81.8	265.1	
Copper	copper oxide	1 day old chicks	47	61.7	American Robin	47.0	38.9	341.4		61.7	51.1	448.2	
Copper	copper oxide	1 day old chicks	47	61.7	Belted Kingfisher	47.0	92.7	434.8	0.320	61.7	121.8	570.7	0.420
Copper	copper oxide	1 day old chicks	47	61.7	American Woodcock	47.0	62.0	465.3		61.7	81.4	610.8	
Copper	copper oxide	1 day old chicks	47	61.7	Cooper's Hawk	47.0	271.5	606.9		61.7	356.4	796.7	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL^{a} (mg/kg/d)	Test Species LOAEL^{a} (mg/kg/d)	Endpoint Species^{b}	Estimated Wildlife NOAEL^{c} (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL^{c} (mg/kg/d)	LOAEL-Based Benchmarks		
							Food^{d} (mg/kg)	Water^{e} (mg/L)	Piscivore^{f} (mg/L)		Food^{d} (mg/kg)	Water^{e} (mg/L)	Piscivore^{f} (mg/L)
Cyanide	potassium cyanide	rat	68.7		White-footed Mouse	128.9	834.3	429.8					
Cyanide	potassium cyanide	rat	68.7		Meadow Vole	108.4	954.2	795.1					
Cyanide	potassium cyanide	rat	68.7		Mink	49.7	362.5	501.6	501.605				
Cyanide	potassium cyanide	rat	68.7		Cottontail Rabbit	47.4	240.2	490.8					
Cyanide	potassium cyanide	rat	68.7		Red Fox	34.1	341.0	403.8					
Cyanide	potassium cyanide	rat	68.7		River Otter	29.5	262.5	369.1	369.092				
Cyanide	potassium cyanide	rat	68.7		Whitetail Deer	18.1	588.1	276.6					
DDT and metabolites	n/a	rat	0.8	4	Little Brown Bat	2.09	6.27	13.07		10.45	31.36	65.34	
DDT and metabolites	n/a	rat	0.8	4	Short-tailed Shrew	1.76	2.93	7.99		8.79	14.65	39.96	
DDT and metabolites	n/a	rat	0.8	4	White-footed Mouse	1.60	10.34	5.33		7.99	51.69	26.63	
DDT and metabolites	n/a	rat	0.8	4	Meadow Vole	1.34	11.82	9.85		6.72	59.11	49.26	
DDT and metabolites	n/a	rat	0.8	4	Mink	0.62	4.49	6.22	3.362e-06	3.08	22.46	31.08	1.681e-05
DDT and metabolites	n/a	rat	0.8	4	Cottontail Rabbit	0.59	2.98	6.08		2.94	14.88	30.41	
DDT and metabolites	n/a	rat	0.8	4	Red Fox	0.42	4.22	5.00		2.11	21.12	25.02	
DDT and metabolites	n/a	rat	0.8	4	River Otter	0.37	3.25	4.57	1.797e-06	1.83	16.26	22.87	8.984e-06
DDT and metabolites	n/a	rat	0.8	4	Whitetail Deer	0.22	7.29	3.43		1.12	36.44	17.14	
DDT and metabolites	n/a	brown pelican	0.0028	0.028	Rough-winged Swallow	0.003	0.004	0.012		0.028	0.037	0.120	
DDT and metabolites	n/a	brown pelican	0.0028	0.028	American Robin	0.003	0.002	0.020		0.028	0.023	0.203	
DDT and metabolites	n/a	brown pelican	0.0028	0.028	Belted Kingfisher	0.003	0.006	0.026	4.136e-09	0.028	0.055	0.259	4.136e-08

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
1,2-Dichloroethane	n/a	chicken	17.2	34.4	Belted Kingfisher	17.2	33.9	159.1	4.284	34.4	67.9	318.2	8.567
1,2-Dichloroethane	n/a	chicken	17.2	34.4	American Woodcock	17.2	22.7	170.3		34.4	45.4	340.6	
1,2-Dichloroethane	n/a	chicken	17.2	34.4	Cooper's Hawk	17.2	99.4	222.1		34.4	198.7	444.2	
1,2-Dichloroethane	n/a	chicken	17.2	34.4	Barn Owl	17.2	64.1	229.0		34.4	128.2	458.0	
1,2-Dichloroethane	n/a	chicken	17.2	34.4	Barred Owl	17.2	146.8	262.4		34.4	293.6	524.8	
1,2-Dichloroethane	n/a	chicken	17.2	34.4	Red-tailed Hawk	17.2	177.7	302.6		34.4	355.4	605.2	
1,2-Dichloroethane	n/a	chicken	17.2	34.4	Osprey	17.2	86.0	335.1	10.795	34.4	172.0	670.1	21.590
1,2-Dichloroethane	n/a	chicken	17.2	34.4	Great Blue Heron	17.2	97.9	388.5	12.293	34.4	195.8	777.1	24.586
1,2-Dichloroethane	n/a	chicken	17.2	34.4	Wild Turkey	17.2	573.3	525.1		34.4	1146.7	1050.1	
1,1-Dichloroethylene	n/a	rat	30		Little Brown Bat	78.4	235.2	490.1					
1,1-Dichloroethylene	n/a	rat	30		Short-tailed Shrew	65.9	109.9	299.7					
1,1-Dichloroethylene	n/a	rat	30		White-footed Mouse	59.9	387.7	199.7					
1,1-Dichloroethylene	n/a	rat	30		Meadow Vole	50.4	443.4	369.5					
1,1-Dichloroethylene	n/a	beagle dog	2.5		Mink	4.4	32.5	44.9	1.281				
1,1-Dichloroethylene	n/a	rat	30		Cottontail Rabbit	22.0	111.6	228.1					
1,1-Dichloroethylene	n/a	beagle dog	2.5		Red Fox	3.1	30.5	36.1					
1,1-Dichloroethylene	n/a	beagle dog	2.5		River Otter	2.6	23.5	33.0	0.929				
1,1-Dichloroethylene	n/a	rat	30		Whitetail Deer	8.4	273.3	128.5					
1,2-Dichloroethylene	n/a	mouse	45.2		Little Brown Bat	63.9	191.8	399.5					

