Supplementary Materials

1. Information about QC/QA in the total amount of HMs

There is no standard sample of MSWI fly ash. The accuracy of the experimental data was determined by adding a standard solution. The fly ash was digested, and a certain amount of standard solution was added into the solution. The samples and the samples added to the standard solution were tested for heavy metals using ICP–OES. The recovery rate of the standard solution added was calculated according to the following formula:

Recovery rate = $\frac{(C3-C1)}{C2}$*100%

Table S1. Recovery rate of the addition of the standard solution (mg/L).

Element	Concentration of the sample (C1)	Concentration of the standard solution added (C2)	Concentration after adding the standard solution (C3)	Recovery ratio
Pb	2.3852	3	5.1778	93.09%
Cu	0.9783	1	1.96745	98.92%
Zn	11.511	10	22.2665	107.56%
Cd	0.4623	0.5	0.94345	96.23%
Cr	0.9578	1	1.9367	97.89%
Ni	0.0449	0.1	0.1357	90.80%
As	0.2198	0.2	0.4297	104.95%
Ba	2.0109	2	4.01635	100.27%

By adding the standard solution at a similar concentration, the recovery rate ranged from 90.80% to 107.56%. According to the standard, when the contents of the components measured was less than 1 mg/L, the allowable limit of recovery was 80%–120%. The allowable limit of recovery was 90%–110% when the contents of the components measured were 1–100 mg/L. When the contents of the components measured were ≥100 mg/L, the allowable limit of recovery was 95%–105%.

Two blank samples were made for each batch, and the blank value of the tested elements was not lower than the detection limit.

Each sample was measured three times, and the relative deviation was calculated according to the following formula, as shown in Table 1:

Relative deviation (Rd) = $\frac{Measured\ value-average}{average}$ × 100%

Table S2. Test concentration and relative deviation (mg/L).

		Spring	Summer	Autumn	Winter	Rd1	Rd2	Rd3	Rd4
Pb	1	2.6503	3.2187	4.3891	2.4890	−1.76%	−2.10%	0.89%	−0.01%
	2	2.6887	3.2902	4.3309	2.4600	−0.33%	0.07%	−0.45%	−1.18%
	3	2.7540	3.3546	4.3315	2.5190	2.09%	2.03%	−0.44%	1.19%
Cu	1	1.0359	1.3209	1.9870	1.3190	−1.33%	−3.99%	−0.90%	−0.27%
	2	1.0400	1.3590	2.1010	1.3789	−0.94%	−1.22%	4.79%	4.25%
	3	1.0738	1.4475	1.9269	1.2700	2.28%	5.21%	−3.89%	−3.98%
Zn	1	11.7908	15.0100	18.5309	12.8134	−0.27%	0.45%	−0.04%	−1.41%
	2	11.8111	14.9500	18.5290	12.9999	−0.10%	0.05%	−0.05%	0.02%
	3	11.8663	14.8684	18.5555	13.1770	0.37%	−0.50%	0.09%	1.39%
Cd	1	0.5041	0.5509	0.6321	0.5499	−0.12%	0.61%	0.68%	−1.13%
	2	0.5109	0.5409	0.6300	0.5599	1.23%	−1.22%	0.34%	0.67%

	3	0.4991	0.5509	0.6215	0.5588	−1.11%	0.61%	−1.02%	0.47%
	1	0.9478	0.6890	0.5200	1.3490	−0.51%	−0.21%	0.43%	0.91%
Cr	2	0.9555	0.7000	0.5199	1.3089	0.30%	1.39%	0.41%	−2.09%
	3	0.9546	0.6823	0.5134	1.3528	0.20%	−1.18%	−0.84%	1.19%
	1	0.0440	0.0899	0.0590	0.0308	−4.09%	−1.12%	1.30%	−0.47%
Ni	2	0.0460	0.0902	0.0590	0.0313	0.29%	−0.77%	1.37%	1.15%
	3	0.0476	0.0926	0.0567	0.0307	3.80%	1.89%	−2.68%	−0.68%
	1	0.2267	0.5409	0.4487	0.1887	1.34%	0.29%	−2.30%	2.78%
As	2	0.2209	0.5279	0.4509	0.1804	−1.26%	−2.12%	−1.83%	−1.74%
	3	0.2235	0.5492	0.4783	0.1817	−0.08%	1.83%	4.13%	−1.04%

The relative deviation for the measured data is between −4.09% and 4.25%.

A standard curve was plotted before each measurement, and the correlation linearity of the standard curve was greater than 0.999.

Calibration Summary

Analyte	Stds.	Equation	Intercept	Slope	Curvature	Corr. Coef.	Reslope
As 188.979	5	Lin, Calc Int	-0.4	36.86	0.00000	0.999858	
Cr 267.716	5	Lin, Calc Int	-16.3	601.3	0.00000	0.999884	
Cd 228.802	5	Lin, Calc Int	-60.0	1014	0.00000	0.999756	
Cu 327.393	5	Lin, Calc Int	-63.5	1035	0.00000	0.999759	
Ni 231.604	5	Lin, Calc Int	-23.6	396.7	0.00000	0.999736	
Pb 220.353	5	Lin, Calc Int	-5.1	114.9	0.00000	0.999790	
Zn 206.200	5	Lin, Calc Int	1789.7	60580	0.00000	0.999522	

Figure S1. Correlation of standard curve.

2. Information about QC/QA in the Leaching Program

Leaching was performed using the HJ/T299-2007 method.

The standard sample measurement details are dictated below.

Table S3. Recovery rate of the addition of the standard solution（mg/L).

Element	Concentration of the sample (C1)	Concentration of the standard solution added (C2)	Concentration after adding the standard solution (C3)	Recovery ratio
Zn	0.3124	0.5	0.7930	96.12%
Pb	3.2823	3	6.2130	97.69%
Cu	0.3305	0.5	0.7952	92.94%
Cr	0.3341	0.5	0.7699	87.16%
Ni	ND	0.5	0.4857	97.14%
As	ND	0.5	0.4903	98.06%
Cd	ND	0.5	0.5123	102.46%

Two blank samples were created for each batch, and the blank value of the tested elements was not below the detection limit.

Detailed data from the three tests are presented below.

Table S4. Details for HM concentration using the HJ/T299-2007 method (mg/L).

Element		Spring	Summer	Autumn	Winter	Rd1	Rd2	Rd3	Rd4
Zn	1	0.3187	1.4789	0.8497	0.4899	1.76%	−0.11%	−0.48%	−1.33%
	2	0.3067	1.4804	0.8502	0.4859	−2.08%	−0.01%	−0.42%	−2.13%
	3	0.3142	1.4822	0.8615	0.5137	0.32%	0.11%	0.90%	3.46%
Pb	1	3.3091	9.3478	10.5923	5.9809	1.00%	−0.12%	−0.44%	−0.15%
	2	3.2987	9.3509	10.6409	6.0010	0.69%	−0.08%	0.02%	0.19%
	3	3.2208	9.3774	10.6835	5.9869	−1.69%	0.20%	0.42%	−0.05%
	1	0.3390	0.2509	0.2103	0.2378	1.44%	3.38%	1.20%	1.62%

Cu	2	0.3356	0.2440	0.1991	0.2301	0.42%	0.54%	0.63%	−1.67%
	3	0.3280	0.2332	0.2140	0.2341	−1.86%	−3.91%	−1.83%	0.04%
Cr	1	0.3079	0.0968	0.0929	0.1622	3.39%	−0.72%	−0.21%	−1.04%
	2	0.2934	0.0969	0.0925	0.1635	−1.48%	−0.62%	−0.64%	−0.24%
	3	0.2921	0.0988	0.0939	0.1660	−1.91%	1.33%	0.86%	1.28%

A standard curve was plotted before each measurement, and the correlation linearity of the standard curve was greater than 0.999.

Calibration Summary

Analyte	Stds.	Equation	Intercept	Slope	Curvature	Corr. Coef.	Reslope
As 188.979	5	Lin, Calc Int	-0.8	31.85	0.00000	0.999529	
Cr 267.716	5	Lin, Calc Int	-26.9	858.2	0.00000	0.999896	
Cd 228.802	5	Lin, Calc Int	-51.1	1084	0.00000	0.999858	
Cu 327.393	5	Lin, Calc Int	-88.8	1517	0.00000	0.999778	
Ni 231.604	5	Lin, Calc Int	-19.9	440.2	0.00000	0.999823	
Pb 220.353	5	Lin, Calc Int	0.2	103.5	0.00000	0.999815	
Zn 206.200	5	Lin, Calc Int	1789.7	60580	0.00000	0.999522	

Figure S2. Correlation of standard curve

Table S5. Details of HM concentration using the TCLP method (mg/L).

Element		Spring	Summer	Autumn	Winter	Rd1	Rd2	Rd3	Rd4
Zn	1	0.4427	1.5326	1.0760	0.5097	-0.11%	0.62%	-0.19%	-0.14%
	2	0.4396	1.5197	1.0803	0.5100	-0.81%	-0.22%	0.21%	-0.08%
	3	0.4473	1.5170	1.0777	0.5115	0.93%	-0.40%	-0.03%	0.22%
Pb	1	3.2278	6.3301	4.9803	2.6983	0.00%	0.04%	0.08%	-1.05%
	2	3.2198	6.3267	4.9703	2.7145	-0.25%	-0.01%	-0.12%	-0.45%
	3	3.2358	6.3254	4.9789	2.7679	0.25%	-0.03%	0.05%	1.50%
Cu	1	0.0856	0.1345	0.0862	0.0693	-1.27%	-2.18%	-2.16%	-0.29%
	2	0.0862	0.1387	0.0894	0.0683	-0.58%	0.87%	1.48%	-1.73%
	3	0.0883	0.1393	0.0887	0.0709	1.85%	1.31%	0.68%	2.01%
Cr	1	0.1667	0.0681	0.0763	0.0937	-1.59%	-1.59%	-2.05%	-0.43%
	2	0.1698	0.0693	0.0764	0.0950	0.24%	0.14%	-1.93%	0.96%
	3	0.1717	0.0702	0.0810	0.0936	1.36%	1.45%	3.98%	-0.53%

A standard curve was plotted before each measurement, and the correlation linearity of the standard curve was greater than 0.999.

Calibration Summary

Analyte	Stds.	Equation	Intercept	Slope	Curvature	Corr. Coef.	Reslope
As 188.979	5	Lin, Calc Int	4.5	3705	0.00000	0.999910	
Cr 267.716	5	Lin, Calc Int	207.2	37000	0.00000	0.999834	
Cd 228.802	5	Lin, Calc Int	1134.4	139700	0.00000	0.999976	
Cu 327.393	5	Lin, Calc Int	-995.7	48850	0.00000	0.999779	
Ni 231.604	5	Lin, Calc Int	588.9	25910	0.00000	0.999866	
Pb 220.353	5	Lin, Calc Int	187.4	7912	0.00000	0.999909	
Zn 206.200	5	Lin, Calc Int	1789.7	60580	0.00000	0.999522	

Figure S3. Correlation of standard curve

3. QC/QA about Metal Bioavailability

The standard sample measurement details are shown below.

Table S6. Recovery rate of the addition of the standard solution (mg/L). (ND means below the detection limit).

Element	Concentration of the sample (C1)	Concentration of the standard solution added	Concentration after adding the standard solution (C3)	Recovery ratio

		(C2)		
Pb	0.0105	0.0100	0.0203	97.78%
Zn	0.0068	0.0500	0.0566	99.55%
Cd	0.0029	0.0050	0.0075	92.84%
Cu	0.0005	0.0005	0.0011	113.20%
Cr	0.0002	0.0002	0.0004	100.00%
As	ND	0.0500	0.0492	98.40%
Ni	ND	0.0500	0.0521	104.20%

Two blank samples were created for each batch, and the blank value of the tested elements was not below the detection limit.

Detailed data from the three tests are presented below.

Table S7. Test concentration and relative deviation (mg/L).

Element		Spring	Summer	Autumn	Winter	Rd1	Rd2	Rd3	Rd4
	1	0.0104	0.0074	0.0145	0.0067	−1.16%	−4.74%	1.44%	−2.47%
Pb	2	0.0103	0.0079	0.0147	0.0065	−2.11%	1.70%	2.84%	−0.44%
	3	0.0109	0.0080	0.0137	0.0070	3.27%	3.04%	−4.28%	2.04%
	1	0.0066	0.0038	0.0068	0.0022	−3.28%	−4.62%	−2.63%	2.61%
Zn	2	0.0067	0.0041	0.0072	0.0021	−1.82%	2.91%	3.09%	−2.05%
	3	0.0072	0.0041	0.0070	0.0021	5.10%	1.71%	−0.46%	−0.56%
	1	0.0029	0.0019	0.0025	0.0018	1.47%	−2.66%	−4.65%	−5.16%
Cd	2	0.0028	0.0019	0.0028	0.0019	−2.03%	−2.66%	6.79%	0.11%
	3	0.0029	0.0021	0.0026	0.0020	0.56%	5.33%	−2.14%	5.06%
	1	0.0005	0.0012	0.0033	0.0001	−6.25%	0.00%	0.00%	−50.00%
Cu	2	0.0005	0.0013	0.0032	0.0003	−6.25%	8.33%	−3.03%	50.00%
	3	0.0006	0.0011	0.0034	0.0002	12.50%	−8.33%	3.03%	0.00%
	1	0.0002	0.0001	0.0001	0.0002	20.00%	50.00%	50.00%	20.00%
Cr	2	0.0002	0.0001	0.000	0.0002	20.00%	50.00%	−100.00%	20.00%
	3	0.0001	0.0000	0.0001	0.0001	−40.00%	−100.00%	50.00%	−40.00%

The relative deviation of the measured data is between −5.16% and 6.79% (for Pb, Zn, and Cd). The large relative deviations for Cu and Cr are due to their low concentrations, and the concentrations for As and Ni are below the detection limit.

The standard curve was plotted before each measurement, and the correlation linearity of the standard curve was greater than 0.999.

Calibration Summary

Analyte	Stds.	Equation	Intercept	Slope	Curvature	Corr. Coef.	Reslope
As 188.979	5	Lin, Calc Int	1.2	32.39	0.00000	0.999135	
Cr 267.716	5	Lin, Calc Int	-16.0	559.0	0.00000	0.999863	
Cd 228.802	5	Lin, Calc Int	-8.1	970.8	0.00000	0.999966	
Cu 327.393	5	Lin, Calc Int	-10600.1	30850	0.00000	0.988232	
Ni 231.604	5	Lin, Calc Int	-4438.0	13450	0.00000	0.989254	
Pb 220.353	5	Lin, Calc Int	0.9	103.5	0.00000	0.999641	
Zn 206.200	5	Lin, Calc Int	-9289.6	28610	0.00000	0.989345	

Figure S4. Correlation of standard curve

4. Other Interesting Information

Research pointed out that the main sources of heavy metals in MSW are kitchen waste, ash, plastic, and paper [1, 2]. The composition changes in domestic waste in Beijing are shown in the table below.

Table S8. MSW physical composition of the Haidian and Dongcheng districts (%) [3]

District	season	Kitchen waste	Paper	Plastic	Fabric	Wood	Ash	Metal	Glass	Mixture
Haidian	Summer	68.83	10.02	13.92	1.43	0.43	1.26	0.87	0.25	3.00
	Winter	50.08	17.40	7.10	6.82	0.80	0.00	10.97	0.88	5.95
Dongcheng	Summer	60.32	18.60	10.96	2.69	0.13	0.22	2.10	4.07	4.24
	Winter	46.75	0.31	8.01	1.08	0.99	0.00	4.19	0.59	2.41

Table S9. MSW physical composition of the Xicheng and Shijingshan districts (%) [4]

	Month	Kitchen-waste	Dirt	Tile	Paper	Plastic	Textile	Glass	Metal	Mang-osteen	Mixture
Xi-cheng	January	50.75	0.00	0.74	23.52	20.52	0.74	1.12	0.00	2.62	0.00
	February	44.89	0.00	0.00	25.16	22.92	0.00	1.97	1.55	3.52	0.00
	March	57.19	0.00	0.00	17.29	21.40	0.00	0.81	0.00	3.31	0.00
	April	51.19	1.29	0.00	23.76	21.00	0.00	1.11	0.00	1.66	0.00
	May	51.90	1.56	0.44	19.81	19.62	1.31	1.56	0.00	3.80	0.00
	June	50.64	0.56	2.03	17.94	18.86	0.00	1.48	1.48	7.02	0.00
	July	42.96	0.00	0.00	20.93	27.28	0.00	1.39	1.39	6.05	0.00
	August	53.45	0.00	2.90	19.62	20.25	0.00	2.90	0.00	0.87	0.00
	September	51.39	0.00	0.00	19.29	24.26	1.43	1.90	0.00	1.72	0.00

	October	53.33	0.00	0.60	18.86	20.74	1.00	1.00	1.14	3.33	0.00
	November	47.67	0.00	0.00	19.84	28.67	0.00	0.00	0.00	3.81	0.00
	December	50.83	0.00	0.00	25.54	18.43	0.00	1.91	0.00	3.28	0.00
	January	55.36	0.00	0.00	16.07	19.64	0.00	5.36	0.00	3.57	0.00
	February	52.94	0.00	2.94	19.12	16.18	4.41	2.94	0.00	1.47	0.00
	March	55.93	0.00	0.00	22.03	18.64	0.00	0.00	o.00	3.39	0.00
	April	44.64	0.00	0.00	28.57	23.21	0.00	0.00	0.00	3.57	0.00
	May	45.65	2.17	0.00	26.09	19.57	0.00	2.17	0.00	4.35	0.00
	June	40.00	0.00	0.00	25.71	28.57	0.00	0.00	0.00	2.86	2.86
Shijingshan	July	43.24	0.00	0.00	18.92	21.62	0.00	2.70	2.70	10.81	0.00
	August	50.82	0.00	0.00	19.67	24.59	0.00	4.92	0.00	0.00	0.00
	September	49.46	0.00	0.00	13.93	25.81	2.40	4.80	0.00	3.60	0.00
	October	54.17	0.00	0.00	16.67	22.22	0.00	0.00	0.00	6.94	0.00
	November	62.26	0.00	0.00	18.87	16.98	0.00	0.00	0.00	1.89	0.00
	December	54.88	0.00	0.00	26.22	17.68	0.00	0.00	0.00	1.22	0.00

1. Long, Y. Y.; Shen, D. S.; Wang, H. T.; Lu, W. J.; Zhao, Y., Heavy metal source analysis in municipal solid waste (MSW): Case study on Cu and Zn. *Journal of Hazardous Materials* **2011,** 186, (2-3), 1082-1087.
2. Erses, A. S.; Fazal, M. A.; Onay, T. T.; Craig, W. H. J. J. o. H. M., Determination of solid waste sorption capacity for selected heavy metals in landfills. **2005,** 121, (1/3), 223-232.
3. Zhang, H. B.; Zhang, H. Y.; Wang, G. Q.; Bai, X. J., Analysis of physical composition and heavy metals pollution of municipal solid waste (MSW) in Beijing. *IOP Conference Series: Earth and Environmental Science* **2018,** 128.
4. wei, C., Comparative analysis of physical composition and characteristics of domestic waste in urban and rural areas of Beijing. *Recycling Research* **2020, 13(1)**.