



Title: Quality Assurance and Quality Control Requirements and Performance Standards for SW-846 Method 7196A, Hexavalent Chromium by UV-Visible Spectrophotometry

VI. Miscellaneous Wet Chemical Methods

B. Quality Assurance and Quality Control Requirements and Performance Standards for SW-846 Method 7196A, Hexavalent Chromium [Cr (VI)] by UV-Visible Spectrophotometry

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1.0 QA/QC Requirements for SW-846 Method 7196A

1.1 Overview of Methods

SW-846 Method 7196A, Determination of Hexavalent Chromium by UV-Visible Spectrophotometry, may be used directly for the determination of dissolved hexavalent chromium (Cr (VI)) in aqueous environmental samples. This analytical method may also be used as the determinative step in the analysis of Cr (VI) in soils, sludges, sediments and similar waste materials that have been pre-digested using SW-846 Method 3060A, Alkaline Digestion for Hexavalent Chromium. All references to SW-846 methods in this document refer to the United States Environmental Protection Agency's most recently published version.

1.1.1 Reporting Limits for SW-846 Method 7196A

Reporting Limits (RL), sensitivity, and/or the optimum linear concentration range can vary with sample matrix and laboratory operating conditions.

SW-846 Method 7196A may be used directly to determine dissolved hexavalent chromium (VI) in aqueous samples containing concentrations from 0.005 – 50 mg/L. This method may also be used in combination with the SW-846 Method 3060A alkaline digestion procedure for the analysis of hexavalent chromium in soils, sludges, sediments and similar waste materials containing concentrations from 1.0 – 2000 mg/kg on a dry weight basis.

Sample preservation, container and analytical holding time specifications for surface water, groundwater, soil, and sediment matrices for hexavalent chromium analyzed in support of MCP decision-making are presented in Appendix VI B–1 of this document and Appendix VII-A, WSC-CAM-VII A, "Quality Assurance and Quality Control Guidelines for the Acquisition and Reporting of Analytical Data in Support of Response Actions Conducted Under the Massachusetts Contingency Plan (MCP)".

1.1.2 General Quality Control Requirements for SW-846 Method 7196A

Each laboratory that uses SW-846 Method 7196A are required to operate a formal quality assurance program to demonstrate the precision and bias of the method as performed by the laboratory and procedures for determining the method reporting limit (RL). The minimum requirements of this program consist of an initial demonstration of laboratory capability, ongoing analysis of standards and blanks as a test of continued performance, and the analysis of laboratory control samples (LCSs), and LCS duplicates to assess accuracy and/or precision. Project-specific matrix duplicates or matrix spike duplicates (MSDs) may be used in lieu of LCS duplicates to evaluate precision when such samples are analyzed either at discretion of laboratory or at request of data-user. Refer to SW-846 Methods 7196A, and 3060A Sections 8.0 and 9.0 for general quality control guidelines for these chromium determinative methods.



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Laboratories must document and have on file an Initial Demonstration of Capability for each combination of sample preparation and determinative chromium methods being used. These data must meet or exceed the performance standards as presented in Section 1.4 and Table VI B-1 of this method. Procedural requirements for performing the Initial Demonstration of Laboratory Capability can be found in SW-846, Chapter One, Section 4.4.1. The data associated with the Initial Demonstration of Laboratory Capability for hexavalent chromium analyses must be kept on file at the laboratory and made available to potential data-users on request and must include the following:

QC Element	Performance Criteria
Initial Calibration	WSC-CAM-VI B, Table VI B-1
Continuing Calibration	WSC-CAM-VI B, Table VI B-1
Method Blanks	WSC-CAM-VI B, Table VI B-1
% Percent Recovery for MS/LCS	WSC-CAM-VI B, Table VI B-1
Relative Percent Difference (RPD) for MSD/LCS Duplicate	WSC-CAM-VI B, Table VI B-1
Soluble Cr (VI)/ Insoluble Cr (VI) Matrix Spike (<i>solid samples only</i>)	WSC-CAM-VI B, Table VI B-1

Laboratories are encouraged to continually strive to minimize variability and improve the accuracy and precision of their analytical results. . In some cases, the standard laboratory acceptance criteria for the various QC elements may have to be modified to accommodate more rigorous project-specific data quality objectives prescribed by the data user. The laboratory may be required to modify routine sample introduction and/or analytical conditions to accommodate project-specific data quality objectives.