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)	Estimated Wildlife LOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Dieldrin	n/a	barn owl	0.077		Belted Kingfisher	0.077	0.152	0.712	2.688e-06				
Dieldrin	n/a	barn owl	0.077		American Woodcock	0.077	0.102	0.762					
Dieldrin	n/a	barn owl	0.077		Cooper's Hawk	0.077	0.445	0.994					
Dieldrin	n/a	barn owl	0.077		Barn Owl	0.077	0.287	1.025					
Dieldrin	n/a	barn owl	0.077		Barred Owl	0.077	0.657	1.175					
Dieldrin	n/a	barn owl	0.077		Red-tailed Hawk	0.077	0.795	1.355					
Dieldrin	n/a	barn owl	0.077		Osprey	0.077	0.385	1.500	6.811e-06				
Dieldrin	n/a	barn owl	0.077		Great Blue Heron	0.077	0.438	1.739	7.752e-06				
Dieldrin	n/a	barn owl	0.077		Wild Turkey	0.077	2.567	2.351					
Diethylphthalate	n/a	mouse	4583		Little Brown Bat	6481	19444	40508					
Diethylphthalate	n/a	mouse	4583		Short-tailed Shrew	5450	9084	24773					
Diethylphthalate	n/a	mouse	4583		White-footed Mouse	4953	32046	16508					
Diethylphthalate	n/a	mouse	4583		Meadow Vole	4165	36648	30540					
Diethylphthalate	n/a	mouse	4583		Mink	1907	13922	19266	290.273				
Diethylphthalate	n/a	mouse	4583		Cottontail Rabbit	1822	9227	18852					
Diethylphthalate	n/a	mouse	4583		Red Fox	1310	13096	15508					
Diethylphthalate	n/a	mouse	4583		River Otter	1134	10081	14176	210.561				
Diethylphthalate	n/a	mouse	4583		Whitetail Deer	696	22590	10623					
Di-N-butylphthalate	n/a	mouse	550	1833	Little Brown Bat	778	2333	4861		2592	7777	16202	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Di-N-hexylphthalate	n/a	mouse	55	550	Little Brown Bat	77.8	233.3	486.1		777.8	2333.5	4861.4	
Di-N-hexylphthalate	n/a	mouse	55	550	Short-tailed Shrew	65.4	109.0	297.3		654.1	1090.1	2973.0	
Di-N-hexylphthalate	n/a	mouse	55	550	White-footed Mouse	59.4	384.6	198.1		594.3	3845.8	1981.1	
Di-N-hexylphthalate	n/a	mouse	55	550	Meadow Vole	50.0	439.8	366.5		499.8	4398.1	3665.1	
Di-N-hexylphthalate	n/a	mouse	55	550	Mink	22.9	167.1	231.2		228.9	1670.8	2312.1	
Di-N-hexylphthalate	n/a	mouse	55	550	Cottontail Rabbit	21.9	110.7	226.2		218.7	1107.3	2262.4	
Di-N-hexylphthalate	n/a	mouse	55	550	Red Fox	15.7	157.2	186.1		157.2	1571.6	1861.1	
Di-N-hexylphthalate	n/a	mouse	55	550	River Otter	13.6	121.0	170.1		136.1	1209.8	1701.3	
Di-N-hexylphthalate	n/a	mouse	55	550	Whitetail Deer	8.3	271.1	127.5		83.5	2711.0	1274.9	
1,4-Dioxane	n/a	rat	0.5	1	Little Brown Bat	1.31	3.92	8.17		2.61	7.84	16.34	
1,4-Dioxane	n/a	rat	0.5	1	Short-tailed Shrew	1.10	1.83	5.00		2.20	3.66	9.99	
1,4-Dioxane	n/a	rat	0.5	1	White-footed Mouse	1.00	6.46	3.33		2.00	12.92	6.66	
1,4-Dioxane	n/a	rat	0.5	1	Meadow Vole	0.84	7.39	6.16		1.68	14.78	12.32	
1,4-Dioxane	n/a	rat	0.5	1	Mink	0.38	2.81	3.88	2.745	0.77	5.61	7.77	5.490
1,4-Dioxane	n/a	rat	0.5	1	Cottontail Rabbit	0.37	1.86	3.80		0.73	3.72	7.60	
1,4-Dioxane	n/a	rat	0.5	1	Red Fox	0.26	2.64	3.13		0.53	5.28	6.25	
1,4-Dioxane	n/a	rat	0.5	1	River Otter	0.23	2.03	2.86	2.010	0.46	4.07	5.72	4.021
1,4-Dioxane	n/a	rat	0.5	1	Whitetail Deer	0.14	4.55	2.14		0.28	9.11	4.28	
Endosulfan	n/a	rat	0.15		Little Brown Bat	0.39	1.18	2.45					

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Endrin	n/a	mouse	0.092	0.92	Little Brown Bat	0.130	0.390	0.813		1.301	3.903	8.132	
Endrin	n/a	mouse	0.092	0.92	Short-tailed Shrew	0.109	0.182	0.497		1.094	1.823	4.973	
Endrin	n/a	mouse	0.092	0.92	White-footed Mouse	0.099	0.643	0.331		0.994	6.433	3.314	
Endrin	n/a	mouse	0.092	0.92	Meadow Vole	0.084	0.736	0.613		0.836	7.357	6.131	
Endrin	n/a	mouse	0.092	0.92	Mink	0.038	0.279	0.387	1.859e-05	0.383	2.795	3.868	1.859e-04
Endrin	n/a	mouse	0.092	0.92	Cottontail Rabbit	0.037	0.185	0.378		0.366	1.852	3.784	
Endrin	n/a	mouse	0.092	0.92	Red Fox	0.026	0.263	0.311		0.263	2.629	3.113	
Endrin	n/a	mouse	0.092	0.92	River Otter	0.023	0.202	0.285	1.383e-05	0.228	2.024	2.846	1.383e-04
Endrin	n/a	mouse	0.092	0.92	Whitetail Deer	0.014	0.453	0.213		0.140	4.535	2.133	
Endrin	n/a	screech owl	0.01	0.1	Rough-winged Swallow	0.010	0.013	0.043		0.100	0.133	0.430	
Endrin	n/a	screech owl	0.01	0.1	American Robin	0.010	0.008	0.073		0.100	0.083	0.726	
Endrin	n/a	screech owl	0.01	0.1	Belted Kingfisher	0.010	0.020	0.093	1.313e-06	0.100	0.197	0.925	1.313e-05
Endrin	n/a	screech owl	0.01	0.1	American Woodcock	0.010	0.013	0.099		0.100	0.132	0.990	
Endrin	n/a	screech owl	0.01	0.1	Cooper's Hawk	0.010	0.058	0.129		0.100	0.578	1.291	
Endrin	n/a	screech owl	0.01	0.1	Barn Owl	0.010	0.037	0.133		0.100	0.373	1.331	
Endrin	n/a	screech owl	0.01	0.1	Barred Owl	0.010	0.085	0.153		0.100	0.854	1.526	
Endrin	n/a	screech owl	0.01	0.1	Red-tailed Hawk	0.010	0.103	0.176		0.100	1.033	1.759	
Endrin	n/a	screech owl	0.01	0.1	Osprey	0.010	0.050	0.195	3.326e-06	0.100	0.500	1.948	3.326e-05
Endrin	n/a	screech owl	0.01	0.1	Great Blue Heron	0.010	0.057	0.226	3.785e-06	0.100	0.569	2.259	3.785e-05

