JACOBS ENGINEERING GROUP INC.

10901 WEST 84th TERRACE, SUITE 210, LENEXA, KANSAS 66214
TELEPHONE (913) 492-9218

August 16, 1990

Mr. Steven Jones
Remedial Project Manager
U. S. Environmental Protection Agency
Region VII - Superfund Branch
726 Minnesota Avenue
Kansas City, Kansas 66101

Re: Mid-America Tanning Site
Addendum No. 1
Sampling and Analysis Plan
For the Remedial Investigation/Feasibility Study
Work Assignment No. 38-7W7M
Project No. 10-D238-00

Dear Mr. Jones:

Enclosed are two copies of Addendum No. 1 of the Sampling and Analysis Plan for the Remedial Investigation/Feasibility Study at the Mid-America Tanning site.

Please contact me if you have any questions.

Sincerely,

Jill R. Biesma
Site Manager

Steven M. Houser
ARCS Program Manager

Enclosures

U.S. ENVIRONMENTAL PROTECTION AGENCY

ALTERNATIVE REMEDIAL
CONTRACTS STRATEGY

REGION VI, VII, VIII

ADDENDUM NO. 1
SAMPLING AND ANALYSIS PLAN (SAP)
FOR THE REMEDIAL
INVESTIGATION/FEASIBILITY
STUDY (RI/FS)

MID-AMERICA TANNING SITE
SERGEANT BLUFF, IOWA

WORK ASSIGNMENT NO. 38-7W7M
U.S. EPA REGION VII

REMEDIAL PLANNING ACTIVITIES
AT
SELECTED UNCONTROLLED HAZARDOUS
SUBSTANCE DISPOSAL SITES

U.S. EPA CONTRACT NO. 68-W8-0122

JACOBS ENGINEERING GROUP INC.
10901 WEST 84TH TERRACE, SUITE 210
LENEXA, KANSAS 66214
(913) 492-9218
PROJECT NUMBER 10-D238-00

AUGUST 1990

ADDENDUM NO. 1
SAMPLING AND ANALYSIS PLAN (SAP)
FOR THE REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS)
MID-AMERICA TANNING SITE
SERGEANT BLUFF, IOWA

PREPARED FOR:
U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION VII
ALTERNATIVE REMEDIAL CONTRACTS STRATEGY
CONTRACT NO. 68-W8-0122
U.S. EPA NO. 38-7W7M
JACOBS PROJECT NO. 10-D238-00

PREPARED BY:
JACOBS ENGINEERING GROUP INC.
10901 WEST 84TH TERRACE, SUITE 210
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REVIEW AND APPROVAL SIGNATURES:

Jill R. Biesma — 8-16-90
Jill R. Biesma — **Date**
ARCS Site Manager

Laurie M. Dunkle — 8-16-90
Laurie M. Dunkle — **Date**
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Jill R. Biesma — **Date**
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Steven M. Houser — 8/16/90
Steven M. Houser — **Date**
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Steven Jones — **Date**
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Region VII Remedial Project Manager

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ADDENDUM NO. 1

SAMPLING AND ANALYSIS PLAN (SAP)

MID-AMERICA TANNING SITE
SERGEANT BLUFF, IOWA

1.0 INTRODUCTION

This document is Addendum Number 1 to the Sampling and Analysis Plan for the Remedial Investigation/Feasibility Study (RI/FS) to be conducted at the Mid-America Tanning Site in Sergeant Bluff, Iowa. This document has been prepared in support of the U.S. Environmental Protection Agency's (EPA) Alternative Remedial Contracts Strategy (ARCS) Program, Work Assignment No. 38-7W7M for the U.S. EPA Region VII.

There are essentially two purposes for the proposed addendum to the Sampling and Analysis Plan (SAP): (1) to propose the use of alternative analytical methods for select soil/sediment and water analyses; and (2) to request the use of a Hach spectrophotometer for the collection of total and hexavalent chromium data from samples of surface water and ground water collected during the RI.

Alternative Analytical Methods

The proposed change in the analytical methodology to be utilized results from the process of solicitation of bids from analytical laboratories to perform the work described by the SAP. During the bidding process, laboratories proposed alternative analytical techniques which will accomplish the objectives of the SAP. These alternative analytical methodologies which have been incorporated into SAP Tables 1 and 2 are outlined in an excerpt from a memo from Mr. Barry Evans, ENSV, to Mr. Steve Jones, Remedial Project Manager. Tables 1 and 2 and the excerpt are included as Attachment A to this addendum.

Field Analyses Using a Spectrophotometer

The use of a Hach Spectrophotometer is proposed for chromium analyses on ground water and surface water samples collected during the RI. Specifically, it is proposed that this instrument be used for total chromium and hexavalent chromium analyses of ground water samples obtained from exploratory borings and monitor wells near the site periphery to facilitate field decisions related to location of monitor wells and screened intervals for sample collection. It is also proposed that the spectrophotometer be used for hexavalent chromium analyses of all liquid samples collected during the RI (ground water, oxbow lake, surface impoundments) to supplement laboratory total chromium analyses.

The proposed methodologies for the Hach spectrophotometer field analysis of total and hexavalent chromium are detailed in Attachments B and C to this addendum, respectively.

Total Chromium Analyses by Spectrophotometer

Because chromium is one of the primary contaminants at the Mid America Tanning site, it is proposed that field analyses for total chromium be used as a screening tool for placement of wells to define the extent of ground water contamination. Hach spectrophotometer analyses of ground water collected using a Hydropunch sampler are proposed to provide in-situ ground water contamination data to facilitate field decisions in locating monitor wells at the boundary of the plume and in selecting screened intervals.

The Hydropunch sampler is similar to a well point and is compatible with hollow stem auger drilling rigs. The Hydropunch is connected to a small diameter drive pipe on the drilling rig and is driven hydraulically into the undisturbed soil below the water table. Ground water is collected by mechanically opening a section of the sampler. Following filling of the sampler with ground water, the Hydropunch is extracted from the boring and the ground water is emptied into a sample container for subsequent analyses.

To minimize matrix interferences for unfiltered ground water, the EPA mild digestion (Attachment D) is proposed for the field analysis of total chromium. Organic material is digested with 5 milliliters of 1:1 hydrochloric acid to reduce interferences detected by the spectrophotometer.

As the field analysis for total chromium is intended to be used for screening purposes, a sufficient volume will be collected to provide confirmatory laboratory analysis of both total and dissolved chromium at each location. It is proposed that all valid laboratory and field analysis data be reported in the RI report. All field data for total chromium analyses and corresponding quality assurance information will be submitted to the EPA for validation.

Hexavalent Chromium Analyses by Spectrophotometer

It is proposed that the Hach spectrophotometer also be used for hexavalent chromium analyses of all filtered ground water, surface water, and impoundment water collected from the site during the RI. Chromium is typically found in one of two states in the environment: trivalent or hexavalent. Trivalent chromium is environmentally less mobile, although it is subject to complexation with negative legands which cause the solubility of trivalent chromium to vary based on solution chemistry. Hexavalent chromium is highly soluble, mobile, and stable in the ground water environment. It is also the more toxic form of chromium. Most regulatory standards are set conservatively based on hexavalent chromium toxicity and the assumption that most of the chromium present is in hexavalent form. Distinguishing between chromium species is not only critical to identifying potential health and environmental threats, but it also is important in understanding contaminant fate and transport and designing of potential treatment systems. Only field analyses are proposed for hexavalent chromium because the holding time for this constituent is only twenty four hours. Based on preliminary tests using the Hach spectrophotometer, this field method is expected to provide valid data at a fraction of the cost associated with sample management and laboratory analyses. It is proposed that all valid data for hexavalent chromium obtained using the Hach spectrophotometer be included in the RI report. The field analyses data as well as quality assurance information will be submitted to the EPA for validation.

