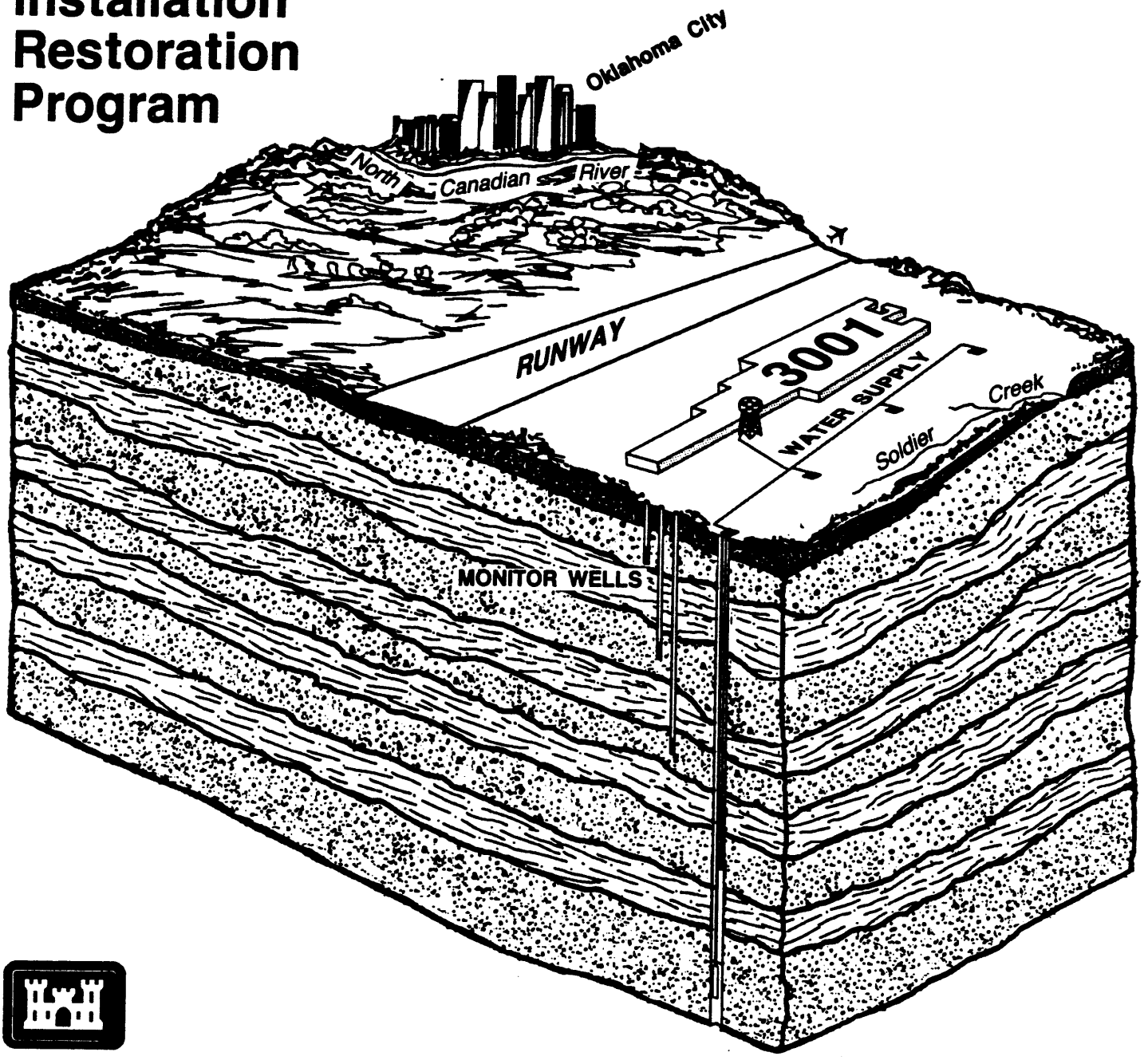
Building 3001
Feasibility Study
Volume 2 - Environmental Assessment of Detailed Alternatives

TINKER AIR FORCE BASE
Installation Restoration Program



US Army Corps of Engineers
Tulsa District

August 1989

ENVIRONMENTAL ASSESSMENT
OF DETAILED ALTERNATIVES

BUILDING 3001 SITE
TINKER AIR FORCE BASE, OKLAHOMA

Prepared For:
TULSA DISTRICT CORPS OF ENGINEERS
Contract No. DACA56-88-C-0004
Project No. WWYK86-311
Site I.D. No. Tinker-0T01

Prepared By:
BLACK & VEATCH, ENGINEERS-ARCHITECTS
With Input From:
TULSA DISTRICT CORPS OF ENGINEERS
Project No. 14186.080
August 16, 1989

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DRAFT

FINDING OF NO SIGNIFICANT IMPACT

In accordance with the National Environmental Policy Act of 1969, including guidelines in 40 CFR, Tinker Air Force Base, Oklahoma, has assessed the environmental impacts of constructing new or modifying existing wastewater treatment facilities to treat contaminated groundwater and the subsequent discharge or reuse of the treated groundwater. The project will develop an effective removal, collection, and treatment system for contaminated groundwater and will provide an acceptable disposal method for treated groundwater. Residual wastes from the treatment process will be properly disposed of in a RCRA authorized disposal facility. The recommended project will provide for current and future site remediation without causing a significant impact on the local environment. The attached Environmental Assessment shows the impacts of any of the alternatives developed, except for no action, would be minimal and would not significantly affect the natural or human environment. Therefore, an environmental impact statement is not required.

_____

date

ALAN LAWRENCE
Director Environmental Management
Tinker Air Force Base

Atch
Env Assess

1.0 INTRODUCTION

Past activities within and in the vicinity of Building 3001 have resulted in contamination of the upper groundwater zones with industrial solvents, metals, and fuel products. The primary contaminants are trichloroethylene (TCE) and chromium (Cr) (predominantly hexavalent chromium (Cr^{+6})). Building 3001, located in the northeast portion of Tinker Air Force Base (AFB), houses a large industrial complex where aircraft and jet engines are serviced, repaired, and/or upgraded. The United States Environmental Protection Agency (EPA) has placed the site on the National Priorities List of hazardous waste sites. Remedial investigations[1] have been conducted at the site by the Tulsa District Corps of Engineers (COE) to define and characterize the sources, extent, and magnitude of the contamination. The investigations are part of the U.S. Air Force Installation Restoration Program (IRP).

1.1 PURPOSE, SCOPE, AND OVERVIEW OF THIS REPORT

The purpose of this Environmental Assessment (EA) report is to provide an environmental evaluation of the remedial action alternatives developed for the Building 3001 site. The EA was prepared in accordance with the provisions of 40 CFR 1508. The objective of the EA is to provide sufficient information to lead to the preparation of one of the following documents:

- o Finding of No Significant Impact (FONSI).
  The FONSI is a document which presents reasons why an action will not have a significant effect on the environment and, thus, will not be subject to an Environmental Impact Statement.

- o Environmental Impact Statement (EIS).
  An EIS is prepared to provide a detailed description of the impacts of a proposed action on the environment.

This report is supplemental to the Feasibility Study (FS) Report[2], which describes and evaluates remedial alternatives for the Building 3001 site. This assessment provides an evaluation of potential environmental impacts that may result from implementing each of the remedial alternatives presented in the FS Report. Preparation of the EA for this federal action

provides compliance with the National Environmental Policy Act (NEPA) of 1969.

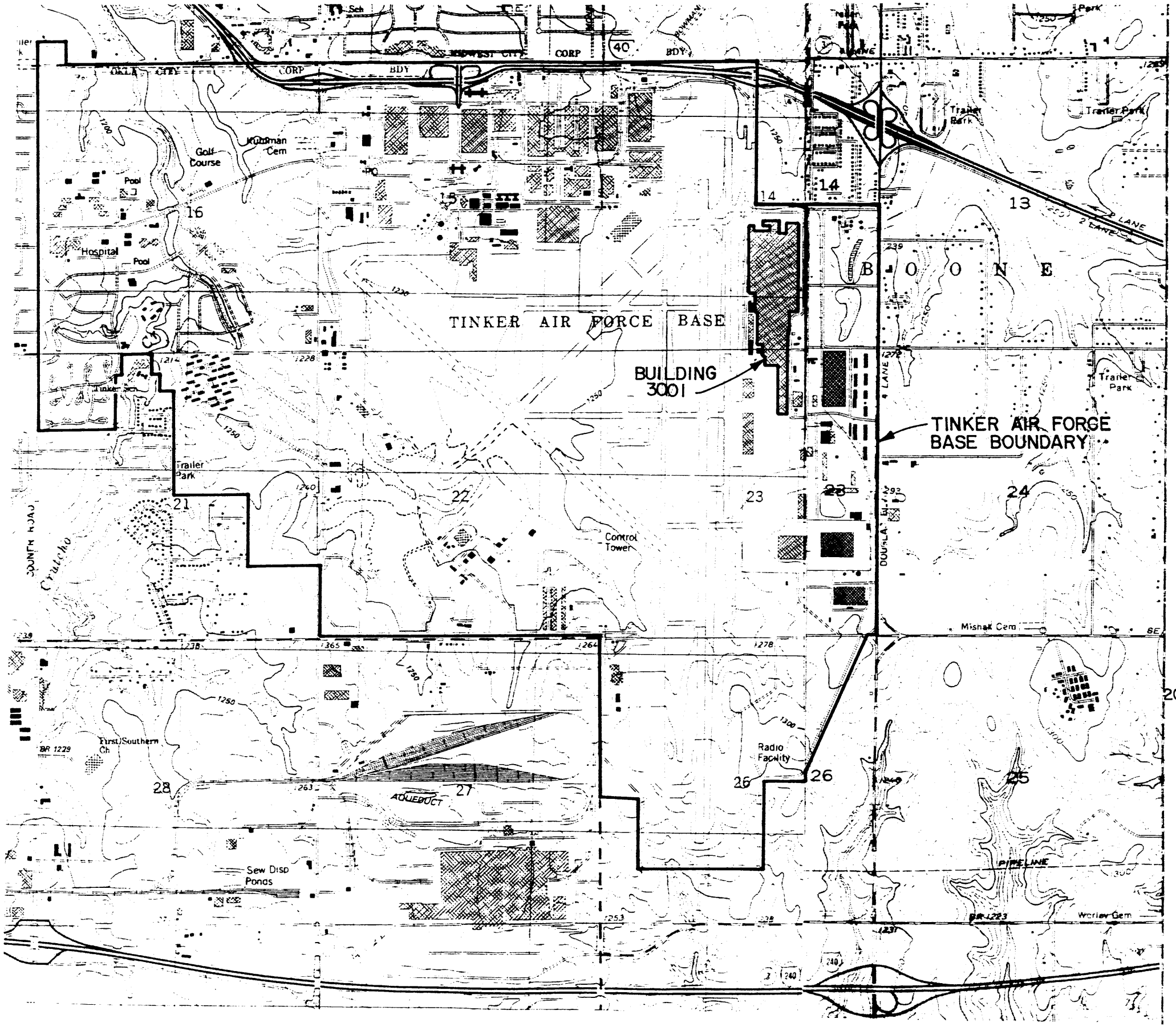
This report is the result of a joint effort by the COE and Black & Veatch. Environmental evaluations are presented according to two alternative groups, with each group evaluated separately. The COE provided an environmental evaluation of recommended alternatives pertaining to groundwater removal and collection, which includes the no action alternative. Black & Veatch, under contract to the COE, was responsible for the environmental evaluation of the alternatives for groundwater treatment and disposal.

