October 23, 2009

Ms. Janice M. Goebel
California Regional Water Quality Control Board
North Coast Region
5550 Skylane Blvd., Suite A
Santa Rosa, CA 95403

Subject: Work Plan for Supplemental Injections
***IRA* for Hexavalent Chromium-Affected Groundwater**
Former Remco Hydraulics Facility, Willits, California

Dear Ms. Goebel:

On behalf of the Willits Environmental Remediation Trust (the Willits Trust), Jacobson James & Associates, Inc. (JJ&A) submits this *Work Plan for Supplemental Injections* as part of the ongoing Interim Remedial Action for Hexavalent Chromium-Affected Groundwater (the "IRA") that is being conducted at the former Remco Hydraulics Facility (Facility) located at 934 South Main Street in Willits, California (Figure 1). This Work Plan provides a summary of the IRA to date, as well as sets forth the technical approach for the supplemental IRA injections including a scope of work, a monitoring and reporting program, and a contingency plan. The Work Plan concludes with a proposed schedule for implementation.

Summary of the IRA

The IRA was originally proposed in the *Interim Remedial Action Work Plan for Hexavalent Chromium-Affected Groundwater* (Geomatrix Consultants, March 11, 2003) and the *Addendum to the Interim Remedial Action Work Plan for Hexavalent Chromium-Affected Groundwater* (Geomatrix Consultants, June 18, 2003). The Regional Water Quality Control Board (RWQCB) approved the IRA, and issued Waste Discharge Requirements R1-2003-085 in accordance with applicable law. The initial IRA injection event was conducted in October and November 2003. The initial IRA injections included the injection of approximately 14,000 gallons of dilute molasses at seventy-two (72) shallow A-Zone locations and seven (7) B-Zone locations. Based on the results of analytical testing, a second IRA injection event was completed during June and July of 2004. During this second IRA injection event, approximately 5,000 gallons of a dilute molasses solution was introduced into thirty-three (33) A-Zone locations and six (6) B-Zone locations. The reader is

directed to the *First Annual Report, IRA for Hexavalent Chromium-Affected Groundwater* (Geomatrix Consultants, February 2005) for a detailed presentation of activities and results of these first two IRA injection events. A third injection event was conducted in December 2005 which consisted of the injection of approximately 13,400 gallons of dilute molasses solution at seventy-two (72) A-Zone locations and approximately 5,000 gallons of dilute molasses solution at fifteen (15) B-Zone locations. The areas where injections have been conducted pursuant to the IRA for Hexavalent Chromium-Affected Groundwater IRA are illustrated on Figure 2.

A comprehensive groundwater monitoring and sampling program has been completed to evaluate the affects of the IRA. Based on the analytical testing conducted, the IRA has proven very effective at remediating hexavalent chromium-affected groundwater at the Facility. During the October 2008 groundwater sampling event, hexavalent chromium was detected in groundwater samples collected from two (2) A-Zone wells, W37A and IMW-7, at 0.0035 milligrams per liter (mg/L) and 5.8 mg/L, respectively; and, one (1) B-Zone well, EW-1B, at 35 mg/L. Hexavalent chromium was not detected (*i.e.*, < 0.001 mg/L) in *any* other groundwater samples. The current distribution of hexavalent chromium in A- and B-Zone groundwater, along with historical grab groundwater data, is presented as Figures 3 and 4.

Technical Approach

Based on the extensive groundwater monitoring and sampling completed (as discussed above), there are discrete areas of residual hexavalent chromium present in A- and B-Zone groundwater at the Facility that require additional injections to meet the goals of the IRA. In addition, injections are proposed in the shallow vadose zone to address potential residual hexavalent contamination in the immediate vicinity of the former chrome plating tanks. The injection programs for each of these areas are described further below.

A-Zone Injections. The A-Zone IRA injection areas are located in: 1) the southeastern portion of the former chrome plating department at the Facility, in the vicinity of monitoring well IMW-7; and 2) northeast of the former chrome plating department in the vicinity of monitoring well W37A.

The area immediately surrounding IMW-7 was not treated during earlier IRA injection events. It has been reported that small scale plating activities were conducted between 1960 and 1963 in an above ground tank located in the southwest corner of building 1945, in the vicinity of IMW-7.[1] Plating operations in this area were conducted in a small above ground tank located atop a wooden platform.

[1] See section 2.3.1.1.1 of the Final Remedial Investigation Report (MWH, 2002).

To verify the extent of hexavalent chromium in groundwater in the southern area, grab groundwater samples will be collected in the proposed IRA injection areas immediately prior to completing the IRA injections at the three locations indicated on Figure 5 (SB-700, SB-701, and SB-702). Groundwater samples collected from these locations will be field screened for hexavalent chromium to confirm the lateral extent of hexavalent chromium in the vicinity of IMW-7. These data will be used to adjust the number and locations of the IRA injections, as necessary. Approximately ten (10) A-Zone injections are anticipated to be completed in the vicinity of IMW-7 at the locations illustrated on Figure 6.

The second area in the A-Zone where hexavalent chromium has been detected is in the vicinity of W37A and TW-6, as illustrated by Figure 2. Prior injections did not include the area immediately surrounding TW-6, but did include the area surrounding W37A (see Figure 1). These prior injections resulted in the significant decrease in concentrations of hexavalent chromium in groundwater in this area. To address low levels (below the MCL) of hexavalent chromium remaining in A-Zone groundwater at and potentially upgradient of these two wells, the Willits Trust proposes to inject remedial solution at approximately six (6) locations as illustrated on Figure 6.

Within both A-Zone areas, IRA injections will be conducted at discrete depth intervals across the A-Zone between approximately two to three (3) feet below grade surface (ft-bgs) and twenty-two (22) ft-bgs. Approximately 25 gallons of remedial solution will be injected across each 1-foot interval for a total of approximately 500 gallons per location.

B-Zone Injections. The B-Zone IRA injection area is located to the west of the former chrome plating department, near the former vertical dipping tanks, at the Facility. A total of twenty (20) B-Zone locations are proposed to be completed in order to address the residual hexavalent chromium impact to groundwater in this area. The proposed locations are illustrated on Figure 7. IRA injections will be conducted at discrete depth intervals across the B-Zone between approximately twenty-four (24) ft-bgs and forty-two (42) ft-bgs. Approximately 25 gallons of remedial solution will be injected across each 1-foot interval for a total of approximately 450 gallons per location.

Vadose Zone Injections. In addition to treating the hexavalent chromium impact observed in groundwater, approximately twenty-five (25) shallow IRA injections are proposed immediately below the building slab to address any potential shallow residual hexavalent chromium impact in the vicinity of the former chrome plating tanks. Approximately 25 to 50 gallons of [molasses] solution will be injected into each of the 25 locations. It is noted that these injections will be conducted at very shallow depths (approximately 1 to 3-ft bgs) that will require relatively low pressures (*e.g.*, 5 to 10 psi) to promote an even distribution of the solution in the subsurface and avoid excessive

surfacing of injected solution. The proposed shallow IRA injection locations are indicated on Figure 8.[2]

In summary, a total of approximately 52 supplemental IRA injections[3] will be completed to introduce reductant into the subsurface at the Remco Facility, as illustrated on Figure 9. A dilute molasses solution will be utilized as the remedial solution for the supplemental IRA injections, the same remedial solution used previously at the Facility. Organic molasses will be mixed at a 10% concentration (10:1 potable water to molasses mixture). A buffer solution[4] may be added to promote a stable reducing environment. Table 1 summarizes the anticipated boring locations and volume of remedial solution to be injected at each location.

At each location an injection tool will be placed across a discrete target interval (*i.e.*, 1-2 feet) using direct push technology (*i.e.*, using Geoprobe® or similar rig). The remedial solutions will be injected at sufficient pressures to cause incipient fracturing where necessary. Based on data collected during prior IRA injection events at the Facility, typical injection pressures are expected to range from 25 to 50 pounds pre square inch (psi) [5], except for the shallow IRA injection locations shown on Figure 8 where injection pressures are expected to range from 5 to 10 psi. At the conclusion of each IRA injection location, the boring will be properly destroyed by sealing the boring with neat cement tremmied from the bottom up.