Use of this method is restricted to use by, or under the supervision of, analysts who are knowledgeable of UV-Visible spectrophotometry as a quantitative tool, and the correction of the chemical, and physical interferences described in this method.

1.2 Summary of Methods

1.2.1 SW-846 Method 7196A, Determination of Hexavalent Chromium by UV-Visible Spectrophotometry

SW-846 Method 7196A may be used to determine the concentration of dissolved hexavalent chromium (Cr (VI)) from 0.5 to 50 mg per liter (PPM) in EP/TCLP characteristic extracts, surface water and groundwater. Dissolved Hexavalent Chromium, in the absence of interfering amounts of substances such as molybdenum, vanadium, and mercury, may be determined spectrophotometrically. Cr (VI) is determined by the addition of an excess of



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diphenylcarbazine in acid solution yielding a red-violet product of unknown composition. The reaction is very sensitive, with an absorbency index (absorptivity) of 40,000 per gram atom of chromium at 540 nm. Absent interfering substances, this method may also be applicable to the analysis of hexavalent chromium (Cr (VI)) in certain domestic and industrial wastes.

Analytical Note:

Determinative methods that utilize automated flow injection analysis (FIA) systems manufactured by Lachat, Technicon and OI Corporation, etc. that use diphenylcarbazine as the color development reagent and maintain the ratio of reagent and sample volumes specified by SW-846 Method 7196A, to accommodate automation, are considered equivalent for the analysis of dissolved hexavalent chromium both in aqueous environmental samples and the alkaline digestate produced by SW-846 Method 3060A. Manufacturer's instructions should be consulted for a more detailed discussion of potential method-specific interferences and operational issues. The quality control requirements and performance standards described in Table VI B-1 may be applied directly to these methods.

1.2.2 SW-846 Method 3060A, Alkaline Digestion for Hexavalent Chromium

SW-846 Method 3060 is an alkaline digestion procedure for extracting hexavalent chromium (Cr (VI)) from soluble, adsorbed, and precipitated forms of chromium compounds in soils, sludges, sediments, and similar waste materials. The pH of the digestate must be carefully adjusted and monitored during the digestion procedure. **Failure to meet the pH specifications of the method will necessitate re-digestion of the samples.**

To quantify all Cr (VI) species contained in a solid matrix, three criteria must be satisfied:

- (1) The extracting solution must solubilize all forms of Cr (VI),
- (2) The conditions of the extraction must not induce reduction of native Cr (VI) to Cr (III), and
- (3) The method must not cause oxidation of native Cr (III) contained in the sample to Cr (VI).

SW-846 Method 3060A meets these criteria for most solid matrices. Under the alkaline conditions of the extraction, minimal reduction of Cr (VI) or oxidation of native Cr (III) occurs. The addition of Mg^{+2} in a phosphate buffer to the alkaline solution has been shown to suppress oxidation. The efficiency (as % Recovery) of the extraction procedure is assessed using spike recovery data for soluble and insoluble forms of Cr (VI) (e.g., $K_2Cr_2O_7$ and $PbCrO_4$), coupled with the measurement of other soil properties, such as oxidation reduction potential (ORP), pH, organic matter content, ferrous iron, and sulfides as indicators that oxidative conditions will be maintained during digestion of the Cr (VI) spike.

Recovery of an insoluble Cr (VI) spike is used to assess efficiency and maintenance of non-reductive conditions during the solubilization process. Method-induced oxidation (Cr (III))



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converted to Cr (VI)) is usually not observed except in soils high in manganese and amended with soluble Cr (III) salts or freshly precipitated Cr (OH)₃.

Alkaline digestion is the required preparative step for the analysis soils, sludges, sediments and similar waste materials under the MCP.

