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FINAL PHASE 2 SITE INSPECTION AT AREA OF CONCERN 20 AND DATA GAPS INVESTIGATION AT AREA OF CONCERN 2 INFORMAL TECHNICAL INFORMATION NAS FORT WORTH TX

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NAVAL AIR STATION FORT WORTH JRB CARSWELL FIELD TEXAS

ADMINISTRATIVE RECORD COVER SHEET

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PHASE II SITE INSPECTION AT AOC 20 AND DATA GAPS INVESTIGATION AT AOC 2 NAS FORT WORTH JRB, TEXAS

INFORMAL TECHNICAL INFORMATION REPORT

FINAL

U.S. Air Force Center for Environmental Excellence
Brooks AFB, Texas

Contract No. F41624-00-D-8030
Delivery Order No. 0018

MARCH 2002

REVIEW OF DRAFT ITIR
PHASE 2 SI AT AOC 20 AND DATA GAPS INVESTIGATION AT AOC 2
NAS FORT WORTH JRB, TEXAS
Response Date: MARCH 2002
Reviewer: USGS, SANDRA EBERTS
Responses By: SAIC

ITIR REVIEW COMMENTS AND RESPONSES
PHASE 2 SITE INSPECTION AT AOC 20 AND DATA GAPS INVESTIGATION AT AOC 2

Comment No.	USGS COMMENTS	RESPONSE
1	FIELD INVESTIGATIONS – Line 28, page 3-1. The statement ".. channels that **created** the northern and southern lobes of the TCE plume" does not seem warranted. Ground water flow directions on Figure 3-5, as well as text on page 3-15 (lines 27-31) that includes the statement "Many soil boring logs indicate clay lithology from the top of the water table to the top of bedrock", do not support the conclusion that the " ... **channels created** .... lobes of the TCE plume". Certainly where relatively high permeability material exists in the channels, the channels likely affect the direction of ground-water flow and thereby plume migration. Suggest being careful with verbiage in here.	Deleted "that created the northern and southern lobes of the TCE plume."
2	Line 36, page 3-7. The (USGS 1998) reference is not in the list of references.	Reference changed to (Seispulse 1998)
3	Figure 3-5, Groundwater Elevation Contours. There is not much data to support groundwater flow in towards the aqueduct—particularly from the south—along much of its length. As a result, the part of the conceptual model (page 4-1) that invokes seasonal changes in flow into the aqueduct to explain migration of contaminants beneath the aqueduct does not seem well supported. No data on annual ground-water level fluctuations are included in this report. What are the annual fluctuations and are observed fluctuations adequate to bring the water table in and out of contact with the aqueduct?	Existing data collected from the area near aqueduct are not adequate for detailed assessment. However, the drainage effect is evident in the quarterly or annual water level contours where the aqueduct is apparently located at the center of a trough. The interpreted contour lines on Figure 3-5 were changed to dashed lines.
4	For the record, the groundwater flowpath into the north side of Farmers Branch Creek is perpendicular to the direction of flow as determined from six years of site-specific data at the phytoremediation demonstration site. Nothing needs changed on Figure 3-5, however, because these contours are currently dashed.	Comment noted. No change was made to the text.
5	Why was a VC map not included? Even if the occurrence of VC is limited, it is not likely to be more limited than PCE, which was mapped. Historic data indicate that there are VC zones within the Terrace Alluvium aquifer that can be mapped.	A VC map will be included in the Phase II SI Report (in preparation).

Comment No.	USGS COMMENTS	RESPONSE
6	DISCUSSION – Lines 2-4, page 3-16. Three areas with high TCE concentrations are mentioned here and shown on figure 3-7. The presence of these three areas was used to suggest that in addition to the sources at WP-7, potential sources may have migrated from AFP4. The "third" area of high TCE concentration is coincident with line EI-6 on figure 3-1, which is noted as an area of fill on page 3-2. In addition, "Fill with hazardous compounds may have existed ..." is discussed in Lines 36-37 on page 3-16. In light of these discussions, why was the fill not noted as a possible source in the conceptual model on page 4-1?	Text on page 4-1 was corrected to include fill as a possible source in the conceptual model.
7	Lines 5-6, page 3-16. Figure 1-2 indicates that AOC 20 extends all the back to AFP 4. Why is there a statement in this section of the manuscript indicating that "... concentrations of TCE ranging from 270 ug/L to 1,020 ug/L are 'migrating into' the AOC 20 area?	Changed "into the AOC 20 area to "across the runway into NAS FW JRB."
8	Lines 10-18, page 3-16. How long have the recovery wells been in use in the East Parking Lot area? The general configuration of the plume has not changed according to historic data in the ERPIMS data base. Suggest making certain that the plume configuration could be tied to the pumping scenarios before making this statement. There is also mention that reduced flushing related to pumping at the recovery wells could have prevented flushing at AOC 20. (I presume this discussion relates to the AOC 20 south plot.) Ground water flow paths on figure 3-5 indicate no relation between the area of the recovery wells in the East Parking Lot and the AOC 20 south plot. This discrepancy needs to be addressed.	Recovery wells were installed in phases. Some older recovery wells have been there since the initial phase. Added "these wells were installed in phases from 1993 to 2000". The last two sentences were deleted to eliminate confusion about the "flushing" theory.
9	Lines 10-34, page 3-29. This lengthy discussion on flow during high and low water table conditions is questionable. There are not enough data on figure 3-5 to draw conclusions about the role of the aqueduct regardless of the position of the water table. One could contour the data to show flow beneath the aqueduct or into the aqueduct. I certainly would not invoke high and low water levels to support hypotheses regarding flow beneath the aqueduct. Even if the saturated zone is in contact with the aqueduct, the aqueduct may serve as a weak sink. That is, allow some water to still flow beneath the aqueduct. In addition, groundwater flow paths are more likely to be coincident with the paleochannel in times of low water levels not high water levels when the saturated zone is less likely to be restricted to the paleochannel.	This discussion is related to the CSM and subject to debate. Comment noted. No change was made to the text.

Comment No.	USGS COMMENTS	RESPONSE
10	Lines 2-24, page 3-29. Why does the plume have to migrate 'within' the paleochannel? There is no evidence that the dissolved phase of the plume is restricted to the paleochannel. Again, a basal gravel could not be mapped within the paleochannel and flow paths on figure 3-5 indicate that the direction of ground water flow, as well as dissolved phase TCE, are not coincident with the axis of the paleochannel. It is worth noting that the potentiometric contours on figure 3-5 are consistent with contours that I have generated in the past except for the detail along the aqueduct.	Due to fluctuation in rainfall over the area, water may be predominantly contained in the paleochannel during drought and the plume can only move within the channel. During recharge, it may spill over and out of the channel. No change was made to the text.
11	Lines 21-22, page 3-29. Why is the "apparent one (source) originating near the aqueduct ..." not mentioned in the conceptual model on page 4-1?	Text on page 4-1 changed to include source originating near the aqueduct in the CSM.
12	Lines 17-32, page 3-30. The text indicates that PCE concentrations in the northern lobe are similar to concentrations at AFP 4 and therefore no additional sources of PCE in the northern lobe are necessary to explain the detection of PCE. However, if there were a relation between PCE near the toe of the northern lobe and AFP 4, the wells in between these two areas wouldn't all have detections below the concentrations at well WSAICTA023. This conclusion should be further substantiated.	With the highest PCE concentration being 17.7 ppb, it is unlikely to have a soil source that is quantifiable, or worth quantifying, especially if it is overlain by a TCE plume with concentrations one order of magnitude greater. Currently, there are no data in the database that indicate TCE concentrations in soil above 1 ppb in the North Lobe area. The cost effectiveness of trying to locate TCE sources in the North Lobe area is debatable. Comment noted. No change was made to the text.
13	Lines 33-34, page 3-30. The statement "The TCE plume configuration is consistent with the current conceptual model: it has migrated from AFP 4" sounds as though AFP 4 is the sole source of TCE in the ground water. As stated before, the maps of ground water flow paths and PCE and TCE concentrations do not support this simple conclusion.	See response to Comment No. 12
14	AOC 20 Conceptual Model – Why are potential sources between WP-7 and AFP 4 not mentioned? Geophysical data, water quality data, and discussions within the text all suggest that there may be sources in the fill material. The need to invoke high and low water table conditions to explain how TCE could migrate from AFP 4 beneath the aqueduct is questionable. Such a conceptualization is not necessary to explain how TCE could have migrated beneath the aqueduct and no water table fluctuation data are included in the report to substantiate this hypothesis. Again, if vinyl chloride has been detected in limited locations, why are these locations not included on a map?	The potential source between WP-7 and AFP-4 was added to the discussion. Water level fluctuation and the drainage effect of the aqueduct are part of the "Data Gap" that should be validated in the future investigation. A VC map will be included in the SI Report.
15	AOC 2 Conceptual Model – Why is building 181 included as a potential source for TCE in the northern lobe? The potentiometric surface map and accompanying ground-water flow paths clearly discount building 181 as a source for the northern lobe. The statement that the migration pathway "Approximately follows hydraulic gradient, locally influenced by preferential pathways created by heterogeneity of aquifer" is a realistic description of contaminant pathways and is somewhat in conflict with discussions in the text regarding the influence of 'the paleochannel' on plume migration.	Due to plume continuity, it is possible. No change was made to the text.

719 4

Comment No.	USGS COMMENTS	RESPONSE
16	In conclusion, there is a lot of good information in this manuscript. I particularly like the inclusion of the potentiometric surface map in figure 3-5, which is lacking in so many AFP 4 and NAS Fort Worth reports. However, for some reason the discussions in the text do not honor the information conveyed by this figure. In general, much of the discussions revert back to previous conceptualizations of contaminant sources and plume migration that are not supported by the data in this report. The data presented here seem to be good data and I suggest that the text is rechecked for consistent interpretation on the basis of data presented herein rather than in historic documents	Comment noted. No change was made to the text.

719 5

REVIEW OF DRAFT ITIR
PHASE 2 SI AT AOC 20 AND DATA GAPS INVESTIGATION AT AOC 2
NAS FORT WORTH JRB, TEXAS

Response Date: **MARCH 2002**
Reviewer: **USGS, CHRISTOPHER BRAUN**

Responses By: **SAIC**

ITIR REVIEW COMMENTS AND RESPONSES
PHASE 2 SITE INSPECTION AT AOC 20 AND DATA GAPS INVESTIGATION AT AOC 2

Comment No.	USGS COMMENTS	RESPONSE
1	Figure 3-2 – You may want to consider dashing or removing the interpreted bedrock interface in areas where it greatly conflicts with borehole data (at BSAICTA001 and W-153 in particular). The explanations provided for these discrepancies on pages 3-1 and 3-2 should justify their absence.	The interpreted bedrock interface surface removed. Text was modified accordingly.
2	Pages 3-7 and 3-8 – You state that "In several areas (Lines 1 and 5 of CH2M Hill's 2000 data), the previously collected data could not be tied to the new data and were omitted." You may want to consider writing a brief description of why the data collected by CH2M Hill did not tie with the new data, so it will not appear as though you were excluding data at your own discretion because it was contradictory to your model	Comment accepted. All CH2M Hill data were deleted because acquisition method varied.
3	Figures 3-3 and 3-4 – It's hard to visually compare the bedrock surface between the two figures. You may want to consider adding a figure in which you subtract one set of bedrock elevations from the other so the differences between the two datasets can be more easily visualized.	After CH2M Hill data were removed, the contours were redrawn and labeled with larger font size. Large-scale comparison is not provided.
4	Page 3-15 – You state that "Concentrations of PCE are negligible in all monitoring points except CPT-2 and CPT-4, which are located within WP-07. This suggests that historic TCE releases at WP-07 from drums contained PCE as well." Although I agree that this is probably the case, this is a very bold statement to make. Does IT's chemical analyses of the drums in this area substantiate this claim?	This is an accurate summary of data presented in Figure 3-6. AFP4 is a different scenario because PCE has not been analyzed recently. Comment noted. No change was made to the text.
5	Page 3-16 – You state that "...potential additional sources exist within the plume that may have migrated from AFP 4." The sources did not actually migrate; it was the contaminants from within the source that migrated.	Text was modified accordingly.
6	Page 3-16 – You state that "An alternative explanation for this plume configuration may be that active pumping from the fifty-one recovery wells located in the East Parking Lot of Building 181..." These wells were only pumped sporadically prior to your August/September sampling event, so it is highly unlikely that they had any noticeable effect on the plume configuration.	Some of the wells have been pumping since 1993. Pumping from newer wells may not have taken effect. To reflect history, added "installed in phases from 1993 to 2000' after "51 recovery wells."

719 6

Comment No.	USGS COMMENTS	RESPONSE
7	Figure 3-9 – Relying exclusively on the oxidation-reduction potential of groundwater is not a reliable means of delineating areas where natural attenuation is occurring. Hydrogen concentrations may be used to achieve this result, or in the absence of hydrogen data, a series of weighted natural attenuation parameters may be used to assess the reduction potential at a well.	This analysis focuses on obvious direct and indirect evidence. It is more mapping than scoring according to the EPA's Technical Protocol. Comment noted. No change was made to the figure.
8	Figure 3-9 – EPA's Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water states that an ORP < 50 mv indicates that a reductive pathway is possible, and an ORP < -100 mv indicates that a reductive pathway is likely. As a result, only one of the wells shown in Figure 3-9 sampled meets the criteria for a likely reductive pathway, and only about half of the wells contained within the shaded areas on Figure 3-9 meet the criteria for a possible reductive pathway. If you choose to retain this figure in the report, the shaded areas should be adjusted accordingly.	This ITIR reports a phenomenon in which ORP < 100 in groundwater coincides with elevated DCE concentrations. Both may be the result of degradation and groundwater movement. Comment noted. No change was made to the figure.

PHASE II SITE INSPECTION AT AOC 20 AND DATA GAPS INVESTIGATION AT AOC 2

NAS FORT WORTH JRB, TEXAS

INFORMAL TECHNICAL INFORMATION REPORT

FINAL

Prepared for

U.S. Air Force Center for Environmental Excellence
Brooks Air Force Base, Texas

Prepared by

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
San Antonio, Texas

Contract No. F41624-00-D-8030
Delivery Order No. 0018

March 2002

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TABLE OF CONTENTS

Acronyms and Abbreviations v

1. Introduction 1-1

2. Field Investigation 2-1
   - 2.1 Fieldwork Objectives 2-1
   - 2.2 Summary of Field Activities 2-1

3. Field Invesigation Results and Discussion 3-1
   - 3.1 Field Investigation Results 3-1
     - 3.1.1 Geophysical Surveys 3-1
     - 3.1.2 Aquitard Topography 3-2
     - 3.1.3 Groundwater Elevation Contour 3-8
     - 3.1.4 Groundwater Plume Geometry Finalization 3-8
   - 3.2 Discussion 3-27
     - 3.2.1 AOC 20 SI 3-27
       - 3.2.1.1 Paleochannel and Subsurface Heterogeneity 3-27
       - 3.2.1.2 Groundwater Plume and Sources of Groundwater Contamination 3-27
       - 3.2.1.3 Plume Migration Pathways 3-28
     - 3.2.2 AOC 2 Data Gap Investigation 3-29
       - 3.2.2.1 Bedrock Confirmation and Paleochannel 3-29
       - 3.2.2.2 Groundwater Plume and Sources of Groundwater Contamination 3-29
       - 3.2.2.3 Groundwater Migration Pathway 3-31

4. Summary 4-1

5. References 5-1

Figures

1-1 Site Location Map NAS Fort Worth JRB 1-2
1-2 AOC 20 Site Inspection Area and Data Gap Investigation Area at AOC 2 1-3
3-1 Seismic, Electrical Imaging Lines and New Soil Boring and Monitoring Well Locations 3-3
3-2 Electrical Imaging Profiles 3-5
3-3 Bedrock Elevation Contours Based on Soil Boring Data 3-9
3-4 Bedrock Elevation Contours Based on Soil Boring Data and Seismic Data 3-11
3-5 Groundwater Elevation Contours 3-13
3-6 Distribution of Tetrachloroethene (PCE) in Groundwater 3-19

TABLE OF CONTENTS (cont.)

Figures (cont.)

