

# OR Annual report 2022

## Appendices



Release of geothermal water from the Nesjavellir and Hellisheidi geothermal power plants. Groundwater monitoring.



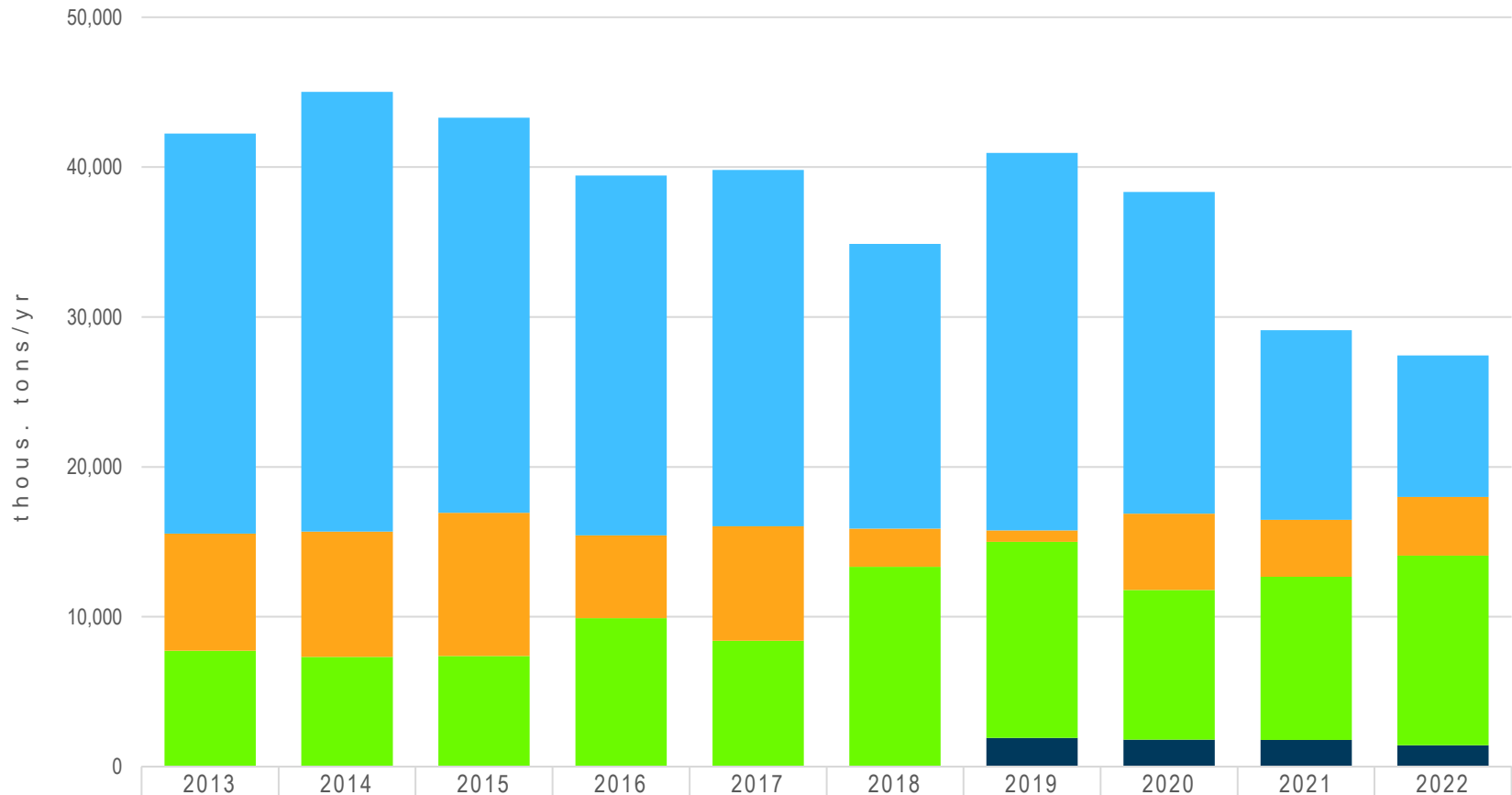
## Table of contents

Volume of geothermal water from the Nesjavellir Geothermal Power Plant by release route .....	1
Volume of geothermal water from the Hellisheidi Geothermal Power Plant by release route 2007 – 2022.....	2
Geothermal fluids discharged via overflows at the Hellisheidi and Nesjavellir Geothermal Power Plant in 2022.....	4
Chemical composition of geothermal water and heated groundwater for space heating from geothermal power plants in the Hengill area .....	5
Chemical composition of geothermal water and heated groundwater from the Hellisheidi and Nesjavellir Geothermal Power Plants .....	6
Chemical composition of groundwater in wells around the Hellisheidi Power Plant in 2022 .....	7

Cover photo: Atli Már Hafsteinsson

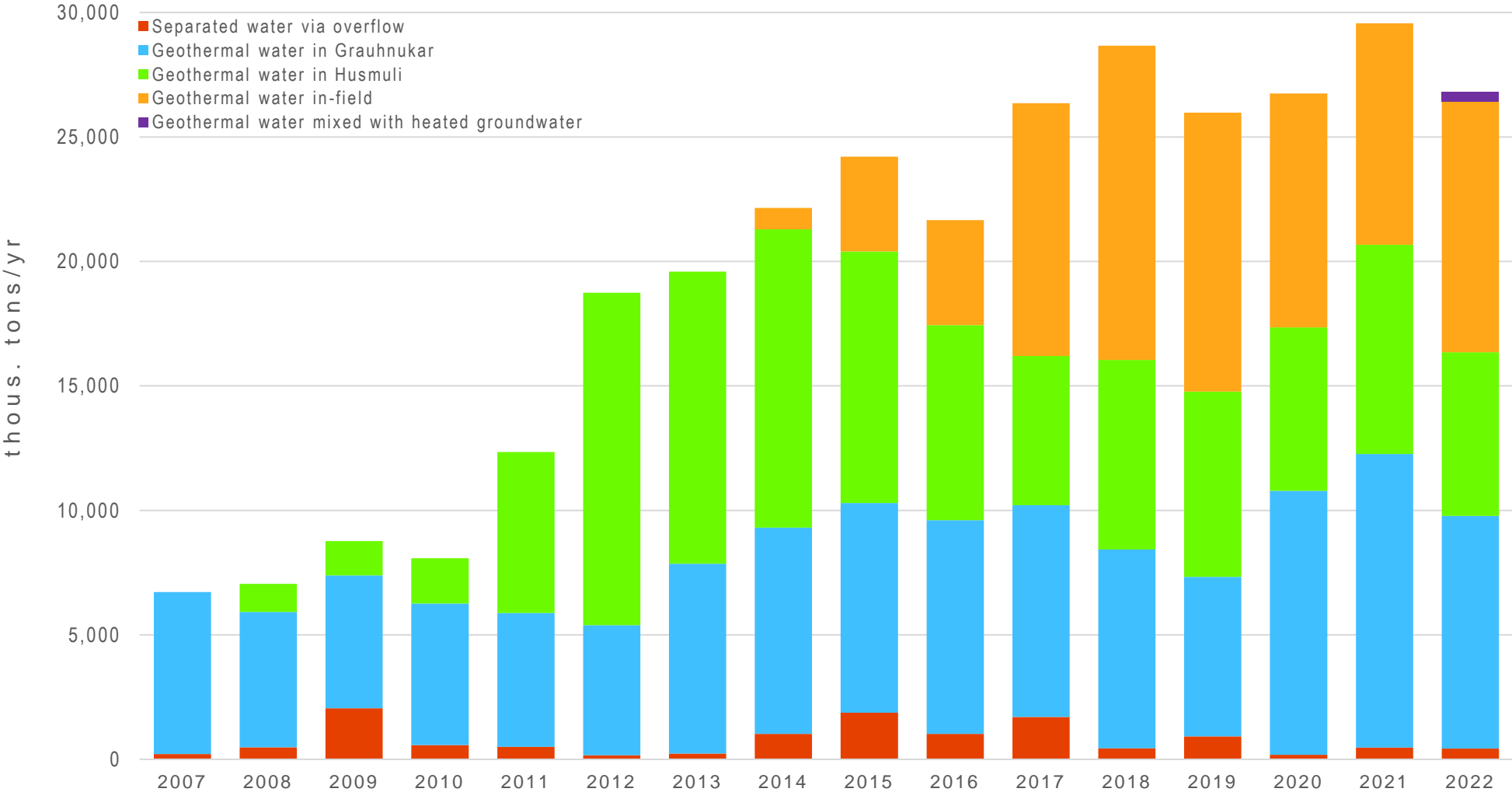
# Volume of geothermal water from the Nesjavellir Geothermal Power Plant by release route

Geothermal water (thous.m<sup>3</sup>/year) from Nesjavellir Geothermal Power Plant 2013-2022 by release route.  
 Volumes are rounded to thousands of tonnes.



# Volume of geothermal water from the Hellisheidi Geothermal Power Plant by release route 2007 – 2022

Until September 2011, the largest part of geothermal water was reinjected through wells in Gráuhnúkar. Geothermal water from the plant increased when the Sleggjan plant was launched in autumn 2011, but the reinjection field at Húsmúli was then put into full operation. Since then, the geothermal water from the plant has increased. Reinjection in discontinued production wells within the production field started in 2014 and in boreholes in Threngsli in 2016. 2022 saw the start of project that involves mixing geothermal water with heated groundwater for district heating for a better utilization of the geothermal resource, reducing the extraction of groundwater at Engidalur and also the reinjection utility.



Year	Separated water via overflow thous. tons/year	Geothermal water in Grauhnukar thous. tons/year	Geothermal water in Husmuli thous. tons/year	Geothermal water in-field thous. tons/year	Geothermal water mixed with heated groundwater thous. tons/year	Total geothermal water thous. tons/year
2007	215	6,502				<b>6,718</b>
2008	483	5,439	1,123			<b>7,045</b>
2009	2,050	5,335	1,382			<b>8,767</b>
2010	572	5,684	1,826			<b>8,082</b>
2011	506	5,374	6,461			<b>12,341</b>
2012	163	5,224	13,358			<b>18,745</b>
2013	233	7,620	11,733			<b>19,586</b>
2014	1,024	8,281	11,982	860		<b>22,147</b>
2015	1,870	8,422	10,107	3,803		<b>24,202</b>
2016	1,025	8,585	7,831	4,213		<b>21,654</b>
2017	1,699	8,506	6,001	10,147		<b>26,353</b>
2018	447	7,982	7,611	12,625		<b>28,665</b>
2019	919	6,409	7,445	11,206		<b>25,980</b>
2020	21	10,610	6,558	9,394		<b>26,583</b>
2021	470	11,979	8,398	8,898		<b>29,562</b>
2022	430	9,352	6,572	10,086	380	<b>26,819</b>
<b>TOTAL</b>	<b>11,697</b>	<b>111,770</b>	<b>101,816</b>	<b>61,146</b>	<b>380</b>	<b>313,407</b>

Volumes are rounded to thousands of tons

## Geothermal fluids discharged via overflows at the Hellisheidi and Nesjavellir Geothermal Power Plants in 2022

The reinjection utility is vulnerable to any operational changes and approximately 1.1% of produced geothermal water at Hellisheidi Power Plant was released via overflow. Licensors have been kept informed on the situation, on actions available at any given time and of the ongoing projects to increase the reception of the reinjection utility..

Date	Type of disturbance	Maximum flow [l/s]
<b>Hellisheidi power plant</b>		
<b>Hellisheidi</b>		
January 12 <sup>th</sup> – 23 <sup>rd</sup>	Maintenance	60
February 8 <sup>th</sup> – 15 <sup>th</sup>	Malfunction	158
February 24 <sup>th</sup> – March 11 <sup>th</sup>	Malfunction due to lightning storm	216
April 22 <sup>nd</sup> – 28 <sup>th</sup>	Malfunction	338
October 19 <sup>th</sup> – 30 <sup>th</sup>	Maintenance	172
<b>Hverahlíð</b>		
September 11 <sup>th</sup>	Maintenance	70

Date	Type of disturbance	Maximum flow[MW]
<b>Nesjavellir Power Plant</b>		
<b>Nesjavellir</b>		
February 5 <sup>th</sup> – March 15 <sup>th</sup>	Malfunction	188
April 23 <sup>rd</sup> – 26 <sup>th</sup>	Malfunction	96
October 11 <sup>th</sup>	Increased hot water production	68
October 26 <sup>th</sup> – 27 <sup>th</sup>	ÍSOR research	139

# Chemical composition of geothermal water and heated groundwater for space heating from geothermal power plants in the Hengill area

Typical concentrations ( $\mu\text{g/L}$ ) of several trace elements in geothermal water (separated water) and heated groundwater (for space heating) from the Hellisheidi and Nesjavellir geothermal power plants and their maximum permissible concentrations ( $\mu\text{g/L}$ ) for potable water. Values exceeding the maximum are indicated in bold.

Trace element	Unit	Max. recommended value for potable water	HELLISHEIDI			NESJAVELLIR		
			Separated water	Condensed water	Heated groundwater	Separated water	Condensed water	Heated groundwater
Arsenic (As)	$\mu\text{g/L}$	10	9.48	< 0.05	1.31	<b>71.60</b>	0.22	1.61
Barium (Ba)	$\mu\text{g/L}$	700	0.38	0.15	0.49	5.08	0.79	0.70
Cadmium (Cd)	$\mu\text{g/L}$	5	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Cobalt (Co)	$\mu\text{g/L}$	*	0.03	0.03	0.07	0.01	0.06	0.01
Chrome (Cr)	$\mu\text{g/L}$	50	0.30	1.99	0.26	0.25	1.38	0.34
Copper( Cu)	$\mu\text{g/L}$	2,000	0.15	0.50	1.66	5.96	1.20	0.38
Mercury (Hg)	$\mu\text{g/L}$	1	< 0.002	< 0.002	< 0.002	< 0.002	0.003	< 0.002
Manganese (Mn)	$\mu\text{g/L}$	50	0.53	0.56	1.28	8.88	15.10	1.75
Molybdenum (Mo)	$\mu\text{g/L}$	*	1.42	0.15	0.61	6.03	0.29	0.45
Nickel (Ni)	$\mu\text{g/L}$	20	0.91	2.21	4.48	1.37	<b>217.0</b>	1.38
Lead (Pb)	$\mu\text{g/L}$	10	0.13	0.06	0.04	0.10	0.33	0.02
Phosphorus (P)	$\mu\text{g/L}$	5,000	< 1	< 1	44.40	64.17	2.30	46.60
Antimony (Sb)	$\mu\text{g/L}$	5	0.13	<0.01	0.05	2.03	0.01	0.03
Selenium (Se)	$\mu\text{g/L}$	10	0.70	< 0.3	< 0.3	<b>20.20</b>	< 0.3	1.08
Strontium(Sr)	$\mu\text{g/L}$	*	< 10	< 2	11.40	< 10	< 2	21.40
Titanium (Ti)	$\mu\text{g/L}$	*	0.47	0.08	0.07	1.79	2.69	0.01
Vanadium (V)	$\mu\text{g/L}$	*	4.88	0.05	14.10	3.00	0.15	22.00
Zinc (Zn)	$\mu\text{g/L}$	3,000	61.40	62.30	45.40	13.40	119.0	3.56

- Maximum limits not specified in the potable water regulation.

# Chemical composition of geothermal water (separated water) and heated groundwater (for space heating) from the Hellisheidi and Nesjavellir Geothermal Power Plants and their maximum permissible concentrations (mg/kg) for potable water

Values exceeding the maximum are indicated in bold.

Chemical- and physiological factors	Unit	Max. recommended value for potable water	HELLISHEIDI				NESJAVELLIR	
			Separated water	Condensed water	Separated water	Condensed water	Separated water	Condensed water
Acidity	pH		9.40	6.93	8.65	8.74	5.31	8.46
T (pH)	°C		15.3	21.6	24.4	24.4	38.8	30.5
Carbon dioxide (CO <sub>2</sub> )	mg/kg	*	16.1	6.9	24.2	22.6	17.5	47.8
Hydrogen sulphide (H <sub>2</sub> S)	mg/kg	*	21.2	2.0	0.44	78.3	35.5	0.55
Silica (SiO <sub>2</sub> )	mg/kg	*	-	0.04	39.0	-	1.15	43.3
Sodium (Na)	mg/kg	200	<b>208.5</b>	0.04	9.97	159.0	0.2	19.0
Potassium (K)	mg/kg	12	<b>36.8</b>	0.21	1.84	<b>30.3</b>	0.17	2.87
Calcium (Ca)	mg/kg	100	< 0.5	0.08	4.92	< 0.5	0.17	10.76
Magnesium (Mg)	mg/kg	50	< 0.4	0.004	2.84	< 0.4	0.24	5.48
Iron (Fe)	mg/kg	0.2	0.013	0.021	0.006	0.16	<b>0.616</b>	0.011
Aluminium (Al)	mg/kg	0.2	<b>2.51</b>	0.003	0.026	<b>2.56</b>	0.04	0.06
Sulphate (SO <sub>4</sub> )	mg/kg	200	14.0	2.55	4.44	14.19	3.03	13.95
Chloride (Cl)	mg/kg	*	209.4	0.7	10.44	145.2	2.8	15.10
Fluoride (F)	mg/kg	1.5	<b>1.56</b>	0.0	0.15	1.33	0.18	0.17

\*Maximum limits not specified in the potable water regulation.



# Chemical composition of groundwater in wells around the Hellisheidi Power Plant in 2022

The impact of the Hellisheidi Power Plant on groundwater is closely monitored in surveillance wells at and around the plant. Samples are collected to analyse overall chemical content and trace elements. in addition to measuring their temperature. conductivity and acidity.

Well	LK-01		HK-07		HK-18		KH-50		KH-12		KH-52		KH-05		KH-06		HK-14		HK-29		
Groundwater flow	Elliðaar flow		Selvogur flow				Selvogur / Thingvellir flow				Thingvellir flow				Olfus flow						
Sample no.	22-5201		22-5173		22-5174		22-5336		22-5196		22-5172		22-5160		22-5159		22-5164		22-5336		
Date	23.8.2022		1.7.2022		20.7.2022		16.11.2022		16.8.2022		1.7.2022		29.6.2022		28.6.2022		29.6.2022		29.11.2022		
Chemical properties	Unit	Maximum value																			
Acidity	pH		7.92	7.50	8.28	6.88	7.43	6.76	7.68	6.82	8.04	7.25									
T (pH)	°C		22.5	22.1	21.9	21.8	22.1	22.2	22.6	22.4	22.4	21.9									
CO <sub>2</sub>	mg/kg	*	20.7	57.5	38.6	49.1	15.6	26.0	51.5	39.3	18.7	42.5									
F	mg/kg	1.5	0.085	0.112	0.098	0.141	0.091	0.097	0.097	0.080	0.078	0.170									
Cl	mg/kg	*	20.67	7.71	9.21	7.91	4.99	6.14	7.07	6.94	7.38	10.69									
SO <sub>4</sub>	mg/kg	200	2.73	11.16	4.21	25.15	5.10	8.77	3.95	2.20	1.80	5.27									
B	Mg/kg	1	< 0.002	0.01	0.003	0.02	0.03	0.01	< 0.002	0.002	< 0.002	0.01									
Ca	mg/kg	100	4.62	8.37	7.79	6.06	3.48	5.32	9.94	4.69	3.29	10.02									
Fe	mg/kg	0.2	0.00486	0.01	0.01	0.03	0.00	0.028	0.01	0.02	0.012	0.018									
K	mg/kg	12	0.994	3.90	0.82	0.94	1.24	1.00	0.90	0.62	0.77	1.07									
Mg	mg/kg	50	2.97	9.39	4.35	13.44	2.03	2.67	6.46	4.43	2.45	3.65									
Na	mg/kg	200	10.92	9.38	9.93	7.36	4.43	5.68	7.88	5.77	5.82	10.14									
SiO <sub>2</sub>	mg/kg	*	15.28	27.77	19.03	43.17	15.15	22.24	27.73	16.50	15.43	29.17									
Al	µg/kg	200	8.1	6.75	4.68	18.00	2.99	9.78	1.62	1.65	3.20	3.86									
As	µg/kg	10	< 0.05	0.08	0.13	0.06	< 0.05	< 0.05	0.08	< 0.05	0.07	0.05									
Ba	µg/kg	700	0.38	0.58	0.45	0.42	0.52	1.51	0.24	1.34	0.30	1.59									
Cd	µg/kg	5	< 0.002	0.004	0.009	0.0209	< 0.002	0.00281	0.011	0.003	0.00292	0.0257									
Co	µg/kg	*	0.00507	0.08	0.02	0.066	0.012	0.115	0.02	0.03	0.015	0.072									
Cr	µg/kg	50	0.3	1.64	2.95	0.16	0.38	2.72	1.28	2.26	2.03	1.96									
Cu	µg/kg	2,000	0.348	0.83	0.67	2.83	0.19	1.58	1.68	0.94	1.06	1.92									
Hg	µg/kg	1	< 0.002	0.00538	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002									
Mn	µg/kg	50	0.152	1.14	0.97	2.42	0.19	1.67	1.17	2.49	0.73	13.50									
Mo	µg/kg	*	0.0836	0.71	0.26	0.13	0.14	0.58	0.32	0.17	0.20	0.29									
Ni	µg/kg	20	0.153	2.13	2.34	5.22	0.18	2.36	2.48	1.57	1.08	1.79									
Pb	µg/kg	10	0.0145	0.09	0.04	0.1	0.0	0.1	0.0	0.0	0.0	0.3									
P	µg/kg	5,000	18.7	47.1	44.9	40.8	24.0	3.9	55.6	5.38	20.0	29.0									
Sb	µg/kg	5	< 0.01	0.064	< 0.01	0.0598	0.845	0.123	< 0.01	< 0.01	< 0.01	0.016									
Se	µg/kg	10	< 0.3	0.63	0.387	< 0.3	1.7	0.706	0.364	< 0.3	< 0.3	< 0.3									
Sr	µg/kg	*	10.2	20.2	14.2	15.4	7.9	13.6	17.8	10.7	8.1	25.6									
Ti	µg/kg	*	0.132	0.252	0.12	0.098	0.052	0.433	0.082	0.109	0.150	0.050									
V	µg/kg	*	9.81	12.7	23.3	1.7	5.4	1.7	9.6	1.7	4.7	12.4									
Zn	µg/kg	3,000	35.6	242.0	32.2	61.4	26.1	259.0	39.3	10.3	26.2	66.2									

\* Maximum limits not specified in the potable water regulation