Attachment A

TABLE 1
SUMMARY OF QA OBJECTIVES FOR SOILS/SLUDGE ANALYSES

Parameters	Method	Detection Level (mg/kg)	Accuracy (% recovery)	Precision[1] (RPD)	Completeness
RAS Metals	CLP SOW Inorganics[a]	CLP SOW Inorganics	CLP SOW Inorganics	CLP SOW Inorganics	90%
Aluminum					
Antimony					
Arsenic					
Barium					
Beryllium					
Cadmium					
Calcium					
Chromium					
Cobalt					
Copper					
Iron					
Lead					
Magnesium					
Manganese					
Mercury					
Nickel					
Potassium					
Selenium					
Silver					
Sodium					
Thallium					
Vanadium					
Zinc					

TABLE 1 (Cont.)
SUMMARY OF QA OBJECTIVES FOR SOILS/SLUDGE ANALYSES

Parameters	Method	Detection Level (mg/kg)	Accuracy (% recovery)	Precision[l] (RPD)	Completeness
Cyanide	9010A/9010[g]	*	*	*	90%
RAS Volatile Organics	CLP SOW Organics[b]	CLP SOW Organics	CLP SOW Organics	CLP SOW Organics	90%
RAS Semi-Volatile Organics	CLP SOW Organics[b]	CLP SOW Organics	CLP SOW Organics	CLP SOW Organics	90%
Nitrogen Species					
Ammonia	10-2.3.2[e]/350.2[d]	12	75 to 125	±20	90%
Total Kjeldahl Nitrogen (TKN)	10-2.3.2[e]/351.3[d]	50	75 to 125	±20	90%
Nitrate & Nitrite	10-2.3.2[e]/300.0[f]	1	75 to 125	±20	90%
Nitrite	10-2.3.2[e]/300.0[f]	1	75 to 125	±20	90%
Chloride	9252[g]	*	*	*	90%
Sulfate	10-2.3.2[e]/300.0[f]	*	*	*	90%
Sulfides	10-2.3.2[e]/376.1[d]	*	*	*	90%
Phosphorus	10-2.3.2[e]/365.2	*	*	*	90%
pH	9045[g]	*	*	*	90%
Physical and Treatability Parameters					
Oil and Grease	9071[g]	*	*	*	90%
Total Organic Carbon (TOC)	9060[g]	*	*	*	90%
Cation Exchange Capacity (CEC)	9081[g]	N/A	N/A	N/A	N/A
Particle Size	ASTM D422[h]	N/A	N/A	N/A	N/A
Moisture Content (Dry Weight %)	ASTM 2216-80[h]	N/A	N/A	N/A	N/A
Density (Relative Specific Gravity)	ASTM 854-83[h]	N/A	N/A	*	90%
Liquid & Plastic Limits	ASTM D4318[h]	N/A	N/A	N/A	N/A
Permeability	ASTM D2434[h], (granular soils) EM 1110-2-1906[j] (cohesive soils)	N/A	N/A	N/A	N/A

TABLE 1 (Cont.)

SUMMARY OF QA OBJECTIVES FOR SOILS/SLUDGE ANALYSES

Parameters	Method	Detection Level (mg/kg)	Accuracy (% recovery)	Precision[l] (RPD)	Completeness
RCRA Waste Characterization					
TCLP	1311[k]	*	*	*	90%
Reactivity	7.3[g]	*	N/A	N/A	N/A

[a]U.S. Environmental Protection Agency. 1986. Contract Laboratory Program Statement of Work Inorganic Analyses.

[b]U.S. Environmental Protection Agency. 1986. Contract Laboratory Program Statement of Work Organic Analyses.

[c]U.S. Environmental Protection Agency. 1981. Procedures for Handling and Chemical Analysis of Sediment and Water Samples. Technical Report EPA/CE-81-1.

[d]U.S. Environmental Protection Agency. 1983. Methods for Chemical Analysis of Water and Wastes. EPA 600/4-79-020.

[e]Page, A.L., et.al. 1982. Monograph No. 9, Methods of Soil Analysis, Part 2, Chemical and Microbiological Properties. 2nd ed. American Society of Agronomy

[f]U.S. Environmental Protection Agency. March 1984. The Determination of Inorganic Anions in Waterby Ion Chromatography, Method - 300.0 Test Method, EPA-60014-84-017.

[g]U.S. Environmental Protection Agency. 1986. Test Methods for Evaluating Solid Waste Physical/Chemical Methods. SW-846 ed., 3rd Edition.

[h]American Society for Testing and Materials. 1989 and 1990. Annual Book of ASTM Standards.

[i]Draft method for the determination of total nitrogen, carbon, and sulfur in soils, plant tissues and wastes using the NA 1500 N-C-S Analyzer developed by the University of Arizona in cooperation with Hydro Geochem for applications at hazardous waste sites, August 14, 1989.

[j]U.S. Army Corps of Engineers. 1970 Engineer Manual D103-613.

[k]Federal Register Vol. 55 No. 61 March 29, 1990.

[l]Applicable only to sample concentrations five times the detection limit.

* As specified in analytical method

Attachmen .Continued)

TABLE 2

SUMMARY OF QA OBJECTIVES FOR WATER ANALYSES

Parameters	Method	Detection Level (mg/l)	Accuracy (% recovery)	Precision[i] (RPD)	Completeness
RAS Metals	CLP SOW Inorganics[a]	CLP SOW Inorganics	CLP SOW Inorganics	CLP SOW Inorganics	90%
Aluminum					
Antimony					
Arsenic					
Barium					
Beryllium					
Cadmium					
Calcium					
Chromium					
Cobalt					
Copper					
Iron					
Lead					
Magnesium					
Manganese					
Mercury					
Nickel					
Potassium					
Selenium					
Silver					
Sodium					
Thallium					
Vanadium					
Zinc					

TABLE _ (Cont.)

SUMMARY OF QA OBJECTIVES FOR WATER ANALYSES

Parameters	Method	Detection Level (mg/l)	Accuracy (% recovery)	Precision[i] (RPD)	Completeness
Cyanide	9010[j]	*	*	*	90%
RAS Volatile Organics	CLP SOW Organics[c]	CLP SOW Organics	CLP SOW Organics	CLP SOW Organics	90%
RAS Semi-Volatile Organics	CLP SOW Organics[c]	CLP SOW Organics	CLP SOW Organics	CLP SOW Organics	90%
Nitrogen Species					
Ammonia	350.2[b]	0.2	75 to 125	±20	90%
Total Kjeldahl Nitrogen (TKN)	351.3[b]	0.2	75 to 125	±20	90%
Other Water Quality Parameters					
Chloride	300.0[d]	1.0	75 to 125	±20	90%
Fluoride	300.0[d]	0.05	75 to 125	±20	90%
Nitrite	300.0[d]	0.05	75 to 125	±20	90%
Nitrate	300.0[d]	0.05	75 to 125	±20	90%
Orthophosphate	300.0[d]	1.0	75 to 125	±20	90%
Sulfate	300.0[d]	1.0	75 to 125	±20	90%
Alkalinity	310.1[b]	20.0	75 to 125	±20	90%
Bicarbonate	310.1[b]	20.0	75 to 125	±20	90%
Carbonate	310.1[b]	20.0	75 to 125	±20	90%
Sulfide	376.1[d]/special method for tanning wastewater[e**]	*	*	*	90%
Phosphorous (all forms)	365.2[b]	0.05	75 to 125	±20	90%
Total Dissolved Solids (TDS)	160.1[b]	N/A	N/A	N/A	N/A
Total Suspended Solids (TSS)	160.2[b]	N/A	N/A	N/A	N/A

TABLE 2 (Cont.)