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Fluoride	NaF	mink	31.37	52.75	Little Brown Bat	106.6	319.8	666.2		179.2	537.7	1120.3	
Fluoride	NaF	mink	31.37	52.75	Short-tailed Shrew	89.6	149.4	407.4		150.7	251.2	685.1	
Fluoride	NaF	mink	31.37	52.75	White-footed Mouse	81.5	527.1	271.5		137.0	886.3	456.6	
Fluoride	NaF	mink	31.37	52.75	Meadow Vole	68.5	602.7	502.3		115.2	1013.5	844.6	
Fluoride	NaF	mink	31.37	52.75	Mink	31.4	229.0	316.9		52.8	385.0	532.8	
Fluoride	NaF	mink	31.37	52.75	Cottontail Rabbit	30.0	151.8	310.1		50.4	255.2	521.4	
Fluoride	NaF	mink	31.37	52.75	Red Fox	21.5	215.4	255.1		36.2	362.2	428.9	
Fluoride	NaF	mink	31.37	52.75	River Otter	18.7	165.8	233.2		31.4	278.8	392.1	
Fluoride	NaF	mink	31.37	52.75	Whitetail Deer	11.4	371.5	174.7		19.2	624.8	293.8	
Fluoride	NaF	screech owl	7.8	32	Rough-winged Swallow	7.8	10.3	33.5		32.0	42.4	137.5	
Fluoride	NaF	screech owl	7.8	32	American Robin	7.8	6.5	56.7		32.0	26.5	232.5	
Fluoride	NaF	screech owl	7.8	32	Belted Kingfisher	7.8	15.4	72.2		32.0	63.1	296.0	
Fluoride	NaF	screech owl	7.8	32	American Woodcock	7.8	10.3	77.2		32.0	42.2	316.8	
Fluoride	NaF	screech owl	7.8	32	Cooper's Hawk	7.8	45.1	100.7		32.0	184.8	413.2	
Fluoride	NaF	screech owl	7.8	32	Barn Owl	7.8	29.1	103.9		32.0	119.3	426.1	
Fluoride	NaF	screech owl	7.8	32	Barred Owl	7.8	66.6	119.0		32.0	273.1	488.2	
Fluoride	NaF	screech owl	7.8	32	Red-tailed Hawk	7.8	80.6	137.2		32.0	330.6	563.0	
Fluoride	NaF	screech owl	7.8	32	Osprey	7.8	39.0	151.9		32.0	160.0	623.4	
Fluoride	NaF	screech owl	7.8	32	Great Blue Heron	7.8	44.4	176.2		32.0	182.1	722.9	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
1,2,3,6,7,8-Hexachlorodibenzofuran	n/a	rat	0.00016	0.0016	Little Brown Bat	0.00042	0.00125	0.00261		0.00418	0.01255	0.02614	
1,2,3,6,7,8-Hexachlorodibenzofuran	n/a	rat	0.00016	0.0016	Short-tailed Shrew	0.00035	0.00059	0.00160		0.00352	0.00586	0.01598	
1,2,3,6,7,8-Hexachlorodibenzofuran	n/a	rat	0.00016	0.0016	White-footed Mouse	0.00032	0.00207	0.00107		0.00320	0.02068	0.01065	
1,2,3,6,7,8-Hexachlorodibenzofuran	n/a	rat	0.00016	0.0016	Meadow Vole	0.00027	0.00236	0.00197		0.00269	0.02365	0.01970	
1,2,3,6,7,8-Hexachlorodibenzofuran	n/a	rat	0.00016	0.0016	Mink	0.00012	0.00090	0.00124		0.00123	0.00898	0.01243	
1,2,3,6,7,8-Hexachlorodibenzofuran	n/a	rat	0.00016	0.0016	Cottontail Rabbit	0.00012	0.00060	0.00122		0.00118	0.00595	0.01216	
1,2,3,6,7,8-Hexachlorodibenzofuran	n/a	rat	0.00016	0.0016	Red Fox	0.00008	0.00084	0.00100		0.00084	0.00845	0.01001	
1,2,3,6,7,8-Hexachlorodibenzofuran	n/a	rat	0.00016	0.0016	River Otter	0.00007	0.00065	0.00091		0.00073	0.00650	0.00915	
1,2,3,6,7,8-Hexachlorodibenzofuran	n/a	rat	0.00016	0.0016	Whitetail Deer	0.00004	0.00146	0.00069		0.00045	0.01458	0.00685	
Lead	lead acetate	rat	8	80	Little Brown Bat	20.91	62.73	130.68		209.09	627.28	1306.84	
Lead	lead acetate	rat	8	80	Short-tailed Shrew	17.58	29.30	79.92		175.83	293.04	799.21	
Lead	lead acetate	rat	8	80	White-footed Mouse	15.98	103.38	53.26		159.77	1033.82	532.57	
Lead	lead acetate	rat	8	80	Meadow Vole	13.44	118.23	98.52		134.35	1182.30	985.25	
Lead	lead acetate	rat	8	80	Mink	6.15	44.91	62.15	0.982	61.53	449.14	621.54	9.823
Lead	lead acetate	rat	8	80	Cottontail Rabbit	5.88	29.77	60.82		58.79	297.68	608.18	
Lead	lead acetate	rat	8	80	Red Fox	4.22	42.25	50.03		42.25	422.48	500.30	
Lead	lead acetate	rat	8	80	River Otter	3.66	32.52	45.73	0.711	36.59	325.22	457.35	7.115

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Lead	metallic	American kestrel	3.85		Barred Owl	3.85	32.86	58.73					
Lead	metallic	American kestrel	3.85		Red-tailed Hawk	3.85	39.77	67.74					
Lead	metallic	American kestrel	3.85		Osprey	3.85	19.25	75.00	0.425				
Lead	metallic	American kestrel	3.85		Great Blue Heron	3.85	21.91	86.97	0.484				
Lead	metallic	American kestrel	3.85		Wild Turkey	3.85	128.33	117.53					
Lindane	Gamma-BHC	rat	8		Little Brown Bat	20.91	62.73	130.68					
Lindane	Gamma-BHC	rat	8		Short-tailed Shrew	17.58	29.30	79.92					
Lindane	Gamma-BHC	rat	8		White-footed Mouse	15.98	103.38	53.26					
Lindane	Gamma-BHC	rat	8		Meadow Vole	13.44	118.23	98.52					
Lindane	Gamma-BHC	rat	8		Mink	6.15	44.91	62.15	0.099				
Lindane	Gamma-BHC	rat	8		Cottontail Rabbit	5.88	29.77	60.82					
Lindane	Gamma-BHC	rat	8		Red Fox	4.22	42.25	50.03					
Lindane	Gamma-BHC	rat	8		River Otter	3.66	32.52	45.73	0.073				
Lindane	Gamma-BHC	rat	8		Whitetail Deer	2.24	72.88	34.27					
Lindane	Gamma-BHC	mallard duck	2	20	Rough-winged Swallow	2.00	2.65	8.59		20.00	26.50	85.95	
Lindane	Gamma-BHC	mallard duck	2	20	American Robin	2.00	1.66	14.53		20.00	16.56	145.28	
Lindane	Gamma-BHC	mallard duck	2	20	Belted Kingfisher	2.00	3.95	18.50	0.009	20.00	39.47	185.00	0.087

