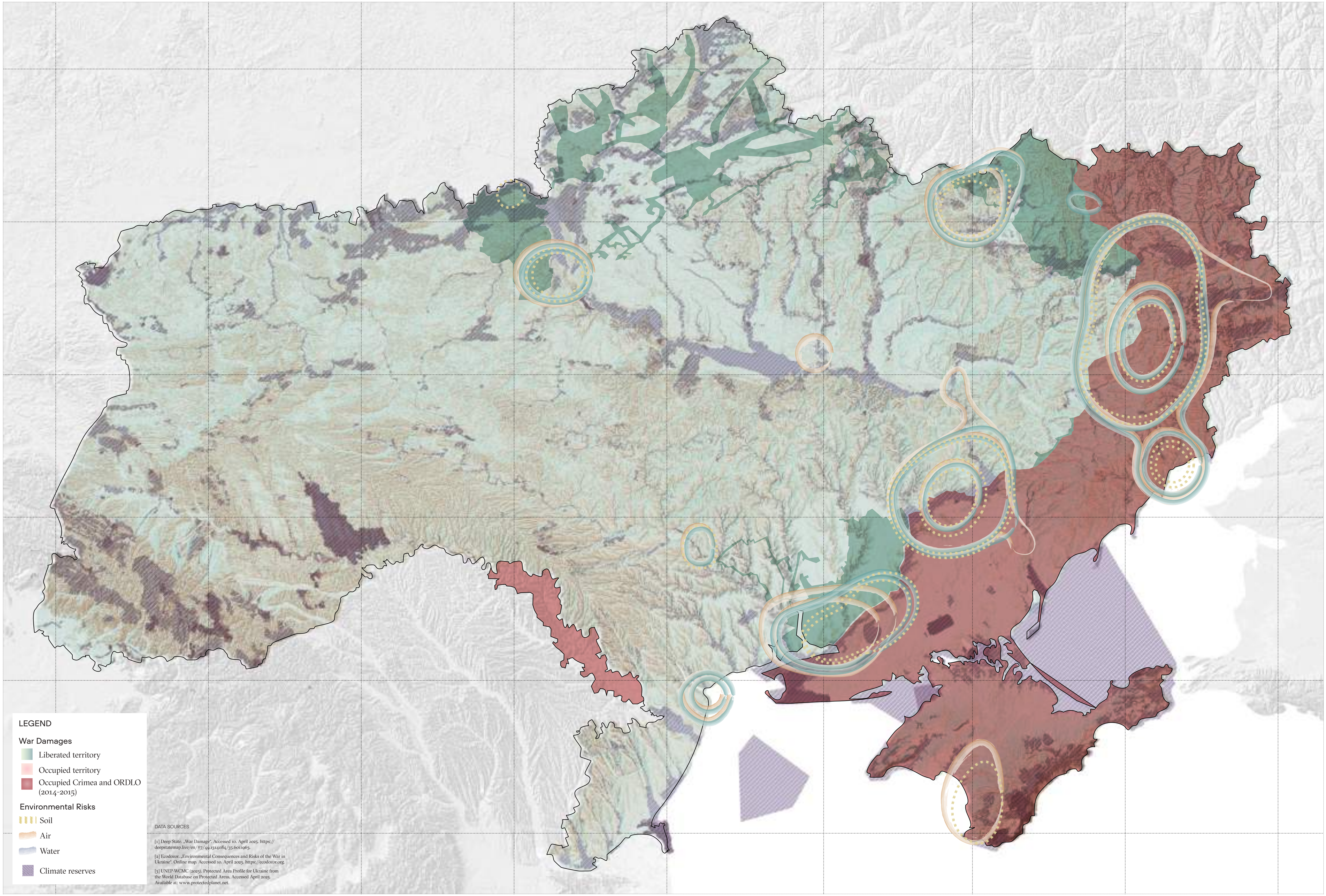
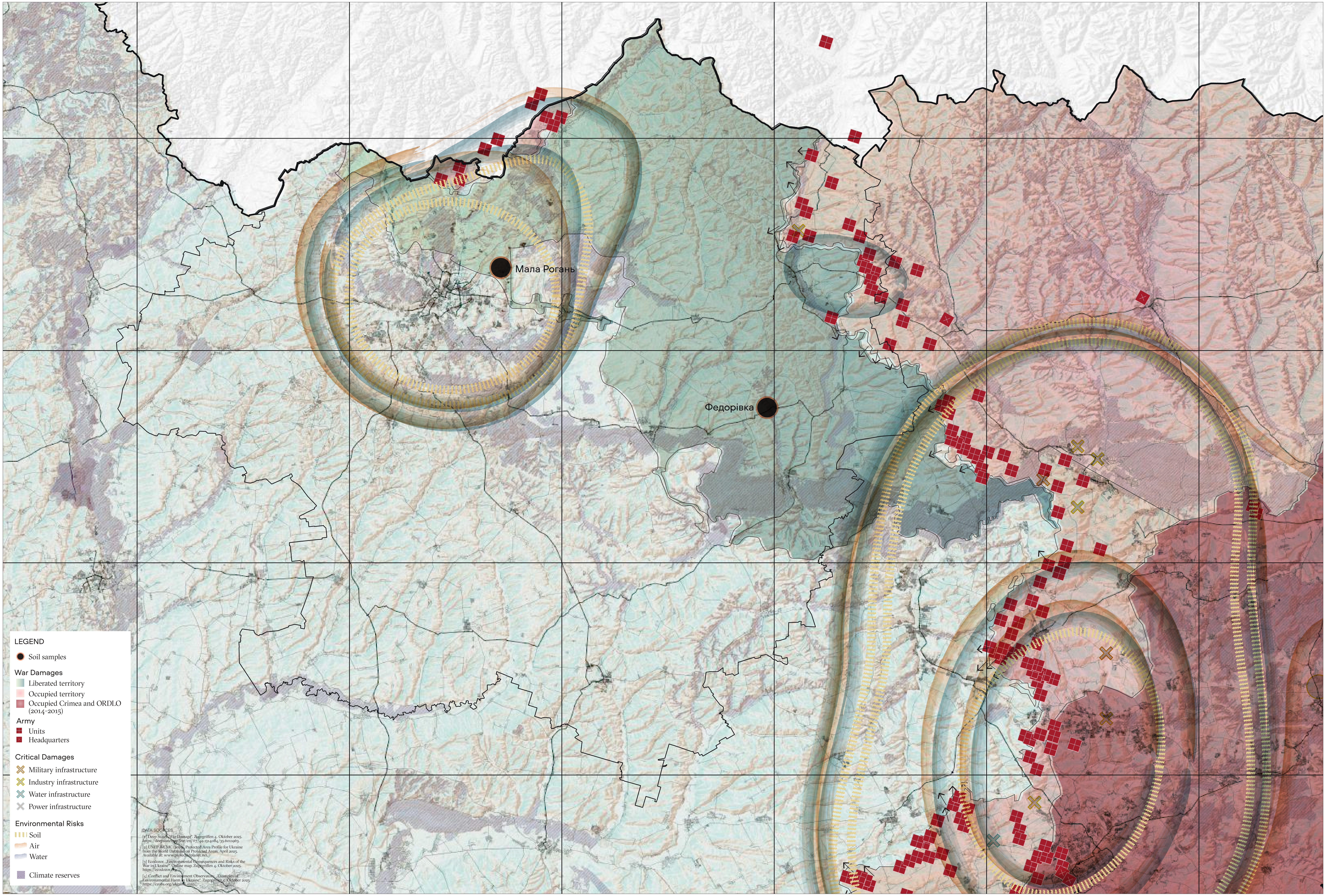



Materia Lab – *Anna Pomazanna & Mykhailo Shevchenko*

BAUHAUS EARTH EXPERIMENTAL

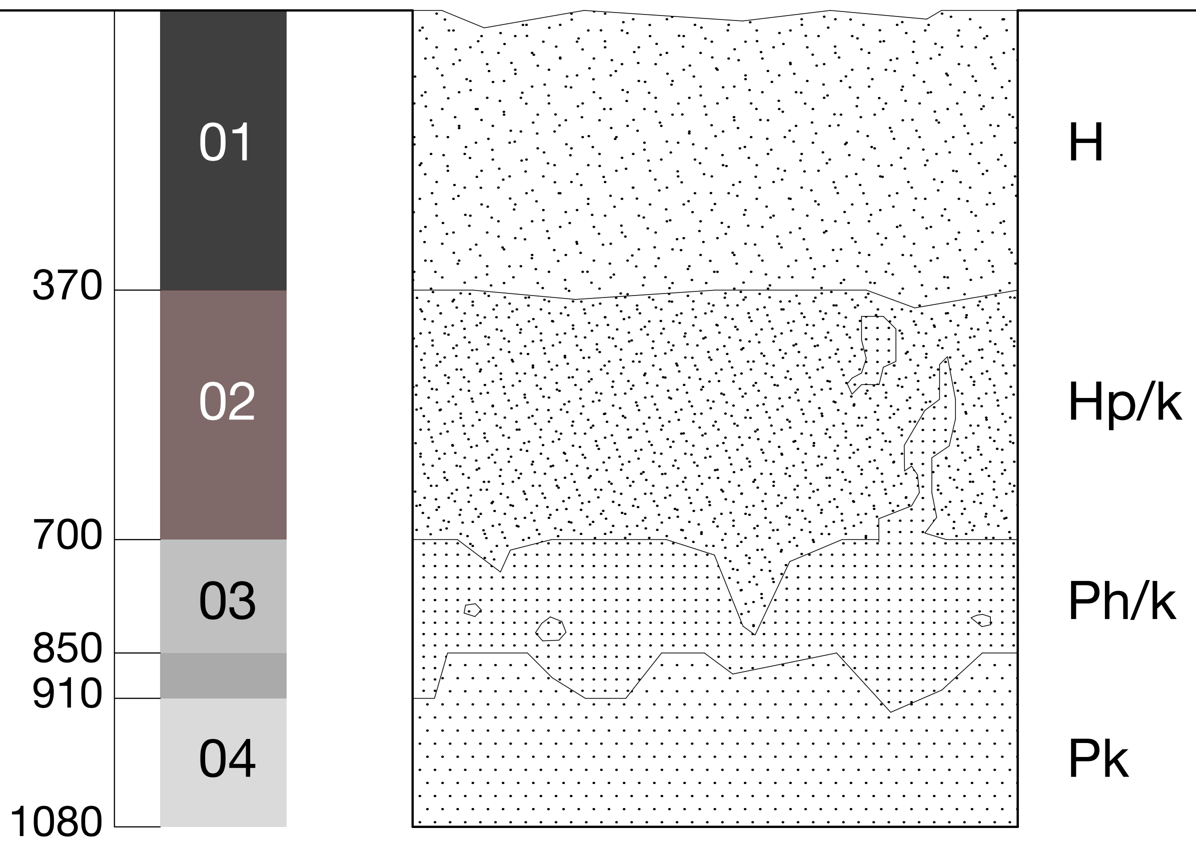

Мала Рогань
Федорівка
LEGEND
Soil samples
War Damages
Liberated territory
Occupied territory
Occupied Crimea and ORDLO (2014-2015)
Army
Units
Headquarters
Critical Damages
Military infrastructure
Industry infrastructure
Water infrastructure
Power infrastructure
Environmental Risks
Soil
Air
Water
Climate reserves
DATA SOURCES
[1] Deep State: „War Damage“. Zugegriffen 4. Oktober 2025. https://deepstatemap.live/en/#7/49.1314084/35.6011963.
[2] UNEP-WCMC (2025). Protected Area Profile for Ukraine from the World Database on Protected Areas, April 2025. Available at: www.protectedplanet.net.
[3] Ecodozor. „Environmental Consequences and Risks of the War in Ukraine“. Online map. Zugegriffen 4. Oktober 2025. https://ecodozor.org.
[4] Conflict and Environment Observatory. „Examples of Environamental Harm in Ukraine“. Zugegriffen 4. Oktober 2025. https://ceobs.org/ukraine-map/.