SUMMARY OF QA OBJECTIVES FOR WATER ANALYSES

Parameters	Method	Detection Level (mg/l)	Accuracy (% recovery)	Precision[i] (RPD)	Completeness
Treatability Parameters					
Biological Oxygen Demand (BOD)	405.1[b]	N/A	N/A	*	90%
Chemical Oxygen Demand (COD)	410.[b]	*	*	*	90%
Total Organic Carbon (TOC)	415.2[b]	0.05	75 to 125	±20	90%
Oil and Grease	413.2[b]	0.2	90 to 110	±10	90%
Boiling Point	Direct Measurement[f]	N/A	N/A	N/A	N/A
Freezing Point	Direct Measurement[k]	N/A	N/A	N/A	N/A
Specific Gravity	ASTM 1429[h]	N/A	N/A	N/A	N/A
Viscosity	Direct Measurement[g] (Oswalt Viscometer)	N/A	N/A	N/A	N/A

[a]U.S. Environmental Protection Agency. 1986. Contract Laboratory Program Statement of Work Inorganic Analyses.

[b]U.S. Environmental Protection Agency. 1983. Methods for Chemical Analysis of Water and Wastes. EPA 600/4-79-020.

[c]U.S. Environmental Protection Agency. 1986. Contract Laboratory Program Statement of Work Organic Analyses.

[d]U.S. Environmental Protection Agency. March 1984. The Determination of Inorganic Anions in Water by Ion Chromatography, Method-300.0. Test Method, EPA-600/4-84-017.

[e]U.S. Environmental Protection Agency. 1988. Supplemental Development Document for Effluent Limitations. Guidelines and Standards for the Leather and Finishing Point Service Category. Exhibit A pg. D7-D19. EPA 440/1-88-016-S. (Monier-Williams Method)

[f]McGraw-Hill. Experimental Physical Chemistry. Seventh Edition.

[g]Academic Press. Laboratory Course in Physical Chemistry.

[h]American Society for Testing and Materials. 1990. Annual Book of ASTM Standards.

[i]Applicable only to sample concentrations five times the detection limit

[j]U.S. Environmental Protection Agency. 1986. Test Methods for Evaluating Solid Waste Physical/Chemical Methods. SW-846 ed., 3rd Edition

[k]Per attached method (reference unknown)

* As specified in analytical method.

** Sulfide analysis for all polishing basin water samples (not sediment extracts) are to be performed using the Monier-Williams method. All other sulfide analyses are to be performed using method 376.1.

Memo Excerpt

Chloride/Sulfate/Sulfide/Phophorus/pH of Soil

SAMPLE PREPARATION:

1. Extraction method specified in the QAPP (Am. Soc. of Agronomy 10-2.3.2) is to be followed.

2. Color of extract (leachate) is to be visually compared to a color standard of 20 chloroplatinate units (Methods for Chemical Analysis of Water and Wastes; COLOR 110.2).
   a. If color of leachate is < 20, then proceed with analysis using proposed method.
   b. If color of leachate is > 20, perform analysis using Method of Standard Additions with proposed method.

SAMPLE ANALYSIS:

1. Sulfide to be analyzed by Method 376.1

2. Phosphorus to be analyzed by Method 365.2

NOTE: Sulfate analysis to be done using IC (Method 300.0).

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Nitrogen Species in Soil

SAMPLE PREPARATION:

1. Follow sample preparation as outlined above.

SAMPLE ANALYSIS:

1. Ammonia to be analyzed by Method 350.2

2. Total Kjeldahl Nitrogen (TKN) to be analyzed using Method 351.3 (NOTE: High nitrate concentration can cause interference. If so, follow the guidelines in the method).

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Ion Chromatography/Wet Chemistry Portion for Water

Sulfide* and phophorus analysis are to be carried out utilizing the same procedures described above. This includes the color comparison of the sample prior to analysis. (* Sulfide analysis for all polishing lagoon samples **must** be performed using the modified Monier-Williams method specified in the QAPP.

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Treatability Parameters for Water

Proposed method for freezing point determination is acceptable.

Attachment A (Continued)

8/3/90

To: Dan Gillespie, Technical Services Manager

From: R. L. Curtin, General Laboratory Manager

Subject: Freezing point determinations

The method described below is widely used for determination of the freezing point for biological fluids. It depends upon observing the change in optical properties when a frozen sample (anisotropic) thaws to produce a fluid (isotropic). The method assumes that under conditions of slowly rising temperature the freezing point and melting point of a solution are coincident.

1. The sample is collected in a glass melting point tube by immersing the open end of the tube into the liquid and relying on capillary rise to partially fill the tube.
2. The open end of the tube is sealed by dipping into hot paraffin and the tube is mounted on a standard microscope slide.
3. The sample is then frozen at -10°C.
4. The frozen sample is immersed in a chilled (-10°C) aqueous glycol solution and positioned so that it can be viewed in a microscope (approximately 20X magnification). When illuminated with plane polarized light the frozen sample glows brightly because of birefringence effects.
5. While observing the sample, the temperature of the glycol solution is allowed to rise slowly by convection (typically warming occurs at a rate of approximately 1°C/minute). The melting (freezing) point of the sample is taken as the temperature at which birefringence is lost. Typically 0.1 to 0.3°C is observed for the range over which the birefringence effects are lost. By convention the freezing point of the sample is reported as the midpoint of the range observed.

Attachment B

Total Chrome Analysis

In the method for the analysis of total chromium, the trivalent chromium in the sample is oxidized to the hexavalent form by hypobromite ion under alkaline conditions using lithium hydroxide and lithium hypobromite, pH 11.8. Excess hypobromite is destroyed by the addition of sulfosalicylic acid, pH 11.67. Then the sample is acidified using potassium pyrosulfate, pH 1.33. Color formation utilizes a single dry powder formulation in the ChromaVer reagent. The pH at this step is 1.33. The reagent contains a buffer combined with 1,5-diphenylcarbohydrazide which reacts to give a purple color when hexavalent chromium is present. The method is applicable for chromium concentrations of 0 to 0.6 mg/L.

Large amounts of organic material may inhibit complete oxidation of trivalent chromium. Pond water samples were spiked with chromium in the range of 0.05 to 0.25 mg/L. These non-digested water samples did not exhibit development of purple color on addition of the ChromaVer 3 Reagent. The interference may be due to the presence of large amounts of organic matter. Using the EPA mild digestion procedure, a purple color formed and chromium was detected. The EPA mild digestion procedure will be used on all samples prior to analysis for total chromium.

Mercurous and mercuric ions interfere slightly with the assay. Iron and vanadium will interfere if present at concentrations greater than 1 mg/L. Highly buffered samples or extreme sample pH may exceed the buffering capacity of the reagents and require sample pretreatment.

Sample Preparation

Groundwater samples collected with the hydropunch will be analyzed for total chromium. The EPA mild digestion procedure will be used on all samples prior to analysis.

1. Transfer 2-100 ml aliquots of the sample to a 250 ml beaker. Read the pH.

2. Perform EPA mild digestion procedure by adding 5 ml of 1:1 hydrochloric acid and heat until the volume has been reduced to 15 to 20 ml. Do not boil.

3. Adjust the sample to a pH of 4 by dropwise addition of 5.0 N sodium hydroxide.

4. Quantitatively transfer the sample with deionized water to a 100 ml volumetric flask and dilute to volume with deionized water. Transfer the sample to a 250 ml beaker.

5. Add 4 Reagent 1 powder pillows and heat in a boiling water bath for five minutes.

6. Cool to approximately $25^{o}C$ in an ice bath.

7. Filter the sample through a 45 micron filter under positive pressure supplied by nitrogen. At this step the chromium should be converted to soluble, hexavalent chrome and should all pass through the 45 micron filter. The iron in the groundwater reacts with the sulfosalicylic acid in Reagent 2, producing a deep, wine red color. This filter step has been included in an attempt to eliminate this interference.

8. Transfer 25 ml to each of three sample cells. One will be the blank, and two will be analyzed as samples.

9. Set wavelength on Hach spectrophotometer to 540 nm.

10. Add the contents of one Reagent 2 powder pillow, sulfosalicylic acid, to each sample and swirl to mix. pH should be 11.67.

