DATA QUALITY OBJECTIVES
GROUNDWATER CONTAMINATION INVESTIGATION
CAMP STANLEY STORAGE ACTIVITY
BOERNE, TEXAS
(with Parsons' comments inserted)
DRAFT FEBRUARY 2002

Step 1. State The Problem

Past operations have contaminated soil, groundwater, and rock at CSSA. Previous investigations have documented the presence of VOCs in all three media and metals and TPH in soils. The extents of these contaminants are not fully characterized at CSSA.

Primary concerns at CSSA involve three VOC source areas (SMWUs B-3, O-1 and AOC-65), which have been identified as sites that have contaminated the groundwater. Based on ~~the~~ present knowledge (February 2002), there are two VOC plumes. CSSA has identified VOCs at detectable levels in on- and off-post drinking water and monitoring wells, ~~that~~These levels are above and below the maximum contaminant levels for the VOCs of concern.

Metals (primarily lead) and TPH contamination have been identified in soils at various sites due to past operations. Impacts of the metal and TPH contamination in groundwater are yet to be established. ~~CSSA has not identified metals consistently across the installation; therefore it is not considered a COC for off-post drinking water.~~Metals have not been consistently detected in on-post wells, nor have significant levels been identified in surface soils in the vicinity of Plume 1 or Plume 2, and therefore, has not been included as a COC for off-post groundwater. Metals and TPH requires further investigations at selected sites, and if present in soils at excessive levels, may need to be evaluated as a potential threat to groundwater. PCBs may also have been used in past operations and will be investigated at selected sites.

The Planning Team:

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Decision Makers:

Mr. Brian Murphy, U. S. Army, CSSA
Mr. Greg Lyssy, U.S. EPA, Region 6
Mr. Kirk Coulter, TNRCC, Corrective Action Section

Step 2. Identify the Decisions - "Prioritize and determine a logical sequence for actions"

1) ~~Establish that~~Determine whether on- and off-post drinking water meets the standard for safe drinking water as prescribed under the EPA and TNRCC rules. (TO42)
2) Determine if VOC levels in off-post drinking water exceed stated values in the CSSA Off-Post Monitoring Response Plan. (TO42)
   a) Is there detection for any VOC?
   b) Does the VOC detection require an action on the part of CSSA or public water system?
3) Determine potential remediation goals based upon the media impacted. Identify cost-effective, technically appropriate, and remedial alternatives (i.e. SVE, MNA, pump and treat, chemical treatment, etc.) for cleaning up groundwater (TO42 & 58).
4) Determine if additional off-post drinking water well locations need to be sampled (TO42), and if so, identify the most appropriate well locations to monitor the status of the plume.
5) ~~Determine~~ Select proper placement of future monitoring wells on- and off-post from geophysical surveys and sampling data (TO42).
6) Determine which formation(s) in the Middle Trinity Aquifer are impacted by the VOC contaminants. (TO42).
7) Determine the impacts of rain events on concentrations and migration of VOCs in the aquifer and vadose zone (TO42).
8) Determine the effectiveness of the GAC units at public and private off-post wells, and determine if CSSA must ~~-~~provide additional GAC units for treatment of private well owner's water supply as specified in CSSA's Off-post Monitoring Response Plan. (TO42).
9) Determine whether groundwater sampling should be ~~-~~expanded or reduced ~~sampling -~~for ~~-~~wells on- and off-post based on historical recently collected and historical data..
10) ~~Reduce~~ Modify the VOC analyte list from long to short at all wells and reduce sampling frequency on selected wells based on historical test data.
11) Determine whether ~~Reduce~~ metals ~~analyte list~~ analysis in our on-post monitoring events should be continued or whether ~~to detected chemical of concern and reduce~~ the ~~sampling~~ metals testing frequency should be reduced.
12) Determine which VOCs should be retained as primary contaminants of concern (COCs).
13) Identify data gaps in groundwater monitoring program.

Alternative Decisions:

1) No action (No additional groundwater monitoring required).
2) ~~Modify~~ Should CSSA's Off-post Monitoring Response Plan be modified?~~-~~

3) ~~Establish~~ Determine if monitored natural attenuation is a viable remediation or response action alternative for reducing contaminant levels in existing plumes to acceptable levels within an acceptable timeframe..