Fedorivka, village in Kharkiv Oblast
49°17’25.7”N 37°18’43.2”E
agricultural land
launch site of the multiple rocket launcher “Grad”

| Code | Mercury (Hg) Lab 1 | Mercury (Hg) Lab 2 | Mercury (Hg) Lab 3 | Cadmium (Cd) Lab 1 | Cadmium (Cd) Lab 2 | Cadmium (Cd) Lab 3 | Lead (Pb) Lab 1 | Lead (Pb) Lab 2 | Lead (Pb) Lab 3 | Arsenic (As) Lab 1 | Arsenic (As) Lab 2 | Arsenic (As) Lab 3 | Copper (Cu) Lab 1 | Copper (Cu) Lab 2 | Copper (Cu) Lab 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FED-01 | 0,05 | | | 4,2 | | | 5,1 | | | (<0,2) | | | 21 | | |
| FED-02 | 0,049 | | | 3,9 | | | 4,8 | | | (<0,2) | | | 18,5 | | |
| FED-03 | 0,051 | | | 4,2 | | | 3,4 | | | (<0,2) | | | 15,4 | | |
| FED-04 | 0,048 | (<0,1) | (<0,05) | 4,1 | 0,73 | 0,2 | 3,3 | 17,5 | 12 | (<0,2) | 6,2 | **10** | 13,4 | 25,4 | 21 |
| **FED-05 2023** | | | | | (<0,1) | | | 8,75 | | | | | | 5,19 | |
| **Background** | | (<0,1) | | | 0.6 | | | 12.5 | | | **6,5** | | | 6.1 | |
| **MPC Ukraine** | | 2,1 | | | 3 | | | 32 | | | **2** | | | | |

| Code | Cobalt (Co) Lab 1 | Cobalt (Co) Lab 2 | Selenium(Se) Lab 1 | Selenium(Se) Lab 2 | Zink (Zn) Lab 1 | Zink (Zn) Lab 2 | Zink (Zn) Lab 3 | Nickel (Ni) Lab 1 | Nickel (Ni) Lab 2 | Nickel (Ni) Lab 3 | Chromium (Cr) Lab 1 | Chromium (Cr) Lab 2 | Chromium (Cr) Lab 3 | Strontium(Sr) Lab 1 | Strontium(Sr) Lab 2 | Vanadium(V) Lab 1 | Vanadium(V) Lab 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FED-01 | (<0,2) | | (<0,5) | | 60 | | | (<0,5) | | | 62 | | | 62 | | 64 | |
| FED-02 | (<0,2) | | (<0,5) | | 56 | | | (<0,5) | | | 59 | | | 65 | | 64 | |
| FED-03 | (<0,2) | | (<0,5) | | 54 | | | (<0,5) | | | 57 | | | 90 | | 61 | |
| FED-04 | (<0,2) | 10,8 | (<0,5) | (<0,1) | 50 | 51,8 | 52 | (<0,5) | 38,3 | 38 | 56 | 46,1 | 47 | 126 | **95,8** | 59 | (<0,1) |
| **FED-05 2023** | | | | | | 44,15 | | | 22,55 | | | 31,45 | | 65,13 | | | |
| **Background** | | | | | | 59,7 | | | 30.1 | | | 41.2 | | **59.3** | | | |
| **MPC Ukraine** | | | 0,6 | | | | | | | | | | | | | 150 | |

| **Code** | Naphthalin | *Acenaphthylen* | *Acenaphthen* | *Fluoren* | *Phenanthren* | *Anthracen* | *Fluoranthen* | *Pyren* | *Benzo(a) anthracen* | *Chrysen* | *Benzo(b) fluoranthen* | *Benzo(k) fluoranthen* | *Benzo(a)pyren* | *Dibenzo(a,h) anthracen* | *Benzo(g,h,i) perylen* | *Indeno(1,2,3,c, d)pyren* | ***SUM PAH*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FED-01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | 0,015 | 0,013 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | 0,028 |
| FED-02 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | - |
| FED-03 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | - |
| FED-04 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | - |
| **MPC Ukraine** | | | | | | | | | | | | | **0,02** | | | | |
| **MPC Germany** | | | | | | | | | | | | | 0,3 | | | | 3 |



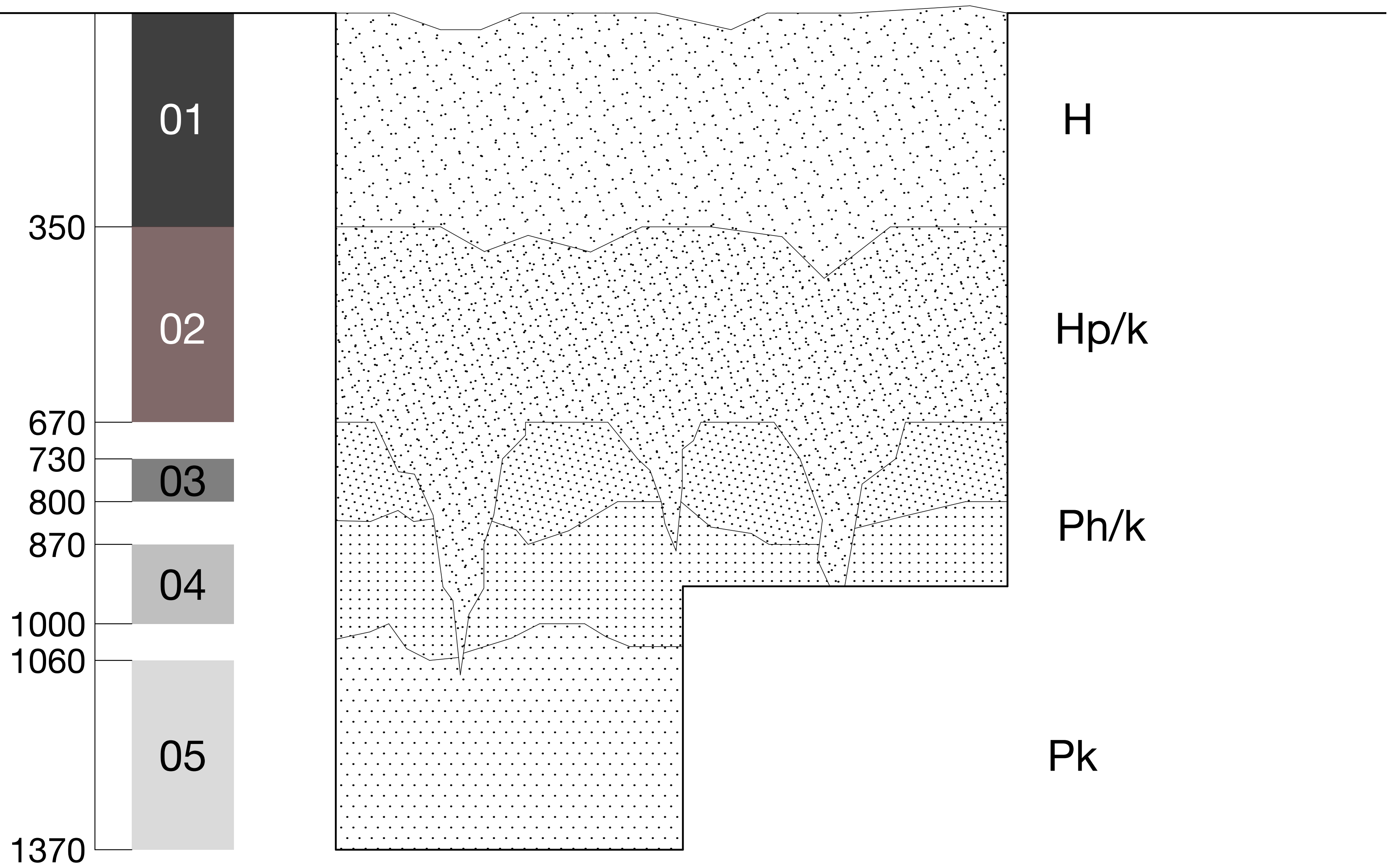

FED 01 - H (Humic horizon)
Black, granular, non-dense (moist, light clayey)
Depth: 0 cm – 37 cm (sample taken at ~15 cm)
FED 02 - Hp/k (Upper transitional, well-humified, carbonate-rich)
Carbonates start at a very high concentration, dark gray, moist, very dense, cloddy-prismatic structure
Depth: 37 cm – 70 cm (sample taken at ~55 cm)
FED 03 - Phk (Lower transitional horizon)
Dark brown, carbonate-rich, prismatic, dense, with numerous mole burrows
Depth: 70 cm – 91 cm (sample taken approximately at 77–85 cm)
FED 04 - Pk (Loess horizon)
Extremely dense loess
Depth: 85 cm – 100 cm

