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REVISED DRAFT FINAL BASELINE ECOLOGICAL RISK ASSESSMENT FOR FOCUSED FEASIBILITY STUDY NAS FORT WORTH TX

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NAVAL AIR STATION
FORT WORTH JRB
CARSWELL FIELD
TEXAS

DEPARTMENT OF THE AIR FORCE
UNITED STATES OF AMERICA
MCMXLVII

ADMINISTRATIVE RECORD
COVER SHEET

AR File Number 650

File:
P.W. 17A-64

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HYDRO GeoLogic INC.

REVISED DRAFT FINAL
BASELINE ECOLOGICAL RISK ASSESSMENT
FOR THE FOCUSED FEASIBILITY STUDY
FORMER CARSWELL AIR FORCE BASE, TEXAS

AF CENTER FOR ENVIRONMENTAL EXCELLENCE

Prepared for

Air Force Center for Environmental Excellence
Brooks AFB, Texas

Contract No. F41624-95-D-8005-0002

May 2001

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Herndon, Virginia 20170
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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BROOKS AIR FORCE BASE TEXAS

8 May 2001

MEMORANDUM FOR RUBEN MOYA (EPA REGION 6)

FROM: Mr. Don Ficklen
HQ AFCEE/ERD
3207 North Road
Brooks AFB, TX 78235

SUBJECT: Former Carswell AFB
Revised Draft Final Baseline Ecological Risk Assessment

Dear Mr. Moya,

One copy of the Revised Draft Final Baseline Ecological Risk Assessment is attached for your review. The report was revised based on the comments from Cheryl Overstreet and Gary Miller (EPA) and Vickie Reat (TNRCC). Responses to comments on the Human Health portion of the Risk Assessment were distributed via email on April 26, 2001. I assume that you will be submitting one set of comments collectively from Gary Miller, the above mentioned risk assessors, and yourself. These comments, along with the comments from the TNRCC reviewers can be either submitted in writing, or if you prefer, a conference call can be held among all the involved parties to answer any questions or comments. After receipt of all comments, the Final Risk Assessment (including both the Human Health and Ecological portions) will be submitted.

Should you have any questions regarding this report, please contact me at (210) 536-5290.

Sincerely,

Mr. Don Ficklen
AFCEE/ERD

cc

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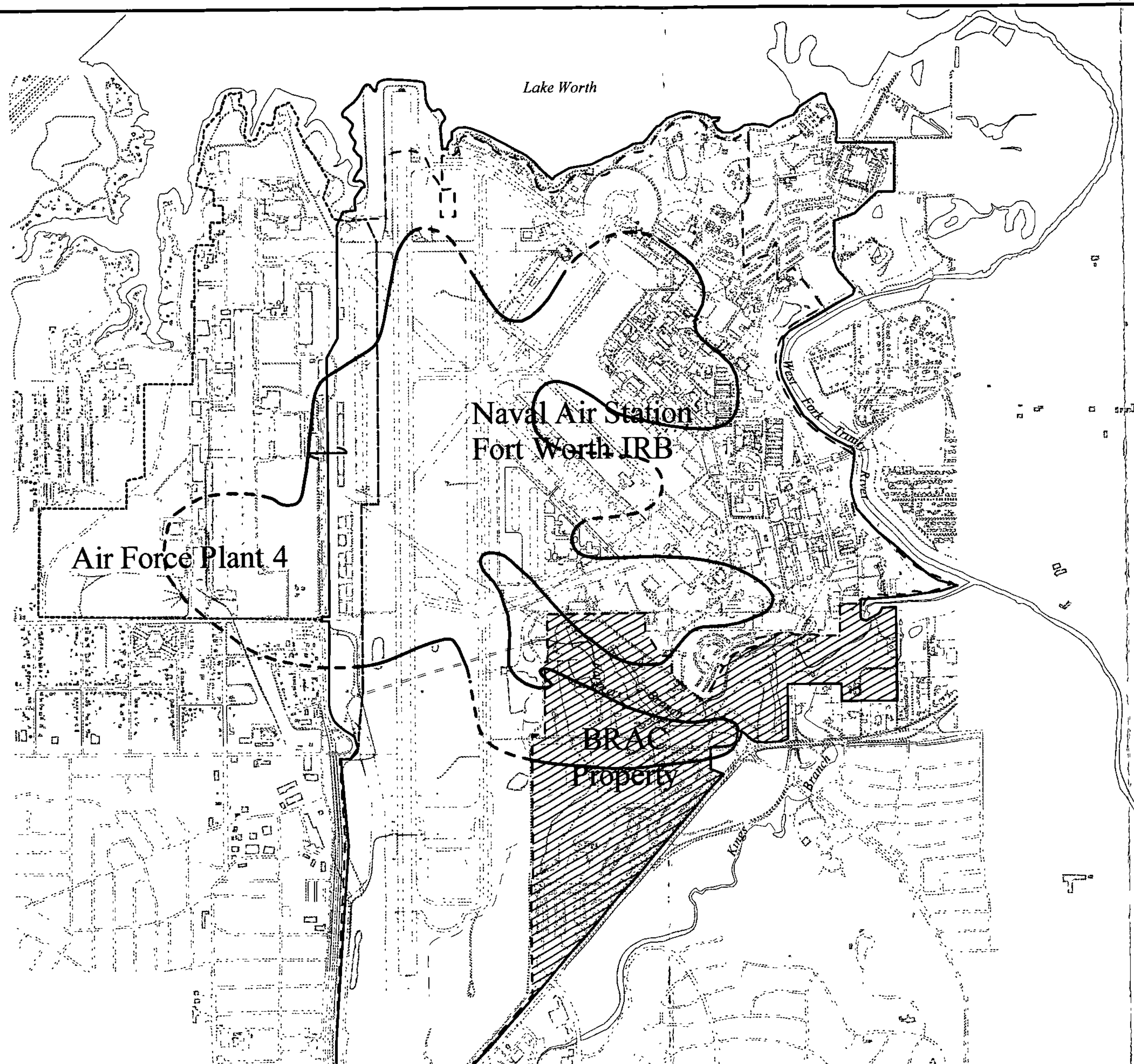
HydroGeoLogic, Inc
NAS Fort Worth JRB, Texas

Figure 1

Site Map
NAS Fort Worth JRB, Texas

U.S. Air Force Center For Environmental Excellence



Legend

- Boundary of NAS Fort Worth JRB
- Former Property Boundary of Carswell Air Force Base
- Property Boundary of Air Force Plant 4
- TCE Contour (5 µg/L, October 2000)
- BRAC Property

N

1000 0 1000 2000
SCALE IN FEET

Filename X:\AFC001\19be\Report\FIG1_2.apr
Project AFC001-19BE
Created 04/23/98 nzehms
Revised 05/09/01 jb
Map Source HydroGeoLogic, Inc
Arcview GIS Database 2001

HYDRO GeoLogic Inc.

RESPONSE TO COMMENTS ON THE DRAFT BASELINE RISK ASSESSMENT FOR THE FOCUSED FEASIBILITY STUDY ECOLOGICAL RISK ASSESSMENT COMMENTS TEXAS NATURAL RESOURCE CONSERVATION COMMISSION VICKIE REAT, TECHNICAL SUPPORT SECTION, REMEDIATION DIVISION COMMENTS DATED MARCH 6, 2001

Overall Comments

Comment 1 *From this reviewer's perspective, it seemed as though the risk assessment was drafted with the presumption that the reviewer would fill in the gaps with historical knowledge of previous assessment reports or risk assessments. Other reports were not referenced, sediment and surface water sample locations were not presented on a map, and the creek environment was not described in any manner. Farmer's Branch Creek was not even mentioned by name until page 6-5 of the report.*

Response **This risk assessment was originally intended to exist as part of a Feasibility Study report. Much of the information requested is included as part of the Feasibility Study. A decision has been made since this submittal to have the Risk Assessment as a stand alone document. Additional sample location maps and a description of the creek environment have been added to the risk assessment.**

Comment 2 *It may be possible that the groundwater plume constituents have/will results in minimal risk to the creek and its biota. However, this risk assessment did not support this conclusion due to the selection of or lack of documentation for benchmarks, exposure assumptions, receptors, and toxicity values.*

Response **Please see responses to specific comments below. This additional information will be included in the subsequent draft of the risk assessment.**

Comment 3 *The report indicated that the risk assessment relied upon TNRCC's current ecological risk assessment guidance (TNRCC, 2000) as the primary guidance document used in performing this ecological risk assessment. In fact, the ten elements of a Tier 2 screening level risk assessment were repeated in the introduction to Chapter 6. In reality, the risk assessment appeared to use this guidance in a very cursory manner.*

Careful review and use of the TNRCC guidance and relevant Superfund guidance is recommended for the final draft of this ecological risk assessment. I will be happy to discuss these comments and/or provide further details if desired.

Response **A clearer understanding of TNRCC's interpretation of their ecological risk assessment guidance was obtained during our March 22 conference call. The report has been extensively revised in order to satisfy the requirements of a Tier 2 TRRP Ecological Risk Assessment as described in the responses to specific comments below.**

Specific Comments

Comment 1 *Page 2-2, 2.1, Land Use Scenarios and Potential Populations of Concern. The report indicates that the only exposure scenarios included in the ecological risk assessment are exposures to surface water and sediment. The risk assessment fails to describe the water body in question and any possibility of downstream transport. There is no description of the water body in question other than that provided in the Tier 1 checklist in Appendix D - Farmer's Branch Creek which is described as intermittent with perennial pools. What is the basis for this description? What reach of the water body is being addressed?*

Response **This risk assessment is intended to evaluate only groundwater and any effect of potential groundwater contaminants on the surface water body associated with the study area. A map indicating surface water and sediment sampling locations for the study area and additional sampling locations downstream of the study area will be added. A fuller description of the surface water body with respect to habitats and potential receptors will be added to the document.**

Comment 2 *Page 2-3, 2.2, Exposure Pathways. Exposure routes identified include direct contact with surface water and sediment, ingestion of food from surface water and sediment, ingestion of prey that may bioaccumulate or bioconcentrate contaminants, and ingestion of surface water. On face value these exposure routes seem reasonable for a generic situation with COPCs in surface water and sediment. As discussed in Section 3.7 of TNRCC, 2000, the conceptual model should ideally graphically depict the movement of COPCs from the source(s) through media to the feeding guilds or to the selected receptors of those guilds. There was no clear discussion of the applicable feeding guilds (See comment 6) or the relationships between the impacted groundwater and the surface water and sediment.*

Response **The exposure routes included are those identified in the Risk Assessment Assumptions Document that was reviewed and commented on by USEPA Region 6 and representatives from TNRCC. The risk assessment has been modified to include a graphical representation of the ecological conceptual model and a discussion of applicable feeding guilds. Section 6.1.2 describes the receptor species selected to represent these guilds.**

Comment 3 *Page 2-3, 2.3, Data Compilation and Evaluation. The discussion indicates that historical surface water and sediment data were compiled and summarized from previous investigation. The report should provide reference(s) for the source of this data. With the information provided in this report, sample locations and historical trends are completely unknown. Nor can the relationship between the groundwater and surface water interface be discerned.*

Response **Additional references pointing to previous data reports will be included. As stated in response to Overall Comment 1, this risk assessment was originally intended to be part of a Feasibility Study report. Figures 46 and 47 were added to the document to show the sampling locations as well as a Figure 1 depicting the surface water bodies in relation to the TCE plume. Figure 1 will be incorporated into earlier sections of the document and has been included in the Revised Draft Final Report for your review.**

Comment 4 *Page 2-4, 2.4.1, Comparison of Site-Related Data to Background Data. There is no description of, or map depicting surface water and sediment sample locations for background (as noted in Tables 3 and 5). This appears to be relevant for sediment only as no surface water COPCs were screened out based on background comparisons according to the information in Table 5.*

Response **An explanation of background sample locations will be added.**

Comment 5 *Page 2-5, 2.4.2, Risk-Based Concentration Screen. The text indicates that surface water constituents were screened based on comparison with tap water PRGs. Maximum surface water concentrations should be screening against the benchmarks provided by TNRCC, 2000 (See Section 3.5). These benchmarks were derived to be protective of aquatic life receptors. Where no benchmark is available, a benchmark should be proposed with suitable justification, or the COPC should be carried* *forward in the risk assessment. The TNRCC surface water screening values for barium, lead, selenium and silver appear to be lower than screening values used and the surface water 95% UCL.*

For sediment, PRGs for residential soil were used. It is unknown if these screening values are appropriately conservative for aquatic receptors exposed to sediment. Maximum sediment concentrations should be screened against the benchmarks provided in TNRCC, 2000 (See Section 3.5). The TNRCC sediment screening values for fluoranthene and pyrene appear to be lower than the screening values used and the sediment 95% UCL.

For surface water and sediment, bioaccumulative COPCs that are above background should be retained even when concentrations are below benchmark screening values. Bioaccumulative constituents are listed in Table 3-1 of TNRCC, 2000.

Response **The screen referenced is intended to assist in the selection of COPCs for the human health risk assessment. Ecological benchmarks were used to screen maximum surface water and sediment constituent concentrations as shown in Tables 19 and 20. However, the screening benchmarks used in the current version of the risk assessment are not those requested in the above comment. The ecological risk assessment has been modified to use the requested benchmark values. These are in Tables 18 and 19 of the current draft. In addition, the definition of bioaccumulative compounds according to USEPA was used in this risk assessment. The current draft of the ecological risk assessment adheres to the list of bioaccumulators provided by TNRCC.**

Comment 6 *Pages 6-2 and 6-3, 6.2, Selection of Assessment and Measurement Endpoints. Generic terrestrial vertebrates, benthic invertebrates, and aquatic vertebrates are used to represent receptors at the site. Assessment receptor species were selected based on the likelihood of finding the species at the former Carswell AFB and the availability of toxicity data. The discussion did not include any specific information regarding the stream habitat and the expected receptors. A screening-level ERA should contain a conceptual model depicting all exposure pathways and potential receptors. In general, it is advisable to initially select receptors form all feeding guilds that are found within the habitats present and address all complete exposure pathways. This should include an evaluation of higher trophic level organism (e.g., a piscivore such as a belted kingfisher, and an omnivorous mammal such as a* *raccoon) as well as community level receptors (e.g., benthic invertebrates). Some of these receptors/pathways can then be scientifically eliminated from consideration based on relative contaminant sensitivities and/or exposures or other factors. A decision to not evaluate some feeding guilds removes these receptors form consideration of exposure, sensitivity, and possible food chain effects. Based on the site in question (e.g., Farmer's Branch Creek) the conceptual model should be expanded to address a greater diversity of food webs and potential receptors. The conceptual model should include multiple trophic levels (e.g., aquatic invertebrate feeders, mammalian and bird piscivores, herbivorous mammals and birds, and carnivorous birds and mammals). The preceding list is just an example of receptor classes that could be included. Please refer to Sections 3.6.6 and 3.6.7 in TNRCC, 2000 for guidance regarding selection of assessment endpoints, measurement endpoints and measurement receptors.*

The risk assessment is silent regarding the presence of threatened, endangered, or otherwise protected species, and the availability of suitable habitat. Where appropriate, these species should be considered when determining selected receptors for the ecological risk assessment. Efforts to document the presence/absence of protected species should be indicated. The species range and availability of suitable habitat should also be considered.

Response **The conceptual site model has been expanded to include exposures through the food chain to various trophic guilds, including herbivores, omnivores, and carnivores. The fish resource at this site is limited and would probably not support a purely piscivorous receptor. In addition, a statement regarding the potential presence of threatened or endangered species has been included (Section 6.1.1). No such species are known to exist at this site.**

Comment 7 *Page 6-4, 6.3.1, Identification of Representative (Terrestrial) Ecological Receptors. The selected indicator species are the deer mouse (omnivorous mammal) and the quail (omnivorous bird). As these are land-based receptors, its seems illogical that they were selected to represent site receptors that may forage in Farmer's Branch Creek. Soil was not identified as an exposure medium for this risk assessment (Section 2.2). If Farmer's Branch Creek is intermittent, it is reasonable to evaluate the risk to receptors that may forage along the watercourse when the creek is dry or almost dry. However it would be more appropriate to select receptors such as a raccoon, mink, and /or marsh* *wren that may preferentially forage within riparian areas. Exposure modifications could reflect food sources outside the watercourse.*

Response **Screening criteria for aquatic and sediment-based receptors were used to evaluate surface water and sediment receptor exposures while the terrestrial receptors were used to evaluate exposure from surface water and sediment to terrestrial receptors as the document states in Section 6.3. However, in light of the comments herein and those discussed in the March 22 conference call, the receptors included in this risk assessment are as follows: the deer mouse and quail (northern bobwhite) were retained and modeled as herbivores. A raccoon and mink were added as omnivorous and carnivorous mammals (respectively). A common snipe and American bittern were added as omnivorous and carnivorous birds (respectively).**

Comment 8 *Page 6-5, 6.4.1, Surface Water Exposure Pathway. See previous comment (number 2) regarding the conceptual model. The report indicates that the potential contaminant sources for surface water and sediment include seepage from groundwater. No information is provided to indicate where the groundwater/ sediment/surface water interfaces are located, and the nature of the current exposure (e.g., historical vs. ongoing release).*

Response **Please see response to comments 1 and 3, above.**

Comment 9 *Page 6-5, 6.4.1, Surface Water Exposure Pathway. The report states that the greatest risk to aquatic vertebrates is "when Farmer's Branch Creek becomes dry like it has during the recent record droughts." The risk assessment should be performed to evaluate potential risks during periods of flow <u>and</u> periods where the creek is mostly dry. Exposure parameters can be adjusted to reflect seasonal changes. If perennial pools exist in the creek, these act as refuges where aquatic receptors may concentrate during dry periods. Additionally, the risk assessment should also address potential risks to receptors in downstream water bodies that may be impacted by constituents that are released downstream. The risk assessment failed to discuss downstream water bodies or the potential transport of COPCS to these locations.*

Response **The statement referred to in the comment has been removed. It was meant to address the potential adverse effects to aquatic organisms from the physical change in the environment associated with the drying of the creek. This assessment considers these periods as part**

of the natural system and focuses on the potential effects of anthropogenic chemical exposures in the system. These chemicals are considered to be limited to surface water and sediment, and the periods when surface water is present are considered to represent the worst case periods for potential exposure (due to the existence of uptake pathways through the aquatic food chain and the existence of the drinking water pathway during these times). Therefore, all risks are evaluated under the assumption that water is present. Because the habitats (and the associated receptors) immediately downstream of the site are essentially the same as those on-site, the risks estimated to these receptors on-site are considered worst case. Risks downstream of the site are expected to decline from those estimated at the site.

