CLASS V UNDERGROUND INJECTION WELL INVENTORY AUTHORIZATION FORM, ENHANCED BIOREMEDIATION PILOT STUDY AT SWMU B-3 BIOREACTOR

Prepared for:

CAMP STANLEY STORAGE ACTIVITY
BOERNE, TEXAS

MAY 2006

Class V Injection Well Inventory/Authorization Form

SUBMIT TO:	TEXAS COMMISSION ON ENVIRONMENTAL QUALITY	For TCEQ Use Only
TCEQ Industrial and Hazardous Waste Permits Section MC130 PO Box 13087 Austin, Texas 78711-3087 512/239-6075	CLASS V INJECTION WELL INVENTORY / AUTHORIZATION FORM	Reg. No. ___________ Date Received ___________ Date Authorized ___________

Reg. No.5X27

Section I General Information

Provide the information in items 1 through 8

1. TCEQ Program Area (PST, VCP, IHW, etc.) Contact Name and Phone Number.

   HW Mr. Sonny Rayos (512) 239-2371

2. Agent/Consultant, Contact Name, Address (Street, City, State, and Zip Code), and Phone Number

   Mr. Brian Vanderglas, Parsons 8000 Centre Park Dr., Suite 200 Austin, TX 78754 (512) 719-6059

3 _____Owner__x___Operator
Owner/Operator, Contact Name, Address (Street, City, State, and Zip Code), and Phone Number

   Installation Manager
   U.S. Army, Camp Stanley Storage Activity
   25800 Ralph Fair Rd.
   Boerne, TX 78015-4800 (210) 698-5208

4. Facility Name, Address, (Street, City, County, State, and Zip Code) or location description (if no address is available) and Facility Contact Person and Phone Number.

   Camp Stanley Storage Activity
   25800 Ralph Fair Rd.
   Boerne, TX 78015-4800

5. Latitude and Longitude (degrees-minutes-seconds) and method of determination (GPS, TOPO, etc.). Attach topographic quadrangle map as Attachment A:

   From GPS data for SWMU B-3: Latitude = 29 degrees 42'34.87"N, Longitude = 98 degrees36'49.57"W.

   A copy of the topographic map for CSSA is included as Figure A.1 in Attachment A

6. Type of Well Construction (Vertical Injection, Subsurface Fluid Distribution System, Infiltration Gallery, Temporary Injection Points, etc.) and Number of Injection Wells.

   Water from wells CS-16-LGR and CS-16-CC will be pumped to five infiltration trenches (former disposal trenches where affected soils and debris have been removed and backfilled with wood chips and gravel at a 1:1 ratio by volume). The water will be distributed across the top of the wood chip/gravel mixture via an irrigation and downward spray system. Water will be pumped from the two wells on an as-needed-basis to maintain saturated conditions in the five trenches as determined by two vertical sumps installed in each trench.

7. Detailed Description regarding purpose of Injection System. Attach a Site Map as Attachment B (Attach the Approved Remediation Plan (if appropriate)).

   A description of the injection system and a site map are included in Attachment B.

8. Subsurface Distribution System Installer, Address (Street, City, State, and Zip Code), Phone Number, and License Number

Bids have been received, but a contract has not been established.

License not required for this type of system installer.

Section II Proposed Down Hole Design
Attach a diagram signed and sealed by a licensed engineer as Attachment C

Name of String	Size	Setting Depth	Sacks Cement/Grout – Slurry Volume – Top of Cement	Hole Size	Weight PVC/Steel (lbs/ft)
n/a	n/a	n/a	n/a	n/a	n/a
n/a	n/a	n/a	n/a	n/a	n/a
n/a	n/a	n/a	n/a	n/a	n/a

Section III Proposed Trench System, Subsurface Fluid Distribution System, or Infiltration Gallery
Attach a diagram signed and sealed by a licensed engineer as Attachment D

12. System(s) Dimension	13. System(s) Construction
A certified diagram of the fluid distribution system is included in Attachment D.	A certified diagram of the fluid distribution system is included in Attachment D.

Section IV Site Hydrogeological and Injection Zone Data
Provide the information in items 14 through 31

14. Name of Contaminated Aquifer

Upper and Middle Trinity Aquifer

15. Receiving Formation Name of Injection Zone

Glen Rose Formation (Upper and Lower Units)

16. Well/Trench Total Depth: Estimates based on test pits (listed from west to east as depicted in Figure B.2):

Trench A - 12 feet;

Trench B - 12 feet;

Trench C - 12 feet;

Trench D - 10 feet.

Trench E - 8 feet.

17. Surface Elevation:

Land surface elevation of the Subsurface Fluid Distribution System location at SWMU B-3 is approximately 1,240 feet MSL.

18. Depth to Ground Water:

Highly variable, approximately 60-305 feet bgs depending on season and climate.

19. Injection Zone Depth:

2 feet below existing grade.

20. Injection Zone vertically isolated geologically? No.

Impervious Strata between Injection Zone and nearest Underground Source of Drinking Water. No

Name: Glen Rose Formation
Thickness: Approximately 350 ft

The injection or infiltration will occur into the Glen Rose limestone. The injection location is approximately 4,000 feet from the nearest water supply well, and injection activities are not anticipated to impact local drinking water supplies. The Lower Glen Rose and Cow Creek limestone units are utilized as sources of drinking water in the immediate vicinity of CSSA. The Bexar Shale, a 60 to 80 foot thick sequence of silty dolomite, marl, calcareous shale, and shaley limestone, serves as an aquitard hydraulically separating the Lower Glen Rose and Cow Creek formations.

21.	Provide a list of contaminants and the levels (ppm) in contaminated aquifer Attach as Attachment E: See Tables E.1 and E.2 in Attachment E.
22.	Horizontal and Vertical extent of contamination and injection plume Attach as Attachment F: See Attachment F.
23.	Formation (Injection Zone) Water Chemistry (Background levels) TDS, *etc*. Attach as Attachment G: See Attachment G.
24.	Injection Fluid Chemistry in PPM at point of injection Attach as Attachment H: See Attachment H.
25.	Lowest Known Depth of Ground Water with < 10,000 PPM TDS The depth to high salinity groundwater containing TDS in excess of 10,000 mg/L has not been identified in the vicinity of the site, however, according to Ground-Water Quality of Texas - An Overview of Natural and Man-Affected Conditions, Texas Water Commission, Report 89-01, March 1989, the Trinity Aquifer in Bexar County does not contain groundwater with TDS concentrations greater than 10,000 mg/L. Therefore, groundwater with TDS below 10,000 mg/L can be expected to extend deeper than the approximately 1000-foot sequence of Cretaceous-age deposits in the area. Groundwater with TDS exceeding 10,000 mg/L is believed to occur in the underlying Paleozoic-age schists where lower groundwater flow velocities and higher water-rock interactions will likely result in highly mineralized groundwater.
26.	Maximum Injection Rate/Volume/Pressure For operation of the bioreactor, it is anticipated that a maximum of 35 gpm of untreated groundwater from CS-MW16-LGR and CS-MW16-CC will be pumped into the bioreactor. The initial injection will be followed periodically by discontinuous, lesser flows of 10-30 gpm of formation water to keep the hydraulic head necessary to maintain anaerobic conditions and infiltration into the aquifer. Required flow into the bioreactor will depend on infiltration rates, precipitation, and overall climatic conditions. Pressures within the piping system will be minimal. Once released, the "injection" water will move into the target formation only under force of gravity (see Attachment B for complete details).
27.	Water wells within ¼ mile radius (attach map as Attachment I) No water supply wells are present within 1/4 mile of the B-3 bioreactor infiltration area. See Figure I.1 in Attachment I.
28.	Injection wells within ¼ mile radius (attach map as Attachment I) See Figure I.1 in Attachment I. CS-B3_MW01 is a monitoring well that was used in an investigation for a one-time substrate injection. This well was authorized as an injection well in 2005 and was designated the following TCEQ identification number: 5X2600408WWC11140446/CN602728206/RN104431655.
29.	Monitor wells within ¼ mile radius (attach drillers logs and map as Attachment I) See Figure I.2 in Attachment I.
30.	Sampling frequency: Prior to activating the bioreactor, one round of baseline sampling from nearby monitoring locations will occur to determine pre-injection water quality. As shown in Table B.1, water levels will be collected twice per week from the Trench sumps, monitoring wells (MWs) and multi-port monitoring wells (MPMWs) for the first month and once per week for the remainder of the bioreactor operation. Make-up water samples from a sampling port located between CS-MW-16 LGR/CC and the additive tank, and water samples from the Trench Sumps will be collected monthly and tested for VOCs. If a substrate is added to the bioreactor via the in-line mixer (Figure D.1), TOC concentrations will also be tested in the sump water. Water samples will be collected from MWs and MPMWs in the vicinity of SWMU B-3 at an approximate frequency of once per month for first three months, followed by quarterly sampling. Quarterly reports will be issued to summarize the results of the sampling/monitoring effects. After baseline values have been established over the first year, the data will be reviewed with CSSA and a revised sampling and reporting frequency will be

proposed to UIC permits of the IHW section of the TCEQ. During the initial sampling of the MWs and MPMWs, groundwater samples will be analyzed for TCE and TCE-related compounds, dissolved OC, VOCs (8260), DO, ORP, Methane, pH, TOC, Dissolved OC, and ions including Fe, Mn, SO4, and NO3.

