

Compendium voor monsterneming en analyse in uitvoering van het Materialendecreet en het Bodemdecreet

Methoden voor bepaling van elementen

Deze procedure vervangt de procedure CMA/2/I/B van **oktober 2018**.

Voor de conservering en bewaring van watermonsters worden verwezen naar CMA/1/B.

MATRICES: GRONDWATER, ELUATEN, DESTRUCTIEVLOEISTOFFEN

ELEMENTEN

Voor grondwater en eluat dient geen ontsluiting te worden uitgevoerd. De analyses worden uitgevoerd op de gefiltreerde ($0.45 \mu\text{m}$) 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, eluat, destructievloeistoffen:

antimoon

- NBN EN ISO 11885:2009 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (ISO 11885:2007) (CMA/2/I/B.1)
- NBN EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (ISO 15586:2003) (CMA/2/I/B.2)
- NBN EN ISO 17294-1:2006 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines (ISO 17294-1:2004)
- **NBN EN ISO 17294-2:2016 Water quality - Application of inductively coupled plasma mass spectrometry (ICP-MS) - Part 2: Determination of selected elements including uranium isotopes (ISO 17294-2:2016)** (CMA/2/I/B.5)
- CMA/2/I/B.6 Bepaling van antimoon, arseen en seleen met hydride-atomaire absorptie spectrometrie
- ISO 17378-1:2014 Water quality - Determination of arsenic and antimony - Part 1: Method using hydride generation atomic fluorescence spectrometry (HG-AFS)
- ISO 17378-2:2014 Water quality - Determination of arsenic and antimony - Part 2: Method using hydride generation atomic absorption spectrometry (HG-AAS)
- ISO 20280:2007 Soil quality -- Determination of arsenic, antimony and selenium in aqua regia soil extracts with electrothermal or hydride-

	generation atomic absorption spectrometry
arsseen	<ul style="list-style-type: none">• NBN EN ISO 11885:2009 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (ISO 11885:2007) (CMA/2/I/B.1)• NBN EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (ISO 15586:2003) (CMA/2/I/B.2)• NBN EN ISO 17294-1:2006 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines (ISO 17294-1:2004)• NBN EN ISO 17294-2:2016 Water quality - Application of inductively coupled plasma mass spectrometry (ICP-MS) - Part 2: Determination of selected elements including uranium isotopes (ISO 17294-2:2016) (CMA/2/I/B.5)• CMA/2/I/B.6 Bepaling van antimoon, arseen en seleen met hydride-atomaire absorptie spectrometrie• ISO 17378-1:2014 Water quality - Determination of arsenic and antimony - Part 1: Method using hydride generation atomic fluorescence spectrometry (HG-AFS)• ISO 17378-2:2014 Water quality - Determination of arsenic and antimony - Part 2: Method using hydride generation atomic absorption spectrometry (HG-AAS)• NEN 6432:1993 Water – Bepaling van het gehalte aan arseen met behulp van atomaire absorptiespectrometrie (hydridegeneratie-techniek). Ontsluiting met salpeterzuur en zoutzuur.• ISO 20280:2007 Soil quality -- Determination of arsenic, antimony and selenium in aqua regia soil extracts with electrothermal or hydride-generation atomic absorption spectrometry
barium	<ul style="list-style-type: none">• NBN EN ISO 11885:2009 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (ISO 11885:2007) (CMA/2/I/B.1)• NBN EN ISO 17294-1:2006 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines (ISO 17294-1:2004)• NBN EN ISO 17294-2:2016 Water quality - Application of inductively coupled plasma mass spectrometry (ICP-MS) - Part 2: Determination of selected elements including uranium isotopes (ISO 17294-2:2016) (CMA/2/I/B.5)
cadmium	<ul style="list-style-type: none">• NBN EN ISO 11885:2009 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (ISO 11885:2007) (CMA/2/I/B.1)• NBN EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (ISO 15586:2003) (CMA/2/I/B.2)• NBN EN ISO 17294-1:2006 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines (ISO 17294-1:2004)• NBN EN ISO 17294-2:2016 Water quality - Application of inductively coupled plasma mass spectrometry (ICP-MS) - Part 2: Determination of