11. Add the contents of an acid reagent powder pillow to each sample cell and swirl to mix. At this step, the pH should be 1.33.

12. Add contents of one ChromaVer 3 Reagent Powder Pillow to each vial of sample, but not to the blank. Swirl to mix. The pH should be 1.5. ChromaVer 3 Reagent contains potassium pyrosulfate and 1,5-diphenylcarbohydrazide. A purple color will result if hexavalent chromium is present.

13. Wait five minutes (reaction time).

14. Fill a sample cell with 25 ml of the blank. The blank will be an aliquot of sample treated with Reagents one and two and the acid reagent. If any turbidity is dissolved by these reagents in the sample, it will also be dissolved in the blank.

15. Thoroughly wipe the sides of the sample cell with a Kim wipe. After the 5 minute reaction time has elapsed, place the blank in the cell holder, with the 25 ml mark facing left. Press "zero", to zero the meter on the blank sample. The readout will show 0.00 mg/L Cr^{+6}. Allow enough time before zeroing the spectrophotometer and reading the sample to allow air bubbles to dissipate and particulates to settle.

16. Pour the prepared samples into the sample cell with a minimum of agitation, allow any precipitate to settle, and wipe the sides with a Kim wipe. Place the cell into the holder with the 25 ml mark facing left, close the light shield and press "read/enter". The results will be displayed in mg/liter chromium. Press "shift/Abs" to get an absorbance reading. Record the mg/L and absorbance readings.

Accuracy Check

An accuracy check will be performed daily. 12.5 mg/L chromium standards, prepared by Hach, will be used for standard additions of 0.1, 0.2, 0.3, 0.4 and 0.5 ml. This will result in concentrations of 0.05, 0.10, 0.15, 0.20 and 0.25 mg/L. Standard additions will be added to deionized water and analyzed in a manner identical to samples. The concentration of chromium added versus the concentration of chromium detected will be plotted to develop a curve, against which sample results will be compared.

Reagent Blank

One reagent blank, comprised of deionized water digested and analyzed with all reagents, will be analyzed each day.

Verification Samples

For each matrix analyzed, a spike sample will be prepared. Spikes will be prepared at a concentration of 0.10 mg/L and analyzed in duplicate. Spikes and duplicate spikes will be analyzed at a minimum of one per every twenty samples or once per day, whichever is greatest. A 0.10 mg/L spike will be prepared by adding 0.8 ml of the 12.5 mg/L standard to 100 ml of sample. Spike recoveries should be between 50 and 150%. The relative percent difference (RPD) between the spike and spike duplicate will be less than or equal to 20.

Precision

Precision of this method will be established by using 0.1 ml standard additions of 12.5 mg/L chromium. One lot of reagent will be used. The procedure will be repeated 10 times.

The standard deviation and a minimum detection limit will be calculated.

Reporting

Results will be reported on the attached form.

Data Usage

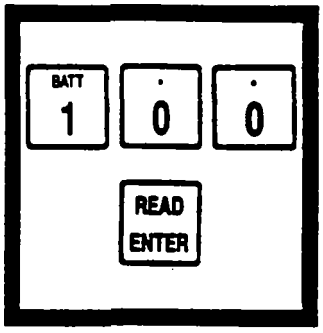
This analysis will be conducted for hydropunch samples collected from exploratory borings. The resulting data will be utilized to evaluate and select well completion locations.

						Sample No. 1			Sample No. 2						
Sample No.	Sample Location	Date	Depth	pH	Sample Description	Cr +6 mg/L	Cr+6 Abs	Color	Cr +6 mg/L	Cr +6 Abs	Color	Avg.	Analyst	Lot No. Chromaver	Comment
DI/0.1 ml Cr															
DI/0.2 ml Cr															
DI/0.3 ml Cr															
DI/0.4 ml Cr															
DI/0.5 ml Cr															
PolBs Spike/0.2 ml Cr															
PolBs Spike/0.2 ml Cr															
Oxb Spike/0.2 ml Cr															
Oxb Spike/0.2 ml Cr															
GW Spike/0.2 ml Cr															
' Spike/0.2 ml Cr															
Reagent Blank															

CHROMIUM, TOTAL (0 to 0.60 mg/L)

For water and wastewater

Alkaline Hypobromite Oxidation Method*, EPA approved—Digestion is required; see Section I.



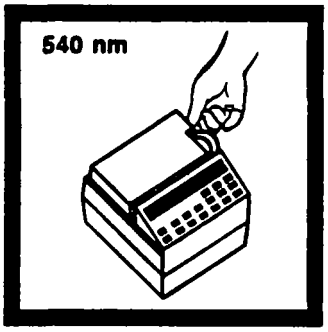
1. Enter the stored program number for total chromium (Cr).

Press: **1 0 0 READ/ENTER**

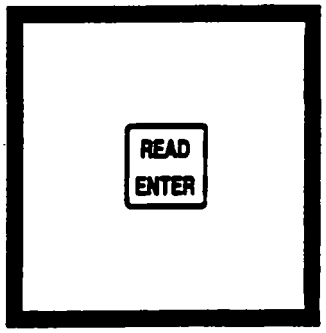
The display will show:
DIAL nm TO 540

Note: Or, use the up and down arrows to scroll the display to:
100 mg/l Cr
and press: READ/ENTER

Note: If sample cannot be analyzed immediately, see Sampling and Storage, below. Adjust the pH of stored samples before analysis.



2. Rotate the wavelength dial until the small display shows:
540 nm

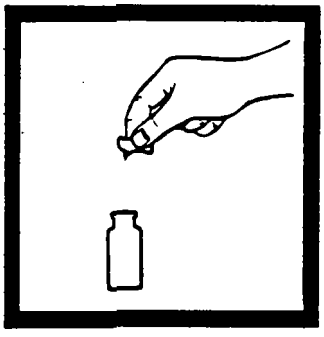


3. Press: **READ/ENTER**

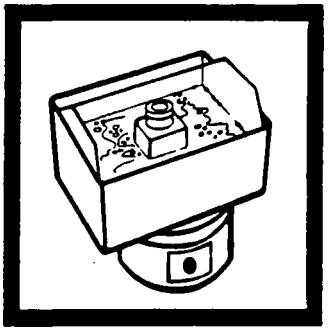
The display will show:
mg/l Cr

4. Fill a clean sample cell with 25 mL of sample.

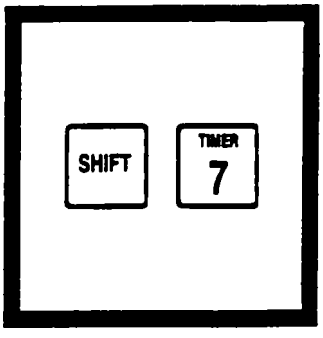
Note: For proof of accuracy, use a 0.25 mg/L trivalent chromium standard solution (preparation given in the Accuracy Check) in place of the sample.



5. Add the contents of one Chromium 1 Reagent Powder Pillow (the prepared sample). Swirl to mix.

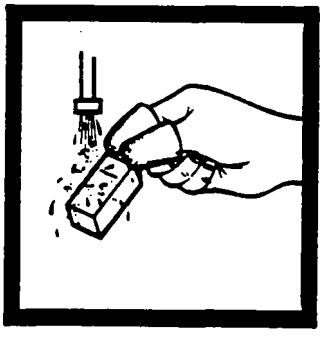


6. Place the prepared sample into a boiling water bath.



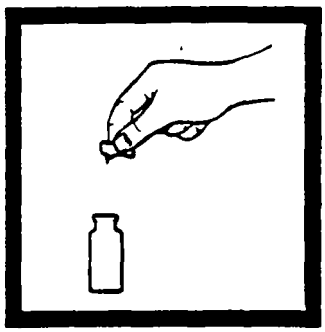
7. Press: **SHIFT TIMER**

A five-minute reaction period will begin.