Step 3. Identify Inputs

1) All **drinking water wells** (on- and off-post) require the full analyte list for VOCs for March 2002. Per our teleconference call on Friday February 15, 2002 with CSSA, Portage and AFCEE, it was agreed that the on-post wells would be sampled for the reduced list of VOC analytes (as approved by TNRCC on 10/5/99). ~~Evaluate~~ Identify which wells where a reduction of analytes to short list for future events is appropriate and ~~seek~~ obtain approval from regulators to reduce the list(TO42 and DO5084[PI]).

2) TNRCC collects VOC samples every three years per the State rules from drinking water wells. The TNRCC also collects split samples from off-post well locations at their discretion.

~~2~~3) All on-post wells (drinking water, agricultural, and monitoring) require analyses for nine RCRA metals (arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, and zinc) in March 20002. Evaluate potential reductions in analyte list and frequencies prior to June 2002 Quarterly Monitoring Event.

4) Collect and analyze **off-post drinking water wells** for VOCs (TO42).
   a) GAC Samples
      (1) **Private wells** LS-6, LS-7, RFR-10, and RFR-11 require semi-annual GAC maintenance, which will occur every February and August. Post-GAC samples will be collected to confirm system effectiveness during routine quarterly sampling events in the month after maintenance.
      (2) **Public wells** LS-2 and LS-3 require GAC maintenance be performed every 470 days (18 months). Post-GAC samples will be collected to confirm system effectiveness in the quarter after maintenance occurs. Also at a minimum, post-GAC confirmation samples will be collected every six months.
      (3) ~~Should~~ If a **new public or private well** with elevated VOC levels (90% of MCL) require GAC treatment, a post-GAC confirmation sample will be collected (within 72 hours) after its installation. Subsequent confirmation samples will be collected in the next scheduled quarterly monitoring event following the six-month maintenance.
   b) Action levels for detection of VOCs:
      (1) A decision to sample an **off-post private well** will be based on the following:
         (a) If VOC contaminant levels are greater than 90% of the MCL based on preliminary data received from the laboratory (4.5 ppb for PCE and TCE) and the well is used as a potable water source, bottled water will be supplied within 24 hours of receipt of the data. and ~~A~~ a confirmation sample will be collected from the well of the original sample. The re-sampling will take

place within 14 days of the receipt of the final validated analytical report. If the follow-up sampling confirms contaminants of concern are above MCLs, the residence or supply well will be evaluated and an appropriate method for wellhead treatment or connection to an alternative water source will be determined. Cost related to the installation and maintenance of wellhead treatment equipment or connection to an alternative water source will be borne by the US Army.

(b) If VOC contaminant levels are greater than 80% of the MCL during any single monitoring event based on preliminary data from the laboratory (4.0 ppb for PCE and TCE) and the well is used as a potable water source, it shall be monitored monthly. If the follow-up sampling confirms contaminants of concern are above 80% of the MCL, it will be re-sampled until the level falls below the 80% value. Should the value exceed 90% of the MCL see rule 1) above.

(c) If any VOC contaminant of concern (COC) is detected at levels greater than the Method Detection Limit (MDL) for SW846 Method 8260, (historically 0.11 ppb for PCE, 0.14 ppb TCE), the well will be re-sampled on a quarterly basis. This sampling will be ~~completed in conjunction~~ conducted concurrently with on-post sampling events and will be used to develop historical trends in the area. Quarterly sampling will continue for a minimum of one year, after which the sampling frequency will be reviewed and possibly decreased with the concurrence of EPA and TNRCC.

(d) If VOCs are not detected during the initial sampling event, (i.e. no VOC contaminant levels above the MDL), further sampling of the well would be considered on an as needed basis. A well that has no detectable VOCs can be removed from the sampling list, unless plume migration could influence the well. The well owner, EPA and TNRCC will be apprised of any re-sampling decisions regarding the non-detect wells.

(e) When **off-post public supply systems** are adversely impacted, CSSA will cooperate and coordinate solutions to the maximum extent practicable. The system operator and CSSA will determine the best course of action for providing potable water when data suggests an exceedance of the MCL. Possible options include:

1) Potable water could be brought in by tanker truck;
2) Potable water could be provided by adjacent water systems; and/or
3) A wellhead protection system (GAC) will be installed by the government.

c) Sampling regime:

1) The following **public and private off-post drinking water wells** have had VOC detections and will be sampled at least quarterly through September 2002: HS-2, LS-1, LS-2, LS-3, LS-4, LS-5, LS-6, LS-7, JW-9, JW-14, RFR-10, RFR-11, RFR-12, I10-2, I10-4, FO-J1, OFR-1, OFR-3. Samples from off-post will be analyzed for a full list of VOCs.