3-7 Distribution of Trichloroethene (TCE) in Groundwater 3-21
3-8 Distribution of Cis-1,2-Dichlorothene (DCE) in Groundwater 3-23
3-9 Oxidation-Reduction Potential in Groundwater 3-25

Tables

3-1 Summary of Groundwater Detections 3-15
4-1 Conceptual Site Model of AOC 20 4-1
4-2 Conceptual Site Model of AOC 2 4-1

ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
µg/L	micrograms per liter
AFCEE	Air Force Center for Environmental Excellence
AFP 4	Air Force Plant 4
AOC	area of concern
B	Indicates that an analyte is present in the method blank as well as in the sample
$CaCO_3$	Calcium carbonate
CL	control limit
Cl	chloride
CSM	Conceptual Site Model
DCE	cis-1,2-dichloroethene
EI	electrical imaging
ERPIMS	Environmental Restoration Program Information Management System
ITIR	Informal Technical Information Report
J	Indicates that a value for an organic analysis is an estimate.
LOC ID	Location Identification
mg/L	milligrams per liter
mS/cm	microSiemens per centimeter
mV	millivolt
N	nitrogen
NA	Not Analyzed/Measured
NAS FW JRB	Naval Air Station Fort Worth Joint Reserve Base
NTU	nephelometric turbidity unit
ORP	oxidation-reduction potential
PCE	tetrachloroethene
R	Indicates validity of data rejected
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation

ACRONYMS AND ABBREVIATIONS (cont.)

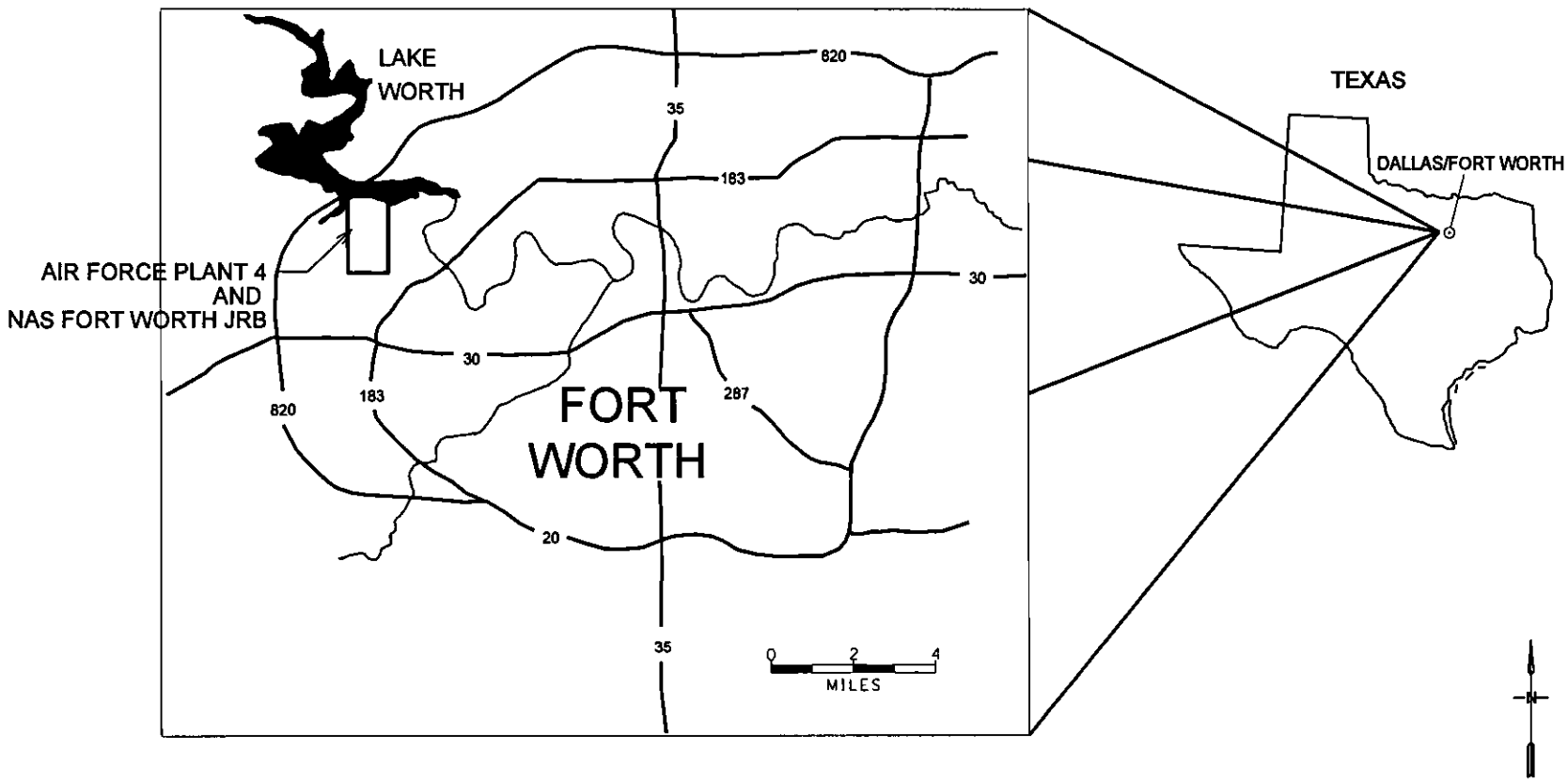
SAIC	Science Applications International Corporation
SI	Site Inspection
SO_4	sulfate
TCE	trichloroethene
TNRCC	Texas Natural Resource Conservation Commission
TOC	total organic carbon
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
V	Indicates carry over suspected
VC	vinyl chloride

1. INTRODUCTION

This Informal Technical Information Report (ITIR) presents the findings of the Phase II Site Inspection (SI) at Area of Concern (AOC) 20 under the Statement of Work dated 30 January 2001, Contract No. F41624-00-D-8030, Delivery Order 0018 for Naval Air Station Fort Worth Joint Reserve Base (NAS FW JRB), Fort Worth, Texas. This ITIR summarizes the work performed according to the Final *Phase II Site Inspection at AOC 20 and Data Gaps Investigation at AOC 2* Work Plan Addendum (United States Air Force [USAF 2001]). It presents updated conceptual models of AOCs 20 and 2, and preliminary major channel delineation results to support future decision-making activities.

The AOC 20 study area extends from Air Force Plant 4 (AFP 4) in the north to the Base Realignment and Closure boundary in the south at NAS FW JRB and includes the AOC 20 Phase II SI North Plot, the AOC 20 Phase I SI Area, and the AOC 20 Phase II SI South Plot (Figures 1-1 and 1-2). The Phase II SI at AOC 20 included performance of a geophysical survey with the objective of delineating the gravel channels (paleochannels) in the Walnut/Goodland bedrock confining layer and determining the preferential pathways for groundwater and the trichloroethene (TCE) plume between AFP 4 and NAS FW JRB.

The AOC 2 study area consists of the north lobe of the TCE plume at AOC 2. A geophysical survey was performed to delineate the paleochannels in the confining layer and determine preferential groundwater pathways. Additional data was collected to determine the source of high concentrations of tetrachloroethene (PCE) in an area distant from any known AFP 4 PCE sources. Fieldwork was also conducted to address data gaps in the Resource Conservation Recovery Act (RCRA) Facility Investigation (RFI) for AOC 2 (USAF 2000) identified by the United States Environmental Protection Agency (USEPA).



Drawn by: CJJ	Date: 5 Oct 00	Figure 1-1	
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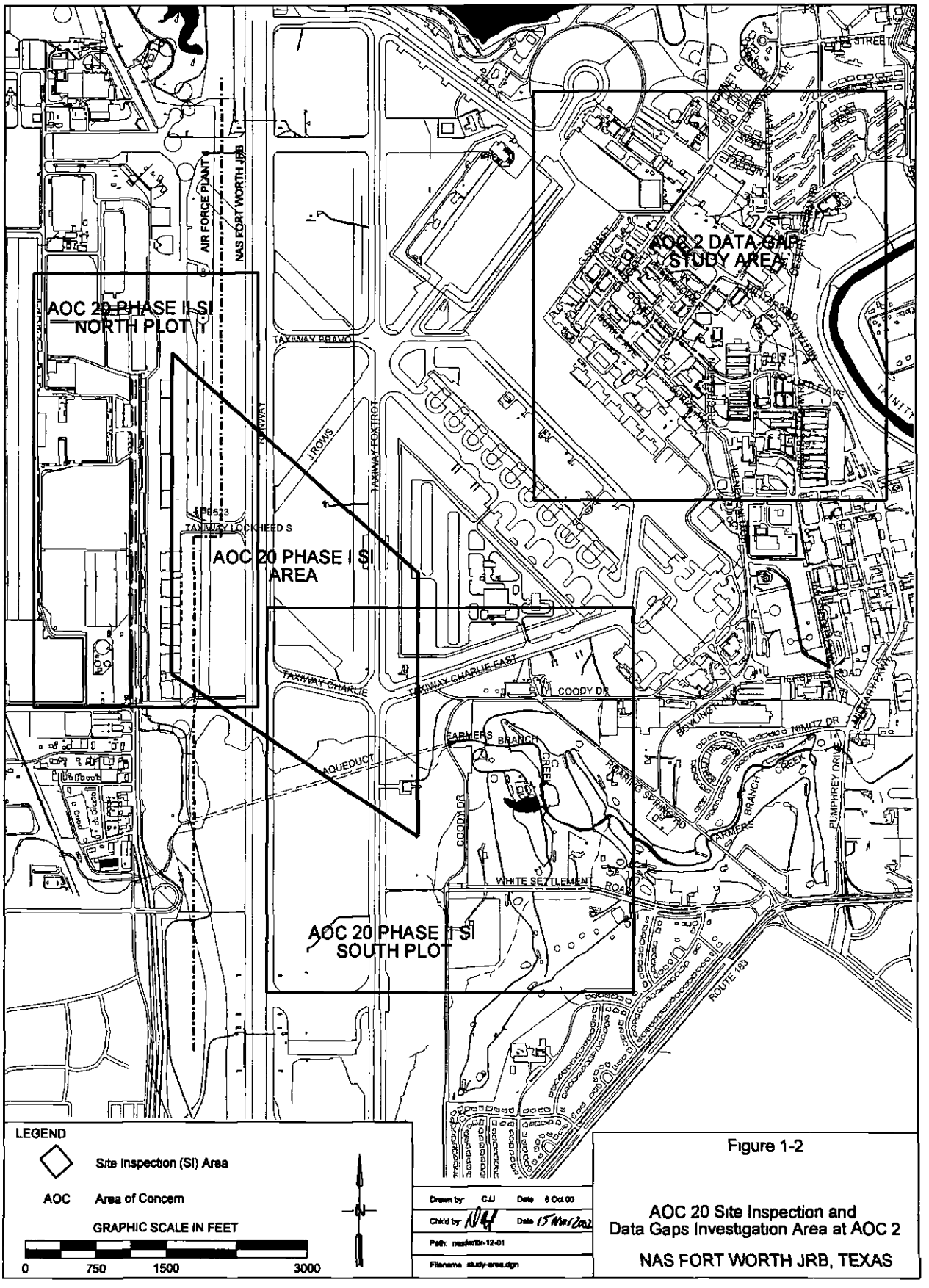

Figure 1-2

AOC 20 Site Inspection and Data Gaps Investigation Area at AOC 2

NAS FORT WORTH JRB, TEXAS

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2. FIELD INVESTIGATION

2.1 FIELDWORK OBJECTIVES

The objectives of the fieldwork at AOC 20 were as follows:

- Map the subsurface topography of the paleochannel (the surface of the Goodland/Walnut Aquitard).
- Map the distribution of the gravelly deposits in the paleochannel.
- Map the groundwater plume pathway.
- Refine the conceptual site model.

The objectives of the fieldwork at AOC 2 were as follows:

- Map the subsurface topography of the paleochannel (the surface of the Goodland/Walnut Aquitard).
- Map the distribution of the gravelly deposits in the paleochannel.
- Map the groundwater plume pathway.
- Confirm the presence and identify potential sources of PCE in groundwater.
- Address data gaps in the RFI for AOC 2 identified by the USEPA.
- Refine the conceptual site model.

The following sections summarize the tasks completed and the procedures followed during the performance of field activities in order to obtain the necessary information to meet the objectives listed above.

2.2 SUMMARY OF FIELD ACTIVITIES

Fieldwork was conducted in two phases. Phase I fieldwork included a seismic reflection survey that determined aquitard topography and an electrical imaging (EI) survey that mapped the Terrace Alluvium deposits. Phase II fieldwork involved the installation of soil borings and groundwater monitoring wells to confirm the results of the geophysical surveys and to collect soil and groundwater samples. Fieldwork consisted of the following:

- A seismic survey (see Figure 3-1).
- A seismic velocity survey.
- An EI survey (Figure 3-1).

- Installation of nine soil borings (Environmental Restoration Program Information Management System [ERPIMS] location identification numbers [LOC ID] BSAICTA009, BSAICTA011, BSAICTA012, BSAICTA013, BSAICTA018, BSAICTA019, BSAICTA020, BSAICTA022, and BSAICTA024).

- Installation of 11 groundwater monitoring wells (LOC IDs WSAICTA007, WSAICTA008, WSAICTA010, WSAICTA014, WSAICTA015, WSAICTA016, WSAICTA017, WSAICTA021, WSAICTA023, WSAICTA025, and WSAICTA026).

- Collection of 20 soil samples (one sample from each soil boring and groundwater monitoring well).

- A visual inspection at the west bank of the West Fork Trinity River to identify and locate any groundwater seeps in the area downgradient of AOC 2.

- Installation of two staff gauges at the west bank of the West Fork Trinity River.

- Collection of 37 groundwater samples.

- Collection of eight surface water samples (six seep samples and two river staff gauge samples).

- A geographical survey of geophysical line end point/intersect, soil boring, and groundwater monitoring well locations.

Locations of seismic shot points, EI electrodes, new soil borings, and new groundwater monitoring wells are presented in Figure 3-1.

3. FIELD INVESIGATION RESULTS AND DISCUSSION

The results of the AOC 20 SI and AOC 2 data gap investigation have been integrated. Site-specific objectives will be mentioned as appropriate.

3.1 FIELD INVESTIGATION RESULTS

3.1.1 Geophysical Surveys

An electrical imaging survey was conducted to map the subsurface heterogeneity and a seismic survey was conducted to map the bedrock elevation. The EI survey was conducted at AOC 20 only. The seismic survey included both study areas. Figure 3-1 presents survey locations (including Phase I surveys and previous surveys in the study area), as well as the field point locations where data were collected. These data points include soil borings, monitoring wells, and seep and river water sampling locations. Data processing procedures for the EI survey are included in this section. Seismic data processing procedures follow in Section 3.1.2.

This ITIR includes an evaluation of both Phase I and Phase II SI data. Geophysical data were integrated with soil boring data to generate an EI profile. Details of the EI data simulation will be presented in a separate report that will be attached to the final SI report.

The EI results are presented on Figure 3-2. The final EI profiles are presented as series of profiles on a base map. Different colors in the profiles represent resistivity changes. These color changes loosely correlate to different lithology. Theoretically, limestone in the bedrock exhibits a higher resistivity than shale, and sandy and gravelly alluvium will have higher resistivity than clay and silt. The following is a summary of the survey (from west to east):

- Line EI-7 intersected two channels. The northern channel is located between soil boring RSB-10 and monitoring well HM-99, and the southern channel is centered around monitoring well WJETA050. Resistivity in the southern channel is higher than resistivity in the northern channel, suggesting that the southern channel may contain more gravel than the northern channel.

- Some data on Line EI-1 was lost due to the concrete cover of the taxiway. The only useable data were located within the southern channel.

- Data from line EI-2 is unexpected because the natural break in resistivity in the middle section of the line appears shallow (around 10 feet below ground surface) while the depth to bedrock is deep (approximately 35 to 40 feet below ground surface). One explanation for this result is a lack of contrast in resistivity between the bedrock and the overlying alluvium in direct contact with the bedrock.

- Lines EI-3 (southern portion), EI-4, (entire line), EI-6, (southern half), and EI-5 (entire line) indicate irregular resistivity patterns. A review of historical data from the area suggests that a series of activities may have altered the subsurface composition significantly, resulting in the presence of significant amounts of non-native materials (fill). These activities may have included conversion of Farmers Branch Creek into the Aqueduct, fill activities associated with Landfill 3, Landfill 5, Landfill 7, and Landfill 8, and waste dumping in the low-lying areas along the banks of the former Farmers Branch Creek.