Work Steps

The Supplemental Injection interim remedial action proposed for the Facility will consist of the following specific work steps:

- Obtain injection (*i.e.*, boring) permits from the Mendocino County Division of Environmental Health (MCDEH);
- Identify all underground structures, utilities, piping, sewer, drains and overhead obstructions within IRA injection areas; field set-up: identify in white paint each IRA injection location with a unique alpha-numeric identification;

[2] The approach presented for the shallow injections was originally proposed, and approved by the RWQCB, in the *First Quarterly Report Interim Remedial Action for Hexavalent Chromium-Affected Groundwater*, (Geomatrix Consultants, April 2004).
[3] The 52 borings consist of 16 A-Zone borings, 11 B-Zone borings, 16 Shallow Borings and 9 borings that include both shallow and B Zone injections, as illustrated on Figure 9.
[4] Newman Zone® by RNAS, Inc., or similar calcium carbonate buffer solution may be added at a 1% (by weight) concentration.
[5] Peak higher pressures may be required (i.e., up to 100 psi) to hydro-fracture the zones comprised of fine grained sediments, particularly in the B-Zone.

- Grab-groundwater sampling and field screening for hexavalent chromium to confirm extent of residual A-Zone impact;
- Inject remedial solutions;
- Conduct routine monitoring to assess the continued effectiveness of remedial action; and,
- Prepare an Interim Remedial Action Report for Hexavalent Chromium-Affected Groundwater.

The specific work steps are further described below.

Pre-mobilization. JJ&A will procure permits from Mendocino County Division of Environmental Health (MCDEH) prior to initiating the drilling/boring work in the field. Subsequent to permit procurement, JJ&A will coordinate field activities with Mendocino County to ensure compliance with permit requirements. JJ&A will outline the project area where the intrusive work will be conducted with white paint and mark all IRA injection points with white paint and contact Underground Services Alert (USA) at least 48 hours before beginning work onsite, as required by law, so that companies with buried utilities in the vicinity of the property may mark the locations of their underground facilities. JJ&A will ensure that the Site-specific Health and Safety Plan (HASP) is current and that all personnel involved are familiar with the safety program at the Facility. All work will be performed in accordance with the HASP.

Grab Groundwater Sampling. Grab groundwater samples will be collected from approximately three (3) temporary borings (SB-700, -701 and 702) as indicated on Figure 5. The groundwater samples will be tested for hexavalent chromium using the HACH colorimeter DR-890 (HACH Method 8023, provided as Attachment A). The results of the field screening will be used to refine IRA injection locations in the field.

Injections. The IRA injections will be completed by using a truck mounted direct push rig. At each location, the remedial solution will be injected across discrete intervals. Approximately 500 gallons of the remedial solution will be injected into each A-Zone location; approximately 450 gallons into each B-Zone location; and, approximately 25-50 gallons into each shallow IRA injection location. Following the injection at each location, the boring will be grouted to grade with neat cement.

Monitoring Program

To evaluate the effectiveness of the supplemental IRA injection program, hexavalent chromium, VOC and dissolved metals will be routinely monitored in the four (4) target wells (IMW-7, W37A, TW-6, and EW-1B). In addition, five (5) A-Zone wells (TW2, TW4, and W21A, W24A, and GMX-

2A) and one (1) B-Zone well (W31B) will be monitored for VOCs and dissolved metals (chromium, arsenic, iron and manganese). These wells constitute the primary performance wells for this supplemental IRA injection event.

Secondary performance wells are located down-gradient of the IRA injection areas, although still within Trust-owned property boundaries. These secondary performance wells consist of three (3) A-Zone wells (W14A, GMX-3A and W9A) and one (1) B-Zone well (W8B). Secondary performance wells will be monitored semi-annually for VOCs and annually for dissolved metals. If analytical data collected from the primary performance wells confirm an increasing trend of dissolved, naturally-occurring, arsenic, dissolved chromium or vinyl chloride at concentrations above the MCL, the secondary performance wells will be added to the quarterly monitoring program, as needed.

Contingency wells are located near the Trust-owned property boundary. The A-Zone contingency wells are IMW-13 and GMX-7A, and the B-Zone contingency wells are W17B and W47B. Contingency wells will be monitored annually for VOC and dissolved metals. If analytical data collected from the secondary performance wells confirm an increasing trend of dissolved, naturally-occurring arsenic or dissolved chromium or vinyl chloride at concentrations above the MCL, then the contingency monitoring wells will be added to the quarterly program.

The monitoring wells associated with the sampling program are illustrated on Figure 5. The constituents to be analyzed, the frequency of sampling, the analytical methods and the reporting limits are provided on Table 2. The monitoring program will be continually updated as needed to ensure it's adequacy in detecting potential deleterious by-products, if any. Additional locations may be tested and/or analyses conducted to ensure the IRA is properly monitored. All data collected will be reported to the RWQCB in a timely fashion as discussed below. The monitoring program will be reviewed after the first year to ensure it is consistent with the objectives of the monitoring plan.

Contingency Plan

If analytical data collected from the contingency wells confirm an increasing trend of the target analytes (*i.e.*, arsenic, chromium or vinyl chloride) at concentrations above the MCL, the contingency plan set forth in the prior IRA Work Plan(s) will be triggered. The contingency plan action consists of implementing, or increasing, hydraulic control in the affected area(s) to mitigate the migration of contamination off Trust-owned property. It should be noted that A-Zone groundwater is currently being extracted downgradient of the supplemental A-Zone IRA injection area. For the B-Zone, groundwater extraction will be implemented in existing B-Zone contingency wells as necessary. .

Reporting Plan

Analytical and field data collected during the quarterly sampling events will be provided in the routine groundwater monitoring and sampling reports prepared for the Remco Facility. At the conclusion of a full year of testing (4 quarterly events), a final report will be provided summarizing all field activities and observations, tabulating all analytical data collected, and an evaluation of the effectiveness of the supplemental IRA injection program. Any recommended changes to the monitoring program, or additional interim remedial actions, will be proposed in the comprehensive One-Year Supplemental Injection Report.

Schedule

The field work for the above scope of work is scheduled to be conducted during the months of January and/or February 2010. Please feel free to call the undersigned at (916) 660–9994, ext. 112 with any questions or comments.

Sincerely,

JJ&A

Terry James, P.G.
Project Manager

cc: Anne Farr, Ph. D., Willits Environmental Remediation Trust
Thomas A. Larson, Esq., Briggs and Morgan, PA
H. James Lance, Esq., City of Willits
David Madrigal, City of Willits
Paul Cayler, City of Willits
Former Remco Document Depository
Philip C. Hunsucker, Esq., Hunsucker Goodstein & Nelson, PC
Earl D. James, R.G., EKI
Stuart Block, Esq.

List of Tables

List of Figures

Attachment

TABLES

TABLE 1
REMEDIAL SUPPLEMENTAL INJECTIONS SUMMARY
Former Remco Hydraulics Facility
Willits, California

Zone	Location ID	Injection Interval (ft-bgs)	Volume of Injectant (total gallons)
Vadose Zone	S1	1 - 3	25-50
	S2	1 - 3	25-50
	S3	1 - 3	25-50
	S4	1 - 3	25-50
	S5	1 - 3	25-50
	S6	1 - 3	25-50
	S7	1 - 3	25-50
	S8	1 - 3	25-50
	S9	1 - 3	25-50
	S10	1 - 3	25-50
	S11	1 - 3	25-50
	S12	1 - 3	25-50
	S13	1 - 3	25-50
	S14	1 - 3	25-50
	S15	1 - 3	25-50
	S16	1 - 3	25-50
	S17	1 - 3	25-50
	S18	1 - 3	25-50
	S19	1 - 3	25-50
	S20	1 - 3	25-50
	S21	1 - 3	25-50
	S22	1 - 3	25-50
	S23	1 - 3	25-50
	S24	1 - 3	25-50
	S25	1 - 3	25-50
A-Zone	A1	3 - 22	500
	A2	3 - 22	500
	A3	3 - 22	500
	A4	3 - 22	500
	A5	3 - 22	500
	A6	3 - 22	500
	A7	3 - 22	500
	A8	3 - 22	500
	A9	3 - 22	500
	A10	3 - 22	500
	A11	3 - 22	500
	A12	3 - 22	500
	A13	3 - 22	500
	A14	3 - 22	500
	A15	3 - 22	500
	A16	3 - 22	500
B-Zone	B1	24 - 42	450
	B2	24 - 42	450
	B3	24 - 42	450
	B4	24 - 42	450
	B5	24 - 42	450
	B6	24 - 42	450
	B7	24 - 42	450
	B8	24 - 42	450
	B9	24 - 42	450
	B10	24 - 42	450
	B11	24 - 42	450
	B12	24 - 42	450
	B13	24 - 42	450
	B14	24 - 42	450
	B15	24 - 42	450
	B16	24 - 42	450
	B17	24 - 42	450
	B18	24 - 42	450
	B19	24 - 42	450
	B20	24 - 42	450