2) After each round of sampling, an evaluation of the sampling results will be necessary to determine if an expansion or reduction of the off-post wells to be sampled is appropriate. New off-post drinking water wells may be added to the program in the future. Locations of new wells to be sampled will be based on the inferred-flow ~~direction~~ delineation of the off-post VOC plume derived from historical data, concerns of residential well owners or municipal purveyors of water in the off-post vicinity, and based on future off-post drinking water well surveys.

4) **On-post monitoring wells** will be sampled quarterly and they are:

Seventeen existing monitoring wells (25-foot screened): MW-1-LGR, MW-2-LGR, MW-3-LGR, MW-4-LGR, MW-5-LGR, MW-6-LGR, MW-6-BS, MW-6-CC, MW-7-LGR, MW-7-CC, MW-8-LGR, MW-8-CC, MW-9-LGR, MW-9-BS, MW-9-CC, MW-10-LGR, MW-10-CC.

a) A newly installed monitoring well will be sampled for the full list of VOCs and nine metals and groundwater quality parameters. Subsequent monitoring events will utilize the short list when there are no detections of chemicals not on the short list.

b) The seven existing agricultural and open-borehole wells: CS-2, CS-11, CS-16, CS-D, CS-G, CS-H, and CS-I will be monitored quarterly utilizing the short VOC list. (Note: When an existing well is upgraded a full list of VOCs shall be analyzed.)

c) The two monitoring wells CS-3, and CS-4 will be monitored periodically using the VOC short list.

5) An evaluation of on-post monitoring and agricultural wells will be undertaken after the March 2002 sampling event. The decision to continue monitoring for the presence of contaminants (VOCs) or exclusion of a particular well from quarterly monitoring will be based on the trend analysis of the analytical results. Other factors contributing to removal or inclusion of a well from the monitoring schedule include: proximity of "sentry" well to public/private production wells, construction detail, location of well relative to other nearby wells, and value of the well to the overall program.

6) Water levels will be taken from all wells during quarterly sampling events. Water level gradient maps should be prepared for each formation of the Middle Trinity Aquifer. Where appropriate, fault blocks should be considered during development of each map. Currently inclusion of wells with open borehole completions with data from monitoring wells completed in a discrete interval is of concern. The use of such wells and faults for development of gradient maps needs to be evaluated. As TO42 and 58 work progresses, impacts from the open boreholes and faults to the CSSA gradient picture should be illuminated and included in production of potentiometeric maps. Once the impacts of these factors become clear, more ~~effective evaluations~~ accurate interpretations of the various gradients can be performed.

7) New monitoring wells (TO42)

a) Install new monitoring wells at the locations depicted on the attached map.

b) The rationale for placement of these wells is ~~beside the well name~~ included on the attached table.

c) Wells ~~where necessary~~ will be installed as two and three well clusters. A cluster includes two or three wells located within proximity to each other (~30 feet) and completed in the ~~various~~ different formations being studied (i.e. Lower Glen Rose, Bexar Shale and Cow Creek). This will ~~aid in determining~~allow evaluation of VOC contaminants in ~~that~~ each cluster location and provide data for determining possible impacts to each ~~the~~ aquifer formation being sampled.

d) Past soil and rock sampling at monitoring well installation sites for VOCs have yielded scattered detections of lab contaminants and non-detect of VOC and COCs. Therefore, as a general rule ~~we will not take~~ soil/rock samples will not be collected for testing during ~~this~~ subsequent well installations at CSSA ~~project~~. However, if a PID reading, discoloration, or an odor indicates potential contamination ~~then a sample will be taken~~then the supervising geologist may opt to collect a sample for VOC testing to determine the type(s) of contaminants present and whether concentrations are indicative of free-phase deposits.

e) Injection testing will not be performed in any new well installations. Past data collected has been qualitative, but is not definitive.

f) Coring at each well site has provided a wealth of information and helped correlate data from electrical geophysical logging. Detailed logging of well cores will be continued in at least one well per cluster. ~~Information such as aquifer unit, fractures, and resistivity is very necessary and photographing labeled core boxes has eased data review~~.