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks Food[d] (mg/kg)	NOAEL-Based Benchmarks Water[e] (mg/L)	NOAEL-Based Benchmarks Piscivore[f] (mg/L)	Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks Food[d] (mg/kg)	LOAEL-Based Benchmarks Water[e] (mg/L)	LOAEL-Based Benchmarks Piscivore[f] (mg/L)
Manganese	Mn_3O_4	rat	88	284	White-footed Mouse	176	1137	586		567	3670	1891	
Manganese	Mn_3O_4	rat	88	284	Meadow Vole	148	1301	1084		477	4197	3498	
Manganese	Mn_3O_4	rat	88	284	Mink	68	494	684		218	1594	2206	
Manganese	Mn_3O_4	rat	88	284	Cottontail Rabbit	65	327	669		209	1057	2159	
Manganese	Mn_3O_4	rat	88	284	Red Fox	46	465	550		150	1500	1776	
Manganese	Mn_3O_4	rat	88	284	River Otter	40	358	503		130	1155	1624	
Manganese	Mn_3O_4	rat	88	284	Whitetail Deer	25	802	377		80	2587	1217	
Manganese	Mn_3O_4	Japanese quail	997		Rough-winged Swallow	997	1321	4284					
Manganese	Mn_3O_4	Japanese quail	997		American Robin	997	825	7242					
Manganese	Mn_3O_4	Japanese quail	997		Belted Kingfisher	997	1967	9222					
Manganese	Mn_3O_4	Japanese quail	997		American Woodcock	997	1316	9870					
Manganese	Mn_3O_4	Japanese quail	997		Cooper's Hawk	997	5759	12873					
Manganese	Mn_3O_4	Japanese quail	997		Barn Owl	997	3717	13274					
Manganese	Mn_3O_4	Japanese quail	997		Barred Owl	997	8510	15210					
Manganese	Mn_3O_4	Japanese quail	997		Red-tailed Hawk	997	10299	17541					
Manganese	Mn_3O_4	Japanese quail	997		Osprey	997	4985	19422					
Manganese	Mn_3O_4	Japanese quail	997		Great Blue Heron	997	5673	22522					
Manganese	Mn_3O_4	Japanese quail	997		Wild Turkey	997	33233	30435					
Mercury	mercuric chloride	mink	1		Little Brown Bat	3.40	10.19	21.24					

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)	Estimated Wildlife LOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Mercury	mercuric sulfide	mouse	13.2		Little Brown Bat	18.67	56.00	116.67					
Mercury	mercuric sulfide	mouse	13.2		Short-tailed Shrew	15.70	26.16	71.35					
Mercury	mercuric sulfide	mouse	13.2		White-footed Mouse	14.26	92.30	47.55					
Mercury	mercuric sulfide	mouse	13.2		Meadow Vole	11.99	105.55	87.96					
Mercury	mercuric sulfide	mouse	13.2		Mink	5.49	40.10	55.49					
Mercury	mercuric sulfide	mouse	13.2		Cottontail Rabbit	5.25	26.58	54.30					
Mercury	mercuric sulfide	mouse	13.2		Red Fox	3.77	37.72	44.67					
Mercury	mercuric sulfide	mouse	13.2		River Otter	3.27	29.04	40.83					
Mercury	mercuric sulfide	mouse	13.2		Whitetail Deer	2.00	65.06	30.60					
Mercury	Methyl Mercury Chloride	rat	0.032	0.16	Little Brown Bat	0.084	0.251	0.523		0.418	1.255	2.614	
Mercury	Methyl Mercury Chloride	rat	0.032	0.16	Short-tailed Shrew	0.070	0.117	0.320		0.352	0.586	1.598	
Mercury	Methyl Mercury Chloride	rat	0.032	0.16	White-footed Mouse	0.064	0.414	0.213		0.320	2.068	1.065	
Mercury	Methyl Mercury Chloride	rat	0.032	0.16	Meadow Vole	0.054	0.473	0.394		0.269	2.365	1.970	
Mercury	Methyl Mercury Chloride	mink	0.015	0.025	Mink	0.015	0.109	0.152	3.924e-06	0.025	0.182	0.253	6.540e-06
Mercury	Methyl Mercury Chloride	rat	0.032	0.16	Cottontail Rabbit	0.024	0.119	0.243		0.118	0.595	1.216	
Mercury	Methyl Mercury Chloride	mink	0.015	0.025	Red Fox	0.010	0.103	0.122		0.017	0.172	0.203	
Mercury	Methyl Mercury Chloride	mink	0.015	0.025	River Otter	0.009	0.079	0.111	1.576e-06	0.015	0.132	0.186	2.626e-06

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Methanol	n/a	rat	50	250	Mink	38.5	280.7	388.5	314.482	192.3	1403.6	1942.3	1572.411
Methanol	n/a	rat	50	250	Cottontail Rabbit	36.7	186.0	380.1		183.7	930.2	1900.6	
Methanol	n/a	rat	50	250	Red Fox	26.4	264.0	312.7		132.0	1320.2	1563.4	
Methanol	n/a	rat	50	250	River Otter	22.9	203.3	285.8	230.691	114.3	1016.3	1429.2	1153.457
Methanol	n/a	rat	50	250	Whitetail Deer	14.0	455.5	214.2		70.1	2277.4	1071.0	
Methoxychlor	n/a	rat	4	8	Little Brown Bat	10.5	31.4	65.3		20.9	62.7	130.7	
Methoxychlor	n/a	rat	4	8	Short-tailed Shrew	8.8	14.7	40.0		17.6	29.3	79.9	
Methoxychlor	n/a	rat	4	8	White-footed Mouse	8.0	51.7	26.6		16.0	103.4	53.3	
Methoxychlor	n/a	rat	4	8	Meadow Vole	6.7	59.1	49.3		13.4	118.2	98.5	
Methoxychlor	n/a	rat	4	8	Mink	3.1	22.5	31.1	0.001	6.2	44.9	62.2	0.003
Methoxychlor	n/a	rat	4	8	Cottontail Rabbit	2.9	14.9	30.4		5.9	29.8	60.8	
Methoxychlor	n/a	rat	4	8	Red Fox	2.1	21.1	25.0		4.2	42.2	50.0	
Methoxychlor	n/a	rat	4	8	River Otter	1.8	16.3	22.9	0.001	3.7	32.5	45.7	0.002
Methoxychlor	n/a	rat	4	8	Whitetail Deer	1.1	36.4	17.1		2.2	72.9	34.3	
Methylene Chloride	n/a	rat	5.85	50	Little Brown Bat	15.3	45.9	95.6		130.7	392.1	816.8	
Methylene Chloride	n/a	rat	5.85	50	Short-tailed Shrew	12.9	21.4	58.4		109.9	183.2	499.5	
Methylene Chloride	n/a	rat	5.85	50	White-footed Mouse	11.7	75.6	38.9		99.9	646.1	332.9	
Methylene Chloride	n/a	rat	5.85	50	Meadow Vole	9.8	86.5	72.0		84.0	738.9	615.8	
Methylene Chloride	n/a	rat	5.85	50	Mink	4.5	32.8	45.5	5.499	38.5	280.7	388.5	47.000