Mala Rohan, village in Kharkiv Oblast
49°56’42.7”N 36°30’07.2”E
abandoned farmland
site of the military helicopter crush

| Code | Mercury (Hg) | | | Cadmium (Cd) | | | Lead (Pb) | | | Arsenic (As) | | | Copper (Cu) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lab 1 | Lab 2 | Lab 3 | Lab 1 | Lab 2 | Lab 3 | Lab 1 | Lab 2 | Lab 3 | Lab 1 | Lab 2 | Lab 3 | Lab 1 | Lab 2 | Lab 3 |
| MRO-01 | 0,052 | | | 4,8 | | | 4,4 | | | (<0,2) | | | 17,3 | | |
| MRO-02 | 0,044 | (<0,1) | | 3,6 | 0,62 | | 3,7 | 15,2 | | (<0,2) | 7,1 | | 14,2 | 22,3 | |
| MRO-03 | 0,047 | | | 3,7 | | | 3,6 | | | (<0,2) | | | 13,8 | | |
| MRO-04 | 0,044 | | | 3,5 | | | 3,5 | | | (<0,2) | | | 10,2 | | |
| MRO-05 | 0,046 | (<0,1) | (<0,05) | 3,6 | 0,59 | **4** | 3,1 | 11,1 | 10 | (<0,2) | 5,8 | **8** | 10,4 | 17,2 | 25 |
| **MRO-04 2023** | | | | 41,23 | | | 9,34 | | | | | | 64,98 | | |
| **Background** | | | | **0,87** | | | 8,15 | | | | | | 8,15 | | |
| **MPC Ukraine** | 2,1 | | | 3 | | | 32 | | | **2** | | | | | |

| Code | Cobalt (Co) | | Selenium(Se) | | Zink (Zn) | | | Nickel (Ni) | | | Chromium (Cr) | | | Strontium(Sr) | | Vanadium(V) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lab 1 | Lab 2 | Lab 1 | Lab 2 | Lab 1 | Lab 2 | Lab 3 | Lab 1 | Lab 2 | Lab 3 | Lab 1 | Lab 2 | Lab 3 | Lab 1 | Lab 2 | Lab 1 | Lab 2 |
| MRO-01 | (<0,2) | | (<0,5) | | 52 | | | (<0,5) | | | 52 | | | 62 | | 54 | |
| MRO-02 | (<0,2) | 12,7 | (<0,5) | (<0,1) | 49 | 64,2 | | (<0,5) | 29,8 | | 57 | 44,8 | | 61 | **57,8** | 62 | (<0,1) |
| MRO-03 | (<0,2) | | (<0,5) | | 47 | | | (<0,5) | | | 52 | | | 77 | | 57 | |
| MRO-04 | (<0,2) | | (<0,5) | | 43 | | | (<0,5) | | | 48 | | | 91 | | 53 | |
| MRO-05 | (<0,2) | 9,5 | (<0,5) | (<0,1) | 45 | 48,3 | 46 | (<0,5) | 33,1 | 31 | 49 | 39,7 | 37 | 117 | **78,2** | 55 | (<0,1) |
| **MRO-04 2023** | | | | | 95,36 | | | 16,23 | | | 36,12 | | | 45,23 | | | |
| **Background** | | | | | 59,18 | | | 19,55 | | | 34,52 | | | **33,2** | | | |
| **MPC Ukraine** | | | 0,6 | | | | | | | | | | | | | 150 | |

| **Code** | *Naphthalin* | *Acenaphthylen* | *Acenaphthen* | *Fluoren* | *Phenanthren* | *Anthracen* | *Fluoranthen* | *Pyren* | *Benzo(a) anthracen* | *Chrysen* | *Benzo(b) fluoranthen* | *Benzo(k) fluoranthen* | *Benzo(a)pyren* | *Dibenzo(a,h) anthracen* | *Benzo(g,h,i) perylen* | *Indeno(1,2,3,c, d)pyren* | ***SUM PAH*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MRO-01 | <0,04 | <0,04 | <0,04 | <0,04 | 0,072 | <0,04 | 0,31 | 0,24 | 0,14 | 0,15 | 0,1 | 0,19 | **0,11** | 0,092 | 0,08 | <0,04 | 1,5 |
| MRO-02 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | - |
| MRO-03 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | - |
| MRO-04 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | - |
| MRO-05 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | <0,01 | - |
| **MPC Ukraine** | | | | | | | | | | | | | **0,02** | | | | |
| **MPC Germany** | | | | | | | | | | | | | 0,3 | | | | 3 |




MRO 01 - H (Humic horizon). Black, loose, granular, with a distinct transition (visible as a sharp boundary from above), includes tree roots and worm burrows
Depth: 0 cm – 35 cm (sample taken at ~15–20 cm)
MRO 02 - Hp/k (Dark gray, slightly lighter than previous, well-humified, carbonate-dusted, cloddy-granular structure, with wavy transition) Inclusions: Small roots, brick fragments
Depth: 35 cm – 67 cm (sample taken at ~45 cm)
MRO 03 and MPO 04 - Samples taken from Phk horizon. At the beginning of the horizon, carbonate tongues intrude from loess, making it rather sticky, whereas at the lower boundary, it is compact
MPO 03: 73 cm – 80 cm
MPO 04: 87 cm – 100 cm
Phk Horizon (Lower transitional). Brown, carbonate-rich, dense, with infiltrating humic tongues, prismatic structure
Depth: 67 cm – 106 cm
MPO 05 - Pk (Parent material)
Loess, prismatic, very dense

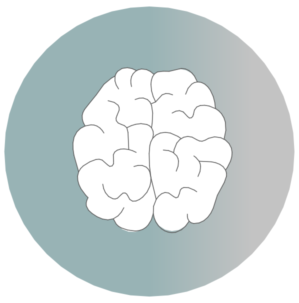
| | Mercury (Hg) | Cadmiun (Cd) | Lead (Pb) | Arsenice (As) | Copper (Cu) | Cobalt (Co) | Selenium (Se) | Zink (Zn) | Nickel (Ni) | Chromium (Cr) | Strontium (Sr) | Vanadium (V) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maximum Permissible Concentration (MPC) in soil, Ukraine | 2,1 | 3 | 32 | 2 | | | 0,6 | | | | | 150 |
| TR Boden der LAGA M20, Germany *Technical guidelines for the recycling of mineral waste* | 0,5 | 1 | 70 | 15 | 40 | | | 150 | 50 | 60 | | |
| Ersatzbaustoffverordnung, Germany *Substitute Building Materials Ordinance* | 0,6 | 2 | 140 | 40 | 80 | | | 300 | 100 | | | |
| MVV TB, Germany *Model Administrative Provisions – Technical Building Rules* | 5 | 10 | 700 | 150 | 400 | | | 1500 | 500 | 600 | | 1500 |
| Natureplus, Germany (clay mortar) | 0,5 | 1 | 15 | 5 | 35 | 20 | | 150 | 20 | 20 | | |
| (perforated bricks) | 0,5 | 1 | 20 | 20 | | | | | 100 | 100 | | |
| WHO target values in soil, 1996 | | 0,8 | 85 | | 36 | | | 50 | 35 | 100 | | |
| Soil remediation values, Belgium (Flanders) | 15 | 6 | 700 | 110 | 400 | | | 1000 | 470 | | | |
| Limit values in soil, Czech Republic | 10 | 20 | 300 | 70 | 600 | 300 | | 2500 | 250 | 500 | | 450 |
| Target value in soil, Estonia | 0,5 | 1 | 50 | 20 | 100 | 20 | 1 | 200 | 50 | 100 | | 50 |
| Reference value in residential zone, Estonia | 2 | 5 | 300 | 30 | 150 | 50 | 5 | 500 | 150 | 300 | | 300 |
| Limit values in soil, Italy | 1 | 2 | 100 | 20 | 120 | 20 | 3 | 120 | 120 | 150 | | 90 |
| Limit values in soil, Lithuania | 1,5 | 3 | 100 | 10 | 100 | 30 | 5 | 300 | 75 | | | 150 |
| Target value in soil, Netherlands | 0,3 | 0,8 | 85 | 29 | 36 | 9 | 0,6 | 140 | 35 | 100 | | 42 |
| Intervention value, Netherlands | 10 | 12 | 600 | 55 | 190 | 240 | 100 | 730 | 210 | 380 | | |
| Limit values in soil, Poland | 4 | 5,5 | 150 | 22,5 | 45 | 45 | | 325 | 75 | 170 | | 250 |
| Limit values in soil, Slovakia | 10 | 20 | 600 | 50 | 500 | 300 | 20 | 3000 | 500 | 800 | | 500 |

# IMPACT ON HUMAN HEALTH

Heavy metals enter the human body through inhalation of toxic dust, ingestion of contaminated food and water. Building materials can be substantial contributors to this exposure. While many construction materials appear stable, they can release heavy metals over time as dust, fumes, or leachates, contaminating indoor air, water supplies, and surrounding soils. These pollutants infiltrate air, food, and water supplies, increasing the risk of exposure. Cadmium, lead, and mercury, commonly found in building materials, have been linked to cancer. (*Healthy Materials Lab*). Additionally, certain metals, including (Al), antimony (Sb), arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr II), cobalt (Co), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), selenium (Se), tin (Sn), and vanadium (V), are classified as metal–estrogens due to their ability to mimic estrogen activation, potentially increasing the risk of hormone-related cancers, such as breast cancer (*Campanale et al., 2020*).

USE OF SOME HEAVY METALS AND THEIR EFFECT ON HUMAN HEALTH

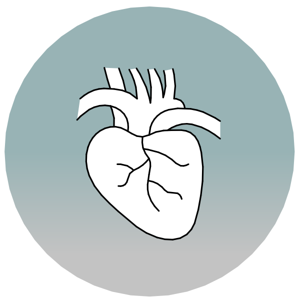
| **HMs** | **Additives** | **Effects** |
|---|---|---|
| Hg | Biocides | Mutagen or carcinogen; induction of the disruption of DNA molecular structure and brain damage. |
| As | Biocides | Congenital disabilities; Carcinogen: lung, skin, liver, bladder, kidneys; gastrointestinal damage; death |
| Cu | Biocides | Formation of reactive oxygen species (ROS); inducing DNA strand breaks and oxidation |
| Cd | Heat stabilizers, UV stabilizers and inorganic pigments | Osteomalacia and bone fractures; lipid peroxidation and the promotion of carcinogenesis; cellular apoptosis; DNA methylation. |
| Pb | Heat stabilizers, UV stabilizers and inorganic pigments | Anemia; hypertension; miscarriages; disruption of nervous Systems; brain damage; infertility; oxidative stress and cell damage. |
| Co | Inorganic pigments | Formation of ROS; neurological (e.g., hearing and visual impairment); cardiovascular and endocrine deficits. |
| Cr | Inorganic pigments | Allergic reactions to the body; nasal septum ulcer; severe cardiovascular, respiratory, hematological, gastrointestinal, renal, hepatic, and neurological effects and possibly death. |



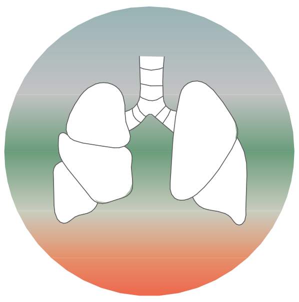
**Brain**
lead, mercury

**Lymph nodes**
lead

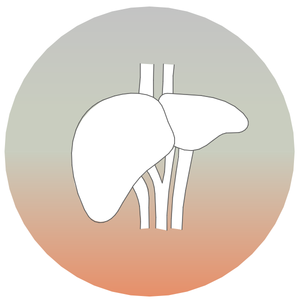
**Thyroid**
cadmium



**Heart**
lead, mercury

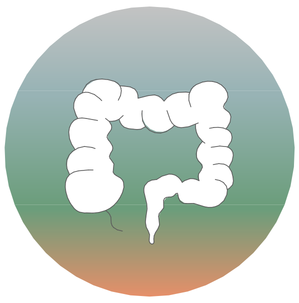


**Lungs**
arsenic, cadmium, chromium, copper mercury

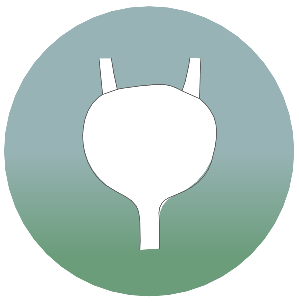


**Liver**
chromium, copper, mercury

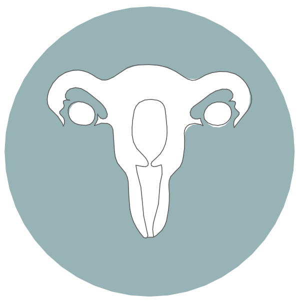
**Kidneys**
cadmium, lead, mercury, arsenic