g) Down hole camera surveys will be conducted at some of the well sites. The well sites will be selected based on the location of the well to previous camera surveys and potential gain of additional data to formulate hypothesizes of what may be happening in the subsurface. At a minimum, ~~a~~ camera surveys will be performed at the locations where Westbay® devices are to be installed to help identify appropriate intervals for placement of Westbay® sampling devices.

h) ~~Geophysical logging is very necessary to gain the additional knowledge gained from the tool~~.Past experience at CSSA has shown that borehole geophysical logging is an ~~in~~valuable tool for confirming subtle lithologic changes, comparison of cross-borehole characteristics (stratigraphy), and even inferring fault planes. Resistivity, spontaneous potential (SP), gamma ray, and caliper logging shall be collected ~~with this tool~~from each new borehole. This data will complement the borehole coring and ~~previous surveys~~ will be evaluated to compare apparent similarities and differences of stratigraphy and geophysical properties between well locations and depth profiles..

i) Based on previous sampling results, ~~it has been determined that~~ all wells installed under TO42 ~~will~~ should require single cased completions only. Changes to this casing strategy will be evaluated if analytical results from discrete interval testing indicate elevated levels of contamination. As a contingency, an adequate volume of eight inch casing will be on-post during drilling to allow installation of surface casing as needed. Temporary casing installed with bentonite sealer is another option to be considered if significant up-hole contamination is identified.

j) Data-loggers and transducers with telemetry will be installed at 9 LGR and 5 CC well locations. Two additional units can be considered for CS-MW-17-LGR & CS-MW-18-LGR. The selected well locations will be in ~~open borehole~~ wells CS-MW-1-LGR,

CS-MW-2-LGR, CS-MW-6-LGR, CS-MW-7-LGR, CS-MW-8-LGR, CS-MW-10-LGR, CS-MW-11-LGR, CS-MW-12-LGR, CS-MW-15-LGR, CS-MW-2-CC, CS-MW-6-CC, CS-MW-7-CC, CS-MW-12-CC, CS-MW-15-CC. The transducer currently located in CS-16 will be reinstalled in CS-MW-16-LGR when re-completed. Each data-logger continuously collects and stores information regarding static water level, water temperature, and/or conductivity. Telemetry will be employed at these wells to provide up to date data on demand.

k) Upon completion of well development, dedicated low-flow pumps (LFPs) will be purchased and installed within 14 wells. A summary of wells requiring LFPs is provided on attached table. The pumps will be pneumatically-operated bladder pumps consistent with the monitoring system already existing at CSSA. Existing low flow pumps will be reinstalled in CS-MW-1-LGR, CS-MW-2-LGR, and CS-MW-16-LGR.

l) Data needs to be collected for the CSM and for incorporation into the eventual numeric groundwater model using GMS and any future risk assessments. Specific study area boundaries (a watershed boundary for example) will be established relative to the CSSA property, offsite boundary conditions (pumping wells), areas of recharge/discharge (creeks and springs), and major fault and fracture systems. The CSM will be developed to assist in describing groundwater flow patterns and contaminant migration.

m) ~~We need to identify data gaps for the groundwater monitoring program both on and off post.~~ Data gaps will be identified in the CSM and all future updates to that document.

8) Metals sampling determination:

a) For the March 2002 sampling event, metals analyses (arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, and zinc) consistent with previous on-post sampling events will be conducted. Detection of metals in groundwater sampling has generally been limited to agricultural wells in the north pasture. Periodically samples from drinking water wells have had detections of metals. Prior to the June 2002 sampling event, a review will be conducted to determine appropriate frequency and analytes of concern for future sampling events (i.e. quarterly, semi-annually, or annually). Upon completion of the review, our findings and recommendations for future testing will be forwarded to EPA and TNRCC for concurrence. [P2]

b) Compliance sampling for metals required under the Safe Drinking Water Act for drinking water wells (CS-1, CS-9, and CS-10) will be continued per TNRCC rules.

Step 4. Define Study Boundaries

The study boundary is not limited to the confines of the installation. The outer limit of the study boundary is based on detections of VOCs in on- and off-post drinking water wells. Plume 1 and Plume 2 are currently used to define the area(s) impacted by past military activities. Our present study boundary is based on past monitoring activities and will be expanded as necessary to determine the lateral and vertical extent of contamination. For background information see CSSA Fact Sheet 3, Groundwater Contamination Plume; CSSA Fact Sheet 4, Groundwater

Contamination Plume2; and CSSA Fact Sheet 5, Groundwater Contamination – September and October 2001 Sampling.

