

## Supplementary Material

**Table S1: Different Heavy Metals, its Permissible Limit, Sources, uses, Effect on Human / Animal / Plant / Soil**

Metal Ions	Source/ Industries	Permissible Level	Effect on Human / Animal / Plant / Soil	Uses	References
Lead	Refinery, Solvents, Paints, Pesticide, Smoking, Automobile Emission, Mining, Burning of Coal	10 µg/L (WHO)	Damage of blood, blood vessels, kidney and brain, Disorder of liver, lungs, spleen, central nervous system, Anaemia, pneumonia and mental health issues, Inflammation of gums, Inhibit photosynthesis, mitosis, water absorption	Batteries, Pigments, Lead glass, Fuels, Photographic materials, Matches, Explosives, Soil fertilization	1, 8, 43
Chromium Cr(III) / Cr(VI)	Weathered rocks, volcanic exhalations, Bio-geochemical processes, Electroplating wastewater, Leather tanning, Textile, Metal processing, Paint and pigments, dyeing, Steel fabrication	50 µg/L (WHO)	Activates teratogenic processes, Disturbs DNA synthesis, mutagens changes – malignant tumours, Carcinogenic, kidney, liver, and gastric damage, Changes soil microbial populations and metabolism, alterations in the germination process, affects growth of roots, stems and leaves	Important in growth and development of human and animals, Alloy formation and plating on metal and plastic materials, Automotive and equipment coating, Nuclear and high temperature research, Inorganic pigments, Decorative or protective coating.	1,43, 70
Mercury	Hydroelectric power plants, Mining, Pesticides, Batteries, Pulp and paper industries, Emission from coal, power plants, Incineration of municipal and medical waste	1µg/L (WHO)	Salivation, throat burning, vomiting, diarrhoea, Intestinal mucosa necrosis, Damage to kidney, lung tissue and nervous system, Pneumonia, Tremor, Mental disorders, Inflammation of the gums, Reduction in seed viability	Used in thermometers, barometers, manometers, Liquid electrolyte, Electrical switches, Dental amalgams and teeth fillings	1, 43, 69
Cadmium	Food and water, Phosphate fertilizers, Welding, Electroplating, Pesticide, Cd-Ni batteries, Nuclear fission plant	3 µg/L (WHO)	Altering the metabolism, Damage to the respiratory track, kidneys, bone marrow, Bronchitis, Gastrointestinal disorder, Cancer, Toxic to soil enzymes, Oxidative damage of proteins	Ni-Cd batteries, Pigments, Stabilizers, Coatings, Alloys, Electronic compounds	1, 8, 43, 71
Arsenic	Natural geological sources, Agricultural pesticides, herbicides, Paints, Fungicides, Insecticides, Wood preservatives, Cotton desiccants, semiconductors, Light emitting diodes, Components of lasers and microwave circuits, Metal smelters	10 µg/L (WHO)	Respiratory system and skin cancer, Necrosis and gangrene of limbs, Xerosis soles and palms, Skin inflammation with ulceration, Nausea, vomiting, abdominal pain, diarrhoea, Bronchitis, Dermatitis, Neoplastic lesions in organs, Disturb the krebs cycle, Disrupt plant metabolism	Paints, Fungicides, Insecticides, Pesticides, Herbicides, Wood preservatives, Cotton desiccants, Animal feed, Cosmetics, Pesticides, Pigments, Medicine for psoriasis, syphilis, asthma, rheumatism, haemorrhoids, cough and pruritus, Health tonic, Analgesic, Anti-inflammatory agent,	1, 43, 71, 72
Zinc	Coal and petroleum product burning, Incineration of municipal solid waste, Production of plant protecting chemicals, phosphate fertilizers, Plumbing	800 µg/L	Affect biochemical processes, Deposition in kidneys, liver, gonads, Skin corrosion, nervous system damage, Plant Poisoning	Functioning of living organisms, Metabolism of proteins and carbohydrates, Growth and metabolism of plants	1, 8, 43
Nickel	Natural element of Earth crust, Combustion of coal and liquid fuels	200 µg/L	Damage to mucous membrane, Respiratory system cancer Plant poisoning	Nickel–titanium, stainless steel and other alloys, Medical instruments. Normal growth and metabolism of plants	1, 8, 43

Manganese	Welding, Ferromanganese Production	260 µg/L	Damage to central nervous system, Poisoning effect on plants when concentration is above optimal value.	Alloy formation, Strength of steel, improve workability and resistance to wear, Normal growth and metabolism of plants	8
Copper	Leaching from water pipes/tubes, Algae treatment, Industry waste, Mine waste, Wood preservatives, Natural deposits, Plating, Polishing, Paint, Printing operations	1300 µg/L	Liver damage, Insomnia, Anaemia, Digestion issues, Damage to liver and kidney, Gastrointestinal irritations, Neurotoxicity, Acute toxicity, Dizziness, Diarrhoea, Plant poisoning.	Help enzymes transfer energy in cells, Construction, Power transmission, Electronic item / industrial machines and vehicle production, Coins, Electrical wiring, Normal growth and metabolism of plants	8, 43
Uranium	Drilled wells, Erosion of tailings from mines and mills, Emission from nuclear industry, Combustion of coal and other fuels	30 µg/L	Kidney damage, Risk of cancer, Affect normal functioning of kidney, brain, liver, heart, Reproductive defects, Nutritive deficiencies in the plant substrate.	Electricity generation in nuclear power stations, Power nuclear submarines and in nuclear weapons.	73, 74
Iron	Leaching of cast iron pipes, Industrial wastes leaching from soil and rocks	300 µg/L	Damage blood vessels, liver / kidneys, Siderosis, Altered respiratory rates pneumoconiosis, Plant poisoning	Essential element in human nutrition, haemoglobin, Transport oxygen and carbon dioxide in the blood, Growth and metabolism of plants	8
Aluminium	Bauxite refineries, Kitchen waste, Electrolytic reduction, Metallurgy and hydrometallurgy processes	200 µg/L	Neurological disorders, Alzheimer's disease, Lower yields of plants Toxic to aquatic life	Foils, Cans, Kitchen utensils, Window frames, Beer kegs, Aeroplane parts, Electrical transmission lines	75
Antimony	Mining, Smelting Refining, Coal power plants, Refuse incineration	6 µg/L	Stomach ulcers, Eye irritation, Carcinogenic to humans, Decreases infant growth	Alloys for lead storage batteries, Solder, Sheet and pipe metal, Bearings, Castings, ammunition Medicine to treat people infected with parasites, Flame retardant in fabrics and brake linings, Polyethylene terephthalate water bottles	76
Bismuth	By-product from lead and copper smelting	20 µg/L	Acidosis, Embolism in capillaries, tissue lesions, Neurological disorders, Liver and kidney damage, Death, Toxic to all living organisms, especially animals	Metallurgy, Additive to creams and hair dyes, Antiulcer, Antibacterial, Anti-HIV, Radio-therapeutic agent, Alloys for thermal electricity generation, Coolants for compact discs, Semiconductors High- temperature superconductors.	77
Lithium	Salt lakes, Geothermal brines, Oil & gas brines, Lithium battery plant waste	700 µg/L	Kidney problems, Diabetes, Excess thirst, Excess urination, Reduces plant yield	Essential dietary element, Increase human lifespan, Treat manic, depression, headache, epilepsy, diabetes, liver disease, kidney disorders, arthritis, seborrhoea, overactive thyroid, asthma, dyskinesia, vomiting, Meniere's disease and hyperactivity, Manufacture of aircraft, Lithium batteries, Electronic devices, Medical appliances, Smart phones, cameras, watches etc.	74

Tin	Industrial wastewater from - the galvanic treatment, Printed circuit boards production	30 µg/L	Vomiting, diarrhoea, Fatigue, Headache, Muscular weakness in animals, Changes enzyme activities, Extensive damage to liver and kidney, Highly toxic to animals-affects central nervous system	Food containers, food-processing equipment-plating/coatings, Alloys such as solders, bronzes and pewters, Pigment	28, 78
Platinum	Electroplating, Milling, Etching industries, Automobile exhaust catalysts; Hospitals, Ammonium oxidation process, Dust, Surface water, Sediments, Plants	NA	DNA damage, Shrinkage of the glomeruli in the kidney, Inhibit cellular functions	To treat malignant neoplasm, cancer, Glass industry, Chemical industry, Electrical industry, Electronics industry, Oil industry, Production of jewellery, In dentistry for dental fillings	28, 79
Silver	Electroplating, Electrolysis Depositions, Coating, Anodizing-Cleaning, Milling, Etching Industries	NA	Skin discoloration, Greying white part of eye	Jewellery, Table ware, Mirrors, Dental alloy, Solder, Battery	28

NA: Not available.