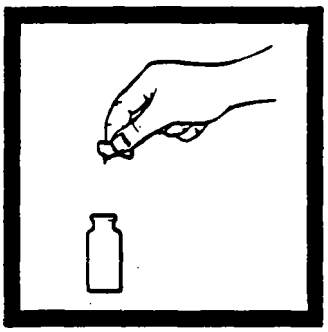


8. When the beeper sounds, remove the prepared sample. Using running tap water, cool the cell to 25°C.

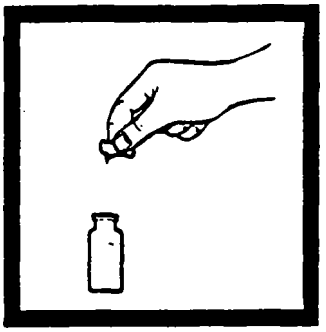
*Adapted from *Standard Methods for the Examination of Water and Wastewater*



9. Add the contents of one Chromium 2 Reagent Powder Pillow. Swirl to mix.



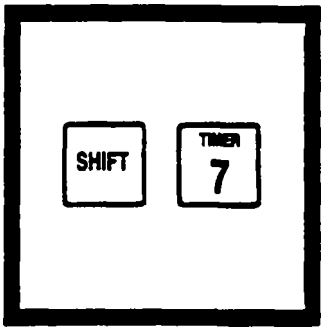
10. Add the contents of one Acid Reagent Powder Pillow. Swirl to mix.



11. Add the contents of one ChromaVer 3 Chromium Reagent Powder Pillow. Swirl to mix.

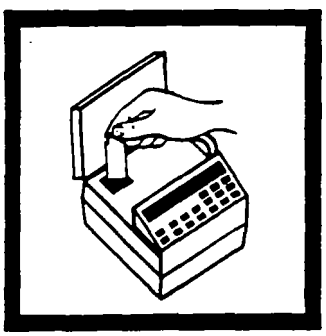
Note: A purple color will form if chromium is present.

Note: The color of ChromaVer 3 should be white to tan. If the color is brown or green, replace the powder. Undissolved powder does not affect accuracy.



12. Press: **SHIFT TIMER**

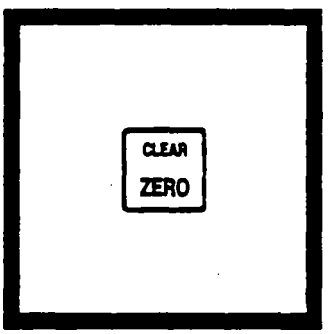
A five-minute reaction period will begin.



13. When the timer beeps, fill another sample cell with 25 mL of sample (the blank). Place it into the cell holder. Close the light shield.

Note: For turbid samples, treat the blank as described in Steps 4 through 10.

Note: The Pour-Thru Cell can be used with this procedure.



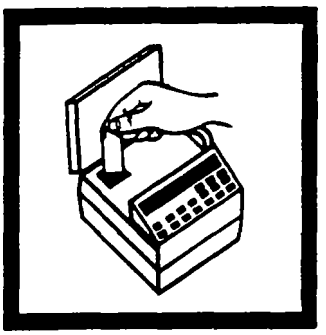
14. Press: **ZERO**

The display will show:

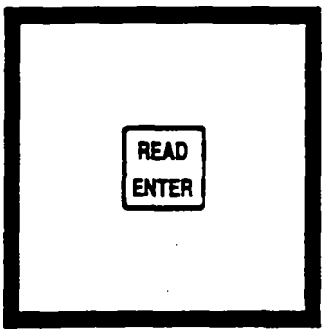
WAIT

then:

0.00 mg/l Cr



15. Place the prepared sample into the cell holder. Close the light shield.



16. Press: **READ/ENTER**

The display will show:

WAIT

then the result in mg/L chromium will be displayed.

Note: In the constant-on mode, pressing READ/ENTER is not required. WAIT will not appear. When the display stabilizes, read the result.

Note: Determine a reagent blank for each new lot of ChromaVer 3 reagent as follows: Repeat Steps 11 to 16, using deionized water as the sample. Subtract this value from each result obtained with this lot of reagent.

SAMPLING AND STORAGE

Collect samples in acid-washed glass or plastic containers. To preserve samples, adjust the pH to 2 or less with nitric acid (about 2 mL per liter). Store preserved samples at room temperature up to six months. Adjust the pH to about 4 with 5.0 N Sodium Hydroxide before analysis. Correct the test result for volume additions; see Sampling and Storage, Volume Additions, (Section I) for more information.

ACCURACY CHECK

a) Snap the top off a Trivalent Chromium Voluette Ampule Standard, 12.5 mg/L as Cr^{3+}.

b) Use the TenSette pipet to add 0.1, 0.2, and 0.3 mL of standard to three 25-mL water samples. Mix each thoroughly.

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 (Section I) for more information.

Prepare a 0.25 mg/L trivalent chromium standard by diluting 5.00 mL of chromium standard solution, 50 mg/L as Cr^{3+}, to 1000 mL with deionized water. Prepare this solution daily.

PRECISION

In a single laboratory using a standard solution of 0.4 mg/L chromium and two representative lots of reagent with the DR/2000, a single operator obtained a standard deviation of ± 0.025 mg/L chromium.

INTERFERENCES

Large amounts of organic material may inhibit complete oxidation of trivalent chromium. If high levels of organic material are present, see Digestion (Section I) for instructions on sample digestion. Perform the analysis as described on the digested sample.

Iron does not interfere.

Highly buffered samples or extreme sample pH may exceed the buffering capacity of the reagents and require sample pretreatment; see Interferences, pH (Section I).

SUMMARY OF METHOD

Trivalent chromium in the sample is oxidized to the hexavalent form by hypobromite ion under alkaline conditions. The sample is acidified. The total chromium content is determined by the 1,5-diphenylcarbohydrazide method. Determine trivalent chromium by subtracting the results of a separate hexavalent chromium test from the results of the total chromium test. See *Chemical Procedures Explained*, Publication 7013, for more information.

REQUIRED REAGENTS

	Cat. No.
Total Chromium Reagent Set (100 Tests)	22425-00
Includes: (2) 2126-66, (2) 12066-66, (1) 2043-99, (1) 2044-99	

Description	Quantity Required Per Test	Unit	Cat. No.
Acid Reagent Powder Pillows	1 pillow	50/pkg	2126-66
ChromaVer 3 Chromium Reagent Powder Pillows	1 pillow	50/pkg	12066-66
Chromium 1 Reagent Powder Pillows	1 pillow	100/pkg	2043-99
Chromium 2 Reagent Powder Pillows	1 pillow	100/pkg	2044-99

REQUIRED APPARATUS

Clippers, for opening pillows	1	each	968-00
Water bath and rack	1	each	1955-55

OPTIONAL REAGENTS

Chromium, trivalent, standard solution, 50 mg/L Cr^{3+}	118 mL	14151-14
Chromium, trivalent, standard solution, Voluette ampule, 12.5 mg/L Cr^{3+}, 10 mL	16/pkg	14257-10
Nitric acid, ACS	473 mL	152-11
Nitric Acid Solution, 1:1	473 mL	2540-11
Sodium Hydroxide Solution, 5.0 N	59 mL* DB	2450-26
Water, deionized	3.78 L	272-17

OPTIONAL APPARATUS

Cylinder, graduated, polypropylene, 25 mL	each	1081-40
Flask, volumetric, 1000 mL	each	547-53
Hot plate, micro	each	12067-01
pH indicator paper, 1 to 11 pH	5 rolls/pkg	391-33
pH meter, Hach One	each	43800-00
Pipet, serological, 2 mL	each	532-36
Pipet, TenSette, 0.1 to 1.0 mL	each	19700-01
Pipet, TenSette, tips for 19700-01	50/pkg	21856-96
Pipet, volumetric, 5 mL	each	515-37
Pipet filler, safety bulb	each	14651-00
Pour-Thru Cell Assembly Kit	each	18331-00

For additional ordering information, see final section.
In the U.S.A. call 800-227-4224 to place an order.