The areas of interest in the groundwater monitoring program are the three formations in the Middle Trinity Aquifer (LGR, BS, and CC) via well data for VOC and metal concentrations. At a minimum the following factors will be evaluated:

1) Wet and dry seasonal variations;
2) rainfall impacts on plume or potential plume migration and groundwater recharge;
3) Remediation alternatives (P&T containment, SVE, MNA); and
4) Fault and fracture location and size, and orientation from geophysical surveys that promote or retard plume migration.

CSSA will continue to monitor wells for the foreseeable future to make technically sound judgements in the following areas:

1) Decisions to sample additional wells or exclude them from our sampling set will be determined and evaluated quarterly;
2) All data collected during the previous year, as well as historical trends will be reviewed annually[P3]; and
3) Throughout the entire process data gaps will be identified. As they are surfaced a list will be compiled for periodic review, at least during the annual historical data review.

Additional constraints to project completion occur prior to and during sampling, and also during analytical data coordination between the prime contractor, the contract laboratory, the government, and it's third-party data validators. Sampling constraints include:

1) Frequency of water level measurements;
2) Securing access agreements with off-post well owners; and
3) Scheduling sampling time with well owners.

The contractor will be required to coordinate and manage tasks to optimize efficiency and accuracy of all field data collection. Completion of analytical work including verification and validation of data from laboratories and the preparation of quarterly groundwater monitoring reports will adhere to the following guidance.

The following schedule constraints referenced in the project schedule provided below are calendar (not working) days.

Drinking Water Samples

- Drinking water analytical data is to be provided by the laboratory to the prime contractor within 21 days of the sampling event.

- **Off-post drinking water analytical data** generated by APPL Labs: (for March 2002 and June 2002) will be provided by APPL in 21 calendar days and distributed to CSSA immediately thereafter. The laboratory will provide the final hard copy of the analytical data in 30 calendar days.

- **Off-post drinking water analytical data** generated by Severn Trent Labs: (September 2002 & onward) will be provided by STL in 21 calendar days and distributed to CSSA immediately thereafter.

- **On-post drinking water analytical data** generated by Severn Trent Labs: (March 2002 and onward) will be provided by STL in 21 calendar days and distributed to CSSA immediately thereafter

1) Validated drinking water data, the draft Drinking Water Quarterly Groundwater Monitoring Report (including all off & on-post drinking water wells) and letters to off-post well owners will be provided to the government 60 days from the sample date.

Off-post analytical **groundwater data** - For up to 30 samples collected, data packages will be validated and submitted to AFCEE for their approval within **30 calendar days of receipt of the data packages from the laboratory**. If more than 30 samples are collected, Parsons will contact Brian Murphy and discuss acceptable turn-around times for data validation.

On-post analytical **groundwater data** - For up to 40 samples collected, data packages will be validated and submitted to AFCEE for approval within **40 calendar days of receipt of the data packages from the laboratory**. If more than 40 samples are collected, Parsons will contact Brian Murphy and discuss acceptable turn-around times

2) The government and third party chemists will provide comments to the draft report and letters within 10 days.

3) Final Quarterly Groundwater Monitoring Reports and well owner letters will be finalized within 75 days of sampling date. These time frames allow for adequate planning for the next quarterly sampling event, which will take place 120 days from previous sampling date.

Monitoring Well Samples

1) Monitoring well analytical data is to be provided by the laboratory to the prime contractor within 30 days of the sampling event.
2) Validated monitoring well analytical data and the draft On-post Monitoring Well Quarterly Groundwater Monitoring Report will be provided to the government 60 calendar days from the sample date.
3) The government and third party chemists will provide comments to the draft report and letters within 10 days.
4) Final On-post Monitoring Well Quarterly Groundwater Monitoring Reports will be finalized within 75 days of sampling date. These time frames allow for adequate planning for the next quarterly sampling event, which will take place 120 days from previous sampling date.

Screening Level Samples (i.e. discrete interval, soil/rock, & IDW samples)

1) Discrete interval analytical data is to be provided by the laboratory to the prime contractor within 24 hours of the sampling event.

2) Prime contractor will review and provide approved discrete interval data to the government within 2 days of the sample date.
3) IDW analytical data is to be provided by the laboratory to the prime contractor within 10 days of sampling event.
4) Prime contractor will review and provide approved IDW data to the government within 14 days of the ~~sample date~~ receipt of the data package from the lab.