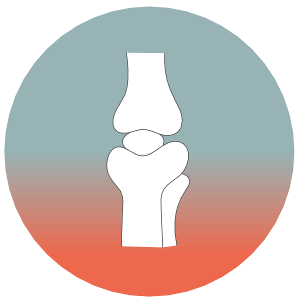
**Intestines**
Arsenic, lead, mercury, copper



**Bladder**
Arsenic, lead



**Reproductive system**
lead



**Bones**
cadmiun, lead

**Skin**
arsenic, chromium

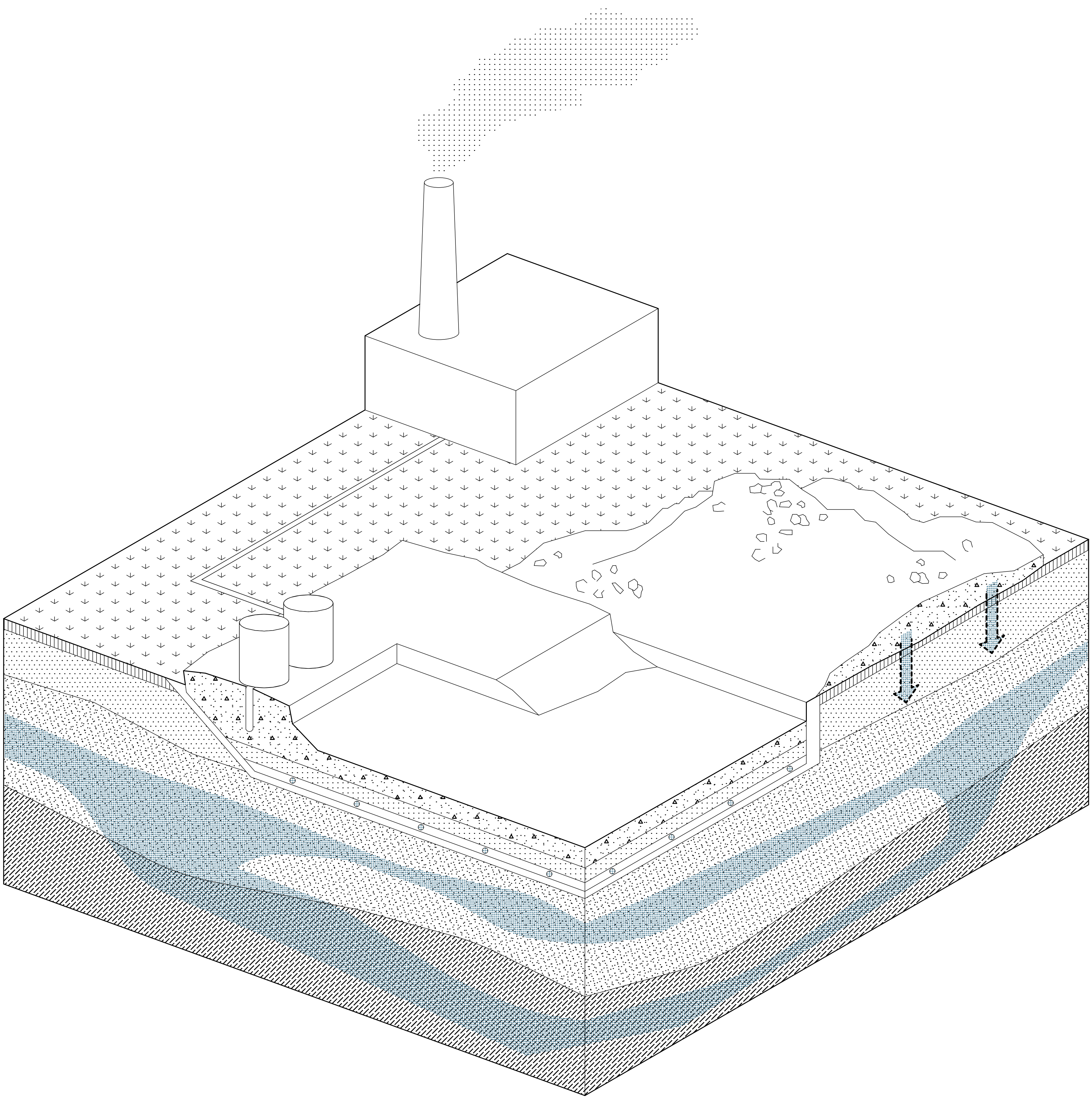
*Sources:* FAO and UNEP. 2021. Global assessment of soil pollution - Summary for policy makers. Rome, FAO.
Campanale C.: A Detailed Review Study on Potential Effects of Microplastics and Additives of Concern on Human Health. Campanale et al., Int. J. Environ. Res. Public Healt 2020
Healthy Materials Lab: Color x Health, Affordable Housing Starts with Healthier Spaces, Parsons School of Design,2017

# LANDFILLING

The post-World War II era led to a significant escalation in waste management challenges due to two primary factors: the rise of consumerism and the advent of the chemical age. Together, these developments dramatically increased waste volumes, altered waste composition, and introduced new toxicity concerns, necessitating stricter regulations on landfilling.

As of 2021, in Europe, 24% of waste was recycled as secondary raw materials, while 18% was processed into compost. In contrast, Ukraine faces a critical waste management issue, with over 90% of waste being landfilled. Since solid waste is disposed of in both regulated and unregulated landfills (either dumped on the soil surface or buried) monitoring maximum permissible concentrations (MPCs) of toxic substances in soil is a crucial indicator. Currently, Ukraine has approximately 300 hazardous waste storage facilities, many of which were constructed without adequate technical safeguards, posing significant regional environmental risks.

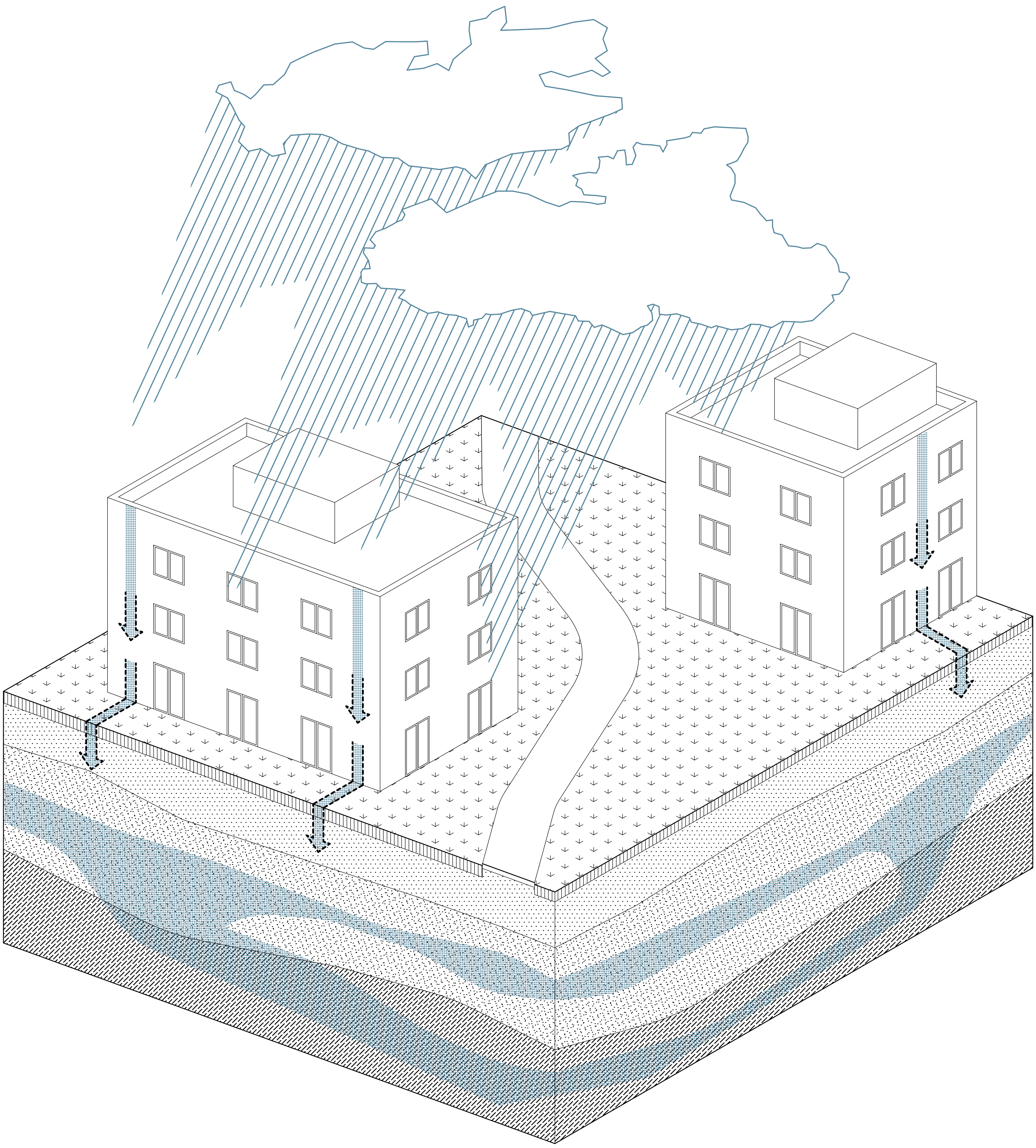
A substantial portion of landfilled solid waste originates from the construction and demolition (C&D) sector, which accounts for 30% of total global waste production. On average, over 35% of C&D waste is disposed of in landfills annually. In Germany, C&D waste that meets the criteria for inert waste under the Waste Framework Directive (2001) and the Landfill Directive (1999) can be deposited in specialized inert waste landfills. However, these regulations were only introduced in 1972. As a result, older landfills used for building rubble disposal in the post-WWII period lack adequate environmental protection measures. Studies indicate that building rubble-based substrates exhibit significantly elevated concentrations of heavy metals and organic pollutants compared to natural soil.



# EMISSIONS FROM BUILDINGS

Building materials can contain heavy metals, that may leach out over time, potentially degrading soil and groundwater quality. Rainwater infiltration and percolation through building materials can facilitate the release of contaminants, which subsequently migrate into the underlying soil. The composition of the leachate, as well as the rate and total amount of contaminant release, varies depending on the material's composition. Once contaminants enter the soil, their downward transport may be slowed due to adsorption onto soil constituents. The extent of this retardation depends on soil properties such as pH, organic matter content, and clay composition. Many of these factors vary spatially and temporally. For instance, alkaline soil conditions promote pollutant sorption, reducing the risk of leaching into groundwater.