3.1.2 Aquitard Topography

The aquitard was mapped using two techniques: using only soil boring data, and incorporating soil boring data with seismic survey data in selected areas.

Data processing included compilation of soil boring data from the entire TCE plume region, including AFP 4 and NAS FW JRB. Soil boring data were obtained from the following sources:

- The AFP 4 ERPIMS database (maintained by the Air Force Center for Environmental Excellence [AFCEE]).
- The NAS FW JRB ERPIMS database (maintained by the AFCEE).
- The AFP 4 and NAS FW JRB ERPIMS database (maintained by the United States Geological Survey for the Aeronautical Systems Center.
- The unofficial and partial ERPIMS database formerly used by Parsons Engineering-Science.
- Data obtained from HydroGeoLogic, Incorporated, including a partial ERPIMS-style database, soil borings logs, interpreted datasheets, and recently installed cone-penetrometer interpretations.
- Soil boring logs from existing soil borings completed during other investigations.
- Soil boring logs from new soil borings installed during this investigation.

The bedrock (or aquitard) surface is defined as the top of the Goodland or Walnut Formation, and, in rare cases, the Paluxy Formation. The distinction is not always made clear on soil boring logs whether the bedrock was Goodland or Walnut, or whether bedrock was encountered during drilling. The following methods were used to identify the aquitard surface:

1. Initial screening of all soil boring logs in the database that contained descriptive terms such as shale, limestone, marl, or various combinations. These were assumed members of Goodland or Walnut Formations.

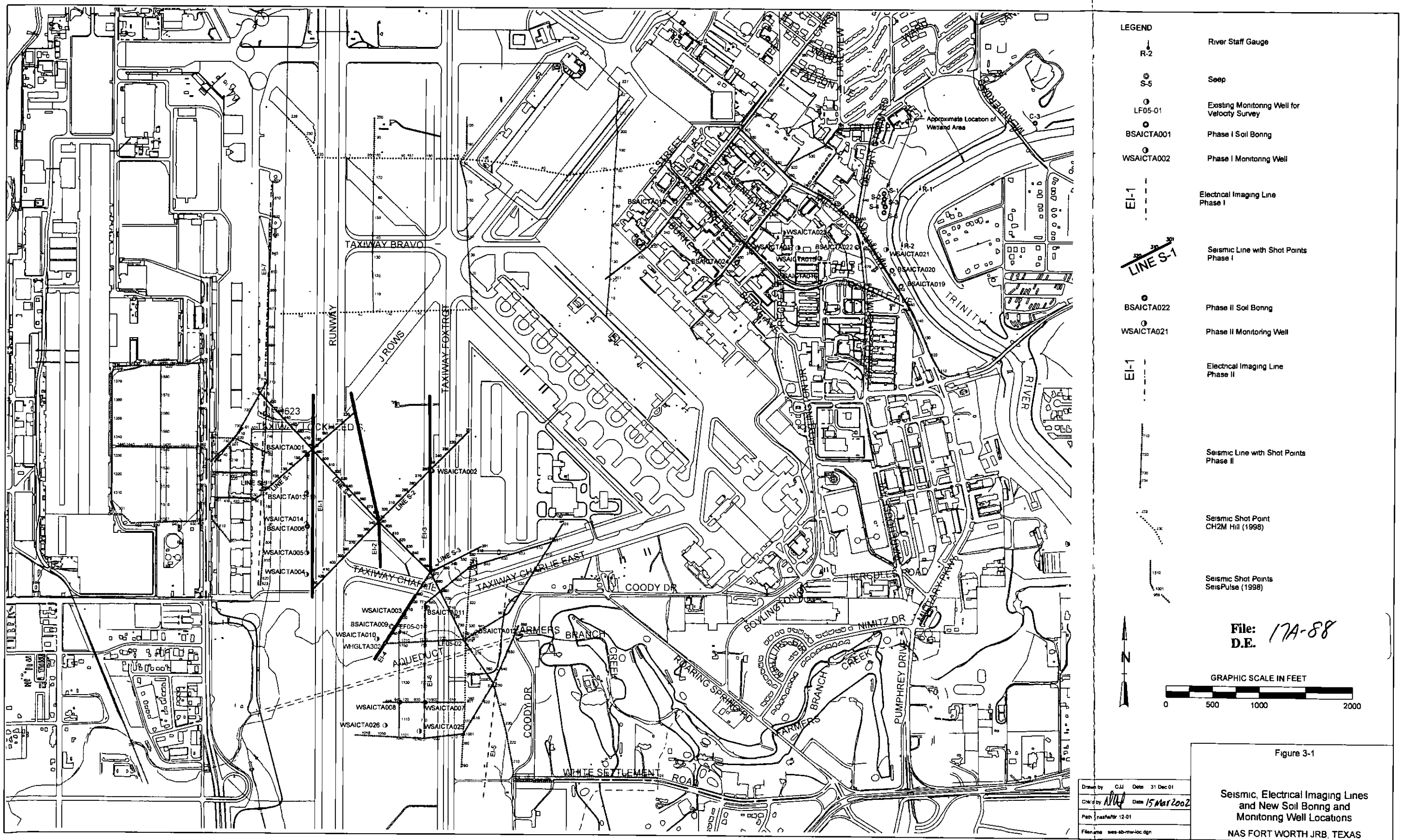

Figure 3-1

Seismic, Electrical Imaging Lines and New Soil Boring and Monitoring Well Locations

NAS FORT WORTH JRB, TEXAS

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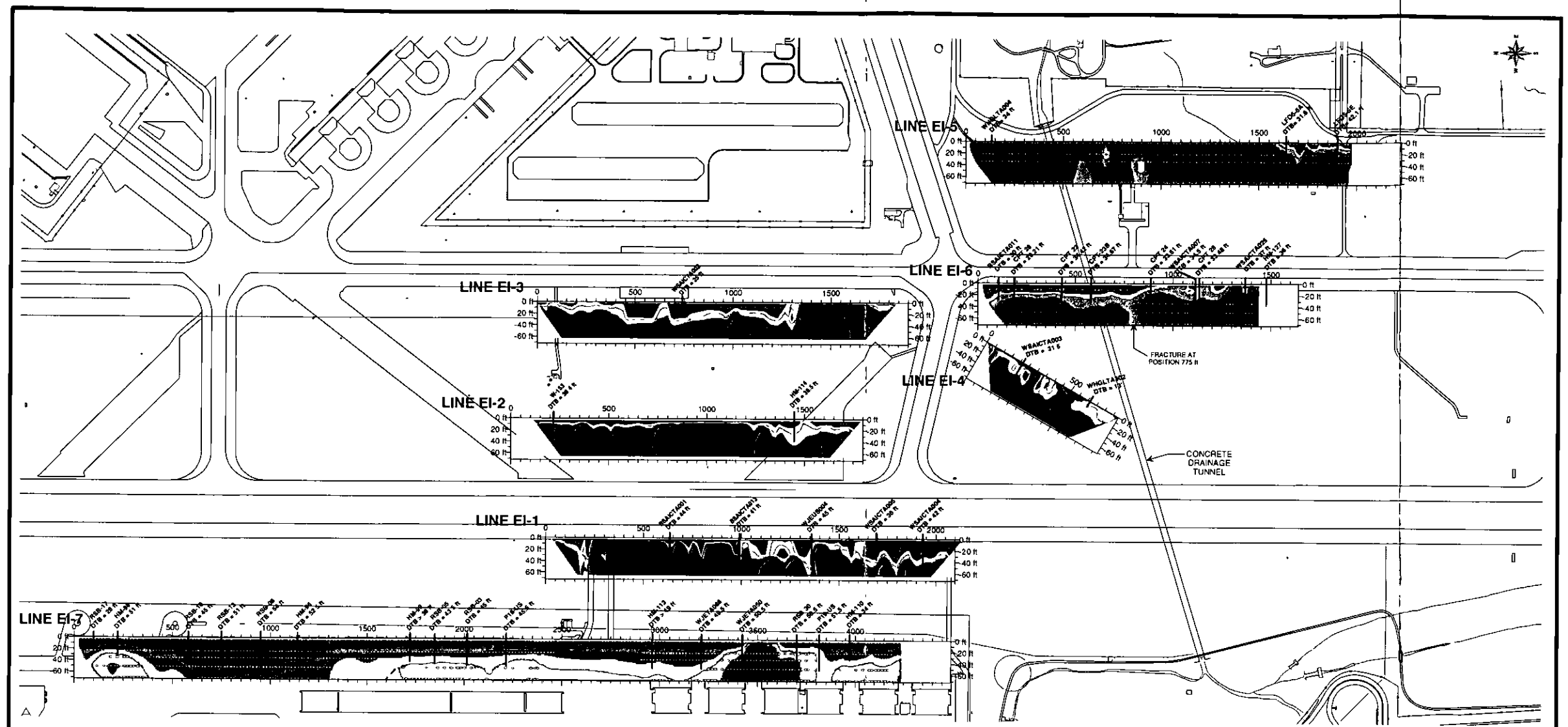
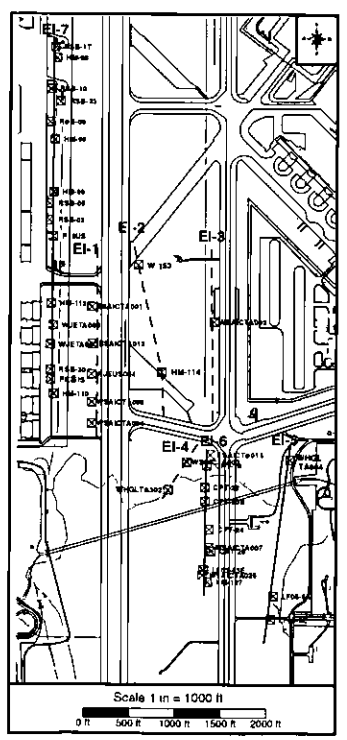


SITE DIAGRAM



Legend

- 60 Ohm-m
- 48 Ohm-m
- 34 Ohm-m
- 26 Ohm-m
- 22 Ohm-m
- 18 Ohm-m
- 14 Ohm-m
- 0 Ohm-m

——— RESISTIVITY SURVEY LINE (MAY 2001)

- - - - RESISTIVITY SURVEY LINE (OCTOBER 2000)

Notes

ROLL ALONG RESISTIVITY SURVEYS CONDUCTED OCTOBER 23-27, 2000 USING STING RESISTIVITY METER WITH 6-METER SPACING AND MAY 9 13, 2001 USING ARS-200 RESISTIVITY METER USING 5 METER SPACING

DTB = APPROXIMATE DEPTH TO BEDROCK (FROM SAIC, MAY 2001)

RESISTIVITY PROFILE HORIZONTAL SCALE 1 in = 300 ft, VERTICAL SCALE 1 in = 100 ft, VERTICAL EXAGGERATION = 3x

RESISTIVITY SURVEY LOCATIONS FROM DELORME EARTHMATE GPS RECEIVER

WELLS ADDED TO SURVEY LINES 12/14/01 INCLUDE BSAICTA013 (EI 1), BSAICTA011 (EI 6), WSAICTA007 (EI 6) AND WSAICTA025 (EI-6)

0 ft 200 ft 400 ft 600 ft 800 ft 1000 ft

File: 17A-88
D.E.

The Hutchinson Group, Ltd

DES	LSB	5/25/01	PROJECT
DRN	LSB	5/25/01	Ft. Worth Naval Air Station Joint Reserve Base
CHK	PJH	6/4/01	
REV	LSB	12/14/01	
PROJ MGR	PJH	12/31/01	
SCALE			SHEET TITLE
SOURCE BASE MAP FROM SAIC MAY 4 2001			Figure 3-2 Electrical Imaging Profiles

SAIC
Channel Delineation Study

DRAWING NO
DWG2255P1

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2. Review of all soil boring logs to determine the top of bedrock, including logs terminated by auger refusal with the notation indicating that bedrock was encountered.

3. The contour of the top of the bedrock and evaluation of the contour pattern. At three existing well/soil boring locations (GMI-22-5W, LF03-03E, and WHGLTA302), new soil borings or monitoring wells were installed to verify depth to bedrock discrepancies between adjacent borings. Confirmation appears to suggest that the depths to bedrock indicated on the boring logs for BHGLTA319, BHGLTA320, LF03-03E, and WHGLTA302 were inaccurate (too shallow) and therefore, were not used.

4. Two additional artificial data sets were considered after the evaluation of soil boring data. Selected contour lines representing bedrock elevation were digitized from a bedrock elevation model developed by Parsons Engineering-Science (Parsons 1998). These contour lines were located along the Trinity River to the east, Meandering Road Creek to the west, and the shore of Lake Worth to the north. During field observations, a cliff was noted along parts of the Farmers Branch Creek where bedrock was exposed. Therefore, some interpolated data points were included in the contour lines to express the cliff. Although these two pieces of information were not based on surveyed field data (and therefore subject to error), the apparent trend may be useful data.

5. The final soil boring data set was used to generate Figure 3-3, which depicts bedrock elevation contours based on soil boring log data.

6. Based on Figure 3-3, seismic data were integrated with soil boring data and an additional contour map of bedrock elevations was created (Figure 3-4). The seismic data used to generate Figure 3-4 included data from the Phase I and Phase II SI investigations, a former survey in the window area (SeisPulse 1998), and the AOC 2 RFI (CH2M Hill 2000). All the seismic surveys were performed by SeisPulse Inc., and all previously collected seismic data were reprocessed to conform to the new data network. However Lines 1 and 5 of CH2M Hill's 2000 data could not be tied to the new data, because the acquisition processes varied. For the time being, all CH2M Hill data were omitted. In the east parking lot of AFP 4, some of the soil borings (8A98 and 8A99 on seismic shot points 930 through 950, F-219, HM-57, SB-054, and SB-055 from shot points 1301 through 1350) indicated bedrock at depths less than 5 feet below ground surface, although the seismic survey predicted depths to bedrock greater than 20 to 30 feet below ground surface. Although the seismic reflector in these areas indicated coherent data profiles, the seismic data on portions of Line 9 and Line 13 were omitted in deference to soil boring data. A separate seismic survey report including details of the seismic data processing and interpretation process will be included in the final AOC 20 Phase II SI report.

3.1.3 Groundwater Elevation Contour

During this investigation, water levels were obtained only from sampled wells. These data were not adequate to contour the water table. Several areas of the aquifer may be under unique hydraulic conditions, which should be re-evaluated in order to develop a more accurate conceptual site model (CSM). For this purpose, water levels obtained from the July 2000 basewide (NAS FW JRB only) groundwater sampling event were used to map the groundwater elevation contour. In addition, the following were considered:

1. Water level measurements from wells installed by Science Applications International Corporation (SAIC) were not included in the basewide survey, therefore, some water level measurements from this investigation were used to fill the data gap.

2. It is assumed that the surface water and groundwater are connected together in a system at NAS FW JRB, therefore water elevations measured at seeps S-1 through S-5 and at the Trinity River (R-1 and R-2) were used.

