**Supplementary**

Environmental Impact of Metals Leaching Generated from Long Term Coal Ash Disposal Placement of more than 10 Years Periods

**Table 1:** . Determination of metals using ICP-MS (ppm)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No** | **Parameter** | **Source** | | | | **Waste** | | | | | | | | | | | **Environment** | | |
| **Coal** | | | | **Fly ash** | | | | **Bottom Ash** | | | | **Disposal** | | | **Soil** | | |
| **Coal-1** | **Coal-2** | **Coal-3** | **FA-1** | | **FA-2** | **FA-3** | **BA-1** | | **BA-2** | **BA-3** | **Disposal-A** | | **Disposal-B** | **A** | | **B** |
| 1 | Ca | 4079 | 8213 | 545 | 13700 | | 20900 | 7040 | 12200 | | 17800 | 7140 | 4460 | | 11500 | 55 | | 4460 |
| 2 | Fe | 53791 | 4445 | 437 | 15900 | | 19400 | 5600 | 14400 | | 20700 | 8950 | 12800 | | 9790 | 22800 | | 12800 |
| 3 | Al | 15127 | 2256 | 599 | 7250 | | 15500 | 11700 | 8400 | | 12000 | 12100 | 10000 | | 15000 | 13000 | | 10000 |
| 4 | Na | 133 | 704 | 276 | 223 | | 582 | 1410 | 208 | | 335 | 312 | 612 | | 4120 | 25 | | 612 |
| 5 | Mg | 5553 | 994 | 137 | 1950 | | 2860 | 1340 | 1370 | | 1970 | 1010 | 1430 | | 2490 | 76 | | 1430 |
| 6 | S | 4585 | 2738 | 336 | 1663 | | 1559 | 593 | 1189 | | 1914 | 615 | 1090 | | 924 | 98 | | 1090 |
| 7 | Mn | 740 | 245 | 5 | 191 | | 502 | 89 | 109 | | 348 | 82 | 20 | | 165 | 20 | | 254 |
| 8 | K | 379 | 223 | 0.1 | 821 | | 1100 | 155 | 622 | | 724 | 56 | 250 | | 489 | 186 | | 250 |
| 9 | Si | 1010 | 1134 | 22 | 392 | | 720 | 0.26 | 1314 | | 947 | 115 | 151 | | 158 | 43 | | 151 |
| 10 | Sr | 28 | 55 | 6 | 117 | | 163 | 171 | 95.9 | | 120 | 246 | 104 | | 338 | 0.7 | | 104 |
| 11 | Ti | 138 | 108.5 | 3.65 | 237 | | 506 | 88 | 211 | | 356 | 285 | 72 | | 516 | 33 | | 72 |
| 12 | Cr-VI | 0.1 | 0.1 | 0.1 | 2.9 | | 2.3 | 2.2 | 0.1 | | 0.1 | 1 | 0.3 | | 0.2 | 0.1 | | 0.25 |
| 13 | As | 3.7 | 2.6 | 0.1 | 24 | | 21 | 0.4 | 4 | | 4 | 3.8 | 0.6 | | 2 | 0.06 | | 0.6 |
| 14 | B | 26.5 | 38 | 5 | 124 | | 191 | 196 | 29 | | 57 | 97 | 81 | | 76 | 10 | | 81 |
| 15 | Ba | 11 | 40 | 2.5 | 178 | | 243 | 105 | 158 | | 160 | 88 | 104 | | 202 | 15 | | 104 |
| 16 | Be | 0.4 | 0.4 | 0.003 | 0.8 | | 1.6 | 0.6 | 0.4 | | 0.8 | 0.4 | 0.7 | | 1.1 | 0.05 | | 0.7 |
| 17 | Cd | 0.7 | 0.5 | 0.1 | 1.8 | | 2.2 | 0.5 | 1.5 | | 2.2 | 0.7 | 1.7 | | 1.3 | 2.8 | | 1.7 |
| 18 | Co | 13 | 2.5 | 0.08 | 5.5 | | 11.2 | 1.3 | 3.9 | | 6.3 | 1.8 | 6.6 | | 3.5 | 0.9 | | 6.6 |
| 19 | Li | 5 | 1.7 | 0.4 | 11 | | 14 | 7 | 8 | | 10 | 8 | 5 | | 23 | 2 | | 5 |
| 20 | Mo | 0.9 | 0.5 | 0.02 | 4.8 | | 5.6 | 0.8 | 1.7 | | 1.9 | 0.4 | 0.6 | | 1.8 | 0.6 | | 1.7 |
| 21 | Ni | 8.5 | 4 | 0.09 | 13.9 | | 20 | 0.8 | 12.7 | | 14.1 | 1 | 10.6 | | 1.9 | 3.4 | | 9 |
| 22 | Pb | 5.8 | 6 | 4 | 4.2 | | 6 | 3.1 | 0.2 | | 1.9 | 1 | 9.3 | | 8.8 | 9.3 | | 10.6 |
| 23 | Sb | 0.5 | 0.4 | 0.03 | 1.8 | | 2 | 0.2 | 1.6 | | 1.3 | 0.2 | 0.2 | | 0.3 | 0.5 | | 0.13 |
| 24 | Ag | 0.1 | 0.8 | 0.15 | 1.5 | | 0.1 | 0.35 | 0.9 | | 0.1 | 0.3 | 1.13 | | 0.5 | 0.3 | | 0.13 |
| 25 | Se | 0.1 | 0.1 | 0.04 | 0.1 | | 0.1 | 0.03 | 0.1 | | 0.1 | 0.2 | 1.22 | | 0.26 | 2.2 | | 1.2 |
| 26 | Sn | 1.5 | 0.1 | 2.3 | 1 | | 1 | 1 | 0.35 | | 0.1 | 1 | 1 | | 3 | 2 | | 1 |
| 27 | V | 123 | 14 | 2.5 | 35.7 | | 60.6 | 16.1 | 16.6 | | 31.1 | 16 | 22.9 | | 23.2 | 37.3 | | 22.9 |
| 28 | Zn | 24 | 4 | 0.45 | 24 | | 33 | 7 | 19 | | 21 | 3 | 96 | | 14 | 15 | | 96 |
| 29 | Hg | 0.034 | 0.015 | 0.009 | 0.037 | | 0.039 | 0.038 | 0.05 | | 0.05 | 0.009 | 0.055 | | 0.078 | 0.24 | | 0.06 |
| 30 | Cu | 14 | 5 | 1 | 12 | | 17 | 1.43 | 14 | | 13 | 0.4 | 21 | | 5 | 0.15 | | 21 |

**Table 2: *Toxicity Characteristic Leaching Procedure* (TCLP) (ppm)**

| No | **Parameter** | **Source** | | | **Waste** | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Coal** | | | **Fly ash** | | | **Bottom Ash** | | | **Disposal** | |
| **Coal-1** | **Coal-2** | **Coal-3** | **FA-1** | **FA-2** | **FA-3** | **BA-1** | **BA-2** | **BA-3** | **Disposal-A** | **Disposal-B** |
| 1 | Ca | 23.18 | 52.31 | 45.42 | 111.38 | 169.92 | 93.87 | 118.45 | 144.72 | 109.85 | 61.1 | 107.48 |
| 2 | Fe | 322.1 | 66.34 | 39.73 | 140.71 | 124.36 | 103.7 | 135.85 | 132.69 | 198.89 | 228.57 | 125.51 |
| 3 | Al | 100.85 | 50.14 | 31.54 | 71.08 | 92.81 | 112.5 | 71.79 | 71.86 | 124.74 | 93.46 | 142.86 |
| 4 | Na | 44.32 | 58.69 | 25.12 | 31.86 | 97 | 41.47 | 41.6 | 55.83 | 8.67 | 68 | 42.04 |
| 5 | Mg | 99.16 | 66.24 | 19.57 | 67.24 | 77.3 | 58.26 | 80.59 | 72.96 | 37.41 | 68.1 | 25.67 |
| 6 | S | 80.44 | 50.7 | 22.43 | 79.19 | 43.31 | 45.62 | 74.31 | 79.75 | 32.37 | 43.6 | 28.88 |
| 7 | Mn | 35.24 | 9.07 | 1.67 | 7.96 | 20.92 | 9.89 | 4.74 | 15.13 | 9.11 | 0.23 | 13.75 |
| 8 | K | 31.58 | 13.94 | 2.75 | 45.61 | 61.11 | 9.12 | 41.47 | 27.85 | 11.2 | 2.23 | 23.29 |
| 9 | Si | 45.91 | 36.58 | 4.4 | 13.52 | 24.83 | 0.07 | 46.93 | 35.07 | 28.75 | 1.3 | 19.75 |
| 10 | Sr | 3.5 | 11 | 0.86 | 23.4 | 23.29 | 34.2 | 12 | 20 | 17.57 | 6.5 | 14.08 |
| 11 | Ti | 15.33 | 27.13 | 0.41 | 39.5 | 56.22 | 12.57 | 26.38 | 44.5 | 25.91 | 4.5 | 57.33 |
| 12 | B | 5.3 | 5.43 | 0.63 | 41.33 | 38.2 | 10.32 | 4.83 | 9.5 | 13.86 | 3.38 | 15.2 |
| 13 | Ba | 1.83 | 6.67 | 0.42 | 25.43 | 48.6 | 17.5 | 22.57 | 22.86 | 9.78 | 3.71 | 18.36 |
| 14 | Cr-VI | 0.05 | 0.03 | 0.03 | 0.97 | 0.77 | 0.31 | 0.02 | 0.02 | 0.33 | 0.03 | 0.04 |
| 15 | As | 0.33 | 0.42 | 0.02 | 1.67 | 1.25 | 0.1 | 0.23 | 0.33 | 0.46 | 0.03 | 0.15 |
| 16 | Be | 0.04 | 0.05 | 0.001 | 0.1 | 0.23 | 0.2 | 0.08 | 0.1 | 0.1 | 0.02 | 0.22 |
| 17 | Cd | 0.23 | 0.17 | 0.02 | 0.2 | 0.37 | 0.1 | 0.18 | 0.21 | 0.14 | 0.11 | 0.19 |
| 18 | Co | 4.5 | 0.63 | 0.03 | 1.1 | 1.4 | 0.65 | 1.3 | 1.26 | 0.23 | 0.33 | 0.39 |
| 19 | Li | 1.4 | 0.34 | 0.1 | 3.67 | 2 | 2.33 | 1.6 | 2.5 | 1.33 | 0.42 | 5.75 |
| 20 | Mo | 0.3 | 0.17 | 0.01 | 1.2 | 0.93 | 0.2 | 0.24 | 0.63 | 0.08 | 0.03 | 0.36 |
| 21 | Ni | 3.83 | 0.44 | 0.02 | 2.78 | 3.5 | 0.16 | 1.59 | 2.82 | 0.25 | 0.38 | 0.48 |
| 22 | Pb | 0.89 | 0.61 | 0.02 | 0.43 | 0.61 | 0.57 | 0.14 | 1.36 | 0.11 | 7.47 | 0.98 |
| 23 | Sb | 0.08 | 0.06 | 0.01 | 0.3 | 0.67 | 0.03 | 0.32 | 0.19 | 0.07 | 0.01 | 0.03 |
| 24 | Ag | 0.01 | 0.1 | 0.04 | 0.16 | 0.005 | 0.07 | 0.01 | 0.01 | 0.04 | 0.06 | 0.1 |
| 25 | Se | 0.01 | 0.01 | 0.01 | 0.03 | 0.02 | 0.01 | 0.03 | 0.03 | 0.03 | 0.08 | 0.07 |
| 26 | Sn | 0.63 | 0.05 | 0.58 | 0.41 | 0.47 | 0.33 | 0.17 | 0.05 | 0.17 | 0.52 | 0.38 |
| 27 | V | 61.5 | 2.8 | 0.42 | 4.46 | 12.12 | 3.22 | 1.84 | 6.22 | 4 | 0.95 | 4.64 |
| 28 | Zn | 8 | 0.57 | 0.09 | 8 | 11 | 1.17 | 3.8 | 5.25 | 0.43 | 3.43 | 4.67 |
| 29 | Hg | 0.0025 | 0.001 | 0.0001 | 0.003 | 0.002 | 0.006 | 0.003 | 0.002 | 0.0001 | 0.002 | 0.005 |
| 30 | Cu | 2.8 | 1.13 | 0.28 | 2.4 | 5.67 | 0.36 | 4.67 | 3.25 | 0.04 | 1.05 | 1.67 |

**Table 3 :** Lechate in disposal (ppm)

|  |  |  |  |
| --- | --- | --- | --- |
| **No** | **Parameter** | **Leachate ( mg/l)** | |
| **Leachate A** | **Leachate B** |
| 1 | Ca | 49.9 | 21.1 |
| 2 | Fe | 0.59 | 0.2 |
| 3 | Al | 1.03 | 0.05 |
| 4 | Na | 109 | 46.5 |
| 5 | Mg | 8.33 | 1.88 |
| 6 | S | 8.1 | 10.4 |
| 7 | Mn | 0.021 | 0.032 |
| 8 | K | 8.4 | 53.4 |
| 9 | Si | 38.4 | 7.5 |
| 10 | Sr | 0.308 | 0.227 |
| 11 | Ti | 0.049 | 0.005 |
| 14 | B | 0.75 | 0.03 |
| 15 | Ba | 0.08 | 0.05 |
| 12 | Cr-VI | 0.005 | 0.005 |
| 13 | As | 0.076 | 0.007 |
| 16 | Be | 0.001 | 0.001 |
| 17 | Cd | 0.01 | 0.01 |
| 18 | Co | 0.001 | 0.001 |
| 19 | Li | 0.04 | 0.02 |
| 20 | Mo | 0.04 | 0.009 |
| 21 | Ni | 0.02 | 0.01 |
| 22 | Pb | 0.09 | 0.01 |
| 23 | Sb | 0 | 0.001 |
| 24 | Ag | 0.01 | 0.01 |
| 25 | Se | 0.018 | 0.005 |
| 26 | Sn | 0.005 | 0.005 |
| 27 | V | 0.046 | 0.005 |
| 28 | Zn | 0.076 | 0.005 |
| 29 | Hg | 0.00009 | 0.00005 |
| 30 | Cu | 0.01 | 0.005 |

**Table 4 :** LR Value Disposal A Vs Disposal B (%)

|  |  |  |  |
| --- | --- | --- | --- |
| **No** | **Parameter** | **LR Disposal-A** | **LR\_Disposal B** |
| 1 | Ca | 1.12 | 0.18 |
| 2 | Fe | 0.00 | 0.00 |
| 3 | Al | 0.01 | 0.00 |
| 4 | Na | 17.81 | 1.13 |
| 5 | Mg | 0.58 | 0.08 |
| 6 | S | 0.74 | 1.13 |
| 7 | Mn | 0.11 | 0.02 |
| 8 | K | 3.36 | 10.92 |
| 9 | Si | 25.43 | 4.75 |
| 10 | Sr | 0.30 | 0.07 |
| 11 | Ti | 0.07 | 0.00 |
| 12 | Cr-VI | 1.67 | 2.50 |
| 13 | As | 12.67 | 0.35 |
| 14 | B | 0.93 | 0.04 |
| 15 | Ba | 0.08 | 0.02 |
| 16 | Be | 0.14 | 0.09 |
| 17 | Cd | 0.59 | 0.77 |
| 18 | Co | 0.02 | 0.03 |
| 19 | Li | 0.80 | 0.09 |
| 20 | Mo | 6.67 | 0.50 |
| 21 | Ni | 0.19 | 0.53 |
| 22 | Pb | 0.97 | 0.11 |
| 23 | Sb | 0.00 | 0.33 |
| 24 | Ag | 0.88 | 2.00 |
| 25 | Se | 1.48 | 1.92 |
| 26 | Sn | 0.50 | 0.17 |
| 27 | V | 0.20 | 0.02 |
| 28 | Zn | 0.08 | 0.04 |
| 29 | Hg | 0.16 | 0.06 |
| 30 | Cu | 0.05 | 0.10 |