Sampling of wells in Camp Stanley's off-post public and private well monitoring network is conducted on a quarterly basis and will be further evaluated relative to potential geochemical changes resulting from the operation of the bioreactor.

31. Known hazardous components in injection fluid

The contaminant concentrations for the water supply from wells CS-MW16-LGR and CS-MW16-CC are summarized in Tables E.1 and E.2 included in Attachment E. Evaluation of these data indicates that these constituents do not exceed hazardous levels as determined by 30 TAC Chapter 350.

Section V Site History

Provide the information in items 32 through 35

32. Type of facility

CSSA is a U.S. Army facility. SWMU B-3 was reportedly a debris disposal area thought to have been used primarily for municipal garbage disposal and trash burning.

33. Contamination Dates

The disposal trenches were reportedly last used during 1990-1991, but the first use of SWMU B-3 as a landfill is unknown.

34. Original Contamination (VOCs, TPH, BTEX, *etc*.) and Concentrations:

Attach as Attachment J

See Attachment J.

35. Previous Remediation

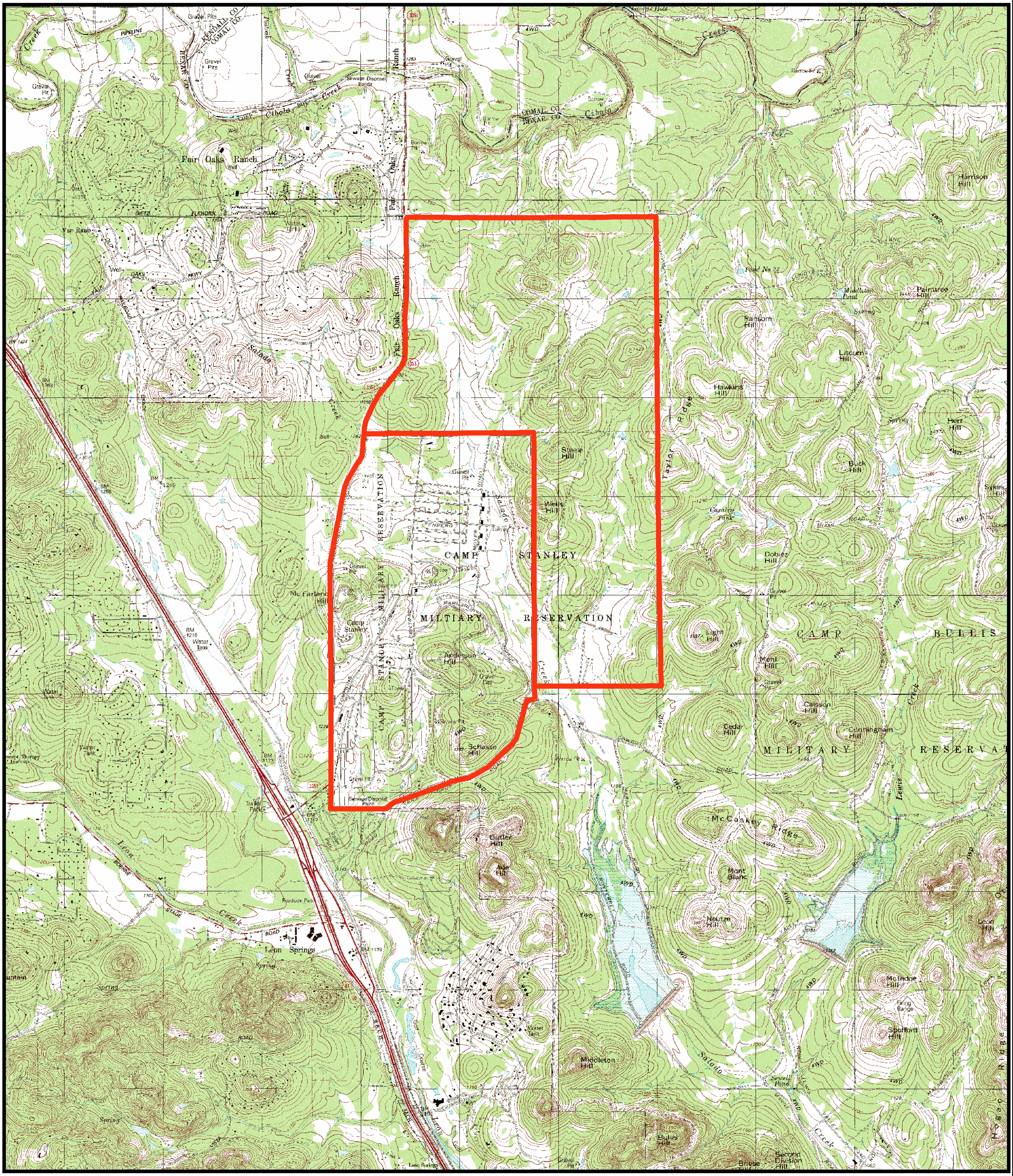
Attach results of any previous remediation as Attachment K

See Attachment K.

<<**NOTE**>> Authorization Form should be completed in detail and authorization given by TCEQ before construction, operation, and/or conversion can begin. Attach additional pages as necessary.

ATTACHMENT A

Maps A.1



0 0.375 0.75 1.5 2.25 3 Miles

Figure: A.1

USGS Topo Map
Camp Bullis Quadrangle
Camp Stanley Storage Activity

P a r s o n s

J:\744223\GIS\b3-permit_app_topo_map.mxd

Attachment B

Design of the SWMU B3 Bioreactor

Introduction

SWMU B-3 is a high priority site and is the main focus of current investigation and interim remediation activities. SWMU B-3 is a site with former disposal trenches located south of Tenberg Drive and east of Salado Creek in the central portion of CSSA as shown in Figure B.1. It covers approximately 3 acres and was reportedly used for municipal garbage disposal and burning. In 1990, the VOCs tetrachloroethene (PCE), trichloroethene (TCE) and *cis*-1,2-dichloroethene (*cis*-DCE) were identified in groundwater samples from nearby water wells CS-16 and CS-D (located approximately 400 feet and 600 feet, respectively, northwest of B-3 as shown in Figure B.1). The detected concentrations exceeded drinking water standards and Well 16 was taken off-line as a post supply well. Well CS-D, which had been used as an agricultural well was maintained as a monitoring well. Based on the proximity of the site to CS-16 and CS-D, SWMU B-3 became the focus of the VOC plume investigation. Subsequent soil gas investigation work confirmed that SWMU B-3 was a VOC source area.

The SWMU B-3 site consists of several north-south trending trenches as shown in Figure B.2. Based on previous soils investigations, the approximate depth of fill material in the five trenches on average appears to be 12 ft below grade. In 2002, the eastern-most trench of the five trenches was excavated to bedrock and backfilled with clean soils.