*Contact Hach for larger sizes.

EPA Mild Digestion with Hot Plate
For Metals Analysis Only

Acidify the entire sample at the time of collection with concentrated nitric acid by adding 5 mL of acid per liter (or quart) of sample. Transfer 100 mL of well-mixed sample to a beaker or flask. Add 5 mL of distilled 1:1 Hydrochloric Acid (HCl) and heat—using a steam bath or hot plate until the volume has been reduced to 15-20 mL. Make certain the sample does not boil. After this treatment, the sample may be filtered to remove any insoluble material. Adjust the digested sample to pH 4 by drop-wise addition of 5.0 N Sodium Hydroxide Standard Solution. Mix thoroughly and check the pH after each addition. Quantitatively transfer the sample with deionized water to a 100-mL volumetric flask and dilute to volume with deionized water. Continue with the procedure. This mild digestion may not suffice for all sample types. A reagent blank also should be carried through the digestion and measurement procedures.

						Sample No. 1			Sample No. 2						
Sample No.	Sample Location	Date	Depth	pH	Sample Description	Cr +6 mg/L	Cr+6 Abs	Color	Cr +6 mg/L	Cr +6 Abs	Color	Avg.	Analyst	Lot No. Chromaver	Comment
DI/0.1 ml Cr															
DI/0.2 ml Cr															
DI/0.3 ml Cr															
DI/0.4 ml Cr															
DI/0.5 ml Cr															
PolBs Spike/0.2 ml Cr															
PolBs Spike/0.2 ml Cr															
Oxb Spike/0.2 ml Cr															
Oxb Spike/0.2 ml Cr															
GW Spike/0.2 ml Cr															
Spike/0.2 ml Cr															
Reagent Blank															

Attachment C

Hexavalent Chrome Analysis

Hexavalent Chromium will be analyzed on site using the 1,5-diphenylcarbohydrazide Method and the Hach DR2000 Spectrophotometer. The reagent contains a buffer combined with 1,5-diphenylcarbohydrazide which reacts to give a purple color when hexavalent chromium is present. Color development is directly proportional to the amount of hexavalent chromium present. The method is applicable for chromium concentrations of 0 to 0.6 mg/L.

Mercurous and mercuric ions interfere slightly with the assay. Iron and vanadium will interfere if present at concentrations greater than 1 mg/L. Highly buffered samples or extreme sample pH may exceed the buffering capacity of the reagents and require sample pretreatment.

Sample Preparation

Groundwater samples from all monitoring wells and surface water samples from the oxbow lake and polishing basin will be analyzed. All samples will be filtered before analysis through a 45 micron filter under positive pressure supplied by nitrogen. The pH of the sample will be determined prior to analysis. The sample will be adjusted to a pH of 4 by dropwise addition of 1:1 nitric acid. The amount of nitric acid added will be recorded. Two 25 ml aliquots of sample will be poured into 40 ml VOA vials. On the first sample from each media collected, an extra 25 ml aliquot will be collected for use as the blank. On one sample per day per medium (groundwater, polishing basin water, and oxbow lake water), two extra 25 ml aliquots will be collected for spike analysis. The samples will be stored at $4^{o}C$ until they are analyzed, and they will be allowed to come to room temperature prior to analysis. After ten samples have been collected, or at the end of the day, samples will be analyzed.

Protocol

1. Set wavelength on Hach spectrophotometer to 540 nm.

2. Add contents of one ChromaVer 3 Reagent Powder Pillow to each vial of sample. Swirl to mix. The pH should be 1.5. ChromaVer 3 Reagent contains potassium pyrosulfate and 1,5-diphenylcarbohydrazide. A purple color will form if hexavalent chromium is present.

3. Wait five minutes (reaction time).

4. Fill a sample cell with 25 ml of the blank, which is comprised of an aliquot of untreated sample. For turbid samples, the blank will be treated with the contents of one Acid Reagent Powder Pillow. This will ensure that any turbidity dissolved by the acid in the ChromaVer 3 Reagent will also be dissolved in the blank.

5. Thoroughly wipe the sides of the sample cell with a Kim wipe. After the 5 minute reaction time has elapsed, place the blank in the cell holder. Press "zero", to zero the meter on the blank sample. The readout should show 0.00 mg/L Cr^{+6}.

6. Pour the prepared samples into the sample cell with a minimum of agitation, allow any precipitate to settle, and wipe the sides with a Kim wipe. Place the cell into the holder with the 25 ml mark facing left, close the light shield and press "read/enter". The results will be displayed in mg/L chromium. Press "shift/Abs" to get an absorbance reading. Record the mg/L and absorbance readings.

Accuracy Check

An accuracy check will be performed daily. 12.5 mg/L chromium standards, prepared by Hach, will be used for standard additions of 0.1, 0.2, 0.3, 0.4 and 0.5 ml. This will result in concentrations of 0.05, 0.10, 0.15, 0.20 and 0.25 mg/L. Standard additions will be added to deionized water and analyzed in a manner identical to samples. The concentration of chromium added versus the concentration of chromium detected will be plotted to develop a curve, against which sample results may be compared.

Reagent Blank

One reagent blank, comprised of deionized water digested and analyzed in a manner identical to the samples, will be analyzed each day.

Verification Samples

For each matrix analyzed a spike sample will be prepared. Spikes will be prepared at concentrations of 0.10 mg/L and analyzed in duplicate. Spikes and duplicate spikes will be analyzed at a minimum of one per every twenty samples or once per day, whichever is greater. A 0.10 mg/L spike will be prepared by adding 0.2 ml of the 12.5 mg/L standard to 25 ml of sample. Spike recoveries should be between 70 and 130 percent. The relative percent difference (RPD) between the spike and duplicate spike samples should be less than or equal to 20.

Precision

Precision of this method was established by using 0.1 ml standard additions of 12.5 mg/L chromium. One lot of reagent was used and the procedure was repeated 10 times. The following results were achieved.

	Theoretical	Hach Reading		Concentration (Mean-Value)^2
Number	Concentration	mg/L	Absorbance	$(\bar{x}-x)^2$
1	0.05	0.05	0.109	0.000081
2	0.05	0.04	0.101	0.000001
3	0.05	0.04	0.096	0.000001
4	0.05	0.04	0.101	0.000001
5	0.05	0.04	0.105	0.000001
6	0.05	0.04	0.099	0.000001
7	0.05	0.04	0.107	0.000001
8	0.05	0.04	0.100	0.000001
9	0.05	0.04	0.095	0.000001
10	0.05	0.04	0.104	0.000001
Mean		0.041		
Sum				0.00009

Std Dev $= \sqrt{\sum_{i=1}^{n}(\bar{x}-x_i)^2/(n-1)} = .0032$

Minimum Detection Limit = 0.0032 x 2.621 = 0.008 or 0.01 mg/L

Reporting

Results will be reported on the attached form.

Data Usage

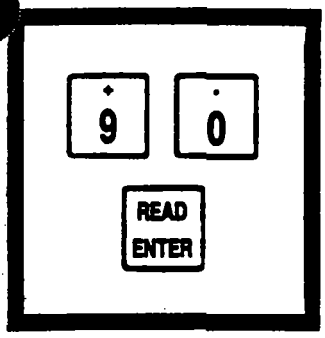
This data will be used in conjunction with laboratory data on total and dissolved chromium in water, to determine the portion of chromium present in the hexavalent form. The hexavalent form of chromium is a carcinogen and is generally considered more toxic than the trivalent form. Therefore, information on the presence or absence of hexavalent chromium in water at the site will be used to evaluate the risks posed by chromium contamination at the site.