Step 5. Develop a Decision Rule

Refer to Step 2 of these DQO's for decision processes related to groundwater monitoring.

Step 6. Specify tolerable limits for decision errors

Currently, the AFCEE QAPP versions 3.0 (Parsons is only following AFCEE QAPP v 3.0) and 3.1 are being utilized by CSSA. A CSSA specific QAPP is being developed. (CSSA QAPP will only be used on new delivery orders, not on existing ones) Both QAPPs specify tolerable limits for errors. This section should only reference AFCEE QAPP 3.0.

Step 7. Optimize the design for obtaining data

Refer to Step 2 of these DQO's for optimization steps related to groundwater monitoring.

Estimated Quantities of Drilling Requirements

Monitoring Well	Estimated Core (Qty)	Production Casing with 25' Screen (feet)	8" Carbon Steel Casing	12" Carbon Steel Casing	Discrete Sample (Qty)	Geophysical Log	Camera Survey	Pump Plan	Transducers	Purpose
Plume 1 (10 New Wells, 5 Well Upgrades)										
Lower Glen Rose										
CS-G-LGR*	No	NA				No	No	LFP		Upgrade to allow collection of routine low flow ground water samples. Work includes: upgrading wellhead and installing LFP.
CS-H-LGR*	No	NA				No	No	High Capacity Pump		Upgrade to allow collection of routine ground water samples from the site. If possible, remove the sucker rods and surface pump and install a new high capacity electrical pump below the water table. If removal of the rods is not possible CS-H will be plugged and a replacement well will be drilled adjacent to it.
CS-MW-1-LGR*	No	3" casing to 313'				No	No	LFP[1]	TR	Upgrade from an open borehole to a 25-foot screened completion that complements our other MW's. Comparison to previous open-hole sample data to data acquired from the newly screened interval will help determine the vertical extent VOC contamination in the LGR at this site. Lower VOC levels in the re-completed well could be a result of closing off a zone that is more contaminated.
CS-MW-2-LGR*	No	3" casing to 343'				No	No	LFP[1]	TR	Upgrade from open borehole to a 25-foot screened completion that complements our other MW's. Comparison to previous open-hole sample data to data acquired from the newly screened interval will help determine the vertical extent VOC contamination in the LGR at this site. Lower VOC levels in the re-completed well could be a result of closing off a zone that is more contaminated.
CS-MW-12-LGR	LGR (370)	4" casing to 360			(4)	Yes	No	LFP	TR	This goal of this well is to define groundwater plume conditions southwest of known VOC source areas. The location is anticipated to be along the plume fringe, between CS-2, CS-3, CS-4 and CS-11 where below MCL detections for PCE and TCE have been periodically found.
CS-MW-16-LGR*	No	4"casing to 305'				No	No	LFP[1]	AT	Upgrade CS-16 open borehole to a completion with 25-feet of screen that complements our other MW's. Reduce the potential for vertical migration of VOCs from the LGR into the BS or CC formations. Comparison to previous open-hole sample data to data acquired from the newly screened interval will help determine the vertical extent VOC contamination in the LGR at this site. Lower VOC levels in the re-completed well could be a result of closing off a zone that is more contaminated.