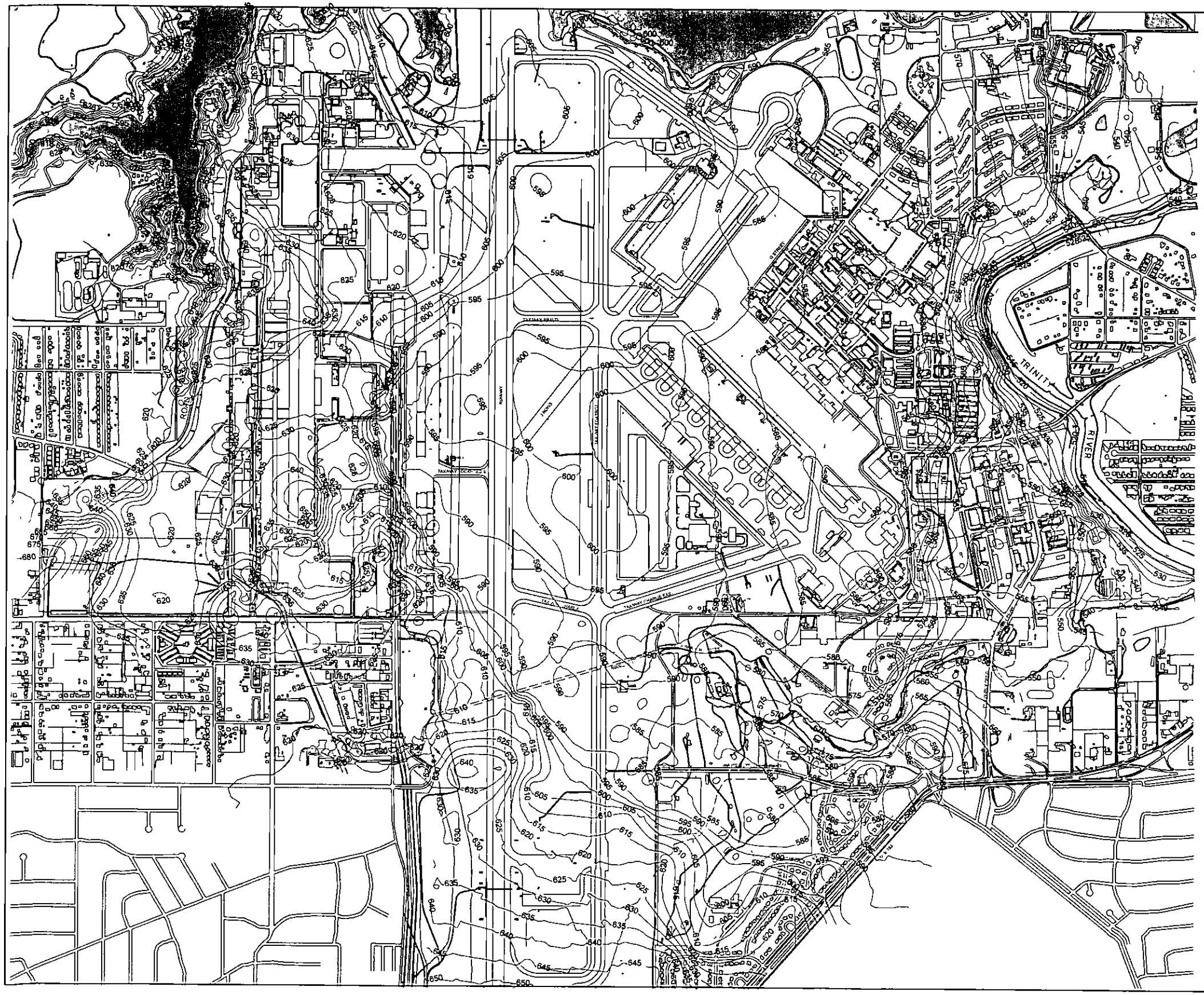
3. In addition, water levels along other portions of the Trinity River, Farmers Branch Creek, the unnamed tributary that feeds into Farmers Branch Creek, and the Aqueduct were extrapolated. Water level contours in these areas are represented by dash lines to indicate extrapolated data.

The resulting groundwater contours and flow direction are presented in Figure 3-5.

3.1.4 Groundwater Plume Geometry Finalization

During this phase of the investigation, groundwater samples were collected from both new and existing monitoring wells. Surface water samples were collected from seeps and the Trinity River. A summary of groundwater analytical results collected during this investigation is presented in Table 3-1.

A representative concentration for each analyte of concern was selected for each monitoring well. Data from this investigation was combined with representative concentrations generated for the Phase I SI report (SAIC 2001), which originated from multiple sources generated in 2000 and 2001. In the case of more than one concentration, the higher value was selected (will result in a more conservative result). To illustrate groundwater contamination and geochemical conditions, four groundwater plume maps were created: the distribution of PCE in groundwater, distribution of TCE in groundwater, distribution of cis-1,2-dichloroethene (DCE) in groundwater, and oxidation-reduction potential in groundwater (Figures 3-6 through 3-9).



LEGEND

600 Line with Bedrock Elevation (Feet Above Mean Sea Level)

N

GRAPHIC SCALE IN FEET

0 700 1400 2800

Drawn by: CJJ Date 7 Jan 02	Figure 3-3
Chkd by: NHJ Date 15 Mar 2002	Bedrock Elevation Contours Based on Soil Boring Data
Path: nasf-ftn-12-01	
Filename: bedrock-sb-1.dgn	NAS FORT WORTH JRB, TEXAS

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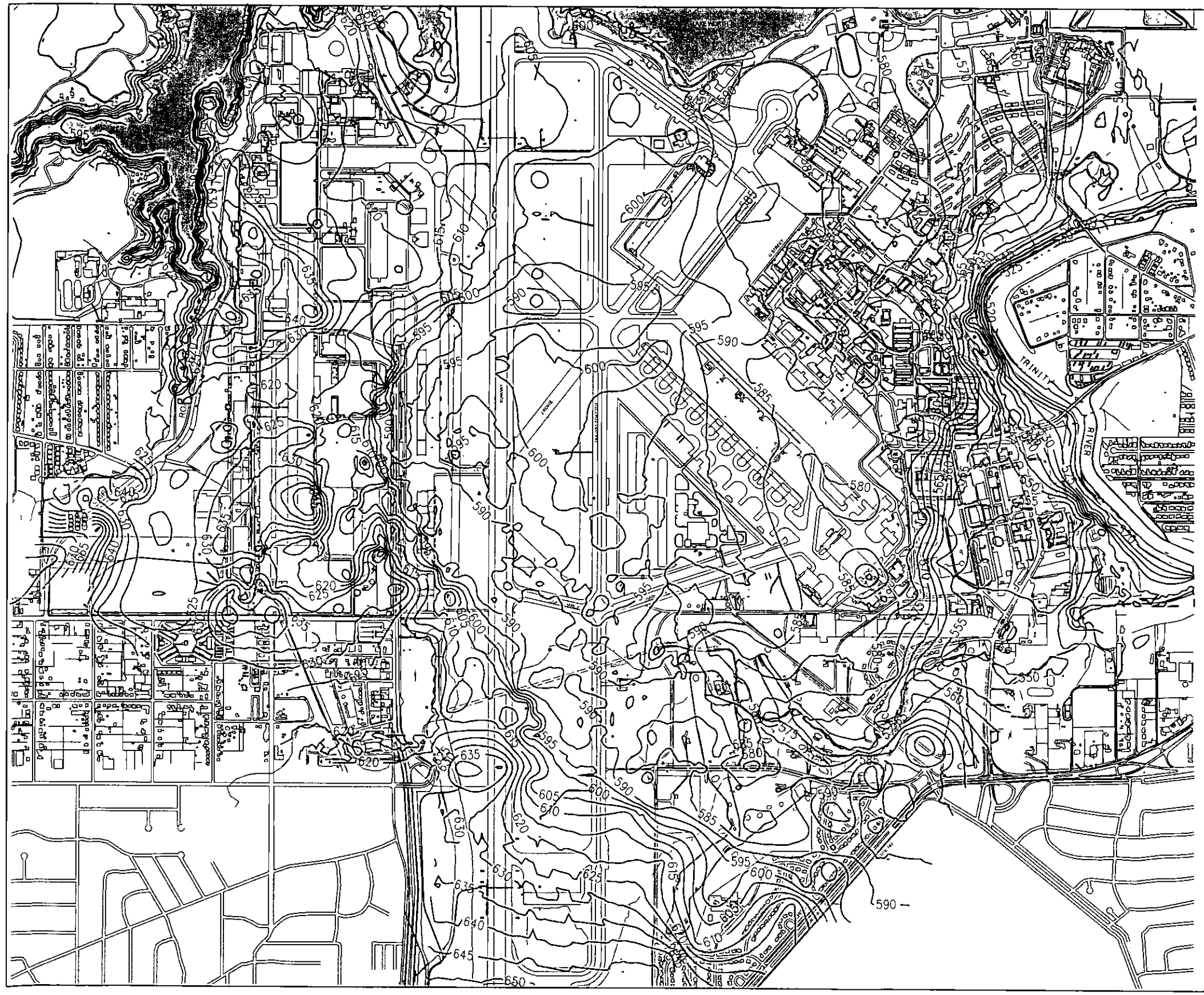

LEGEND

600 Bedrock Elevation Contours

N

GRAPHIC SCALE IN FEET

0 700 1400 2800

Drawn by CJJ Date 7 Jan 02	Figure 3-4
Chk'd by NWD Date 15 Mar 2002	Bedrock Elevation Contours Based on Soil Boring Data and Seismic Data
Path nasf-ttr 12-01	NAS FORT WORTH JRB, TEXAS
Filename bedrock sb-seis-1.dgn	

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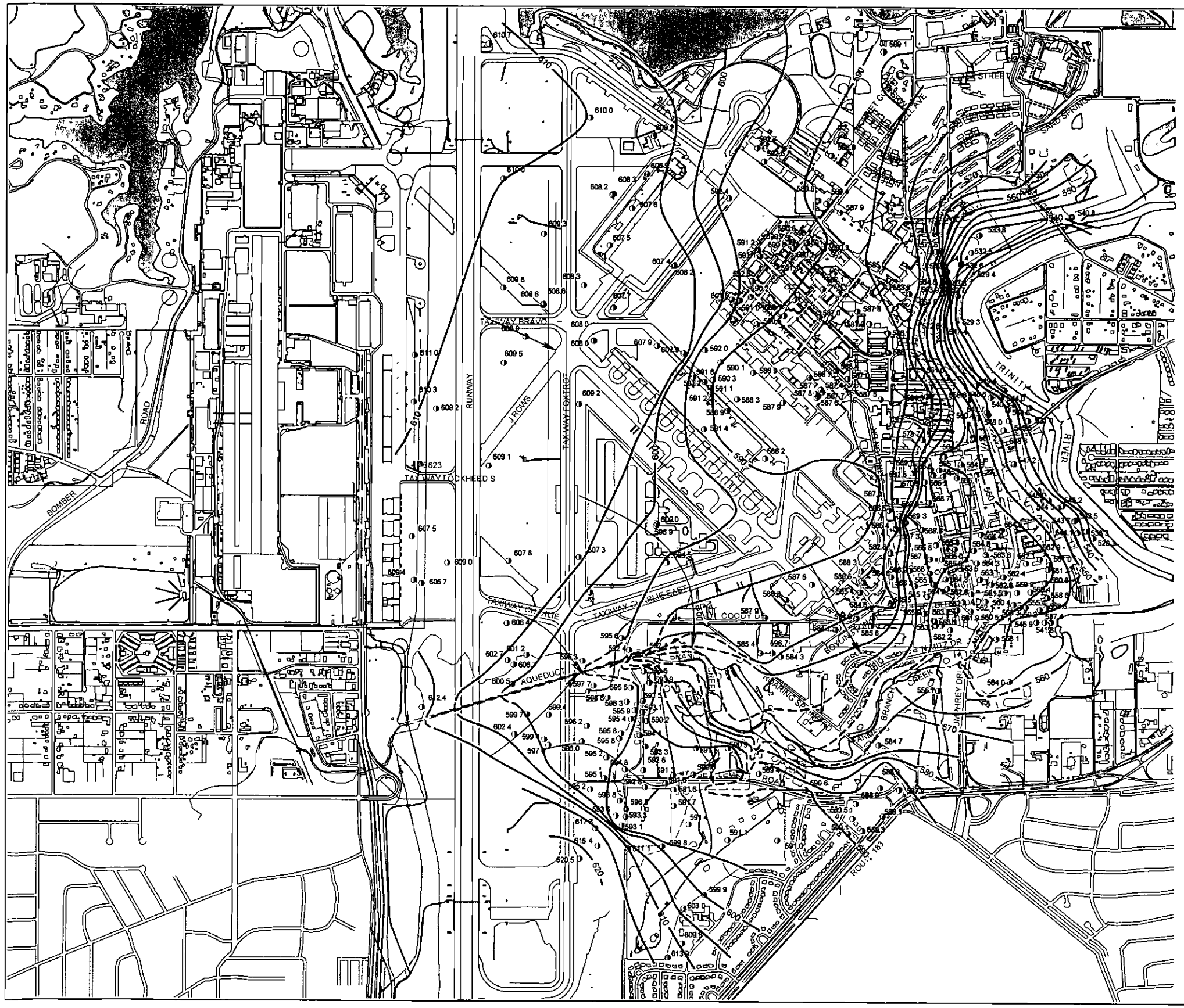

LEGEND

River Staff Gauge

Seep

600 Potentiometric Surface Contour Line

600 Estimated Potentiometric Surface Contour Line

564 5 Groundwater Elevation

Monitoring Well

General Direction of Groundwater Flow

Primary Data Sources October 2000

N

GRAPHIC SCALE IN FEET

0 700 1400 2800

File: 17A-88
D.E.

Drawn by	CJJ	Date	31 Oct 01
Chk'd by	NH	Date	15 Mar 2002
Path	nasf-ttr-12-01		
Filename	potentio-10-01a dgn		

Figure 3-5

Groundwater Elevation Contours

NAS FORT WORTH JRB, TEXAS

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Table 3-1
Summary of Groundwater Detections

