Protocol for Characterizing Severely Impaired Water Sources through Elemental Analysis

This protocol describes the analysis of severely impaired waters for a total of 34 elements. In addition to the 12 primary drinking water standard metals (aluminum, arsenic, barium, beryllium, cadmium, chromium, mercury, nickel, lead, antimony, selenium, and thallium), the 5 secondary drinking water standard metals (silver, copper, iron, manganese, and zinc), and the two California UCMR elements boron and vanadium, it provides for the analysis of the following 15 elements: calcium, cerium, cobalt, potassium, lithium, magnesium, molybdenum, sodium, phosphorus, silicon, tin, strontium, thorium, titanium, and uranium. In essence, the protocol is a combination of two EPA methods, one using inductively coupled plasma atomic emission spectrometry (ICP-AES, method 200.7) the other using inductively coupled plasma mass spectrometry (ICP-MS, 200.8). Because of their multi-element capability, these methods are most suitable for the determination of a large number of elements in a given sample. The elements to which each method is applicable are indicated in Table 1. It should be noted that only a subset of the method analytes is typically determined in routine drinking water analyses. Using the full (combined) range of elements to which the two methods are applicable provides for wide elemental coverage while maintaining cost effectiveness of the analysis. With this test protocol each sample of severely impaired water is analyzed twice - once by EPA 200.7 and once by EPA 200.8. There are thirteen analytes to be determined by EPA 200.7: boron, calcium, cerium, iron, potassium, lithium, magnesium, sodium, phosphorus, silicon, tin, strontium, and titanium. The twenty-one analytes to be determined by EPA 200.8 are: silver, aluminum, arsenic, barium, beryllium, cadmium, cobalt, chromium, copper, mercury, manganese, molybdenum, nickel, lead, antimony, selenium, thorium, thallium, uranium, vanadium, and zinc. The assignments of elements to each of the two methods are based on the typical abundance of the elements in drinking water and the sensitivity of ICP-AES and ICPMS. ICP-AES is generally less sensitive than ICP-MS and is therefore preferred for the more abundant elements, such as sodium and magnesium. Table 1 also lists reporting limits (RRL) for the 34 analytes covered by this protocol. In cases in which DLRs exist in regulation, these values were adopted; they are shown in bold in Table 1. For elements for which revisions to the DLRs have been proposed (silver, aluminum, barium, cadmium, manganese, and antimony), the new, revised DLRs were chosen. For chromium, the hexavalent chromium screening reporting limit of 1 µg/L was selected. If the result obtained by EPA 200.8 for total chromium exceeds 1 µg/L, a new sample must be drawn and analyzed by EPA 218.6 for Cr (VI). If the result obtained by EPA 200.8 for mercury exceeds 1 µg/L, the sample must be re-analyzed by EPA 245.1. This latter requirement was added because in SRLB's experience the analysis of mercury by EPA 200.8 can suffer positive interference from memory effects.

Table 1: Target Analytes of Protocol for Characterizing Severely Impaired Water Sources through Elemental Analysis

#	Element	EPA 200.7 Rev. 4.4 EMMC	EPA 200.8 Rev. 5.4 EMMC	Reporting Limits (ug/L)	Comments
1	Ag	X	O	5	Proposed DLR
2	Al	X	O	100	Proposed DLR
3	As	X	O	2	-
4	B	O	-	100	UCMR element
5	Ba	X	O	10	Proposed DLR
6	Be	X	O	1	-
7	Ca	O	-	1000	-
8	Cd	X	O	0.5	Proposed DLR
9	Ce	O	-	500	-
10	Co	X	O	10	-
11	Cr	X	O	1	If result > 1ug/L, perform EPA 218.6 for Cr(VI)
12	Cu	X	O	50	-
13	Fe	O	-	100	-
14	Hg	X	O	1	If result > 1ug/L, perform EPA 245.1 to confirm
15	K	O	-	1000	-
16	Li	O	-	100	-
17	Mg	O	-	1000	-
18	Mn	X	O	5	Proposed DLR
19	Mo	X	O	10	-
20	Na	O	-	1000	-
21	Ni	X	O	10	-
22	P	O	-	1000	-
23	Pb	X	O	5	-
24	Sb	X	O	2	Proposed DLR
25	Se	X	O	5	-

26	Si	O	-	1000	-
27	Sn	O	-	100	-
28	Sr	O	-	1000	-
29	Th	-	O	1	-
30	Tl	X	O	1	-
31	Ti	O	-	100	-
32	U	-	O	1	DLR for total U
33	V	X	O	3	UCMR element
34	Zn	X	O	50	-

"X" indicates that an element is an applicable method analyte.

“O” indicates that an element is an applicable method analyte and that, for this protocol, an element is to be analyzed by a particular method.