This analysis will be conducted for hydropunch samples collected from exploratory borings. The resulting data will also be utilized to evaluate and select well completion locations.

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

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

USING POWDER PILLOWS

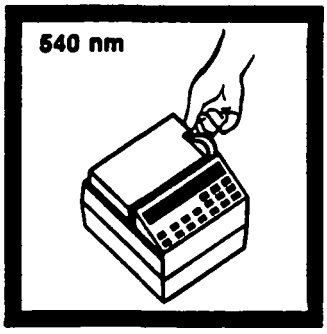


1. Enter the stored program number for hexavalent chromium (Cr^{6+}).

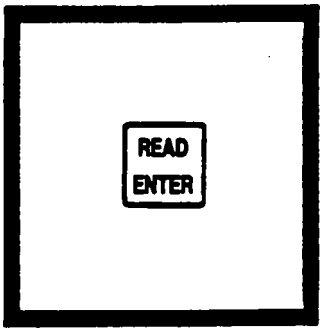
Press: **9 0 READ/ENTER**

The display will show:
DIAL nm TO 540

***Note:** Or, use the up and down arrows to scroll the display to:*
90 mg/l Cr^{6+}
and press: READ/ENTER



2. Rotate the wavelength dial until the small display shows:
540 nm



3. Press: **READ/ENTER**

The display will show:
mg/l Cr^{6+}

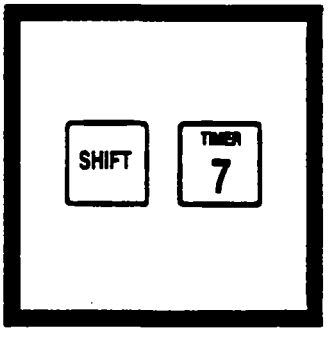
4. Fill a sample cell with 25 mL of sample.

***Note:** For proof of accuracy, use a 0.25 mg/L hexavalent chromium standard solution (preparation given in the Accuracy Check) in place of the sample.*

5. Add the contents of one ChromaVer 3 Reagent Powder Pillow to the cell (the prepared sample). Swirl to mix.

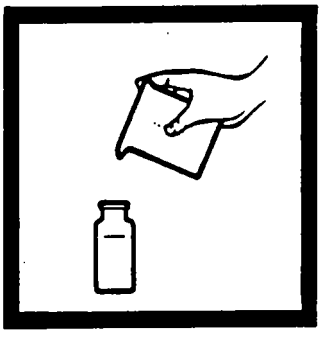
***Note:** A purple color will form if hexavalent chromium is present.*

***Note:** At high chromium levels a precipitate will form. Dilute sample according to Sample Dilution Techniques (Section I).*



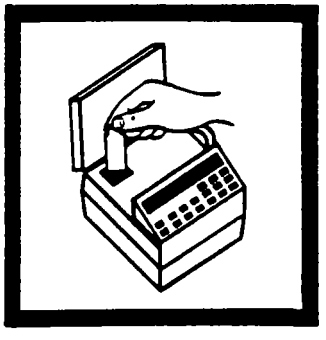
6. Press: **SHIFT TIMER**

A five-minute reaction period will begin.



7. Fill another sample cell with 25 mL of sample (the blank).

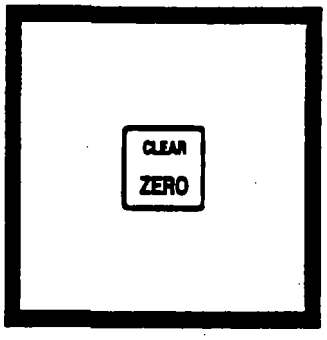
***Note:** For turbid samples, treat the blank with the contents of one Acid Reagent Powder Pillow. This will ensure any turbidity dissolved by the acid in the ChromaVer 3 Chromium Reagent also will be dissolved in the blank.*



8. When the timer beeps, the display will show:
mg/l Cr^{6+}
Place the blank into the cell holder. Close the light shield.

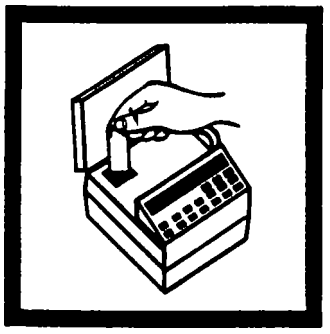
***Note:** The Pour-Thru Cell can be used with this procedure.*

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

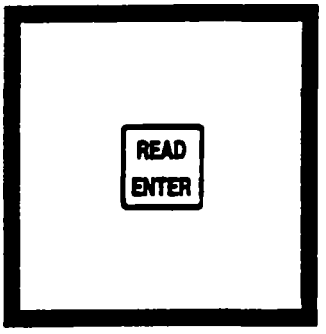


9. Press: **ZERO**

The display will show:
WAIT
then:
0.00 mg/l Cr^{6+}



10. Place the prepared sample into the cell holder. Close the light shield.



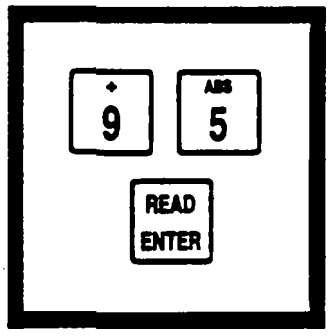
11. Press: **READ/ENTER**

The display will show
WAIT
then the results, in mg/L hexavalent chromium will be displayed.

Note: The results can be expressed as mg/L chromate (CrO_4^{2-}) or mg/L sodium chromate (Na_2CrO_4) by multiplying the mg/L hexavalent chromium by 2.33 or 3.12, respectively.

Note: In the constant-on mode, pressing READ/ENTER is not required. WAIT will not appear. When the display stabilizes, read the result.

USING ACCUVAC AMPULS

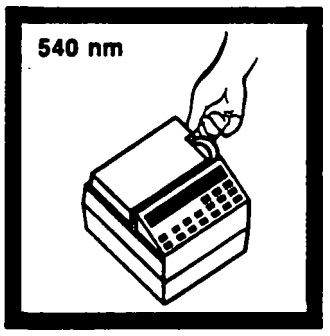


1. Enter the stored program number for hexavalent chromium.

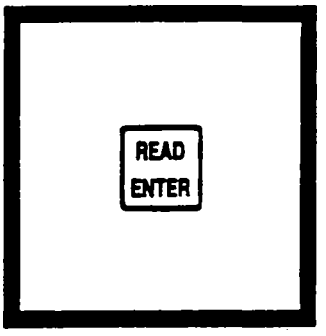
Press: **9 5 READ/ENTER**

The display will show:
DIAL nm TO 540

Note: Or, use the up and down arrows to scroll the display to:
95 mg/l Cr^{6+} AV
and press: READ/ENTER

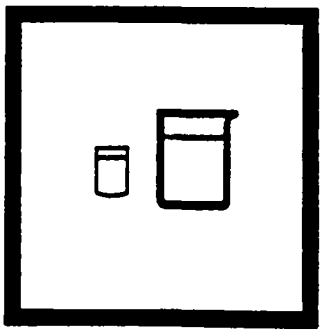


2. Rotate the wavelength dial until the small display shows:
540 nm



3. Press: **READ/ENTER**

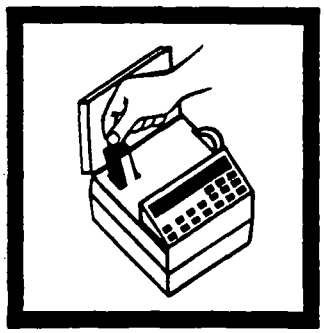
The display will show:
mg/l Cr^{6+} AV



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

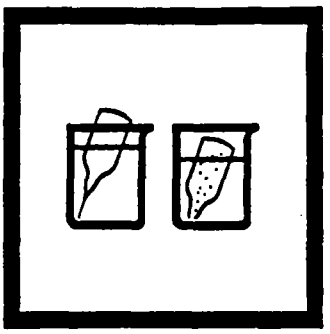
Note: For turbid samples, treat 25 mL of the blank with the contents of one Acid Reagent Powder Pillow. This will ensure any turbidity dissolved by the acid in the Chromaver 3 Chromium Reagent also will be dissolved in the blank.