The quantification of Cr (VI) in Method 3060A digestates may be performed using any analytical technique with suitable accuracy and precision. The following summary table presents the recommended alternative SW-846 methods that may be used in conjunction with the alkaline digestion procedure for the analysis of Hexavalent Chromium in soils, sludges, sediments, and similar waste materials. Other less commercially-available analytical techniques such as ion chromatography (IC) coupled with inductively coupled plasma – mass spectrometric (ICP-MS) detection, high performance liquid chromatography (HPLC) with ICP-MS detection, capillary electrophoresis (CE) with ICP-MS detection, etc. may be considered once their performance effectiveness has been validated.

1.2.3 Determination of Total Chromium and Chromium (III)

Total Chromium may be determined by flame or flameless atomic absorption methods, ICP-AES or by ICP-MS. Refer to the appropriate MADEP Analytical Method (WSC-CAM III A, III C or III D) for specific analytical and reporting details. Chromium (III) is defined as the difference between the Total Chromium concentration and the Chromium (VI) concentration.

$$\text{Chromium (III)} = \text{Total Chromium} - \text{Chromium (VI)}$$

1.3 Method Interferences

1.3.1 General Interferences Associated with Trace Metal Analyses

Samples submitted to a laboratory for trace metal analysis may be subject to contamination during both sampling and analysis. Potential sources of contamination may include:

- !" Metallic or metal-containing containers and sampling equipment,
- !" Laboratory acids or reagents,
- !" Improperly cleaned or stored equipment, and
- !" Atmospheric inputs such as dirt and dust.



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1.3.2 Specific SW-846 Method 7196A Interferences

The chromium reaction with diphenylcarbazide is usually free from interferences. However, certain substances may interfere if the chromium concentration is relatively low. Hexavalent molybdenum and mercury salts also react to form color with the reagent; however, the red-violet intensities produced are much lower than those for chromium at the specified pH.

- !" Concentrations of up to 200 mg/L of molybdenum and mercury can be tolerated.
- !" Vanadium interferes strongly, but concentrations up to 10 times that of chromium can be tolerated.
- !" Iron in concentrations greater than 1 mg/L may produce a yellow color, but the ferric iron color is not strong and difficulty is not normally encountered if the absorbance is measured spectrophotometrically at the appropriate wavelength.

1.3.3 Specific SW-846 Method 3060A Interferences

1.3.3.1 Oxidizing/Reducing Conditions in Sample Matrix

Under the MCP, determination of the reducing/oxidizing tendency of each soil type and/or sediment matrix for each analytical batch is required when measuring hexavalent chromium. This is accomplished by characterization of each sample for two (2) additional analytical parameters:

- !" pH (SW-846 Method 9045C), and
- !" Oxidation Reduction Potential (ORP) (ASTM Method D 1498-93).

Section 7.2 of SW-846 Method 9045C should be referenced as the preparatory method for solid samples for ORP. The ORP and pH probes are inserted directly into the soil slurry. The displayed ORP and pH values are allowed to equilibrate and the resulting measurements are recorded. Additional optional parameters include:

- !" Ferrous iron (ASTM Method D3872-86), and
- !" Sulfides (SW-846 Method 9030B).

Other indirect indicators of reducing/oxidizing tendency include:

- !" Total Organic Carbon (TOC),
- !" Chemical Oxygen Demand (COD), and
- !" Biological Oxygen Demand (BOD).

Analysis of these parameters establishes the tendency of Cr (VI) to exist or not exist in the unspiked sample(s) and assists in the interpretation of QC data for matrix spike recoveries outside of the acceptance criteria.



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1.3.3.2 Interfering Substances Present in Digestate

Certain substances, not typically found in the alkaline digestates of soils, may interfere in the analytical methods for Cr (VI) following alkaline extraction if the concentrations of these interfering substances are high and the Cr (VI) concentration is low. Refer to Section 2.2 for a discussion of the specific metals that may interfere with Cr (VI) quantification. Reducing agents such as soluble fulvic acids, which are sometimes present in alkaline digestates, may also be potential interferents for this method. Analytical techniques that reduce bias caused by co-extracted matrix components may be effective to minimize these biases after validation of their performance.