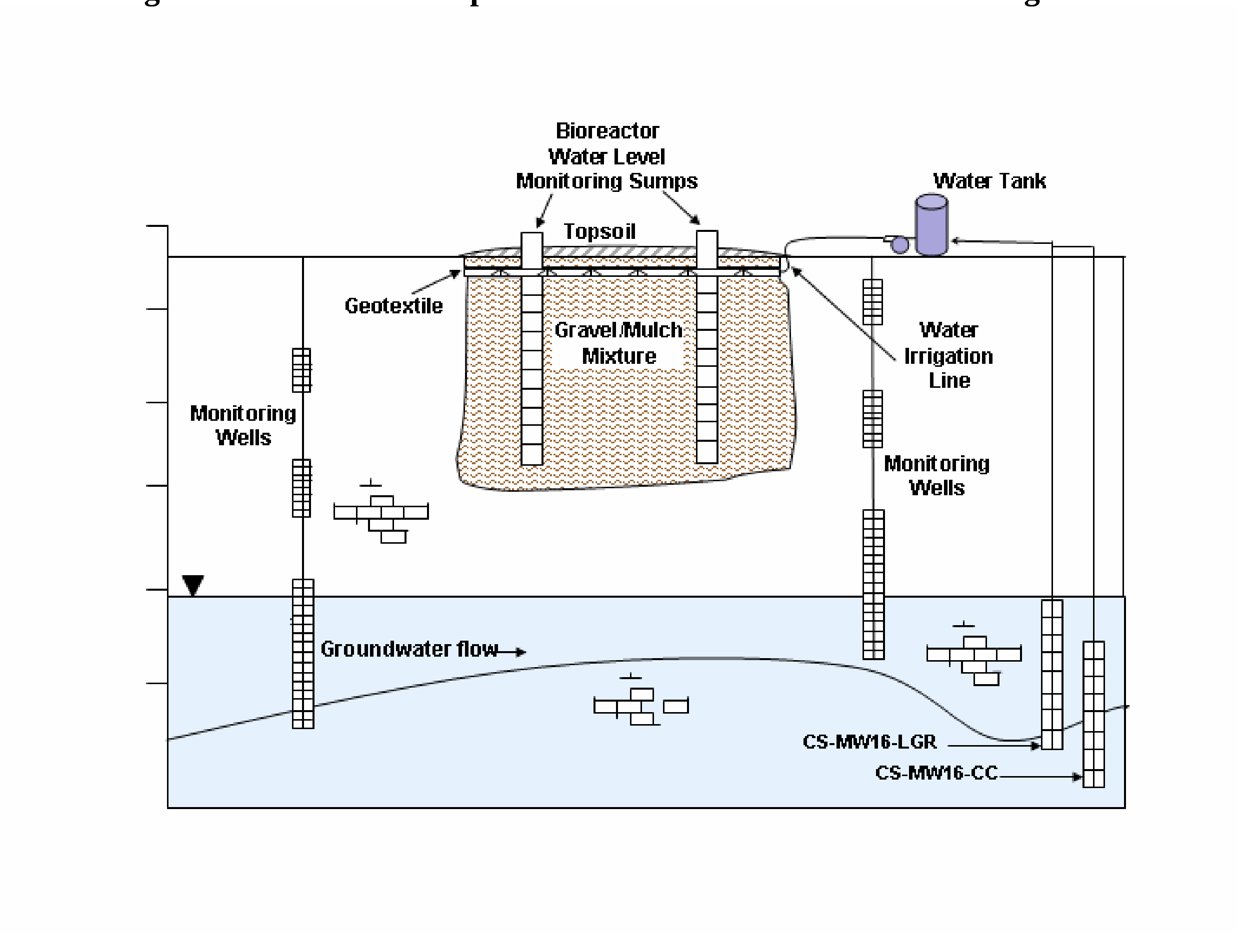
As part of the RCRA activities at Camp Stanley Storage Activity (CSSA), personnel at CSSA are proposing to excavate all waste material from the landfill trenches. After the trenches are excavated, a bioreactor will be constructed at the SWMU B-3 site and a Pilot Study will be conducted to evaluate the effectiveness of enhanced anaerobic degradation to treat volatile organic compounds (VOCs) associated with the SWMU B-3 site. The objective of the bioreactor will be two-fold:

1. To create a bioreactor treatment cell within the excavated trenches for degrading VOCs in the affected ground water from wells CS-MW16-LGR and CS-MW16-CC, and
2. To create a liquid organic food source that will gravity drain into the bedrock underlying SWMU B-3 and promote anaerobic degradation of subsurface contaminants.

The general concept will be to pump water approximately 400 feet from wells CS-MW16-LGR and CS-MW16-CC as shown in Figure B.1 to a network of pipes that overlay the SWMU B-3 trenches identified in Figure B.2. Downward-pointing discharge nozzles located throughout the piping network, will allow water to flow on demand into each trench to create saturated conditions within a portion of the gravel/wood chip mixture. To ensure that saturated conditions are maintained within a vertical portion of each trench, water levels will be periodically monitored via two sumps installed into each of the five trenches. The capability of the bioreactor (combination of all five trenches) to reduce the concentrations of contaminants associated with CS-MW16-LGR and CS-MW16-CC as well as in the subsurface will be accessed through periodic sampling of ground water monitoring wells located around B-3. To further enhance the anaerobic degradation, possible future plans may call for amending the groundwater from CS-16 with anorganic substrate that would be added to the bioreactor via an in-line mixer. A general illustration of the key components associated with the bioreactor is depicted in Figure B.3.

The field activities anticipated for the construction of the bioreactor includes excavation of the soils from the five trenches, placement of a gravel/tree mulch mixture into the five trenches, and installation of the water delivery system. These activities are further described below.

Figure B.3 - General Components of the Bioreactor and Monitoring Points



Soils Excavation

Approximately 18,300 CY of soil/debris will be excavated from the four western trenches (Trenches A, B, C and D in Figure B.2) and the materials will be segregated into three types of stockpiles: 1) metal scrap, 2) visibly affected soils and other non-soil materials greater than six inches in diameter if present, and 3) other soils. Soils within the trenches will be excavated to the top of the weathered limestone, which is the target of the bioreactor treatment. Parson's on-site representative will sample each pile for ex situ waste characterization. The metal scrap, if segregated, will be recycled. Contaminated soil media and other non-soil waste materials will be hauled to permitted off-site landfill for disposal as non-hazardous waste. Unaffected soils will be retained for possible future use at the site as backfill material.

Debris and contaminated soil were excavated from Trench E and backfilled with clean soils in 2002. For the bioreactor construction, the Parsons site representative will direct the contractor to remove the clean backfill soils in this eastern most Trench. The soils which are estimated to be approximately 6,700 CY in volume will be excavated and stockpiled at the site for possible future use in construction of the bioreactor or other on-site use.

Construction of the Bioreactor

The technical basis of the bioreactor will be to pump water from a holding tank to a network of pipes overlying the five trenches shown in Figure B.2. The trenches will contain a mixture of gravel and tree mulch. As water passes over the mulch, the water will become organic-rich and will thus provide a food source for anaerobic degradation of chlorinated organic compounds, e.g., tetrachloroethylene (PCE), trichloroethylene (TCE) and TCE-related compounds in the subsurface strata underlying B-3.

To ensure that saturated conditions are maintained within each trench, water levels will be periodically monitored with a minimum of two bioreactor monitoring sumps installed in each of the five bioreactor trenches at SWMU B-3. Prior to placement of the gravel/tree mulch mixture into a trench, the two monitoring sumps will be temporarily anchored in a vertical position within each trench. The sump casing will consist of 6-inch diameter, five-foot long Schedule 40 PVC well screen with 0.01-inch wide slots, a PVC riser and a base endcap. The sump casing will be set high enough such that it will be two to three feet above the final site grade. During operation of the bioreactor, adjustments to the flow rate into the bioreactor will be maintained by manual adjustments and perhaps in the future, the flow rate of water or a water/substrate mixture into each trench will be automatically adjusted (i.e., via a SCADA system) based on the height of the water column which will be maintained at an approximate height of two feet.

Without damaging the sumps, the trenches will be backfilled with a mixture of gravel and tree mulch at a ratio of 1:1 by volume. The gravel will range from 0.25 to 0.625 inches in diameter, and the tree mulch shall originate from deciduous trees and be approximately 2 inches in nominal size. The tree mulch will not be from weathered source and will be double-ground. After it is thoroughly mixed, the gravel/mulch mixture will be placed into the base of each of the five trenches to a minimum thickness of 5 feet.

Installation of a Water Delivery System

A water delivery system will be installed to convey water from Wells CS-MW16-CC and CS-MW16-LGR to the north side of the trenches at B-3, a distance of approximately 400 feet. The general components of the system are depicted in Figure D.1 and include the following sequence:

The water will be pumped from Wells CS-MW16-CC and CS-MW16-LGR into a holding tank located on the north side of B-3. The tank will be used for temporary water storage prior to the water being pumped to the bioreactor. If a substrate is deemed necessary to stimulate biodegradation, then the substrate will be added to the bioreactor via an in-line mixer as depicted in Figure D.1. The substrate would be a commercially available emulsion that would be pumped into the bioreactor via the storage tank. The purpose of the substrate will be to increase the potential of anaerobic degradation in the bioreactor. If double-ground tree mulch mixed with gravel is not creating the desired results, then a substrate will be added.

A network of pipes (1.5-inch HDPE) will be installed from the transfer pump at the storage tank to each of the five trenches. A main header will run east-west across the north side of the trenches and five supply pipes perpendicular to the header will run lengthwise across the top of each of the trenches. At every 7.5-foot increment, there will be a 0.053-inch stainless steel nozzle pointed downward into the bioreactor. The estimated maximum flow rate that can be made available to the bioreactor from the two wells is approximately 35 gpm. Rigid spacers will be placed along the supply pipes to suspend the spray nozzles off the surface of the gravel/mulch mixture.