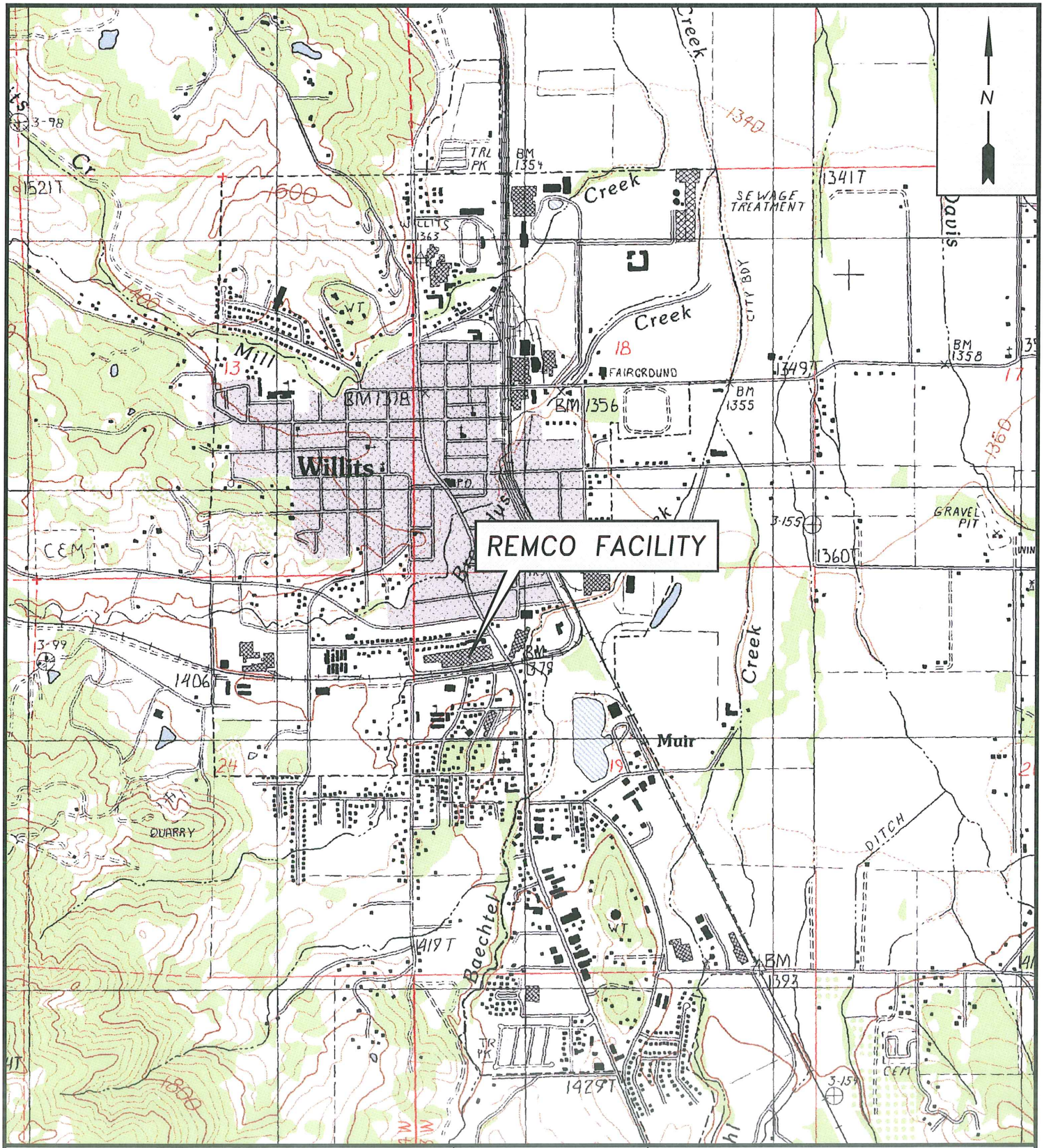
Notes:
ft-bgs = feet below surface grade

TABLE 2
MONITORING PROGRAM
Former Remco Hydraulics Facility
Willits, California

Aquifer Zone	Well ID	VOCs	Metals (1)	Cr VI	Frequency
Primary Wells					
A	IMW-7	Q	Q	Q	Testing to be conducted subsequent to supplemental injection for the constituents and at the frequency noted.
A	TW-2	Q	Q	_	
A	TW-4	Q	Q	_	
A	TW-6	Q	Q	Q	
A	W21A	Q	Q	_	
A	W24A	Q	Q	_	
A	GMX-2A	Q	Q	_	
A	W37A	Q	Q	Q	
B	EW1B	Q	Q	Q	
B	W31B	Q	Q	_	
Secondary Wells					
A	W14A	SA	A	--	Secondary wells will be tested as indicated. Quarterly testing will commence upon confirmation of an increasing trend in vinyl chloride or arsenic (above the MCL) detected in upgradient primary well.
A	W9A	SA	A	--	
A	GMX-3A	SA	A	--	
B	W8B	SA	A	--	
Contingency Wells					
A	IMW-13	A	A	--	Contingency wells will be tested as indicated. Quarterly testing will commence upon confirmation of an increasing trend of vinyl chloride or arsenic in upgradient secondary well.
A	GMX-7A	A	A	--	
B	W17B	A	A		
B	W47B	A	A	--	

Notes:
All wells will be tested prior to injections to establish baseline conditions. After the first year, monitoring of the subject IRA will be in conducted in conjunction with the routine monitoring and
1 = Dissolved metals include total chromium (Cr III), arsenic, iron and manganese.
VOCs = volatile organic compounds
Cr VI = hexavalent chromium
MCL = maximum contaminant level
Q = Well tested quarterly.
SA = Well tested semi-annually (April and October).
A = Well tested Annually (October).
-- = Testing conducted as needed.

FIGURES



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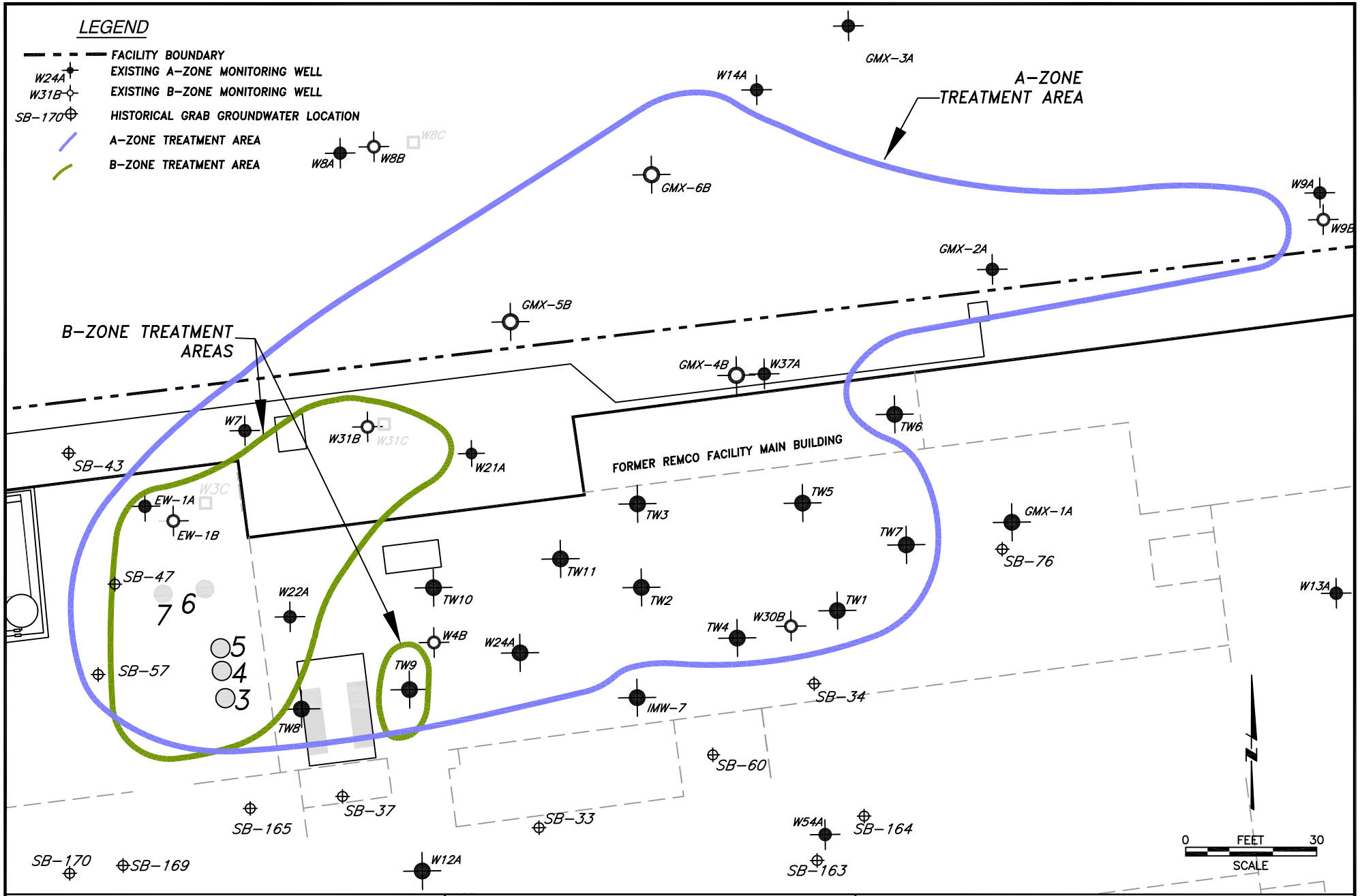
& associates, inc