	selected elements including uranium isotopes (ISO 17294-2:2016) (CMA/2/I/B.5)
	<ul style="list-style-type: none">• ISO 8288: 1986 Water quality – Determination of cobalt, nickel, copper, zinc, cadmium and lead – Flame atomic absorption spectrometric methods• ISO 5961: 1994 Water quality: Determination of cadmium by atomic absorption spectrometry
calcium	<ul style="list-style-type: none">• NBN EN ISO 11885:2009 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (ISO 11885:2007) (CMA/2/I/B.1)• NBN EN ISO 17294-1:2006 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines (ISO 17294-1:2004)• NBN EN ISO 17294-2:2016 Water quality - Application of inductively coupled plasma mass spectrometry (ICP-MS) - Part 2: Determination of selected elements including uranium isotopes (ISO 17294-2:2016) (CMA/2/I/B.5)
chroom	<ul style="list-style-type: none">• NBN EN ISO 11885:2009 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (ISO 11885:2007) (CMA/2/I/B.1)• NBN EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (ISO 15586:2003) (CMA/2/I/B.2)• NBN EN ISO 17294-1:2006 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines (ISO 17294-1:2004)• NBN EN ISO 17294-2:2016 Water quality - Application of inductively coupled plasma mass spectrometry (ICP-MS) - Part 2: Determination of selected elements including uranium isotopes (ISO 17294-2:2016) (CMA/2/I/B.5)• NBN EN 1233: 1996 Water quality – Determination of chromium – Atomic absorption spectrometric methods• 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)
fosfor	<ul style="list-style-type: none">• NBN EN ISO 11885:2009 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (ISO 11885:2007) (CMA/2/I/B.1)• NBN EN ISO 6878: 2004 Water quality – Determination of phosphorus – Ammonium molybdate spectrometric method (ISO 6778:2004)• NBN EN ISO 17294-1:2006 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines (ISO 17294-1:2004)• NBN EN ISO 17294-2:2016 Water quality - Application of inductively coupled plasma mass spectrometry (ICP-MS) - Part 2: Determination of selected elements including uranium isotopes (ISO 17294-2:2016) (CMA/2/I/B.5)• NBN EN ISO 15681-1:2005 Water quality – Determination of orthophosphate and total phosphorus contents by flow analysis (FIA)

	and CFA) – Part 1: Method by flow injection analysis (FIA) (ISO 15681-1:2003)
	• NBN EN ISO 15681-2:2005 Water quality – Determination of orthophosphate and total phosphorus contents by flow analysis (FIA and CFA) – Part 2: Method by continuous flow analysis (CFA) (ISO 15681-2:2003)
kalium	• NBN EN ISO 11885:2009 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (ISO 11885:2007) (CMA/2/I/B.1) • NBN EN ISO 17294-1:2006 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines (ISO 17294-1:2004) • NBN EN ISO 17294-2:2016 Water quality - Application of inductively coupled plasma mass spectrometry (ICP-MS) - Part 2: Determination of selected elements including uranium isotopes (ISO 17294-2:2016) (CMA/2/I/B.5)
kobalt	• NBN EN ISO 11885:2009 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (ISO 11885:2007) (CMA/2/I/B.1) • NBN EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (ISO 15586:2003) (CMA/2/I/B.2) • NBN EN ISO 17294-1:2006: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines (ISO 17294-1:2004) • NBN EN ISO 17294-2:2016 Water quality - Application of inductively coupled plasma mass spectrometry (ICP-MS) - Part 2: Determination of selected elements including uranium isotopes (ISO 17294-2:2016) (CMA/2/I/B.5) • ISO 8288: 1986 Water quality – Determination of cobalt, nickel, copper, zinc, cadmium and lead – Flame atomic absorption spectrometric methods • 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)
koper	• NBN EN ISO 11885:2009 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (ISO 11885:2007) (CMA/2/I/B.1) • NBN EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (ISO 15586:2003) (CMA/2/I/B.2) • NBN EN ISO 17294-1:2006 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines (ISO 17294-1:2004) • NBN EN ISO 17294-2:2016 Water quality - Application of inductively coupled plasma mass spectrometry (ICP-MS) - Part 2: Determination of selected elements including uranium isotopes (ISO 17294-2:2016) (CMA/2/I/B.5) • ISO 8288: 1986 Water quality – Determination of cobalt, nickel, copper,