1.3.3.3 Elevated Chromium (III) Native Concentrations in Sample

Cr (VI) results obtained using this method may be biased high due to method-induced oxidation for waste materials or solid samples containing soluble Cr (III) concentrations greater than four times the laboratory Cr (VI) reporting limit. The addition of Mg^{2+} in a phosphate buffer to the alkaline extraction solution has been shown to suppress this oxidation. The presence of soluble Cr (III) can be approximated by extracting the solid sample with deionized water (ASTM methods D4646-87, D5233-92, or D3987-85) and analyzing the resultant leachate for both Cr (VI) and total chromium. The difference between these two values approximates the concentration of soluble Cr (III).

1.4 Specific QA/QC Requirements and Performance Standards for SW-846 Methods 7196A and 3060A

Specific QA/QC requirements and performance standards for SW-846 Methods 7196A are presented below in Tables VI B-1. Strict compliance with the QA/QC requirements and performance standards for this method, as well as satisfying other analytical and reporting requirements will provide a data user with "Presumptive Certainty" regarding the usability of analytical data to support MCP decisions. The concept of "Presumptive Certainty" is explained in detail in Section 2.0 of WSC-CAM-VII A.

While optional, parties electing to utilize these protocols will be assured of "Presumptive Certainty" of data acceptance by agency reviewers. In order to achieve "Presumptive Certainty", parties must:

- (a) Comply with the procedures described and referenced in WSC-CAM-VI B;
- (b) Comply with the applicable QC analytical requirements prescribed in Table VI B-1 for this test procedure;
- (c) Evaluate, and narrate, as necessary, compliance with performance standards prescribed in Table VI B-1 for this test method; and
- (d) Adopt the reporting formats and elements specified in the CAM.



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In achieving the status of "Presumptive Certainty", parties will be assured that analytical data sets:

- # Will satisfy the broad QA/QC requirements of 310 CMR 40.0017 and 40.0191 regarding the scientific defensibility, precision and accuracy, and reporting of analytical data;
- # May be used in a data usability assessment, and if in compliance with all MCP Analytical Method standards, laboratory QC requirements, and field QC recommended limits and action levels, the data set will be considered useable data to support site characterization decisions made pursuant to the MCP; and
- # May be used to help support a data representativeness assessment.

Widespread adherence to the "Presumptive Certainty" approach will promote inter-laboratory consistency and provide the regulated community with a greater degree of certainty regarding the quality of data used for MCP decision-making. The issuance of these requirements and standards is in no way intended to preempt the exercise of professional judgement by the LSP in the selection of alternative analytical methods. However, parties who elect not to utilize the "Presumptive Certainty" option have an obligation, pursuant to 310 CMR 40.0017 and 40.0191(2)(c), to demonstrate and document an overall level of (laboratory and field) QA/QC, data usability, and data representativeness that is adequate for and consistent with the intended use of the data.

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Required QA/QC	Data Quality Objective	Performance Standard	Required Deliverable	Recommended Corrective Action	Analytical Response Action
Method (Preparation) Blank	Laboratory Method Sensitivity (contamination evaluation)	<ol style="list-style-type: none"> (1) Frequency - One per digestion batch of < 20 field samples. (2) Must be matrix-matched (the same reagent concentration as calibration and QC standards) and digested with the samples (3) Cr (VI) must be < RL 	Yes	Determine source of contamination. Re-digest/ Re-analyze all associated samples unless all detected results are > 10x method blank level.	Narrate non-compliance.
Laboratory Control Sample (LCS)	Laboratory Method Accuracy	<ol style="list-style-type: none"> (1) Frequency - One per digestion batch of < 20 field samples. (2) LCS must be media-matched (aqueous or solid) to field samples and digested with the samples. (3) LCS percent recovery for Cr (VI) must be within 80-120% or certified acceptance limits, whichever is applicable. 	Yes	Re-digest/reanalyze all associated samples.	<p>Narrate non-compliance.</p> <p>Note: MADEP modification to frequency of LCS for consistency with other methods.</p>
LCS Duplicate	Laboratory Method Precision	<ol style="list-style-type: none"> (1) Frequency - One per digestion batch of < 20 field samples. (2) LCS Duplicate must be media-matched (aqueous or solid) to field samples; prepared using the standard source and concentration as the LCS, and digested with the samples. (3) Recommended to be run immediately after LCS in analytical sequence. (4) Laboratory-determined Relative Percent Difference (RPD) must be " 20 (aqueous) and " 35 (soils/sediments), and (5) A project-specific MD or MSD may be substituted to evaluate precision in lieu of an LCS duplicate. 	Yes	Re-digest/reanalyze all associated samples.	<ol style="list-style-type: none"> (1) Locate and rectify source of non-conformance before proceeding with the analyses of subsequent sample batches. (2) Narrate non-compliance. <p>Note: MADEP modification to frequency of LCS for consistency with other methods.</p>