Sample Number	C3-01	GMI-22-06M-01	HM-123-01	HM-127-01	HM-96-01	HM-99-01	MW-12-01	MW-19-01	MW-7-01	R-1-01	R-2-01	S-1-01	S-2-01	S-3-01	S-4-01	S-5-01
Sample Location	C3	GMI-22-06M	HM-123	HM-127	HM-96	HM-99	MW-12	MW-19	MW-7	R-1	R-2	S-1	S-2	S-3	S-4	S-5
Chain of Custody Number	S01517	S01417	S01519	S01519	S01518	S01518	S01416	S01416	S01416	S01517	S01517	S01419	S01419	S01419	S01419	S01419
Sample Date	25-Sep-01	23-Aug-01	27-Sep-01	27-Sep-01	26-Sep-01	26-Sep-01	22-Aug-01	22-Aug-01	22-Aug-01	25-Sep-01	25-Sep-01	06-Sep-01	06-Sep-01	06-Sep-01	06-Sep-01	06-Sep-01
Organics (µg/L)																
1,1,1-trichlorethane	<0.0511	<0 169	**0.0759J**	<0.0511	<0.0438	<0.0438	<0 0438	<0 0438	<0 0438	<0.0511	<0 0511	<0.0438	<0.0438	<0 0438	<0.0438	<0.0438
1,1-dichloroethane	<0.0445	<0 124	**0.561**	<0.0445	**0.498J**	**0.467J**	<0.0465	<0 0465	<0 0465	<0.0445	<0 0445	<0 0465	<0.0465	<0 0465	<0.0465	<0.0465
1,1-dichloroethene	<0.0492	**0.298J**	**1.01**	<0.0492	**3.85**	**0.625**	<0.116	**0.646**	<0 116	<0 0492	<0.0492	<0.116	<0 116	<0 116	<0 116	<0 116
1,4-dichlorobenzene	<0 0495	<0 15	<0 0495	<0 0495	<0.0667	<0.0667	<0.0667	<0 0667	<0.0667	<0.0495	<0.0495	<0.0667	<0.0667	<0.0667	<0 0667	<0 0667
benzene	<0.0465	<0.0641	**0.0825J**	<0 0465	**0.0449J**	<0 0401	<0.0401	<0.0401	<0.0401	<0 0465	<0 0465	<0 0401	<0.0401	<0.0401	<0 0401	<0 0401
bromodichloromethane	<0 0528	<0.118	<0.0528	<0 0528	**0.242J**	<0 0747	<0.0747	<0.0747	<0 0747	<0 0528	<0.0528	<0 0747	<0.0747	<0.0747	<0.0747	<0.0747
chlorobenzene	<0 0404	<0.0842	<0.0404	<0.0404	<0 0712	<0 0712	<0 0712	<0 0712	<0 0712	<0 0404	<0.0404	<0 0712	<0.0712	<0.0712	<0 0712	<0.0712
chloroform	<0.0338	<0 0896	**0.343J**	<0.0338	**1.3**	**0.257J**	<0.111	**0.298J**	<0 111	<0.0338	<0 0338	<0.111	<0.111	<0.111	<0 111	<0.111
cis-1,2-dichloroethene	<0 0353	**64.9**	**317**	**2.4**	**25.6**	**10.9**	<0 0883	**41.9**	<0.0883	<0.0353	**0.143J**	<0 0883	<0.0883	<0 0883	<0 0883	<0 0883
methylene chloride	<0 021	<0 126	<0.021	<0.021	<0 054	<0 054	<0.054	<0 054	<0 054	**0.0857J**	<0 021	<0 054	<0 054	<0.054	<0.054	<0.054
styrene	<0.0295	<0 0977	<0 0295	<0.0295	<0.0362	<0 0362	<0 0362	<0 0362	<0 0362	<0 0295	<0.0295	<0.0362	<0.0362	<0 0362	<0 0362	**0.123J**
tert-butyl methyl ether	<0 0619	<0 116	<0.0619	<0 0619	<0.0856	**0.39J**	<0.0856	**0.31J**	<0.0856	<0 0619	<0 0619	<0 0856	<0 0856	<0 0856	<0 0856	<0.0856
tetrachloroethene (PCE)	<0 103	<0 144	**0.142J**	<0.103	**26.5**	**2.71**	<0.228	**0.258J**	<0.228	<0 103	<0.103	<0.228	<0.228	<0.228	<0.228	<0 228
toluene	**0.0718J**	<0 0637	<0 0236	<0.0236	<0.057	<0 057	<0.057	**0.174J**	<0 057	<0 0236	<0 0236	<0 057	<0 057	<0.057	<0 057	<0 057
trans-1,2-dichloroethene	<0 043	**44.4**	**7.74**	**0.0857J**	**1.1**	**0.91**	<0 074	**1.72**	<0.074	<0 043	<0 043	<0 074	<0.074	<0.074	<0.074	<0.074
trichloroethene (TCE)	**0.408JV**	**104**	**978**	**14.9**	**296**	**99.2**	**0.397J**	**156**	**0.172J**	**0.106JV**	**0.146J**	<0 0648	<0 0648	<0 0648	<0.0648	<0.0648
trichlorofluoromethane	<0 0495	<0 106	<0.0495	<0.0495	<0 12	**0.554J**	<0 12	<0.12	<0 12	<0 0495	<0.0495	<0.12	<0 12	<0.12	<0 12	<0.12
Vinyl Chloride	<0 0501	**1.88**	**0.825**	<0 0501	<0.0744	<0 0744	<0 0744	<0 0744	<0 0744	<0 0501	<0.0501	<0 0744	<0 0744	<0.0744	<0.0744	<0.0744
Metals																
arsenic (mg/L)	<0.0026	<0.0026	<0 0017	<0 0017	<0 0026	<0 0026	<0.0017	<0.0017	<0.0017	<0 0026	**0.00293**	<0.0026	<0.0026	<0.0026	<0 0026	<0.0026
Natural Attenuation Parameters																
TOC (mg/L)	**3.36**	**4.53**	**2.36B**	**1.5B**	**1.77**	**3.95**	**1.88**	**0.587**	**1.38**	**3.99**	**3.52**	**2.69B**	**2.65B**	**2.79B**	**2.46B**	**2.63B**
dissolved oxygen (mg/L)*	NA	1 25	1 02	4 58	1 10	2 55	1.12	3 35	4 45	NA	NA	NA	NA	NA	NA	NA
ethene (µg/L)	<0 073	<0.073	<0 073	<0.074	<0 074	<0 073	<0 073	<0 075	<0.073	<0 072	<0 074	<0.073	<0.073	<0.072	<0 073	<0.074
ethane (µg/L)	<0 0782	**1.34**	**0.132**	<0.0795	<0 0793	**0.168**	<0.0787	<0 0799	<0.0782	<0.0776	<0 0797	<0 0782	<0.0787	<0.0774	<0 0782	<0 0793
methane (µg/L)	**14.1B**	**4.37B**	**102B**	**0.332B**	**0.314B**	**1.31B**	**0.483B**	**0.331B**	**0.314B**	**14.9B**	**20.5B**	**11.6B**	**11.9B**	**29.2B**	**9.44B**	**21.3B**
alkalinity, total (as $CaCO_3$) (mg/L)	**208B**	**440B**	NA	NA	**335B**	**324B**	**334B**	**300B**	**279B**	**179B**	**187B**	**238B**	**269B**	**272B**	**277B**	**317B**
chloride (as Cl) (mg/L)	**52**	**90.8**	**18.1**	**8.94**	**39.7**	**27.2**	**47.5B**	**22.1B**	**34.5B**	**43.1**	**45.1**	**57.4**	**73.7**	**84.6**	**79**	**77.9**
nitrate (as nitrous oxide) (mg/L)	**0.0916J**	**0.773**	**2.94**	**0.774**	**7.82R**	**2.78R**	**4.62**	**3.63**	**7.7**	**0.0507J**	**0.0753J**	**0.29**	**0.15**	**0.0332J**	**0.0303J**	**0.217**
sulfate (as SO_4) (mg/L)	**21.8**	**102**	**66**	**119**	**43.4**	**20**	**98.2**	**15.4**	**124**	**29.8**	**31.7**	**57**	**49.3**	**43.9**	**55.2**	**55.3**
total suspended solids (mg/L)	<3.61	**4J**	<3.61	<3.61	<3.61	**532**	<3 61	**53.6**	<3.61	**12J**	**10.4J**	**37.6**	**8J**	<3.61	**354**	**46**
ferrous iron (mg/L)**	0.02	0 03	0.01	0		0 86	0 01	0.04	0.01	0.19	0 12	0	0.01	0 04	0	0
Other Parameters																
ORP (mV)*	NA	27	196	304	160	109	82	98	80	NA	NA	NA	NA	NA	NA	NA
turbidity (NTU)*	NA	100	0	0	0	999	239	258	230	NA	NA	NA	NA	NA	NA	NA
specific conductivity (mS/cm)*	NA	5.13	0.711	0 748	0.877	0 707	4.29	3 25	3 88	NA	NA	NA	NA	NA	NA	NA
pH*	NA	6.34	6 81	7 00	6 94	6 93	6 24	6 3	6 32	NA	NA	NA	NA	NA	NA	NA
temperature (°C)*	NA	23.93	21.9	20.2	22.4	23.4	22.06	21 43	29 94	NA	NA	NA	NA	NA	NA	NA

Bold typeface indicates detected analyte.
Only analytes with at least one detection are presented
Location WHGL707 was sampled on 20 August 01 and 28 September 01 to track change over time
Sample location WHGLTA702 is a blind duplicate of sample at WHGLTA701
Sample WHGLTA707-02 is a duplicate of sample WHGLTA707-01

Explanation of Data Qualifiers

B Indicates that an analyte is present in the method blank as well as in the sample
J Indicates that a value for an organic analysis is an estimate It is used when a compound is determined to be present at a concentration less than the quantitation limit of the method
R Indicates validity of data rejected
V Indicates carry over suspected.

* Dissolved oxygen, ORP, turbidity, specific conductivity, pH, and temperature were analyzed in the field at the time of sampling using a Horiba U-22 Water Quality Meter
** Ferrous iron was analyzed in the field using Hach Fe^{2+} kit

°C	degrees Celsius	mg/L	milligrams per liter	NTU	nephelometric turbidity units	TCE	trichloroethene
µg/L	micrograms per liter	mS/cm	microSiemens per centimeter	ORP	oxidation-reduction potential	TOC	Total Organic Carbon
<	indicates result less than reporting limit shown	mV	millivolt	PCE	tetrachloroethene		
$CaCO_3$	calcium carbonate	N	nitrogen	SO4	sulfate		
Cl	chloride	NA	Not Analyzed/Measured				

Table 3-1
Summary of Groundwater Detections (cont.)

Sample Number	WCHMHTA004-01	WCHMHTA010-01	WCHMHTA011-01	WHGLTA004-01	WHGLTA052-01	WHGLTA053-01	WHGLTA056-01	WHGLTA303-01	WHGLTA701-01	WHGLTA702-01	WHGLTA707-01
Sample Location	WCHMHTA004	WCHMHTA010	WCHMHTA011	WHGLTA004	WHGLTA052	WHGLTA053	WHGLTA056	WHGLTA303	WHGLTA701	WHGLTA702	WHGLTA707
Chain of Custody Number	S01518	S01518	S01518	S01415	S01272	S01415	S01416	S01416	S01415	S01415	S01520
Sample Date	26-Sep-01	26-Sep-01	26-Sep-01	21-Aug-01	22-May-01	21-Aug-01	22-Aug-01	10-May-00	21-Aug-01	21-Aug-01	28-Sep-01
Organics (µg/L)											
1,1,1-trichlorethane	<0.0438	<0.0876	<0.0438	<0.0438	<0.0438	<0.0438	<0.0438	<0.169	<0.0438	<0.0438	<0.0438
1,1-dichloroethane	<0.0465	<0.093	<0.0465	<0.0465	**0.351J**	<0.0465	<0.0465	<0.124	**0.432J**	**0.432J**	<0.0465
1,1-dichloroethene	**0.21J**	**0.33J**	**0.409J**	**1.22**	**0.857**	<0.116	<0.116	**1.56**	**1.34**	**1.39**	<0.116
1,4-dichlorobenzene	<0.0667	<0.133	<0.0667	<0.0667	<0.0667	<0.0667	**0.42J**	<0.15	<0.0667	<0.0667	<0.0667
benzene	<0.0401	<0.0802	<0.0401	<0.0401	<0.0401	<0.0401	<0.0401	<0.0641	**0.112J**	<0.0401	<0.0401
bromodichloromethane	<0.0747	<0.149	<0.0747	<0.0747	<0.0747	<0.0747	<0.0747	<0.118	**0.356J**	**0.385J**	<0.0747
chlorobenzene	<0.0712	<0.142	<0.0712	<0.0712	<0.0712	<0.0712	<0.0712	<0.0842	<0.0712	<0.0712	<0.0712
chloroform	**0.162J**	**0.7J**	**0.495J**	**0.299J**	**0.269J**	<0.111	<0.111	<0.0896	**1.3**	**1.24**	<0.111
cis-1,2-dichloroethene	**2.2**	**7.31**	**5.22**	**77.9**	**70.5**	**0.272J**	**11.2**	**7.56**	**321**	**300**	**9.95**
methylene chloride	<0.054	<0.108	<0.054	<0.054	<0.054	**0.0724JB**	<0.054	<0.126	**8.87JB**	<0.054	<0.054
styrene	<0.0362	<0.0724	<0.0362	<0.0362	<0.0362	<0.0362	<0.0362	<0.0977	<0.0362	<0.0362	<0.0362
tert-butyl methyl ether	<0.0856	<0.171	<0.0856	<0.0856	**0.379J**	<0.0856	<0.0856	<0.116	<0.0856	<0.0856	**1.05**
tetrachloroethene (PCE)	**1.96**	**3.88**	**5.15**	**0.237J**	**0.508**	<0.228	<0.228	<0.144	<0.228	<0.228	<0.228
toluene	**0.167J**	**0.26J**	**0.197J**	<0.057	<0.057	**0.185J**	<0.057	<0.0637	<0.057	<0.057	<0.057
trans-1,2-dichloroethene	**0.104J**	**0.246J**	**0.262J**	**3.77**	**2.45**	<0.074	**0.485J**	<0.119	**23.6**	**22.9**	**1.26**
trichloroethene (TCE)	**54.4**	**457**	**198**	**493**	**401**	**9.75**	**34.3**	**3.77**	**1020**	**943**	**4.46**
trichlorofluoromethane	<0.12	<0.24	<0.12	<0.12	**0.55J**	<0.12	<0.12	<0.106	<0.12	<0.12	<0.12
Vinyl Chloride	<0.0744	<0.149	<0.0744	<0.0744	<0.0744	<0.0744	<0.0744	**11.7**	**6.93**	**7.13**	**0.757**
Metals											
arsenic (mg/L)	<0.0026	<0.0026	<0.0026	<0.0017	**0.0136J**	<0.0017	<0.0017	**0.00549**	<0.0017	<0.0017	<0.0017
Natural Attenuation Parameters											
TOC (mg/L)	**1.64**	**2.31**	**3.07**	**1.21**	**3.7**	**0.607**	**0.887**	**4.91**	**1.34**	**1.17**	**3.89B**
dissolved oxygen (mg/L)*	4.87	4.4	1.85	1.56	6.61	4.20	2.82	4.15	1.05	1.05	1.83
ethene (µg/L)	<0.073	<0.073	<0.074	<0.073	<0.073	<0.074	<0.074	**0.213J**	<0.074	<0.075	<0.073
ethane (µg/L)	<0.0784	<0.078	<0.0793	<0.0784	<0.0795	<0.0795	<0.0789	**0.540**	<0.0789	<0.0803	<0.0799
methane (µg/L)	**0.33B**	**0.193B**	**3.46B**	**0.306B**	**0.248B**	**0.336B**	**426B**	**72.9J**	**196B**	**167B**	**51.4B**
alkalinity, total (as $CaCO_3$) (mg/L)	**267B**	**316B**	**334B**	**268B**	**340B**	**250B**	**272B**	**429**	**299B**	**299B**	**458B**
chloride (as Cl) (mg/L)	**17.7**	**133**	**125**	**17.3**	**20.7**	**15.5**	**9.36B**	**20.9**	**18.7**	**18.7**	**11.6**
nitrate (as nitrous oxide) (mg/L)	**3.03R**	**13.6**	**8.92R**	**2.96**	**5.07**	**0.69**	**0.404**	<0.0641	**3.01**	**2.99**	**0.0216J**
sulfate (as SO_4) (mg/L)	**28.4**	**50.8**	**49.5**	**20.3**	**22.7**	**40.7**	**65.9**	**101**	**47.1**	**46.7**	**12.5**
total suspended solids (mg/L)	<3.61	<3.61	<3.61	**6.4J**	**1150**	**7J**	**4J**	**1980**	**12.4J**	<3.61	<3.61
ferrous iron (mg/L)**	NA	NA	NA	0.3	0.29	0.02	0.01	0	0	0	0
Other Parameters											
ORP (mV)*	147	211	137	-99	166	-120	96	10	77	77	95
turbidity (NTU)*	0	0	0	137	999	395	725	999	29	29	0
specific conductivity (mS/cm)*	0.610	1.26	1.23	0.724	0.791	0.626	3.24	0.91	0.717	0.717	0.876
pH*	7.13	6.81	6.85	6.51	6.54	6.47	6.28	6.77	6.23	6.23	6.68
temperature (°C)*	21.8	25.2	24.6	23.98	25.0	26.92	25.99	28.5	23.33	23.33	21.7

Bold typeface indicates detected analyte
Only analytes with at least one detection are presented
Location WHGL707 was sampled on 20 August 01 and 28 September 01 to track change over time.
Sample location WHGLTA702 is a blind duplicate of sample at WHGLTA701.
Sample WHGLTA707-02 is a duplicate of sample WHGLTA707-01.

Explanation of Data Qualifiers

B Indicates that an analyte is present in the method blank as well as in the sample
J Indicates that a value for an organic analysis is an estimate It is used when a compound is determined to be present at a concentration less than the quantitation limit of the method
R Indicates validity of data rejected
V Indicates carry over suspected

* Dissolved oxygen, ORP, turbidity, specific conductivity, pH, and temperature were analyzed in the field at the time of sampling using a Horiba U-22 Water Quality Meter
** Ferrous iron was analyzed in the field using Hach Fe^{2+} kit

°C	degrees Celsius	mg/L	milligrams per liter	NTU	nephelometric turbidity units	TCE	trichloroethene
µg/L	micrograms per liter	mS/cm	microSiemens per centimeter	ORP	oxidation-reduction potential	TOC	Total Organic Carbon
<	indicates result less than reporting limit shown	mV	millivolt	PCE	tetrachloroethene		
$CaCO_3$	calcium carbonate	N	nitrogen	SO4	sulfate		
Cl	chloride	NA	Not Analyzed/Measured				

Table 3-1
Summary of Groundwater Detections (cont.)