	<p>zinc, cadmium and lead – Flame atomic absorption spectrometric methods</p> <ul style="list-style-type: none">• 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)
lood	<ul style="list-style-type: none">• NBN EN ISO 11885:2009 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (ISO 11885:2007) (CMA/2/I/B.1)• NBN EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (ISO 15586:2003) (CMA/2/I/B.2)• NBN EN ISO 17294-1:2006 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines (ISO 17294-1:2004)• NBN EN ISO 17294-2:2016 Water quality - Application of inductively coupled plasma mass spectrometry (ICP-MS) - Part 2: Determination of selected elements including uranium isotopes (ISO 17294-2:2016) (CMA/2/I/B.5)• ISO 8288: 1986 Water quality – Determination of cobalt, nickel, copper, zinc, cadmium and lead – Flame atomic absorption spectrometric methods
magnesium	<ul style="list-style-type: none">• NBN EN ISO 11885:2009 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (ISO 11885:2007) (CMA/2/I/B.1)• NBN EN ISO 17294-1:2006 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines (ISO 17294-1:2004)• NBN EN ISO 17294-2:2016 Water quality - Application of inductively coupled plasma mass spectrometry (ICP-MS) - Part 2: Determination of selected elements including uranium isotopes (ISO 17294-2:2016) (CMA/2/I/B.5)
mangaan	<ul style="list-style-type: none">• NBN EN ISO 11885:2009 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (ISO 11885:2007) (CMA/2/I/B.1)• NBN EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (ISO 15586:2003) (CMA/2/I/B.2)• NBN EN ISO 17294-1:2006 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines (ISO 17294-1:2004)• NBN EN ISO 17294-2:2016 Water quality - Application of inductively coupled plasma mass spectrometry (ICP-MS) - Part 2: Determination of selected elements including uranium isotopes (ISO 17294-2:2016) (CMA/2/I/B.5)• 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)
molybdeen	<ul style="list-style-type: none">• NBN EN ISO 11885:2009 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry

	(ICP-OES) (ISO 11885:2007) (CMA/2/I/B.1)
	• NBN EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (ISO 15586:2003) (CMA/2/I/B.2)
	• NBN EN ISO 17294-1:2006 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines (ISO 17294-1:2004)
	• NBN EN ISO 17294-2:2016 Water quality - Application of inductively coupled plasma mass spectrometry (ICP-MS) - Part 2: Determination of selected elements including uranium isotopes (ISO 17294-2:2016) (CMA/2/I/B.5)
nikkel	• NBN EN ISO 11885:2009 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (ISO 11885:2007) (CMA/2/I/B.1)
	• NBN EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (ISO 15586:2003) (CMA/2/I/B.2)
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	• NBN EN ISO 17294-2:2016 Water quality - Application of inductively coupled plasma mass spectrometry (ICP-MS) - Part 2: Determination of selected elements including uranium isotopes (ISO 17294-2:2016) (CMA/2/I/B.5)
	• ISO 8288: 1986 Water quality – Determination of cobalt, nickel, copper, zinc, cadmium and lead – Flame atomic absorption spectrometric methods
	• 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)
seleen	• NBN EN ISO 11885:2009 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (ISO 11885:2007) (CMA/2/I/B.1)
	• NBN EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (ISO 15586:2003) (CMA/2/I/B.2)
	• NBN EN ISO 17294-1:2006 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines (ISO 17294-1:2004)
	• NBN EN ISO 17294-2:2016 Water quality - Application of inductively coupled plasma mass spectrometry (ICP-MS) - Part 2: Determination of selected elements including uranium isotopes (ISO 17294-2:2016) (CMA/2/I/B.5)
	• CMA/2/I/B.6 Bepaling van antimoon, arseen en seleen met hydride-atomaire absorptie spectrometrie
	• ISO/TS 17379-1:2013 Water quality - Determination of selenium - Part 1: Method using hydride generation atomic fluorescence spectrometry (HG-AFS)
	• ISO/TS 17379-2:2013 Water quality - Determination of selenium - Part