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Required QA/QC	Data Quality Objective	Performance Standard	Required Deliverable	Recommended Corrective Action	Analytical Response Action
Project Specific Matrix Spike (MS) <i>Aqueous Samples Only</i>	Method Accuracy in Sample Matrix	(1) Frequency - One per digestion batch of < 20 field samples per matrix at the discretion of the laboratory or at the request of data user. Percent recoveries of Cr(VI) must be between 75 –125%.	Yes, if MS requested by data user or run by laboratory as routine QA/QC	Evaluate LCS. If LCS within acceptance limits, no further action needed. If LCS is outside acceptance limits, reanalyze MS.	Narrate non-compliance
Project Specific Matrix Spike Duplicate Sample*(MSD)	Method Precision in Sample Matrix	(1) Optional (may be done in lieu of MD); Frequency - One per digestion batch of < 20 field samples per matrix at the discretion of the laboratory or at the request of data user. (2) Percent recoveries must be between 75 – 125%. (3) MSD RPD criteria: aqueous samples: ≤ 20 ; soil and sediment samples: ≤ 35 .	Yes, if MSD requested by data user or run by laboratory as routine QA/QC	Refer to corrective action for the associated MS (Aqueous MS, Soluble Cr[VI] MS, or Insoluble Cr[VI] MS)	Narrate non-compliance
Project Specific Matrix Duplicate* (MD)	Method Precision in Sample Matrix	(1) Optional (may be done in lieu of MSD)- Frequency: One per digestion batch of < 20 field samples at the discretion of the laboratory or at the request of data user. (2) MD RPD criteria: aqueous results > 5x RL: $\pm 20\%$; aqueous results < 5x RL: difference \leq RL; soil and sediment results > 5x RL: $\pm 35\%$; soil and sediment results < 5x RL: difference $\leq 2x$ RL.	Yes, if MD requested by data user	No corrective action required,	Narrate non-compliance. Note: acceptance criteria consistent with USEPA Region I data validation guidance

* It is recommended that a matrix spike duplicate analysis be performed if analytes are not suspected to be detected. A matrix duplicate analysis should be performed if analytes are suspected to be detected.