Comment 10 *Page 6-6, 6.4.2, Sediment Exposure Pathway. Like surface water, the discussion indicates that a potential source for contaminants in sediment is seepage from groundwater. The text further states that the release mechanisms include surface water runoff, groundwater discharge, and airborne deposition. This latter statement is confusing given that soil is not an exposure medium evaluated in this risk assessment. Are seepage areas known outside of the watercourse?*

Response **This statement has been deleted from the text. Seepage is only known to occur along the drainages.**

Comment 11 *Page 6-7, 6.5, Exposure Estimate and Risk Calculation. The intake calculation conservatively assumes that the receptor only ingests potentially impacted sediment or surface water. Ideally the risk assessment should evaluate the exposure to media constituents through food chain transfer, and incidental ingestion of media (See TNRCC, 2000). Intake calculation should be combined where the receptor is potentially exposed to multiple media. See comment number 16 also.*

Response **Tables 18 and 19 of the reviewed draft show EQ estimates for combined exposures to both surface water and sediment. The current draft includes four additional wildlife receptors. These now include three trophic levels, with multiple exposure pathways that include food chain pathways as well as direct ingestion of media.**

Comment 12 *Page 6-8, 6.5, Risk Calculation. The discussion indicates that contaminant-specific hazard quotients will not be summed since there is* *little data concerning a mechanism of action or target organ toxicity for species other than mammalian species. In accordance with TNRCC, 2000 (See section 3.10) a hazard index (HI) should be calculated for each receptor and exposure area for any class of constituents with the same toxicological mechanism. In particular, it is appropriate to calculate a HI for low molecular weight PAHs (generally two or three rings) and high molecular weight PAHs (generally four or more rings). This should be done regardless of the outcome of the hazard quotient calculation for each receptor. The risk assessment should be revised to reflect this evaluation. It is not necessary to sum the hazard quotients for every COC - only those that are expected to have the same toxicological mechanism for a particular receptor.*

Response **The sample containing the PAH detections has been removed from the data set being evaluated for this site. None of the other COPECs are similar enough in toxicological mechanism to warrant summing as HIs.**

Comment 13 *Pages 6-8 and 6-9, 6.6.1, Comparison with Surface Water and Sediment Benchmarks. Surface water concentrations were compared with EPA Region 4 freshwater screening values, where available. If no screening value was fund, the constituent was not evaluated. Surface water concentrations should be compared to Texas Water Quality Standards (TSWQS) for aquatic life. If there is no state standard, a federal criterion can be used. Where this is not available, a value should be derived using LC_{50} toxicity data as allowed in §307.6 of the TSWQS (See TNRCC, 2000). If Farmer's Branch Creek is truly intermittent, acute criteria can be used. However, if the creek is perennial or intermittent with perennial pools, chronic and acute criteria must be used.*

Response **TNRCC benchmarks for surface water and sediment were used in the current draft. Benchmarks were available for all COPCs that were greater than background and were not nutrients, with the exceptions of barium and vanadium in sediment. Insufficient information was found to support an alternative benchmark for these COPCs, and they were therefore carried through the risk assessment.**

Comment 14 *Pages 6-8 and 6-9, 6.6.1, Comparison with Surface Water and Sediment Benchmarks. Sediment concentrations were compared with EPA Region 4 sediment screening benchmarks, where available. If no screening value was found, the constituent was not evaluated. Sediment* *concentrations should be compared to TNRCC benchmarks (TNRCC, 2000) for initial screening (element 1 of Tier 2). If no benchmark is available, another benchmark should be proposed, or the COPC should be carried through the risk assessment. After this step, alternate benchmarks or toxicity data can be proposed to develop a sediment protective concentration level (PCL) protective of benthics.*

Response **The current draft of the risk assessment uses TNRCC screening criteria as requested above. As stated in the response to comment 13, only barium and vanadium did not have benchmarks for sediment. These were carried through the risk assessment.**

Comment 15 *Page 6-9, 6.6.1, Comparison with Surface Water and Sediment Benchmarks. Benzo(a) anthracene and indeno(1,2,3-cd)pyrene concentrations in sediment were found to exceed the sediment benchmarks. The discussion indicates that PAHs are byproducts of fossil fuel and are therefore, typically associated with anthropogenic activities rather than from site-related contamination. It is inappropriate to make this conclusion without a demonstration of background, where this is allowed. This may also conflict with the statement in Appendix D (Tier 1 Checklist) that waste oil, solvents, and fuels were disposed of in landfills or were burned during fire training exercises during the plant's history.*

Response **PAHs were only detected at one sampling location included in the reviewed draft. This location has since been altered and is not currently considered to be a potential source of COPCs. Therefore, PAHs are not currently being considered as COPCs at this site.**

Comment 16 *Table 21. 6.6.2, Estimates of Ecological Risk. The sediment dose calculations were modified (lowered) to account for the fraction of soil in the diet, and because the total ingested fraction was assumed to be 50% for soil, and 50% for sediment. The intake calculations were inappropriate, as food chain exposure was not considered. Although it is appropriate to account for incidental ingestion of sediment [or soil], the percentage of food items in the diet of measurement receptor should sum to 100% and not be normalized to include the media ingestion percentage (see Section 2.9.2.3 of TNRCC, 2000). A hypothetical formula using a variety of food types is provided below. It is simply provided as an example and not as a presentation of the various food types for the deer mouse. Nor is it an indication that the deer mouse is an appropriate receptor. If a receptor is selected that forages in the creek and on the land, it is appropriate to provide an exposure* *modification to reflect these different exposure areas in the refined calculations. However, this should be justified and the exposure to dry sediment [soil] should be factored in for periods when the creek is dry.*

$$I_{diet} = \frac{AUF\left[\left(C_{sed} \cdot DIR_f\right)\cdot\left(\left(P_i \cdot BAF_i\right)+\left(P_p \cdot BAF_p\right)+\left(P_{sed}\right)\right)\right]}{bw}$$

I_{diet}	=	*Chemical intake from food and sediment (mg/kg body weight -day)*
AUF	=	*Area use factor that accounts for the fraction of the receptor's exposure that occurs in the affected sediment (unitless)*
C_{sed}	=	*Sediment exposure point concentration (mg/kg dry weight)*
DIR_f	=	*Total daily food ingestion from site (kg/day dry weight)*
P_i	=	*Proportion of invertebrates in diet (unitless)*
BAF_i	=	*Bioaccumulation factor for invertebrates (unitless)*
P_p	=	*Proportion of plants in diet (unitless)*
BAF_p	=	*Bioaccumulation factor for plants (unitless)*
P_{sed}	=	*Proportation of sediment in diet (unitless)*
bw	=	*body weight (kg)*

Response **The following equation (as per TNRCC, 2000) is used to evaluate exposures in the wildlife receptors:**

$$Dose_{oral} = \frac{(IR_f \cdot C_f \cdot EMF_f) + (IR_w \cdot C_w \cdot EMF_w) + (IR_{so} \cdot C_{so} \cdot EMF_{so}) + (IR_{sd} \cdot C_{sd} \cdot EMF_{sd})}{BW}$$

This equation is described in Section 6.2 of the current report. All exposure through incidental ingestion is through sediment rather than 50% sediment and 50% soil and is calculated in addition to the food ingestion rate, not as part of it. The potential for the receptors to forage outside of the contaminated area is evaluated in the less conservative exposure scenario by using EMF values of 0.5 for the appropriate receptors.

Comment 17 *Tables 21 and 22, 6.6.2, Estimates of Ecological Risk. The text and the tables do not provide any justification or reference for the NOAEL values provided to reach receptor. The risk assessment should be revised to provide the laboratory species, dosage, dietary concentration, effect measured/observed, reference, uncertainty factor(s) and the normalized NAOEL. IF a literature compilation document (e.g., Oak Ridge National Laboratory) is used as a source of toxicity values, the original literature source listed in the compilation document should be indicated. Finally,* *the revisions should also explain how lab NOAELs are converted to NOAELs for the mouse, quail, or other receptor. Similar information should be presented for the LOAEL (elements 5 and 7 of the Tier 2 ERA).*

Response **The reference to data from Oak Ridge National Laboratories was inadvertently omitted. The document has been modified as requested.**

Comment 18 *Page 6-10, 6.6.3, Uncertainties Associated with the Ecological Risk Assessment. The risk assessment fails to adequately identify toxicity values for all COPCs for the quail (or other bird receptor). For most volatile and semivolatile organics, no hazard quotient was determined because a toxicity value was not identified. This presents a significant amount of uncertainty regarding the potential risk to ecological receptors exposed to water and sediment in the creek or downstream water bodies. In addition, to compilation references, the facility is encouraged to use the open literature to obtain toxicity values for these COPCs, or for suitable surrogate compounds. For example, high molecular weight PAHs can be grouped together and evaluated using the toxicity data from a PAH compound belonging to this group, such as benzo(a) pyrene. Relevant toxicological endpoint(s) associated with the surrogate selection should be reviewed to evaluate whether the candidate surrogate is appropriate given the selected receptor/food web.*

Response **The lack of toxicity data for all detected compounds for every receptor is, indeed, a source of uncertainty. The document includes as many verifiable toxicity values as possible within a timeframe dictated by project and budget constraints. No toxicity benchmark gaps exist for the mammalian receptors. Only three currently exist for the avian receptors (antimony, iron, and cis-1,2-DCE). No data were found that were considered as appropriate surrogate values for these COPCs. As described in the uncertainty section (Section 6.5), results from the conservative analysis of these COPECs for the mammalian receptors do not indicate that these three chemicals are likely to pose a significant risk to other wildlife receptors.**

Comment 19 *Page 7-2, 7.0, Risk Assessment Conclusions. The risk assessment concludes that although some exceedances have been noted for ecological screening criteria, hazard quotients for surface water and sediment exposures were less than one with exception of aluminum in surface water. It further concludes that remedial actions for surface water and sediment are not warranted. Due to the inappropriate or ill-*

defined benchmarks, exposure assumptions, receptors, and toxicity values, the TNRCC cannot support these conclusions at this time.

Response **Comment noted. The risk assessment has been extensively modified to correct previous deficiencies.**

Comment 20 *Add Reference: TNRCC, 2000. Guidance for Conducting Ecological Risk Assessments at Remediation Sites in Texas. Draft Final. August 28, 2000.*

Response **Reference has been added.**

650 18

REVISED DRAFT FINAL BASELINE ECOLOGICAL RISK ASSESSMENT FOR THE FOCUSED FEASIBILITY STUDY FORMER CARSWELL AIR FORCE BASE, TEXAS

Prepared for

Air Force Center for Environmental Excellence
Brooks AFB, Texas

Contract No. F41624-95-D-8005-0002

Prepared by

HydroGeoLogic, Inc.
1155 Herndon Parkway, Suite 900
Herndon, VA 20170

May 2001

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Page

NOTE: ***Sections 1 through 5 of the Risk Assessment will be re-written for the Final Risk Assessment based on general comments and the comments on the human health portion of the Risk Assessment. Only Sections 6 through 8 and Appendices D and E of the report have been included in this Revised Draft Final Report. Please refer to the Draft Final Report and Responses to Comments for additional information.***

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet/second
cis-1,2-DCE	*cis*-1,2-dichloroethene
cm	centimeters
COPCs	chemicals of potential concern
COPEC	constituents of potential ecological concern
CSM	conceptual site model
1,4- DCB	1,4-dichlorobenzene
1,1-DCE	1,1-dichloroethene
EMF	exposure modifying factor
EPA	Environmental Protection Agency
ERA	ecological risk assessment
EQs	ecological hazard quotients
g	gram
H_0	null hypothesis
HI	Hazard Index
HQ	Hazard Quotient
IRP	Installation Restoration Program
J	qualified as estimated data
JRB	Joint Reserve Base
kg	kilograms
L	Liter
LD_{50}	lethal dose for 50 %
LOAEL	lowest observed adverse effect level
m	meters
mg	milligrams

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

NAS	Naval Air Station
NOAEL	no observed adverse effect level
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PCLs	protective concentration levels
R	classified as rejected data
RfDs	reference doses
RME	reasonable maximum exposure
SQL	sample quantitation limit
SFs	slope factors
TCE	trichloroethylene
TNRCC	Texas Natural Resource Conservation Commission
U	qualified below detection limits
μg	micrograms
UCL	Upper Confidence Level
UJ	qualified as estimated data

6.0 ECOLOGICAL RISK ASSESSMENT

An ecological risk assessment (ERA) is a process that can be used to estimate the risk or probability of adverse effects to biota. Estimates of risk to biota based on this ERA can be used to determine if risks are acceptable or if further assessment is necessary.

Ecological risk assessment is a qualitative and/or quantitative appraisal of the actual or potential effects of chemical or physical stressors on plants and animals other than people and domesticated species. The objective of this ecological risk assessment is to determine whether or not there are any potential adverse ecological effects that may be caused by exposure to potential contaminants in surface water and sediment at the BRAC property. The primary objective of the ERA is to determine whether unacceptable adverse risks are posed to ecological receptors as a result of the hazardous substance releases. This objective is met by characterizing the representative ecological community in the vicinity of the surface water body, determining the particular hazardous substances associated with the surface water body, identifying pathways for receptor exposure, and determining the extent to which response actions are necessary.

The State of Texas has recently published ecological risk assessment guidance (TNRCC, 2000). This guidance applies to sites regulated within the Texas Natural Resource Conservation Commission's (TNRCC) Remediation Division. Although this site is regulated under CERCLA, and since this guidance mirrors the EPA's Ecological Risk Assessment Guidance for Superfund (EPA, 1997b), and the Tri-Service Procedural Guidelines for Ecological Risk Assessments (Wentsel, et al., 1996), the TNRCC guidance was used as the primary guidance document used in performing this ecological risk assessment.

The TNRCC ecological risk assessment methodology is a tiered approach to assessing ecological risk. Tier 1 is an exclusion criteria checklist. If the site does not meet the exclusion criteria, a Tier 2, screening-level ecological risk assessment, is conducted. The Tier 2 assessment includes:

1) A comparison of detected constituent concentrations for non-bioaccumulative COPCs to established ecological benchmarks.
2) The identification of communities and major feeding guilds and their representative species which are supported by habitats at the site.
3) The development of a conceptual model that depicts the movement of COPCs through media to communities and the feeding guides.
4) A discussion of COPC fate and transport and toxicological profiles.
5) The preparation of a list of input data which includes values from the literature (e.g., exposure factors, intake equations, no-observed-adverse-effect-level (NOAEL) and lowest-observed-adverse-effect-level (LOAEL) values, references) and reasonably conservative exposure assumptions, and the calculation of the total exposure to selected ecological receptors from each COPC not eliminated according to item number 1.

6) The utilization of an ecological hazard quotient methodology to compare exposures to NOAELs in order to eliminate COPCs that pose no unacceptable risk (i.e., NOAEL hazard quotient less than 1). If all COPCs are eliminated at this point, the ecological risk assessment process ends. Otherwise, the process continues.
7) The utilization of less conservative assumptions for exposure for re-calculating the hazard quotients. If all COPCs are eliminated at this point, the ecological risk assessment process ends. Otherwise, the process continues.
8) The development of an uncertainty analysis that discusses the major areas of uncertainty associated with the screening level ecological risk assessment. If all COPCs are eliminated at this point, the ecological risk assessment process ends. Otherwise, the process continues.
9) The calculation of medium-specific protective concentration levels (PCLs) bounded by NOAELs and LOAELs for those COPCs which are not eliminated as a result of the hazard quotient exercises or the uncertainty analysis.
10) Development of recommendations for managing ecological risk at the site based on final PCLs. Recommendations can also be made for proceeding with a Tier 3 evaluation.

6.1 PROBLEM FORMULATION

This section presents the problem formulation that establishes the goals, breadth, and focus of the ERA through an evaluation of Constituents of Potential Ecological Concern (COPEC), a characterization of the ecological communities, a selection of assessment and measurement endpoints, an identification of ecological receptors, and a presentation of an ecological conceptual site model. As stated in Section 2.0, soil is not included in this risk assessment. Therefore, potential adverse affects to terrestrial plants will not be addressed in this ecological risk assessment.

6.1.1 Selection of Assessment and Measurement Endpoints

The protection of ecological resources, such as habitats and species of plants and animals, is a principal motivation for conducting an ERA. Key aspects of ecological protection are presented as policy goals. These are general goals established by legislation or agency policy that are based on societal concern for the protection of certain environmental resources. For example, environmental protection is mandated by a variety of legislation and government agency policies (e.g., CERCLA, National Environmental Policy Act). Other legislation includes the Endangered Species Act 16 U.S.C. 1531-1544 (1993, as amended) and the Migratory Bird Treaty Act 16 U.S.C. 703-711 (1993, as amended). To determine whether these protection goals are met at the site, assessment and measurement endpoints have been formulated to define the specific ecological values to be protected and to define the degree to which each may be protected.

An ecological endpoint is a characteristic of an ecological component that may be affected by exposure to a chemical and/or physical stressor. Assessment endpoints represent environmental values to be protected and generally refer to characteristics of populations and ecosystems (Suter, 1993). Unlike the human health risk assessment process, which focuses on individual receptors, the ERA focuses on populations or groups of interbreeding nonhuman, nondomesticated receptors. In the ERA process, the risks to individuals are assessed only if they are protected under the Endangered Species Act, as well as species that are candidates for protection and those considered rare. No such special-status species are known to occur in the habitats potentially affected by groundwater contaminant plumes on the Former Carswell AFB.