SOURCE: U.S.G.S. 7.5' QUAD SHEET
WILLITS, CALIFORNIA
PHOTOREVISED 1993

SCALE: 0 FEET 2000	TITLE: FACILITY LOCATION MAP	
CLIENT: WILLITS ENVIRONMENTAL REMEDIATION TRUST		DATE: 7/24/08
LOCATION: FORMER REMCO HYDRAULICS, INC. WILLITS, CALIFORNIA		FIGURE: 1



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LOCATION: *WILLITS ENVIROMENTAL REMEDIATION TRUST*
FORMER REMCO HYDRAULICS, INC.
WILLITS, CALIFORNIA

PROJECT NO.	DATE	DR. BY	APP. BY
01.WIL.2009	9/25/09	DJH	TJ

TITLE:

FIGURE 2
AREAS TREATED: HEXAVALENT CHROMIUM-AFFECTED GROUNDWATER IRA

LEGEND

FACILITY BOUNDARY

A-ZONE MONITORING WELL

A-ZONE PILOT TEST WELL

SB-57 HISTORICAL GRAB GROUNDWATER LOCATION (VARIOUS DATES)

<0.0010 CONCENTRATION OF HEXAVALENT CHROMIUM (mg/L)

* MOST RECENT DATA AVAILABLE PLOTTED

NS NOT SAMPLED

UNOCAL 76 STATION

UMW-4 NS

UMW-7 NS

UMW-8 NS

FRANKLIN AVENUE

W17A <0.0010

IMW-13 * <0.001

W18A * <0.001U

IMW-9 NS

W42A <0.0010

W41A <0.0010

W43A * <0.001

GMX-3A * <0.05UJ+

GMX-8A * <0.01

W14A <0.0010U

W8A <0.0010

IMW-12 NS

FOMER LUNA MOTEL & MARKET

W9A <0.0010

GMX-7A * <0.05UJ+

MAIN STREET/U.S. HWY 101

GMX-2A <0.0010

EM-01 * <0.001

EM-02 * <0.001

EM-03 * <0.001

W37A 0.0036

0.001

TW6 * 0.023

SB-43 <0.00500

W7 * <0.001

W21A <0.0010

EW-1A <0.0010U

TW5 <0.0010U

<0.0010UJ- GMX-1A

TW11 * <0.01

TW3 * <0.05UJ+

TW7 * <0.055

SB-76 0.678

SB-47 <0.00500

TW2 <0.0010U

W13A * <0.0010U

EM-04 * <0.0010

W22A <0.0010U

TW10 * <0.05UJ+

TW1 * <0.031U

ON-SITE TREATMENT FACILITY

SB-57 <0.00500

TW8 * <0.05UJ+

W24A <0.0010U

1.0

IMW-7 5.8

TW4 * <0.055

SB-34 <0.00500

W11A <0.0010U

TW9 * <0.05

SB-60 <0.00500

SB-37 <0.005

SB-165 0.110

SB-164 <0.00500

W54A <0.0010U

<0.00500 SB-170

SB-169 <0.00500

W12A * <0.0010U

SB-163 <0.00500

FORMER REMCO FACILITY MAIN BUILDING

<0.00500

W38A * <0.0010

W15A * <0.0010

W23A * <0.0010

N

0 FEET 50

SCALE

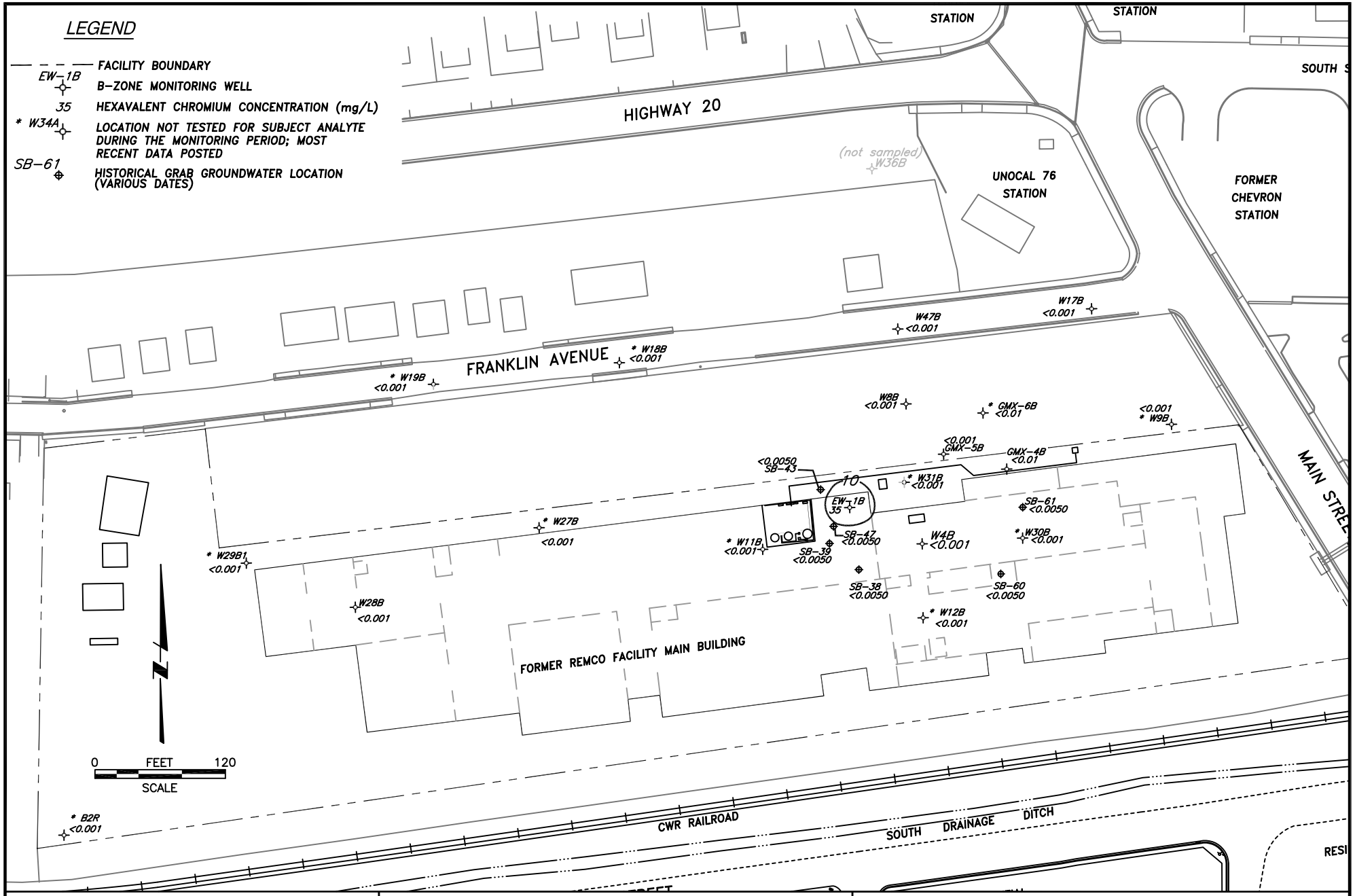
JACOBSON | JAMES & associates, inc

TITLE: HEXAVALENT CHROMIUM DETECTED IN THE A-ZONE (OCTOBER 2008)