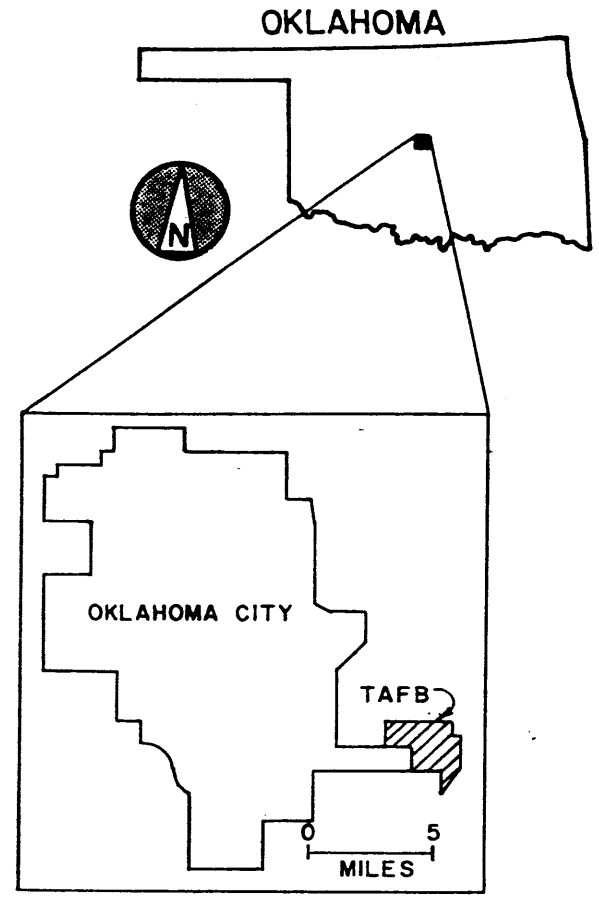
Section 1 of this report presents the site background information and the nature and extent of the problem. Presented in Section 2 are descriptions of remedial action alternatives presented in the FS Report for each alternative group. A summary of the affected environment is included in Section 3. An environmental evaluation of each of the alternatives presented in the FS report, with the exception of management controls, is presented in Section 4. Section 5 presents the recommended alternatives in the FS report[2]. Included in Section 6 are the regulatory agencies with which coordination will be required to review the environmental impacts of each alternative.

1.2 SITE BACKGROUND INFORMATION

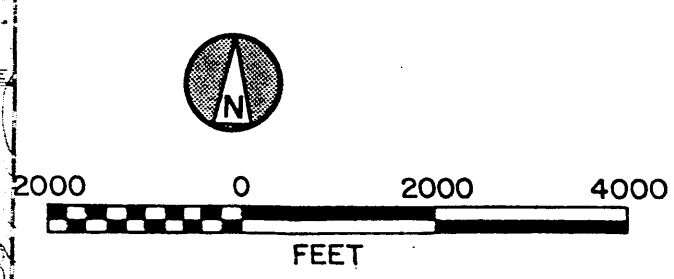
1.2.1 Location

Tinker AFB is located in central Oklahoma, in the southeast portion of the Oklahoma City metropolitan complex, in Oklahoma County. The Base is bounded by Sooner Road to the west, Douglas Boulevard to the east, Interstate 40 to the north, and Southeast 74th Street to the south. Building 3001 is located in the northeast portion of the Base, east of the north-south runway. Figure 1-1 shows the location of the Base.





VICINITY MAP



SOURCE:
(1) USGS 1986, DMA 6554 IV NW-SERIES V883
(2) USGS 1956, PHOTOREVISED 1969 & 1975
AMS 6554 IV NE-SERIES V883

FIGURE 1-1
LOCATION AND VICINITY MAP
TINKER AIR FORCE BASE
BUILDING 3001 SITE

1.2.2 Site Description

The Building 3001 site includes the building complex (covering 80 acres), and the surrounding areas corresponding to the lateral extent of the contaminant plume. The site is located near the northeast boundary of the Base and covers an area of approximately 220 acres. A site map is shown in Figure 1-2. Two fuel storage tank areas are located adjacent to Building 3001. One tank area is located immediately north of Building 3001 (north tank area) and the other tank area is located to the southwest (southwest tank area).

1.2.2.1 Building 3001. The building houses an aircraft overhaul and modification facility to support the mission of the Oklahoma City Air Logistics Center. Some industrial processes conducted in Building 3001 used or generated solutions containing solvents and metals similar to contaminants found in the underlying groundwater. Organic solvents were used for cleaning and degreasing metal engine parts. Trichloroethylene (TCE) was the predominant solvent used from the 1940's until the 1970's. The degreasing operations were conducted in tanks set below the floor level in concrete pits. In the early 1970's, tetrachloroethylene (PCE) began to replace TCE as the primary solvent used in degreasing operations. About the same time, the subsurface pits were replaced with above grade degreasing stations, where the entire system (tank, piping, pumps, etc.) are located aboveground. The subsurface pits were abandoned typically by backfilling with sand and capping with concrete. Cleaning operations may have included paint stripping, in which the stripper and the wastewaters produced contained high concentrations of metals (particularly Cr). Waste materials generated from plating, painting, and heat treating activities contained both solvents and metals. Subsurface contamination below the building complex occurred by leakage from trenches and pits, inadvertent discharging of solvents or wastewaters into storm drains, accidental spills, and improper connections between wastewater and storm drains.

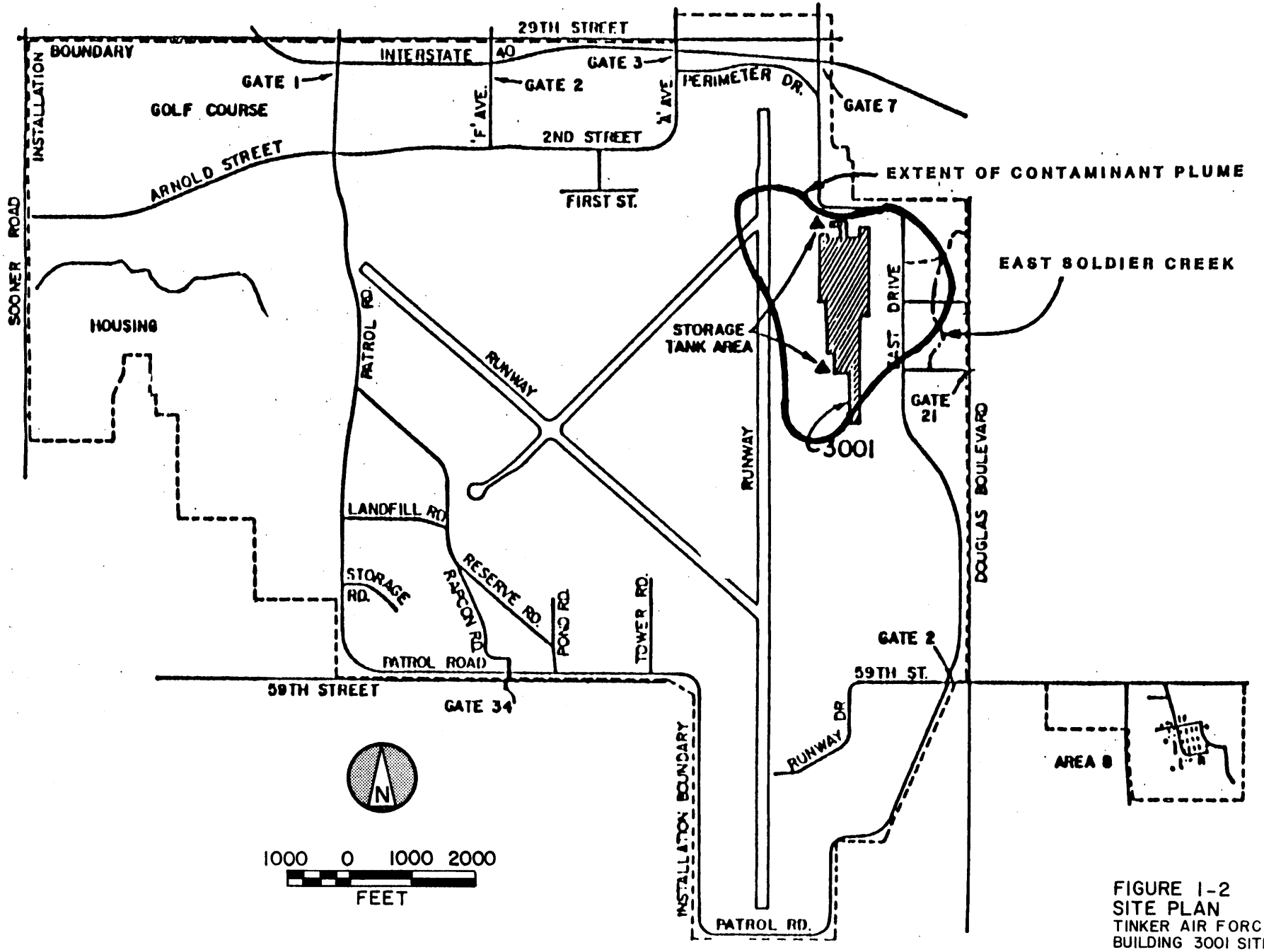


FIGURE 1-2
SITE PLAN
TINKER AIR FORCE BASE
BUILDING 3001 SITE

1.2.2.2 North and Southwest Tank Areas. Although remediation of the north and southwest tank areas were not within the scope of the FS, brief site descriptions are provided because of their contribution to groundwater contamination at the 3001 site. The tank areas will be remediated as separate operable units.