Given the diversity of the biological world and the multiple values placed on it by society, there is no universally applicable list of assessment endpoints. Suggested criteria that were considered in selecting assessment endpoints suitable for this ecological risk assessment are: (1) ecological relevance, (2) susceptibility to the contaminant(s), (3) accessibility to prediction and/or measurement, (4) societal relevance, and (5) definability in clear, operational terms (Suter, 1993). Assessment and measurement endpoints are presented as screening criteria in Tables 18 and 19 and toxicity values in Tables 20 through 25.

6.1.1.1 Assessment Endpoints

The assessment endpoints for Former Carswell AFB are stated as the protection of long-term survival and reproductive capabilities for mammals and birds that occupy the various trophic levels of the potentially affected ecological community, as well as the long-term viability of the populations of benthic invertebrates and aquatic vertebrates (fin fish) that form the prey base of this community. The corresponding null hypothesis (H_o) for each of the assessment endpoints is stated as: the presence of site contaminants within surface water and sediment will have no effect on the survival or reproductive capabilities of herbivorous, omnivorous, and carnivorous mammals and birds, or on the continued existence of benthic invertebrate and aquatic vertebrate populations in both on-site and downstream habitats.

Assessment receptor species were selected based on the likelihood of finding the species at the Former Carswell AFB. Historical information, potential occurrence in affected habitats, and the availability of toxicological data were used to select receptor species. Specific receptor species were used as indicators of potential risk to terrestrial vertebrates at various trophic levels of the community. Potential risks to benthic invertebrates and aquatic vertebrates were evaluated generically, without specifying indicator species.

6.1.1.2 Measurement Endpoints

Measurement endpoints are defined as a measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint (USEPA, 1992e). Measurement endpoints are frequently numerical expressions of observations (*e.g.* toxicity test results or community diversity indices) that can be compared statistically to detect adverse responses to a site contaminant. Examples of typical measurement endpoints include mortality, growth or reproduction in toxicity tests; individual abundance; species diversity; and the presence or absence of indicator data in field surveys of existing impacts (USEPA, 1994c).

For this assessment measurable responses to stressors include LOAEL and NOAEL (for mammalian and avian species), and media-specific ecological screening benchmarks (for benthic and aquatic species). The most appropriate measurement endpoints were chosen based on exposure pathways as well as ecotoxicity of the contaminant.

6.1.2 Identification of Representative Ecological Receptors

This section presents the selection and rationale for representative terrestrial and aquatic ecological receptors at the site. The selection of ecological populations of potential concern focused on key species that are indicators of risk to various levels of the trophic structure in both terrestrial and aquatic communities that use the stream habitats of Farmers Branch Creek. The habitat conditions of this area are dominated by the highly landscaped nature of the golf course that surrounds it (see photos in Appendix E). Surface water features include both lotic reaches of the creek, which are not perennial, and lentic features, which include two golf course ponds and perennial pools within the creek channel. Steep banks of this channel and golf course landscaping to the edge of the channel have severely limited the development of a riparian community along Farmers Branch Creek. Therefore, actual use of this habitat by the wildlife represented by the selected receptor species is also expected to be limited. For this reason, exposures estimated in this assessment are considered conservative.

6.1.2.1 Aquatic

Exposure to aquatic organisms within the water bodies is assumed to occur via direct exposure to contaminants in the water and via ingestion of benthic invertebrates and pelagic prey exposed to contaminants in surface water and sediment. Potential effects to fish, macroinvertebrates, and phytoplankton (algae) were assessed using available surface water and sediment quality benchmarks for the protection of aquatic life. Adverse effects to aquatic species are evaluated though comparisons with surface water and sediment screening benchmarks as provided by TNRCC (2000).

6.1.2.2 Terrestrial

Indicator species represent two classes of vertebrate wildlife, mammals and birds. For each of these classes, a representative species for the three major trophic levels (herbivores, omnivores, and carnivores) that may use the affected habitat were selected. The three mammal species selected include the deer mouse (*Peromyscus maniculatus*), the raccoon (*Procyon lotor*), and the mink (*Mustela vison*). The three species of birds selected include the northern bobwhite (*Colinus virginianus*), the common snipe (*Gallinago gallinago*), and the American bittern (*Botaurus lentiginosus*).

Of these receptors, the deer mouse has the most limited home range which makes it particularly vulnerable (i.e., conservative) to exposure to site contaminants. The selected terrestrial receptor species have a potential to occur at the site and sufficient toxicological information is available in the literature for comparative and interpretive purposes. In addition, all of the selected species are likely to occur after site remediation (if risk management decisions require it), and all are important to the stability of the local ecological food chain and biotic community. Finally, all the selected species have readily available exposure data, as summarized in the *Wildlife Exposure Factors Handbook* (USEPA, 1993) and other sources. The deer mouse, raccoon, and bobwhite are particularly known to inhabit areas that are urbanized and adapt readily to human-altered habitats. Since much of this area is a golf course (and is expected to remain a golf course), the diversity of wildlife occurring there is probably limited.

The following sections present brief receptor profiles for the representative receptors selected for the site.

Deer Mouse (Peromyscus maniculatus). This medium-sized mouse is found in the eastern United States from the Hudson Bay to Pennsylvania, the southern Appalachians, central Arkansas and central Texas. In the west it is found from Mexico to the south Yukon and Northwest Territories (Whitaker, 1995). Deer mice habitat includes nearly every dry land habitat within its range, including forest, grasslands, or a mixture of the two (Burt and Grossenheider, 1980). Nocturnal and active year-round, these mice construct nests in the ground, trees, stumps, and buildings (Burt and Grossenheider, 1980). Omnivorous, the deer mouse feeds on nuts and seeds (e.g., jewel weed and black cherry pits), fruits, beetles, caterpillars, and other insects. Their home range is 0.5 to 3 acres (Burt and Grossenheider, 1980). Density of populations is 4 to 12 mice per acre, and average life span is two years in the wild (Burt and Grossenheider, 1980). The breeding season is from February to November, depending on latitude. Three to five young are born in each of two to four litters per year (Burt and Grossenheider, 1980). They are greyish to reddish-brown with a white belly, with a distinctly short-haired, bicolor tail (Whitaker, 1995). Weight range is 14.8 (USEPA, 1993) to 33 grams (Whitaker, 1995).

Raccoon (*Procyon lotor*). This medium-sized mammal is found throughout most of the United States, including all of Texas (Davis, 1966). Raccoons are usually found near water. They are nocturnal and do not hibernate, but may be less active during cold weather. They typically use hollow trees or logs for dens. Mature females typically produce a single litter of from one to seven young each year (Davis, 1966). Raccoons are omnivorous and opportunistic in feeding habits. Their diets may consist of a variety of plant material (e.g., fruits, nuts, and grains), aquatic and terrestrial invertebrates, and small vertebrates (USEPA, 1993). Average home ranges vary from 96 to over 6,000 acres (USEPA, 1993). Weights of adult raccoons range from 3.7 to 7.6 kg (USEPA, 1993).

Mink (Mustela vison). This small, carnivorous mammal is found throughout the eastern and northern parts of the United States, including eastern Texas (Davis, 1966). As with raccoons, mink are usually found near water, especially small streams. They are active year-round. Mink den in burrows along stream banks (often burrows dug by other species) or under roots or plant debris. Mature females typically produce a single litter of from four to eight young each year (Davis, 1966). Mink diets consist of a wide variety of animal prey, including invertebrates, fish, frogs, snakes, small mammals, and birds (USEPA, 1993). They may also eat carrion (Davis, 1966). Measured home ranges vary from 19 to over 1,900 acres (USEPA, 1993). In Sweden, individual mink have been observed to range over 0.6 to 3 miles of stream length (USEPA, 1993). Weights of adult mink range from 0.55 to 1.7 kg (USEPA, 1993).

Northern Bobwhite (*Colinus virginianus*). Northern bobwhites are ground-dwelling birds with short, heavy bills adapted for foraging on the ground for seeds and insects. Bobwhites inhabit brush, abandoned fields, and open woodlands; some inhabit parklands. They are poor flyers that seldom leave the ground and do not migrate. They range from southern Maine to southeastern Wyoming, and south to Florida and across Texas to eastern New Mexico. These quail forage during the day, primarily on the ground or in a light litter layer less than 5 cm deep. Seeds from weeds, woody plants, and grasses comprise the majority of the adult quail's diet. In some areas, quail can acquire their daily water needs from dew, succulent plants, and insects; in more arid areas; however, bobwhites need surface water for drinking. In breeding season, the quail's home range includes foraging areas, cover, and the nest site and may encompass several hectares (USEPA, 1993).

Common Snipe (*Gallinago gallinago*). Common snipes are ground-dwelling birds with relatively long, stout bills adapted for probing for prey. Snipes breed in boreal forests of the northern United States and Canada, but migrate to the southern United States and Mexico for the winter . Their wintering range includes most of Texas (National Geographic Society, 1983). Snipes forage around water and wetland areas, feeding on both plant and animal items. From the fall through the spring, their diet consists of about 20 percent plant material and 80 percent animal prey (primarily aquatic invertebrates and some fish) (Martin et al., 1951). Weights of the common snipe range from 116 g for females to 128 g for males (Dunning, 1993).

American Bittern (*Botaurus lentiginosus*). The American bittern is relatively small member of the heron family (Ardeidae) that is a common inhabitant of wetlands and creeks across most of the United States and southern Canada. It tends to be secretive and generally ground-dwelling. Although migratory, in eastern and central Texas, it may be present throughout the year (National Geographic Society, 1983). American bitterns forage around water and wetland areas, feeding primarily on animal prey, including both invertebrates (insects and crayfish) and vertebrates (fish, frogs, and small mammals) (Martin et al. (1951). Weights of the American bittern range from 520 to 1,072 g, with an average of 706 g (Dunning, 1993).

6.1.3 Conceptual Site Model

The Conceptual Site Model for this ERA identifies pathways by which ecological receptors may be exposed to COPECs in contaminated media. Exposure pathways evaluated in this

ERA include direct exposures to sediment and surface water, and indirect exposures through the food chain. Figure 45 provides a graphical representation of the Conceptual Site Model for this site. The ecological exposure pathways for each medium are described below.

The data listed on Figures 46 and 47 were used in calculating the risks to surface water and sediment. This data was collected by HydroGeoLogic in 1997. This data set was chosen because it is the only event which contained analyses for a full suite of metals, volatile organic compounds, and semi-volatile organic compounds.

6.1.3.1 Surface Water Exposure Pathway

The main surface water bodies on the BRAC property are Farmers Branch, an unnamed tributary that flows into Farmers Branch, and two ponds on the Carswell AFB golf course (Figure 46). Farmers Branch is culverted through an aqueduct beneath the flightlines before its discharge onto the BRAC property. Surface drainage in the Flightline Area is generally to the north and east toward Farmers Branch. Farmers Branch ultimately discharges to the Trinity River, located on the eastern boundary of Carswell AFB. Several seeps exist along Farmers Branch as mapped in Figure 46. The evaluation of groundwater flow at the Flightline Area suggests that the surface water bodies may receive groundwater inflow, and possibly contaminants associated with the groundwater. In 1990, a staff gage was installed in Farmers Branch and professionally surveyed during the additional Stage 2 field activities. Synoptic groundwater and surface water-level measurements made in June 1990 were used to estimate flow volumes and evaluate Upper Zone groundwater/surface water communication (Radian 1991). Estimated flow volumes at the time of sampling (April 1990) were approximately 6 cubic feet/second (cfs) for the four locations on Farmers Branch and approximately 0.2 cfs for the unnamed tributary. Water in the two ponds appeared stagnant at the time of sampling, and at most other times. Observed flow in Farmers Branch during field activities was extremely variable, ranging from <5 to >100 cfs (following heavy rains). Pictures of Farmers Branch are shown in Appendix E.

Surface water represents a potential transport medium for the COPECs. Potential sources for contaminated surface water for this assessment includes seepage of groundwater. Potential receptors of contaminated surface water include terrestrial and aquatic fauna and aquatic flora. Exposure routes for contaminated surface water include ingestion by terrestrial fauna, and uptake and absorption by aquatic flora and fauna. Consumption of bioaccumulated contaminants constitutes a potential indirect exposure pathway for faunal receptors. Chemical bioavailability of some metals and other chemicals is controlled by water hardness, pH, and total suspended solids.

6.1.3.2 Sediment Exposure Pathway

Sediment consists of materials precipitated or settled out of suspension in surface water. Potential contaminant sources for sediment in this assessment includes seepage from groundwater. Potential receptors of chemicals in contaminated sediment include aquatic flora and fauna. Direct exposure routes for contaminated sediment include uptake by aquatic flora and ingestion by aquatic fauna. Indirect exposure pathways from sediment include consumption of bioaccumulated contaminants by consumers in the food chain. Chemical bioavailability of many nonpolar organic compounds, including PCBs and pesticides, decreases with increasing concentrations of total organic carbon in sediment; however, these compounds can still bioaccumulate up the food chain (Landrum and Robbins, 1990). Neither PCBs nor pesticides have been detected as COPECs in this assessment.

6.1.3.3 Groundwater Exposure Pathway

Groundwater represents a potential transport medium for COPECs. Potential contaminant sources for groundwater include contaminated soil, and buried or stored waste. The release mechanism for contaminants into groundwater is direct transfer of contaminants from waste materials to water as water passes through the materials.

Groundwater itself is not an exposure point. Contaminant transport along the shallow groundwater pathway may be an exposure route to aquatic life, wetlands, and some wildlife where the groundwater discharges to surface water. The potential impact of groundwater to surface water has been examined though direct sampling and evaluation of surface water.

6.2 EXPOSURE ESTIMATION

Risk is estimated by comparing reasonable maximum exposure levels (i.e., levels based on 95% UCL concentrations) with the screening-level ecotoxicity values. For aquatic receptors, exposure is based directly on the measured concentrations in the media (surface water and sediment) with which the receptors are in direct contact. For terrestrial wildlife receptors, methods for quantifying intake for each species of concern and each media are presented in EPA (1993). Intake for a receptor is estimated as the sum of the intakes from each applicable pathway for that receptor. Applicable pathways may include direct exposure to COPECs in sediment and surface water, and exposures through the ingestion of food items that may bioaccumulate COPECs from their environment, either directly from surface water and sediment or indirectly through food consumptions. The estimated total intake of the receptor is then compared with NOAELs and LOAELs described above to estimate potential risk.

6.2.1 Estimation of Total Intake by Wildlife Receptors

The general equation used to estimate sediment intake by the mammalian and avian wildlife receptor species is described below (TNRCC, 2000):

$$Dose_{oral} = \frac{(IR_f \cdot C_f \cdot EMF_f) + (IR_w \cdot C_w \cdot EMF_w) + (IR_{so} \cdot C_{so} \cdot EMF_{so}) + (IR_{sd} \cdot C_{sd} \cdot EMF_{sd})}{BW}$$

where:

$Dose_{oral}$	=	estimated daily dose from ingestion (mg/kg-day)
IR_x	=	ingestion rate of medium x; where potentially ingested media are food (x = f), water (x = w), soil (x = so), and sediment (x = sd) (kg dry weight/day when the medium is food, soil, or sediment; L/day when the medium is water)
C_x	=	contaminant concentration in medium x (mg/kg dry weight when the medium is food, soil, or sediment; mg/L when the medium is water)
EMF_x	=	exposure modifying factor for medium x (unitless)
BW	=	receptor body weight (kg)

Input parameters for each species of concern are provided in Table 26. The exposure modifying factor (EMF) for each medium is a value between 0 and 1, inclusive, that takes into account a seasonal use of the site (or of the specific medium) by the receptor or partial use of the site or medium due to home range size. In this assessment, doses are initially estimated under the assumption that the receptors are confined to the Installation Restoration Program (IRP) site area over a time sufficient for the dose to be considered chronic. Therefore, all EMFs are initially assumed to be 1. Refined estimates of EMFs are based on comparisons of IRP site area with known foraging area data for the species under evaluation.

For the site currently under investigation, COPEC contamination is only being evaluated in water and associated sediments. Soil is not considered a medium of concern, and therefore, the soil term in the above equation is 0. However, it is recognized that during dry seasons (and especially during drought years), surface water may not always be present in the drainages being evaluated, and the sediments in these drainages may dry out and function as soil. No distinction is made in this assessment between wet sediment and dry sediment in the estimation of potential exposures to the wildlife receptors.

6.2.2 Estimation of Food Intake

In the general equation described above for total intake, the term for intake through the food ingestion pathway assumes all exposure is from a single food type. Of the receptors used in this assessment, this condition is only true for the species modeled as herbivores (i.e., the deer mouse and the northern bobwhite). For the receptors modeled as omnivores and carnivores, multiple food items comprise the diet, including plants, aquatic invertebrates, fish, and small mammals. The dietary composition of each species of concern is provided in Table 26. For those species with multiple food items in the diet, the contaminant concentration in food is defined as:

$$C_f = \sum_{i=1}^{k} P_i \cdot C_i$$

where:

C_f	=	average contaminant concentration in the diet of the receptor (mg/kg dry weight)
P_i	=	the proportion of the i^{th} food item in the diet of the receptor (unitless)
C_i	=	contaminant concentration in the i^{th} food item in the diet of the receptor (mg/kg dry weight)
k	=	the number of food items in the diet of the receptor

The COPEC concentrations in the plant tissues were modeled using soil-to-plant transfer factors. For inorganic COPECs, the transfer factors specific to aboveground plant tissue from TNRCC (2000) were used when available. Otherwise, transfer factors (not specific to aboveground tissues) from Baes et al. (1984) were used. For the organic COPECs, chemical-specific transfer factors from EPA (1995d) were used. These transfer factors are presented in Table 27. The model for estimating plant tissue concentration based on the soil-to-plant transfer factor is:

$$C_p = TF_{sp} \cdot C_{sd}$$

where:

C_p	=	the COPEC concentration in plant tissue (mg/kg dry weight)
TF_{sp}	=	the soil-to-plant transfer factor (unitless)
C_{sd}	=	the COPEC concentration in sediment (mg/kg dry weight).