DATE: 9/25/09

LOCATION: WILLITS ENVIRONMENTAL REMEDIATION TRUST FORMER REMCO HYDRAULICS, INC. WILLITS, CALIFORNIA

FIGURE: 3



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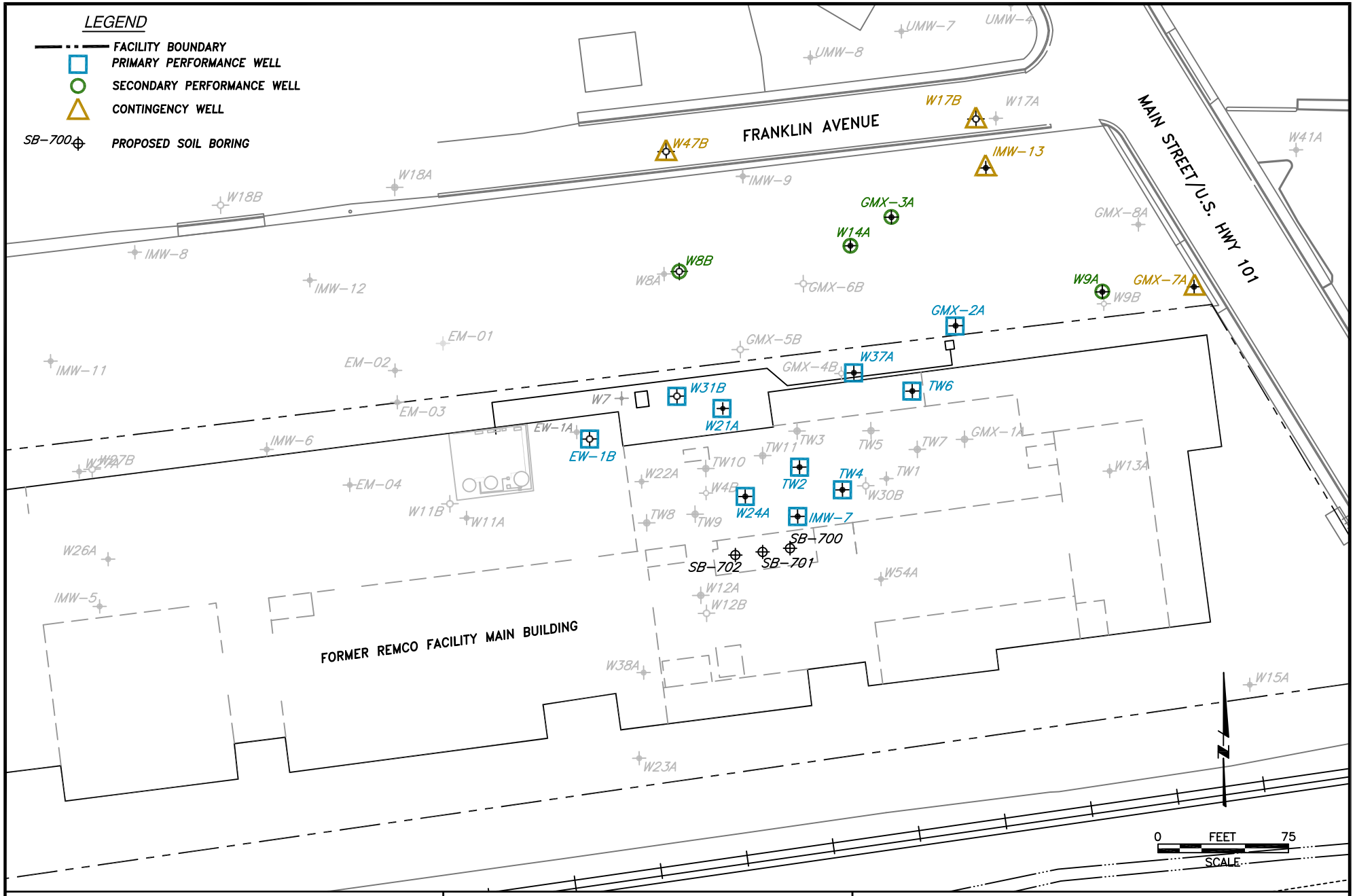
& associates, inc

LOCATION: *WILLITS ENVIROMENTAL REMEDIATION TRUST*
FORMER REMECO HYDRAULICS, INC.
WILLITS, CALIFORNIA

PROJECT NO.	DATE	DR. BY	APP. BY
01.WIL.2009	9/16/09	MM	TJ

TITLE:
FIGURE 4
HEXAVALENT CHROMIUM DECTECTED IN THE B-ZONE
(OCTOBER 2008)



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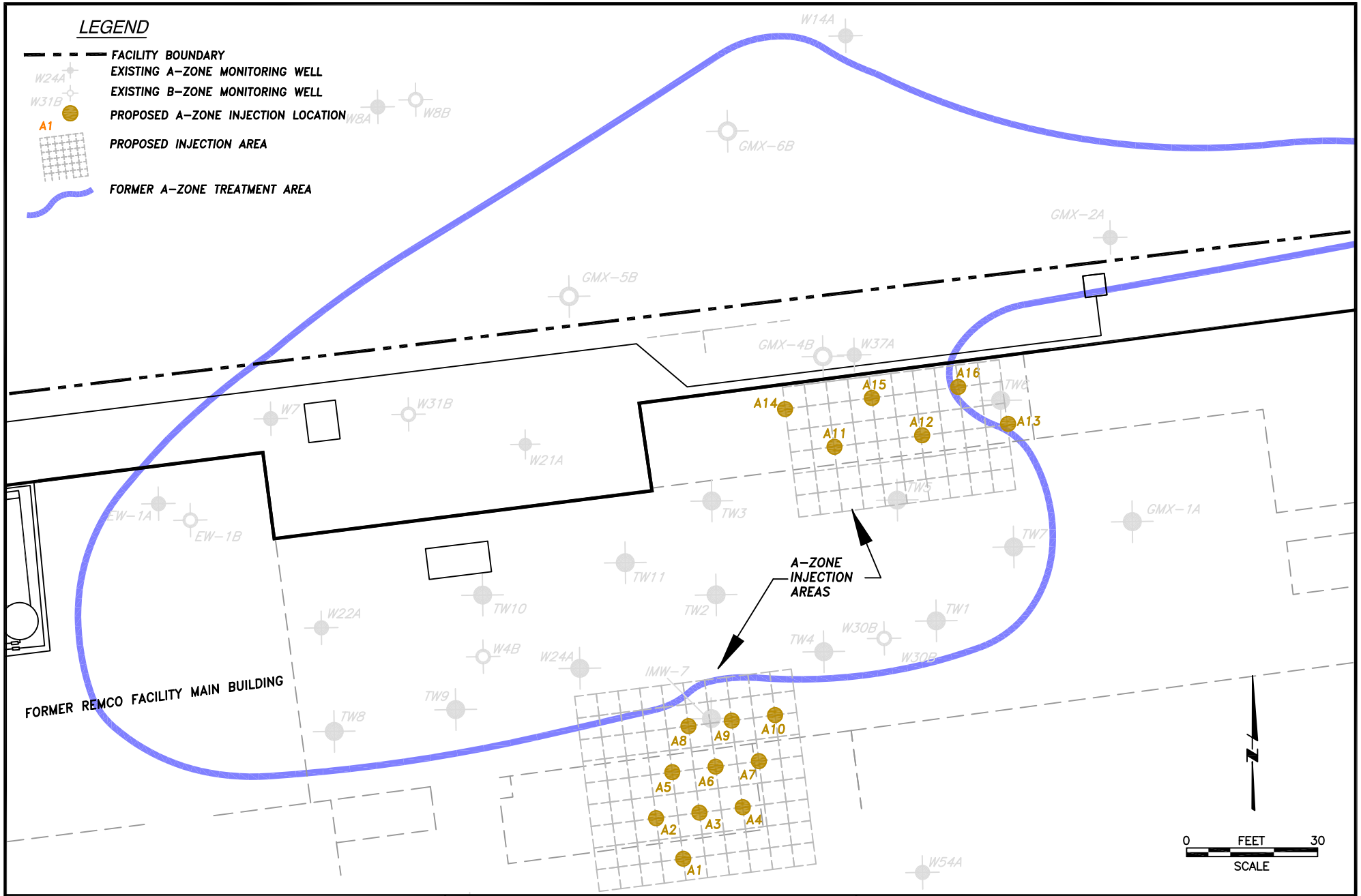
LOCATION: WILLITS ENVIROMENTAL REMEDIATION TRUST FORMER REMCO HYDRAULICS, INC. WILLITS, CALIFORNIA			
PROJECT NO.	DATE	DR. BY	APP. BY
01.WIL.2009	9/25/09	DJH	TJ