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks Food[d] (mg/kg)	NOAEL-Based Benchmarks Water[e] (mg/L)	NOAEL-Based Benchmarks Piscivore[f] (mg/L)	Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks Food[d] (mg/kg)	LOAEL-Based Benchmarks Water[e] (mg/L)	LOAEL-Based Benchmarks Piscivore[f] (mg/L)
4-Methyl 2-Pentanone	methyl isobutyl ketone	rat	25		Cottontail Rabbit	18.4	93.0	190.1					
4-Methyl 2-Pentanone	methyl isobutyl ketone	rat	25		Red Fox	13.2	132.0	156.3					
4-Methyl 2-Pentanone	methyl isobutyl ketone	rat	25		River Otter	11.4	101.6	142.9	18.713				
4-Methyl 2-Pentanone	methyl isobutyl ketone	rat	25		Whitetail Deer	7.0	227.7	107.1					
Molybdenum	MoO_4	mouse	0.26	2.6	Little Brown Bat	0.37	1.10	2.30		3.68	11.03	22.98	
Molybdenum	MoO_4	mouse	0.26	2.6	Short-tailed Shrew	0.31	0.52	1.41		3.09	5.15	14.05	
Molybdenum	MoO_4	mouse	0.26	2.6	White-footed Mouse	0.28	1.82	0.94		2.81	18.18	9.37	
Molybdenum	MoO_4	mouse	0.26	2.6	Meadow Vole	0.24	2.08	1.73		2.36	20.79	17.33	
Molybdenum	MoO_4	mouse	0.26	2.6	Mink	0.11	0.79	1.09		1.08	7.90	10.93	
Molybdenum	MoO_4	mouse	0.26	2.6	Cottontail Rabbit	0.10	0.52	1.07		1.03	5.23	10.70	
Molybdenum	MoO_4	mouse	0.26	2.6	Red Fox	0.07	0.74	0.88		0.74	7.43	8.80	
Molybdenum	MoO_4	mouse	0.26	2.6	River Otter	0.06	0.57	0.80		0.64	5.72	8.04	
Molybdenum	MoO_4	mouse	0.26	2.6	Whitetail Deer	0.04	1.28	0.60		0.39	12.82	6.03	
Molybdenum	sodium molybdate (MoO_4)	chicken	3.5	35.3	Rough-winged Swallow	3.50	4.64	15.04		35.30	46.77	151.69	
Molybdenum	sodium molybdate (MoO_4)	chicken	3.5	35.3	American Robin	3.50	2.90	25.42		35.30	29.23	256.42	
Molybdenum	sodium molybdate (MoO_4)	chicken	3.5	35.3	Belted Kingfisher	3.50	6.91	32.38		35.30	69.66	326.53	
Molybdenum	sodium molybdate (MoO_4)	chicken	3.5	35.3	American Woodcock	3.50	4.62	34.65		35.30	46.60	349.47	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL^a (mg/kg/d)	Test Species LOAEL^a (mg/kg/d)	Endpoint Species^b	Estimated Wildlife NOAEL^c (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL^c (mg/kg/d)	LOAEL-Based Benchmarks		
							Food^d (mg/kg)	Water^e (mg/L)	Piscivore^f (mg/L)		Food^d (mg/kg)	Water^e (mg/L)	Piscivore^f (mg/L)
Nickel	nickel sulfate	mallard duckling	77.4	107	Rough-winged Swallow	77.40	102.56	332.61		107.00	141.78	459.81	
Nickel	nickel sulfate	mallard duckling	77.4	107	American Robin	77.40	64.08	562.25		107.00	88.59	777.26	
Nickel	nickel sulfate	mallard duckling	77.4	107	Belted Kingfisher	77.40	152.74	715.95	1.438	107.00	211.15	989.75	1.988
Nickel	nickel sulfate	mallard duckling	77.4	107	American Woodcock	77.40	102.17	766.26		107.00	141.24	1059.30	
Nickel	nickel sulfate	mallard duckling	77.4	107	Cooper's Hawk	77.40	447.09	999.37		107.00	618.07	1381.56	
Nickel	nickel sulfate	mallard duckling	77.4	107	Barn Owl	77.40	288.55	1030.53		107.00	398.90	1424.63	
Nickel	nickel sulfate	mallard duckling	77.4	107	Barred Owl	77.40	660.66	1180.76		107.00	913.32	1632.32	
Nickel	nickel sulfate	mallard duckling	77.4	107	Red-tailed Hawk	77.40	799.56	1361.76		107.00	1105.34	1882.53	
Nickel	nickel sulfate	mallard duckling	77.4	107	Osprey	77.40	387.00	1507.79	3.642	107.00	535.00	2084.42	5.035
Nickel	nickel sulfate	mallard duckling	77.4	107	Great Blue Heron	77.40	440.44	1748.45	4.145	107.00	608.88	2417.11	5.731
Nickel	nickel sulfate	mallard duckling	77.4	107	Wild Turkey	77.40	2580.00	2362.74		107.00	3566.67	3266.32	
Niobium	sodium niobate	mouse	0.155	1.55	Little Brown Bat	0.219	0.658	1.370		2.192	6.576	13.700	
Niobium	sodium niobate	mouse	0.155	1.55	Short-tailed Shrew	0.184	0.307	0.838		1.843	3.072	8.379	
Niobium	sodium niobate	mouse	0.155	1.55	White-footed Mouse	0.167	1.084	0.558		1.675	10.838	5.583	
Niobium	sodium niobate	mouse	0.155	1.55	Meadow Vole	0.141	1.239	1.033		1.408	12.395	10.329	
Niobium	sodium niobate	mouse	0.155	1.55	Mink	0.065	0.471	0.652		0.645	4.709	6.516	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
1,2,3,4,8-Penta-chlorodibenzofuran	n/a	rat	0.048		Cottontail Rabbit	0.035	0.179	0.365					
1,2,3,4,8-Penta-chlorodibenzofuran	n/a	rat	0.048		Red Fox	0.025	0.253	0.300					
1,2,3,4,8-Penta-chlorodibenzofuran	n/a	rat	0.048		River Otter	0.022	0.195	0.274					
1,2,3,4,8-Penta-chlorodibenzofuran	n/a	rat	0.048		Whitetail Deer	0.013	0.437	0.206					
1,2,3,7,8-Penta-chlorodibenzofuran	n/a	rat	0.00016	0.0016	Little Brown Bat	0.00042	0.00125	0.00261		0.00418	0.01255	0.02614	
1,2,3,7,8-Penta-chlorodibenzofuran	n/a	rat	0.00016	0.0016	Short-tailed Shrew	0.00035	0.00059	0.00160		0.00352	0.00586	0.01598	
1,2,3,7,8-Penta-chlorodibenzofuran	n/a	rat	0.00016	0.0016	White-footed Mouse	0.00032	0.00207	0.00107		0.00320	0.02068	0.01065	
1,2,3,7,8-Penta-chlorodibenzofuran	n/a	rat	0.00016	0.0016	Meadow Vole	0.00027	0.00236	0.00197		0.00269	0.02365	0.01970	
1,2,3,7,8-Penta-chlorodibenzofuran	n/a	rat	0.00016	0.0016	Mink	0.00012	0.00090	0.00124		0.00123	0.00898	0.01243	
1,2,3,7,8-Penta-chlorodibenzofuran	n/a	rat	0.00016	0.0016	Cottontail Rabbit	0.00012	0.00060	0.00122		0.00118	0.00595	0.01216	
1,2,3,7,8-Penta-chlorodibenzofuran	n/a	rat	0.00016	0.0016	Red Fox	0.000084	0.00084	0.00100		0.00084	0.00845	0.01001	
1,2,3,7,8-Penta-chlorodibenzofuran	n/a	rat	0.00016	0.0016	River Otter	0.000073	0.00065	0.00091		0.00073	0.00650	0.00915	
1,2,3,7,8-Penta-chlorodibenzofuran	n/a	rat	0.00016	0.0016	Whitetail Deer	0.000045	0.00146	0.00069		0.00045	0.01458	0.00685	
2,3,4,7,8-Penta-chlorodibenzofuran	n/a	rat	0.000016	0.00016	Little Brown Bat	0.000042	0.00013	0.00026		0.00042	0.00125	0.00261	
2,3,4,7,8-Penta-chlorodibenzofuran	n/a	rat	0.000016	0.00016	Short-tailed Shrew	0.000035	0.00006	0.00016		0.00035	0.00059	0.00160	
2,3,4,7,8-Penta-chlorodibenzofuran	n/a	rat	0.000016	0.00016	White-footed Mouse	0.000032	0.00021	0.00011		0.00032	0.00207	0.00107	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Pentachloronitro-benzene	n/a	chicken	7.07	70.7	Wild Turkey	7.070	235.667	215.821		70.700	2356.667	2158.211	
Pentachlorophenol	n/a	rat	0.24	2.4	Little Brown Bat	0.627	1.882	3.921		6.273	18.818	39.205	