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Required QA/QC	Data Quality Objective	Performance Standard	Required Deliverable	Recommended Corrective Action	Analytical Response Action
Project Specific Soluble Cr (VI) Matrix Spike <i>Solid Samples Only</i>	Method Accuracy in Sample Matrix	(1) Frequency - One per digestion batch of < 20 field samples per matrix at the discretion of the laboratory or at the request of data user. (2) Percent recoveries of Cr (VI) must be between 75 –125%.	Yes, if MS requested by data user or run by laboratory as routine QA/QC	Evaluate LCS. If LCS within acceptance limits, evaluate oxidation/reduction characteristics of sample, as specified on Figures 1 and 2 in Appendix VI B-4. Alternatively, perform mass balance as per Section 8.5.2 of SW-846 method 3060A. If reducing conditions exist, no further action required.	Narrate non-compliance and note oxidation/reduction characteristics of sample.
Project Specific Insoluble Cr (VI) Matrix Spike <i>Solid Samples Only</i>	Method Accuracy in Sample Matrix	(1) Frequency - One per digestion batch of < 20 field samples per matrix at the discretion of the laboratory or at the request of data user. (2) Percent recoveries of Cr (VI) must be between 75 –125%.	Yes, if MS requested by data user or run by laboratory as routine QA/QC	Evaluate LCS. If LCS within acceptance limits, evaluate oxidation/reduction characteristics of sample, as specified on Figures 1 and 2 in Appendix VI B-4. Alternatively, perform mass balance as per Section 8.5.2 of SW-846 method 3060A. If reducing conditions exist, no further action required.	Narrate non-compliance and note oxidation/reduction characteristics of sample.
Sample Quantitation and General Reporting	NA	(1) Non-detected values must be reported with the sample-specific reporting limit for each analyte. (2) The RL must be supported by the low-level standard in the calibration curve. (3) Results for solid matrices must be reported on a dry- weight basis to compare to MCP standards. (4) Sample concentrations that exceed the calibration range must be diluted (in the same acid matrix) to fall within the calibration range when re-analyzed. pH and ORP must be performed and reported for each soil type and/or sediment matrix for each analytical batch.	Yes	Not applicable.	



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2.0 Analytical Data Usability Assessment for SW-846 Method 7196A

Overall data usability is influenced by uncertainties associated with both sampling and analytical activities. This document provides detailed quality control requirements and performance standards for SW-846 Methods 7196A and 3060A which may be used to assess the analytical component of data usability. The sampling component of data usability, an independent assessment of the effectiveness of sampling activities to meet data quality objectives, is not substantively addressed in this document.

3.0 Analytical Reporting Requirements for SW-846 Method 7196A

3.1 General Reporting Requirements for SW-846 Method 7196A

General environmental laboratory reporting requirements for analytical data used in support of assessment and evaluation decisions at MCP disposal sites are presented in CAM VII A, Section 2.4. This guidance document provides recommendations for field QC, as well as the required content of the Environmental Laboratory Report, including

- !" Laboratory identification information presented in WSC-CAM-VII A, Section 2.4.1,
- !" Analytical results and supporting information in WSC CAM-VII A, Section 2.4.2,
- !" Sample- and batch-specific QC information in WSC CAM-VII A, Section 2.4.3,
- !" Laboratory Report Certification Statement in WSC CAM-VII A, Section 2.4.4,
- !" Copy of the Analytical Report Certification Form in WSC CAM-VII A, Exhibit VII A-1,
- !" Environmental Laboratory Case Narrative contents in WSC CAM-VII A, Section 2.4.5,
- !" Chain of Custody Form requirements in WSC CAM-VII A, Section 2.4.6

3.2 Specific Reporting Requirements for SW-846 Method 7196A

Specific Quality Control Requirements and Performance Standards for SW-846 Method 7196A are presented in Table VI B-1. Specific QA/QC Requirements and Performance Standards for SW-846 Method 7196A are summarized below in Table VI B-2 as "Required Analytical Deliverables (**YES**)". These routine reporting requirements should always be included as part of the laboratory deliverable for this method. It should be noted that although certain items are not specified as "Required Analytical Deliverables (**NO**)", these data are to be available for review during an audit and may also be requested on a client-specific basis.



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Table VI B-2 Routine Analytical Reporting Requirements for SW-846 Method 7196A

Parameter	Required Analytical Deliverable
Initial Calibration	NO
Initial Calibration Verification (ICV)	NO
Continuing Calibration Verification (CCV)	NO
Continuing Calibration Blank (CCB)	NO
Method (Preparation) Blank	YES
Laboratory Control Standard (LCS)	YES
LCS Duplicate	YES
Project-Specific Aqueous Matrix Spike (MS)	YES, if requested by data user
Project-Specific Matrix Spike Duplicate (MSD) (Aqueous or solid)	YES, if requested by data user
Project-Specific Matrix Duplicate (MD) (Aqueous or solid)	YES, if requested by data user
Project-Specific Solid Soluble Cr (VI) Matrix Spike (MS)	YES, if requested by data user
Project-Specific Solid Insoluble Cr (VI) Matrix Spike (MS)	YES, if requested by data user
pH and ORP (for each soil type and/or sediment matrix for each analytical batch)	YES
General Reporting	YES¹