TITLE:

FIGURE 5

IRA MONITORING WELL LOCATIONS



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LOCATION:			
WILLITS ENVIROMENTAL REMEDIATION TRUST FORMER REMCO HYDRAULICS, INC. WILLITS, CALIFORNIA			
PROJECT NO.	DATE	DR. BY	APP. BY
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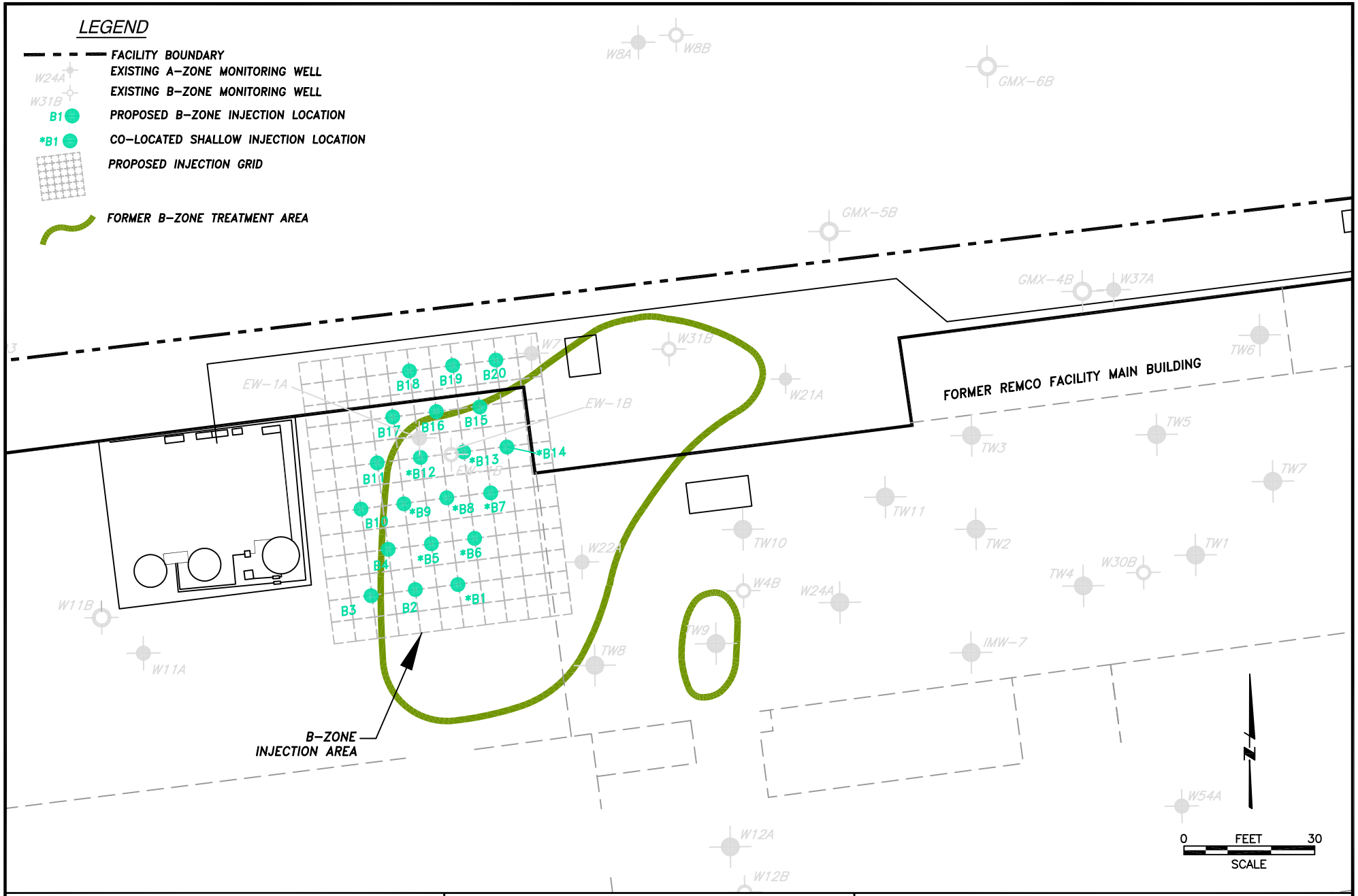
TITLE:

FIGURE 6
A-ZONE SUPPLEMENTAL INJECTION LOCATIONS



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LOCATION: WILLITS ENVIROMENTAL REMEDIATION TRUST FORMER REMCO HYDRAULICS, INC. WILLITS, CALIFORNIA			
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TITLE:

FIGURE 7
B-ZONE SUPPLEMENTAL INJECTION LOCATIONS

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LOCATION: *WILLITS ENVIROMENTAL REMEDIATION TRUST*
FORMER REMCO HYDRAULICS, INC.
WILLITS, CALIFORNIA

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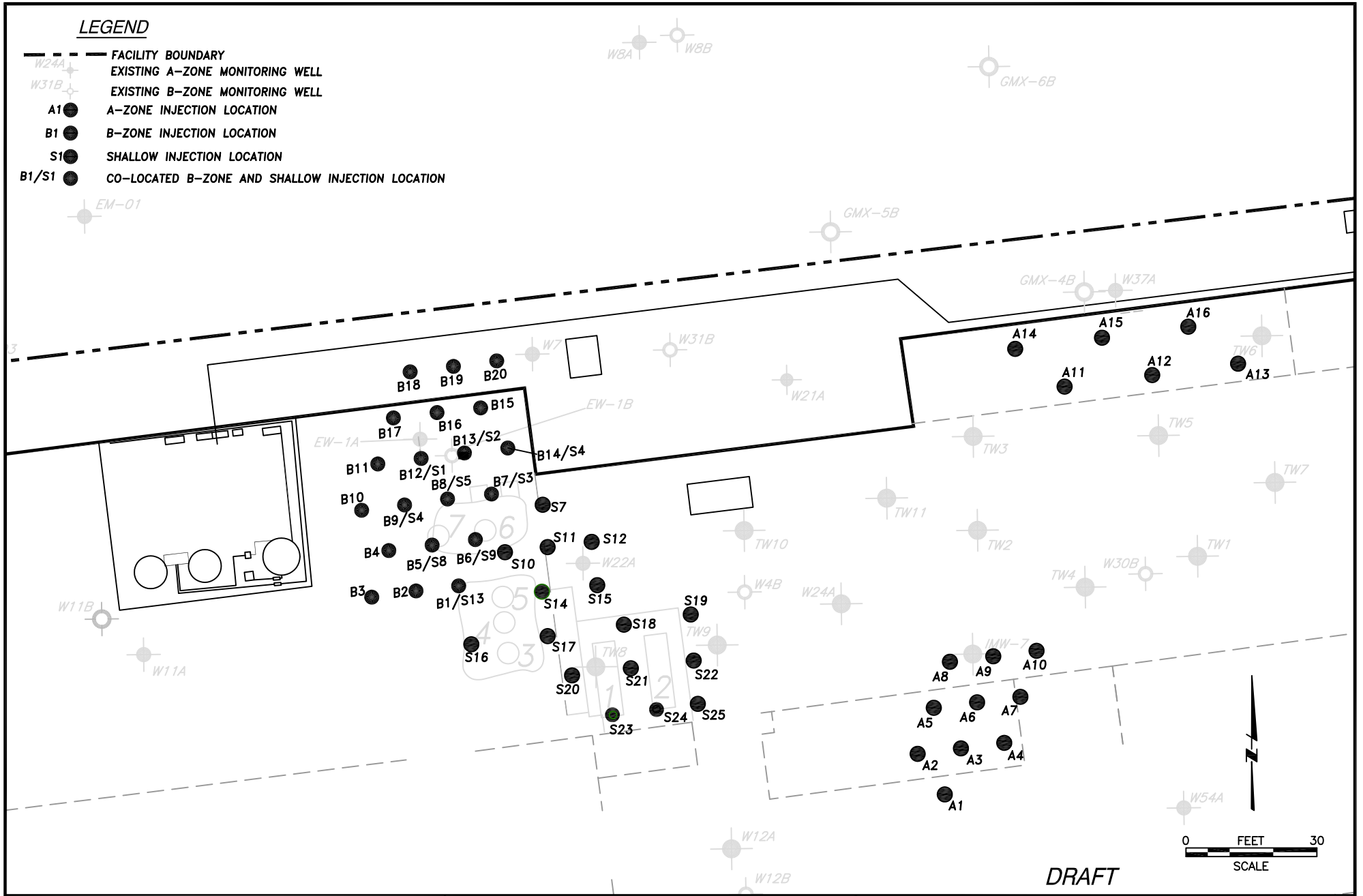
01.WIL.2009	9/15/09	DJH	TJ