Pentachlorophenol	n/a	rat	0.24	2.4	Short-tailed Shrew	0.527	0.879	2.398		5.275	8.791	23.976	
Pentachlorophenol	n/a	rat	0.24	2.4	White-footed Mouse	0.479	3.101	1.598		4.793	31.015	15.977	
Pentachlorophenol	n/a	rat	0.24	2.4	Meadow Vole	0.403	3.547	2.956		4.031	35.469	29.557	
Pentachlorophenol	n/a	rat	0.24	2.4	Mink	0.185	1.347	1.865	3.698e-04	1.846	13.474	18.646	3.698e-03
Pentachlorophenol	n/a	rat	0.24	2.4	Cottontail Rabbit	0.176	0.893	1.825		1.764	8.930	18.246	
Pentachlorophenol	n/a	rat	0.24	2.4	Red Fox	0.127	1.267	1.501		1.267	12.674	15.009	
Pentachlorophenol	n/a	rat	0.24	2.4	River Otter	0.110	0.976	1.372	2.750e-04	1.098	9.757	13.720	2.750e-03
Pentachlorophenol	n/a	rat	0.24	2.4	Whitetail Deer	0.067	2.186	1.028		0.673	21.863	10.282	
Selenium	Selenate (SeO_4)	rat	0.2	0.33	Little Brown Bat	0.523	1.568	3.267		0.863	2.588	5.391	
Selenium	Selenate (SeO_4)	rat	0.2	0.33	Short-tailed Shrew	0.440	0.733	1.998		0.725	1.209	3.297	
Selenium	Selenate (SeO_4)	rat	0.2	0.33	White-footed Mouse	0.399	2.585	1.331		0.659	4.265	2.197	
Selenium	Selenate (SeO_4)	rat	0.2	0.33	Meadow Vole	0.336	2.956	2.463		0.554	4.877	4.064	
Selenium	Selenate (SeO_4)	rat	0.2	0.33	Mink	0.154	1.123	1.554	4.318e-04	0.254	1.853	2.564	7.124e-04
Selenium	Selenate (SeO_4)	rat	0.2	0.33	Cottontail Rabbit	0.147	0.744	1.520		0.243	1.228	2.509	
Selenium	Selenate (SeO_4)	rat	0.2	0.33	Red Fox	0.106	1.056	1.251		0.174	1.743	2.064	
Selenium	Selenate (SeO_4)	rat	0.2	0.33	River Otter	0.091	0.813	1.143	2.363e-04	0.151	1.342	1.887	3.899e-04
Selenium	Selenate (SeO_4)	rat	0.2	0.33	Whitetail Deer	0.056	1.822	0.857		0.093	3.006	1.414	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL^a (mg/kg/d)	Test Species LOAEL^a (mg/kg/d)	Endpoint Species^b	Estimated Wildlife NOAEL^c (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL^c (mg/kg/d)	LOAEL-Based Benchmarks		
							Food^d (mg/kg)	Water^e (mg/L)	Piscivore^f (mg/L)		Food^d (mg/kg)	Water^e (mg/L)	Piscivore^f (mg/L)
Selenium	selanomethio-nine	screech owl	0.44	1.5	Osprey	0.440	2.200	8.571		1.500	7.500	29.221	
Selenium	selanomethio-nine	mallard duck	0.4	0.8	Great Blue Heron	0.400	2.276	9.036		0.800	4.552	18.072	
Selenium	selanomethio-nine	mallard duck	0.4	0.8	Wild Turkey	0.400	13.333	12.211		0.800	26.667	24.421	
Selenium	selanomethio-nine	black-crowned night-heron	1.8		Belted Kingfisher	1.800	3.552	16.650					
Selenium	selanomethio-nine	black-crowned night-heron	1.8		Great Blue Heron	1.800	10.243	40.662					
Strontium	stable strontium chloride	rat	263		Little Brown Bat	687	2062	4296					
Strontium	stable strontium chloride	rat	263		Short-tailed Shrew	578	963	2627					
Strontium	stable strontium chloride	rat	263		White-footed Mouse	525	3399	1751					
Strontium	stable strontium chloride	rat	263		Meadow Vole	442	3887	3239					
Strontium	stable strontium chloride	rat	263		Mink	202	1477	2043					
Strontium	stable strontium chloride	rat	263		Cottontail Rabbit	193	979	1999					
Strontium	stable strontium chloride	rat	263		Red Fox	139	1389	1645					
Strontium	stable strontium chloride	rat	263		River Otter	120	1069	1504					
Strontium	stable strontium chloride	rat	263		Whitetail Deer	74	2396	1127					
2,3,7,8-TCDD	n/a	rat	0.000001	0.00001	Little Brown Bat	0.0000001	0.0000003	0.0000007		0.0000011	0.0000032	0.0000067	
2,3,7,8-TCDD	n/a	rat	0.000001	0.00001	Short-tailed Shrew	0.0000022	0.0000037	0.0000100		0.0000220	0.0000366	0.0000999	
2,3,7,8-TCDD	n/a	rat	0.000001	0.00001	White-footed Mouse	0.0000020	0.0000129	0.0000067		0.0000200	0.0001292	0.0000666	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL^{a} (mg/kg/d)	Test Species LOAEL^{a} (mg/kg/d)	Endpoint Species^{b}	Estimated Wildlife NOAEL^{c} (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL^{c} (mg/kg/d)	LOAEL-Based Benchmarks		
							Food^{d} (mg/kg)	Water^{e} (mg/L)	Piscivore^{f} (mg/L)		Food^{d} (mg/kg)	Water^{e} (mg/L)	Piscivore^{f} (mg/L)
2,3,7,8-Tetrachloro-dibenzofuran	n/a	1 day old chick	0.000001	0.00001	Rough-winged Swallow	0.0000010	0.0000013	0.0000043		0.0000100	0.0000133	0.0000430	
2,3,7,8-Tetrachloro-dibenzofuran	n/a	1 day old chick	0.000001	0.00001	American Robin	0.0000010	0.0000008	0.0000073		0.0000100	0.0000083	0.0000726	
2,3,7,8-Tetrachloro-dibenzofuran	n/a	1 day old chick	0.000001	0.00001	Belted Kingfisher	0.0000010	0.0000020	0.0000093		0.0000100	0.0000197	0.0000925	
2,3,7,8-Tetrachloro-dibenzofuran	n/a	1 day old chick	0.000001	0.00001	American Woodcock	0.0000010	0.0000013	0.0000099		0.0000100	0.0000132	0.0000990	
2,3,7,8-Tetrachloro-dibenzofuran	n/a	1 day old chick	0.000001	0.00001	Cooper's Hawk	0.0000010	0.0000058	0.0000129		0.0000100	0.0000578	0.0001291	
2,3,7,8-Tetrachloro-dibenzofuran	n/a	1 day old chick	0.000001	0.00001	Barn Owl	0.0000010	0.0000037	0.0000133		0.0000100	0.0000373	0.0001331	
2,3,7,8-Tetrachloro-dibenzofuran	n/a	1 day old chick	0.000001	0.00001	Barred Owl	0.0000010	0.0000085	0.0000153		0.0000100	0.0000854	0.0001526	
2,3,7,8-Tetrachloro-dibenzofuran	n/a	1 day old chick	0.000001	0.00001	Red-tailed Hawk	0.0000010	0.0000103	0.0000176		0.0000100	0.0001033	0.0001759	
2,3,7,8-Tetrachloro-dibenzofuran	n/a	1 day old chick	0.000001	0.00001	Osprey	0.0000010	0.0000050	0.0000195		0.0000100	0.0000500	0.0001948	
2,3,7,8-Tetrachloro-dibenzofuran	n/a	1 day old chick	0.000001	0.00001	Great Blue Heron	0.0000010	0.0000057	0.0000226		0.0000100	0.0000569	0.0002259	
2,3,7,8-Tetrachloro-dibenzofuran	n/a	1 day old chick	0.000001	0.00001	Wild Turkey	0.0000010	0.0000333	0.0000305		0.0000100	0.0003333	0.0003053	
1,1,2,2-Tetrachloro-ethylene	n/a	mouse	1.4	7	Little Brown Bat	1.98	5.94	12.37		9.90	29.70	61.87	
1,1,2,2-Tetrachloro-ethylene	n/a	mouse	1.4	7	Short-tailed Shrew	1.66	2.77	7.57		8.32	13.87	37.84	
1,1,2,2-Tetrachloro-ethylene	n/a	mouse	1.4	7	White-footed Mouse	1.51	9.79	5.04		7.56	48.95	25.21	
1,1,2,2-Tetrachloro-ethylene	n/a	mouse	1.4	7	Meadow Vole	1.27	11.20	9.33		6.36	55.98	46.65	
1,1,2,2-Tetrachloro-ethylene	n/a	mouse	1.4	7	Mink	0.58	4.25	5.89	0.066	2.91	21.26	29.43	0.331