Tissue concentrations in the aquatic invertebrate and fish prey items in the diets of the omnivorous and carnivorous receptors were modeled from water concentrations using bioconcentration factors (BCFs). In these aquatic prey animals, the concentrations of COPECs are the result of both direct uptake from the surrounding surface water and uptake with ingested food, which is influenced by the trophic level of the organism. Therefore, COPEC concentrations in fish are actually determined by the use of bioaccumulation factors (BAFs), which include all uptake pathways. For inorganic COPECs, BCFs and BAFs are considered to be equal (Sample et al., 1996). For organics, BAF values from EPA (1995d) were used to estimate COPEC concentrations in fish and invertebrates. The model for estimating these concentrations is:

$$C_f = BAF \cdot C_w \cdot CF$$

where:

C_f	=	the COPEC concentration in the fish or invertebrate tissue (mg/kg dry weight)
BAF	=	the bioaccumulation factor (L/kg)
C_w	=	the COPEC concentration in surface water (mg/L)
CF	=	the conversion factor for wet weight to dry weight concentrations in fish or invertebrates (based on the water content in bony fish of 75 and in aquatic invertebrates of 77 percent [USEPA, 1993], where CF = 1/[1-percent water]).

The BCFs and BAFs were taken from various literature sources and are presented in Table 27. When a BCF or BAF specific to invertebrates could not be found, the corresponding value for fish was used as default. The BAF for bis(2-ethylhexyl)phthalate for fish from the EPA (1995d) was lipid-based. A lipid content of 7.1 percent was used for the fish, based on the fat content of carp (Diem and Lentner, 1970). The full BAF was conservatively applied to the invertebrate.

For estimating concentrations in the small mammal prey (i.e., deer mice), two modeling approaches were used. For most inorganic COPECs, the concentrations in small mammals were estimated directly from soil concentrations based on models derived from empirical data using regression analysis (Sample et al., 1998) and based on the relationship:

$$\ln C_m = B_0 + B_1 \cdot \ln C_{sd}$$

where:

C_m = the COPEC concentration in the small mammal prey (mg/kg dry weight)
C_{sd} = the COPEC concentration in sediment (mg/kg dry weight)
B_0 and B_1 = COPEC-specific factors derived in the regression analysis (from Sample et al., 1998).

This equation can also be written:

$$C_m = e^{B_0} \cdot C_{sd}^{B_1}$$

or

$$C_m = P_0 \cdot C_{sd}^{P_1}$$

where $P_0 = e^{B_0}$ and $P_1 = B_1$.

Values for P_0 and P_1 are presented in Table 28. It should be noted that when P_1 equals 1, this model reduces to a linear uptake model (similar to that for plants) with a slope of P_0. For bis(2-ethylhexyl)phthalate, a linear transfer factor from EPA (1995d) was used for P_0. Soil-based modeling parameters could not be found for antimony and cis-1,2-dichloroethylene. For these COPECs, tissue concentrations for small mammals were determined from the estimated concentration of the COPECs in the food of the small mammal. This modeling approach applies mammal-based food-to-muscle transfer factors derived for modeling chemical concentrations in beef, by the equation:

$$C_m = TF_{fm} \cdot C_f \cdot CF$$

where:

C_m = the COPEC concentration in the small mammal prey species (mg/kg dry weight)
TF_{fm} = the food-to-muscle transfer factor.

C_f = the COPEC concentration in the small mammal prey species' food (mg/kg dry weight)

CF = a conversion factor for the whole-body, dry-weight concentration in the small mammal (for wet-weight to dry-weight conversion, the CF is based on the water content in mammals of 32 percent [USEPA, 1993] where CF = 1/[1-0.32]; for lipid-based transfer to whole-body transfer, the CF is based on an assumed lipid content of 10 percent by dry weight, where CF = 0.1)

For antimony, the food-to-muscle transfer factor is from Baes et al. (1984). For cis-1,2-dichloroethylene, the transfer factor is based on the regression of the transfer factors for organic compounds on the logarithm of the compound's octanol-water partition coefficient (K_{ow}), as based on data specific to rodents presented in Garten and Trabalka (1983). This regression is:

$$\log TF_{fm} = -4.941 + 0.8698 \cdot \log K_{ow}$$

The log K_{ow} of cis-1,2-dichloroethylene is 1.86 (TNRCC, 2000). The transfer factors for antimony and cis-1,2-dichloroethylene are presented in Table 28.

6.3 RISK CALCULATION

Ecological hazard quotients (EQs) are developed for each constituent of potential concern in each media for each potentially exposed representative species. The EQ is expressed as the ratio of a potential exposure or dose to a toxicity value (EPA, 1994c):

$$EQ = \frac{Dose_{oral}}{TL} \text{ or } \frac{EEC}{Benchmark}$$

where:

EQ	=	ecological hazard quotient (unitless)
$Dose_{oral}$	=	average daily dose (mg/kg-day)
TL	=	toxicity level; either a NOAEL or extrapolate NOAEL based on a LOAEL (mg/kg-day)
EEC	=	estimated environmental concentration (mg/kg or mg/L)
Benchmark	=	media concentration associated with minimal adverse effects to the species of concern (mg/kg) or (mg/L)

EQs for exposures to terrestrial and avian species are developed using intake values developed using equations in Sections 6.2.1 and 6.2.2. Sediment and surface water exposures to aquatic and benthic species are evaluated by comparisons of sediment and surface water constituent concentrations with ecotoxicologically-based benchmarks developed by TNRCC (2000) (Tables 18 and 19). EQs for direct and indirect exposures to COPECs in surface water, and sediment in the deer mouse, raccoon, mink, northern bobwhite, common snipe, and American bittern are presented in Tables 20 through 25, respectively.

The intent of the ERA is to evaluate population effects rather than effects to the individual. NOAELs are benchmarks which evaluate effects to all individuals within the exposed population compared with LD_{50}'s or LD_5's which evaluate population benchmarks. Since NOAELs are the chosen benchmarks for this evaluation, an EQ of 1 will be evaluated as the target EQ. An EQ greater than 1 will be interpreted as a level at which adverse ecological effects may occur to the population. An EQ less than 1 will be associated with less likelihood of adverse ecological effects. Risk management decisions should take into account the magnitude of the EQ when determining the need for remediation. There is no consensus regarding the issue of summation across pollutants in the calculation of EQs. Since there is little data concerning mechanism of action or target organ toxicity for species other than mammalian species, contaminant-specific EQs will not be summed.

6.4 RESULTS OF THE ECOLOGICAL RISK ASSESSMENT

As indicated above, the ERA has been developed using a tiered approach. Tier 1 involves a criteria exclusion checklist. This Tier 1 form is found in Appendix D. The results of this exclusion checklist indicate that a Tier 2 evaluation in necessary. The Tier 2 evaluation included a comparison of detected constituent concentrations in surface water and sediment to benchmark criteria and a calculation of EQs for site-specific receptors. The results of the Tier 2 evaluations are provided below.

6.4.1 Comparisons with Surface Water and Sediment Benchmarks

Tables 18 and 19 summarize the comparisons of surface water and sediment benchmarks with COPCs. The COPCs included in the ecological risk assessment are those detected chemicals that exceed background and have been detected at a frequency greater than five percent.

Surface water COPCs found to exceed surface water benchmarks are inorganics, aluminum and lead, and the semivolatile organic, bis(2-ethylhexyl)phthalate (Table 18). As a result, these chemicals were retained as COPECs for surface water. Copper, mercury, and zinc were also retained as COPECs because they are identified as bioaccumulators (TNRCC, 2000). Bis(2-ethylhexyl)phthalate, as a component of many plastics, is found ubiquitously in the environment. Its presence in surface water at Carswell may not be associated with site-specific activities.

Sediment COPCs found to exceed sediment benchmarks include inorganics, antimony, arsenic, iron, manganese, nickel, and zinc; and volatile organic, cis-1,2-dichloroethylene (Table 19). As a result, these chemicals were retained as COPECs for sediment. Barium and vanadium were also retained because no sediment benchmark could be determined for these COPCs. Cadmium, copper, and mercury, were also retained as COPECs because they are identified as bioaccumulators (TNRCC, 2000).

6.4.2 Estimates of Ecological Risk

Tables 20 through 25 summarize the calculated EQs for the deer mouse, raccoon, mink, northern bobwhite, common snipe, and American bittern, respectively, as based on conservative estimates of exposure and NOAELs. Of the mammalian receptors, no COPECs were found to result in EQ values greater than unity for the deer mouse; however, aluminum and mercury were found to result in EQs greater than unity for both the raccoon and mink. The consumption of fish and invertebrates were the principal sources of exposure to these COPECs for both of these receptors. The estimated exposure of the raccoon to vanadium also resulted in an EQ slightly greater than unity (EQ = 1.46). Direct ingestion of sediment was the primary source of the raccoon's exposure to vanadium.

For the avian receptors, EQs could not be determined for antimony, iron, and cis-1,2-dichloroethylene due to a lack of avian-specific toxicity information for these COPECs. Of the other COPECs, bis(2-ethylhexyl)phthalate resulted in EQs greater than unity for all three avian receptors. Mercury resulted in EQs greater than unity for both the common snipe and the American bittern (EQs equal 359 and 160, respectively). In addition, both aluminum and zinc resulted in EQs slightly greater than unity (EQs equal 1.10 and 1.59, respectively) in the common snipe.

For those COPECs that resulted in one or more EQs greater than unity using the conservative exposure assumptions and NOAEL-based toxicity benchmarks, EQs were also calculated based on less conservative exposure assumptions and LOAEL-based toxicity benchmarks. For example, it was assumed in the initial EQ calculations that the entire home range of the receptor contained COPEC concentrations equal to those of the site (or equivalently, that the all of the food, water, and sediment ingested by the receptor was from the site). As noted above (Section 6.2.1), however, EMFs can be incorporated in the exposure estimation to account for potential foraging outside of the site when the home range of the receptor is larger than the area of the site. Because the habitats being included in this assessment are generally linear, that is, following drainage channels, the "area" of the site is difficult to measure. It was assumed, therefore, that the habitat in which the receptors would be exposed to potentially contaminated water or sediment was included within a 100-foot-wide strip along the course of Farmers Branch Creek. Such a strip would contain approximately 12 acres of habitat per mile of channel.

The sampling of surface water and sediment along Farmers Branch Creek covered approximately 0.5 mile of channel downstream of the aqueduct outfall, or about 6 acres of creek habitat. The golf course ponds provides no more than about 2 acres of habitat, and the unnamed tributary of Farmers Branch Creek, which was also sampled along an approximate 0.5 mile reach, but is smaller than Farmers Branch Creek, may account for an additional 3 to 6 acres. Thus, the potential exposure area is estimated to be 11 to 14 acres in area of available habitat. This is less than the lower end of the home ranges of the raccoon and mink (Section 6.1.2.2) and is less than one half the mean home range of the northern bobwhite (28.6 acres, as based on data in EPA [1993]). Using the regression presented in Schoener (1968) based on body weight, the home range sizes of the common snipe and American bittern were estimated to be 37 and 352 acres, respectively. Based on these data, and considering the relatively low quality of the habitat, an EMF of 0.5 can be reasonably applied to the exposure estimations of each of these receptors. Applying this EMF is sufficient to reduce the EQs that are less than 2 to EQs that are less than 1. For the raccoon, this reduces its EQ for exposure to vanadium to 0.73, and for the common snipe, this reduces the EQs for exposure to aluminum and zinc to 0.55 and 0.65, respectively. This EMF was used in the re-calculation of the EQs as based on less conservative assumptions.

For aluminum, the exposure point concentration in surface water was initially assumed to be the maximum measured concentration (0.63 mg/L). The 95% UCL of this COPEC concentration was calculated to be less than the maximum (0.33 mg/L). Because the latter value is probably more representative of the average exposure concentration on surface water, it was used in the less conservative re-calculation of the EQs.

Finally, the re-calculation of the EQs incorporated less conservative toxicity benchmark values. LOAELs were used as the less conservative benchmarks. In the cases of aluminum, vanadium, and bis(2-ethylhexyl)phthalate in birds, the NOAELs were based on single dose levels that showed no adverse effects. In these cases, the LOAEL was estimated by multiplying the NOAEL by an uncertainty factor of 5. For mercury, the initial EQs were calculated using NOAELs based on methyl mercury. The form of mercury at the site is not known, and the assumption that it is entirely in organic form is conservative. Therefore, the EQs for mercury were re-calculated based on toxicity values for inorganic mercury (mercuric chloride).

Table 29 presents the results of the re-calculation of EQs based on less conservative assumptions. As shown in this table, all EQs are less than unity as a result of this recalculation. Therefore, risk to these receptors is not predicted from exposures to the COPECs initially identified at this site.

6.5 UNCERTAINTIES IN THE ECOLOGICAL RISK ASSESSMENT

A wide variety of factors contribute to the uncertainty associated with this ecological risk assessment. These factors are related to the exposure assessment, characterization of ecological effects, and the characterization of risk. The quantitative modeling of exposures to wildlife receptors incorporates a large number of parameters which are highly stochastic in nature or for which very limited quantitative information is available in the literature. In general, the values used in the exposure models were selected to result in a conservative estimation of risk. That is, the values for uncertain or stochastic parameters were generally biased toward those that would more likely overestimate the actual exposure rather than underestimate it.

The COPEC concentrations used in all exposure models were the 95 percent UCL or maximum measured concentrations, thereby allowing for the overestimation of the probable concentration at this point. The COPECs are also assumed to be 100 percent bioavailable at this concentration. Further, this concentration was initially assumed to be uniform throughout the receptor's home range, allowing for the probable overestimation of exposure to the receptor species. The expected result of these factors is an overestimation of exposure and a conservative estimation of risk estimated by either EQs or by comparison with the screening values. Specifically, the low EQs observed for the exposure of the raccoon to vanadium and for the exposure of the common snipe to aluminum and zinc (all being less than 2.0) were reduced to values less than 1 by applying an EMF of 0.5 to the exposure to account for foraging outside of the affected area. This EMF is probably still conservative due to the expected sizes of the home ranges of these species and the relatively poor quality of the habitat at this site for these species.

Wildlife exposure factors included body weight, daily food consumption, and dietary composition. In general, these were selected as average or mid-range values, to model exposure to an "average" individual of the modeled species. Body weights were taken as averages or the midpoint of ranges. Food and water ingestion rates were generally modeled allometrically from these body weights. Because most animals feed opportunistically, dietary composition is also highly variable between individuals. The dietary compositions selected for the key receptor species were generalized from published literature, which will lead to the overestimation of exposure to some individuals and the underestimation of others.

Exposure pathways were limited to ingestion. Although the exclusion of inhalation and dermal contact may result in an underestimation of exposure, this is probably compensated by conservatisms in the dietary exposure modeling.

The use of NOAELs is conservative and may over estimate the hazards that will actually occur. The actual threshold of toxicity is expected to be between the NOAEL and the LOAEL. When LOAELs were used as the basis for the wildlife toxicity benchmarks, all of the EQs were reduced to values less than unity. In the case of mercury, however, it also had to be assumed that the majority of the mercury in the environment is in inorganic form. Although this is often the case, it has not been verified at this site.

The wildlife toxicity benchmarks are extrapolated from test species that are different from the target wildlife receptor species. This extrapolation was performed within a wildlife class (i.e., mammals or birds) based on body-weight scaling. When the test species was in a different class (e.g., a mammal species compared with a bird species), no extrapolation was performed as the target class may be either more or less sensitive to the chemical than the test species class. This results in a toxicity benchmark data gap for three of the avian COPECs. The lack of toxicity data for some COPECs may result in the underestimation of receptor hazards, however, these constituents (antimony, iron, and cis-1,2-dichloroethylene) are not believed to be overly toxic to the selected receptors, and it is unlikely hazard indices and overall ERA conclusions would change significantly if toxicity data were included for these COPECs.

In conclusion, many factors contribute to the uncertainty associated with these predicted risk results. Several of the factors can be ascribed to either leading to probable overestimation of risk or underestimations. It is expected that, in this ecological risk assessment, most factors were overestimated.

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7.0 RISK ASSESSMENT CONCLUSIONS

Results of media with carcinogenic or noncarcinogenic constituents contributing to human health risk and hazard above the target risk range include:

- *Groundwater - Potential future residential cancer risk associated with groundwater exposures in excess of $1x10^{-4}$ risk is estimated for TCE (Figure 2), vinyl chloride (Figure 3) and 1,1-DCE (Figure 4). Noncancer hazard associated with potential future residential exposures is in excess of the target of 1 for PCE (Figure 17), TCE (Figure 18), cis-1,2-DCE (Figure 19) and chloroform (Figure 23). Evaluation of site-specific screening criteria for the potential intrusion of volatile organics into residential basements indicate that this pathway is not associated with risk greater than $1x10^{-6}$. It should also be noted that none of these volatile organics are known to bioaccumulate in terrestrial or aquatic animals.*

  Exposures to groundwater under the scenario of institutional controls to prevent residential use of groundwater was evaluated using the construction worker as the only potential receptor. Cumulative risk to organic COPCs for this receptor was less than $1x10^{-6}$. However, noncancer hazard in excess of the target of 1 was estimated for TCE (Figure 28), cis-1,2-DCE (Figure 29) and vinyl chloride (Figure 40). Furthermore, it should be kept in mind, that groundwater exposures are only possible if the shallow contaminated aquifer, which is not currently in use, is used as a source of drinking water.

- Surface Water - All cancer risks and noncancer hazards are below EPA limits for surface water (Tables 15 through 17).

- Sediment - All cancer risks and noncancer hazards are below EPA limits for sediment (Tables 15 through 17).

Groundwater risk was estimated to be in excess of risk-based targets for both potential future residents and construction workers. Those COPCs that contribute to the potential for adverse health effects include 1,1-DCE, cis-1,2-DCE, PCE, TCE, and vinyl chloride. Since adverse health effects are estimated under both the residential scenario and the scenario of institutional controls, remedial action is warranted.

