

## Methoden voor de bepaling van elementen

Deze procedure vervangt de procedure CMA/2/I/B van **september 2012**.  
 Voor de conservering en bewaring van watermonsters worden verwezen naar CMA/1/B.

## MATRICES: GRONDWATER, ELUATEN, DESTRUCTIEVLOEISTOFFEN

### ELEMENTEN

Voor grondwater en eluaten dient geen ontsluiting te worden uitgevoerd. De analyses worden uitgevoerd op de gefiltreerde (0.45 µm) monsters. Enkel indien een neerslag wordt waargenomen, dient een ontsluiting te worden uitgevoerd conform CMA/2/I/A.6.1 of CMA/2/I/A.6.3.

Voor bodem, vaste en pasteuze afvalstoffen dient een destructie te worden uitgevoerd conform CMA/2/II/A.3.

Voor materialen die als meststof/bodemverbeterend middel worden aangewend, dient de destructie te worden uitgevoerd conform CMA/2/IV/6 met uitzondering van vloeibare monsters met een droge stofgehalte < 2%. Deze worden behandeld als een afvalwater en ontsloten conform WAC/III/B/002.

Voor olie dient een destructie te worden uitgevoerd conform CMA/2/III/F.

De volgende analysetechnieken kunnen gebruikt worden voor de bepaling van de elementen in grondwater, eluaten, destructievloeistoffen:

antimoon	<ul style="list-style-type: none"> <li>• ISO 11885:2007 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (CMA/2/I/B.1)</li> <li>• ISO 17294-1: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines</li> <li>• ISO 17294-2: 2003 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 2: Determination of 62 elements (CMA/2/I/B.5)</li> <li>• CMA/2/I/B.6 Bepaling van antimoon, arseen en seleen met hydride-atomaire absorptie spectrometrie</li> <li>• ISO 17378-1:2014 Water quality - Determination of arsenic and antimony - Part 1: Method using hydride generation atomic fluorescence spectrometry (HG-AFS)</li> <li>• ISO 17378-2:2014 Water quality - Determination of arsenic and antimony - Part 2: Method using hydride generation atomic absorption spectrometry (HG-AAS)</li> <li>• <del>NEN 6433:1993 Water – Bepaling van het gehalte aan antimoon met behulp van atomaire absorptiespectrometrie (hydridegeneratietechniek). Ontsluiting met salpeterzuur en zoutzuur (WAC/III/B/012)</del></li> <li>• EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (CMA/2/I/B.2)</li> <li>• ISO 20280:2007 Soil quality -- Determination of arsenic, antimony and</li> </ul>
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	<p>selenium in aqua regia soil extracts with electrothermal or hydride-generation atomic absorption spectrometry</p>
arsen	<ul style="list-style-type: none"> <li>• ISO 11885:2007 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (CMA/2/I/B.1)</li> <li>• ISO 17294-1: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines</li> <li>• ISO 17294-2: 2003 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 2: Determination of 62 elements (CMA/2/I/B.5)</li> <li>• CMA/2/I/B.6 Bepaling van antimoon, arseen en seleen met hydride-atomaire absorptie spectrometrie</li> <li>• ISO 17378-1:2014 Water quality - Determination of arsenic and antimony - Part 1: Method using hydride generation atomic fluorescence spectrometry (HG-AFS)</li> <li>• ISO 17378-2:2014 Water quality - Determination of arsenic and antimony - Part 2: Method using hydride generation atomic absorption spectrometry (HG-AAS)</li> <li>• <del>ISO 11969: 1996 Water quality — Determination of arsenic — Atomic absorption spectrometric method (hydride technique)</del></li> <li>• NEN 6432:1993 Water – Bepaling van het gehalte aan arseen met behulp van atomaire absorptiespectrometrie (hydridegeneratietechniek). Ontsluiting met salpeterzuur en zoutzuur.</li> <li>• EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (CMA/2/I/B.2)</li> <li>• ISO 20280:2007 Soil quality -- Determination of arsenic, antimony and selenium in aqua regia soil extracts with electrothermal or hydride-generation atomic absorption spectrometry</li> </ul>
barium	<ul style="list-style-type: none"> <li>• ISO 11885:2007 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (CMA/2/I/B.1)</li> <li>• ISO 17294-1: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines</li> <li>• ISO 17294-2: 2003 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 2: Determination of 62 elements (CMA/2/I/B.5)</li> </ul>
cadmium	<ul style="list-style-type: none"> <li>• ISO 11885:2007 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (CMA/2/I/B.1)</li> <li>• ISO 8288: 1986 Water quality – Determination of cobalt, nickel, copper, zinc, cadmium and lead – Flame atomic absorption spectrometric methods</li> <li>• ISO 5961: 1994 Water quality: Determination of cadmium by atomic absorption spectrometry</li> <li>• ISO 17294-1: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines</li> <li>• ISO 17294-2: 2003 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 2: Determination of 62</li> </ul>