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Tin	bis(tributyltin)-oxide (TBTO)	mouse	23.4	35	Mink	9.7	71.1	98.4		14.6	106.3	147.1	
Tin	bis(tributyltin)-oxide (TBTO)	mouse	23.4	35	Cottontail Rabbit	9.3	47.1	96.3		13.9	70.5	144.0	
Tin	bis(tributyltin)-oxide (TBTO)	mouse	23.4	35	Red Fox	6.7	66.9	79.2		10.0	100.0	118.4	
Tin	bis(tributyltin)-oxide (TBTO)	mouse	23.4	35	River Otter	5.8	51.5	72.4		8.7	77.0	108.3	
Tin	bis(tributyltin)-oxide (TBTO)	mouse	23.4	35	Whitetail Deer	3.6	115.3	54.2		5.3	172.5	81.1	
Tin	bis(tributyltin)-oxide (TBTO)	Japanese quail	6.8	16.9	Rough-winged Swallow	6.8	9.0	29.2		16.9	22.4	72.6	
Tin	bis(tributyltin)-oxide (TBTO)	Japanese quail	6.8	16.9	American Robin	6.8	5.6	49.4		16.9	14.0	122.8	
Tin	bis(tributyltin)-oxide (TBTO)	Japanese quail	6.8	16.9	Belted Kingfisher	6.8	13.4	62.9		16.9	33.3	156.3	
Tin	bis(tributyltin)-oxide (TBTO)	Japanese quail	6.8	16.9	American Woodcock	6.8	9.0	67.3		16.9	22.3	167.3	
Tin	bis(tributyltin)-oxide (TBTO)	Japanese quail	6.8	16.9	Cooper's Hawk	6.8	39.3	87.8		16.9	97.6	218.2	
Tin	bis(tributyltin)-oxide (TBTO)	Japanese quail	6.8	16.9	Barn Owl	6.8	25.4	90.5		16.9	63.0	225.0	
Tin	bis(tributyltin)-oxide (TBTO)	Japanese quail	6.8	16.9	Barred Owl	6.8	58.0	103.7		16.9	144.3	257.8	
Tin	bis(tributyltin)-oxide (TBTO)	Japanese quail	6.8	16.9	Red-tailed Hawk	6.8	70.2	119.6		16.9	174.6	297.3	
Tin	bis(tributyltin)-oxide (TBTO)	Japanese quail	6.8	16.9	Osprey	6.8	34.0	132.5		16.9	84.5	329.2	
Tin	bis(tributyltin)-oxide (TBTO)	Japanese quail	6.8	16.9	Great Blue Heron	6.8	38.7	153.6		16.9	96.2	381.8	
Tin	bis(tributyltin)-oxide (TBTO)	Japanese quail	6.8	16.9	Wild Turkey	6.8	226.7	207.6		16.9	563.3	515.9	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)	Estimated Wildlife LOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
1,1,1-Trichloroeth-ane	n/a	mouse	1000		Short-tailed Shrew	1236	2060	5618					
1,1,1-Trichloroeth-ane	n/a	mouse	1000		White-footed Mouse	1123	7267	3744					
1,1,1-Trichloroeth-ane	n/a	mouse	1000		Meadow Vole	944	8311	6926					
1,1,1-Trichloroeth-ane	n/a	mouse	1000		Mink	433	3157	4369	68.126				
1,1,1-Trichloroeth-ane	n/a	mouse	1000		Cottontail Rabbit	413	2092	4275					
1,1,1-Trichloroeth-ane	n/a	mouse	1000		Red Fox	297	2970	3517					
1,1,1-Trichloroeth-ane	n/a	mouse	1000		River Otter	257	2286	3215	49.419				
1,1,1-Trichloroeth-ane	n/a	mouse	1000		Whitetail Deer	158	5123	2409					
Trichloroethylene	n/a	mouse	0.7	7	Little Brown Bat	0.990	2.970	6.187		9.899	29.698	61.872	
Trichloroethylene	n/a	mouse	0.7	7	Short-tailed Shrew	0.832	1.387	3.784		8.324	13.874	37.838	
Trichloroethylene	n/a	mouse	0.7	7	White-footed Mouse	0.756	4.895	2.521		7.564	48.946	25.215	
Trichloroethylene	n/a	mouse	0.7	7	Meadow Vole	0.636	5.598	4.665		6.361	55.975	46.646	
Trichloroethylene	n/a	mouse	0.7	7	Mink	0.291	2.126	2.943	0.031	2.913	21.265	29.427	0.308
Trichloroethylene	n/a	mouse	0.7	7	Cottontail Rabbit	0.278	1.409	2.879		2.783	14.093	28.794	
Trichloroethylene	n/a	mouse	0.7	7	Red Fox	0.200	2.000	2.369		2.000	20.002	23.687	
Trichloroethylene	n/a	mouse	0.7	7	River Otter	0.173	1.540	2.165	0.022	1.732	15.398	21.653	0.224
Trichloroethylene	n/a	mouse	0.7	7	Whitetail Deer	0.106	3.450	1.623		1.063	34.504	16.226	
Uranium	Uranyl acetate	mouse	3.07	6.13	Little Brown Bat	4.267	12.802	26.671		8.521	25.563	53.256	
Uranium	Uranyl acetate	mouse	3.07	6.13	Short-tailed Shrew	3.588	5.981	16.311		7.165	11.942	32.569	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Uranium	depleted metallic U	black duck	16		Wild Turkey	16.0	533.3	488.4					
Vanadium	sodium metavanadate ($NaVO_3$)	rat	0.21	2.1	Little Brown Bat	0.510	1.529	3.185		5.096	15.287	31.848	
Vanadium	sodium metavanadate ($NaVO_3$)	rat	0.21	2.1	Short-tailed Shrew	0.428	0.714	1.948		4.285	7.141	19.477	
Vanadium	sodium metavanadate ($NaVO_3$)	rat	0.21	2.1	White-footed Mouse	0.389	2.519	1.298		3.894	25.194	12.979	
Vanadium	sodium metavanadate ($NaVO_3$)	rat	0.21	2.1	Meadow Vole	0.327	2.881	2.401		3.274	28.813	24.010	
Vanadium	sodium metavanadate ($NaVO_3$)	rat	0.21	2.1	Mink	0.150	1.095	1.515		1.500	10.946	15.147	
Vanadium	sodium metavanadate ($NaVO_3$)	rat	0.21	2.1	Cottontail Rabbit	0.143	0.725	1.482		1.433	7.254	14.821	
Vanadium	sodium metavanadate ($NaVO_3$)	rat	0.21	2.1	Red Fox	0.103	1.030	1.219		1.030	10.296	12.192	
Vanadium	sodium metavanadate ($NaVO_3$)	rat	0.21	2.1	River Otter	0.089	0.793	1.115		0.892	7.926	11.146	
Vanadium	sodium metavanadate ($NaVO_3$)	rat	0.21	2.1	Whitetail Deer	0.055	1.776	0.835		0.547	17.760	8.352	
Vanadium	vanadyl sulfate	mallard duck	11.4		Rough-winged Swallow	11.400	15.105	48.989					
Vanadium	vanadyl sulfate	mallard duck	11.4		American Robin	11.400	9.439	82.811					