No human health effects have been estimated for exposures to surface water and sediment. In addition, although some exceedances have been noted for ecological screening benchmarks, EQs for surface water and sediment exposures were less than 1. Therefore, remedial action for surface water and sediment is not warranted.

NOTE: Italicized portions will be modified once responses to the human health comments are approved.

Results of media with ecological risk about target include:

- Surface Water - Surface water COPCs found to exceed surface water benchmarks are inorganics aluminum and lead, and the semivolatile organic, bis(2-ethylhexyl)phthalate (Table 18). Copper, mercury, and zinc were detected above background and retained for further evaluation because of their potential for bioaccumulation in the food chain. Bis(2-ethylhexyl)phthalate, as a component of many plastics, is found ubiquitously in the environment. Its presence in surface water at Carswell may not be associated with site-specific activities. Although aluminum, mercury, zinc, and bis(2-ethylhexyl)phthalate were initially found to pose a possible risk to wildlife receptors, re-evaluation of the EQs based on less conservative assumptions resulted in no predictions of potential risk to wildlife from exposures to these COPCs (Table 29).

- Sediment - Sediment COPCs found to exceed sediment benchmarks include inorganics, antimony, arsenic, barium, iron, manganese, nickel, vanadium, and zinc; and volatile organic cis-1,2-dichloroethylene (Table 22). Cadmium, copper, and mercury were detected above background and retained for further evaluation because of their potential for bioaccumulation in the food chain. Although mercury, vanadium, and zinc were initially found to pose a possible risk to wildlife receptors, re-evaluation of the EQs based on less conservative assumptions resulted in no predictions of potential risk to wildlife from exposures to these COPCs (Table 29).

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TAB

TABLES

Table 18
Selection of Contaminants of Potential Ecological Concern, Surface Water
Former Carswell AFB, Texas

Chemical	Frequency of Detection (%)	Range of Detected Values, mg/L	Statistical Distribution[a]	95% UCL mg/L[b]	Background mg/L[c]	Screening Criteria mg/L[d]	Exclusion Rationale[e]	COPEC?[f]	Exposure Point Concentration mg/L[g]
Inorganics									
Aluminum	7/10(70)	1 1E-01 - 6 3E-01	L	3 3E-01	2 7E-01	8 7E-02	--	Y	6 3E-01
Antimony	2/10(20)	3 8E-03 - 7 0E-03	NP	7.0E-03	3 0E-03	6 9E-01	C	N	--
Barium	10/10(100)	7 5E-02 - 1 3E-01	L	1 1E-01	1 5E-01	4 0E-03	A	N	--
Calcium	10/10(100)	6 5E+01 - 1 7E+02	L	1 4E+02	1 3E+02	NA	D	N	--
Copper	2/10(20)	3 3E-03 - 5 2E-03	NP	5 2E-03	1 0E-02	7 0E-03	--	Y (B)	5 2E-03
Iron	10/10(100)	5 7E-02 - 5 2E-01	L	2 4E-01	9 2E-01	1 0E+00	A,C	N	--
Lead	8/10(80)	2 0E-03 - 3 1E-03	N	2 7E-03	NA	1 0E-03	--	Y (B)	3 1E-03
Magnesium	10/10(100)	5 4E+00 - 8 3E+00	N	7 5E+00	9 4E+00	NA	A	N	--
Manganese	10/10(100)	5 0E-03 - 1 3E-01	L	5 0E-02	4 2E-01	1 2E-01	A	N	--
Mercury	3/10(30)	5 7E-05 - 2 1E-04	NP	2 1E-04	1 0E-04	1 3E-03	--	Y (B)	2 1E-04
Potassium	10/10(100)	9 7E-01 - 2 6E+00	N	2 3E+00	6 4E+00	NA	A,D	N	--
Vanadium	3/10(30)	2 4E-03 - 2 7E-03	NP	2 7E-03	1 6E-02	2 0E-02	A,C	N	--
Zinc,	2/10(20)	3 0E-02 - 3 2E-02	NP	3 2E-02	1 2E-02	5 8E-02	--	Y (B)	3 2E-02
Volatile Organic Compounds									
1,1-Dichloroethane	1/10(10)	4 7E-03	NP	4 7E-03	NA	5 9E+00	C	N	--
1,1-Dichloroethene	1/10(10)	3 1E-04	NP	3 1E-04	NA	2 5E-02	C	N	--
cis-1,2-Dichloroethylene	10/10(100)	3 2E-04 - 6 4E-02	L	4 8E-01	NA	1 4E+00	C	N	--
Tetrachloroethylene	1/10(10)	1 1E-03	NP	1 1E-03	NA	1 3E-01	C	N	--
Trichloroethylene	10/10(100)	3 5E-04 - 2 0E-01	L	3 7E+00	NA	2 6E-01	C	N	--
Semi-Volatile Organic Compounds									
Bis(2-ethylhexyl)phthalate	3/10(30)	4 4E-03 - 1 2E-02	NP	1 2E-02	NA	7 0E-03	--	Y	1 2E-02
Diethyl phthalate	1/10(10)	1.5E-03	NP	1 5E-03	NA	2 1E-01	C	N	--
Di-n-Butyl phthalate	1/10(10)	2 1E-03	NP	2 1E-03	NA	7 0E-03	C	N	--

[a] Statistical Distribution N = Normal distribution, L = Lognormal distribution, U = Undetermined distribution, NP = Nonparametric distribution for data sets with greater than 50% nondetects,
[b] 95% Upper Confidence Limit calculated for the indicated distribution NA = sample size is less than 5 and distribution is not calculated
[c] Background concentrations for inorganic constituents
[d] Toxicity/concentration screen based on TNRCC (2000)
[e] Rationale for exclusion of chemical as a contaminant of potential ecological concern (COPEC)
A = within background concentration
B = detection frequency less than 5%
C = maximum detection is less than screening criteria
D = essential nutrient
[f] N = Chemical is not chosen as a COPEC; Y = Chemical is chosen as COPEC, (B) indicates chemical is a bioaccumulator and is automatically retained as a COPEC
[g] Concentration used in risk assessment equals the maximum value
NA = Value not available

Table 19
Selection of Contaminants of Potential Ecological Concern, Sediment
Former Carswell AFB, Texas

Chemical	Frequency of Detection (%)	Range of Detected Values, mg/kg	Statistical Distribution [a]	95% UCL mg/kg [b]	Background mg/kg [c]	Screening Criteria mg/kg [d]	Exclusion Rationale [e]	COPEC? [f]	Exposure Point Concentration mg/kg [g]
Inorganics									
Aluminum	11/11(100)	8.9E+02 - 1.3E+04	L	6.6E+03	2.0E+04	NA	A	N	--
Antimony	9/11(82)	1.7E-01 - 6.5E+00	U	6.5E+00	3.3E-01	2.0E+00	--	Y	6.5E+00
Arsenic	11/11(100)	5.5E+00 - 3.7E+01	L	1.6E+01	8.0E+00	5.9E+00	--	Y	1.6E+01
Barium	11/11(100)	1.2E+01 - 4.6E+02	L	5.4E+02	1.4E+02	NA	--	Y	4.6E+02
Beryllium	11/11(100)	1.6E-01 - 5.5E-01	L	4.3E-01	7.2E-01	NA	A	N	--
Cadmium	8/11(73)	7.8E-02 - 5.9E-01	L	4.0E+00	1.8E+00	6.0E-01	--	Y (B)	5.9E-01
Calcium	11/11(100)	2.6E+04 - 3.6E+05	N	2.3E+05	3.6E+05	NA	A,D	N	--
Cobalt	11/11(100)	1.4E+00 - 2.2E+01	L	1.5E+01	4.8E+01	NA	A	N	--
Copper	11/11(100)	1.9E+00 - 6.1E+00	L	5.3E+00	1.7E+01	3.6E+01	--	Y (B)	5.3E+00
Iron	11/11(100)	5.7E+02 - 2.5E+04	N	1.3E+04	1.0E+04	2.0E+04	--	Y	1.3E+04
Lead	11/11(100)	5.2E+00 - 6.3E+01	L	2.7E+01	8.8E+01	3.5E+01	A	N	--
Magnesium	11/11(100)	1.0E+03 - 3.1E+03	L	2.5E+03	2.6E+03	NA	D	N	--
Manganese	11/11(100)	1.7E+02 - 2.1E+03	L	1.7E+03	3.5E+02	4.6E+02	--	Y	1.7E+03
Mercury	11/11(100)	1.2E-02 - 1.2E-01	U	1.2E-01	3.6E-02	1.7E-01	--	Y (B)	1.2E-01
Nickel	11/11(100)	2.7E+00 - 2.1E+01	L	1.3E+01	1.6E+00	1.8E+01	--	Y (B)	1.3E+01
Potassium	11/11(100)	1.3E+02 - 1.5E+03	L	9.6E+02	5.0E+03	NA	A,D	N	--
Sodium	11/11(100)	8.8E+01 - 2.7E+02	N	2.1E+02	6.1E+00	NA	D	N	--
Vanadium	11/11(100)	1.4E+01 - 1.1E+02	L	5.3E+01	3.2E+01	NA	--	Y	5.3E+01
Zinc	8/12(67)	1.3E+01 - 1.6E+02	U	1.6E+02	8.1E+01	1.2E+02	--	Y (B)	1.6E+02
Volatile Organic Compounds									
Cis-1,2-Dichloroethylene	5/11(45)	2.7E-03 - 1.2E-02	NP	1.2E-02	NA	NA	--	Y	1.2E-02
Toluene	1/10(10)	1.4E-02	NP	1.4E-02	NA	6.7E-01	C	N	--
Trichloroethylene	7/11(64)	2.1E-03 - 5.6E-02	L	2.8E-02	NA	1.6E+00	C	N	--
Semi-Volatile Organic Compounds									
No detected values									

[a] Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution; NP = Nonparametric distribution for data sets with greater than 50% nondetects;
[b] 95% Upper Confidence Limit calculated for the indicated distribution. NA = sample size is less than 5 and distribution is not calculated
[c] Background concentrations for inorganic constituents
[d] Toxicity/concentration screen based on TNRCC (2000)
[e] Rationale for exclusion of chemical as a contaminant of potential ecological concern (COPEC)
A = within background concentration
B = detection frequency less than 5%
C = maximum detection is less than screening criteria
D = essential nutrient
[f] N = Chemical is not chosen as a COPEC, Y = Chemical is chosen as COPEC; (B) indicates the chemical is a bioaccumulator and automatically retained as a COPEC
[g] Concentration used in risk assessment equal to 95% UCL or maximum value, if maximum value is less than UCL or if no UCL is calculated
NA = Value not available

Table 20
Ecological Hazard Quotients for the Deer Mouse
Former Carswell AFB, TX

Chemical Name	NOAEL[a]	Source-Specific COPEC Intake Rate (mg/day)			Dose (mg/kg-day)	EQ (unitless)[b]
		Water	Sediment	Plant		
Aluminum	1.97E+00	1.93E-03	NA	NA	9.18E-02	4.65E-02
Antimony	1.28E-01	NA	4.50E-04	1.57E-03	9.63E-02	7.54E-01
Arsenic	1 29E-01	NA	1.11E-03	5.53E-04	7.90E-02	6.14E-01
Barium	6.12E+00	NA	3.18E-02	7.79E-02	5.23E+00	8.54E-01
Cadmium	1.17E+00	NA	4 08E-05	2.86E-04	1.55E-02	1.32E-02
Copper	1.48E+01	1.59E-05	3.67E-04	5.31E-03	2.71E-01	1.84E-02
Iron	3.55E+02[c]	NA	8.99E-01	1 80E-01	5.14E+01	1.45E-01
Lead	9.47E+00	9.48E-06	NA	NA	4 52E-04	4.77E-05
Manganese	1.04E+02	NA	1.18E-01	5.88E-01	3 36E+01	3.22E-01
Mercury	3.79E-02	6 42E-07	8.30E-06	2 28E-06	5.34E-04	1.41E-02
Nickel	4.74E+01	NA	8.99E-04	1.12E-03	9.63E-02	2.03E-03
Vanadium	2.44E-01	NA	3.67E-03	6 60E-04	2.06E-01	8.43E-01
Zinc	1.89E+02	9.79E-05	1 11E-02	4.98E-02	2 90E+00	1.53E-02
cis-1,2-Dichloroethylene	4.62E+01	NA	8.30E-07	NA	3.95E-05	8.56E-07
Bis(2-ethylhexyl)phthalate	1.87E+01	3.67E-05	NA	9.54E-02	4 55E+00	2.43E-01

[a]Based on NOAELs from Sample et al (1996), except where noted, and scaled to body weight as per TNRCC (2000).
[b]Values in **bold** are greater than unity.
[c]Based on LD_{50} from RTECS (2000) with applied uncertainty factor of 0 01, and scaled to body weight as per TNRCC (2000).
NA indicates that the chemical is not a COPEC for the exposure medium pathway to this receptor.

Table 21
Ecological Hazard Quotients for the Raccoon
Former Carswell AFB, TX

Chemical Name	NOAEL[a]	Source-Specific COPEC Intake Rate (mg/day)					Dose	EQ
		Water	Sediment	Plant	Invertebrate	Fish	(mg/kg-day)	(unitless)b
Aluminum	1.41E+00	3.01E-01	NA	NA	2.27E+02	1 68E+01	4.26E+01	**3.02E+01**
Antimony	9.12E-02	NA	1 77E-01	5.26E-02	NA	NA	3.99E-02	4.38E-01
Arsenic	9.19E-02	NA	4.35E-01	1.85E-02	NA	NA	7.89E-02	8 59E-01
Barium	4.37E+00	NA	1.25E+01	2.60E+00	NA	NA	2.63E+00	6.02E-01
Cadmium	8.38E-01	NA	1.60E-02	9 55E-03	NA	NA	4 45E-03	5.31E-03
Copper	1.05E+01	2.48E-03	1.44E-01	1.78E-01	3.27E+00	1.20E-01	6.46E-01	6.14E-02
Iron	2.54E+02[c]	NA	3.53E+02	6.01E+00	NA	NA	6.26E+01	2.47E-01
Lead	6.76E+00	1.48E-03	NA	NA	1.95E-01	1.07E-01	5.29E-02	7.82E-03
Manganese	7.44E+01	NA	4.62E+01	1.96E+01	NA	NA	1.15E+01	1.54E-01
Mercury	2.71E-02	1.00E-04	3.26E-03	7.63E-05	2.99E+00	6.77E-01	6.40E-01	**2.37E+01**
Nickel	3.38E+01	NA	3 53E-01	3.76E-02	NA	NA	6.81E-02	2.01E-03
Vanadium	1.74E-01	NA	1.44E+00	2.21E-02	NA	NA	2.55E-01	**1.46E+00**
Zinc	1.35E+02	1.53E-02	4.35E+00	1.66E+00	2.27E+01	5.95E-01	5.11E+00	3 78E-02
cis-1,2-Dichloroethylene	3.30E+01	NA	3.26E-04	NA	NA	NA	5.68E-05	1.72E-06
Bis(2-ethylhexyl)phthalate	1.34E+01	5.73E-03	NA	3.19E+00	1 81E+01	1.30E+00	3.93E+00	2.95E-01

[a]Based on NOAELs from Sample et al. (1996), except where noted, and scaled to body weight as per TNRCC (2000).
[b]Values in **bold** are greater than unity.
[c]Based on LD_{50} from RTECS (2000) with applied uncertainty factor of 0.01, and scaled to body weight as per TNRCC (2000).
NA indicates that the chemical is not a COPEC for the exposure medium pathway to this receptor.

Table 22
Ecological Hazard Quotients for the Mink
Former Carswell AFB, TX

Chemical Name	NOAEL[a]	Source-Specific COPEC Intake Rate (mg/day)					Dose (mg/kg-day)	EQ (unitless)[b]
		Water	Sediment	Mammal	Invertebrate	Fish		
Aluminum	1 62E+00	3.75E-02	NA	NA	6 79E+00	1.13E+01	3 19E+01	**1.97E+01**
Antimony	1.05E-01	NA	7.85E-03	3.55E-05	NA	NA	1.39E-02	1.33E-01
Arsenic	1.06E-01	NA	1.93E-02	1.60E-03	NA	NA	3 69E-02	3.49E-01
Barium	5.02E+00	NA	5 56E-01	5.06E-01	NA	NA	1.87E+00	3.72E-01
Cadmium	9.63E-01	NA	7.13E-04	3 09E-03	NA	NA	6.70E-03	6.96E-03
Copper	1.21E+01	3.09E-04	6.40E-03	1.31E-01	9.76E-02	8.08E-02	5.56E-01	3.75E-02
Iron	2 91E+02[c]	NA	1.57E+01	4.32E+00	NA	NA	3.53E+01	1.21E-01
Lead	7.77E+00	1.84E-04	NA	NA	5.82E-03	7.22E-02	1.38E-01	1.77E-02
Manganese	8 55E+01	NA	2.05E+00	6.77E-01	NA	NA	4 81E+00	5.62E-02
Mercury	3.11E-02	1.25E-05	1.45E-04	1.27E-04	8.94E-02	4.55E-01	9.59E-01	**3.09E+01**
Nickel	3.89E+01	NA	1 57E-02	5.01E-02	NA	NA	1.16E-01	2.98E-03
Vanadium	2.00E-01	NA	6.40E-02	1.27E-02	NA	NA	1 35E-01	6.74E-01
Zinc	1.55E+02	1.90E-03	1.93E-01	2.47E+00	6 78E-01	4.00E-01	6 59E+00	4.24E-02
cis-1,2-Dichloroethylene	3.79E+01	NA	1.45E-05	6.92E-10	NA	NA	2.55E-05	6.74E-07
Bis(2-ethylhexyl)phthalate	1.53E+01	7.14E-04	NA	NA	5 40E-01	8.72E-01	2 49E+00	1.62E-01

[a]Based on NOAELs from Sample et al. (1996), except where noted, and scaled to body weight as per TNRCC (2000).

[b]Values in **bold** are greater than unity.