	<p>elements (CMA/2/I/B.5)</p> <ul style="list-style-type: none"> <li>• EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (CMA/2/I/B.2)</li> </ul>
calcium	<ul style="list-style-type: none"> <li>• ISO 11885:2007 Water quality – Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (CMA/2/I/B.1)</li> <li>• ISO 17294-1: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines</li> <li>• ISO 17294-2: 2003 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 2: Determination of 62 elements (CMA/2/I/B.5)</li> </ul>
chrom	<ul style="list-style-type: none"> <li>• ISO 11885:2007 Water quality – Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (CMA/2/I/B.1)</li> <li>• EN 1233: 1996 Water quality – Determination of chromium – Atomic absorption spectrometric methods</li> <li>• ISO 17294-1: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines</li> <li>• ISO 17294-2: 2003 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 2: Determination of 62 elements (CMA/2/I/B.5)</li> <li>• EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (CMA/2/I/B.2)</li> <li>• CEN/TS 16188:2012 Sludge, treated biowaste and soil – Determinations of elements in aqua regia and nitric acid digests – Flame atomic absorption spectrometry method (FAAS)</li> </ul>
fosfor	<ul style="list-style-type: none"> <li>• ISO 11885:2007 Water quality – Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (CMA/2/I/B.1)</li> <li>• EN ISO 6878: 2004 Water quality – Determination of phosphorus – Ammonium molybdate spectrometric method</li> <li>• ISO 17294-1: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines</li> <li>• ISO 17294-2: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 2: Determination of 62 elements (CMA/2/I/B.5)</li> <li>• ISO 15681-1: 2003 Water quality – Determination of orthophosphate and total phosphorus contents by flow analysis (FIA and CFA) – Part 1: Method by flow injection analysis (FIA)</li> <li>• ISO 15681-2: 2003 Water quality – Determination of orthophosphate and total phosphorus contents by flow analysis (FIA and CFA) – Part 2: Method by continuous flow analysis (CFA)</li> </ul>
kalium	<ul style="list-style-type: none"> <li>• ISO 11885:2007 Water quality – Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (CMA/2/I/B.1)</li> <li>• ISO 17294-1: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines</li> </ul>

	<ul style="list-style-type: none"> <li>• ISO 17294-2: 2003 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 2: Determination of 62 elements (CMA/2/I/B.5)</li> </ul>
kobalt	<ul style="list-style-type: none"> <li>• ISO 11885:2007 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (CMA/2/I/B.1)</li> <li>• ISO 8288: 1986 Water quality – Determination of cobalt, nickel, copper, zinc, cadmium and lead – Flame atomic absorption spectrometric methods</li> <li>• ISO 17294-1: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines</li> <li>• ISO 17294-2: 2003 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 2: Determination of 62 elements (CMA/2/I/B.5)</li> <li>• EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (CMA/2/I/B.2)</li> <li>• CEN/TS 16188:2012 Sludge, treated biowaste and soil – Determinations of elements in aqua regia and nitric acid digests – Flame atomic absorption spectrometry method (FAAS)</li> </ul>
koper	<ul style="list-style-type: none"> <li>• ISO 11885:2007 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (CMA/2/I/B.1)</li> <li>• ISO 8288: 1986 Water quality – Determination of cobalt, nickel, copper, zinc, cadmium and lead – Flame atomic absorption spectrometric methods</li> <li>• ISO 17294-1: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines</li> <li>• ISO 17294-2: 2003 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 2: Determination of 62 elements (CMA/2/I/B.5)</li> <li>• EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (CMA/2/I/B.2)</li> <li>• CEN/TS 16188:2012 Sludge, treated biowaste and soil – Determinations of elements in aqua regia and nitric acid digests – Flame atomic absorption spectrometry method (FAAS)</li> </ul>
lood	<ul style="list-style-type: none"> <li>• ISO 11885:2007 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (CMA/2/I/B.1)</li> <li>• ISO 8288: 1986 Water quality – Determination of cobalt, nickel, copper, zinc, cadmium and lead – Flame atomic absorption spectrometric methods</li> <li>• ISO 17294-1: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines</li> <li>• ISO 17294-2: 2003 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 2: Determination of 62 elements (CMA/2/I/B.5)</li> <li>• EN ISO 15586:2003 Water quality – Determination of trace elements</li> </ul>