The north tank area contains an inactive 500 gallon waste oil tank, an inactive underground fuel tank (235,000 gallon capacity), and an active underground diesel tank (approximately 20,000 gallon capacity). An abandoned gasoline tank (approximately 13,000 gallon capacity) was removed from the area in 1985. The north tank area is grass covered and encompasses approximately 16,400 square feet. The soil and groundwater beneath the north tank area have become contaminated with fuel product, benzene, toluene, and xylene due to leaking tanks and/or possible fuel spills. Some metals and organic solvents are also present in the groundwater, which may be attributed to leaking pipes in the area or dispersion of contaminants from more distant sources.

The southwest tank area contains both abandoned fuel tanks and abandoned solvent tanks. The tanks and their history of use are listed in the FS report[2]. Also, two active 12,000 gallon solvent tanks, containing PD680 Solvent, are located south of Building 3108. The tank area covers approximately 2.5 acres. The groundwater in this area is contaminated with toluene, benzene, and xylene, which likely occurred from past leaking of tanks or possible spills. Some metals and solvents, probably originating from inside Building 3001, are also present in the groundwater.

1.3 NATURE AND EXTENT OF THE PROBLEM

The past activities within Building 3001 have resulted in contamination of the groundwater, with chlorinated solvents and heavy metals being detected to a maximum depth of approximately 175 feet. The primary contaminants are TCE and Cr, whose composite plume encompasses an area of approximately 220 acres in the groundwater. The extent of the composite plume for TCE and Cr is contained within 1800 feet of Building 3001 and within the boundaries of Tinker AFB. The approximate extent of the plume is indicated on Figure 1-2. Chemical tests of the valency states of the Cr indicate that most of it is hexavalent chromium (Cr^{+6}). Other contaminants that exist at the site include additional organic and metal contaminants, fuel product at the north storage tank area, and benzene, toluene, and xylene at both the southwest and north storage tank areas. The Remedial Investigation [1] provides detailed information on all contaminants detected in the groundwater at the Building 3001 site.

To date, contamination has been detected in the perched aquifer, upper portions of the regional aquifer (Garber-Wellington aquifer), and in near surface soils. The contamination has been identified through an extensive monitoring well network and soil boring program. The monitoring wells typically monitor: (1) the perched water table from 15 to 30 feet; (2) the top of the regional aquifer, which is the first major water bearing unit of the Garber-Wellington Formation, at depths of 50 to 80 feet; (3) and the regional zone, the deeper portion of the Garber-Wellington aquifer, at depths of 110 to 175 feet. Production wells for Tinker AFB pump water from the more productive units of the Garber-Wellington aquifer found at depths between 250 and 700 feet.

Past discharges into East and West Soldier Creeks have resulted in contamination of water and sediments within the creeks. Storm water sewers draining into the creeks have carried discharges of industrial wastes due to improper connections between industrial wastewater lines and storm drains, and the washing down or possible dumping of waste liquids or solvents into drains. Hydrogeologic investigations have shown that East Soldier Creek is a discharge point for some perched groundwater beneath the

east portion of Building 3001. Although contaminant concentrations are relatively low in the perched groundwater near the creek, the potential for contaminant migration into the creek exists.

Past sampling of sediments in East Soldier Creek has shown the presence of heavy metals and volatile organic compounds [1]. A cleanup operation was conducted in early 1986 to remove highly contaminated sediments. Sampling of water and sediments within the creeks is ongoing.

2.0 REMEDIAL ACTION ALTERNATIVE DESCRIPTIONS

Contaminated groundwater remediation alternatives for the Building 3001 site involve removal, collection, treatment, and disposal of contaminated groundwater removed from the various regions of the aquifer beneath the Building 3001 site. This section presents descriptions of the remedial alternatives developed and evaluated in the FS report for each alternative group. Alternatives for groundwater removal and collection are described in Section 2.1. Groundwater treatment and disposal alternatives are described in Section 2.2.

2.1 GROUNDWATER REMOVAL AND COLLECTION

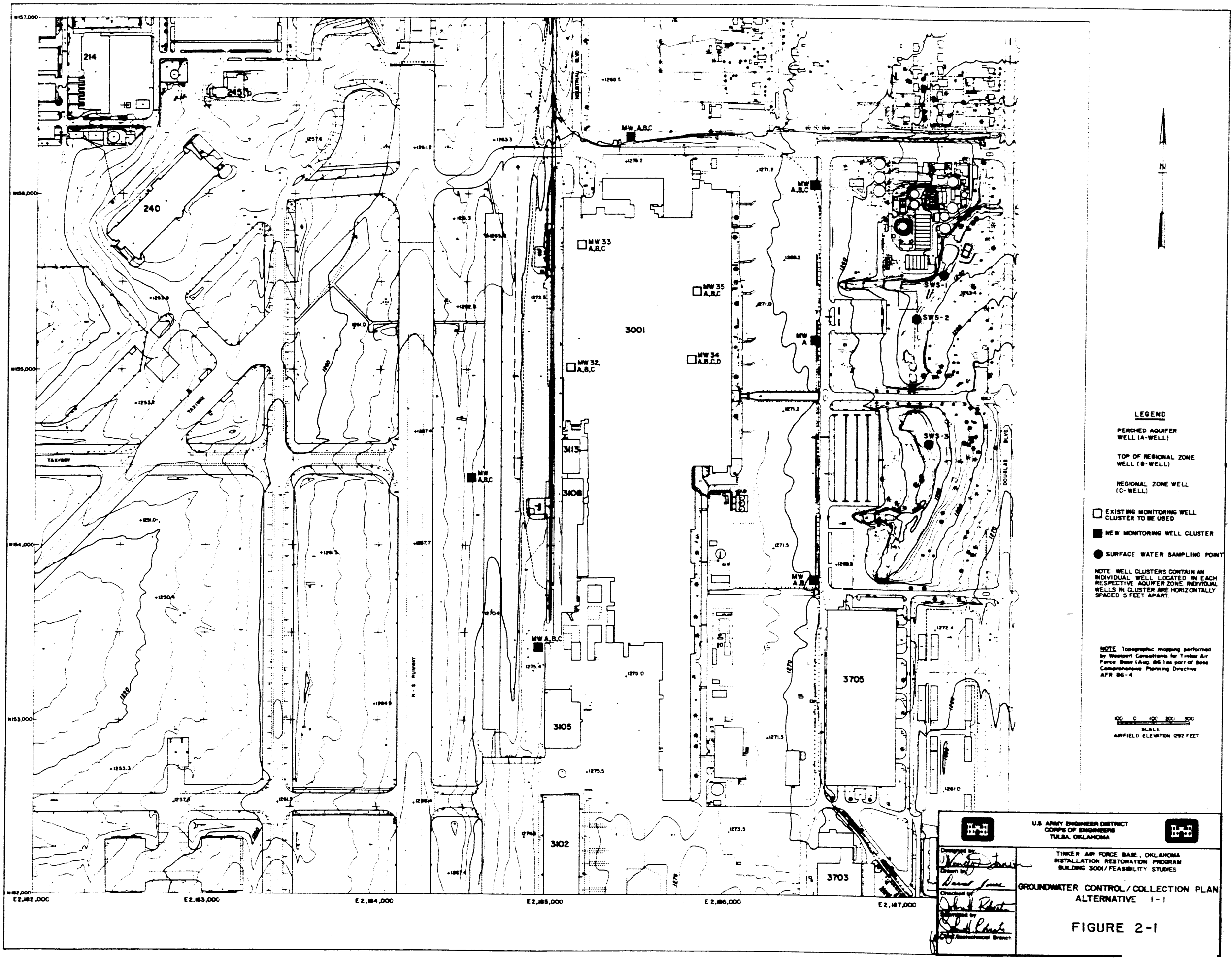
Following is a summary of each remedial alternative considered for removal and collection of contaminated groundwater. The no action alternative will be evaluated as required under NEPA.

2.1.1 Alternative 1-1 - No Action

The no action alternative does not involve any pumping from the contaminated aquifers but does include monitoring of the groundwater contaminant plumes. The monitoring well network would consist of 18 new stainless steel wells combined with 13 existing wells, as shown on Figure 2-1. These 31 wells would be sampled on a yearly basis for volatile organics and metals. Groundwater monitoring will enable the plume migration to be observed so that any increase in risk to the public or environment can be evaluated.