After backfilling, each trench will be covered with a geotextile filter fabric followed by placement of an approximate two-foot thick layer of soil to bring the site to grade. The fabric will be placed over the mulch/gravel mixture such that the fabric edge extends one to two feet beyond the top of slope of each trench. The fabric will be stretched across the trench and cut to allow for the two monitoring sumps. The edge of the fabric will be kept loose along the sidewall (to allow for some settlement of the tree mulch) and anchored along the top of slope. Flexible piping is currently proposed for the project, but special allowances may have to be made where the flexible piping extends over the gravel/mulch contact (i.e., the mulch material will likely subside). The north/south road through the B-3 area will be retained and soils excavated from the site during the construction of the bioreactor will be graded across the site so that there is a gradual slope from east to west across the site.

Operation and Maintenance of Bioreactor

The system will be operated for a two to four month period to determine if the sprinkler heads used for this system provide an adequate flow rate of water into the bioreactor to maintain saturated conditions in the trenches. Parsons and CSSA will review water level data from the monitoring sumps to confirm optimum conditions are being maintained. Based on this review, the sump with the closest sump base water elevation to the average base water elevation of all ten sumps will be equipped with a high level switch (LSH) approximately 2 feet above the sump base and a low level switch (LSL) several inches above the base. Activation of the LSH will turn off the transfer pump while activation of the LSL will turn on the transfer pump. The ground water pumps in CS-MW16-CC and CS-MW16-LGR will be equipped with LSL switches to reduce the potential for the wells running dry. The storage tank will also be automated to receive water on demand by the installation of LSL and LSH switches connected directly to controlling power to the well pumps.

Periodic monitoring and maintenance will be implemented at SWMU B-3 to assess the effectiveness of the bioreactor to: 1) treat the contaminants in the groundwater being pumped to the trench, and 2) treat the contaminants present in the materials surrounding and underlying the excavation trenches. The primary monitoring will initially be twice per week measurements of the water levels in the sumps located in each of the trenches. Water samples will be collected from the sumps to measure the effectiveness of treatment of CS-16 water within the bioreactor. Additional sampling will be conducted from the surrounding monitoring wells and MPMWs installed to monitor the recharge of groundwater percolating through the formation. A summary of the anticipated data collection efforts and projected frequency of sampling along with the parameters to be tested are provided in **Table B.1.**

Table B.1 – Sampling and Monitoring Schedule

Parameter(s)	Sample Type	Well Type	Frequency
Water level measurement and 24-hour rainfall totals.	Measurement	Trench sumps, MWs, and MPMWs	Twice per week for first month and once per week for remainder
-TCE and TCE-related compounds - VOCs (8260) - TOC (if a substrate is added to the water entering the bioreactor)	Water sample	Sampling port between the CS-MW16 wells and the storage tank as well as samples from the trench sumps	Monthly for first three months, then once per quarter for the rest of the year with quarterly reporting. Data will be reviewed after one year. A revised sampling and reporting frequency may be proposed to UIC permits of TCEQ at that time.
-TCE and TCE-related compounds - Dissolved OC - VOCs (8260) - DO - ORP - Methane - pH - TOC - Dissolved OC - Ions including Fe, Mn, SO4, and NO3	Water sample	MWs and MPMWs in vicinity of SWMU B-3	Monthly for first three months, then once per quarter for the rest of the year with quarterly reporting. Data will be reviewed after one year. A revised sampling and reporting frequency may be proposed to UIC permits of TCEQ at that time.

Aerial Photo Date: 2003

N
W E
S

150 75 0 150 Feet

Creeks (Dashed where intermittent)

Water Well Locations

SWMU Boundary

Figure: B.1

Pilot Study Location Map

Camp Stanley Storage Activity

PARSONS

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Figure B.2

Trench Locations
SWMU B-3
Camp Stanley Storage Activity

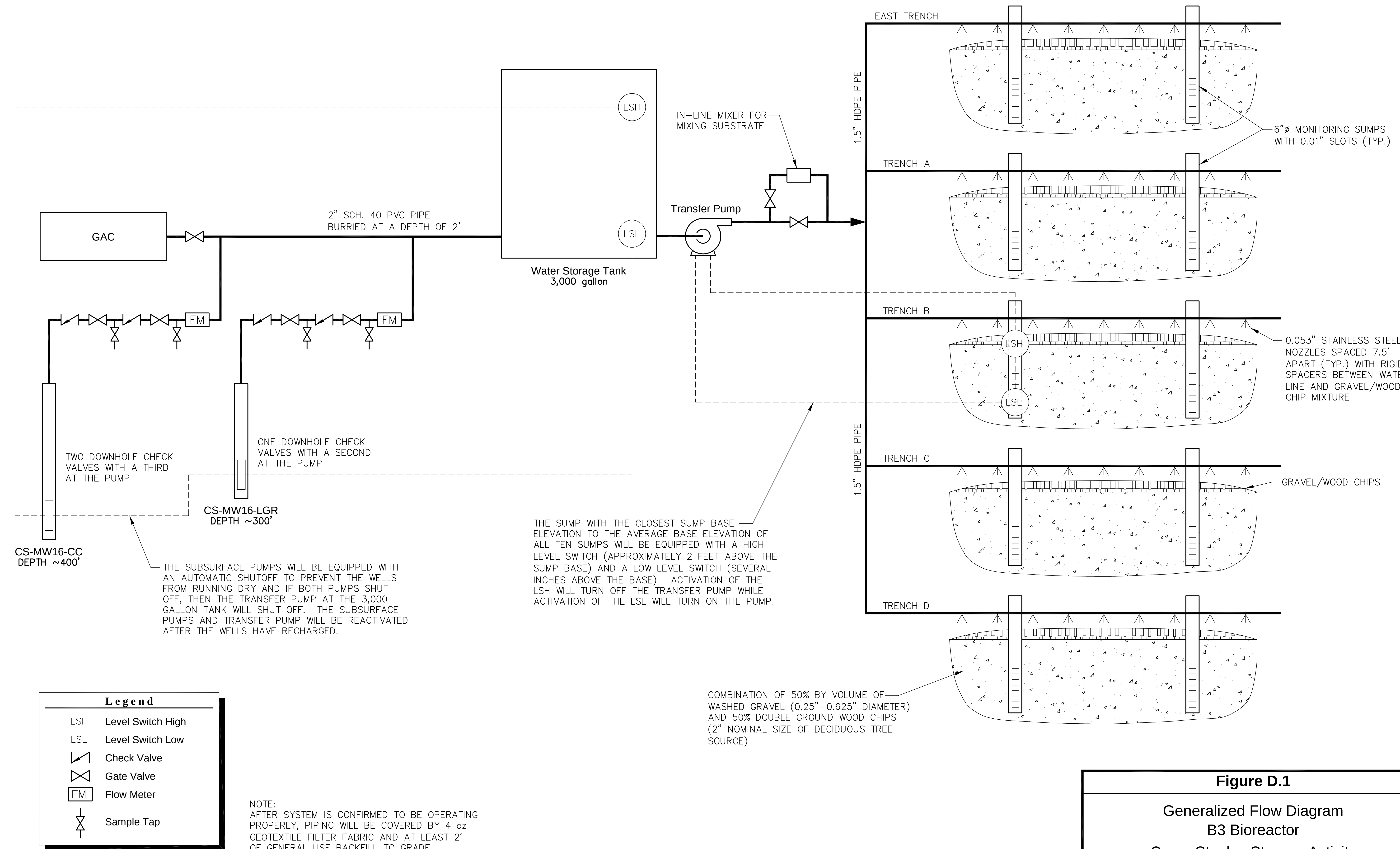
PARSONS

ATTACHMENT C

Not applicable

ATTACHMENT D

Trenches and fluid distribution system for the B3 Bioreactor



744223 CSSA-GENFD.DWG

Figure D.1

Generalized Flow Diagram
B3 Bioreactor
Camp Stanley Storage Activity

PARSONS

ATTACHMENT E

Groundwater from the planned area of water infiltration, the B-3 bioreactor, has not been sampled and contaminant concentrations from this location are currently not available. However, constituent concentrations for samples collected in June 2005 from CS-MW16-LGR and CS-MW16-CC are summarized in Tables E.1 and E.2, respectively.

Table E.1
Groundwater Results for Monitoring Well CS-MW16-LGR
Volatiles tested in March 2006 and Metals tested in June 2005

Compound	Results (μg/L)		Maximum Concentration Limit (μg/L)
Volatiles			
Bromodichloromethane	0.19	U	80
Bromoform	0.2	U	80
Chloroform	0.15	U	80
Dibromochloromethane	0.19	U	80
Dichlorodifluoromethane	0.19	U	ne
1,1-Dichloroethene	0.17	U	7
cis -1,2-Dichloroethene	58		70
trans -1,2-Dichloroethene	1.5		100
Methylene Chloride	0.21	F	5
Naphthalene	0.23	U	ne
Tetrachloroethene	53		5
Toluene	0.17	U	1000
Trichloroethene	59		5
Vinyl Chloride	0.21	U	2
Metals			
Arsenic	0.42	F	50
Barium	37		2000
Cadmium	0.93	F	5
Chromium	0.82	U	100.0
Copper	4.5	U	1300
Lead	0.56	F	15
Mercury	0.044	U	2
Nickel	1.2	U	100
Zinc	320		ne

Notes:

F =The analyte was positively identified, but the associated numerical value is below the reporting limit.