	<p>2: Method using hydride generation atomic absorption spectrometry (HG-AAS)</p> <ul style="list-style-type: none">ISO 20280:2007 Soil quality -- Determination of arsenic, antimony and selenium in aqua regia soil extracts with electrothermal or hydride-generation atomic absorption spectrometry
thallium	<ul style="list-style-type: none">NBN EN ISO 11885:2009 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (ISO 11885:2007) (CMA/2/I/B.1)NBN EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (ISO 15586:2003) (CMA/2/I/B.2)NBN EN ISO 17294-1:2006 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines (ISO 17294-1:2004)NBN EN ISO 17294-2:2016 Water quality - Application of inductively coupled plasma mass spectrometry (ICP-MS) - Part 2: Determination of selected elements including uranium isotopes (ISO 17294-2:2016) (CMA/2/I/B.5)
tin	<ul style="list-style-type: none">NBN EN ISO 11885:2009 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (ISO 11885:2007) (CMA/2/I/B.1)NBN EN ISO 17294-1:2006 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines (ISO 17294-1:2004)NBN EN ISO 17294-2:2016 Water quality - Application of inductively coupled plasma mass spectrometry (ICP-MS) - Part 2: Determination of selected elements including uranium isotopes (ISO 17294-2:2016) (CMA/2/I/B.5)
vanadium	<ul style="list-style-type: none">NBN EN ISO 11885:2009 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (ISO 11885:2007) (CMA/2/I/B.1)NBN EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (ISO 15586:2003) (CMA/2/I/B.2)NBN EN ISO 17294-1:2006 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines (ISO 17294-1:2004)NBN EN ISO 17294-2:2016 Water quality - Application of inductively coupled plasma mass spectrometry (ICP-MS) - Part 2: Determination of selected elements including uranium isotopes (ISO 17294-2:2016) (CMA/2/I/B.5)
zink	<ul style="list-style-type: none">NBN EN ISO 11885:2009 Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (ISO 11885:2007) (CMA/2/I/B.1)NBN EN ISO 15586:2003 Water quality – Determination of trace elements using atomic absorption spectrometry with graphite furnace (ISO 15586:2003) (CMA/2/I/B.2)NBN EN ISO 17294-1:2006 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General

	guidelines (ISO 17294-1:2004)
	<ul style="list-style-type: none">• NBN EN ISO 17294-2:2016 Water quality - Application of inductively coupled plasma mass spectrometry (ICP-MS) - Part 2: Determination of selected elements including uranium isotopes (ISO 17294-2:2016) (CMA/2/I/B.5)• ISO 8288: 1986 Water quality – Determination of cobalt, nickel, copper, zinc, cadmium and lead – Flame atomic absorption spectrometric methods• 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)
	<ul style="list-style-type: none">• NBN EN ISO 12846:2012 Water quality : Determination of mercury - Method using atomic absorption spectrometry (AAS) with and without enrichment (ISO 12846:2012) (CMA/2/I/B.3)• NBN EN ISO 17852:2008 Water quality -- Determination of mercury -- Method using atomic fluorescence spectrometry (ISO 17852:2006) (CMA/2/I/B.3)• NBN EN ISO 17294-1: 2006 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 1: General guidelines (ISO 17294-1:2004)
Kwik ¹	<ul style="list-style-type: none">• NBN EN ISO 17294-2: 2004 Water quality – Application of inductively coupled plasma mass spectrometry (ICP-MS) – Part 2: Determination of 62 elements (ISO 17294-2:2003) (CMA/2/I/B.5)• EPA 200.8:2007 Determination of trace elements in waters and wastes by inductively coupled plasma- mass spectrometry.• EPA 7473:1998 Mercury in solids and solutions by thermal decomposition, amalgamation, and atomic absorption spectrophotometry

¹ C. Vanhoof, F. Beutels, K. Duyssens, J. De Wit, K. Tirez en J. Annys (VMM), *Bepaling van Hg met ICP-MS*, VITO rapport 2018/SCT/R/1586, mei 2018,
<https://esites.vito.be/sites/reflabos/onderzoeksrapporten/Online%20documenten/2017%20Rapport%20bepaling%20van%20Hg%20ICP-MS-finaal2.pdf>