TITLE:

FIGURE 8
SHALLOW INJECTION LOCATIONS



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LOCATION: WILLITS ENVIROMENTAL REMEDIATION TRUST FORMER REMCO HYDRAULICS, INC. WILLITS, CALIFORNIA			
PROJECT NO.	DATE	DR. BY	APP. BY
01.WIL.2009	9/25/09	DJH	TJ

TITLE:

FIGURE 9
SUPPLEMENTAL INJECTION LOCATION SUMMARY

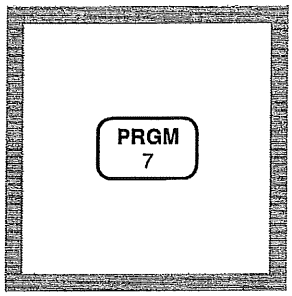
ATTACHMENT

CHROMIUM, HEXAVALENT (0 to 0.60 mg/L Cr^{6+}) For water and wastewater

1,5-Diphenylcarbohydrazide Method* (Powder Pillows or AccuVac Ampuls)

USEPA accepted for wastewater analyses**

Using Powder Pillows

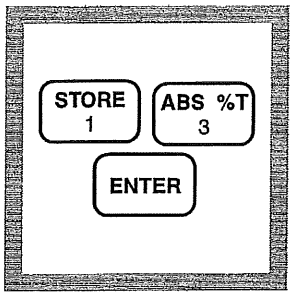


1. Enter the stored program number for hexavalent chromium (Cr^{6+})- powder pillows.

Press: **PRGM**

The display will show:

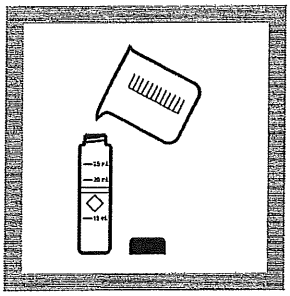
PRGM ?



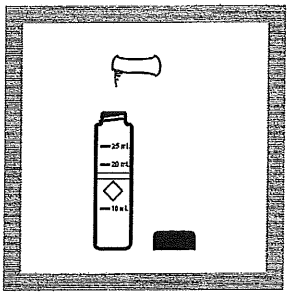
2. Press: **13 ENTER**

The display will show **mg/L, Cr6** and the **ZERO** icon.

Note: For alternate forms (CrO_4, Cr_2O_7), press the **CONC** *key.*

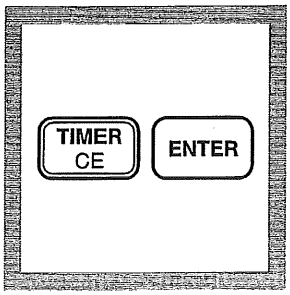


3. Fill a sample cell with 10 mL of sample.



4. Add the contents of one ChromaVer 3 Reagent Powder Pillow to the cell (the prepared sample). Cap the cell and invert several times to mix.

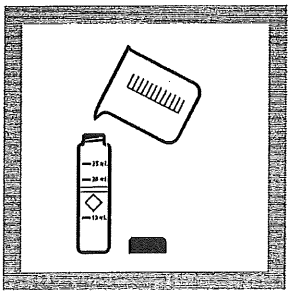
Note: A purple color will form if Cr^{6+} is present.



5. Press:

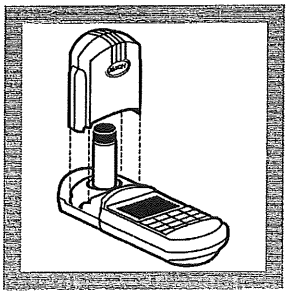
TIMER ENTER

A five-minute reaction period will begin.

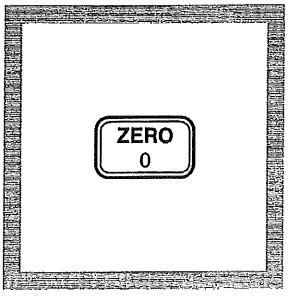


6. Fill another sample cell with 10 mL of sample (the blank).

Note: For turbid samples, add the contents of one Acid Reagent Powder Pillow. This ensures turbidity dissolved by the acid in the ChromaVer 3 Chromium Reagent is also dissolved in the blank.



7. When the timer beeps, place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.



8. Press: **ZERO**

The cursor will move to the right, then the display will show:

0.00 mg/L Cr6

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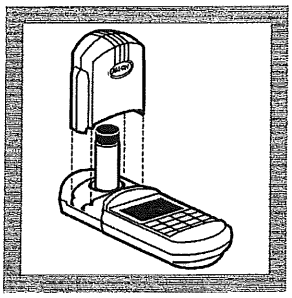
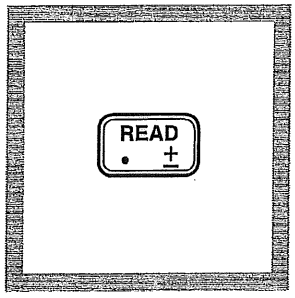
* Adapted from *Standard Methods for the Examination of Water and Wastewater*

** Procedure is equivalent to USGS method I-1230-85 for wastewater.



9. Place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.

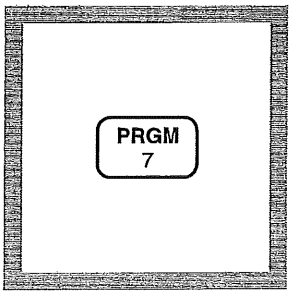


10. Press: **READ**

The cursor will move to the right, then the result in mg/L hexavalent chromium will be displayed.

Note: *Standard Adjust may be performed using a prepared standard (see Standard Adjust in Section 1).*

Using Accuvac Ampuls

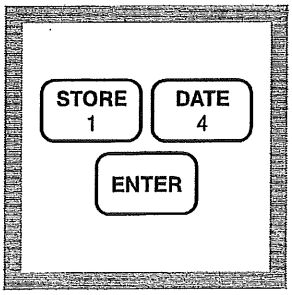


1. Enter the stored program number for hexavalent chromium (Cr^{6+})- AccuVac Ampuls.

Press: **PRGM**

The display will show:

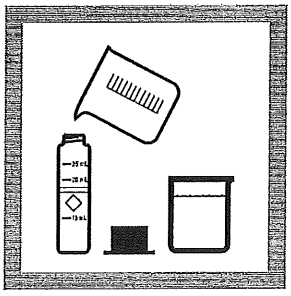
PRGM ?



2. Press: **14 ENTER**

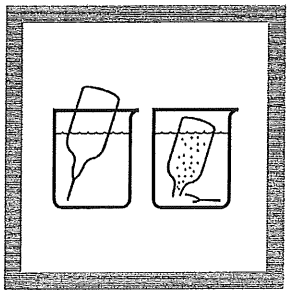
The display will show **mg/L, Cr6** and the **ZERO** icon.