U =The analyte was analyzed for but not detected. The associated numerical value is at or below the method detection limit.

ne - Maximum Concentration Limit not established

Table E.2
Groundwater Results for Monitoring Well CS-MW16-CC
Volatiles tested in March 2006 and Metals tested in June 2005

Compound	Results (µg/L)		Maximum Concentration Limit (µg/L)
Volatiles			
Bromodichloromethane	0.19	U	80
Bromoform	0.2	U	80
Chloroform	0.15	U	80
Dibromochloromethane	0.19	U	80
Dichlorodifluoromethane	0.19	U	ne
1,1-Dichloroethene	0.37	U	7
cis -1,2-Dichloroethene	68		70
trans -1,2-Dichloroethene	23		100
Methylene Chloride	0.17	U	5
Naphthalene	0.23	U	ne
Tetrachloroethene	0.86	F	5
Toluene	160		1000
Trichloroethene	12		5
Vinyl Chloride	0.33	F	2
Metals			
Arsenic	0.43	F	50
Barium	23		2000
Cadmium	0.04	F	5
Chromium	0.82	U	100.0
Copper	4.5	U	1300
Lead	0.94	F	15
Mercury	0.044	U	2
Nickel	4.3	F	100
Zinc	40	F	ne

Notes:

F =The analyte was positively identified, but the associated numerical value is below the reporting limit.

U =The analyte was analyzed for but not detected. The associated numerical value is at or below the method detection limit.

ne - Maximum Concentration Limit not established

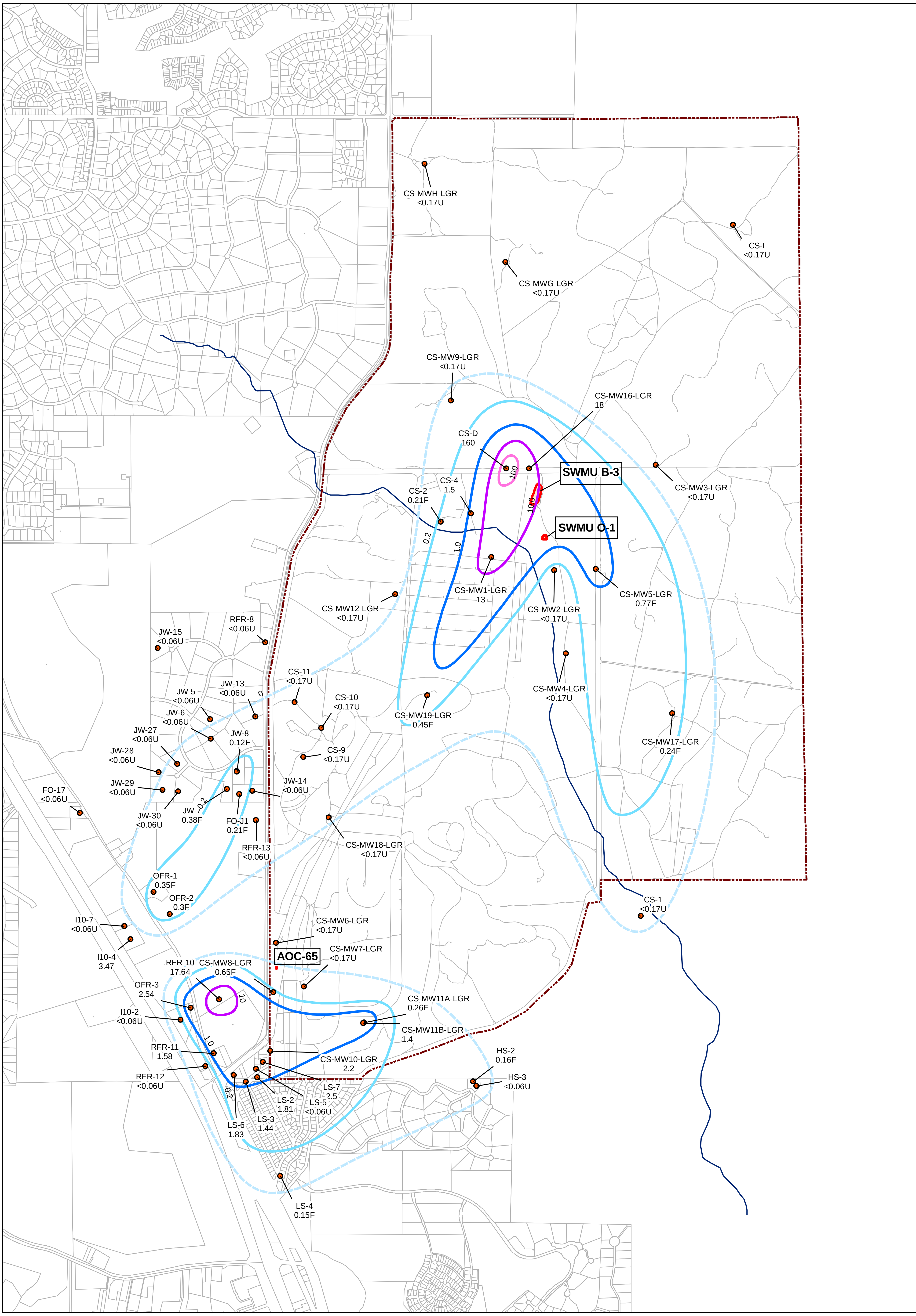
ATTACHMENT F

Water level and analytical data collected as part of the CSSA Groundwater Monitoring Program indicate that the horizontal and vertical extent of groundwater contamination in and around CSSA varies over time. It is likely these fluctuations are in response to variations in groundwater gradients resulting from the rise and fall of groundwater levels due to seasonal changes in rainfall/recharge rates and well pumping. For the most part, VOC contamination appears to be confined to the Lower Glen Rose unit of the Middle Trinity Aquifer (Figure F.1). VOCs have also been identified in the isolated portions of the Upper Glen Rose, Bexar Shale, and Cow Creek units. A potentiometric surface map for the LGR with June 2005 data is presented in Figure F.2. The nearest contributing zones and recharge zones for the Edward's Aquifer are located north of CSSA and are depicted in Figure F.3.

The injection water from MW16-LGR/CC with the possible addition of vegetable oil or other substrate would infiltrate into the Lower Glen Rose via the bioreactor. The infiltration will not result in significant migration of fluids because the water is anticipated to follow the gradient within the cone of influence back to CS-MW16-LGR\CC. In addition, because of its viscous nature the vegetable oil emulsion or other substrate will have limited mobility in the aquifer. After an extended period of O&M, vegetable oil may be introduced into the bioreactor trenches occasionally to re-energize the bioreactor materials. Since the oil is present as an emulsion, it will adhere to the inter-granular surfaces within the formation and is not expected to migrate significantly. Degradation byproducts (such as Cl- and Fe2+) will likely be mobilized in the aquifer due to anaerobic conditions occurring within the established reaction zone. Degradation products mobilized in the reduced reaction zone will undergo chemical alterations (oxidation, mineralization, *etc*.) once they migrate outside the reaction zone at which time their mobility will be reduced. More conservative degradation products (Cl-) will have the highest mobility in the aquifer but will undergo significant dilution over time. Additionally, the inorganic degradation products are generally not produced at concentrations that could result in health concerns.

Accurate predictions of byproduct concentration over distance and time that also account for the effects of attenuation (dilution, absorption, degradation), generally require complex numerical modeling. However, the migration rate of degradation byproducts (and also the conservative tracers) can be approximated using analytical solutions for groundwater flow and transport processes. Using a maximum hydraulic conductivity for the injection zone of 15.8 feet per day (ft/day) (5.6 x 10-3 cm/sec) as determined during previous aquifer testing of the LGR at CSSA, an assumed hydraulic gradient of 0.01 ft/ft and an effective porosity of 5 percent, the maximum estimated groundwater velocity in the area would be 1.3 ft/day (475 ft/yr). Applying this estimated groundwater velocity and assuming no retardation or attenuation, it would take approximately 8.5 years for these constituents to migrate from the injection location to the nearest water supply well, approximately 4,000 feet away. Since this approximation does not include the effects of attenuation, it represents an estimate and the actual migration rates can be expected to be much longer.