Note: For proof of accuracy, use a 0.25 mg/L hexavalent chromium standard solution (preparation given in the Accuracy Check) in place of the sample.



5. Place the AccuVac Vial Adapter into the cell holder.

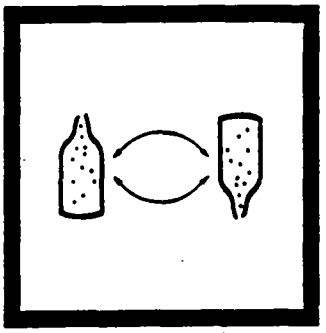
Note: Place the grip tab at the rear of the cell holder.



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

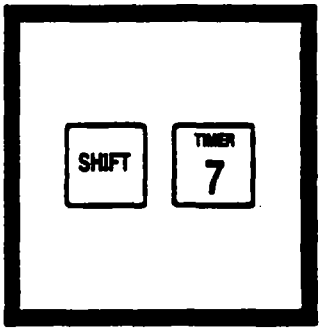
Note: Keep the tip immersed while the ampul fills completely.

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



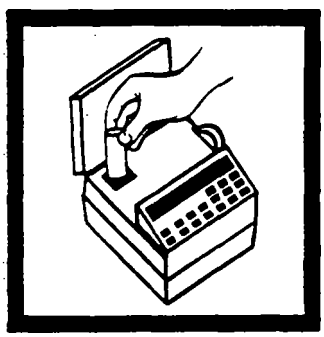
7. Quickly invert the ampul several times to mix. Wipe off any liquid or fingerprints.

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



8. Press: **SHIFT TIMER**

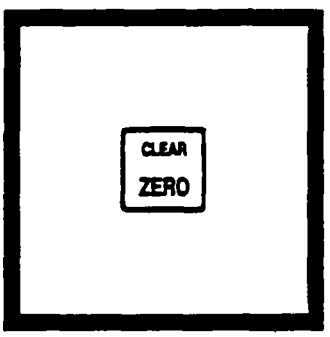
A five-minute reaction period will begin.



9. When the timer beeps, the display will show:

mg/l Cr^{6+} AV

Place the blank into the cell holder. Close the light shield.



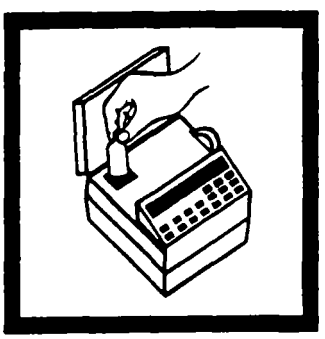
10. Press: **ZERO**

The display will show:

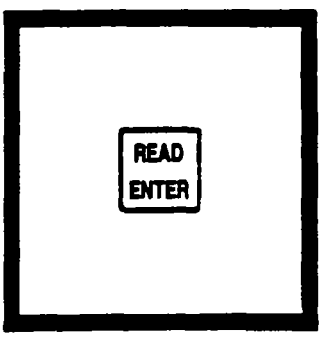
WAIT

then:

0.00 mg/l Cr^{6+} AV



11. Place the prepared sample into the cell holder. Close the light shield.



12. Press: **READ/ENTER**

The display will show:

WAIT

then the result in mg/L hexavalent chromium will be displayed.

Note: The results can be expressed as mg/L chromate (CrO_4^{2-}) or mg/L sodium chromate ($NaCrO_4$) by multiplying the mg/L hexavalent chromium (Cr^{6+}) by 2.33 or 3.12, respectively.

Note: In the constant-on mode, pressing READ/ENTER is not required. WAIT will not appear. When the display stabilizes, read the result.

SAMPLING AND STORAGE

Collect samples in a cleaned glass or plastic container. Adjust the pH to 2 or less with nitric acid (about 2 mL per liter). Preserved samples can be stored for at least six months at room temperature. Adjust the pH to 4 with 5.0 N Sodium Hydroxide before analysis. Correct the test result for volume additions; see Sampling and Storage, Volume Additions, (Section I) for more information.

ACCURACY CHECK

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

b) Use the TenSette pipet to add 0.1 mL, 0.2 mL and 0.3 mL of standard, respectively to three 25-mL samples. Mix each thoroughly.

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 (Section I) for more information.

Prepare a 0.25-mg/L Cr^{6+} by pipetting 5.00 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. Prepare this solution daily. Perform the chromium procedure as described above. The mg/L Cr^{6+} reading should be 0.25-mg/L Cr^{6+}.

PRECISION

In a single laboratory using a standard solution of 0.4 mg/L Cr^{6+} and two representative lots of reagent with the DR/2000, a single operator obtained a standard deviation of ± 0.003 mg/L Cr^{6+}.

In a single laboratory using a standard solution of 0.4 mg/L Cr^{6+} and two representative lots of AccuVac ampuls with the DR/2000, a single operator obtained a standard deviation of ± 0.001 mg/L Cr^{6+}.

INTERFERENCES

The following do not interfere in the test up to the following concentrations:

Mercurous & Mercuric Ions	Interferes Slightly
Iron	1 mg/L
Vanadium	1 mg/L

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 Interferences, pH (Section I).

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 a buffer combined with 1,5-diphenylcarbohydrazide, which reacts to give a purple color when hexavalent chromium is present. See *Chemical Procedures Explained*, Publication 7013, for more information.

REQUIRED REAGENTS AND APPARATUS (Using Powder Pillows)

Description	Quantity Required Per Test	Unit	Cat. No.
ChromaVer 3 Chromium Reagent Powder Pillows	1 pillow	50/pkg	12066-66
Clippers, for opening pillows	1	each	968-00

REQUIRED REAGENTS AND APPARATUS (Using AccuVac Ampuls)

ChromaVer 3 AccuVac ampuls	1 ampul	25/pkg	25050-25
Adapter, AccuVac Vial	1	each	43784-00
Beaker, 50 mL	1	each	500-41
Vial, zeroing	1	each	21228-00

OPTIONAL REAGENTS

Acid Reagent Powder Pillows	50/pkg	2126-66
Chromium, Hexavalent, Standard Solution, 50 mg/L Cr^{6+}	118 mL	810-14
Chromium, Hexavalent, Standard Solution, Voluette ampule, 12.5 mg/L Cr^{6+}, 10 mL	16/pkg	14256-10
Nitric acid, ACS	473 mL	152-11
Nitric Acid Solution, 1:1	473 mL	2540-11
Sodium Hydroxide Solution, 5.0 N	59 mL* SCDB	2450-26
Water, deionized	3.78 L	272-17

OPTIONAL APPARATUS

Flask, volumetric, Class A, 25 mL	each	14574-40
Flask, volumetric, Class A, 1000 mL	each	14574-53
pH indicator paper, 1 to 11 pH	5 rolls/pkg	391-33
pH Meter, Hach One	each	43800-00
Pipet, serological, 2 mL	each	532-36
Pipet, TenSette, 0.1 to 1.0 mL	each	19700-01
Pipet, TenSette, tips for 19700-01	50/pkg	21856-96
Pipet, volumetric, 5.00 mL	each	14515-37
Pipet filler	each	14651-00
Pour-Thru Cell Assembly Kit	each	18331-00
Sample cell, with 25-mL mark, matched pair	each pair	20950-00

For additional ordering information, see final section.
In the U.S.A. call 800-227-4224 to place an order.

*Contact Hach for larger sizes.