Sample Number	WHGLTA707-01	WHGLTA707-02	WHGLTA801-01	WITCTA009-01	WITCTA012-01	WITCTA013-01	WITCTA014-01	WITCTA015-1	WITCTA017-01	WITCTA025-01	WSAICTA007-01
Sample Location	WHGLTA707	WHGLTA707-02	WHGLTA801	WITCTA009	WITCTA012	WITCTA013	WITCTA014	WITCTA015	WITCTA017	WITCTA025	WSAICTA007
Chain of Custody Number	S01415	S01520	S01272	S01417	S01417	S01417	S01417	S01417	S01417	S01416	S01519
Sample Date	20-Aug-01	28-Sep-01	22-May-01	23-Aug-01	23-Aug-01	23-Aug-01	23-Aug-01	23-Aug-01	23-Aug-01	22-Aug-01	27-Sep-01
Organics (µg/L)											
1,1,1-trichlorethane	<0.0438	<0.0438	<0.0438	<0 169	<0 169	<0.169	<0 169	<0.169	<0.169	<0 0438	<1 02
1,1-dichloroethane	<0.0465	<0 0465	**0.253J**	<0 124	<0.124	<0.124	<0 124	<0.124	<0.124	<0 0465	<0.89
1,1-dichloroethene	<0.116	<0.116	**0.998**	**0.598**	**0.331J**	<0.122	**0.224J**	**0.305J**	<0.122	**0.243J**	<0 984
1,4-dichlorobenzene	<0.0667	<0.0667	<0 0667	<0 15	<0.15	<0.15	<0 15	<0.15	<0.15	<0.0667	<0.99
benzene	<0.0401	<0.0401	**0.0922J**	<0.0641	<0 0641	<0.0641	<0 0641	<0.0641	<0.0641	<0 0401	<0.93
bromodichloromethane	<0.0747	<0 0747	<0.0747	<0.118	<0.118	<0 118	<0 118	<0.118	<0 118	<0 0747	<1.06
chlorobenzene	<0.0712	<0.0712	<0.0712	<0.0842	<0 0842	<0 0842	<0 0842	<0.0842	<0.0842	<0 0712	<0.808
chloroform	**0.54**	<0.111	<0.111	**0.37J**	<0 0896	**0.278J**	<0.0896	<0.0896	<0.0896	<0 111	<0 676
cis-1,2-dichloroethene	**8.25**	**9.49**	**233**	**20.6**	**98.1**	**23.3**	**41.9**	**189**	<0.112	**65.8**	**357**
methylene chloride	<0.054	<0 054	<0.054	<0.126	<0 126	<0 126	<0.126	<0 126	<0.126	<0 054	<0 42
styrene	<0.0362	<0.0362	<0 0362	<0.0977	<0.0977	<0.0977	<0 0977	<0.0977	<0.0977	<0.0362	<0 59
tert-butyl methyl ether	**0.89J**	**1.01**	**0.144J**	<0.116	**0.394J**	<0 116	<0 116	<0.116	<0.116	<0.0856	<1.24
tetrachloroethene (PCE)	<0.228	<0.228	<0.228	**0.862**	<0.144	**0.244J**	<0 144	**4.04**	<0.144	**0.644**	<2 06
toluene	**0.312J**	<0 057	<0.057	<0.0637	<0 0637	<0 0637	<0 0637	<0 0637	<0.0637	**0.19J**	<0 472
trans-1,2-dichloroethene	**1.04**	**1.28**	**28.4**	**9.37**	**95.1**	**7.89**	**8.39**	**38.2**	<0.119	**32.3**	**6.05J**
trichloroethene (TCE)	**4.45**	**4.12**	**238**	**353**	**3.81**	**112**	**106**	**68.5**	<0.137	**54.3**	**1010**
trichlorofluoromethane	<0 12	<0 12	<0.12	<0.106	<0 106	<0.106	<0.106	<0.106	<0 106	<0.12	<0 99
Vinyl Chloride	**0.536**	**0.701**	**0.776**	**0.72**	**1.72**	<0 114	<0.114	<0 114	<0 114	<0.0744	<1
Metals											
arsenic (mg/L)	<0.0017	<0.0017	**0.0115J**	<0.0026	**0.0133J**	<0 0026	<0 0026	<0.0026	<0.0026	<0.0017	<0.0017
Natural Attenuation Parameters											
TOC (mg/L)	**4.75**	**3.8B**	**6.09**	**1.81**	**4.32**	**2.62**	**2.99**	**2.73**	**2.23**	**1.54**	**2.23B**
dissolved oxygen (mg/L)*	1.10	1.83	3.5	1.56	2.39	1.24	1 01	1.81	1.94	3.19	1.94
ethene (µg/L)	<0 073	<0.073	<0 073	<0.075	<0.074	<0.073	<0.074	<0.074	<0.074	<0.074	<0.075
ethane (µg/L)	<0.0787	<0.0787	**0.329**	**3.44**	**0.586**	**0.295**	<0.0793	**0.548**	<0 0795	<0.0793	**0.138**
methane (µg/L)	**44.7B**	**50.7B**	**2.74B**	**32.7B**	**59.4B**	**0.928B**	**3.53B**	**12.5B**	**0.249B**	~~**0.325B**~~	**41.9B**
alkalinity, total (as $CaCO_3$) (mg/L)	**468B**	**459B**	**370B**	**414B**	**487B**	**334B**	**347B**	**468B**	**331B**	**363B**	NA
chloride (as Cl) (mg/L)	**12**	**11.9**	**13.5**	**132**	**143**	**53.1**	**64.1**	**79.4**	**66.5**	**99.5B**	**19.1**
nitrate (as nitrous oxide) (mg/L)	**0.0656J**	**0.0218J**	**0.716**	**5.02**	**0.244**	**2.75**	**1.96**	**1.81**	**0.522**	**1.28**	**3.06**
sulfate (as SO_4) (mg/L)	**17.1**	**13**	**33.6**	**79.2**	**104**	**43**	**32.4**	**49.9**	**66.3**	**56.5**	**74.1**
total suspended solids (mg/L)	**4.4J**	<3.61	**1150**	<3.61	**6J**	<3 61	<3.61	<3.61	<3.61	<3.61	<3 61
ferrous iron (mg/L)**	0	0	0.1	0.02	0.01	0	0 01	0 01	0.01	0	0.01
Other Parameters											
ORP (mV)*	48	95	165	-14	-12	12	7	-5	31	67	262
turbidity (NTU)*	230	0	999	269	400	345	133	218	79	287	2
specific conductivity (mS/cm)*	0.889	0.876	0.929	5 52	6.25	3.58	3 71	4.78	3.84	5.03	0.798
pH*	6.40	6 68	6.46	6 28	6 31	6 35	6.30	6.35	6.33	6.30	6 91
temperature (°C)*	24.13	21.7	22.04	29 20	29.92	25.46	22.91	25 95	23.97	28.57	19.8

Bold typeface indicates detected analyte
Only analytes with at least one detection are presented
Location WHGL707 was sampled on 20 August 01 and 28 September 01 to track change over time.
Sample location WHGLTA702 is a blind duplicate of sample at WHGLTA701.
Sample WHGLTA707-02 is a duplicate of sample WHGLTA707-01

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R Indicates validity of data rejected
V Indicates carry over suspected

* Dissolved oxygen, ORP, turbidity, specific conductivity, pH, and temperature were analyzed in the field at the time of sampling using a Horiba U-22 Water Quality Meter
** Ferrous iron was analyzed in the field using Hach Fe^{2+} kit

°C	degrees Celsius	mg/L	milligrams per liter	NTU	nephelometric turbidity units	TCE	trichloroethene
µg/L	micrograms per liter	mS/cm	microSiemens per centimeter	ORP	oxidation-reduction potential	TOC	Total Organic Carbon
<	indicates result less than reporting limit shown	mV	millivolt	PCE	tetrachloroethene		
$CaCO_3$	calcium carbonate	N	nitrogen	SO4	sulfate		
Cl	chloride	NA	Not Analyzed/Measured				

Table 3-1
Summary of Groundwater Detections (cont.)

Sample Number	WSAICTA008-01	WSAICTA010-01	WSAICTA014-01	WSAICTA015-01	WSAICTA016-01	WSAICTA017-01	WSAICTA021-01	WSAICTA023-01	WSAICTA025-01	WSAICTA026-01
Sample Location	WSAICTA008	WSAICTA010	WSAICTA014	WSAICTA015	WSAICTA016	WSAICTA017	WSAICTA021	WSAICTA023	WSAICTA025	WSAICTA026
Chain of Custody Number	S01517	S01519	S01517	S01516	S01517	S01517	S01521	S01521	S01521	S01521
Sample Date	25-Sep-01	27-Sep-01	25-Sep-01	24-Sep-01	25-Sep-01	24-Sep-01	03-Oct-01	03-Oct-01	03-Oct-01	03-Oct-01
Organics (µg/L)										
1,1,1-trichlorethane	<0.0511	**0.436J**	<0.0511	<0.0511	<0.0511	<0.0511	<0.0511	<0.0511	<0.0511	<0.0511
1,1-dichloroethane	<0.0445	**1.08**	**0.494J**	<0.0445	<0.0445	<0.0445	<0.0445	<0.0445	<0.0445	<0.0445
1,1-dichloroethene	**0.235J**	**1.23**	**0.955**	<0.0492	**0.13J**	<0.0492	**0.161J**	**0.102J**	<0.0492	<0.0492
1,4-dichlorobenzene	<0.0495	<0.0495	<0.0495	<0.0495	<0.0495	<0.0495	<0.0495	<0.0495	<0.0495	<0.0495
benzene	**0.0873J**	**0.0811J**	**0.0619J**	<0.0465	<0.0465	<0.0465	<0.0465	**0.214J**	**0.133J**	**0.261J**
bromodichloromethane	<0.0528	**0.112J**	**0.107J**	<0.0528	<0.0528	<0.0528	<0.0528	<0.0528	<0.0528	<0.0528
chlorobenzene	<0.0404	**0.0895J**	<0.0404	<0.0404	<0.0404	<0.0404	<0.0404	<0.0404	<0.0404	<0.0404
chloroform	<0.0338	**0.624**	**0.416J**	**4.8**	**0.139J**	**0.186J**	<0.0338	<0.0338	<0.0338	<0.0338
cis-1,2-dichloroethene	**43.8**	**190**	**103**	**12.2**	**49.2**	**0.236J**	<0.0353	**48.5**	**2.58**	**0.868**
methylene chloride	<0.021	**0.0469J**	<0.021	**0.43J**	<0.021	<0.021	<0.021	<0.021	<0.021	<0.021
styrene	<0.0295	<0.0295	<0.0295	<0.0295	<0.0295	<0.0295	<0.0295	<0.0295	<0.0295	<0.0295
tert-butyl methyl ether	**0.0771J**	<0.0619	<0.0619	<0.0619	**0.262J**	<0.0619	<0.0619	<0.0619	<0.0619	<0.0619
tetrachloroethene (PCE)	<0.103	**0.401J**	**0.191J**	**9.47**	<0.103	<0.103	<0.103	**17.7**	**0.423J**	**0.419J**
toluene	**0.186J**	<0.0236	**0.161J**	**0.0902J**	**0.314J**	**0.126J**	<0.0236	<0.0236	<0.0236	<0.0236
trans-1,2-dichloroethene	**6.27**	**3.04**	**1.54**	**5.95**	**35.6**	**0.114J**	<0.043	**29.7**	**1.45**	**0.459J**
trichloroethene (TCE)	**67.2**	**1810**	**1020**	**1.15**	**44**	<0.0506	<0.0506	**5.26**	**0.293J**	**0.14J**
trichlorofluoromethane	<0.0495	**0.31J**	<0.0495	<0.0495	<0.0495	<0.0495	<0.0495	<0.0495	<0.0495	<0.0495
Vinyl Chloride	**3.33**	<0.0501	<0.0501	<0.0501	<0.0501	<0.0501	<0.0501	<0.0501	<0.0501	<0.0501
Metals										
arsenic (mg/L)	<0.0026	<0.0017	<0.0026	<0.0026	<0.0026	<0.0026	**0.0118J**	**0.0029J**	<0.0017	<0.0017
Natural Attenuation Parameters										
TOC (mg/L)	**3.98**	**1.81B**	**1.87**	**1.89**	**4.05**	**1.17**	**2.97B**	**4.97B**	**1.92B**	**3.28B**
dissolved oxygen (mg/L)*	1.25	4.21	7.75	1.35	1.57	2.23	3.28	6.70	5.82	5.16
ethene (µg/L)	<0.072	<0.075	<0.072	<0.073	<0.074	<0.072	<0.073	<0.074	<0.074	<0.074
ethane (µg/L)	**0.301**	<0.0799	<0.077	<0.0787	<0.0789	<0.0776	<0.078	<0.0791	<0.0791	<0.0791
methane (µg/L)	**87.1B**	**1.18B**	**1.03B**	**2.11B**	**1.93B**	**1.84B**	**28.2B**	**0.539B**	**0.358B**	**0.331B**
alkalinity, total (as $CaCO_3$) (mg/L)	**385B**	NA	**259B**	**276B**	**446B**	**130B**	**381B**	**496B**	**344B**	**332B**
chloride (as Cl) (mg/L)	**37.8**	**24.1**	**11.2**	**155**	**102**	**108**	**77.1**	**141**	**8.4**	**9.58**
nitrate (as nitrous oxide) (mg/L)	**0.0623J**	**5.57**	**3**	**1.73**	**0.264**	**0.802**	<0.0092	**0.0461J**	**0.689**	**0.506**
sulfate (as SO_4) (mg/L)	**42.4**	**66.5**	**84.2**	**58.4**	**94**	**46.2**	**352**	**87.1**	**76.1**	**78.7**
total suspended solids (mg/L)	<3.61	<3.61	<3.61	<3.61	<3.61	<3.61	**13J**	<3.61	<3.61	<3.61
ferrous iron (mg/L)**	0.11	0.06	0.04	0	0.02	0.01	1.42	0.03	0.06	0.02
Other Parameters										
ORP (mV)*	59	223	240	105	91	180	-71	73	146	97
turbidity (NTU)*	3	0	27	8.2	5.1	5	11	0	5	7
specific conductivity (mS/cm)*	0.847	0.725	0.674	1.26	1.35	0.737	1.63	1.61	0.796	0.787
pH*	6.85	6.95	7.19	7.02	6.86	7.37	6.76	7.05	6.94	6.97
temperature (°C)*	20.4	20.2	21.9	27.0	23.2	26.9	22.4	24.6	20.3	22.5

Bold typeface indicates detected analyte
Only analytes with at least one detection are presented.
Location WHGL707 was sampled on 20 August 01 and 28 September 01 to track change over time
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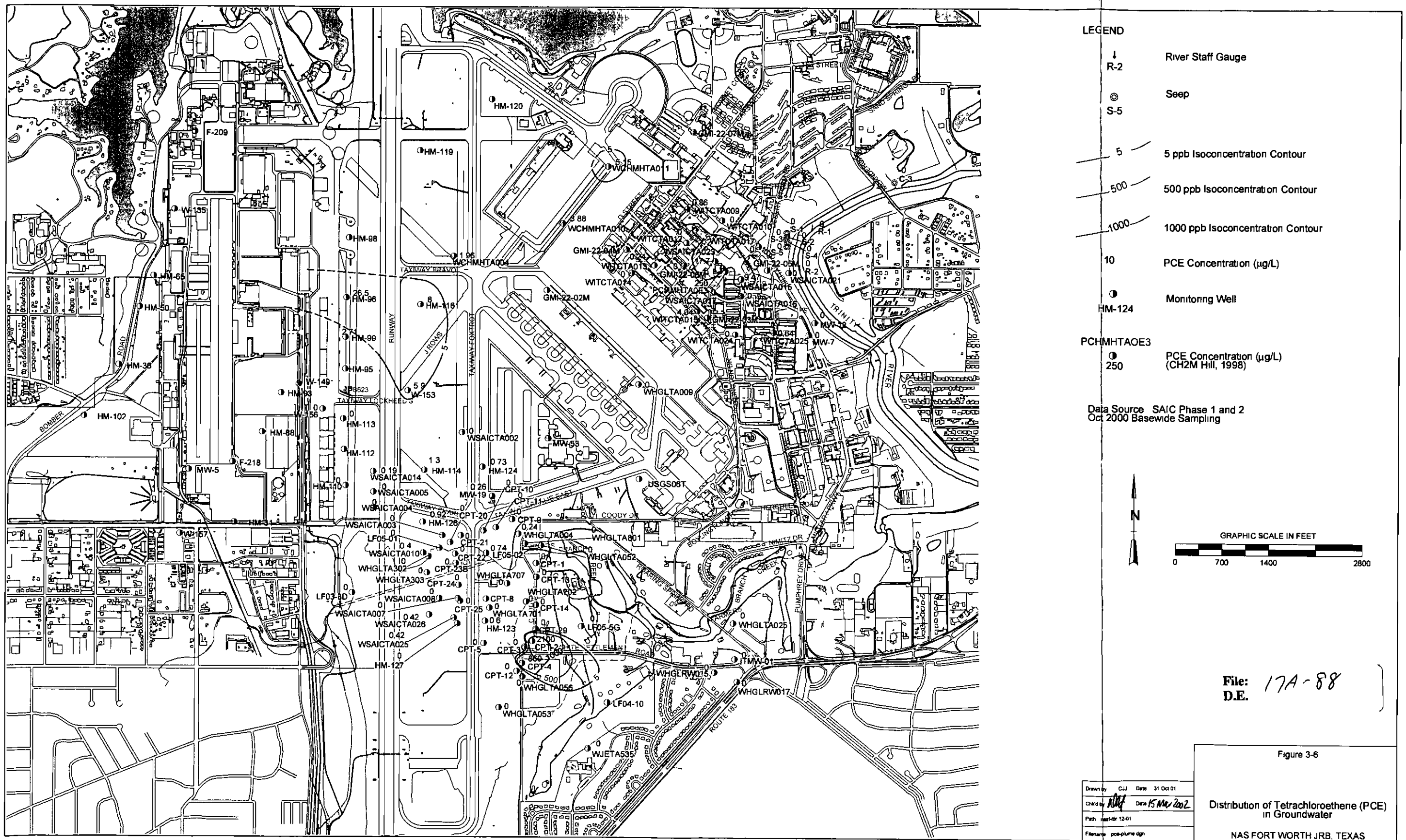
* Dissolved oxygen, ORP, turbidity, specific conductivity, pH, and temperature were analyzed in the field at the time of sampling using a Horiba U-22 Water Quality Meter
** Ferrous iron was analyzed in the field using Hach Fe^{2+} kit.