In addition, CSSA has set up an effective monitoring network to track any degradation byproduct plume development/migration. If any drinking water wells are threatened, CSSA will respond with appropriate well-head protection in accordance with the CSSA Off-Post Monitoring and Response Plan. The ten sumps installed in the five trenches will enable testing of the bioreactor effectiveness and to make adjustments as necessary to maintain the energized bioreactive processes. Bioreactor O&M will follow the monitoring and sampling schedule presented in Table B.1. Six sampling events are scheduled over the O&M period. Groundwater for energizing the bioreactor will be pumped from CS-MW16-CC and CS-MW16-CC, and the two wells will be sampled on regular basis to monitor VOC concentrations.



Wells
Parcels
CSSA Boundary
Salado Creek
Faults

PCE Concentrations (µg/L)
Estimated Plume Boundary Based on Historical Data
0.2
1.00
10.00
100.00

0 2,000 4,000 Feet

Figure F.1

PCE Concentrations for LGR Wells, June 2005

PARSONS

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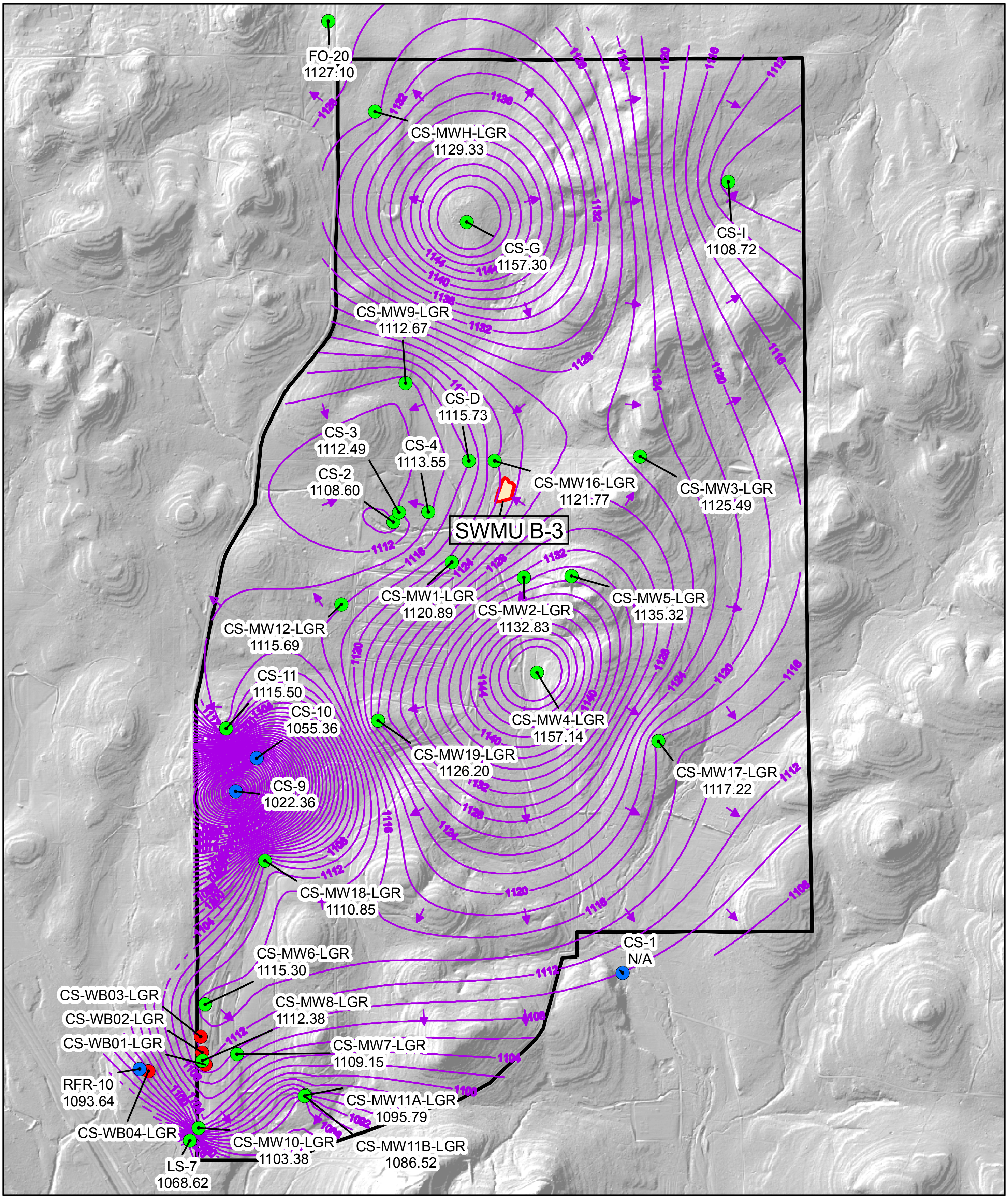

N
W E
S

0 1,250 2,500 5,000
Feet

Flow direction
LGR Groundwater Contours
Outer fence
LGR Wells
Location of Westbay Wells
Drinking water wells, currently pumping may be completed in LGR, BS, and/or CC

Figure F.2

June 2005 Potentiometric Surface Map, LGR Wells

Camp Stanley Storage Activity

PARSONS

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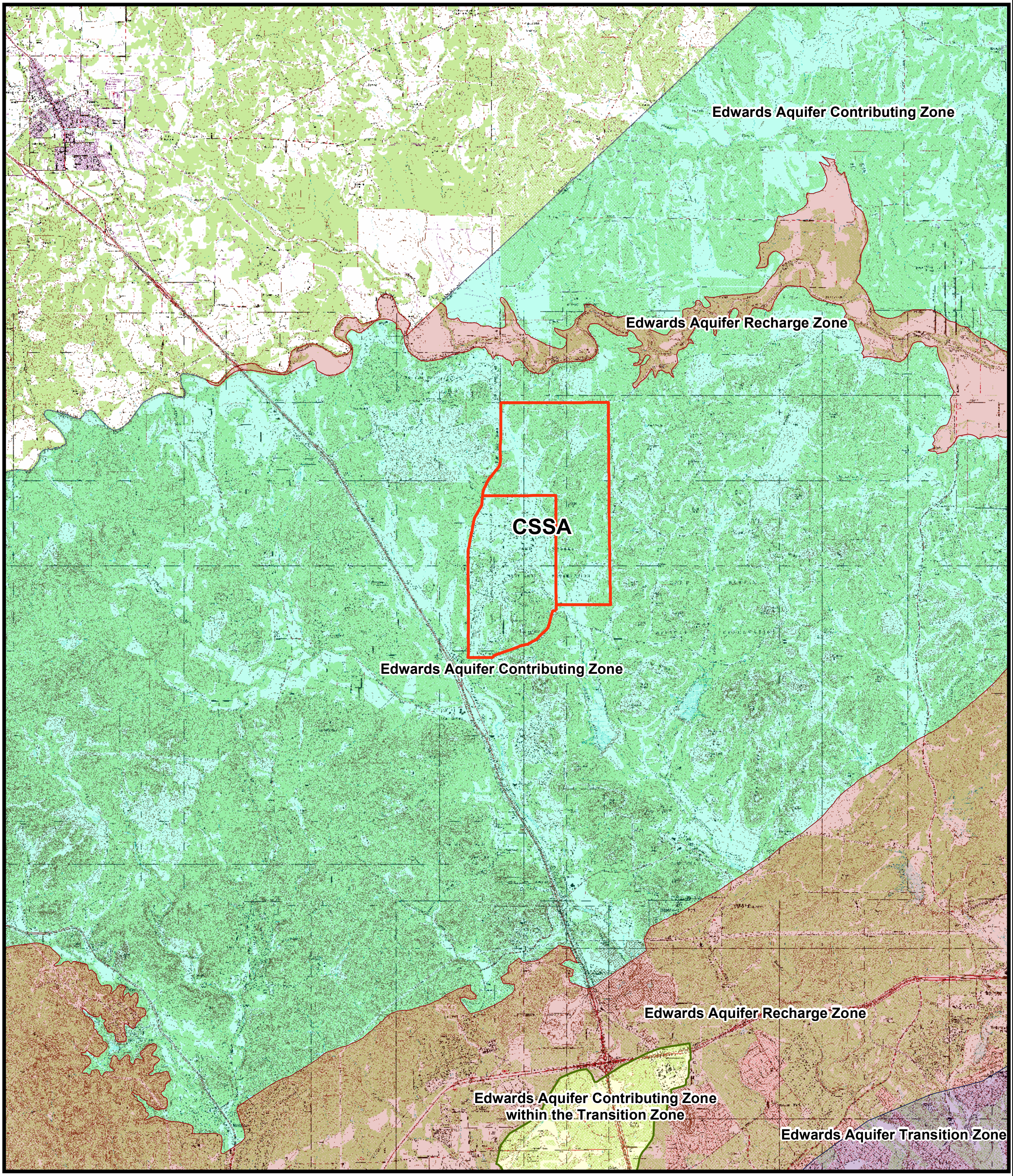

Basemap: USGS Topographic Quadrangles

N
W E
S

2 1 0 2 Miles

CSSA Boundary

Figure: F.3

Location of Edwards Aquifer Boundaries

PARSONS

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ATTACHMENT G

Results of geochemical analyses for the Lower Glen Rose Formation are summarized in Table G.1. Wells are shown on Figure G.1.