In Germany, regulations such as the Ersatzbaustoffverordnung (2021) establish guidelines for leachate testing of secondary building materials. Similarly, in the Netherlands, the Soil Quality Decree (2007) introduced a simplified set of emission limit values to facilitate the screening of primary and secondary building materials for permissible use. Mitigating emissions requires minimizing material pollution at the source. However, this presents challenges, as many substances added to building materials serve specific functions, for example, biocides in facade paints to prevent algae growth. Additionally, methodologies for assessing the environmental impact of such substances are still being developed, underscoring the need for further research and regulatory advancements.

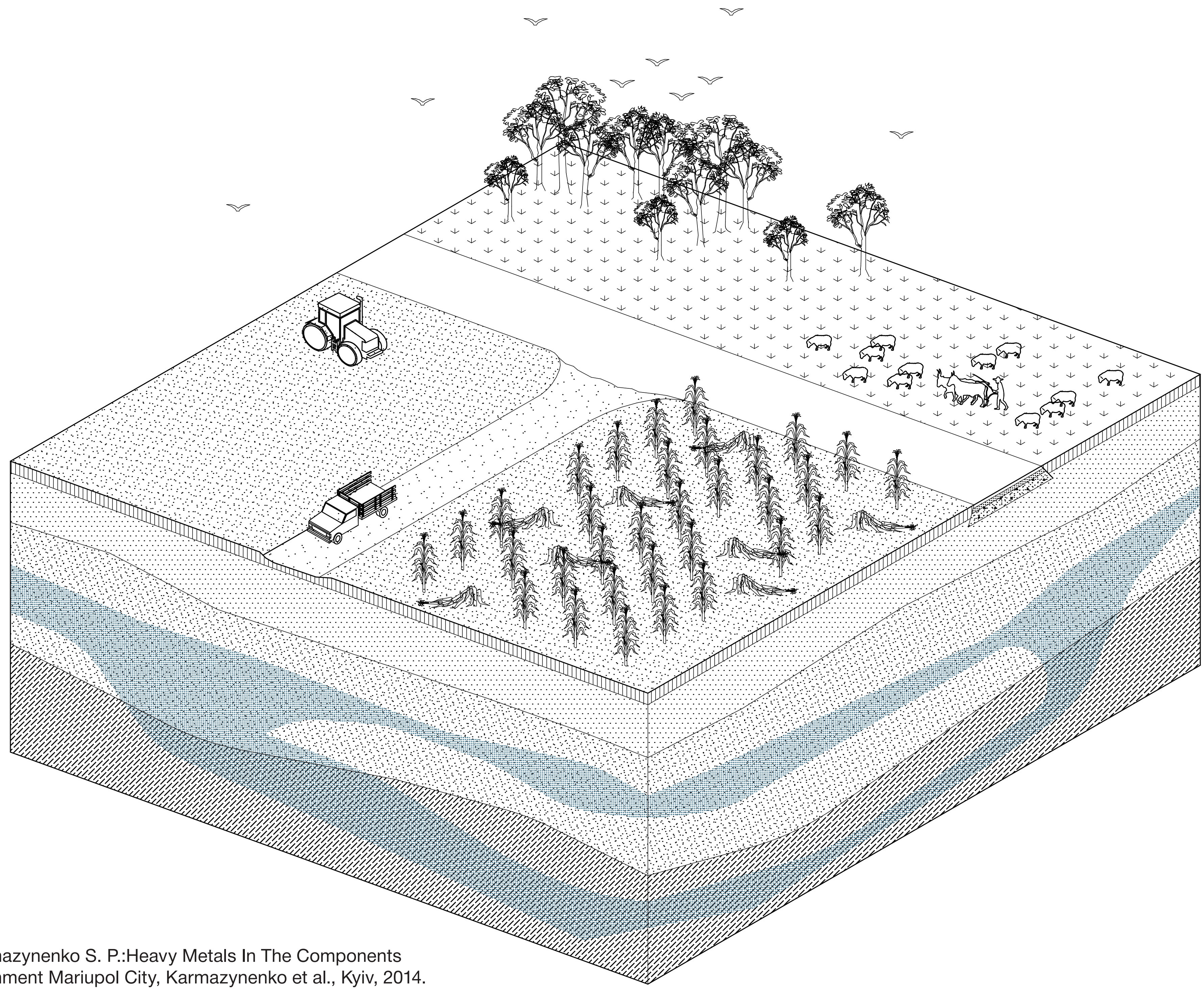


# IMPACT ON LANDSCAPES

Heavy metals can persist in the environment and accumulate through the food chain. Recent research has also highlighted that heavy metals can be adsorbed to microplastics. Microplastics act as carriers for these metals. As a result, increasing amounts of toxic substances accumulate in soils, ultimately entering the metabolic cycles of living organisms. Cadmium, for instance, is absorbed from contaminated soil by grass and fodder crops, accumulating in the liver and kidneys of animals before reaching humans through meat and dairy consumption. Lead exposure occurs via soil, water, industrial emissions, equipment, pipelines, lead-based pesticides, packaging materials, and household items. Arsenic, another highly toxic element, comes from sources such as industrial emissions, copper smelters, lignite-fired power plants, arsenic-containing pesticides, and feed additives.

IMPACT OF HEAVY METAL CONCENTRATIONS ON SOIL BIOCHEMICAL ACTIVITY

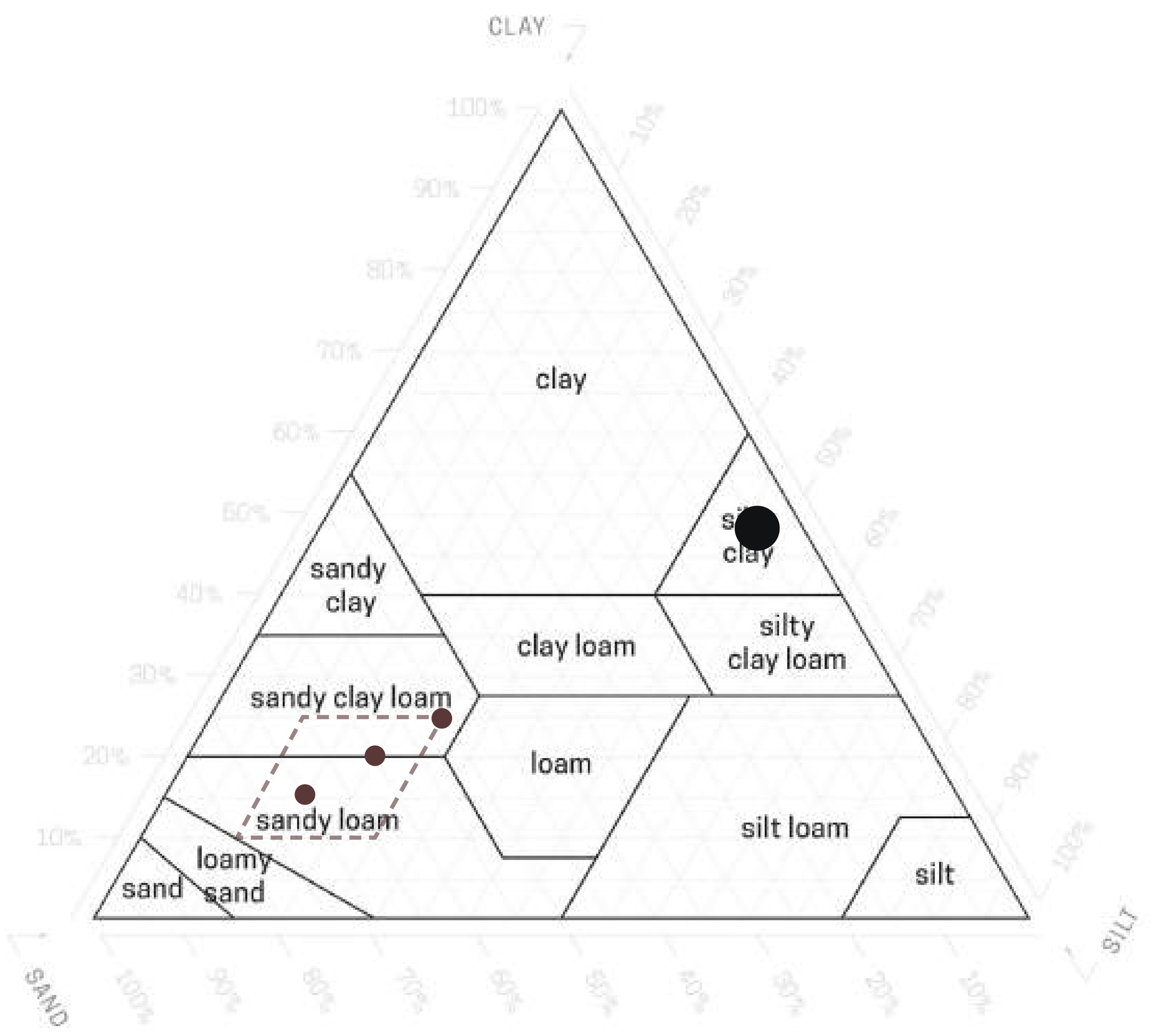
| **Level of HM Contamination in Soil (Relative to Background Levels)** | **Effects on Soil Biochemical Activity, Species Composition, and Microbial Abundance** |
|---|---|
| 2 orders of magnitude above background | Reduction in the diversity of soil micromycetes. Emergence of dominance by the most resistant species, particularly amylolytic microbial groups. Decrease in specific indicators of biochemical and enzymatic activity of soil microorganisms. |
| 3 orders of magnitude above background | Pronounced alterations in nearly all microbiological indicators. Inhibition and mortality of the typical microbiota found in uncontaminated soils. Concurrent proliferation and even absolute dominance of a very limited number of HM-resistant microorganisms, predominantly micromycetes. |
| 4 orders of magnitude above background | Manifestation of a catastrophic decline in soil microbiological activity, approaching the threshold of complete microbial extinction. |