°C	degrees Celsius	mg/L	milligrams per liter	NTU	nephelometric turbidity units	TCE	trichloroethene
µg/L	micrograms per liter	mS/cm	microSiemens per centimeter	ORP	oxidation-reduction potential	TOC	Total Organic Carbon
<	indicates result less than reporting limit shown	mV	millivolt	PCE	tetrachloroethene		
$CaCO_3$	calcium carbonate	N	nitrogen	SO4	sulfate		
Cl	chloride	NA	Not Analyzed/Measured				


LEGEND
R-2 River Staff Gauge
S-5 Seep
5 5 ppb Isoconcentration Contour
500 500 ppb Isoconcentration Contour
1000 1000 ppb Isoconcentration Contour
10 PCE Concentration (µg/L)
HM-124 Monitoring Well
PCHMHTAOE3
250 PCE Concentration (µg/L) (CH2M Hill, 1998)
Data Source SAIC Phase 1 and 2 Oct 2000 Basewide Sampling
N
GRAPHIC SCALE IN FEET
0 700 1400 2800
File: 17A-88
D.E.
Figure 3-6
Distribution of Tetrachloroethene (PCE) in Groundwater
NAS FORT WORTH JRB, TEXAS
Drawn by CJJ Date 31 Oct 01
Chk'd by Date 15 Mar 2002
Path nasf-tbr 12-01
Filename pce-plume.dgn
TAXIWAY BRAVO
TAXIWAY FOXTROT
TAXIWAY LOCKHEED
RUNWAY
BOMBER ROAD
COODY DR
NIMITZ DR
ROUTE 183
TRINITY RIVER
PUMPHREY DRIVE
HM-120
HM-119
HM-98
HM-65
HM-50
HM-36
HM-102
HM-88
HM-96
HM-99
HM-95
HM-116
HM-113
HM-112
HM-114
HM-124
HM-126
HM-127
HM-123
HM-110
HM-31
F-209
F-218
W-135
W-149
W-153
W-156
W-157
MW-5
MW-19
MW-53
MW-7
MW-12
WCHMHTA011
WCHMHTA010
WCHMHTA004
GMI-22-02M
GMI-22-04M
GMI-22-05M
WITCTA009
WITCTA010
WITCTA012
WITCTA013
WITCTA014
WITCTA015
WITCTA016
WITCTA017
WITCTA024
WITCTA025
WSAICTA002
WSAICTA003
WSAICTA004
WSAICTA005
WSAICTA007
WSAICTA008
WSAICTA010
WSAICTA014
WSAICTA015
WSAICTA016
WSAICTA021
WSAICTA023
WSAICTA025
WSAICTA026
WHGLTA009
WHGLTA004
WHGLTA801
WHGLTA052
WHGLTA302
WHGLTA303
WHGLTA707
WHGLTA202
WHGLTA701
WHGLTA056
WHGLTA053
WHGLTA025
WHGLRW015
WHGLRW017
WJETA535
LF05-01
LF05-02
LF03-3D
LF05-5G
LF04-10
CPT-1
CPT-2
CPT-3
CPT-4
CPT-5
CPT-8
CPT-9
CPT-10
CPT-12
CPT-13
CPT-14
CPT-20
CPT-21
CPT-22
CPT-23B
CPT-24
CPT-25
CPT-29
ITMW-01
USGS06T
C-3
R-1
R-2
S-1
S-2
S-3
S-4
S-5

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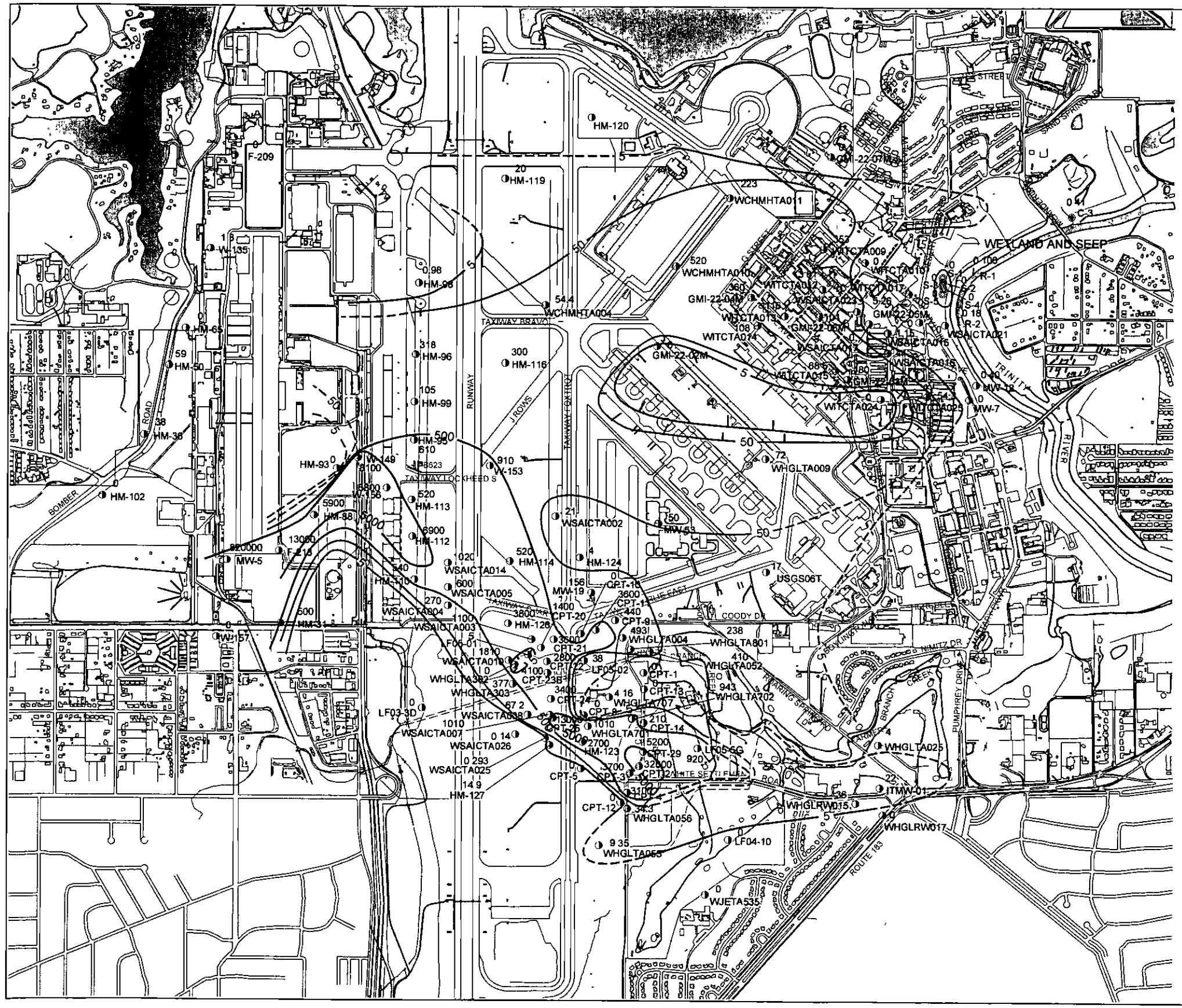

LEGEND

R-2 River Staff Gauge

S-5 Seep

5 5 ppb Isoconcentration Contour

50 50 ppb Isoconcentration Contour

500 500 ppb Isoconcentration Contour

5000 1000 ppb Isoconcentration Contour

5 Estimated Isoconcentration Contour

10 TCE Concentration (µg/L)

HM-124 Monitoring Well

Data Source SAIC Phase 1 and 2 Oct 2000 Basewide Sampling

N

GRAPHIC SCALE IN FEET

0 700 1400 2800

File: 17A-88
D.E.

Drawn by CJJ Date 31 Oct 01
Chk'd by [illegible] Date 15 Mar 2002
Path nasf-ftr-12-01
Filename tce-plume-1.dgn

Figure 3-7

Distribution of Trichloroethene (TCE) in Groundwater

NAS FORT WORTH JRB, TEXAS

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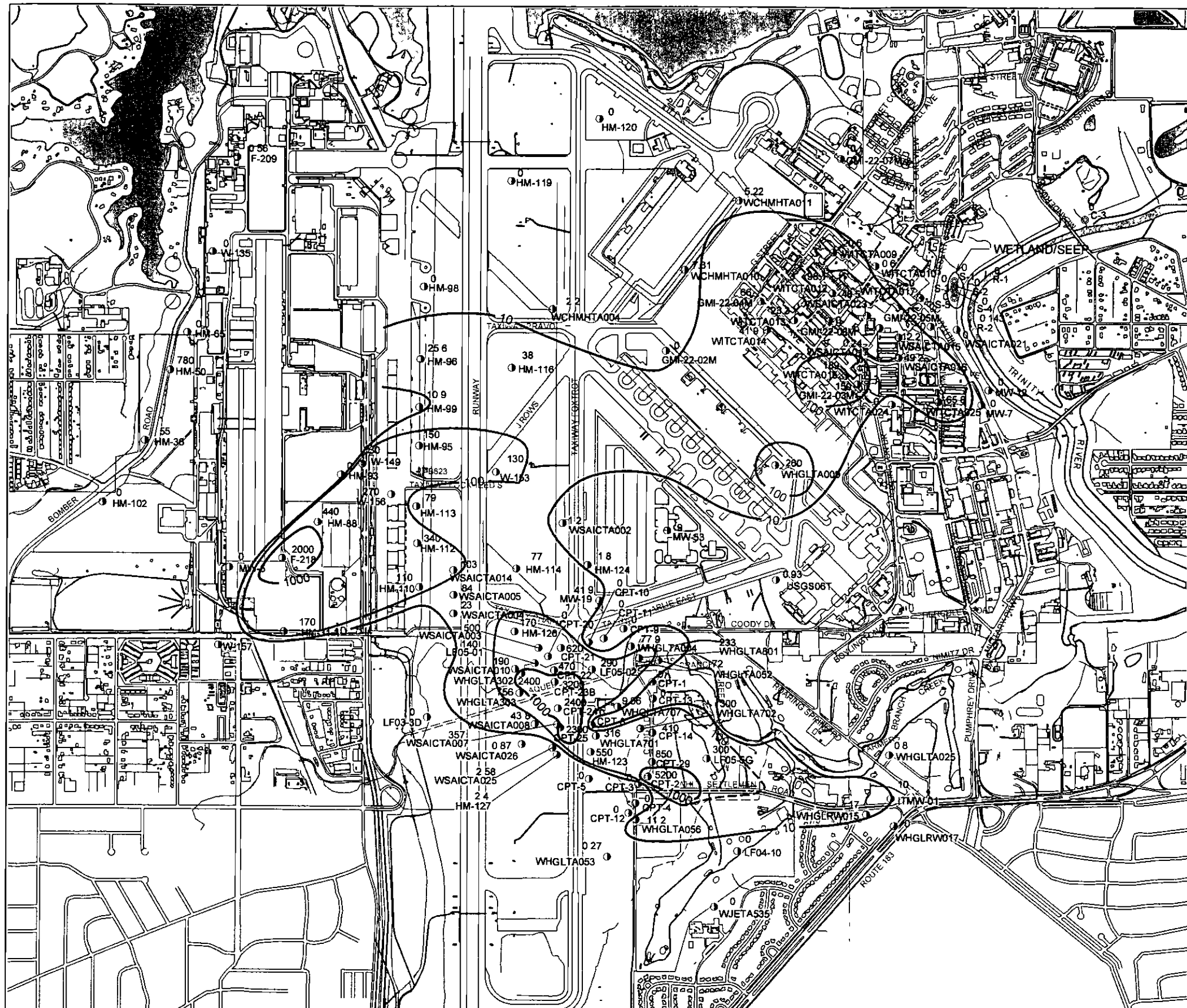

LEGEND

R-2	River Staff Gauge
S-5	Seep
10	10 ppb Isoconcentration Contour
100	100 ppb Isoconcentration Contour
1000	1000 ppb Isoconcentration Contour
10	Estimated Isoconcentration Contour
10	Cis-1,2-DCE Concentration (µg/L)
HM-124	Monitoring Well

Data Source SAIC Phase 1 and 2 October 2000
Basewide Sampling

N

GRAPHIC SCALE IN FEET
0 700 1400 2800

File: 12A-88
D.E.

Drawn by CJJ Date 31 Oct 01	Figure 3-8
Chk'd by [illegible] Date 15 MAR 2002	Distribution of Cis-1,2-Dichloroethane (DCE) in Groundwater
Path nasf-dir-12-01	
Filename dce-12-plume.dgn	NAS FORTH WORTH JRB, TEXAS

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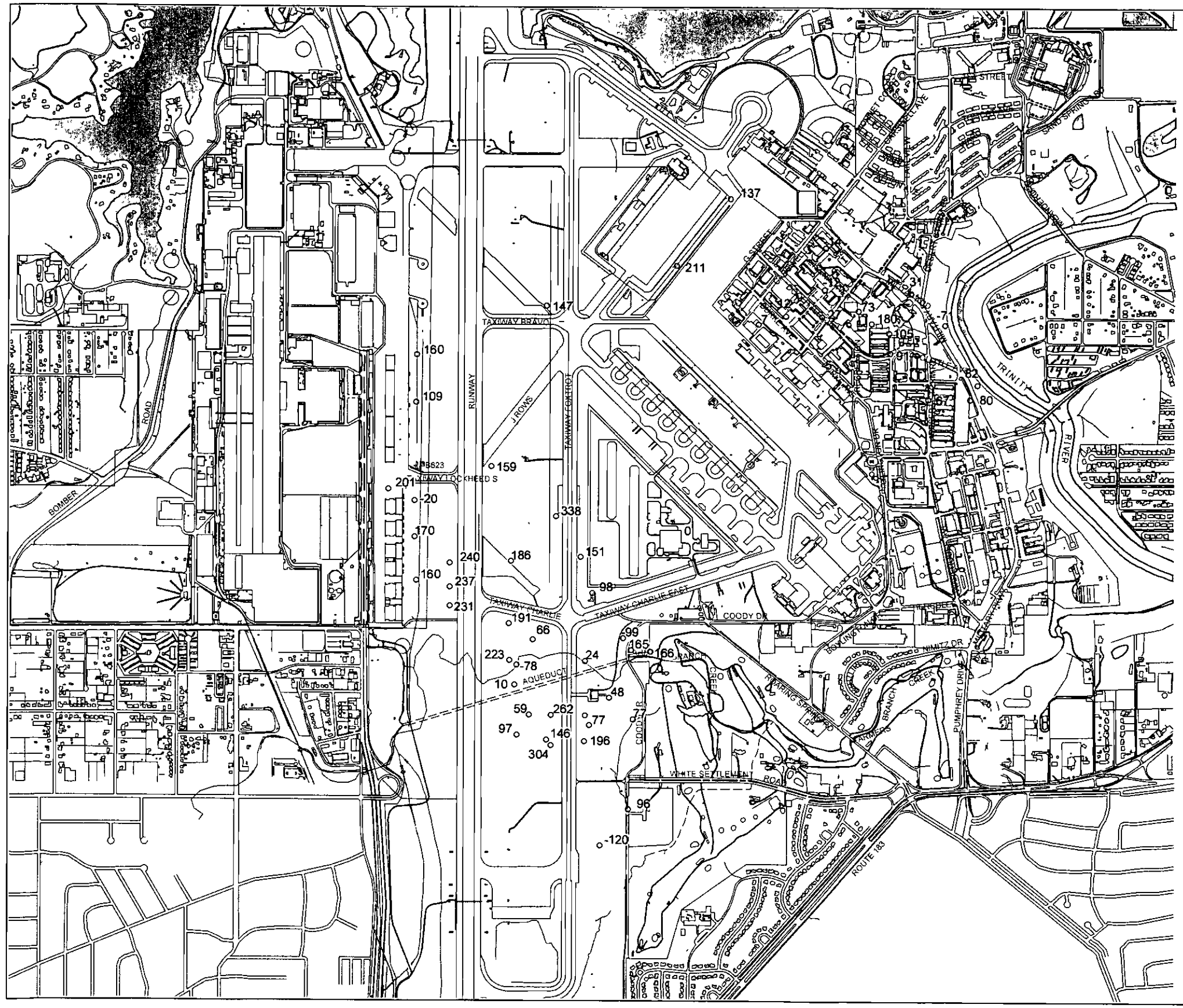

LEGEND

80	Oxidation Reduction Potential (ORP) (mV)
○	Data Point
	Approximate Area of ORP < 100 mV

N

GRAPHIC SCALE IN FEET

0 700 1400 2800

File: 17A-88
D.E.