Table G.1
Results of Natural Attenuation Study - On-Post Monitoring Wells
Field Analysis
Camp Stanley Storage Activity

SampleID / **Sample Date** / **ParamID**	CS-16	CS-D	CS-9	CS-10	CS-11	CS-1	CS-MW1-LGR	CS-MW2-LGR	CS-2	CS-MW8-LGR	CS-MW5-LGR	CS-MW4-LGR	CS-MW3_LGR
	09/09/02	09/09/02	09/10/02	09/10/02	09/10/02	09/10/02	09/10/02	09/10/02	09/10/02	09/10/02	09/11/02	09/11/02	9/11/2002
Hach Testing (mg/L)													
Alkalinity	230	250	236	258	244	228	258	262	242	300	244	280	158
Carbon Dioxide	60	45	55	45	65	65	45	35	60	56	65	55	45
Ferrous Iron	0	0	0	0	0.29	0.02	0.08	0.08	0.04	0	0.02	0.05	0
Hydrogen Sulfide	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese	0.2	0.2	0	0	0	0	0	0.5	0.1	0	0	0.1	0
Nitrate	3.2	3.9	2.5	2.2	0.6	2	1.9	1.3	1.9	10.4	2.8	1.7	2.1
Nitrite	0	0.001	0.001	0	0	0.001	0.002	0.002	0.002	0.018	0	0	0.006
Sulfate	24.37	18.89	28.19	28.91	43.39	38.94	23.44	40.7	48.35	3.59	20.75	36.25	24.57
Direct Readings													
pH	6.81	7.01	7.46	7.62	7.13	7.47	6.39	6.94	6.02	5.43	6.38	6.57	5.86
Conductivity*													
Redox Potential	188	207.8	-26.4	3.4	33.6	35	377.4	352.3	369.4	418.2	262.3	333.7	436.9
Dissolved Oxygen	3.44	1.41	3.65	3.35	2.52	3.35	5.24	0.16	2.51	0.44	0.47	0.11	0.95
Temperature	21.94	22.23	22.54	22.89	22.12	22.97	23.09	22.44	22.51	23.11	23.09	22.9	23.56
DH (nM)													
Dissolved Hydrogen	59	1.8	1.8	2.7	1.4	2.1	1.3	1.9	1.7	2.4	0.14	2	2.3
M2720C (ug/L)													
Methane	0.22 F	0.25 F	0.23 F	0.3 F	6.3	1	0.23 F	9.2	0.32 F	0.28 F			
Ethane	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U
Ethene	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0.25 F	0 U	0.36 F	0 U
SW9056 (mg/L)													
Chloride	12	11	17	13	17	12	9	9.7	26	11			
Method SW9060													
DOC	5.4	4.7	3.8	3.6	3.9	1.5	2.1	2.5	3	1.5	1.6	4.5	2.1

Table G.1 (continued)
Results of Natural Attenuation Study - On-Post Monitoring Wells
Field Analysis
Camp Stanley Storage Activity

SampleID / **Sample Date** / **ParamID**	CS-G 9/11/2002	CS-MW9-LGR 9/11/2002	CS-MW6-LGR 9/11/2002	CS-MW19-LGR 9/12/2002	CS-MW17-LGR 9/12/2002	CS-MW18-LGR 9/12/2002	CS-MW7-LGR 9/13/2002	CS-MW10-LGR 9/13/2002	Min	Max
Hach Testing (mg/L)										
Alkalinity	180	262	226	256	274	254	250	282	158	300
Carbon Dioxide	50	45	50	35	60	55	65	85	35	85
Ferrous Iron	0	0	0	0	0.02	0	0.01	0	0	0.29
Hydrogen Sulfide	0	0	0	0	0	0	0	0	0	0
Manganese	0	0	0	0.1	0	0.3	0	0.2	0	0.5
Nitrate	3	2.5	2.2	4.4	4.3	0.14	8.8	0	0	10.4
Nitrite	0.004	0.002	0.001	0.004	0.003	0.002	0	0.002	0	0.018
Sulfate	15.37	17.96	21.58	10.62	20.75	43.8	1.84	17.96	1.84	48.35
Direct Readings										
pH	6.09	4.2	7.38	7.3	7.03	7.63	8	7.9	4.2	8
Conductivity*			571	617	618	564	624	688	564	688
Redox Potential	404	535.6	12	93.9	40.1	32.5	-108.6	-59.5	-108.6	535.6
Dissolved Oxygen	3.83	2.2	1.12	7.36	4.57	1.74	0.32	1.96	0.11	7.36
Temperature	22.27	23.11	22.79	22.11	22.29	22.54	21.4	22.22	21.4	23.56
DH (nM)										
Dissolved Hydrogen	4.1	2.7	2.4	0.8	1.4	2	3	2.5	0.14	59
M2720C (ug/L)										
Methane	0.21 F		2.1	0.34 F	0.32 F	0.34 F		0.26 F	0.21 F	9.2
Ethane	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0	0
Ethene	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0	0.36 F
SW9056 (mg/L)										
Chloride	13		12	14	15	11		9.2	9	26
Method SW9060										
DOC	2.1	3.7	5	6.2	6.2	5.9	5.5	6.2	1.5	6.2

Aerial Photo Date: 2003

Monitoring Well Locations

Proposed Injection Well Location

1/4 Mile Radius around Proposed Injection Well

Creeks (Dashed where intermittent)

SWMU Boundary

N W E S

2,000 1,000 0 2,000 Feet

Figure: G.1

On-Post Monitoring Well Locations Used in Natural Attenuation Study Camp Stanley Storage Activity

PARSONS

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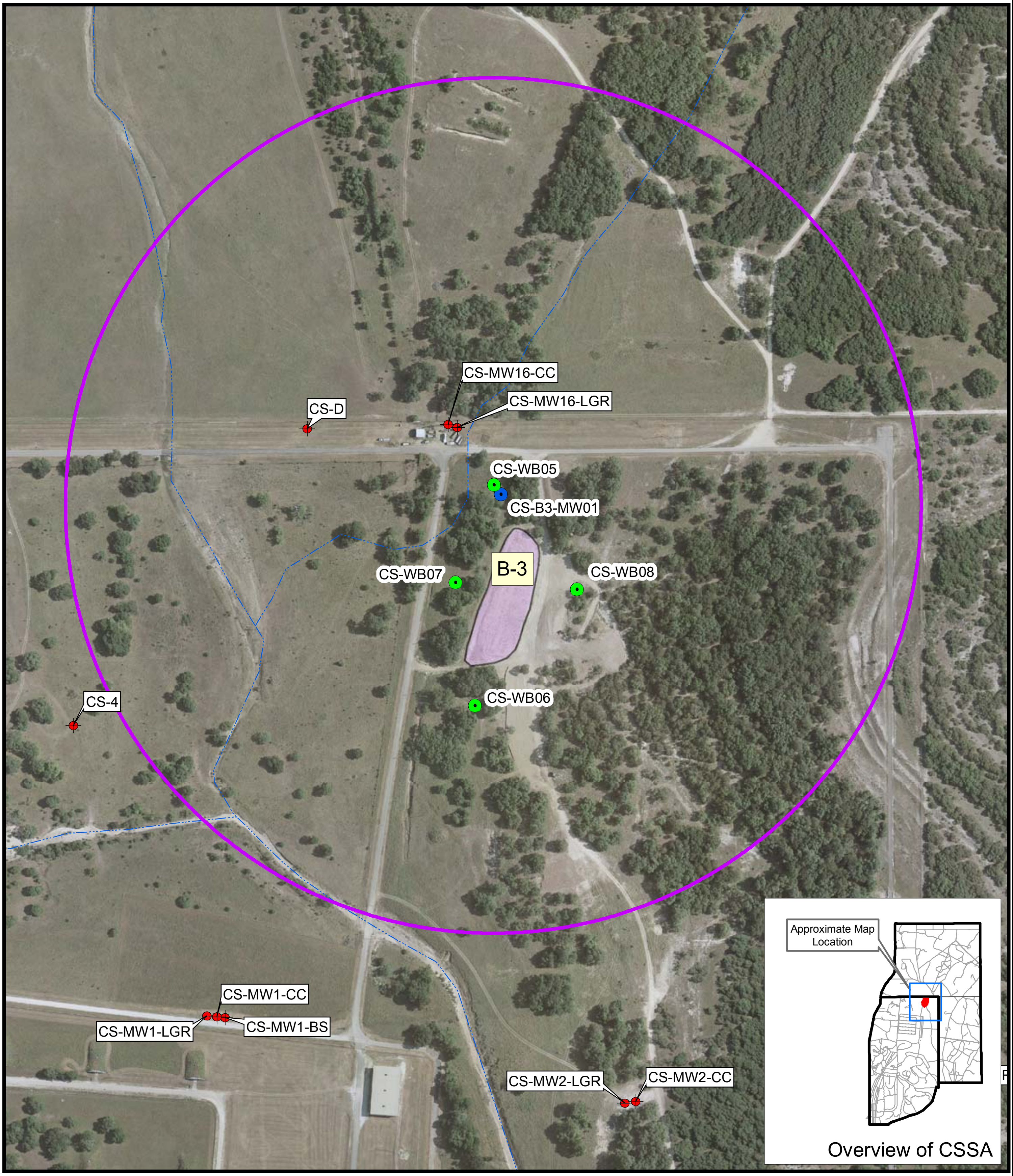
ATTACHMENT H