2.1.2 Alternative 1-2 - Groundwater Removal From Exterior Wells Only

Approximately 111 groundwater extraction wells would be placed in locations surrounding Building 3001. The extraction wells would be connected to a groundwater collection manifold, as shown on Figure 2-2. The wells would be positioned such that they would not cause physical disruption of existing facility structures or impede current installation activities. Collection pump well heads would be located adjacent to and up to 1000 feet from the industrial complex at positions and depths that would facilitate effective removal and collection of contaminated groundwater. The removal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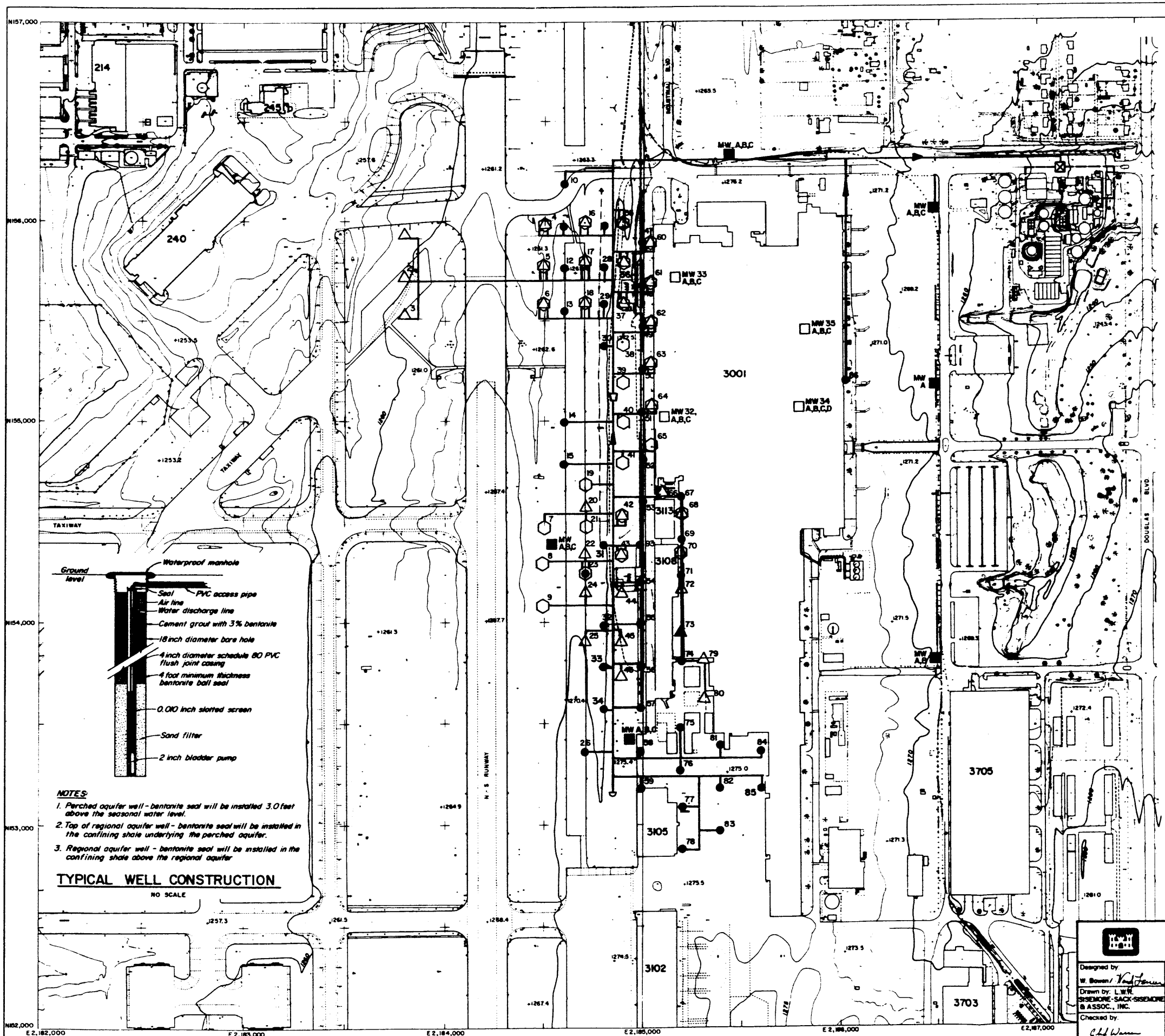
240
3001
3313
3108
3105
3102
3705
3703
MW A,B,C
MW 33 A,B,C
MW 35 A,B,C
MW 32, A,B,C
MW 34 A,B,C,D
MW A
MW A,B
SWS-1
SWS-2
SWS-3
TAXIWAY
N-S RUNWAY
DOUGLAS BLVD
N
LEGEND
PERCHED AQUIFER WELL (A-WELL)
TOP OF REGIONAL ZONE WELL (B-WELL)
REGIONAL ZONE WELL (C-WELL)
EXISTING MONITORING WELL CLUSTER TO BE USED
NEW MONITORING WELL CLUSTER
SURFACE WATER SAMPLING POINT
NOTE: WELL CLUSTERS CONTAIN AN INDIVIDUAL WELL LOCATED IN EACH RESPECTIVE AQUIFER ZONE. INDIVIDUAL WELLS IN CLUSTER ARE HORIZONTALLY SPACED 5 FEET APART.
NOTE: Topographic mapping performed by Newport Consultants for Tinker Air Force Base (Aug. 86) as part of Base Comprehensive Planning Directive AFR 86-4
100 0 100 200 300
SCALE
AIRFIELD ELEVATION 1292 FEET
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
TULSA, OKLAHOMA
Designed by
Drawn by
Checked by
Approved by
Chief, Geotechnical Branch
TINKER AIR FORCE BASE, OKLAHOMA
INSTALLATION RESTORATION PROGRAM
BUILDING 3001/FEASIBILITY STUDIES
GROUNDWATER CONTROL/COLLECTION PLAN
ALTERNATIVE 1-1

FIGURE 2-1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214
240
245
18
3001
3705
3703
3102
3105
3106
3113
MW A,B,C
MW 33 A,B,C
MW 35 A,B,C
MW 34 A,B,C,D
MW 32, A,B,C
MW A
TAXIWAY
N-S RUNWAY
DOUGLAS BLVD
Ground level
Waterproof manhole
Seal
PVC access pipe
Air line
Water discharge line
Cement grout with 3% bentonite
18 inch diameter bore hole
4 inch diameter schedule 80 PVC flush joint casing
4 foot minimum thickness bentonite ball seal
0.010 inch slotted screen
Sand filter
2 inch bladder pump
NOTES:
1. Perched aquifer well - bentonite seal will be installed 3.0 feet above the seasonal water level.
2. Top of regional aquifer well - bentonite seal will be installed in the confining shale underlying the perched aquifer.
3. Regional aquifer well - bentonite seal will be installed in the confining shale above the regional aquifer
TYPICAL WELL CONSTRUCTION
NO SCALE
N
LEGEND
PERCHED AQUIFER COLLECTI WELL (A-WELL)
TOP OF REGIONAL ZONE COLL WELL (B-WELL)
REGIONAL ZONE COLLECTION (C-WELL)
A and B WELL CLUSTER
A and C WELL CLUSTER
B and C WELL CLUSTER
A, B and C WELL CLUSTER
EXISTING MONITORING WELL CLUSTER TO BE USED
NEW MONITORING WELL CLUST
GROUNDWATER COLLECTION PIPING
NEW IWTP MODIFICATIO OR NEW GROUNDWATER TREATMENT PLANT
NEW FACILITIES OUTLET LINE
NOTE: WELL CLUSTERS CONTAIN AN VISUAL WELL LOCATED IN EACH RESPECTIVE AQUIFER ZONE. INDIVID WELLS IN CLUSTER ARE HORIZONTA SPACED 5 FEET APART.
NOTE: Topographic mapping performed by Woodward Consultants for Tinker Air Force Base (Aug. 86) as part of Base Comprehensive Planning Directive AFR 86-4
100 0 100 200 300
SCALE
NOT FOR CONSTRUCTION
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
TULSA, OKLAHOMA
Designed by: W. Bowen
Drawn by: L.W.K. SISEMORE-SACK-SISEMORE & ASSOC., INC.
Checked by: C.H.J.
Submitted by: Chief, Geotechnical Branch
TINKER AIR FORCE BASE, OKLAHOMA
INSTALLATION RESTORATION PROGRAM
BUILDING 3001/FEASIBILITY STUDIES
GROUNDWATER CONTROL/COLLECTION
ALTERNATIVE 1-2
FIGURE 2-2
Date: NOVEMBER, 1988

and collection system will provide an effective means for removal of contaminated groundwater.

2.1.3 Alternative 1-3 - Groundwater Removal From Interior and Exterior Wells

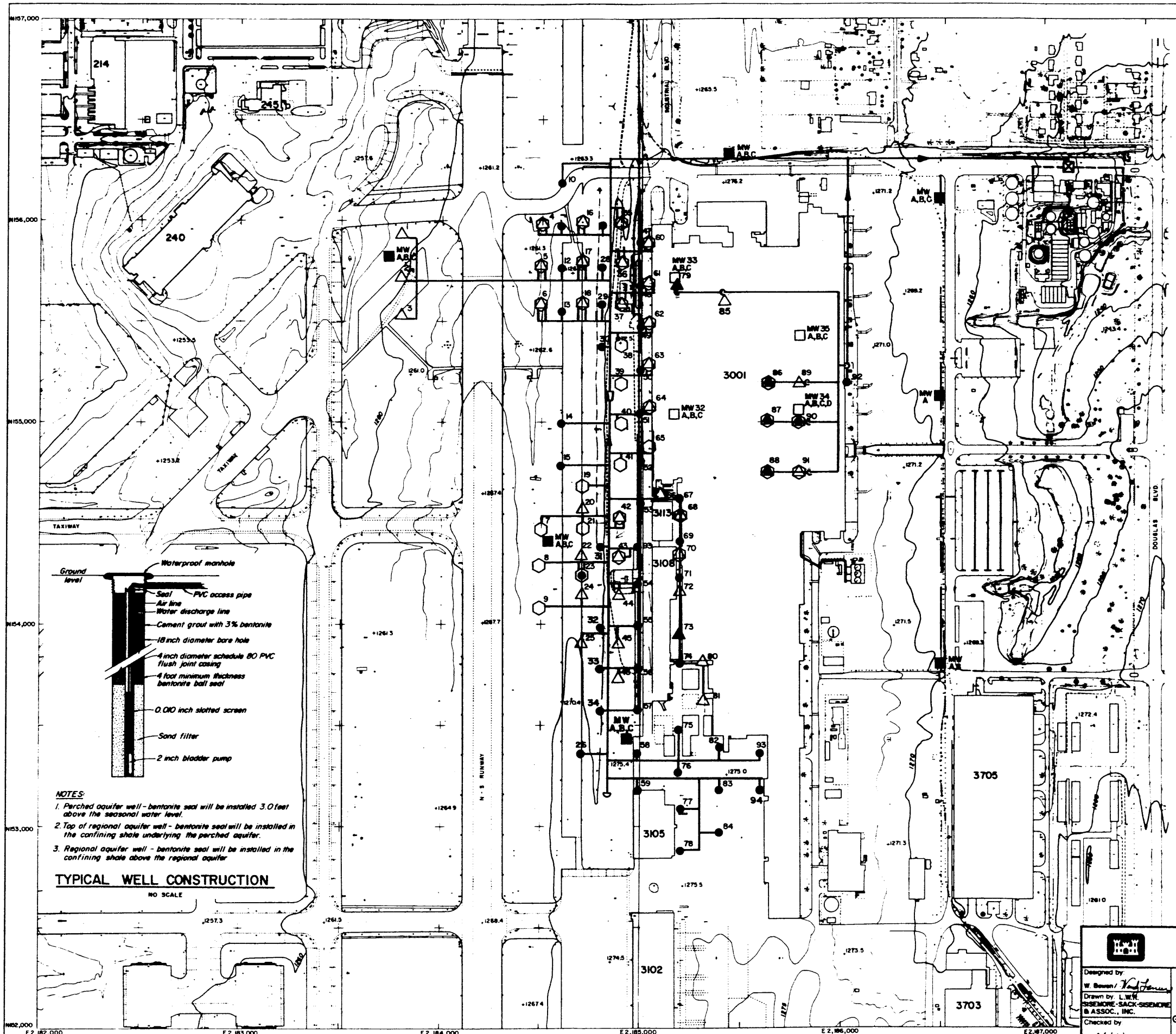
Under this alternative, groundwater extraction wells would be placed inside Building 3001 and outside of the building. Approximately 129 extraction wells would be constructed at a distance of up to 1000 feet from the building to provide for effective control and collection of the contaminant plume. A groundwater collection manifold similar to that of Alternative 1-2 would be connected to the extraction wells. The groundwater collection manifold and the extraction well locations are shown on Figure 2-3. The construction and placement of extraction wells within and outside the 3001 complex would be accomplished such that minimal disruption of facility activities would occur.