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL^a (mg/kg/d)	Test Species LOAEL^a (mg/kg/d)	Endpoint Species^b	Estimated Wildlife NOAEL^c (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL^c (mg/kg/d)	LOAEL-Based Benchmarks		
							Food^d (mg/kg)	Water^e (mg/L)	Piscivore^f (mg/L)		Food^d (mg/kg)	Water^e (mg/L)	Piscivore^f (mg/L)
Xylene	mixed isomers	mouse	2.1	2.6	Short-tailed Shrew	2.497	4.162	11.352		3.092	5.153	14.054	
Xylene	mixed isomers	mouse	2.1	2.6	White-footed Mouse	2.269	14.684	7.564		2.810	18.180	9.365	
Xylene	mixed isomers	mouse	2.1	2.6	Meadow Vole	1.908	16.793	13.994		2.363	20.791	17.326	
Xylene	mixed isomers	mouse	2.1	2.6	Mink	0.874	6.379	8.828	0.038	1.082	7.898	10.930	0.047
Xylene	mixed isomers	mouse	2.1	2.6	Cottontail Rabbit	0.835	4.228	8.638		1.034	5.235	10.695	
Xylene	mixed isomers	mouse	2.1	2.6	Red Fox	0.600	6.001	7.106		0.743	7.429	8.798	
Xylene	mixed isomers	mouse	2.1	2.6	River Otter	0.520	4.619	6.496	0.028	0.643	5.719	8.043	0.035
Xylene	mixed isomers	mouse	2.1	2.6	Whitetail Deer	0.319	10.351	4.868		0.395	12.816	6.027	
Zinc	zinc oxide	rat	160	320	Little Brown Bat	418.2	1254.6	2613.7		836.4	2509.1	5227.4	
Zinc	zinc oxide	rat	160	320	Short-tailed Shrew	351.7	586.1	1598.4		703.3	1172.2	3196.8	
Zinc	zinc oxide	rat	160	320	White-footed Mouse	319.5	2067.6	1065.1		639.1	4135.3	2130.3	
Zinc	zinc oxide	rat	160	320	Meadow Vole	268.7	2364.6	1970.5		537.4	4729.2	3941.0	
Zinc	zinc oxide	rat	160	320	Mink	123.1	898.3	1243.1	0.929	246.1	1796.6	2486.2	1.858
Zinc	zinc oxide	rat	160	320	Cottontail Rabbit	117.6	595.4	1216.4		235.2	1190.7	2432.7	
Zinc	zinc oxide	rat	160	320	Red Fox	84.5	845.0	1000.6		169.0	1689.9	2001.2	
Zinc	zinc oxide	rat	160	320	River Otter	73.2	650.4	914.7	0.673	146.4	1300.9	1829.4	1.346
Zinc	zinc oxide	rat	160	320	Whitetail Deer	44.9	1457.6	685.4		89.8	2915.1	1370.9	
Zinc	zinc sulfate	white leghorn hen	14.5	131	Rough-winged Swallow	14.5	19.2	62.3		131.0	173.6	562.9	
Zinc	zinc sulfate	white leghorn hen	14.5	131	American Robin	14.5	12.0	105.3		131.0	108.5	951.6	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Zirconium	zirconium sulfate	mouse	1.74		Whitetail Deer	0.264	8.577	4.033					

Notes:

[a] See Appendix A for derivation, Study Duration, and study endpoint.

[b] See Appendix B for body weights, food and water consumption rates.

[c] Calculated using Eq. 4 or 6.

[d] Calculated using Eq. 10.

[e] Calculated using Eq. 22.

[f] Combined food and water benchmark for aquatic-feeding species. Calculated using Eq. 28.