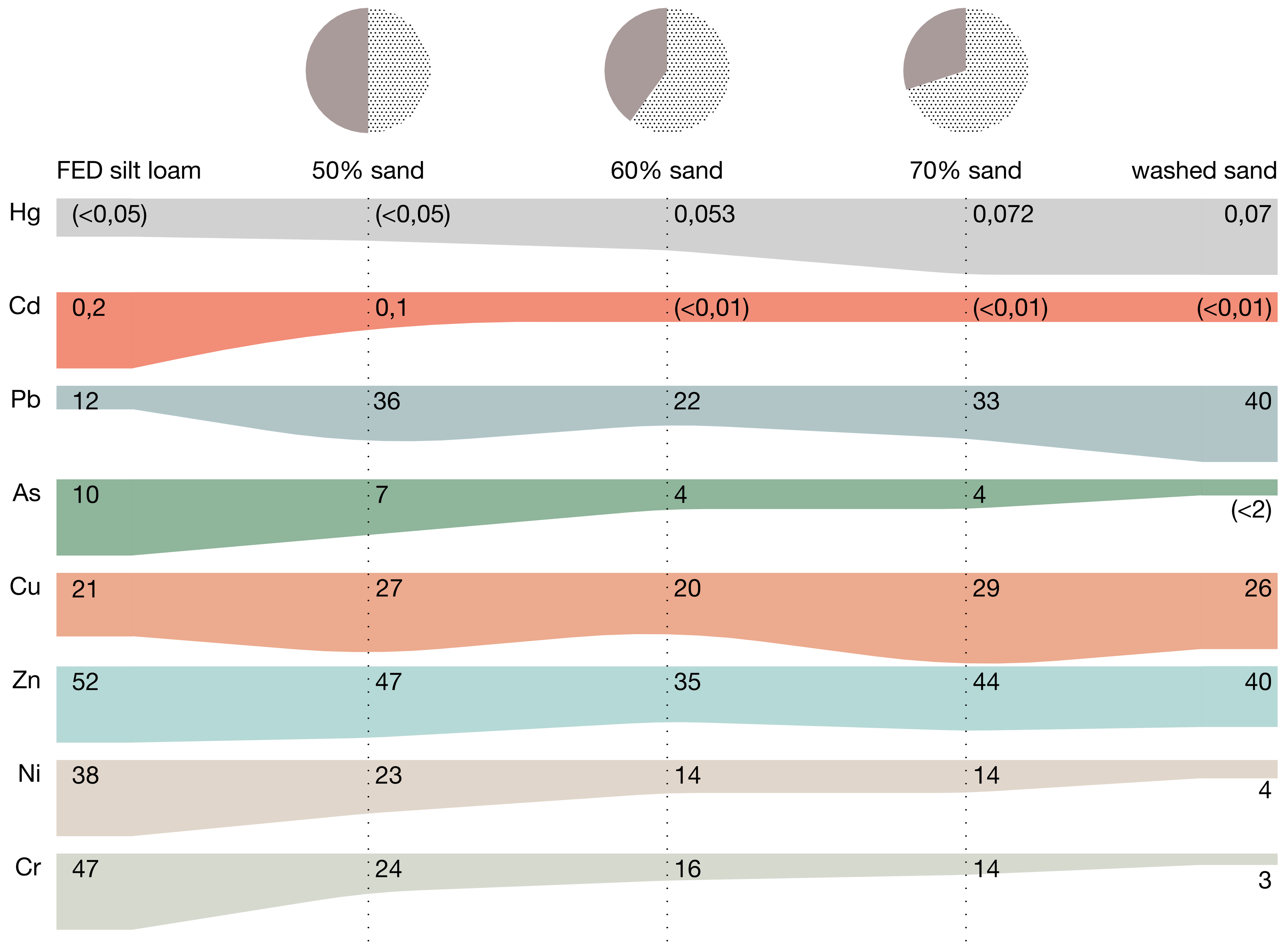


*Sources:* Karmazynenko S. P.:Heavy Metals In The Components Of The Environment Mariupol City, Karmazynenko et al., Kyiv, 2014.

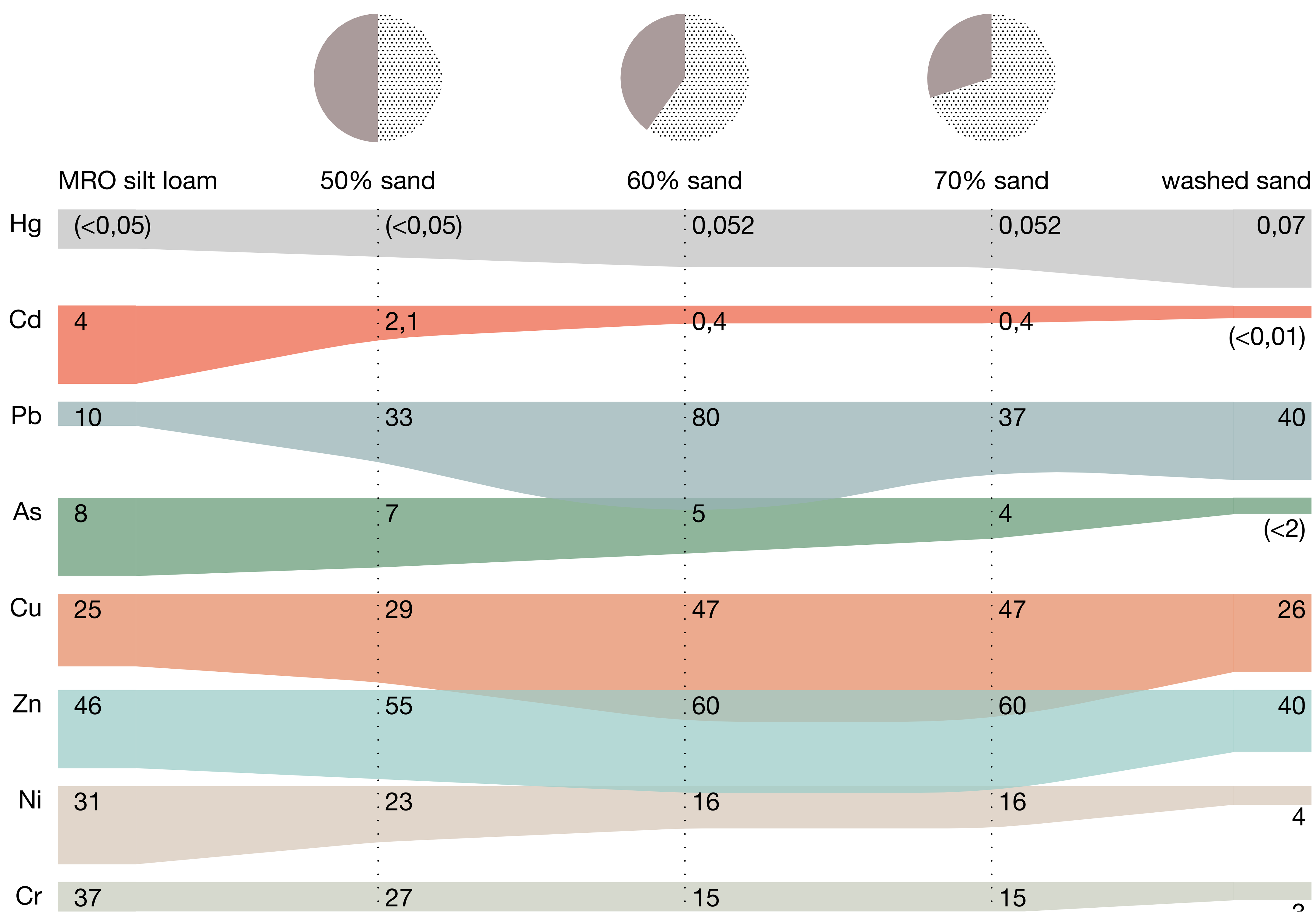
# DILUTION STRATEGY

Since concentration is the key indicator of pollution, we aimed to dilute contaminated material by incorporating secondary raw materials with lower pollutant levels or different contaminants. To optimize the mixture, we used washed sand from a soil washing facility to enhance the natural sand content. Throughout the process, we closely monitored the balance between structural integrity and pollutant concentration.