2.2 GROUNDWATER TREATMENT AND DISPOSAL

A summary is provided in this section for each of four remedial alternatives which were considered in the FS report for the treatment and disposal of contaminated groundwater. These groundwater treatment and disposal alternatives, with the exception of the no action alternative, pertain to treatment facilities which follow the groundwater collection manifold system described in Section 2.1.3 above.

2.2.1 Alternative 2-1 - Modified IWTP/Industrial Reuse

Alternative 2-1 consists of initially routing contaminated groundwater from the extraction wells to an air stripper. The air stripper will remove volatile organic compounds. The air-stripped water will then be pumped to the existing IWTP and mixed with the influent industrial wastewater. Treatment for inorganics and nonvolatile organics will occur at the existing IWTP. The treated wastewater stream groundwater and industrial wastewater) will then be routed to Tinker AFB's existing industrial reuse system. A site plan is shown on Figure 2-4 and a flow schematic is shown on Figure 2-5.



U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
TULSA, OKLAHOMA

Designed by W. Bowen
Drawn by L.W.H. SISEMORE-SACK-SISEMORE & ASSOC., INC.
Checked by
Submitted by
Chief, Geotechnical Branch

TINKER AIR FORCE BASE, OKLAHOMA
INSTALLATION RESTORATION PROGRAM
BUILDING 3001/FEASIBILITY STUDIES

GROUNDWATER CONTROL/COLLECTION PLAN
ALTERNATIVE 1-3

FIGURE 2-3

Dwg. No.

Date: NOVEMBER, 1988

Existing treatment processes at the IWTP include oil/water separation, flow equalization, metals reduction/precipitation by sulfide precipitation, biological treatment by activated sludge, oxidation/disinfection by chlorination, and pressure filtration. Sludge is thickened and dewatered onsite and disposed of offsite at a RCRA permitted facility.

The air stripper design is based on flow rate of 62 gpm and influent concentrations as presented in Table 2-1. Discharge limits will be based on toxic pollutant effluent limitations for end of pipe biological treatment for the organic chemistry industry (40 CFR 414.91) and are also presented in Table 2-1.

TABLE 2-1

VOLATILE ORGANIC COMPOUND INFLUENT AND EFFLUENT CONCENTRATIONS

Volatile Organic	Influent Concentration, ug/L	Discharge Limit, ug/L
Trichloroethylene	3,139	21
1,2-Dichloroethylene	122	21
Tetrachloroethylene	27	22
Toluene	6	26
Benzene	4	37
Xylene	1	--
Acetone	58	--

Design of the air stripper is based on reducing the TCE concentration to below the discharge limit. Significant concentration reductions are anticipated for all other volatile organic compounds, with the exception of acetone, which will be reduced by only 10 percent.