Drawn by CJ	Date 28 Dec 01
Chk'd by	Date 15 Mar 2002
Path nasf-ftr 12-01	
Filename oxid-reduct-potent-1.dgn	

Figure 3-9

Oxidation-Reduction Potential in Groundwater

NAS FORTH WORTH JRB, TEXAS

719 45

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3.2 DISCUSSION

3.2.1 AOC 20 SI

3.2.1.1 Paleochannel and Subsurface Heterogeneity

In the AOC 20 area, the paleochannel geometry appears to be consistent with that mapped by Parsons Engineering-Science in 1998. Figures 3-3 and 3-4 provide graphic illustrations of the channel configuration; this information will be useful during the evaluation of remedial alternatives.

As shown in Figure 3-2, the saturated portion of the channel is not uniform. The conceptual model developed by Parsons Engineering-Science (Parsons 1998) indicated a consistent layer of basal gravel (mixture of sand and gravel) overlying bedrock. One of the tasks of this investigation is to map the distribution of the basal gravel. However, soil boring logs indicate that the thickness and extent of basal gravel is not uniform. Many soil boring logs indicate clay lithology from the top of the water table to the top of the bedrock. A more accurate description of the saturated portion of the alluvium is a "mixture of different proportions of clay, silt, sand, and gravel". The "basal gravel" may not be mapped as a separate unit. Therefore, no gravel distribution map has been provided in this ITIR.

3.2.1.2 Groundwater Plume and Sources of Groundwater Contamination

The major chemicals of concern in the AOC 20 area are chlorinated ethenes. Figure 3-6 through 3-8 present the synoptic concentration of PCE, TCE, and DCE from the recent sampling events. Concentrations of PCE are negligible in all monitoring points except CPT-2 and CPT-4, which are located within WP-07. This suggests that historic TCE releases at WP-07 from drums contained PCE as well. Concentrations of TCE were mapped to show the extent of TCE concentrations greater than the drinking water standard of 5 micrograms per liter (µg/L). The presence of three areas of concentrations that exceed 5,000 µg/L suggests that, in addition to the sources at WP-07 and Building 181, potential additional sources exist in the aqueduct area. Analysis of Figure 3-7 indicates concentrations of TCE ranging from 270 µg/L to 1,020 µg/L, are migrating across the runways into NAS FW JRB. This is illustrated by the TCE concentrations found in WSAICTA003, WSAICTA004, and WSAICTA014. Detections of TCE at concentrations above 1,000 µg/L in AOC 20 may be originating from sources within the fill material in the area.

An alternative explanation for this plume configuration may be the active pumping of 51 recovery wells. These wells were installed in phases from 1993 to 2000 and are located in the East Parking Lot of Building 181 and in the window area near the AFP 4 and NAS FW JRB boundary. Active pumping from these wells may have reduced the concentrations of TCE in groundwater entering NAS FW JRB to approximately

1,000 µg/L, as indicated by the TCE concentrations in WSAICTA003, WSAICTA004, and WSAICTA014.

TCE concentrations in wells WHGLTA302 and LF05-01 (0 and 5 µg/L, respectively) appear to be the result of degradation. DCE is a degradation product of PCE or TCE. Its presence is an indication of biodegradation and groundwater migration. Degradation of TCE has occurred near the AFP 4 source, as indicated by the high concentration of DCE in monitoring well F-218. The plume at WP-07 also contains high concentrations of DCE. In addition, another groundwater region near the central portion of the Aqueduct that has elevated concentrations of DCE suggests degradation in this area. Generation of DCE typically requires a reduced condition and additional carbon sources with adequate biological activity. Analysis of Table 3-1 oxidation-reduction potential and Figure 3-9 indicates reducing conditions in this region. Accumulation of methane in groundwater detected during Phase I SI sampling (LF05-02, WHGLTA302, WSAICTA003) and Phase II sampling (HM-123, WHGLTA701, WHGLTA702, WSAICTA008) confirmed elevated bioactivity in wells in this region (SAIC 2001). In the location of the former Farmers Branch Creek channel, which was replaced by the Aqueduct during the extension of the runways and regrading of the surface, these parameters suggest that additional carbon sources are promoting bio-activities and degrading the TCE to near non-detectable concentrations. Trash and fill materials with hazardous compounds may have existed in this area before it was regraded.

3.2.1.3 Plume Migration Pathways

Groundwater flow and groundwater plume migration follows the hydraulic gradient in a uniform aquifer and preferential pathway in a heterogeneous aquifer. In an unconfined aquifer, groundwater typically discharges into a surface water body. In the AFP 4 area and at AOC 20, contaminated groundwater also has a potential to migrate vertically into the Paluxy aquifer through a "window area" where the Walnut Formation is absent or less than 5 feet thick. This section discusses only the horizontal migration pathway. Some of the discussion is hypothetical where water level data were extrapolated (dashed lines in Figure 3-5).

Based on the groundwater elevation contours, a trough exists along the Aqueduct, similar to the trough parallel to the Farmers Branch Creek and the unnamed tributary perpendicular to White Settlement Road feeding into the Farmers Branch Creek. This may indicate that:

- The plume migrating from AFP 4 and the apparent one originating near the Aqueduct may be partially drained by the Aqueduct and partially by Farmers Branch Creek. If the aquifer is uniform, the Aqueduct becomes a hydraulic barrier for the plume from AFP 4. Because the aquifer is not homogeneous, the barrier will not completely prevent the plume from moving across the Aqueduct.

- When the water level falls below the level of the bottom of the Aqueduct, the plume from AFP 4 and the apparent one originating near the Aqueduct may migrate southeast within the paleochannel toward WP-07. It may then move onto Air Force Base Conversion Agency property before discharging into the unnamed tributary and Farmers Branch Creek.

- During rainy seasons with high water levels, the plume downgradient of WP-07 may discharge into many sections of the unnamed tributary and Farmers Branch. During lower water level season, groundwater discharge may not follow the paleochannel, but instead cross the unnamed tributary before discharging into the Farmers Branch Creek. This concept is illustrated in Figure 3-7, where 50 and 500 µg/L contours are dashed to indicate termination of the major portion of the plume at the unnamed tributary and extension of the diluted plume beyond the tributary. This theory may be supported by concentrations of TCE as high as 1,400 µg/L in historical surface water samples collected from the unnamed tributary (Radian 1991).

3.2.2 AOC 2 Data Gap Investigation

3.2.2.1 Bedrock Confirmation and Paleochannel

One specific comment from the USEPA on the AOC 2 RFI (CH2M Hill 2000) was that the TCE concentration in existing monitoring well GMI-22-05M was low because the well was terminated before bedrock was encountered. Monitoring well GMI-22-05M was installed using the direct push method. An attempt was made during this investigation to install a well near GMI-22-05M, and to screen the well to the top of the bedrock. Bedrock was encountered at the same depth as encountered at GMI-22-05M, suggesting that GMI-22-05M indeed terminated in bedrock, and that contaminant concentrations in groundwater samples collected from this well represent actual aquifer conditions.

Consolidation of all soil boring data provides better definition of the paleochannel in the northern lobe of the TCE plume in AOC 2 (Figure 3-3). The channel apparently runs east to west through Taxiway Bravo and is well defined by the 595-foot contour line and additional contours downgradient. The channel may not run straight to the Trinity River, instead it may turn slightly to the north and then to the east, as shown in Figure 3-4.

3.2.2.2 Groundwater Plume and Sources of Groundwater Contamination

Data gap sampling tasks were performed to address two specific comments from the USEPA on the AOC 2 RFI report related to the groundwater plume. One task was to confirm the presence of PCE in groundwater and to discern its source. The other task was to delineate the extent of the groundwater plume at the leading edge.

During the second phase of RFI investigation (CH2M Hill 2000), a direct push soil sample at location PCHMHTA0E3 contained PCE at a concentration of 250 µg/L (Figure 3-6). During this data gap investigation (in an attempt to confirm the presence of

PCE) new monitoring well WSAICTA017 was installed at the same location as PCHMHTA0E3. A groundwater sample from this well had a non-detectable PCE concentration. Monitoring well WSAICTA023, installed slightly upgradient of PCHMHTA0E3, contained groundwater with PCE at a concentration of 17.7 µg/L. A review of Figure 3-6 and historical detections of PCE in groundwater (e.g., CH2M Hill 2000) do not indicate additional sources of PCE within the northern lobe of TCE plume as necessary to explain the PCE plume. The PCE concentrations are in the same order of magnitude as those detected upgradient at AFP 4. The 250 µg/L detected in PCHMHTA0E3 was not reproduced in a new well installed near its location, suggesting a possible false high detection during the RFI sampling. The discussion above does not suggest that there were no PCE spills in the past and that there are no residuals in the soil. However, the concentration in the groundwater does suggest that it is unlikely to have detectable PCE concentrations in soil in the north lobe of the TCE plume.

The TCE plume configuration is consistent with the current conceptual model: it has migrated from AFP 4. However, comparison of groundwater elevation contours and the TCE distribution pattern suggests that sources at B181 alone may not be sufficient to generate the current plume. Additional residual sources may be located near the northern portion of AFP 4. Historical data suggest that there are several wells in northern AFP 4 with very high TCE concentrations. These wells are either dry, or have not been recently sampled. Residual concentrations from past contamination may be high enough to cause further contamination in northern lobe. Contaminant migration may not be continuous, rather it may be caused by storm and/or catastrophic events.

Another major task of this investigation was to delineate the leading edge of the plume and to assess the potential for its discharge to the Trinity River. Four types of samples were collected to accomplish this task:

1. Surface water samples (S-1 through S-5) from a wetland fed by multiple groundwater seeps.

2. Surface water samples from a previously identified seep (C-3).

3. Surface water samples from two river staff gauge locations (R-1 and R-2).

4. Groundwater samples from new and existing monitoring wells near the west bank of the Trinity River.

Figure 3-7 shows that all samples in this group had TCE concentrations that were either not detected or detected below Texas Natural Resource Conservation Commission (TNRCC) Maximum Contaminant Level for Organic Chemicals in Public Drinking Water Supplies (TNRCC 2002) of 5 µg/L. Water samples collected from the wetland had no detectable TCE concentrations. However, surface water monitoring point C-3 had a TCE concentration of 0.41 µg/L (maximum historical detection was approximately 50 µg/L) and the river water samples had trace concentrations of TCE. Apparently, TCE has entered Trinity River most likely as base flow or small groundwater seeps under the river

water surface. However, discharge of the groundwater has not resulted in TCE concentrations in the Trinity River increasing to the public drinking water standard.

As in AOC 20, the presence of the DCE plume in the AOC 2 northern lobe suggests that in addition to the degradation of sources at AFP 4, TCE has further degraded to DCE. Several monitoring wells in AOC 2 contain free petroleum product, reportedly released from underground storage tanks and an aviation fuel distribution system (Jacobs 1995). Figure 3-9 contains a large area where oxidation-reduction potential contours indicate reduced conditions in the aquifer, suggesting extensive biodegradation of TCE and generation of DCE.

3.2.2.3 Groundwater Migration Pathway

Other than the potential for entering the Paluxy aquifer via fractures, the only discharge route for groundwater in the AOC 2 area is the Trinity River. The groundwater plume distribution suggests that groundwater flow mainly follows the hydraulic gradient. Theoretically, all the seeps entering Trinity River should contain some TCE. Water in the wetland (S-1 through S-5) may have originated from leaks of subsurface utilities or a direct passage of surface water from Lake Worth to the Trinity River. No contamination has been detected in a large area extending from soil boring BSAICTA009, and monitor wells WITCTA010, GMI-22-05M, and WSAICTA021, northwest to the wetland area. The contamination may have been completely diluted and/or flushed out by high volumes of clean water.

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4. SUMMARY

A summary of the investigation and the current CSMs of AOC 20 and AOC 2 are presented in Table 4-1 and Table 4-2.

Table 4-1
Conceptual Site Model of AOC 20

CSM Component	Explanation
Major Chemicals of Concern	TCE, DCE, and VC. Trace PCE concentrations in the source at WP-07.
Sources	1. B181 via East parking Lot at AFP 4 2. Potential sources of TCE and petroleum hydrocarbons (evidenced by reducing conditions in the aquifer) in the fill materials at the former Farmers Branch Creek channel. 3. Additional potential source at WP-07.
Extent of Contamination	Farmers Branch Creek and its tributary
Migration Pathway	Three potential sources of TCE migrate in two patterns. During draught season, the plume flows along the paleochannel and then discharges into the Farmers Creek During wet (probably including average condition) the plumes from AFP 4 and Aqueduct area may discharge into the Aqueduct and Farmers Branch Creek. The plume from WP-07 may discharge into Farmers Branch Creek and its tributary.
Natural Attenuation	Groundwater under anaerobic condition in several areas where biodegradation is degrading TCE to DCE. In some locations, TCE has been completely degraded. Vinyl chloride has been detected in limited locations.
Impact to Surface Water	Surface water in Farmers Branch Creek and its tributary contain concentrations of TCE exceeding drinking water standards

TCE	trichloroethene	PCE	tetrachloroethene
DCE	cis-1,2-dichloroethene	AFP 4	Air Force Plant 4
VC	vinyl chloride	CSM	conceptual site model

Table 4-2
Conceptual Site Model of AOC 2

CSM Component	Explanation
Major Chemicals of Concern	PCE, TCE, DCE, petroleum hydrocarbons
Sources	1. B181 via East parking Lot at AFP 4 2. Northern portion of AFP 4 may contain additional sources of TCE and trace PCE 3. Release of petroleum hydrocarbons from underground storage tanks and fuel hydrant system
Extent of Contamination	Trinity River
Migration Pathway	Approximately follows hydraulic gradient, locally influenced by preferential pathway created by heterogeneity of aquifer.
Natural Attenuation	The groundwater is under anaerobic condition in a large area where biodegradation is degrading TCE to DCE In some areas, TCE has been completely degraded to DCE
Impact to Surface Water	Surface water in Trinity River contains concentrations of TCE less than the drinking water standard.

PCE	tetrachloroethene	AFP 4	Air Force Plant 4
TCE	trichloroethene	CSM	conceptual site model
DCE	cis-1,2-dichloroethene		

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FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE