National Institute of Advanced Industrial Science and Technology  
National Metrology Institute of Japan  
Reference Material Certificate  
NMIJ CRM 7203-a  
No. +++  
Tap Water for Heavy Metals  
(Elevated Level)

This certified reference material (CRM) was produced in accordance with the NMIJ’s management system, and in compliance with ISO GUIDE 34:2009 and ISO/IEC 17025:2005. This CRM is intended for use in the calibration of instruments, and for validation of analytical methods and instruments during the quantification of trace elements in tap water, drinking water, and other freshwater samples.

**Certified Values**

The certified values for the elements in this CRM are given in the tables below. The uncertainty of the certified value is the half-width of the expanded uncertainty interval calculated using a coverage factor (k) of 2, which gives a level of confidence of approximately 95%.

<table>
<thead>
<tr>
<th>Element</th>
<th>Certified value, Mass fraction (μg/kg)</th>
<th>Expanded uncertainty, Mass fraction (μg/kg)</th>
<th>Analytical methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al</td>
<td>67</td>
<td>3</td>
<td>2, 3, 4, 6</td>
</tr>
<tr>
<td>As</td>
<td>5.3</td>
<td>0.3</td>
<td>2, 3, 6</td>
</tr>
<tr>
<td>B</td>
<td>43</td>
<td>4</td>
<td>1, 2</td>
</tr>
<tr>
<td>Cd</td>
<td>0.345</td>
<td>0.020</td>
<td>1, 2, 3</td>
</tr>
<tr>
<td>Cr</td>
<td>5.03</td>
<td>0.12</td>
<td>1, 2</td>
</tr>
<tr>
<td>Cu</td>
<td>9.2</td>
<td>0.3</td>
<td>1, 2, 4</td>
</tr>
<tr>
<td>Fe</td>
<td>7.7</td>
<td>0.3</td>
<td>1, 2, 4</td>
</tr>
<tr>
<td>Mn</td>
<td>5.0</td>
<td>0.3</td>
<td>2, 3, 4</td>
</tr>
<tr>
<td>Mo</td>
<td>1.02</td>
<td>0.09</td>
<td>1, 2</td>
</tr>
<tr>
<td>Ni</td>
<td>0.70</td>
<td>0.07</td>
<td>1, 2</td>
</tr>
<tr>
<td>Pb</td>
<td>0.77</td>
<td>0.04</td>
<td>1, 2</td>
</tr>
<tr>
<td>Rb</td>
<td>3.65</td>
<td>0.11</td>
<td>1, 2</td>
</tr>
<tr>
<td>Sb</td>
<td>0.146</td>
<td>0.009</td>
<td>1, 2</td>
</tr>
<tr>
<td>Se</td>
<td>5.0</td>
<td>0.2</td>
<td>1, 2</td>
</tr>
<tr>
<td>Sr</td>
<td>107</td>
<td>3</td>
<td>1, 2</td>
</tr>
<tr>
<td>Zn</td>
<td>12.0</td>
<td>0.6</td>
<td>1, 2, 5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Element</th>
<th>Certified value, Mass fraction (mg/kg)</th>
<th>Expanded uncertainty, Mass fraction (mg/kg)</th>
<th>Analytical methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca</td>
<td>18.1</td>
<td>0.6</td>
<td>1, 2, 4, 5</td>
</tr>
<tr>
<td>K</td>
<td>5.35</td>
<td>0.16</td>
<td>1, 2, 4, 5</td>
</tr>
<tr>
<td>Mg</td>
<td>7.9</td>
<td>0.3</td>
<td>1, 2, 4, 5</td>
</tr>
<tr>
<td>Na</td>
<td>33.1</td>
<td>1.1</td>
<td>2, 4, 5</td>
</tr>
</tbody>
</table>

**Analytical Methods**

1) Isotope dilution (ID) inductively coupled plasma mass spectrometry (ICP-MS).
2) ICP-MS.
3) High resolution (HR) ICP-MS.
4) Inductively coupled plasma optical emission spectrometry (ICP-OES).
5) Microwave plasma optical emission spectrometry (MP-OES).
6) Graphite furnace atomic absorption spectrometry (GF-AAS).

Analysis
The certified values of this CRM are the weighted means of the results from two or more analytical methods conducted at NMII. The quantitative analyses of the elements were made using the aforementioned analytical methods, 1) to 6), and combinations of these based on: (1) a single primary method (ID-ICP-MS) with one or more reference methods or (2) three or more reference methods.

The expanded uncertainty in each certified value is equal to \( U = k \cdot u_c \), where \( u_c \) is the combined standard uncertainty derived from: (a) the analytical results, (b) the method-to-method variance, (c) the concentration of the standard solution, (d) the long-term stability, and (e) the sample homogeneity.

Metrological Traceability
Each certified value was determined by multiple methods with standard solutions guaranteed by JCSS (Japanese Calibration Service System), and is traceable to the International System of Units (SI). All the working standards and sample solutions were prepared by a gravimetric method, using a balance calibrated by JCSS.

Mutual Recognition Arrangement under Meter Convention
This certificate is consistent with the calibration and measurement capabilities (CMCs) that are included in Appendix C of the Mutual Recognition Arrangement (MRA) drawn up by the International Committee for Weights and Measures (CIPM). Under the MRA, all participating institutes recognize the validity of each other’s calibration and measurement certificates for the quantities, ranges and measurement uncertainties specified in Appendix C (as for Appendix C of MRA, see http://kcdb.bipm.org/AppendixC/default.asp).

Expiration of Certification
This certificate is valid for one year from the date of shipment, provided that the material is stored in accordance with the instructions given in this certificate.

Sample Form
This CRM is in the form of a water solution in a polyethylene bottle. The bottle is sealed in a plastic package. The net amount of water solution in each bottle is about 100 mL.

Homogeneity
The homogeneity of this CRM was determined by analyzing 10 bottles hierarchical-randomly sampled from 730 bottles. The elements were determined by inductively coupled plasma mass spectrometry. The homogeneity of each element is reflected in the uncertainty of the certified value.

Instructions for Storage
This CRM should be kept at 5 °C to 25 °C and shielded from light.

Instructions for Use
Care should be taken to prevent any contamination from equipment, vessels, or the working environment because the concentrations of the trace elements are extremely low. To avoid contaminating this CRM, pipet tips should not be dipped into the CRM bottle. This CRM should be opened in a clean space such as a clean booth and used up as soon as possible after opening to prevent contamination.

Precautions for Handling
Wear a mask, gloves, and other protective equipment when handling this CRM. Entrust disposal of this reference material to a professional waste disposal company licensed by local or national authority. Refer to the safety data sheet (SDS) on this CRM.
before use.

**Preparation Method**
Tap water was filtered with cartridge filters (pore size 0.45 μm and 0.20 μm, in turn). Nitric acid (1 %) and hydrochloric acid (0.3 %) were added to ensure the stability of the trace elements and to prevent their adsorption to the bottle. The concentrations of As, Cd, Cr, Hg, Mn, and Se in the initial material were extremely low and solutions of these elements were added to achieve the target concentrations (ca. 0.4 μg/kg for Cd and Hg, ca. 5 μg/kg for As, Cr, Mn, and Se).

**Information**
The concentration of Hg in the CRM was 0.39 μg/kg determined by ICP-MS and ID-ICP-MS, when the certification was complete.

**NMIJ Analysts**
The technical manager for this CRM is K. Inagaki, the production manager Y. Zhu, the analysts are Y. Zhu, T. Narukawa, K. Inagaki, S. Miyashita, T. Kuroiwa, I. Kudo, and M. Koguchi.

**Technical Information**
Customer registration on the NMIJ Website (given below) will facilitate notification of any revision of the information given above. Technical reports regarding this CRM can be obtained from the contact details given below.

**Reproduction of Certificate**
In reproducing this certificate, it should be clearly indicated that the document is a copy.

**Note**
The certified values of the trace elements were additionally verified in a co-analysis program “Trace Elements in Tap Water” performed by the “ACRM (Asian Collaboration on Reference Materials)” that is composed of NMIJ (Japan), KRISS (Korea), and NIM (China).

March 9, 2016
Ryoji Chubachi
President
National Institute of Advanced Industrial Science and Technology

If you have any questions about this CRM, please contact:
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