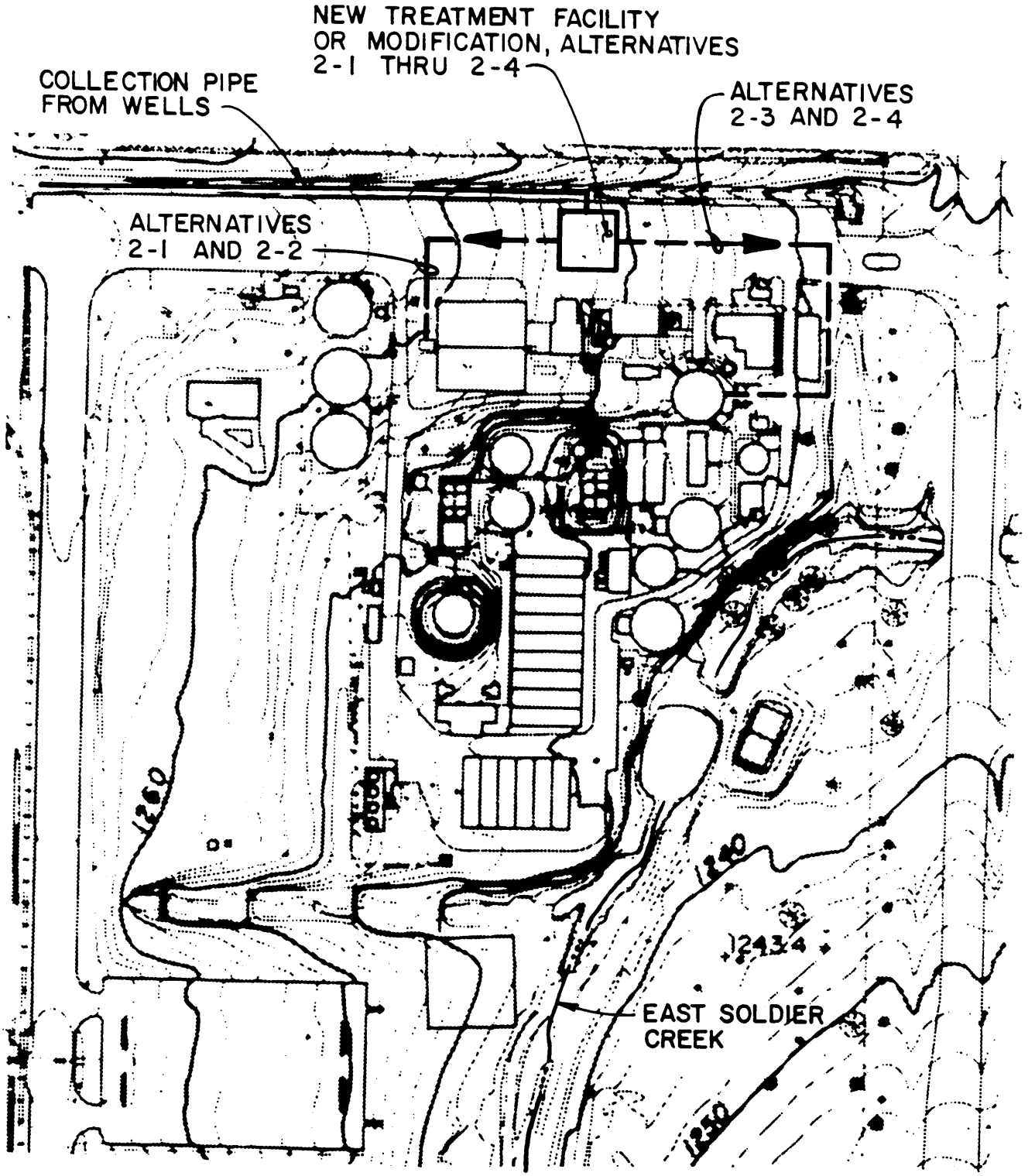


FIGURE 2-4
GROUNDWATER TREATMENT
AND DISPOSAL SITE PLAN
ALTERNATIVES 2-1,2-2,2-3 & 2-4

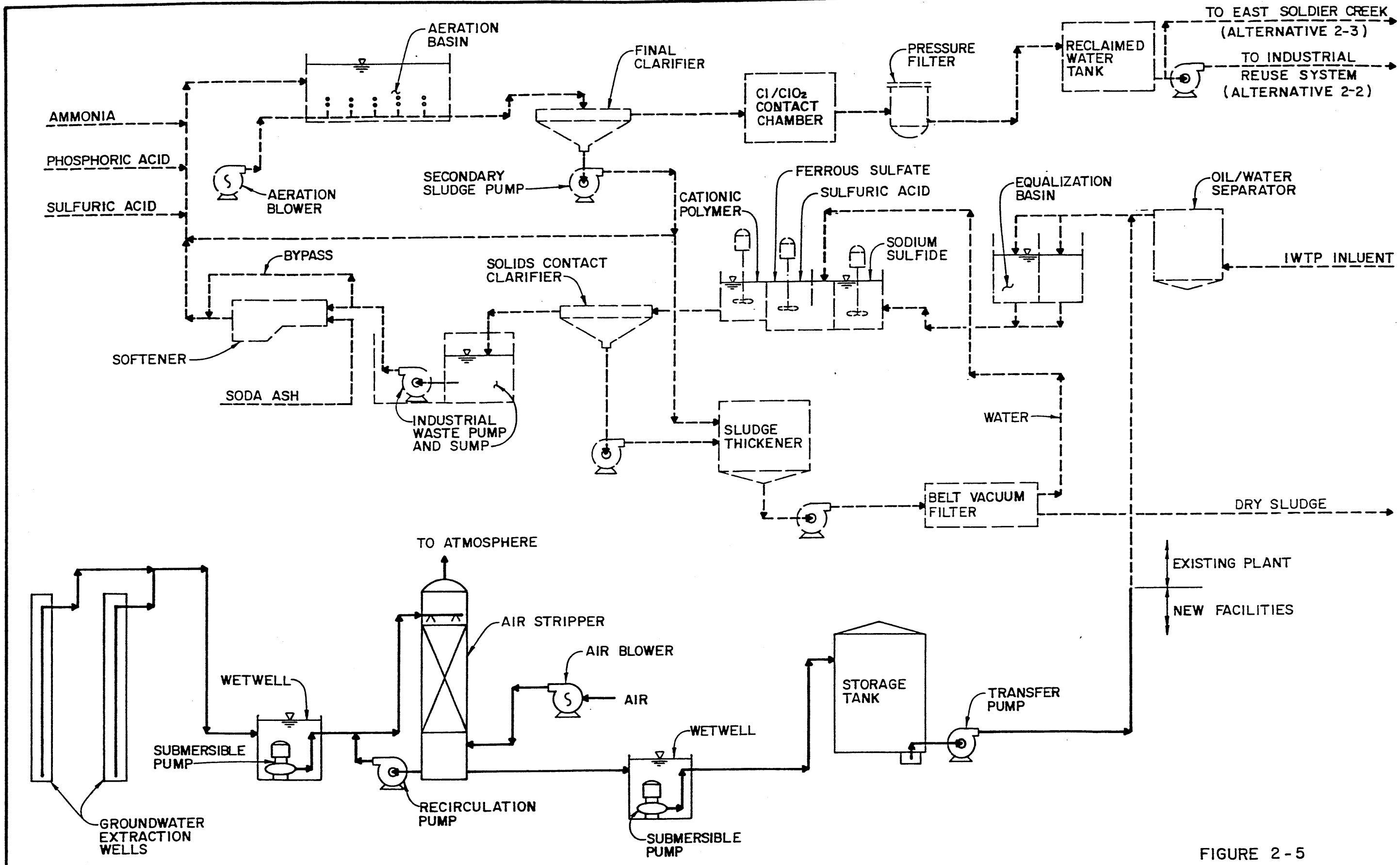


FIGURE 2-5
FLOW SCHEMATIC
ALTERNATIVES 2-1 AND 2-2

The fate of the volatile compounds removed from the groundwater by the air stripper was studied to evaluate potential air emission problems. Trichloroethylene was the only contaminant that exited the stripper at concentrations exceeding occupational safety or ambient air quality standards (Table 2-2). Because TCE exceeded these limits a dispersion model was used to examine the effects of time and distance on concentration. Modeling results predicted that maximum ambient air TCE concentration at ground level would be less than 0.2 ppm, below the 0.5 maximum acceptable ambient air concentration for TCE.

TABLE 2-2

AIR STRIPPER STACK GAS
VOLATILE ORGANIC CONCENTRATION
AND AIR STANDARDS

Contaminant	Discharge Concentration, ppm	Maximum Acceptable Ambient Air Concentration (OCAA, 1981)
Trichloroethylene	5.63	0.5
1-2 Dichloroethylene	.289	1.0
Tetrachloroethylene	.038	0.5
Toluene	.015	10.0
Benzene	.012	0.1
Xylene	.002	10.0
Acetone	.002	1.0

Groundwater will be treated for heavy metal and nonvolatile organic removal by using the existing metals reduction/precipitation and activated sludge units of the IWTP.

Under this alternative, treated groundwater will be reused in various on-base operations associated with servicing, repairing, and/or upgrading aircraft and jet engines. The water quality requirements for industrial reuse and the calculated concentration of contaminants found in the pumped groundwater are given in Table 2-3.

2.2.2 Alternative 2-2 - Modified IWTP/Surface Water Discharge

Alternative 2-2 differs from Alternative 2-1 only by the effluent discharge destination. Instead of industrial reuse of the modified IWTP effluent, as in Alternative 2-1, the effluent will be discharged to East Soldier Creek via the existing IWTP outfall.

2.2.3 Alternative 2-3 - Treatment/Industrial Reuse

A new wastewater treatment system will be provided under this alternative. This new system will then be connected to the existing wastewater reuse system. A flow schematic for this process is shown on Figure 2-6. The new system will initially treat the groundwater by air stripping. The air-stripped groundwater will then be pumped to a new metals removal unit. This process will use sodium sulfide and ferrous sulfate (SS/FS) to chemically reduce and precipitate heavy metals.

Water from the new SS/FS unit will flow to a granular activated carbon unit, which will remove non-volatile organics. Water from the granular activated carbon unit will then flow to the industrial reuse system described in Alternative 2-1.

2.2.4 Alternative 2-4 - Treatment/Surface Water Discharge

Alternative 2-4 differs from Alternative 2-3 only by the effluent discharge destination. Instead of industrial reuse of the new treatment plant effluent, as in Alternative 2-3, the effluent will be discharged to East Soldier Creek.

TABLE 2-3

INDUSTRIAL REUSE WATER REQUIREMENTS VS. CONTAMINATED GROUNDWATER CHARACTERISTICS

	Instantaneous Limits for Industrial Water Reuse[1]	Calculated Concentration of Contaminants in Pumped Groundwater[2]
		(mg/l)
pH	6.0 to 9.5	-
Specific Conductance	2000 umhos/cm	-
Turbidity	50 units	-
Total Hardness as ($CaCO_3$)	200 mg/l	-
Chemical Oxygen Demand	150 mg/l	-
Total Suspended Solids	30 mg/l	-
Cadmium, Total	0.05 mg/l	-
Chromium, Total	1.0 mg/l	0.606
Chromium, Hexavalent	0.1 mg/l	-
Cyandie, Total	0.025 mg/l	-
Copper, Total	0.1 mg/l	-
Lead, Total	0.1 mg/l	0.153
Nickel, Total	1.0 mg/l	0.156
Zinc, Total	1.0 mg/l	-
Phenols	1.0 mg/l	-
Oil and Grease	10.0 mg/l	-
TCE	-	3.149
1,2-DCE	-	0.122
PCE	-	0.027
Toluene	-	0.006
Benzene	-	0.004
Xylene	-	0.001
Acetone	-	0.058
Barium	-	4.138

(1) Tolerence Levels for Treated Effluent Use in Chemical Cleaning

(2) Letter from Black & Veatch to COE, Tulsa District, dated May 11, 1988.

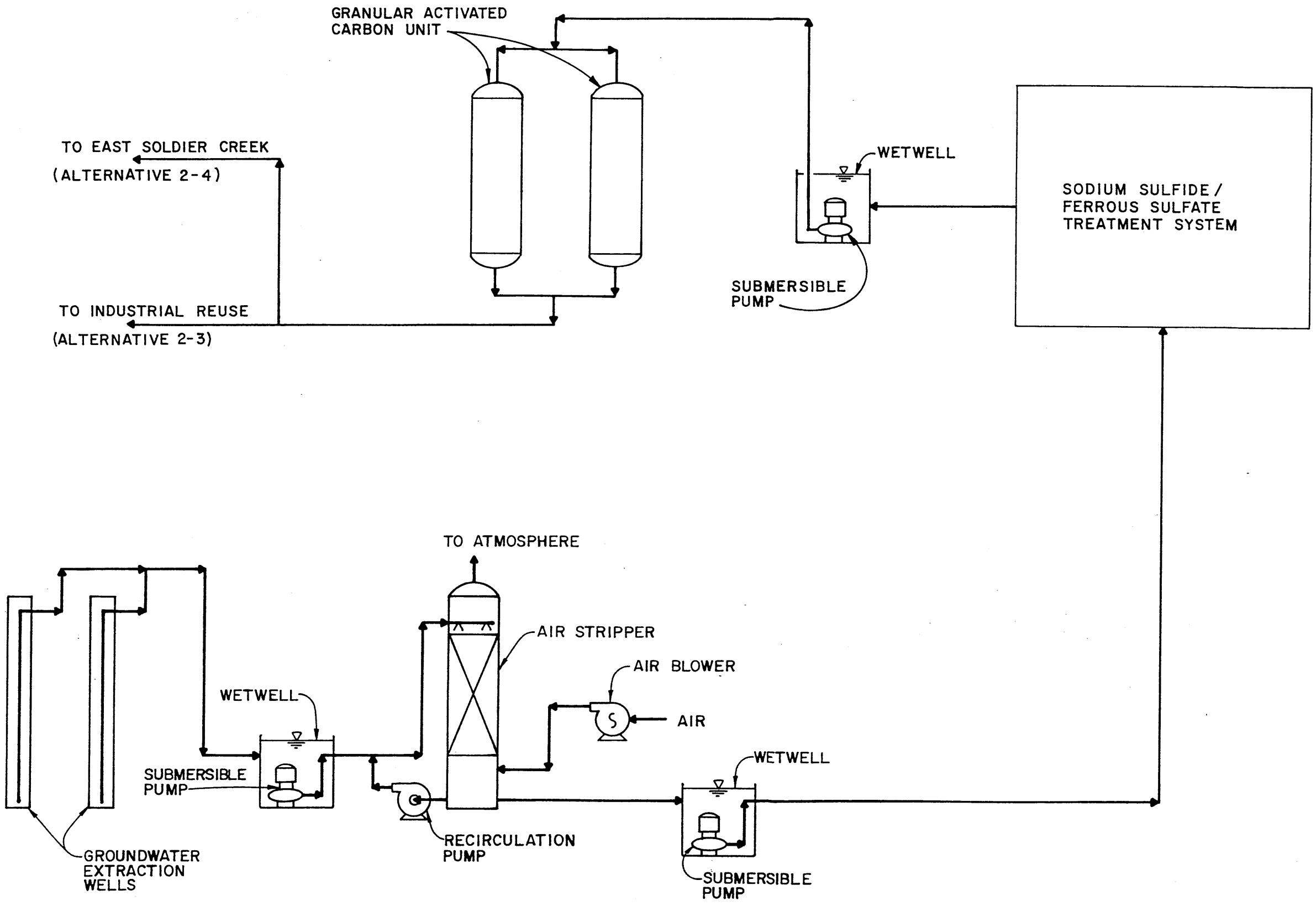


FIGURE 2-6
FLOW SCHEMATIC
ALTERNATIVES 2-3 AND 2-4

3.0 AFFECTED ENVIRONMENT

Tinker AFB lies in a heavily populated area within metropolitan Oklahoma County. Building 3001 encompasses an 80-acre area of the base. Other installation facilities and structures are adjacent to the Building 3001 complex. The lands surrounding this industrial complex have been heavily disturbed. The surrounding land is used predominantly for parking areas, roadways, sidewalks, and aircraft taxiway. Little undisturbed area exists within the project area. Open areas around the facilities are vegetated by domestic grasses and are mowed and landscaped. Natural areas existing at Tinker AFB occur on the less developed portions of the installation outside of the project area.

Wildlife common to Tinker AFB includes predominantly those species which are adaptable to a habitat developed for human use. Mammalian species found on Tinker AFB include the eastern fox squirrel (Scurius niger), thirteen-lined ground squirrel (Citelbus tridecemlineatus), plains pocket gopher (Geomys Bursarius), eastern cottontail rabbit (Sylvilagus floridanus), striped skunk (Mephitus mephitus), raccoon (Procyon lotor), opossum (Didelphis marsupalis), and white-footed deer mouse (Peromyscus lucopus). A variety of avian species may be found at the installation, including killdeer (Charadrius vociferus), night hawk (Chordeiles minor), chimney swift (Choetura pelagica), scissor tail flycatcher (Muscivora forficata), and others.