Note: *For alternate forms (CrO_4, Cr_2O_7), press the* **CONC** *key.*



3. Fill a sample cell with at least 10 mL of sample (the blank). Collect at least 40 mL of sample in a 50-mL beaker.

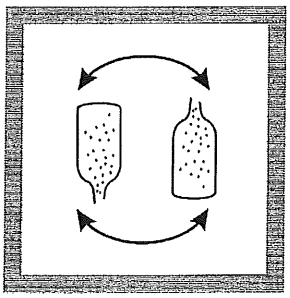
Note: *For turbid samples, add the contents of one Acid Reagent Powder Pillow to 10 mL of the blank. This ensures turbidity dissolved by the acid in the ChromaVer 3 Chromium Reagent is also dissolved in the blank.*



4. Fill a ChromaVer 3 Reagent AccuVac Ampul (the prepared sample) with sample.

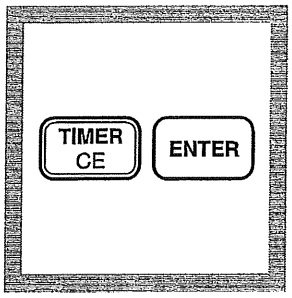
Note: *Keep the tip immersed while the ampul fills completely.*

Note: *ChromaVer 3 should be white to tan in color. Replace if it is brown or green.*



5. Quickly invert the ampul several times to mix. Wipe off any liquid or fingerprints.

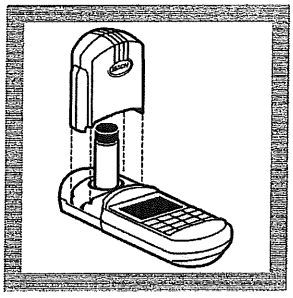
Note: *A purple color will form if hexavalent chromium is present.*



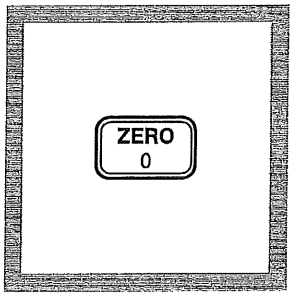
6. Press:

TIMER ENTER

A five-minute reaction period will begin.



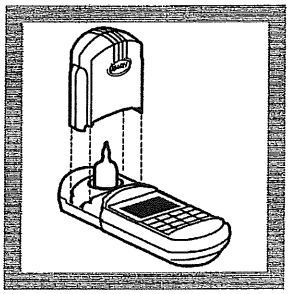
7. When the timer beeps place the blank into the cell holder.



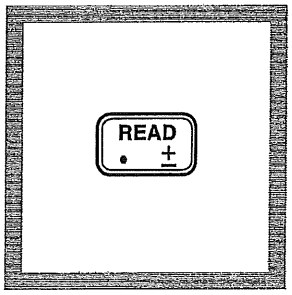
8. Press: **ZERO**

The cursor will move to the right, then the display will show:

0.00 mg/L Cr6



9. Place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.



10. Press: **READ**

The cursor will move to the right, then the result in mg/L hexavalent chromium will be displayed.

Note: *Standard Adjust may be performed using a prepared standard (see Standard Adjust in Section 1).*

Sampling and Storage

Collect samples in a cleaned glass or plastic container. Store at 4 °C (39 °F) up to 24 hours. Samples must be analyzed within 24 hours.

Accuracy Check

Standard Additions Method (powder pillows)

a) Snap the neck off a Hexavalent Chromium PourRite Standard Ampule, 5 mg/L Cr^{6+}.

b) Use the TenSette Pipet to add 0.1 mL, 0.2 mL and 0.3 mL of standard to three 10-mL samples, respectively. Swirl to mix.

c) Analyze each sample as described above. The chromium concentration should increase 0.05 mg/L for each 0.1 mL of standard added.

d) If these increases do not occur, see *Standard Additions* in *Section 1* for more information.

Standard Additions Method (AccuVac Ampuls)

a) Snap the neck off a Hexavalent Chromium Voluette Standard Ampule, 12.5 mg/L Cr^{6+}.

b) Use the TenSette Pipet to add 0.1 mL, 0.2 mL and 0.3 mL of standard to three 25-mL samples in beakers. Swirl gently to mix.

c) Analyze each sample as described above. The chromium concentration should increase 0.05 mg/L for each 0.1 mL of standard added.

d) If these increases do not occur, see *Standard Additions* in *Section 1* for more information.

Standard Solution Method

Prepare a 0.50-mg/L Cr^{6+} solution by pipetting 10.00 mL of Hexavalent Chromium Standard Solution, 50.0 mg/L Cr^{6+}, into a 1000-mL volumetric flask and diluting to the mark with deionized water. Invert repeatedly to mix. Prepare this solution daily. Perform the chromium procedure as described above, using this solution in place of the sample.

Method Performance

Precision

In a single laboratory using a standard solution of 0.6 mg/L Cr^{6+} and two representative lots of powder pillow reagent with the instrument, a single operator obtained a standard deviation of ±0.008 mg/L Cr^{6+}.

In a single laboratory using a standard solution of 0.6 mg/L Cr^{6+} and two representative lots of AccuVac Ampuls with the instrument, a single operator obtained a standard deviation of ±0.005 mg/L Cr^{6+}.

Estimated Detection Limit (EDL)

The EDL for program 13 (powder pillows) and program 14 (AccuVac Ampuls) is 0.01 mg/L Cr^{6+}. For more information on derivation and use of Hach's estimated detection limit, see *Section 1*.

Interferences

The following substances do not interfere in the test, up to the following concentration:

Substance	Concentration
Mercurous & Mercuric Ions	Interferes slightly
Iron	1 mg/L
Vanadium	1 mg/L. At higher levels vanadium interference can be overcome by waiting ten minutes before reading.

Highly buffered samples or extreme sample pH may exceed the buffering capacity of the reagents and require sample pretreatment; see *pH Interference* in *Section 1*.

Summary of Method

Hexavalent chromium is determined by the 1,5-diphenylcarbohydrazide method using a single dry powder formulation called ChromaVer 3 Chromium Reagent. This reagent contains an acidic buffer combined with 1,5-diphenylcarbohydrazide, which reacts to give a purple color which is proportional to the amount of hexavalent chromium present.

REQUIRED REAGENTS AND APPARATUS (Using Powder Pillows)

Description	Quantity Required Per Test	Unit	Cat. No.
ChromaVer 3 Chromium Reagent Powder Pillows..	1 pillow	100/pkg	12710-99
Sample Cell, 10-20-25 mL, w/ cap	2	6/pkg	24019-06

REQUIRED REAGENTS AND APPARATUS (Using AccuVac Ampuls)

ChromaVer 3 AccuVac Ampuls	1 ampul	25/pkg	25050-25
Beaker, 50 mL	1	each	500-41H

OPTIONAL REAGENTS

Description	Unit	Cat. No
Acid Reagent Powder Pillows	100/pkg	2126-99
Chromium, Hexavalent, Standard Solution, 50 mg/L Cr^{6+}	100 mL	810-42
Chromium, Hexavalent, Standard Solution, Voluette Ampule, 12.5 mg/L Cr^{6+}, 10 mL	16/pkg	14256-10
Chromium, Hexavalent, Standard Solution, PourRite Ampule, 5 mg/L Cr^{6+}, 2 mL	20/pkg	26056-20
Water, deionized	4 L	272-56

OPTIONAL APPARATUS

Description	Unit	Cat. No.
AccuVac Snapper Kit	each	24052-00
Ampule Breaker Kit	each	21968-00
Flask, volumetric, Class A, 1000 mL	each	14574-53
pH Paper, 1 to 11 pH units	5 rolls/pkg	391-33
pH Meter, EC10, portable	each	50050-00
Pipet, TenSette, 0.1 to 1.0 mL	each	19700-01
Pipet Tips, for 19700-01 TenSette Pipet	50/pkg	21856-96
Pipet Tips, for 19700-01 TenSette Pipet	50/pkg	21856-96
Pipet, volumetric, 5.00 mL, Class A	each	14515-37
Pipet Filler, safety bulb	each	14651-00
PourRite Ampule Breaker, 2 mL	each	24846-00

In the U.S.A.—Call 800-227-4224
Outside the U.S.A.—Contact the Hach office or distributor serving you.