Monitoring Well	Estimated Core (Qty)	Production Casing with 25' Screen (feet)	8" Carbon Steel Casing	12" Carbon Steel Casing	Discrete Sample – (Qty)	Geophysical Log	Camera Survey	Pump Plan	Transducers	Purpose
CS-MW-17-LGR	(380)	4" casing to 340'	No		No	Yes	No	LFP	OT	This goal of this well is to define groundwater plume conditions southeast of known VOC source areas. The location is anticipated to be along the plume fringe, between CS-MW-5-LGR and CS-1 where below MCL detections for PCE and TCE have been found periodically.
CS-MW-18-LGR	(375)	4" casing to 370'	No		Yes (3)	Yes	Yes	LFP	OT	Define groundwater plume conditions south of known VOC source areas. Fill in LGR ground water gradient data gap. The location is anticipated to be in Plume 1, south of the CS-MW-1-LGR and CS-MW-2-LGR well set, where elevated levels of VOCs (PCE and TCE) have been found consistently. Also, placement may assist in determining migration of plume 1 to the east/west (towards Salado Creek or Wells CS-9, CS-10, and CS-11).
CS-MW-19-LGR	(390)	4" casing to 380'	No		Yes (3)	Yes	No	LFP	OT	Define groundwater plume conditions south of known VOC source areas. Fill in LGR ground water gradient data gap. The location is anticipated to be along the plume fringe, south of the CS-MW-1-LGR and CS-MW-2-LGR well set, where elevated levels of VOCs (PCE and TCE) have been found consistently. Also, the location of this well will potentially distinguish boundaries between Plumes 1 and 2 with respect to CS-MW-6-LGR, CS-MW-7-LGR, CS-9, CS-10, and CS-11. (An optional placement could be towards F Section near SWMU B-12.)
Bexar Shale										
CS-MW-1-BS	(70')	4" casing to 373'	No		No	Yes	No	LFP		Determine if the BS is a confining layer and/or contributes significant amounts of water to the LGR or CC. Determine if faults in the areas of the well placement impact the characteristics of the BS. There is known VOC contamination above the BS formation in this area. Data gathered from this well and CS-MW-9-BS and CS-MW-12-BS will be used to determine potential impacts to this formation.

Monitoring Well	Estimated Core (Qty)	Production Casing with 25' Screen (feet)	8" Carbon Steel Casing	12" Carbon Steel Casing	Discrete Sample – (Qty)	Geophysical Log	Camera Survey	Pump Plan	Transducers	Purpose
CS-MW-12-BS	(70')	4" casing to 402'	No		No	Yes	No	LFP		Determine if the BS is a confining layer and/or contributes significant amounts of water to the LGR or CC. Determine if faults in the areas of the well placement impact the characteristics of the BS. There is known VOC contamination above the BS formation in this area. Data gathered from this well and CS-MW-1-BS and CS-MW-9-BS will be used to determine potential impacts to this formation. Contaminant levels are expected to be low, therefore protective casing is not anticipated.
Cow Creek										
CS-MW-1-CC	(82)	4" casing to 445'	?		Yes (4)	Yes	No	LFP		Characterize CC conditions in known area of LGR contamination and evaluate potential for CC contamination down gradient of known VOC source areas. Data gathered from this well and CS-MW-2-CC, CS-MW-16-CC, CS-MW-9-CC, CS-MW-12-CC will determine potential impacts to the CC. Evaluate potential effectiveness of BS as a confining layer between the LGR and CC in known fault area.
CS-MW-2-CC	(82')	4" casing to 474'	?		Yes (4)	Yes	No	LFP	TR	Characterize CC conditions in known area of LGR contamination and evaluate potential for CC contamination down gradient of known VOC source areas. Data gathered from this well and CS-MW-1-CC, CS-MW-16-CC, CS-MW-9-CC, CS-MW-12-CC will determine potential impacts to the CC. Evaluate potential effectiveness of BS as a confining layer between the LGR and CC in known fault area.
CS-MW-12-CC	(82)	4" casing to 450'			Yes (4)	Yes	No	LFP	TR	This goal of this well is to define CC groundwater plume conditions southwest of known VOC source areas. Evaluate potential effectiveness of BS as a confining layer between the LGR and CC in known fault area. Contaminant levels are expected to be low, therefore protective casing is not anticipated.
CS-MW-16-CC	(82')	4" casing to 430			No	Yes	No	LFP		Characterize CC conditions in known area of LGR contamination. Data gathered from this well and CS-MW-1-CC, CS-MW-2-CC, CS-MW-9-CC will determine potential impacts to CC related to open borehole completion at former CS-16 and will help evaluate effectiveness of BS as a confining layer between the LGR and CC in known fault area.