	using atomic absorption spectrometry with graphite furnace (CMA/2/I/B.2)
magnesium	<ul style="list-style-type: none"> <li>• ISO 11885:2007 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (CMA/2/I/B.1)</li> <li>• ISO 17294-1: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines</li> <li>• ISO 17294-2: 2003 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 2: Determination of 62 elements (CMA/2/I/B.5)</li> </ul>
mangaan	<ul style="list-style-type: none"> <li>• ISO 11885:2007 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (CMA/2/I/B.1)</li> <li>• ISO 17294-1: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines</li> <li>• ISO 17294-2: 2003 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 2: Determination of 62 elements (CMA/2/I/B.5)</li> <li>• EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (CMA/2/I/B.2)</li> <li>• CEN/TS 16188:2012 Sludge, treated biowaste and soil – Determinations of elements in aqua regia and nitric acid digests – Flame atomic absorption spectrometry method (FAAS)</li> </ul>
molybdeen	<ul style="list-style-type: none"> <li>• ISO 11885:2007 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (CMA/2/I/B.1)</li> <li>• ISO 17294-1: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines</li> <li>• ISO 17294-2: 2003 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 2: Determination of 62 elements (CMA/2/I/B.5)</li> <li>• EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (CMA/2/I/B.2)</li> </ul>
nikkel	<ul style="list-style-type: none"> <li>• ISO 11885:2007 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (CMA/2/I/B.1)</li> <li>• ISO 8288: 1986 Water quality – Determination of cobalt, nickel, copper, zinc, cadmium and lead – Flame atomic absorption spectrometric methods</li> <li>• ISO 17294-1: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines</li> <li>• ISO 17294-2: 2003 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 2: Determination of 62 elements (CMA/2/I/B.5)</li> <li>• EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (CMA/2/I/B.2)</li> </ul>

	<ul style="list-style-type: none"> <li>• CEN/TS 16188:2012 Sludge, treated biowaste and soil – Determinations of elements in aqua regia and nitric acid digests – Flame atomic absorption spectrometry method (FAAS)</li> </ul>
seleen	<ul style="list-style-type: none"> <li>• ISO 11885:2007 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (CMA/2/I/B.1)</li> <li>• ISO 17294-1: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines</li> <li>• ISO 17294-2: 2003 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 2: Determination of 62 elements (CMA/2/I/B.5)</li> <li>• CMA/2/I/B.6 Bepaling van antimoon, arseen en seleen met hydride-atomaire absorptie spectrometrie</li> <li>• ISO/TS 17379-1:2013 Water quality - Determination of selenium - Part 1: Method using hydride generation atomic fluorescence spectrometry (HG-AFS)</li> <li>• ISO/TS 17379-2:2013 Water quality - Determination of selenium - Part 2: Method using hydride generation atomic absorption spectrometry (HG-AAS)</li> <li>• <del>NEN 6434:1993 Water – Bepaling van het gehalte aan seleen met behulp van atomaire absorptiespectrometrie (hydridegeneratietechniek). Ontsluiting met salpeterzuur en zoutzuur</del></li> <li>• EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (CMA/2/I/B.2)</li> <li>• ISO 20280:2007 Soil quality -- Determination of arsenic, antimony and selenium in aqua regia soil extracts with electrothermal or hydride-generation atomic absorption spectrometry</li> </ul>
thallium	<ul style="list-style-type: none"> <li>• ISO 11885:2007 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (CMA/2/I/B.1)</li> <li>• ISO 17294-1: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines</li> <li>• ISO 17294-2: 2003 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 2: Determination of 62 elements (CMA/2/I/B.5)</li> <li>• EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (CMA/2/I/B.2)</li> </ul>
tin	<ul style="list-style-type: none"> <li>• ISO 11885:2007 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (CMA/2/I/B.1)</li> <li>• ISO 17294-1: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines</li> <li>• ISO 17294-2: 2003 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 2: Determination of 62 elements (CMA/2/I/B.5)</li> </ul>
vanadium	<ul style="list-style-type: none"> <li>• ISO 11885:2007 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES)</li> </ul>