The composition of the initial bioreactor water will be organic-rich as a result of the water passing through the gravel/wood chip mixture. Scheduled testing of water samples from the trench sumps will indicate whether the contaminant concentrations detected in water samples from the two CS-16 wells have decreased. It is anticipated that a substrate (e.g., vegetable oil) may be added periodically to the water entering the bioreactor to enhance the anaerobic VOC degradation.

ATTACHMENT I

There are no drinking water supply wells within the ¼-mile radius of the subsurface distribution system. Figure I.1 depicts the location of SWMU B-3 and the nearby monitoring wells. Figure I.2 shows the location of the nearest water supply wells to the SWMU B-3 site.



Aerial Photo Date: 2003

N W E S

400 200 0 400 Feet

Existing Monitoring Well Locations

Proposed WestbayÆ Well Location

Proposed Injection Well Location

1/4 Mile Radius around Proposed Injection Well

Creeks (Dashed where intermittent)

SWMU Boundary

Figure: I.1

Well Location Map

Camp Stanley Storage Activity

PARSONS

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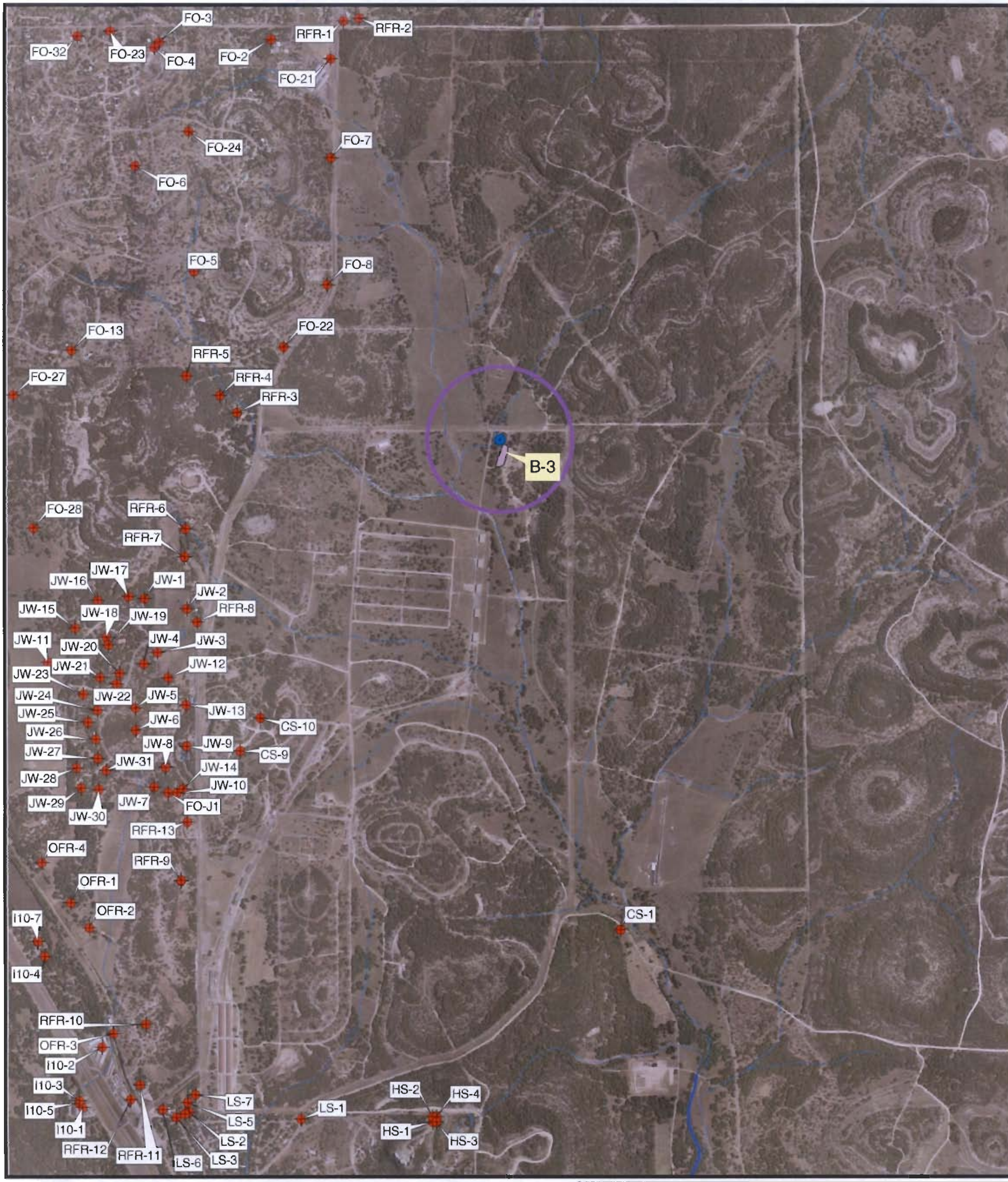
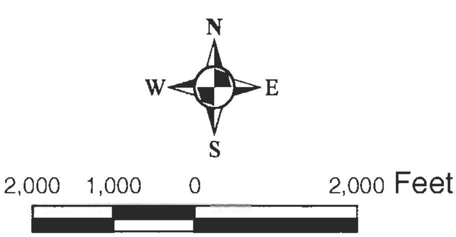


Aerial Photo Date: 2003



Existing Water Supply Well Locations

1/4 Mile Radius around Proposed Injection Well

Creeks (Dashed where intermittent)

SWMU Boundary

Figure: I.2

Water Supply Well Location Map

Camp Stanley Storage Activity

PARSONS

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ATTACHMENT J

In 1991, volatile organic compounds (chlorinated hydrocarbons) were detected in groundwater from CSSA supply well CS-16 approximately 500 feet north-northwest of SWMU B-3. The concentrations were above drinking water standards and prompted several investigations aimed at identifying possible source areas that could be contributing to the contamination. Various investigations, including geophysical surveying, surface and subsurface soil, and soil gas sampling, indicated that tetrachloroethene (PCE) and trichloroethene (TCE) were present at SWMU B-3. The presence of these chlorinated hydrocarbons implicated SWMU B-3 as a likely source area for the contamination detected in well CS-16. The original contamination concentrations in the landfill at SWMU B-3 are unknown; however, the concentrations detected at the nearby monitoring well CS-MW16-LGR (former CS-16) are presented in Table E.1 of Attachment E.

ATTACHMENT K

There have been no remediation efforts made within the saturated zone at the site. A shallow soil vapor extraction (SVE) system was installed at SWMU B-3 in 1996 as a pilot study to evaluate the effectiveness of SVE at the site. The SVE system remained in operation as an interim remedial measure until 2002, when the SVE system was removed during limited removal actions performed at the site. A new two-well SVE system was installed in 2003, and CSSA plans to eventually expand that SVE system to address volatile organic contaminants in the bedrock material surrounding the landfill.

In 2002, a previous contractor identified the five north-south trenches at the locations shown in Figure B.2. In addition, they excavated and disposed 696 CY of hazardous waste and 1,242 CY of Class 2 nonhazardous waste from the East Trench or Trench E. With the construction of the bioreactor, CSSA plans to conduct additional removal actions at SWMU B-3 to remove the remaining contaminated landfill material. The trenches will be filled with a gravel/wood chip mixture and overlain with an irrigation system to serve as the SWMU B-3 bioreactor.