Monitoring Well	Estimated Core (Qty)	4" Casing with 25' Screen (feet)	8" Carbon Steel Casing	12" Carbon Steel Casing	Discrete Sample – (Qty)	Geophysical Log	Camera Survey	Pump Plan	Transducers	Purpose
Plume 2 (7 New Wells)										
Lower Glen Rose										
CS-MW-13-LGR-T	Yes	120						No Pump or WB		Option one: Install a three well set in the selected intervals based on geophysical data as well as past data at CW-MW-6-LGR, -8-LGR, -7-LGR, and –10-LGR. Option two : Install a Westbay® multi-port sampler with at least five zones to be sampled (based on geohysical data and discrete sampling). Determine this type of wells potential to be used in the other three T-M-B well clusters (CS-MW-14, CS-MW-20, and CS-MW-21). Collect data for two months to assist in determining effectiveness of this well. We need to determine where the largest concentration of COC are located in the shallow portion of the LGR. Need to install this well prior to sping rain events if possible. Data can be collected during wetter times and then in the later part of the summer when zones would not have appreciable amounts of water.
CS-MW-13-LGR-M		200						No Pump or WB		See MW-13-LGR above.
CS-MW-13-LGR-B	Yes	300			(5)	Yes	Yes	No Pump or WB		See MW-13-LGR above.
CS-MW-14-LGR-T	Yes	120						No Pump or WB		See MW-13-LGR above.
CS-MW-14-LGR-M	Yes	200						No Pump or WB		See MW-13-LGR above.
CS-MW-14-LGR-B	Yes	300			(5)	Yes	Yes	No Pump or WB		See MW-13-LGR above.
CS-MW-20-LGR-T	Yes	120						No Pump or WB		See MW-13-LGR above.
CS-MW-20-LGR-M	Yes	200						No Pump or WB		See MW-13-LGR above.
CS-MW-20-LGR-B	Yes	300			(5)	Yes	Yes	No Pump or WB		See MW-13-LGR above.
CS-MW-21-LGR-T	Yes	120						No Pump or WB		See MW-13-LGR above.
CS-MW-21-LGR-M	Yes	200						No Pump or WB		See MW-13-LGR above.

Monitoring Well	Estimated Core (Qty)	4" Casing with 25' Screen (feet)	8" Carbon Steel Casing	12" Carbon Steel Casing	Discrete Sample – (Qty)	Geophysical Log	Camera Survey	Pump Plan	Transducers	Purpose
CS-MW-21-LGR-B	Yes	300			(5)	Yes	Yes	No Pump or WB		See MW-13-LGR above.
CS-MW-11-LGR	(370)	360			(3)	Yes	Yes	LFP	TR	Determine if plume 2 is moving southeasterly towards the Bexar Met water supply wells (LS-1 and HS-2). Place well on northern side of the fault line.
CS-MW-15-LGR	(395)	385			(3)	Yes	Yes	LFP	TR	Installing this well will provide much needed water level data to the west/southwest and a monitoring point in a 25-foot screened interval. Placement of this well should be west of RFR-10 adjacent to Old Fredericksburg Road. This will provide data from the bottom portion on the LGR in an area of known PCE and TCE contamination (OFR-1, OFR-3, 110-2, 110-4, RFR-11). Determine the effects of casing on the LGR and possibly the vertical extent of contamination. Final well location based on surface geophysical data (i.e. 2D seismic and electronic resistivity).
Cow Creek										
CS-MW-15-CC	(105)	490			(3)	Yes	Yes	LFP	TR	Installing this well will provide much needed water level data to the west/southwest and a monitoring point with a 25-foot screened interval that will compliment the CSSA monitoring wells. Placement of this well should be west of RFR-10 adjacent to Old Fredericksburg Road. Determine the effects of casing on the water bearing units of the CC. Final well location based on surface geophysical data (i.e. 2D seismic and electronic resistivity).

[1] Reinstall low-flow pump after upgrade completion.

AT=already transducered
B= Bottom (deepest well).
LFP=low flow pump
OT= optional transducer
M= Middle (mid-zone)
T= Top (shallow)
TR=New Transducer
WB=Westbay®

Casing Requirements

All wells will be completed with 4-inch Schedule 80 PVC and 25 feet of 0.050" wire-wrapped stainless steel screen. Primary and secondary casing will be low-carbon steel with welded joints. Cow Creek wells will be double-cased, and Bexar Shale wells will be double-cased. The remaining Lower Glen Rose wells will be single-cased.

Assumptions

Coring, geophysical logs, and video surveys may be composited within a cluster
(*) denotes locations were coring will resume at a depth comparable where prior drilling ceased.
Geophysical and video surveys will require multiple mobilizations per cluster to log the entire stratigraphic sequence penetrated.

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[P1]Sampling of offsite wells is currently not in the TO42 scope of work. DO5084 will fund offsite sampling for one more quarter (June 2002).

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[P2]This input is similar to Step 3, number 2) input.

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[P3]In what context will the data be reviewed annually. What type of format is planned for the review? What is the expectation for the outcome of the review? Will any decisions be made regarding this review? What specifically will be covered by the review?