1. Non-detected values must be reported with the sample-specific reporting limit.



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4.0 Regulatory Limits for Total Chromium, Chromium (VI) and Chromium (III) under 310 CMR 40.0000

The Reportable Quantity (RQ) together with the most stringent (lowest) MCP Reportable Concentrations (RCs) and Method 1 Standards for Chromium (VI), Chromium (III) and Total (or undifferentiated) Chromium are listed below in Table VI B-3:

Table VI B-3 Regulatory Limits for Total Chromium, Chromium (VI) and Chromium (III) under 310 CMR 40.0000

Total Chromium	
MCP Regulatory Criteria	Regulatory Limit
RQ	100 Pounds
RC GW-1	100 µg/L (ppb)
RC S-1	1000 mg/kg (ppm)
Groundwater Method 1 GW-1 Standard	100 µg/L (ppb)
Method 1 Soil Category S-1 & GW-1 Standard	1000 µg/g (ppm)
Chromium (VI)	
MCP Regulatory Criteria	Regulatory Limit
RQ	10 Pounds
RC GW-1	50 µg/L (ppb)
RC GW-2	100 µg/L (ppb)
RC S-1	200 mg/kg (ppm)
Groundwater Method 1 GW-1 Standard	50 µg/L (ppb)
Groundwater Method 1 GW-3 Standard	100 µg/L (ppb)
Method 1 Soil Category S-1 & GW-1 Standard	200 µg/g (ppm)
Chromium (III)	
MCP Regulatory Criteria	Regulatory Limit
RQ	100 pounds
RC GW-1	1000 µg/L (ppb)
RC S-1	1000 mg/kg (ppm)
Groundwater Method 1 GW-1 Standard	100 µg/L (ppb)
Method 1 Soil Category S-1 & GW-1 Standard	1000 µg/g (ppm)



Title: Sample Preservation, Container and Analytical Holding Time Specifications for Surface Water, Groundwater, Soil and Sediment Samples Analyzed for Chromium (VI) in Support of MCP Decision Making

Sample preservation, container and analytical holding time specifications for surface water, groundwater, soil, and sediment matrices for Chromium (VI) conducted in support of MCP decision-making are summarized below and presented in Appendix VII-A of WSC-CAM-VII A, "Quality Assurance and Quality Control Guidelines for Sampling, Data Evaluation, and Reporting Activities for the Massachusetts Contingency Plan (MCP)". Additional guidance may be found in SW-846, Chapter Three.

Sample Matrix	Container	Preservation	Holding Time ¹
Concentrated Waste Samples All Species	125 mL wide-mouth glass or polyethylene bottle	Cool, 4 ± 2° °C	Extract within 30 days of collection. Analyze within 7 days after extraction. <u>Store at 4!C until analyzed.</u>
Aqueous Chromium (VI)	500 mL glass or polyethylene bottle	Cool, 4 ± 2° !C	24 Hours
Dissolved Chromium (VI)	500 mL glass or polyethylene bottle	Filter (0.45 µm) on site; or at the laboratory (prior to extraction) Cool, 4 ± 2° !C	24 Hours
Soil/Sediment Chromium (VI)	(1) 4-ounce glass jar with teflon-lined cap	Samples should be collected with non-metallic devices and stored field-moist at 4 ± 2°!C	Extract within 30 days of collection. Analyze within 7 days after extraction. <u>Store at 4!C until analyzed.</u>
Soil/Sediment pH and ORP	(1) 4-ounce glass jar with teflon-lined cap	Cool, 4 ± 2° °C	24 hours
Soil/Sediment Ferrous iron and Sulfide (optional analyses)	(1) 4-ounce glass jar with teflon-lined cap	Cool, 4 ± 2° °C	7 days

1. Holding time begins from time of sample collection.



Title: Eh/pH Phase Diagram



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WSC-CAM

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Alkaline Digestion for Hexavalent Chromium (Figure 1 of 2)



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