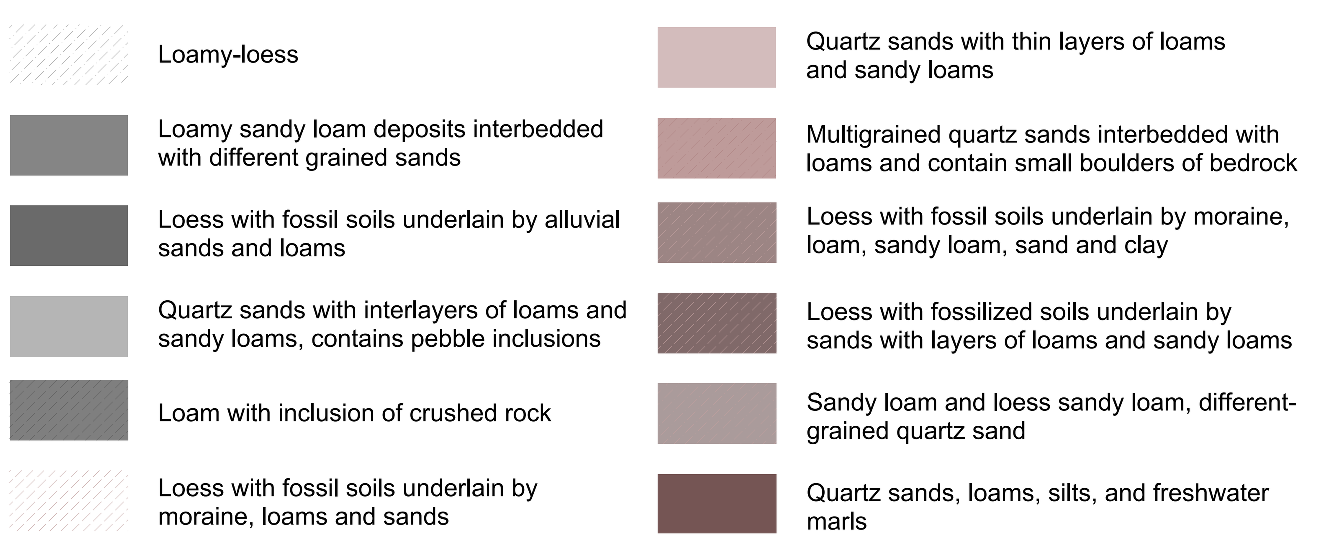



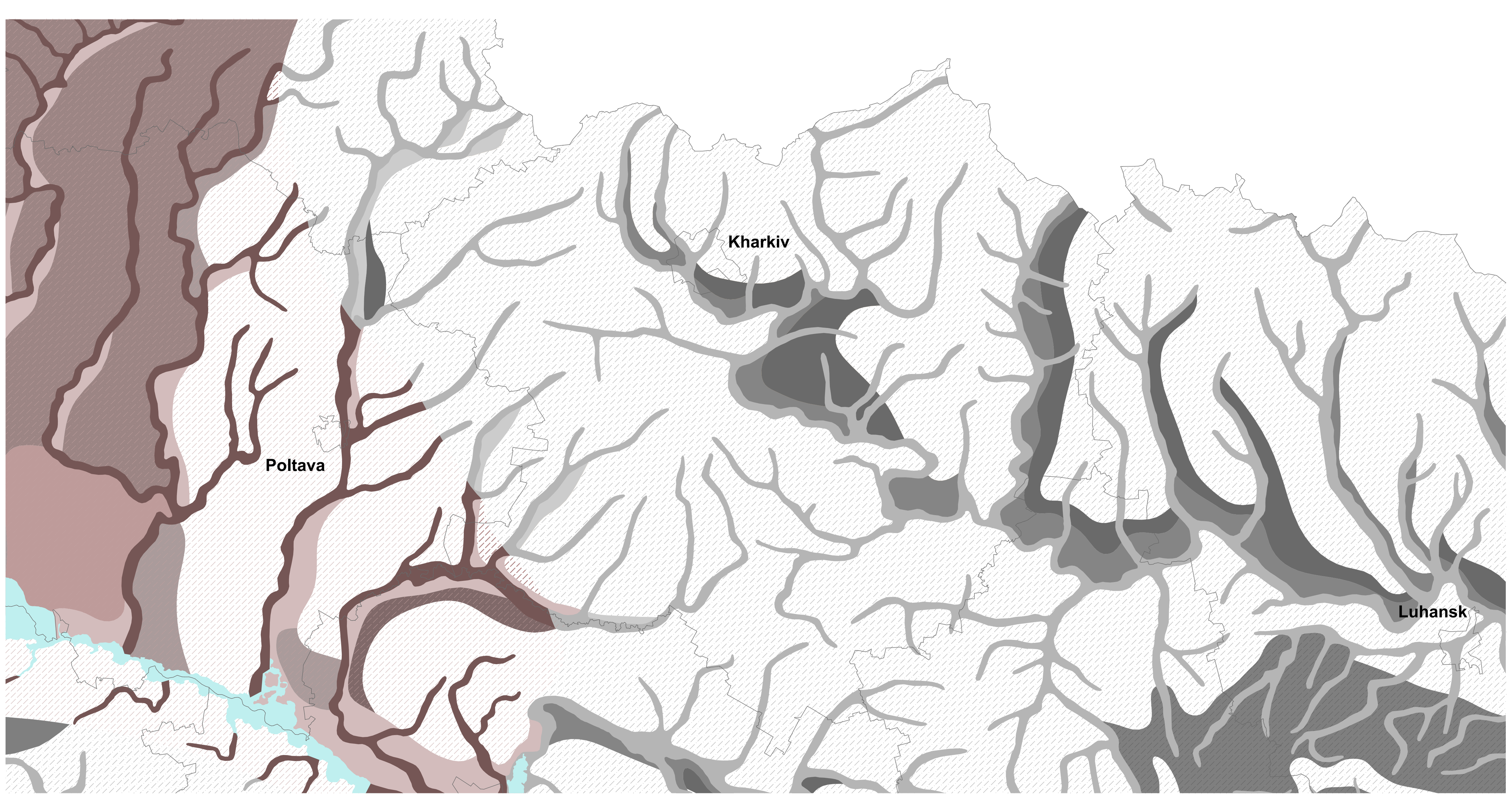

Loess from Fedorivka consists of 15% clay particles, 80% silt and 5% sand. Total proportion of particles <0.063 mm is 94,8%


Loess from Mala Rohan consists of 23% clay particles, 62% silt and 15% sand. Total proportion of particles <0.063 mm is 84,9%

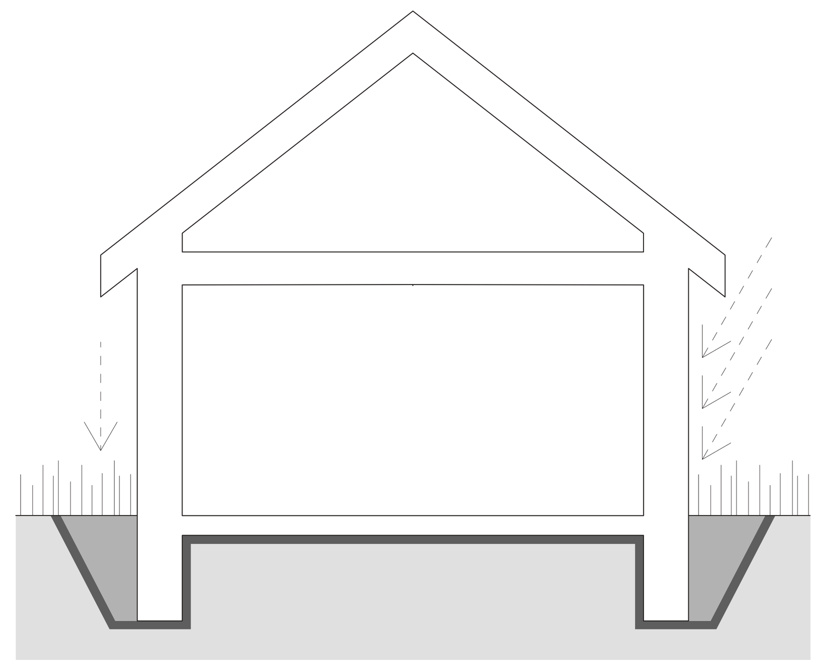
In the Kharkiv region, various natural sand sources are available to balance soil mixtures for CEB production. However, rather than depleting natural resources, we should prioritize the use of secondary materials, particularly demolition rubble in the context of war. Additionally, the demand for clean energy and water in processing these materials remains a critical concern.



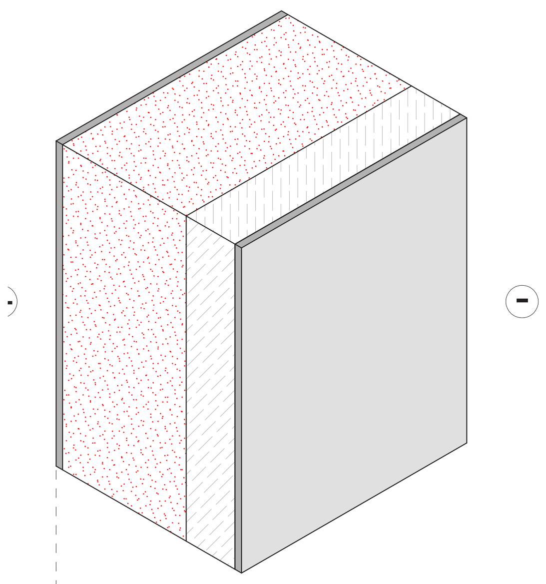



# ENCAPSULATION STRATEGY

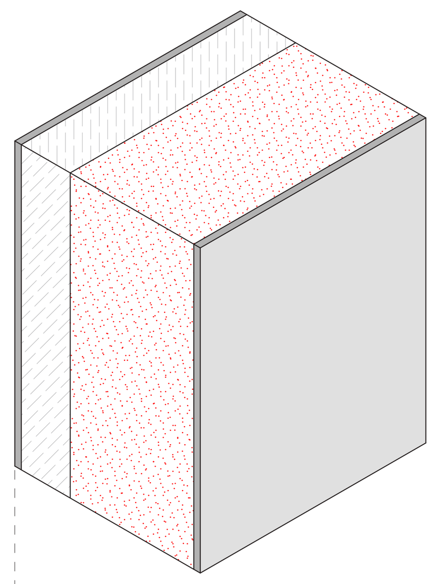
This strategy represents large-scale design details of building elements engineered to securely contain materials contaminated with heavy metals. We have created examples of building details that would be safe for users and would not create additional pollution by spreading contaminants already present in building elements. A key feature is the prototype of a 'filter house,' encircled by a rain garden equipped with an underground filtration system. This system gradually leaches contaminants from the exterior walls, effectively managing pollution over time.



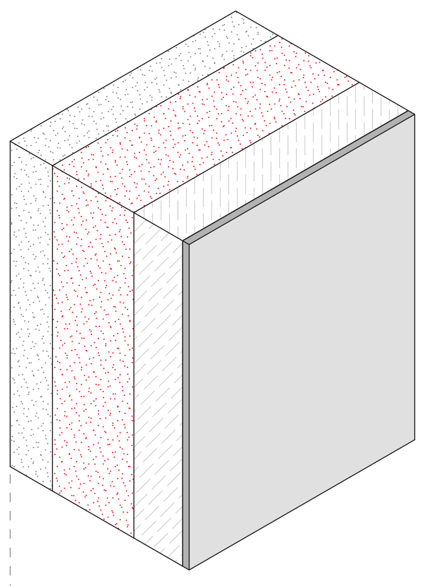
## EXTERIOR WALLS



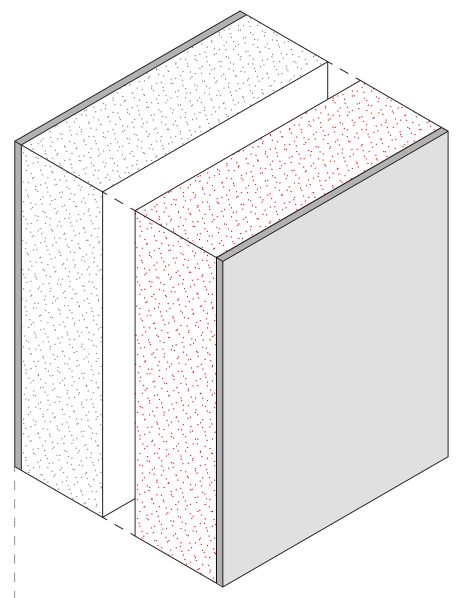
clay or lime plaster
RE or CEB wall, contaminated
hemp insulation
clay or lime plaster



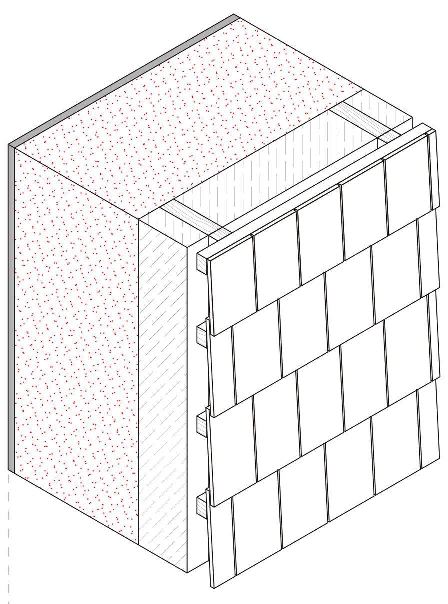
clay or lime plaster
hemp insulation
RE or CEB wall, contaminated
clay or lime plaster



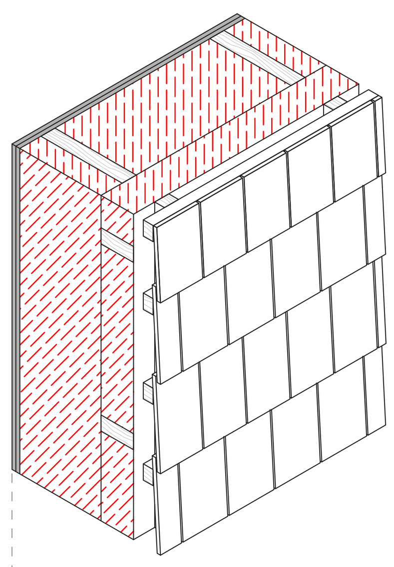
RE
RE, contaminated
hemp insulation
clay or lime plaster



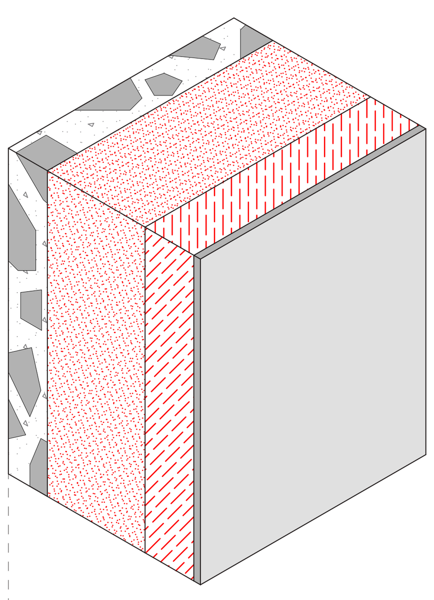
clay or lime plaster
RE or CEB wall
air layer
RE or CEB wall, contaminated
clay or lime plaster



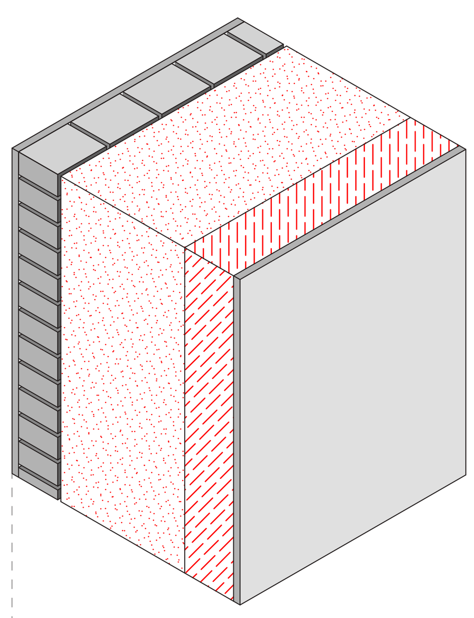
clay or lime plaster
RE or CEB wall, contaminated
hemp insulation
ventilated facade



drywall
light earth, contaminated
timber frame structure
ventilated facade

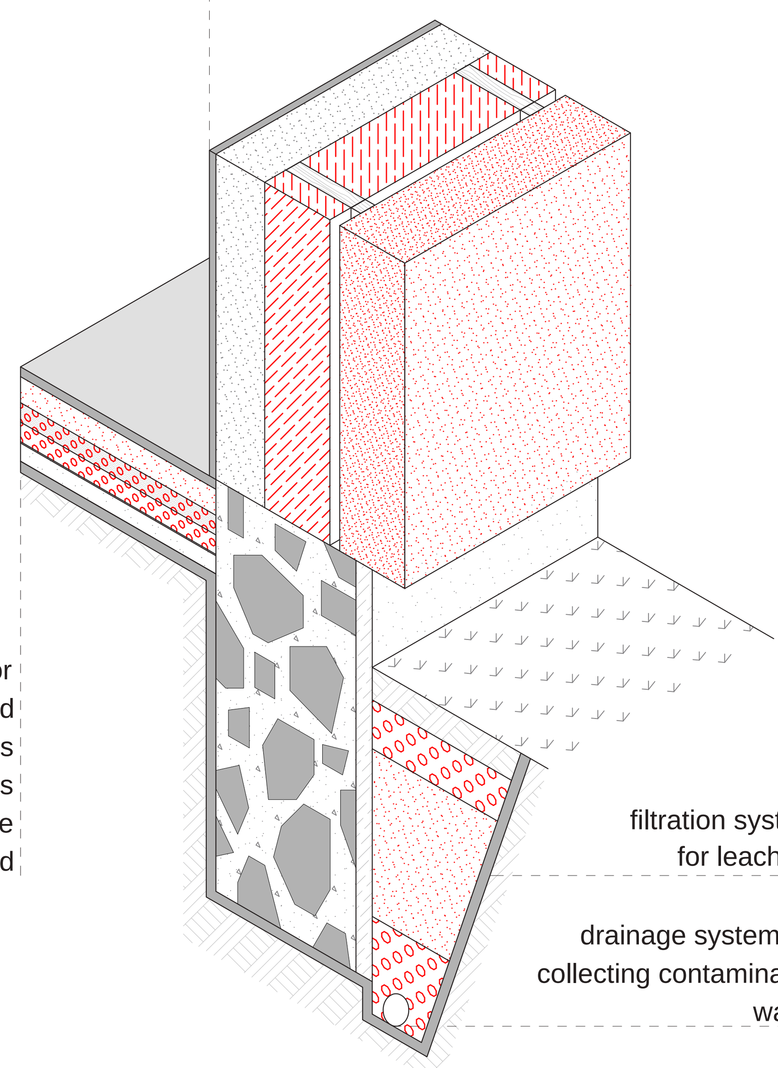


concrete wall with the rubbles
RE or CEB wall, contaminated
light earth insulation, contaminated
clay or lime plaster



clay or lime plaster
reused bricks cladding
RE or CEB wall, contaminated
light earth, contaminated
clay or lime plaster

## FILTRATION SYSTEM



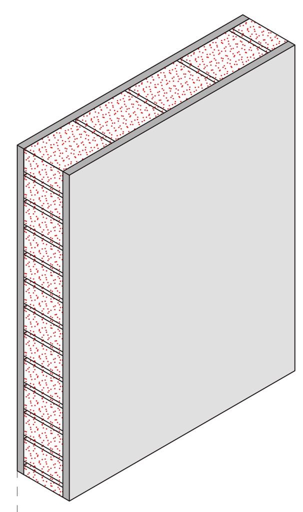
clay or lime plaster
RE or CEB wall, contaminated
light earth insulation, contaminated
air layer

oiled earth floor
poured earth, contaminated
concrete slab with the rubbles
compressed rubbles
insulating membrane
sand

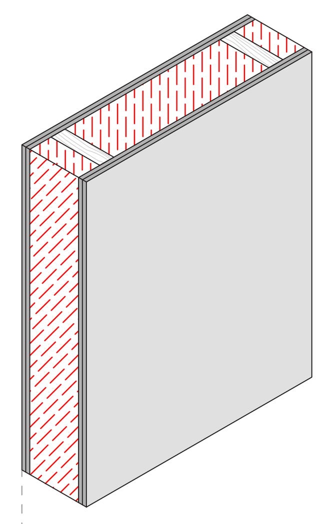
filtration system
for leachate

drainage system for
collecting contaminated
water

## INTERIOR WALLS

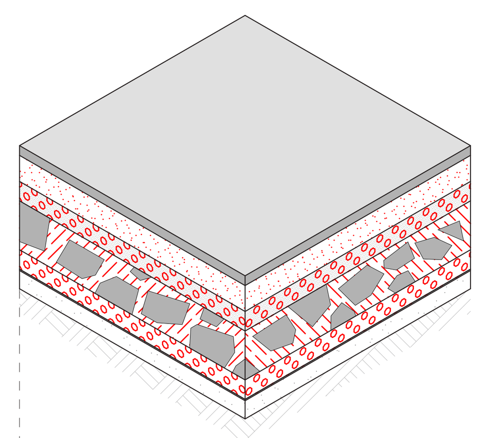


clay or lime plaster
CEB wall, contaminated
clay or lime plaster

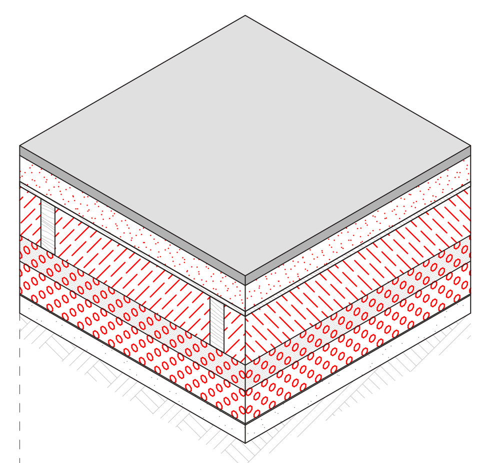


drywall
light earth, contaminated
drywall

## GROUND FLOOR

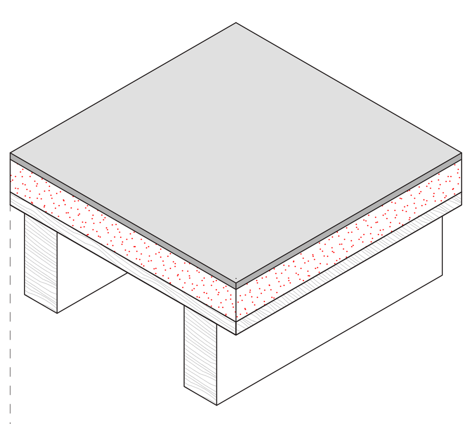


oiled earth floor
poured earth, contaminated
concrete slab with the rubbles
big rubbles with the light earth filling
compressed rubbles
insulating membrane
sand

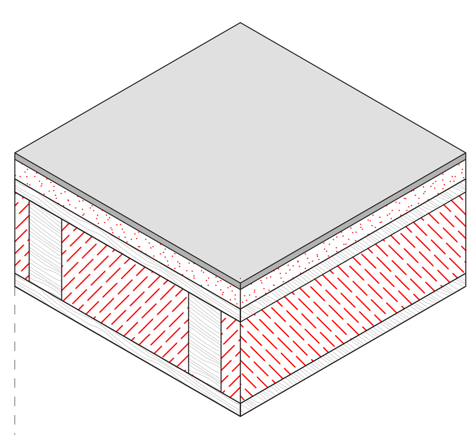


oiled earth floor
poured earth, contaminated
light earth, contaminated
timber structure
concrete slab with the rubbles
compressed rubbles
insulating membrane
sand

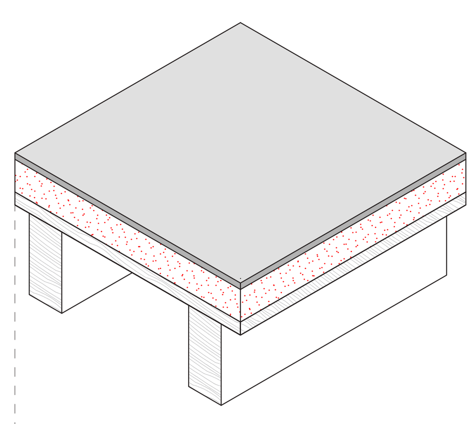
## FLOOR SLABS



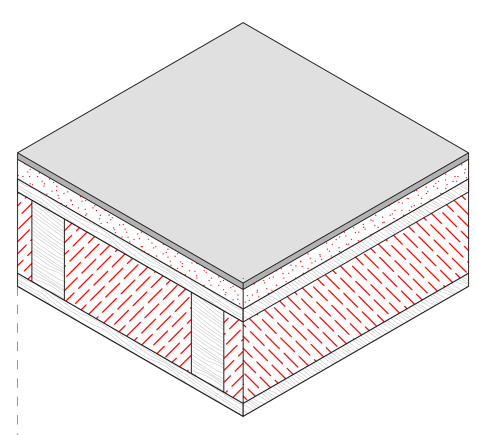
oiled earth floor
poured earth, contaminated
timber structure



oiled earth floor
poured earth, contaminated
light earth, contaminated
timber structure



oiled earth floor
poured earth, contaminated
timber structure



oiled earth floor
poured earth, contaminated
light earth, contaminated
timber structure