4.0 ENVIRONMENTAL EVALUATION

This section presents an environmental evaluation of the groundwater removal and collection alternatives and the groundwater treatment and disposal alternatives described in Section 2. The environmental evaluation includes environmental and public health impacts, both of which are presented in the FS Report[2] and summarized in this section. Environmental and public health impacts are required to be evaluated along with three other primary criteria, in accordance with Section 300.68(h) of the National Contingency Plan (NCP).

The environmental requirements shown in Table 4-1 were reviewed to determine needed or appropriate interaction with state or Federal agencies having required administrative responsibilities.

TABLE 4-1
ENVIRONMENTAL STATUTES
AND OTHER ENVIRONMENTAL REQUIREMENTS

Federal Statutes

a. Archeological and Historic Preservation Act, as amended, 16 U.S.C. 469, et seq.
b. Clean Air Act, as amended, 42 U.S.C., 1857h-7. et seq.
c. Clean Water Act, as amended, (Federal Water Pollution Control Act) 33 U.S.C. 1251, et seq.
d. Endangered Species Act, as amended, 15 U.S.C. 1531, et seq.
e. Fish and Wildlife Coordination Act, as amended, 16 U.S.C. 661, et seq.
f. National Environmental Policy Act, as amended, 42 U.S.C. 4321, et seq.
g. Wild and Scenic Rivers Act, as amended, 16 U.S.C. 1271, et seq.
h. Farmland Protection Policy Act, 7 U.S.C. 4201, et seq.
i. Toxic Substances Control Act

Executive Orders, Memoranda, etc.

j. Floodplain Management (E.O. 11988)
k. Protection of Wetlands (E.O. 11990)

4.1 EVALUATION PROCESS

This subsection provides a description of the process used in the FS report to evaluate the previously described alternatives in terms of both

environmental and public health impacts. To facilitate evaluation, a numerical system with a scale of 1 to 5 has been used to rate each alternative. The ratings range from 1 for the best rating to 5 for the worst. Alternatives are considered unacceptable if they receive a rating of 5 for either evaluation criteria.

4.1.1 Public Health Impacts.

The public health evaluation of alternatives assesses the extent to which each alternative mitigates long-term exposure to any residual contamination and protects public health during and after completion of the remedial action. SARA emphasizes that remedies must be protective of human health by meeting or exceeding applicable or relevant and appropriate standards (ARARs) or health-based threshold concentration limits established through a site-specific endangerment assessment.

In evaluating both long- and short-term public health impacts, two primary areas must be considered. First, there must be an exposure or a potential exposure to the contaminant for the recipient's health to be affected adversely. If there is no exposure, there will be no adverse health effects. The second area requiring consideration in the evaluation of alternatives is the relationship of the actual concentration of the contaminant to published exposure limits or threshold limits established during an endangerment or risk assessment. Both areas must be considered to properly evaluate the impact an alternative might have on public health.

Evaluation of short-term impacts will consider health effects on workers during construction of the remedial action and on the public for the interim periods prior to remedial action implementation. Long-term impacts will be judged based on the chronic intake of the contaminant over the lifetime of the remedial action.

Alternatives for both the short-term and long-term are evaluated on the following scale:

1 - Alternative prevents intake and incidental contact with contaminant concentrations exceeding limits established by ARARs.

2 - Alternative prevents intake but allows potential incidental contact with contaminant concentrations exceeding limits established by ARARs.

3 - Alternative allows for intake of contaminant concentrations approaching limits established by ARARs.

4 - Alternative allows for intake of contaminants at concentrations above limits established by ARARs but below threshold limits.

5 - Alternative allows for intake of contaminants at concentrations above limits established by ARARs and threshold limits.

4.1.2 Environmental Impacts.

Each remedial alternative will be evaluated for beneficial and adverse environmental impacts for both the long- and short-term. Criteria for evaluating beneficial effects are final environmental conditions, improvements in the biological environment, and improvements in resources people use. Criteria for evaluting adverse effects are the expected effect of the remedial action and the measures taken in the event inevitable or irreversible effects are realized.

For each alternative, the environmental impacts are rated in accordance with the following scale:

1 - Alternative mitigates damages to the environment.

2 - Alternative minimizes damages to the environment.

3 - Adverse environmental impacts are generally limited, controllable, and within acceptable limits.

4 - Alternative causes limited uncontrollable or unacceptable effects.

5 - Alternative causes significent uncontrollable or unacceptable effects.

4.2 GROUNDWATER REMOVAL AND COLLECTION

The no action alternative and the two groundwater removal and collection alternatives are evaluated in this subsection with regard to public health and environmental impacts.

4.2.1 Alternative 1-1 - No Action

The no action alternative does not involve any pumping or treatment of contaminated groundwater, but does include monitoring of the groundwater contaminant plumes and surface water monitoring at East Soldier Creek. The monitoring well network would consist of 18 new stainless steel wells combined with 13 existing stainless steel wells.

4.2.1.1 Public Health Impacts. The public health impacts of the no action alternative were assessed in the baseline risk assessment[3] of the groundwater contamination of Building 3001 site. As a result of the predicted contamination of several water supply wells, a complete pathway of exposure exists. The no action alternative would continue to allow that groundwater pathway to exist. Although short-term risk analysis from that pathway failed to show potential public health impacts from present levels of contamination in drinking water wells, future migration from the perched aquifer would increase contaminant concentrations to levels greater than Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs) and create potential long-term health risks. Continued migration of the contaminant plume will create an additional exposure pathway, surface water, under no action. Creation of the surface water pathway into Soldier Creek exposes offsite populations around Tinker AFB and downstream to contaminants through inhalation and ingestion routes. Hazards posed by noncarcinogens and risks by carcinogens from groundwater and surface water pathways were quantified in the baseline risk assessment[3]. Public health risks were indicated from long-term exposure (70 years) to noncarcinogens through ingestion of groundwater and through ingestion of fish in Soldier Creek. Risk characterization of carcinogens indicated acceptable risks (10^{-5} to 10^{-7}) from consumption of groundwater at Tinker AFB (10^{-5}) and consumption of fish from Soldier Creek (10^{-6}). The Alternative 1-1 rating for public health impacts is 5.

4.2.1.2 Environmental Impacts. The no action alternative does not create any physical disturbance or disruption of the environment, but introduces contaminants to the environment that may create toxic or physiological

impacts once the surface pathway is complete. The effects of no action have no short-term impacts, but once contaminants in the perched aquifer reach Soldier Creek, the contaminants may result in acute or chronic impacts on aquatic organisms. Aquatic organisms will bioconcentrate contaminants from the water column of Soldier Creek, potentially resulting in reproductive effects, carcinogenic effects, or physiologic stress causing secondary impacts from disease. Terrestrial organisms ingesting water or aquatic organisms from Soldier Creek may experience similar impacts. This alternative could potentially result in adverse impacts on the environment of Soldier Creek. The Alternative 1-1 rating for environmental impacts is five.

4.2.2 Alternative 1-2 - Groundwater Removal From Exterior Wells Only. This alternative includes pumping groundwater from 111 extraction wells located around the exterior of building 3001 at a combined flow rate of 71,820 gallons per day (gpd) or 50 gallons per minute (gpm), as well as the groundwater monitoring described for Alternative 1-1 (with the exception of the surface water sampling).

4.2.2.1 Public Health Impacts. Placement and operation of the recovery well field would provide remediation over a 30 year time period. Concentrations of indicator contaminants migrating from highly contaminated overlying aquifers to water supply wells would decline over the remediation period. Contaminant concentrations at these water supply wells (which were predicted to exceed SDWA MCLs between exposure years 50 and 70 under no action) would return to prerelease levels, resulting in a reduction in health threats over the no action alternative. Half of the contaminated monitoring wells are expected to achieve zero concentrations of indicator organics within the first 10 years of remediation. Therefore, no adverse public health impacts would result from this alternative. The Alternative 1-2 rating for public health impacts is 2.

4.2.2.2 Environmental Impacts. The placement and operation of the ground water removal system would result in no adverse impacts to the environment. The alternative would not physically affect the surface environment of

Tinker AFB or the surrounding environment. The removal system would stop future migration to uncontaminated waters of the aquifer and, over the 30 year remediation period, return the groundwater in the producing zone to prerelease quality. Control of the migration of the perched aquifer into Solider Creek would prevent seepage into the surface water and impacts on the aquatic populations. The remediation alternative would result in beneficial impacts on the human and wildlife environment of Tinker AFB and surrounding community. The Alternative 1-2 rating for environmental impacts is 2.

4.2.3 Alternative 1-3 - Groundwater Removal From Interior and Exterior Wells

Alternative 1-3 has the same well layout, including monitoring wells, as Alternative 1-2 except that wells will be located in the building interior. The 111 exterior wells would be combined with 18 interior wells and pumped at a total flow rate of 88,180 gpd or 62 gpm.

4.2.3.1 Public Health Impacts. Public health effects from placement and operation of the groundwater removal system under this alternative would be essentially the same as those of Alternative 1-2. The predicted results in the decline of contaminant concentrations in water supply wells from groundwater removal would have the same beneficial health effects. Placement and operation of the recovery well field would provide remediation over a 30 year time period. Concentrations of indicator contaminants migrating from highly contaminated overlying aquifers to water supply wells would decline over the remediation period. Contaminant concentrations at these water supply wells (which were predicted to exceed SDWA MCLs between exposure years 50 and 70 under no action) would return to prerelease levels, resulting in a reduction in health threats over the no action alternative. Half of the contaminated monitoring wells are expected to achieve zero concetrations of indicator organics within the first 10 years of remediation. Therefore, no adverse public health impacts would result from this alternative. The Alternative 1-3 rating for public health impacts is 2.

4.2.3.2 Environmental Impacts. The placement and operation of the groundwater removal system would result in no adverse impacts on the environment. The alternative would not physically affect the surface environment of Tinker AFB or the surrounding environment. The removal system would stop future migration to uncontaminated waters of the aquifer and over the 30 year remediation period, returning the producing zone groundwater to prerelease quality. Control over migration of the perched aquifer into Soldier Creek would prevent seepage into the surface water and impacts on the aquatic populations. The remediation alternative would result in beneficial impacts on the human and wildlife environment of Tinker AFB and surrounding community. The Alternative 1-3 rating for environmental impacts is 1.