[c]Based on LD_{50} from RTECS (2000) with applied uncertainty factor of 0.01, and scaled to body weight as per TNRCC (2000)

NA indicates that the chemical is not a COPEC for the exposure medium pathway to this receptor.

Table 23
Ecological Hazard Quotients for the Northern Bobwhite
Former Carswell AFB, TX

Chemical Name	NOAEL[a]	Source-Specific COPEC Intake Rate (mg/day)			Dose	EQ
		Water	Sediment	Plant	(mg/kg-day)	(unitless)[b]
Aluminum	1.10E+02	1.08E-02	NA	NA	6 85E-02	6.23E-04
Antimony	--	NA	8.11E-03	6.11E-03	9.05E-02	--
Arsenic	3.55E+00	NA	2 00E-02	2.15E-03	1.41E-01	3.97E-02
Barium	2.19E+01	NA	5.74E-01	3.02E-01	5.58E+00	2.55E-01
Cadmium	9.73E-01	NA	7 36E-04	1.11E-03	1.17E-02	1.21E-02
Copper	3.68E+01	8.87E-05	6.61E-03	2.06E-02	1.74E-01	4.73E-03
Iron	--	NA	1 62E+01	6 98E-01	1 08E+02	--
Lead	1.14E+00	5.29E-05	NA	NA	3.37E-04	2.95E-04
Manganese	1.14E+03	NA	2 12E+00	2 28E+00	2.80E+01	2.46E-02
Mercury	4.42E-03	3.58E-06	1 50E-04	8 86E-06	1.03E-03	2.34E-01
Nickel	5.61E+01	NA	1.62E-02	4.36E-03	1.31E-01	2.34E-03
Vanadium	7.63E+00	NA	6.61E-02	2.56E-03	4.38E-01	5.74E-02
Zinc	8.77E+00	5.46E-04	2 00E-01	1 93E-01	2.51E+00	2.86E-01
cis-1,2-Dichloroethylene	--	NA	1.50E-05	NA	9.54E-05	--
Bis(2-ethylhexyl)phthalate	1 10E+00	2.05E-04	NA	3.70E-01	2.36E+00	**2.14E+00**

[a]Based on NOAELs from Sample et al. (1996) and scaled to body weight as per TNRCC (2000)
[b]Values in **bold** are greater than unity.
NA indicates that the chemical is not a COPEC for the exposure medium pathway to this receptor.

Table 24
Ecological Hazard Quotients for the Common Snipe
Former Carswell AFB, TX

Chemical Name	NOAEL[a]	Source-Specific COPEC Intake Rate (mg/day)				Dose	EQ
		Water	Sediment	Plant	Invertebrate	(mg/kg-day)	(unitless)[b]
Aluminum	1.05E+02	9.08E-03	NA	NA	1.40E+01	1.15E+02	**1.10E+00**
Antimony	--	NA	7.51E-03	1.01E-03	NA	6.98E-02	--
Arsenic	3.37E+00	NA	1.85E-02	3.55E-04	NA	1.54E-01	4.57E-02
Barium	2.08E+01	NA	5.31E-01	5 01E-02	NA	4.76E+00	2 29E-01
Cadmium	9.25E-01	NA	6 81E-04	1.83E-04	NA	7.09E-03	7.66E-03
Copper	3.50E+01	7 49E-05	6.12E-03	3.41E-03	2.01E-01	1.72E+00	4.93E-02
Iron	--	NA	1.50E+01	1 15E-01	NA	1 24E+02	--
Lead	1.08E+00	4.47E-05	NA	NA	1.20E-02	9.85E-02	9.08E-02
Manganese	1.09E+03	NA	1.96E+00	3.77E-01	NA	1.92E+01	1.77E-02
Mercury	4.20E-03	3.03E-06	1.39E-04	1.47E-06	1.84E-01	1 51E+00	**3.59E+02**
Nickel	5.34E+01	NA	1.50E-02	7.22E-04	NA	1.29E-01	2.42E-03
Vanadium	7.25E+00	NA	6 12E-02	4.24E-04	NA	5.05E-01	6.96E-02
Zinc	8.34E+00	4.61E-04	1.85E-01	3.20E-02	1.40E+00	1.32E+01	**1.59E+00**
cis-1,2-Dichloroethylene	--	NA	1.39E-05	NA	NA	1.14E-04	--
Bis(2-ethylhexyl)phthalate	1.05E+00	1.73E-04	NA	6.13E-02	1.11E+00	9.62E+00	**9.17E+00**

[a]Based on NOAELs from Sample et al. (1996) and scaled to body weight as per TNRCC (2000).

[b]Values in **bold** are greater than unity.

NA indicates that the chemical is not a COPEC for the exposure medium pathway to this receptor.

Table 25
Ecological Hazard Quotients for the American Bittern
Former Carswell AFB, TX

Chemical Name	NOAEL[a]	Source-Specific COPEC Intake Rate (mg/day)					Dose (mg/kg-day)	EQ (unitless)[b]
		Water	Sediment	Invertebrate	Mammal	Fish		
Aluminum	1.49E+02	2.94E-02	NA	3.26E+01	NA	6.04E+00	5 48E+01	3.69E-01
Antimony	--	NA	5.39E-03	NA	1.90E-05	NA	7.67E-03	--
Arsenic	4.79E+00	NA	1.33E-02	NA	8.54E-04	NA	2 00E-02	4.18E-03
Barium	2.96E+01	NA	3.82E-01	NA	2.70E-01	NA	9.23E-01	3.12E-02
Cadmium	1.31E+00	NA	4.90E-04	NA	1 65E-03	NA	3.03E-03	2.31E-03
Copper	4.97E+01	2.43E-04	4 40E-03	4 69E-01	6.98E-02	4 32E-02	8.31E-01	1.67E-02
Iron	--	NA	1.08E+01	NA	2 31E+00	NA	1.85E+01	--
Lead	1.54E+00	1.45E-04	NA	2 80E-02	NA	3.86E-02	9.45E-02	6 13E-02
Manganese	1.54E+03	NA	1.41E+00	NA	3.62E-01	NA	2.51E+00	1.63E-03
Mercury	5.97E-03	9 81E-06	9.96E-05	4.30E-01	6 76E-05	2.43E-01	9.54E-01	**1.60E+02**
Nickel	7.58E+01	NA	1.08E-02	NA	2.68E-02	NA	5.32E-02	7.02E-04
Vanadium	1.03E+01	NA	4.40E-02	NA	6.76E-03	NA	7.19E-02	6.98E-03
Zinc	1 19E+01	1 50E-03	1.33E-01	3.26E+00	1 32E+00	2.14E-01	6.98E+00	5.89E-01
cis-1,2-Dichloroethylene	--	NA	9.96E-06	NA	3.70E-10	NA	1.41E-05	--
Bis(2-ethylhexyl)phthalate	1.49E+00	5.61E-04	NA	2 60E+00	NA	4.66E-01	4.34E+00	**2.91E+00**

[a]Based on NOAELs from Sample et al. (1996) and scaled to body weight as per TNRCC (2000).
[b]Values in **bold** are greater than unity.
NA indicates that the chemical is not a COPEC for the exposure medium pathway to this receptor.

Table 26
Species-Specific Exposure Parameters
Former Carswell AFB, TX

Parameter	Deer Mouse	Raccoon	Mink	Northern Bobwhite	Common Snipe	American Bittern
Body weight (kg)[a]	0 021[a]	5 74	0.568	0.157	0.122[b]	0.706[b]
Water ingestion rate (L/day)[c]	0.0031	0.477	0 0595	0.0171	0.0144	0.0467
Food ingestion rate (kg dw/day)[d]	0 0035	0.289	0 0432	0.0134	0.0111	0.0415
Dietary composition (%)[e]						
Plants	100	40	0	100	20	0
Invertebrates	0	50	10	0	80	50
Small fish	0	10	45	0	0	25
Small mammals	0	0	45	0	0	25
Incidental soil ingestion (% of food ingestion)[f]	2	9 4	2.8	9 3	10.4	2
Exposure Modifying Factor (initial)	1	1	1	1	1	1

[a]From EPA (1993), except as noted.
[b]From Dunning (1993).
[c]Based on allometric equations from Calder and Braun (1983).
[d]Based on allometric equations from Nagy (1987).
[e]Dietary compositions generalized based on information in EPA (1993) and Martin et al (1951).
[f]From Beyer et al. (1993). Where species-specific data were not available, soil ingestion rates from a species with similar diet or feeding strategy was used.

Table 27
Bioconcentration Factors (BCF) and Bioaccumulation Factors (BAF) for Chemicals of Potential Ecological Concern
Former Carswell AFB, TX

Chemical	Plant BAF[a]	Source	Aquatic Invertebrate BCF[b]	Source	Fish BCF	Source
Inorganics						
Aluminum	0 0015	(see footnote a)	574	Wren and Stephenson, 1991	231	Sample et al , 1996
Antimony	0.07	(see footnote a)	10	Bodek et al., 1988	1	Bodek et al , 1988
Arsenic	0.01	(see footnote a)	333	Bodek et al., 1988	333	Bodek et al , 1988
Barium	0.049	(see footnote a)	4 (F)	IAEA, 1994	4	IAEA, 1994
Cadmium	0.14	(see footnote a)	2,000	Bodek et al , 1988	200	Bodek et al , 1988
Copper	0.29	(see footnote a)	1,000	Bodek et al., 1988	200	Bodek et al , 1988
Iron	0.004	Baes et al , 1984	200 (F)	IAEA, 1994	200	IAEA, 1994
Lead	0 045	Baes et al., 1984	100	Bodek et al , 1988	300	Bodek et al , 1988
Manganese	0.1	(see footnote a)	10,000	Vanderploeg et al., 1975	400	IAEA, 1994
Mercury	0.0055	(see footnote a)	22,700	EPA, 1995d	27,900	EPA, 1995d
Nickel	0.025	(see footnote a)	100	Bodek et al , 1988	100	Bodek et al., 1988
Vanadium	0.0036	(see footnote a)	3,000	Bodek et al , 1988	10	Bodek et al , 1988
Zinc	0.09	(see footnote a)	1,130	Eisler, 1993	161	EPA, 1995d
Organics						
cis-1,2-Dichloroethene	3.3	EPA, 1995	5.7 (F)	EPA, 1995d	5.7	EPA, 1995d
Bis(2-ethylhexyl)phthalate	2,300	EPA, 1995	2,400 (F)	EPA, 1995d	240[c]	EPA, 1995d

[a]From TNRCC Texas Risk Reduction Program Section 350.73 (September 23, 1999), except where noted. BAFs for aboveground plant tissues used when available

[b](F) following the value indicates it is based on the fish BCF

[c]Based in lipid-based BCF of 2,400 with assumed lipid content of fish as 7.1% of fresh weight (Diem and Lentner, 1970).

Table 28
Parameters Used to Model Uptake into Small Mammal Prey
Former Carswell AFB, TX

Chemical Name	Food-based Transfer Factor	Soil-to-Mammal Uptake Model Parameters		Source
		P_0	P_1	
Inorganics				
Aluminum		2 63E-02	1.00E+00	Sample et al , 1998
Antimony	1.00E-03			Baes et al. 1984
Arsenic		3 51E-03	1.14E+00	Sample et al , 1998
Barium		5.66E-02	1.00E+00	Sample et al., 1998
Cadmium		2.15E-01	5 66E-01	Sample et al., 1998
Copper		4 30E+00	2.68E-01	Sample et al , 1998
Iron		6.21E-01	6.21E-01	Sample et al., 1998
Lead		5.43E-01	5.18E-01	Sample et al., 1998
Manganese		2.05E-02	1 00E+00	Sample et al., 1998
Mercury		5.43E-02	1.00E+00	Sample et al., 1998
Nickel		7.82E-01	4.66E-01	Sample et al , 1998
Vanadium		1.23E-02	1.00E+00	Sample et al., 1998
Zinc		8.75E+01	7.38E-02	Sample et al., 1998
Organics				
cis-1,2-Dichloroethene	4 75E-05			Garten and Trabalka, 1983
Bis(2-ethylhexyl)phthalate		3.50E-01	1.00E+00	EPA, 1995

Table 29
Ecological Hazard Quotients (EQ) Re-Calculated Using Less Conservative Assumptions
Former Carswell AFB, TX

Chemical Name	LOAEL (mg/kg/d)	Dose (mg/kg/d)	EQ (unitless)
Raccoon			
Aluminum	1.41E+01	2.23E+01	7.91E-01
Mercury	4.50E+00	6.40E-01	7.11E-02
Vanadium	1.74E+00	2.55E-01	7.30E-02
Mink			
Aluminum	1 62E+01	1 67E+01	5.17E-01
Mercury	5.17E+00	9.59E-01	9.27E-02
Northern Bobwhite			
Bis(2-ethylhexyl)phthalate	5.51E+00	2.36E+00	2.14E-01
Common Snipe			
Aluminum	5.23E+02	6.00E+01	5.74E-02
Mercury	8.64E-01	1.51E+00	8 74E-01
Zinc	7 54E+01	1.32E+01	8.77E-02
Bis(2-ethylhexyl)phthalate	5.24E+00	9.62E+00	9.17E-01
American Bittern			
Mercury	1.23E+00	9.54E-01	3 89E-01
Bis(2-ethylhexyl)phthalate	7.45E+00	4.34E+00	2.91E-01

Note: Less conservative values and assumptions include the use of LOAEL-based toxicity benchmarks, the use of inorganic-based toxicity values for mercury, the use of the 95% UCL concentration of aluminum in surface water, and the use of 0.5 as the EMF for all receptors.

TAB

FIGURES

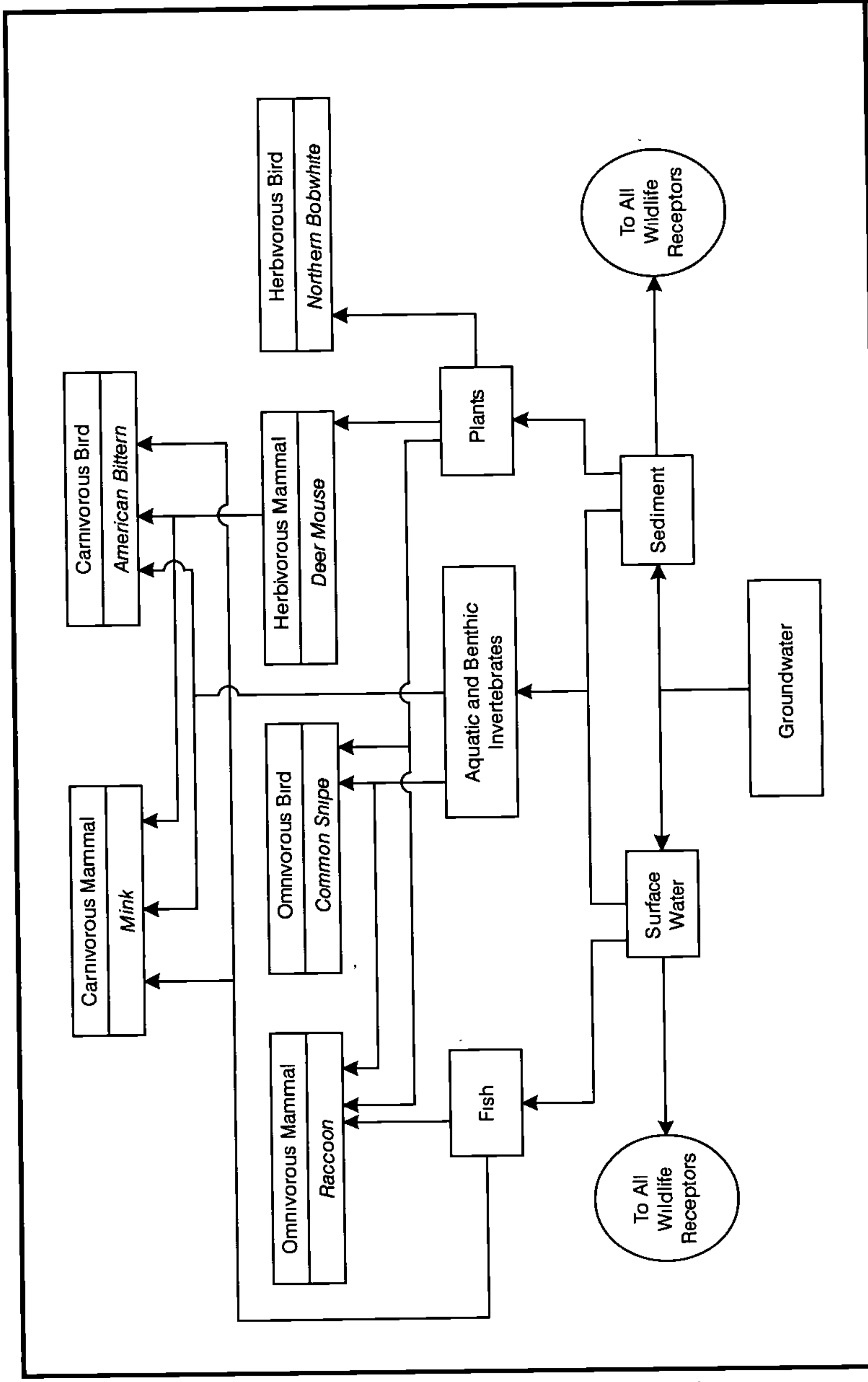
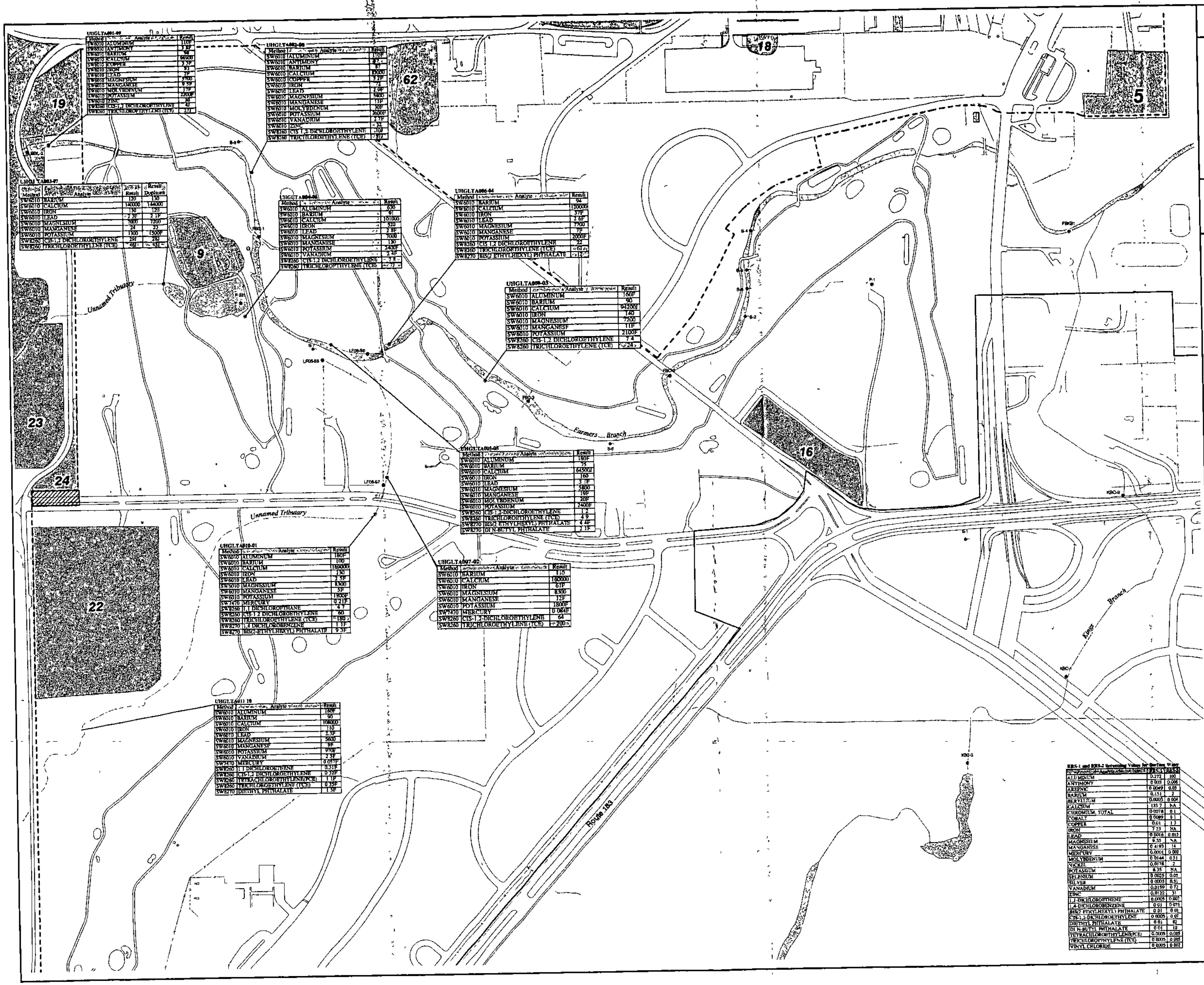