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	<p>(CMA/2/I/B.1)</p> <ul style="list-style-type: none"><li>• ISO 17294-1: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines</li><li>• ISO 17294-2: 2003 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 2: Determination of 62 elements (CMA/2/I/B.5)</li><li>• EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (CMA/2/I/B.2)</li></ul>
zink	<hr/> <ul style="list-style-type: none"><li>• ISO 11885:2007 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (CMA/2/I/B.1)</li><li>• ISO 8288: 1986 Water quality – Determination of cobalt, nickel, copper, zinc, cadmium and lead – Flame atomic absorption spectrometric methods</li><li>• ISO 17294-1: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines</li><li>• ISO 17294-2: 2003 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 2: Determination of 62 elements (CMA/2/I/B.5)</li><li>• EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (CMA/2/I/B.2)</li><li>• CEN/TS 16188:2012 Sludge, treated biowaste and soil – Determinations of elements in aqua regia and nitric acid digests – Flame atomic absorption spectrometry method (FAAS)</li></ul> <hr/>



**KWIK**

Voor de bepaling van kwik in grondwater en eluaten is het toepassen van een ontsluiting afhankelijk van de conserverings- en bepalingstechniek.

Bij de bepaling van kwik met CV-AAS en CV-AFS (CMA/2/I/B.3) en BrCl als conservering reagens dient voor grondwater en eluaten geen ontsluiting te worden uitgevoerd.

Bij de bepaling van kwik met CV-AAS en CV-AFS (CMA/2/I/B.3) en kaliumdichromaat als conservering reagens dient zowel grondwater als de eluaten ontsloten te worden.

Volgende ontsluitingsmethoden kunnen worden toegepast:

- CMA/2/I/A.6.1 Ontsluiting voor de bepaling van geselecteerde elementen in water – aqua regia ontsluiting
- Ontsluitingsmethode met kalium permanganaat/ kalium peroxodisulfaat
  - Breng 100 ml monster geconserveerd met HNO<sub>3</sub> en K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> (0.05%), in een ontsluitingsrecipiënt
  - Voeg 15 ml kalium permanganaat oplossing (50 g KMnO<sub>4</sub>/liter), 1 ml HNO<sub>3</sub> en 1 ml H<sub>2</sub>SO<sub>4</sub> toe.
  - Laat de oplossing 15 min. staan, en voeg 10 ml kalium peroxodisulfaat oplossing (40 g K<sub>2</sub>S<sub>2</sub>O<sub>6</sub>/liter) toe
  - Plaats het recipiënt in een verwarmingstoestel (bv. blok of waterbad) bij 95°C gedurende 2uur
  - Indien nodig, voeg bijkomend kalium permanganaat oplossing toe
  - Laten afkoelen, en aanlengen tot gewenst volume.
- Ontsluiting met BrCl oplossing bij kamertemperatuur gedurende min. 24 u volgens ISO 12846 § 7.4 (kT)
- Ontsluiting met BrCl-reagens bij verhoogde temperatuur, BrCl (hT)<sup>1</sup>

Bij de bepaling van Hg met ICP-MS dient onafhankelijk van de conservering voor grondwater en eluaten geen ontsluiting te worden uitgevoerd.

Voor bodem, vaste en pasteuze afvalstoffen dient een destructie te worden uitgevoerd conform CMA/2/II/A.3.

Voor materialen die als bodemverbeterende middel/meststof worden aangewend, dient de destructie te worden uitgevoerd conform CMA/2/IV/6.

De volgende analysetechnieken kunnen gebruikt worden voor de bepaling van kwik in grondwater, eluaten en destructievloeistoffen:

Kwik	<ul style="list-style-type: none"> <li>• ISO 12846:2012 Water quality : Determination of mercury - Method using atomic absorption spectrometry (AAS) with and without enrichment (CMA/2/I/B.3)</li> <li>• ISO 17852:2006 Water quality -- Determination of mercury -- Method using atomic fluorescence spectrometry (CMA/2/I/B.3)</li> <li>• EN 12338: 1998 Water quality: Determination of mercury – enrichment methods by amalgamation</li> </ul>
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<sup>1</sup> EPA Method 1631, Revision E: Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry, August 2002.

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- ISO 17294-1: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines
  - ISO 17294-2: 2003 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 2: Determination of 62 elements (CMA/2/I/B.5)
  - EPA 200.8 Determination of trace elements in waters and wastes by inductively coupled plasma- mass spectrometry.
  - ISO 5666: 1999 Water quality: Determination of mercury (CMA/2/I/B.3)
  - EN 1483: 2007 Water quality – Determination of mercury (CMA/2/I/B.3)
  - EPA 7473:1998 Mercury in solids and solutions by thermal decomposition, amalgamation, and atomic absorption spectrophotometry
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