4.3 GROUNDWATER TREATMENT AND DISPOSAL

The four alternatives for groundwater treatment and disposal are evaluated in this subsection with regard to public health and environmental impacts.

4.3.1 Alternative 2-1 - Modified IWTP/Industrial Reuse

Alternative 2-1 consists of routing contaminated groundwater collected from the extraction wells to an air stripper, using the air stripper to remove volatile organic compounds, pumping the air stripper effluent to a storage tank, treating for inorganics and nonvolatile organics at the existing IWTP, and reusing the treated groundwater.

4.3.1.1 Public Health Impacts. A potential exists for short-term health impacts during operation and maintenance of the treatment facilities, particularly contact with contaminated groundwater or inhalation of vapors.

Treatment plant personnel should be aware of the nature of the waste stream being treated and should use the appropriate personnel protection equipment and take the necessary monitoring precautions. As previously discussed in Section 2.2, emissions from the air stripping operation will not affect the health of Tinker AFB personnel or the surrounding populace.

Treated groundwater will have low levels of contaminants when it is directed to the facility reuse system. These levels are expected to be below hazardous exposure levels for groundwater and industrial water. However, the reuse system still may expose (dermal contact and inhalation) Tinker AFB personnel to low levels of hazardous contaminants. Therefore, this alternative was given a public health impact rating of 3.

4.3.1.2 Environmental Impacts. The treatment of groundwater in the modified IWTP will reduce the potential for adverse environmental impacts. Under this alternative, contaminants removed from the groundwater will either be released to the air from an air stripper (volatile organic compounds) or sent to a RCRA approved facility for final disposal in the form of sludge (metals).

These releases, discussed further in Section 2.2, are not expected to result in any adverse environmental impacts. Organic contaminants will be released to the atmosphere. However, air releases are predicted to be below existing air quality standards after dispersion (Section 2.2). Construction activities associated with IWTP modifications will impose short-term impacts on low quality habitat (not supportive of native wildlife) at the site. Wildlife in this area will experience no long-term impacts as a result of this activity.

This alternative will minimize the release of contaminants to East Soldier Creek and will reduce the extent of groundwater contamination. Therefore, this alternative was given an environmental impact rating of 2.

4.3.2 Alternative 2-2 - Modified IWTP/Surface Water Discharge

Alternative 2-2 differs from Alternative 2-1 only by the effluent discharge destination. Instead of industrial reuse of the Modified IWTP effluent, as in Alternative 2-1, the effluent will be discharged to East Soldier Creek via the existing IWTP outfall.

4.3.2.1 Public Health Impacts. Under this alternative a potential exists for treatment facility exposures similar to those described for Alternative 2-1. However, no predictable exposures during wastewater reuse would occur, since there will be surface water discharge under this alternative. These discharges will meet existing NPDES limitations.(2) Therefore, this alternative is given a public health impact rating of 2.

4.3.2.2 Environmental Impacts. This alternative will have similar environmental impacts as discussed for Alternative 2-1. With surface water discharges of treated groundwater, increased flows to Soldier Creek can be expected. Provided that treatment of this water reduces contaminants to permitted levels (Section 2.2), these discharges should not adversely affect the aquatic environment. This alternative is given an environmental impact rating of 2.

4.3.3 Alternative 2-3 Treatment/Industrial Reuse.

This alternative consists of on-site treatment of contaminated groundwater in a new groundwater facility, followed by industrial reuse. The new treatment facility will consist of flow equalization, air stripping, reduction/precipitation, filtration, and carbon adsorption. Sludge will be dewatered onsite and disposed of in a RCRA authorized disposal facility.

4.3.3.1 Public Health Impacts. The public health impacts for this alternative will be the same as Alternative 2-1, which also incorporates industrial reuse of treated groundwater. The level of treatment anticipated is expected to be comparable to the modified IWTP. Therefore, this alternative was given a public impact rating of 3.

4.3.3.2 Environmental Impacts. This alternative will have similar environmental impacts as Alternative 2-1. Therefore, this alternative was given an environmental impact rating of 2.

4.3.4 Alternative 2-4 - Treatment/Surface Water Discharge

Alternative 2-4 differs from Alternative 2-3 only by the effluent discharge destination. Instead of industrial reuse of the new treatment plant

effluent, as in Alternative 2-3, the effluent will be discharged to East Soldier Creek via a new outfall structure.

4.3.4.1 Public Health Impacts. The public health impacts for this alternative will be the same as Alternative 2-2, which also uses surface water discharge for treated groundwater. Therefore, this alternative is given a public health rating of 2.

4.3.4.2 Environmental Impacts. This alternative will have similar environmental impacts as Alternative 2-2. Therefore, this alternative is given an environmental impact rating of 2.

4.4 EVALUATION SUMMARY

This subsection summarizes the previous public health and environmental evaluations. Presented in Table 4-2 is a summary of each alternative with respect to both evaluation criteria. As shown, with the exception of no action, the competing alternatives are relatively indistinguishable regarding public health and environmental factors. However, the following conclusions can be made:

- Alternative 1-3 (Interior and Exterior Wells) provides the best overall protection to public health and the environment of the groundwater removal/collection alternatives considered.
- The groundwater treatment and disposal alternatives considered are comparable in terms of environmental impacts, however, Alternatives 2-2 and 2-4, which include surface water discharge, are rated higher public health impacts. This is due to the public exposure potential with the industrial reuse system used for discharge of treated groundwater in Alternatives 2-1 and 2-3.

TABLE 4-2
ENVIRONMENTAL AND PUBLIC HEALTH
EVALUATION SUMMARY

ALTERNATIVES	EVALUATION CRITERIA: PUBLIC HEALTH IMPACTS	EVALUATION CRITERIA: ENVIRONMENTAL IMPACTS
GROUNDWATER REMOVAL AND COLLECTION		
Alternative 1-1 No Action	Does not protect public health. Allows migration into creek and producing zone.	Mobility and volume of contamination will increase.
	Rating is 5.	Rating is 5.
Alternative 1-2 Exterior Wells	Protects public health. Prevents migration into creek and reduces it to producing zone.	Mobility and volume of contamination will decrease.
	Rating is 2.	Rating is 2
Alternative 1-3 Interior and Exterior Wells	Same as Alt. 1-2, but reduces the threat to the producing zone faster.	Mobility and volume of contaminants will decrease more than Alt 1-2 since less will be going into lower aquifers.
	Rating is 2.	Rating is 1.
GROUNDWATER TREATMENT AND DISPOSAL		
Alternative 2-1 Modified IWTP/ Industrial Reuse	Tinker AFB personnel may be exposed to low levels of hazardous contaminants during operation and maintenance of the treatment facility and wastewater reuse system.	Adverse environmental impacts are not expected. Release of contaminants into Soldier Creek and its tributaries will be minimized.
	Rating is 3.	Rating is 2.

TABLE 4-2 (Continued)
ENVIRONMENTAL AND PUBLIC HEALTH
EVALUATION SUMMARY

ALTERNATIVES	EVALUATION CRITERIA: PUBLIC HEALTH IMPACTS	EVALUATION CRITERIA: ENVIRONMENTAL IMPACTS
GROUNDWATER TREATMENT AND DISPOSAL		
Alternative 2-2 Modified IWTP/ Surface Water Discharge	Tinker AFB personnel may be exposed to low levels of hazardous contaminants during operation and maintenance of the treatment facility.	Adverse environmental impacts are not expected. Increased flows to Soldier Creek should not adversely affect the aquatic habitat.
	Rating is 2.	Rating is 2.
Alternative 2-3 Treatment/ Industrial Reuse	Tinker AFB personnel may be exposed to low levels of hazardous contaminants during operation and maintenance of the treatment facility and wastewater reuse system.	Adverse environmental impacts are not expected. Release of contaminants into Soldier Creek and its tributaries will be minimized.
	Rating is 3.	Rating is 2.
Alternative 2-4 Treatment/Surface Water Discharge	Tinker AFB personnel may be exposed to low levels of hazardous contaminants during operation and maintenance of the treatment facility.	Adverse environmental impacts are not expected. Increased flows to Soldier Creek should not adversely affect the aquatic habitat.
	Rating is 2.	Rating is 2.

5.0 RECOMMENDED ALTERNATIVES

Specific remedial alternatives are recommended in the FS report[2] based on environmental and public health impacts along with other evaluation criteria. The other evaluation criteria considered in this recommendation, as required by the NCP, are technical feasibility, institutional requirements, and implementation costs. Presented in Table 5-1 is the alternative recommended in the FS report[2] for groundwater removal/collection.

TABLE 5-1
RECOMMENDED ALTERNATIVE

Alternative Group	Recommended Alternative
Groundwater Removal and Collection	Alternative 1-3 - Groundwater Removal from Interior and Exterior Wells

The recommended remedial alternative as well as either of Alternatives 2-1, 2-2, 2-3, or 2-4 for groundwater treatment and disposal when implemented will produce few adverse environmental impacts in or around the Building 3001 site . The area has been heavily disturbed in the past and currently has little terrestrial habitat available. The habitat available is of low quality and is frequently disturbed through mowing.

Much of the project area is paved or covered by facility structures. Construction activities will cause short-term impacts on low quality habitat at the project site. Wildlife of the area would experience no long-term impacts as a result of the proposed action. Treated water discharges are not expected to adversely affect existing water quality in Soldier Creek.

Endangered species have not been reported in the vicinity of the Building 3001 site. Therefore, no impacts on endangered species are expected.

The proposed remedial action would produce long-term improvements to the environment by removing contaminated groundwater and reducing the potential for hazardous contaminant discharges to Soldier Creek.

The proposed remedial action will have no impacts on archeological sites on the installation. The project sites have been heavily disturbed through industrial development in the past and, therefore, have no potential for archeological activities.

6.0 COORDINATION

The recommended remedial actions are being coordinated with the U.S. Fish and Wildlife Service, Oklahoma Department of Wildlife Conservation, Environmental Protection Agency, and the Oklahoma State Historic Preservation Officer. Coordination will be conducted through personal communication and submission of the Environmental Assessment to these regulatory agencies.

REFERENCES

COE (U.S. Army Corps of Engineers). 1988. Environmental Assessment Ground Water Pump Station Construction and Fuels Area Soils Remediation. Tinker Air Force Base.

OCAA (Oklahoma Clean Air Act). 1981. Section 3.8.