Figure 45
Conceptual Site Model for the Evaluation of Potential Ecological Risk NAS Fort Worth JRB, Texas

HYDROGEOLOGIC INC

Filename X \AFC001\024d\ecological_risk cdr
Project AFC001\024D
Created by cfarmer 05/08/01
Revised 05/09/01 cf
Source Hand-drawn sketch



HydroGeoLogic, Inc.
NAS Fort Worth JRB, Texas

Figure 46

1997 Surface Water Analytical Results Used in Risk Assessment

U.S. Air Force Center For Environmental Excellence

Legend

- NAS Fort Worth JRB Boundary
- Former Carswell Air Force Base Boundary
- 1997 Surface Water Sample Locations
- 1998 Surface Water Sample Locations
- Jacobs Semi-Annual Surface Water Sample Locations
- 1998 Spring Sample Locations
- Solid Waste Management Unit (SWMU)
- Area of Concern (AOC)
- Groundwater Treatment System

Note: Results in µg/L. Only detections noted on map. All other analytes in the SW6010, SW8260, and SW8270 were not detected.

ND - Not Detected
F - The estimated detection between adjusted MDL and adjusted MQL
J - The analyte was positively identified, the quantitation is an estimation

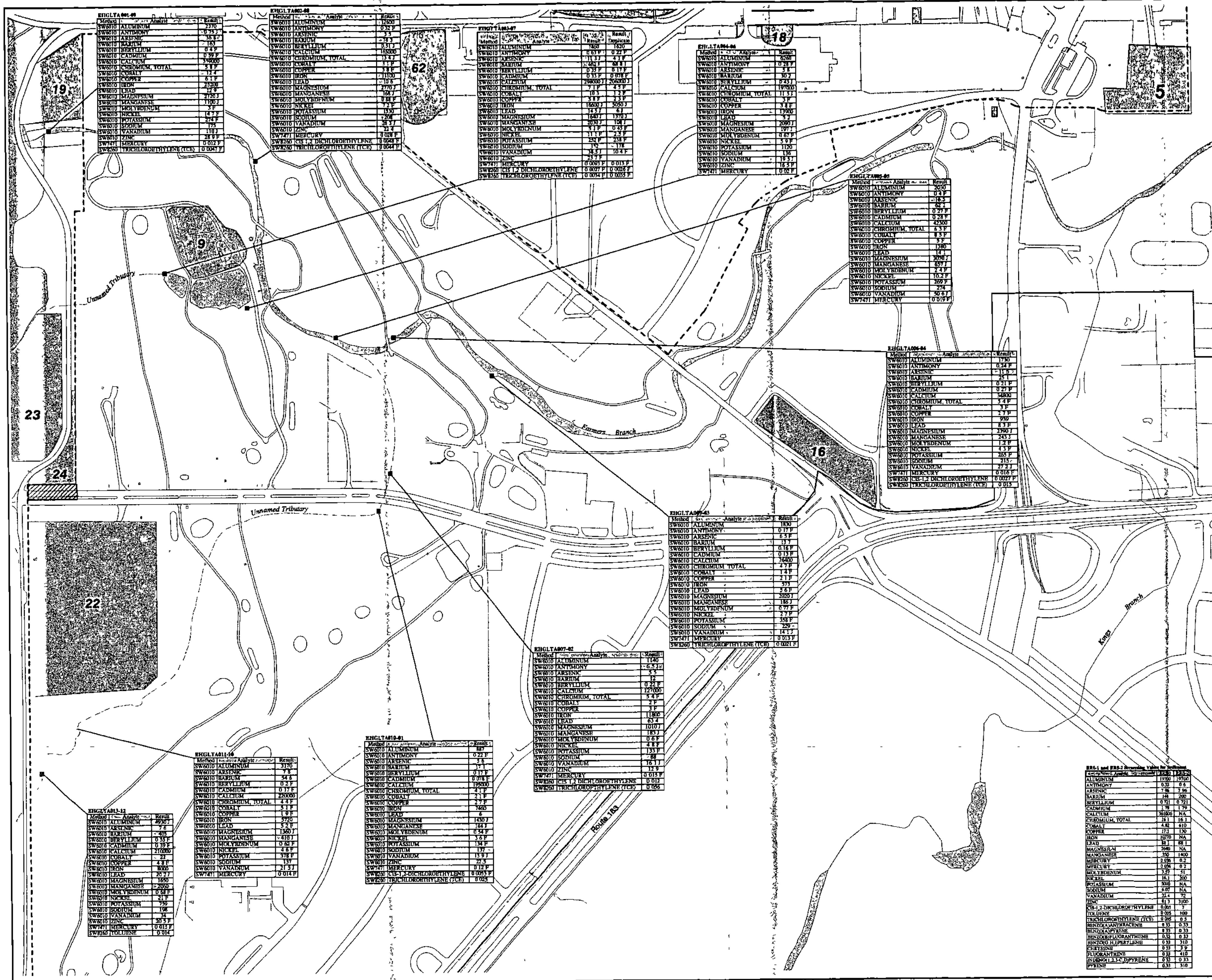
Result above RRS1
Result above RRS2

N

200 0 200 400
SCALE IN FEET

HYDRO GeoLogic INC

Filename: X:\Afc001\19cd\Final Summary Southern Lobe\97surface water.apr
Project: AFC001-36CC
Created: 02/23/01 jbelcher
Revised: 05/08/01 jb
Map Source: HydroGeoLogic, Inc
ArcView GIS Database, 2001



HydroGeoLogic, Inc
NAS Fort Worth JRB, Texas

~Figure 47

1997 Sediment Analytical Results Used in Risk Assessment

U S Air Force Center
For Environmental Excellence

Legend

- NAS Fort Worth JRB Boundary
- Former Carswell Air Force Base Boundary
- 1997 Sediment Locations
- Solid Waste Management Unit (SWMU)
- Area of Concern (AOC)
- Groundwater Treatment System

Note Results in mg/kg. Only detections noted on map All other analytes in the SW6010 SW8260, and SW8270 were not detected

ND - Not Detected
F - The estimated detection between adjusted MDL and adjusted MQL
J - The analyte was positively identified, the quantitation is an estimation

Result above RRS1
Result above RRS2

N

200 0 200 400
SCALE IN FEET

HYDRO GeoLogic INC

Filename X \Afc001\19cd\Final Summary Southern Lobe\97sediment apr
Project AFC001-36CC
Created 02/26/01 jbelcher
Revised 05/08/01 jb
Map Source HydroGeoLogic, Inc
ArcView GIS Database, 2001

TAB

APPENDIX D

Appendix D

Tier 1 TNRCC Form Ecological Risk Assessment

Figure : 30 TAC §350.77(b)

TIER 1: Exclusion Criteria Checklist

This exclusion criteria checklist is intended to aid the person and the TNRCC in determining whether or not further ecological evaluation is necessary at an affected property where a response action is being pursued under the Texas Risk Reduction Program (TRRP). Exclusion criteria refer to those conditions at an affected property which preclude the need for a formal ecological risk assessment (ERA) because there are **incomplete or insignificant ecological exposure pathways** due to the nature of the affected property setting and/or the condition of the affected property media. This checklist (and/or a Tier 2 or 3 ERA or the equivalent) must be completed by the person for all affected property subject to the TRRP. The person should be familiar with the affected property but need not be a professional scientist in order to respond, although some questions will likely require contacting a wildlife management agency (i.e., Texas Parks and Wildlife Department or U.S. Fish and Wildlife Service). The checklist is designed for general applicability to all affected property; however, there may be unusual circumstances which require professional judgement in order to determine the need for further ecological evaluation (e.g., cave-dwelling receptors) In these cases, the person is strongly encouraged to contact TNRCC before proceeding.

Besides some preliminary information, the checklist consists of three major parts, **each of which must be completed unless otherwise instructed.** PART I requests affected property identification and background information. PART II contains the actual exclusion criteria and supportive information. PART III is a qualitative summary statement and a certification of the information provided by the person. **Answers should reflect existing conditions and should not consider future remedial actions at the affected property.** Completion of the checklist should lead to a logical conclusion as to whether further evaluation is warranted. Definitions of terms used in the checklist have been provided and users are strongly encouraged to familiarize themselves with these definitions before beginning the checklist.

Name of Facility:
Air Force Plant 4

Affected Property Location:
Former Carswell Air Force Base / Golf Course Area

Mailing Address:
ASC/ENVR, BLDG. 8
Attn: George Walters
1801 Tenth St, Suite 2

TNRCC Case Tracking #s:
None

Solid Waste Registration #s:
65004

Voluntary Cleanup Program #:
None

EPA I.D. #s:
Carswell – TX0571924042 and TPDES0118257

Figure: 30 TAC §350.77(b) continued

Definitions[1]

Affected property - The entire area (i.e., on-site and off-site; including all environmental media) which contains releases of chemicals of concern at concentrations equal to or greater than the assessment level applicable for residential land use and groundwater classification.

Assessment level - A critical protective concentration level for a chemical of concern used for affected property assessments where the human health protective concentration level is established under a Tier 1 evaluation as described in §350.75(b) of this title (relating to Tiered Human Health Protective Concentration Level Evaluation), except for the protective concentration level for the soil-to-groundwater exposure pathway which may be established under Tier 1, 2, or 3 as described in §350.75(i)(7) of this title, and ecological protective concentration levels which are developed, when necessary, under Tier 2 and/or 3 in accordance with §350.77(c) and/or (d), respectively, of this title (relating to Ecological Risk Assessment and Development of Ecological Protective Concentration Levels).

Bedrock - The solid rock (i.e., consolidated, coherent, and relatively hard naturally formed material that cannot normally be excavated by manual methods alone) that underlies gravel, soil or other surficial material.

Chemical of concern - Any chemical that has the potential to adversely affect ecological or human receptors due to its concentration, distribution, and mode of toxicity. Depending on the program area, chemicals of concern may include the following: solid waste, industrial solid waste, municipal solid waste, and hazardous waste as defined in Texas Health and Safety Code, §361.003, as amended; hazardous constituents as listed in 40 Code of Federal Regulations Part 261, Appendix VIII, as amended; constituents on the groundwater monitoring list in 40 Code of Federal Regulations Part 264, Appendix IX, as amended; constituents as listed in 40 CFR Part 258 Appendices I and II, as amended; pollutant as defined in Texas Water Code, §26.001, as amended; hazardous substance as defined in Texas Health and Safety Code, §361.003, as amended, and the Texas Water Code §26.263, as amended; regulated substance as defined in Texas Water Code §26.342, as amended and §334.2 of this title (relating to Definitions), as amended, petroleum product as defined in Texas Water Code §26.342, as amended and §334.122(b)(12) of this title (relating to Definitions for ASTs), as amended, other substances as defined in Texas Water Code §26.039(a), as amended; and daughter products of the aforementioned constituents.

Community - An assemblage of plant and animal populations occupying the same habitat in which the various species interact via spatial and trophic relationships (e.g., a desert community or a pond community).

Complete exposure pathway - An exposure pathway where a human or ecological receptor is exposed to a chemical of concern via an exposure route (e.g., incidental soil ingestion, inhalation of volatiles and particulates, consumption of prey, etc)

De minimus - The description of an area of affected property comprised of one acre or less where the ecological risk is considered to be insignificant because of the small extent of contamination, the absence of protected species, the availability of similar unimpacted habitat nearby, and the lack of adjacent sensitive environmental areas.

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[1]These definitions were taken from 30 TAC §350.4 and may have both ecological and human health applications. For the purposes of this checklist, it is understood that only the ecological applications are of concern.

Figure: 30 TAC §350.77(b) continued

Ecological protective concentration level - The concentration of a chemical of concern at the point of exposure within an exposure medium (e.g., soil, sediment, groundwater, or surface water) which is determined in accordance with §350.77(c) or (d) of this title (relating to Ecological Risk Assessment and Development of Ecological Protective Concentration Levels) to be protective for ecological receptors. These concentration levels are primarily intended to be protective for more mobile or wide-ranging ecological receptors and, where appropriate, benthic invertebrate communities within the waters in the state. These concentration levels are not intended to be directly protective of receptors with limited mobility or range (e.g., plants, soil invertebrates, and small rodents), particularly those residing within active areas of a facility, unless these receptors are threatened/endangered species or unless impacts to these receptors result in disruption of the ecosystem or other unacceptable consequences for the more mobile or wide-ranging receptors (e.g., impacts to an off-site grassland habitat eliminate rodents which causes a desirable owl population to leave the area).

Ecological risk assessment - The process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors; however, as used in this context, only chemical stressors (i.e., COCs) are evaluated.

Environmental medium - A material found in the natural environment such as soil (including non-waste fill materials), groundwater, air, surface water, and sediments, or a mixture of such materials with liquids, sludges, gases, or solids, including hazardous waste which is inseparable by simple mechanical removal processes, and is made up primarily of natural environmental material

Exclusion criteria - Those conditions at an affected property which preclude the need to establish a protective concentration level for an ecological exposure pathway because the exposure pathway between the chemical of concern and the ecological receptors is not complete or is insignificant.

Exposure medium - The environmental medium or biologic tissue in which or by which exposure to chemicals of concern by ecological or human receptors occurs.

Facility - The installation associated with the affected property where the release of chemicals of concern occurred.

Functioning cap - A low permeability layer or other approved cover meeting its design specifications to minimize water infiltration and chemical of concern migration, and prevent ecological or human receptor exposure to chemicals of concern, and whose design requirements are routinely maintained.

Landscaped area - An area of ornamental, or introduced, or commercially installed, or manicured vegetation which is routinely maintained.

Off-site property (off-site) - All environmental media which is outside of the legal boundaries of the on-site property.

On-site property (on-site) - All environmental media within the legal boundaries of a property owned or leased by a person who has filed a self-implementation notice or a response action plan for that property or who has become subject to such action through one of the agency's program areas for that property.

Figure: 30 TAC §350.77(b) continued

Physical barrier - Any structure or system, natural or manmade, that prevents exposure or prevents migration of chemicals of concern to the points of exposure.

Point of exposure - The location within an environmental medium where a receptor will be assumed to have a reasonable potential to come into contact with chemicals of concern. The point of exposure may be a discrete point, plane, or an area within or beyond some location.

Protective concentration level - The concentration of a chemical of concern which can remain within the source medium and not result in levels which exceed the applicable human health risk-based exposure limit or ecological protective concentration level at the point of exposure for that exposure pathway.

Release - Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment, with the exception of:

(A) A release that results in an exposure to a person solely within a workplace, concerning a claim that the person may assert against the person's employer;

(B) An emission from the engine exhaust of a motor vehicle, rolling stock, aircraft, vessel, or pipeline pumping station engine;

(C) A release of source, by-product, or special nuclear material from a nuclear incident, as those terms are defined by the Atomic Energy Act of 1954, as amended (42 U.S C. §2011 et seq.), if the release is subject to requirements concerning financial protection established by the Nuclear Regulatory Commission under §170 of that Act;

(D) For the purposes of the environmental response law §104, as amended, or other response action, a release of source, by-product, or special nuclear material from a processing site designated under §102(a)(1) or §302(a) of the Uranium Mill Tailings Radiation Control Act of 1978 (42 U.S.C. §7912 and §7942), as amended; and

(E) The normal application of fertilizer.

Sediment - Non-suspended particulate material lying below surface waters such as bays, the ocean, rivers, streams, lakes, ponds, or other similar surface water body (including intermittent streams). Dredged sediments which have been removed from below surface water bodies and placed on land shall be considered soils.

Sensitive environmental areas - Areas that provide unique and often protected habitat for wildlife species. These areas are typically used during critical life stages such as breeding, hatching, rearing of young, and overwintering. Examples include critical habitat for threatened and endangered species, wilderness areas, parks, and wildlife refuges.

Source medium - An environmental medium containing chemicals of concern which must be removed, decontaminated and/or controlled in order to protect human health and the environment. The source medium may be the exposure medium for some exposure pathways

Stressor - Any physical, chemical, or biological entity that can induce an adverse response, however, as used in this context, only chemical entities apply.

Figure. 30 TAC §350.77(b) continued

Subsurface soil - For human health exposure pathways, the portion of the soil zone between the base of surface soil and the top of the groundwater-bearing unit(s). For ecological exposure pathways, the portion of the soil zone between 0.5 feet and 5 feet in depth.

Surface cover - A layer of artificially placed utility material (e.g., shell, gravel).

Surface soil - For human health exposure pathways, the soil zone extending from ground surface to 15 feet in depth for residential land use and from ground surface to 5 feet in depth for commercial/industrial land use; or to the top of the uppermost groundwater-bearing unit or bedrock, whichever is less in depth. For ecological exposure pathways, the soil zone extending from ground surface to 0.5 feet in depth.

Surface water - Any water meeting the definition of surface water in the state as defined in §307.3 of this title (relating to Abbreviations and Definitions), as amended.

Figure: 30 TAC §350.77(b) continued

PART I. Affected Property Identification and Background Information

1) Provide a description of the specific area of the response action and the nature of the release. Include estimated acreage of the affected property and the facility property, and a description of the type of facility and/or operation associated with the affected property. Also describe the location of the affected property with respect to the facility property boundaries and public roadways.

Air Force Plant 4
Air Force Plant (AFP) 4 became operational in 1942 when Consolidated Aircraft began manufacturing the B-24 bomber for national defense during World War II. In 1953, General Dynamics took over operation of the manufacturing facility. Since 1953, AFP 4 has produced B-36, B-58, F-111 aircraft. The plant currently produces F-16 aircraft. In addition to F-16 aircraft, AFP 4 produces spare parts, radar units, and missile components. On March 1, 1993, Lockheed, Forth Worth Company, took over operations of AFP 4 as a successor to General Dynamics. AFP 4 currently occupies 602 acres.

Manufacturing operations at AFP 4 have resulted in the generation of various hazardous wastes that include waste oils, fuels, spent solvents, paint residues, and spent process chemicals Throughout most of the plant's history, waste oil, solvents, and fuels were disposed at on-site landfills or were burned during fire training exercises. Chemical wastes were initially discharged to the sanitary sewer system and treated by the City of Fort Worth's treatment system In the 1970's, chemical process wastes were treated on site at a newly constructed chemical waste treatment system prior to being discharged to the sanitary sewer system. Currently, on site burning of waste has been discontinued while waste oils and solvents are disposed through a contractor. Chemical wastes continue to be treated on site. AFP 4 was placed on the National Priority List (NPL) in August 1990 because of a large release of trichloroethene (TCE) arising from past disposal practices at AFP 4. While the source areas are currently being remediated, the dissolved TCE plume appears to have migrated toward the east of APF 4 and extends under NAS Fort Worth JRB and the Former Carswell AFB/Base Realignment and Closure (BRAC) area. The plume is referred to as the southern lobe, and is migrating in a southeast direction.

NAS Fort Worth JRB
The NAS Fort Worth JRB started as a modest dirt runway built to service the aircraft manufacturing plant formerly located at AFP 4's current location. In August 1942, the base was opened as Tarrant Field Airdrome and was used to train pilots to fly B-24 bombers. In May 1943, the field was re-designed as Fort Worth Army Air Field. It was renamed Carswell Air Force Base in 1948, and the 7th Bomber Wing became the base host unit. The Strategic Air Command (SAC) mission remained at Carswell AFB until 1992, when the Air Combat Command assumed control of the base upon de-establishment of SAC. In October 1994, the U.S. Navy assumed responsibility for much of the facility, and its name was changed from Carswell AFB to NAS Fort Worth JRB. The principal activities on the base have been maintaining and servicing bombers, fuel tankers, and fighter jet aircraft.

Major industrial operations that have been performed at the NAS Fort Worth JRB include the following: maintenance of jet engines, aerospace ground equipment, fuel systems, weapons systems, pneudraulic systems and general and special purpose vehicles; aircraft corrosion control; and non-destructive inspection activities. Most liquid wastes that have been generated by industrial operations can be characterized as waste oils, recoverable fuels, spent solvent, and spent cleaners. Several landfills exist just up gradient of the BRAC area, with one landfill (SWMU 22) on the western portion of the BRAC property. Two areas of concern (AOC) exist within the BRAC area; they are the AOC 9, the Golf Course Maintenance Yard, and AOC 16, the Family Camp.

In 1991, the Corps of Engineers performed excavation activities at Waste Burial Area 7 (WP-07), SWMU 24, to remove a total of 34 drums, of which 9 were partially full, and 25 were empty. TCE and perchloroethylene (PCE) were the primary constituents contained within the drums. These drums contributed to the southern lobe TCE plume contamination As part of an RFI at SWMU 24, an electromagnetic survey was performed on May 2000, for the purpose of confirming drum removal activities performed by the Corps of Engineers. In July, 2000 IT Corporation began excavation activities to investigate twelve geophysical anomalies. A total of 16 metal 55-gallon drums were encountered. Of the 16 drums, 12 were empty, compressed, or A total of 21 metal 55-gallon drums were encountered between two areas. Of the 21 drums, 17 were empty, compressed, or corroded, and contained no liquids. Also discovered were lengths of pipe, a tire iron, and metal post. Three of the drums were still in tact and partially full with an unknown liquid. Analytical results from characterization sampling will be addressed under a separate and pending (December 2000) project report by IT Corporation, but preliminary results indicate that the drums contain at least a fraction of TCE. A fourth in tact drum contained a blue, wet, powdery substance. Analytical results from characterization sampling of this unknown powdery substance will also be addressed in the IT report on excavation activities. Although analytical results from excavation activities are not available for this Internal Draft Risk Assessment, it is expected that the analytical results will be available and incorporated in the Final Risk Assessment.

The resulting southern lobe TCE plume originating from AFP 4 and possibly other NAS Fort Worth source areas covers approximately 453 acres, 75 of which are on the BRAC property The down gradient extent (TCE at 5 μg/L) of the plume is within 6 feet of the federal property boundary in WHGLRW015. An off-site well has been installed and analytical results are pending. Two additional offsite wells WHGLRW016 and WHGLRW017 (approximately 20 feet from the boundary show no detectable concentrations of TCE).

Attach available USGS topographic maps and/or aerial or other affected property photographs to this form to depict the affected property and surrounding area. Indicate attachments:

X Topo map X Aerial photo ☐ Other

2) Identify environmental media known or suspected to contain chemicals of concern (COCs) at the present time. Check all that apply:

Known/Suspected COC Location	Based on sampling data?	
☐ Soil ≤ 5 ft below ground surface	☐ Yes	☐ No
☐ Soil >5 ft below ground surface	☐ Yes	☐ No
X Groundwater	X Yes	☐ No
X Surface Water/Sediments	X Yes	☐ No

Explain (previously submitted information may be referenced):

Detected chemicals in groundwater, surface water and sediment are identified in Tables 6-1, 6-3, and 6-4, respectively.

Figure: 30 TAC §350.77(b) continued

3) Provide the information below for the nearest surface water body which has become or has the potential to become impacted from migrating COCs via surface water runoff, air deposition, groundwater seepage, etc. Exclude wastewater treatment facilities and stormwater conveyances/impoundments authorized by permit. Also exclude conveyances, decorative ponds, and those portions of process facilities which are:

   a. Not in contact with surface waters in the State or other surface waters which are ultimately in contact with surface waters in the State, and

   b. Not consistently or routinely utilized as valuable habitat for natural communities including birds, mammals, reptiles, etc.

The nearest surface water body is 0 feet/miles from the affected property and is named Farmers Branch Creek. The water body is best described as a.

X freshwater stream: ______ perennial (has water all year)
______ intermittent (dries up completely for at least 1 week a year)
X intermittent with perennial pools
❒ freshwater swamp/marsh/wetland
❒ saltwater or brackish marsh/swamp/wetland
❒ reservoir, lake, or pond; approximate surface acres:
❒ drainage ditch
❒ tidal stream ❒ bay ❒ estuary
❒ other; specify

Is the water body listed as a State classified segment in Appendix C of the current Texas Surface Water Quality Standards; §§307.1 - 307.10?

❒ Yes Segment # ______ Use Classification:

✗ No

If the water body is not a State classified segment, identify the first downstream classified segment.

Name: West Fork of the Trinity Below Lake Worth

Segment #: 0806

Use Classification: Contact recreation, high aquatic life use, public water supply

As necessary, provide further description of surface waters in the vicinity of the affected property:

Figure. 30 TAC §350.77(b) continued

PART II. Exclusion Criteria and Supportive Information

Subpart A. Surface Water/Sediment Exposure

1) Regarding the affected property where a response action is being pursued under the TRRP, have COCs migrated and resulted in a release or imminent threat of release to either surface waters or to their associated sediments via surface water runoff, air deposition, groundwater seepage, etc.? Exclude wastewater treatment facilities and stormwater conveyances/impoundments authorized by permit. Also exclude conveyances, decorative ponds, and those portions of process facilities which are:

   a. Not in contact with surface waters in the State or other surface waters which are ultimately in contact with surface waters in the State; and

   b. Not consistently or routinely utilized as valuable habitat for natural communities including birds, mammals, reptiles, etc.

   X Yes ☐ No

Explain:

Measured concentrations of volatile and semivolatile chemicals (see Tables 6-3 and 6-4) have been detected in surface water and sediment samples.

If the answer is Yes to Subpart A above, the affected property does not meet the exclusion criteria. However, complete the remainder of Part II to determine if there is a complete and/or significant soil exposure pathway, then complete PART III - Qualitative Summary and Certification. If the answer is No, go to Subpart B.

Soil is not included under this remedial investigation.

Subpart B. Affected Property Setting

In answering "Yes" to the following question, it is understood that the affected property is not attractive to wildlife or livestock, including threatened or endangered species (i e., the affected property does not serve as valuable habitat, foraging area, or refuge for ecological communities). (May require consultation with wildlife management agencies.)

1) Is the affected property wholly contained within contiguous land characterized by: pavement, buildings, landscaped area, functioning cap, roadways, equipment storage area, manufacturing or process area, other surface cover or structure, or otherwise disturbed ground?

   ✗ Yes ☐ No

Explain:

Figure: 30 TAC §350.77(b) continued

If the answer to Subpart B above is Yes, the affected property meets the exclusion criteria, assuming the answer to Subpart A was No. Skip Subparts C and D and complete PART III - Qualitative Summary and Certification. If the answer to Subpart B above is No, go to Subpart C.

Subpart C. Soil Exposure

1) Are COCs which are in the soil of the affected property solely below the first 5 feet beneath ground surface or does the affected property have a physical barrier present to prevent exposure of receptors to COCs in surface soil?

❒ Yes ✗ No

Explain·

Soil is not included under this remedial investigation.

If the answer to Subpart C above is Yes, the affected property meets the exclusion criteria, assuming the answer to Subpart A was No. Skip Subpart D and complete PART III - Qualitative Summary and Certification. If the answer to Subpart C above is No, proceed to Subpart D.

Subpart D. *De Minimus* Land Area

In answering "Yes" to the question below, it is understood that all of the following conditions apply:

- The affected property is not known to serve as habitat, foraging area, or refuge to threatened/endangered or otherwise protected species. (Will likely require consultation with wildlife management agencies.)
- Similar but unimpacted habitat exists within a half-mile radius.
- The affected property is not known to be located within one-quarter mile of sensitive environmental areas (e g , rookeries, wildlife management areas, preserves). (Will likely require consultation with wildlife management agencies.)
- There is no reason to suspect that the COCs associated with the affected property will migrate such that the affected property will become larger than one acre.

1) Using human health protective concentration levels as a basis to determine the extent of the COCs, does the affected property consist of one acre or less <u>and</u> does it meet all of the conditions above?

❒ Yes X No

Explain how conditions are met/not met:

The surface water body is contained within a golf course area that is highly maintained and does not serve as a viable habitat for threatened/endangered or otherwise protected species.

If the answer to Subpart D above is Yes, then no further ecological evaluation is needed at this affected property, assuming the answer to Subpart A was No. Complete PART III - Qualitative Summary and Certification. If the answer to Subpart D above is No, proceed to Tier 2 or 3 or comparable ERA.

PART III. Qualitative Summary and Certification (Complete in all cases.)

Attach a brief statement (not to exceed 1 page) summarizing the information you have provided in this form. This summary should include sufficient information to verify that the affected property meets or does not meet the exclusion criteria. The person should make the initial decision regarding the need for further ecological evaluation (i e., Tier 2 or 3) based upon the results of this checklist. After review, TNRCC will make a final determination on the need for further assessment. **Note that the person has the continuing obligation to re-enter the ERA process if changing circumstances result in the affected property not meeting the Tier 1 exclusion criteria.**

Completed by: Deborah L McKean, Ph.D. _(Typed/Printed Name)_

Senior Toxicologist , IT Corporation _(Title)_

November 20, 2000 _(Date)_

I believe that the information submitted is true, accurate, and complete, to the best of my knowledge.

________________________ _(Typed/Printed Name of Person)_

________________________ _(Title of Person)_

________________________ _(Signature of Person)_

________________________ _(Date Signed)_

HydroGeoLogic, Inc —NAS Fort Worth JRB, Texas

Figure A.1

**Topographic/Aerial Map
Golf Course/BRAC Area**

U.S. Air Force Center for
Environmental Excellence

Legend

- - - NAS Fort Worth JRB (Carswell Field)

——— Former Carswell Air Force Base

——— 10' Contours

Project AFC001-36CA
Filename X \AFC001\36ca\Report\Golf_Course apr
Created 11/17/00 ASP
Revised 12/04/00 cf
Map Source HydroGeoLogic, Inc —GIS Database

HYDRO GeoLogic INC.

TAB

APPENDIX E

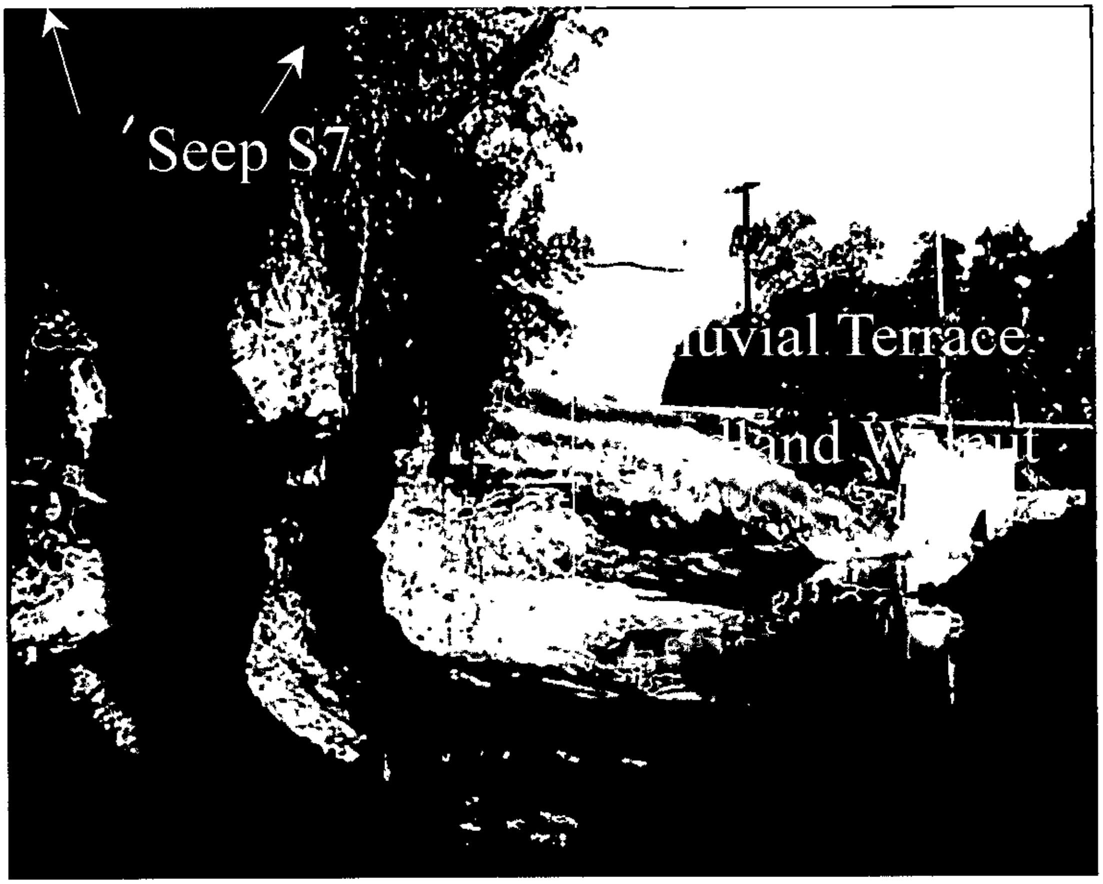
Appendix E

Photographs

Farmers Branch at the eastern edge of Aqueduct

Confluence of Kings Branch with Farmers Branch

Farmers Branch along the Golf Course Area



Seep S7 at Outcrop of Alluvial Terrace Deposit at Goodland/Walnut Formation Contact along Bank of Farmers Branch Creek

X:\AFC001\024D\photos.cdr

FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE