

Protecting health through urban redevelopment of contaminated sites

A planning brief



ABSTRACT

Across the WHO European Region, the urban population is growing steadily and demand for land is rapidly increasing. Revitalizing and/or remediating industrial sites and contaminated land presents an opportunity for sustainable urban development. Such actions can also help in reducing the pressure on undisturbed land resources. However, redevelopment of contaminated sites may cause continued environmental and health consequences if contamination risks are not properly managed or remediated.

This brief summarizes the lessons learned across Europe on the redevelopment of contaminated sites as a part of urban planning and renewal. Specifically, it aims to provide information on the health and environmental impacts to be considered during site redevelopment projects, and to identify good practice and relevant local experiences to support effective, healthy and sustainable redevelopment of contaminated sites. As such, this brief offers key messages to support the work of local decision-makers, planners, practitioners, researchers and civil society organizations.

KEYWORDS

CONTAMINATED SITES
URBAN PLANNING
ENVIRONMENT AND HEALTH
IMPACT ASSESSMENT
HEALTHY CITIES

ISBN: 978-92-890-5634-2

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The WHO European Centre for Environment and Health

The WHO European Centre for Environment and Health, now located in Bonn, Germany, was established in 1989 by the First European Conference on Environment and Health and is an integral part of the WHO Regional Office for Europe. The centre provides technical and scientific expertise on the impacts of environment on health. It delivers policy advice, tools to inform and support decision-making in the areas of air quality, access to safe drinking-water, sanitation and hygiene, minimizing the adverse effects of chemicals, adaptation to and mitigation of climate change, environmental sustainability of health systems, urban health planning, including transport and mobility, as well as violence and injury prevention. It also works with partners to develop collaborative initiatives addressing environment-related diseases. The centre strengthens country capacities to address environment and health challenges through a range of training courses on environment and health, including health impact assessment.

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Acknowledgments

This brief is based on the full report of the WHO project consultation on “Urban redevelopment of contaminated sites” (WHO Regional Office for Europe, 2021) and summarizes the key messages of the project for urban planners and decision-makers.

The WHO Regional Office for Europe would like to thank the authors of the three working papers for the project, and all experts who took part in the project consultation for their contributions and support in preparing the report.

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This brief was produced with the financial support of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.



Former textile production plant in Lokeren, Belgium
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1. Introduction

Redevelopment of contaminated sites is urgent

By 2050 it is predicted that 80% of Europe's population will be urban (Eurostat, 2016). Increasing urbanization means that more land is required for homes, economic activities and urban infrastructure, putting pressure on the countryside surrounding cities. At the same time, industrial decline and land use changes have resulted in large areas of vacant land often located close to where people live and work, providing an opportunity for urban development without sprawl.

However, when environmental contamination affects these sites, it may also pose a risk to the health and well-being of urban residents. The effective and sustainable redevelopment of contaminated sites is therefore a priority from ecological, environmental and health perspectives, and is a prerequisite for growth and development in some urban areas. As contaminated sites tend to be more often located in urban areas

Contaminated sites are areas having hosted or being affected by human activities which have produced environmental contamination of soil, sediment, surface or groundwater, air, or food-chain, resulting or being able to result in harm to human health, the environment or ecological systems (based on Martuzzi, Pasetto & Martin-Olmedo, 2014).

populated by socially disadvantaged residents, their redevelopment may also contribute to the reduction of inequalities.

Many different land uses have resulted in contamination from the disposal of waste materials, accidental spillage or deposition of pollutants. Such land uses include industrial processes, energy generation, waste disposal/processing, mining and processing of metals, transport, and engineering, as well as agricultural or military activities. Contaminants include inorganic heavy metals and metalloids (e.g. arsenic, cadmium, lead), organic substances (e.g. oils, polycyclic aromatic hydrocarbons, benzene, chlorinated compounds), acids and alkalis, asbestos, gases (e.g. methane) and – in specific cases – radioactive substances.

The local legacy of contaminated sites

Many cities have a substantial legacy of contaminated sites. In 2018, the European Commission Joint Research Centre estimated that there were 2.8 million potentially contaminated sites across the member countries of the European Union, with only around 690 000 of these having been formally registered (Payá Pérez & Rodríguez Eugenio, 2018). Redevelopment of contaminated sites is a priority and a challenge for most countries. Such redevelopment has many potential benefits, including: reducing the risks to health and the environment, providing land to accommodate increased urbanization, and regenerating neighbourhoods suffering environmental degradation and/or economic decline.

The need for green and healthy urban recovery

The redevelopment of contaminated sites in urban settings is not only a chance for the improvement of environmental health conditions in these areas, it also provides opportunities for urban renewal and restructuring at larger scale, and contributes to the call for changing our cities in response to global trends, such as the increase in climate events or global pandemics (WHO, 2020). The redevelopment of formerly contaminated sites helps to generate the required

urban land resources to establish more open and public spaces, provide local services and reduce mobility needs, and enable better resilience for future events.

Addressing these key challenges to “build forward better” requires an investment in sustainable and green recovery, and the establishment of new urban infrastructure. Repurposing contaminated sites for urban redevelopment may therefore not only address the environmental legacy of the past, but also help to establish opportunities for healthy and sustainable cities in the future.



Abandoned coking plant in Zeebrugge, Belgium
© Public Waste Agency of Flanders



Restored and replanted area of a former landfill in Àrids Catalonia, Spain
© Parc de l'Alba

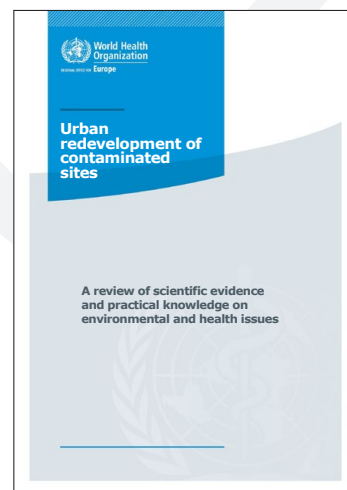
2. About this brief

Purpose

The purpose of this brief is to provide urban policy-makers, planners and practitioners with good practices and lessons learned on managing the redevelopment of contaminated urban sites and ensuring the adequate consideration of health aspects.

The brief focuses on the coordination and implementation of contaminated site conversion and redevelopment as an urban planning and development task. Emphasis is put on how local authorities and decision-makers can ensure – through adequate planning and coordination mechanisms – that the redeveloped sites provide a social and environmental benefit to the local community and do not pose future health risks. Due to the focus on planning and local implementation procedures, the brief does not contain detailed information on techniques for site remediation and cleaning.¹

The information in this brief is based on the conclusions of a WHO expert meeting, which brought together an international team of urban health, planning and contaminated land experts to discuss evidence and practice related to the redevelopment of contaminated sites, and the implications for urban planning. A full technical report of the expert meeting is also available (WHO Regional Office for Europe, 2021), including background papers on research evidence, site redevelopment case studies, and the applicability of impact assessment approaches.



The following actors and stakeholders are likely to find this brief of interest:

- ▶ environment and/or health practitioners at the local level involved with identification, management, remediation and redevelopment of contaminated sites;
- ▶ urban planners and local decision-makers, politicians and public authorities with responsibility for urban development, regeneration, environmental management, social affairs and public health;
- ▶ civil society organizations, local initiatives and citizens concerned with the impact of contamination in urban settings and the local quality of life;
- ▶ researchers, landowners, environmental consultancies, engineers and developers (who may also be interested in the reflections shared).

¹ A list of projects providing such information can be found in Annex 1 of the full project report – *Urban redevelopment of contaminated sites: a review of scientific evidence and practical knowledge on environmental and health issues* (WHO Regional Office for Europe, 2021).

Target audience

Local decision-makers, planners and civil society organizations dealing with contaminated sites already know that the redevelopment of such sites provides environmental, economic, social and health benefits and can contribute to the local implementation of the Sustainable Development Goals (e.g. by reducing soil and water pollution and its impact on health and the environment).

Member States of the WHO European Region established the prevention and elimination of adverse environmental and health effects related to waste management and contaminated sites as one of the main priorities of the Declaration of the Sixth Ministerial Conference on Environment and Health (WHO Regional Office for Europe, 2017).

Structure

This brief is structured as follows: section 3 provides an overview of the health and environmental outcomes from the remediation and redevelopment of contaminated sites; section 4 describes the process of remediation and redevelopment including risk assessment; section 5 presents experiences and lessons learned from practical case studies on the coordination of such projects; and section 6 concludes the brief with key messages.



Griftpark in Utrecht, Netherlands, after remediation of a gas manufacturing plant
© V.M. Lansink

3. Health impacts and benefits of contaminated site redevelopment

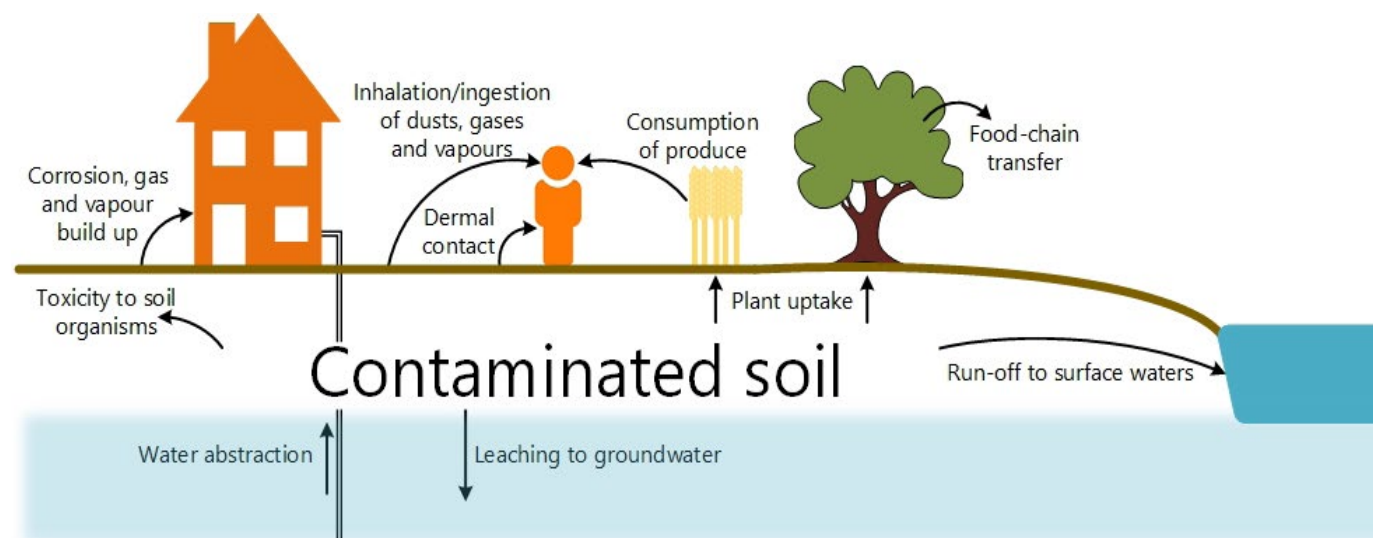
3.1. Health impacts of contaminated sites

Accumulated evidence suggests that living nearby or frequently visiting contaminated sites may have serious impacts on health and well-being (WHO Regional Office for Europe, 2021). Processes occurring in the environment may cause pollutants in soil to migrate into groundwater and surface water or to be taken up by plants – contaminating drinking water and food, damaging crops and livestock, and harming ecosystems. Pollutants can also damage buildings and properties (e.g. through corrosion or explosion), reduce soil functions, and cause direct toxicity to humans via ingestion of soil and food; inhalation of dusts, gases and vapours; and contact with the skin (Fig. 1).

The health and environmental impacts of contaminants are various, but include:

- cognitive impairment and neurological damage
- adverse impacts on respiratory, renal, reproductive and digestive systems (e.g. cancers)
- miscarriages and reduced fetal growth
- acute poisoning in humans
- damage to ecological systems.

Fig. 1. Health impact pathways of contaminated sites



Contaminated sites do not only present a health challenge to be addressed; they also present an urban planning challenge. Many contaminated sites are a product of the past and are now vacant and abandoned, and – due to their contamination history – cannot be used for new urban functions and infrastructure without prior interventions.

Contaminated sites need to be treated and cleaned before any redevelopment. The most appropriate remediation of any contaminated site is dependent on a range of local factors.

These include the contaminants present; the migration of contaminants through soil, air, water and food; and the current and future land uses – all of which affect the risk to human and environmental health. In practice, the cocktail of contaminants and the variety of site conditions often mean that several methods may be needed to make a site safe for future use. Remediation technologies include physical, chemical or biological interventions, and can aim at removing the contaminated material, or addressing and mitigating the contamination on-site.

3.2. Benefits of redevelopment of contaminated sites

Reducing environmental damage and population health risks

Remediation of contaminated sites decreases both direct and indirect exposure to pollution in nearby populations, in soil, in surface and groundwater, and in ecosystems. For example, contaminant removal, the introduction of physical barriers or changes in contaminant mobility can reduce concentrations in soil, air and water and prevent further mobilization of pollution.

Studies also suggest that soil remediation is largely responsible for the recorded reductions in soil, water, dust and blood concentrations of pollutants. Public health campaigns are also effective at reducing exposure pathways where local populations are present and affected during remediation programmes (WHO Regional Office for Europe, 2021).

Making land available for urban redevelopment

Given that many contaminated sites are derelict or vacant, their redevelopment can contribute to wider neighbourhood regeneration, improving their physical appearance as well as enabling the provision of housing, greenspace and other urban functions. After successful remediation and redevelopment, these new uses can also make a positive contribution to improving health, well-being and environmental quality.

Reducing inequality and increasing social cohesion

Redevelopment of contaminated sites can reduce local inequalities and increase social cohesion – since such sites are often located in or around disadvantaged neighbourhoods – and enable the establishment of healthy settings for all citizens.



Heritage centre and community space on a former metal mining site, Cornwall, United Kingdom
© Danielle Sinnett

4. Process overview and steps of a redevelopment project

4.1. Categorization of contaminated site status

Before beginning the process of planning a redevelopment project, the individual contaminated site needs to be assessed and its contamination status determined. Fig. 2 provides a schematic overview of the different status categories that can be distinguished. It is important to maintain a clear overview of the respective site status. In particular, when several sites are identified, there is a need for a comprehensive rehabilitation programme that clearly distinguishes the status of all individual sites, describing the progress of site remediation and redevelopment and showing the next steps. This categorization is important in planning, but also provides the opportunity to showcase successes and therefore offers motivation to continue.

A recent European Commission Joint Research Centre report stated that around 690 000 contaminated sites have been formally registered in national and/or regional inventories in 29 European countries. Some 240 000 of those sites are in need of investigation or are already being investigated to assess the risk posed to human health and environment, while just a tenth of the sites (65 500) have been remediated already (Payá Pérez & Rodríguez Eugenio, 2018).

Fig. 2. Status categories of contaminated sites



Source: based on Payá Pérez & Rodríguez Eugenio (2018).

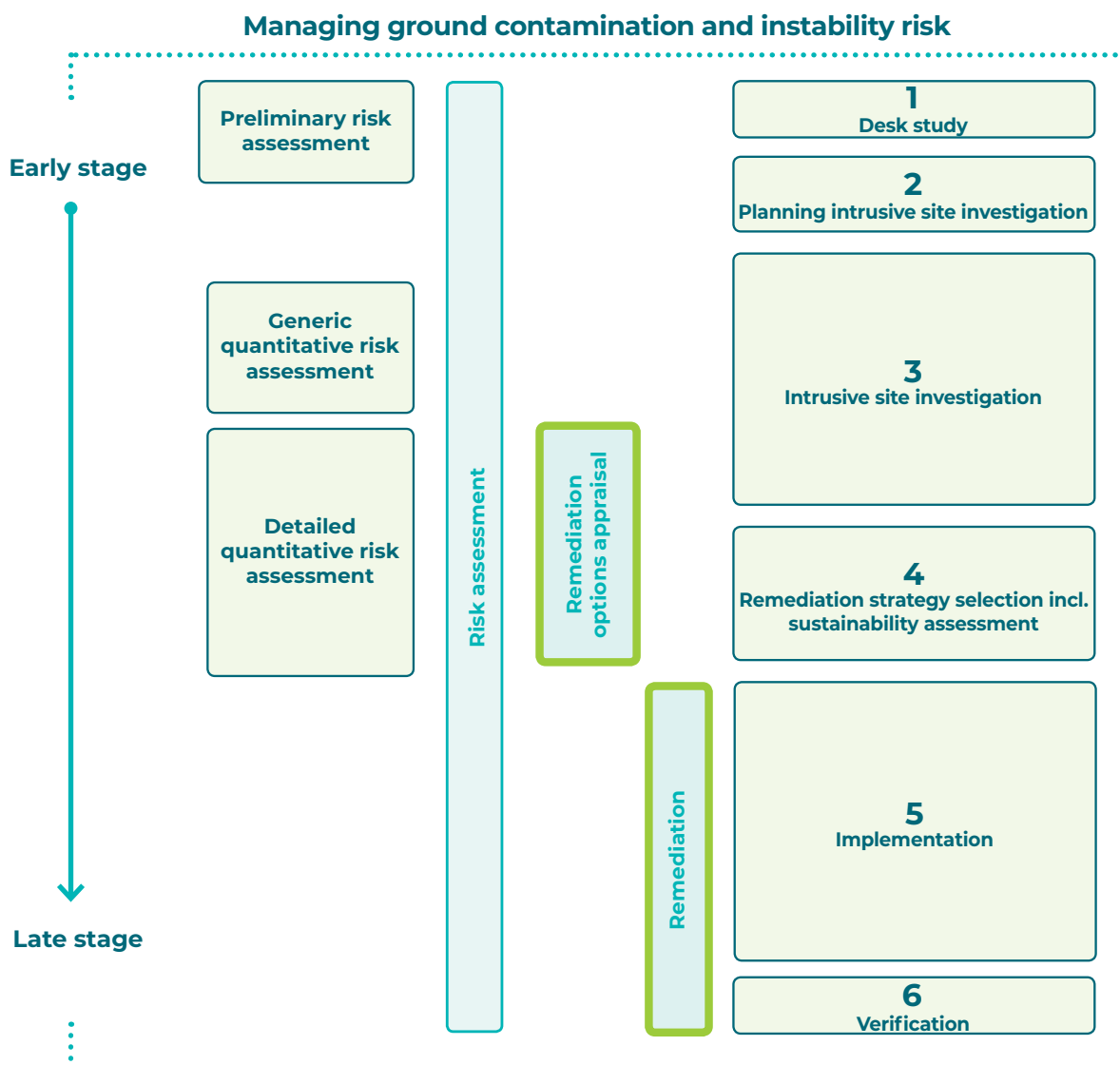
4.2. Remediation of a contaminated site – step by step

Although countries develop their own legal definitions and frameworks for the management of contaminated land, a significant consensus can be observed on the redevelopment process. Any remediation and redevelopment of a contaminated site follows a series of action steps, as illustrated in Fig. 3 and described further below. However, it is critical to emphasize that many of these steps may require expert knowledge, often

from several disciplines, which is not necessarily available to all public authorities or all site owners.

Ideally, these stages of investigation and remediation are directly linked to urban planning schemes for the redevelopment of new site functions, and are aligned with and inform such schemes.

Fig. 3. Action steps on site remediation and related risk assessment



Source: based on Hammond et al. (2021).

Step 1: Desk study

Industrialization has radically changed our environment over the last two centuries. During this evolution, new industrial facilities appeared, and others relocated to areas outside the city. The diversity of companies, their production processes and the type of environmental safety measures in place and compliance with them has also had a variety of impacts on the environment, and especially on soil quality.

Therefore, it is important to implement a thorough desk study, collecting relevant data on past and current industrial operations and site functions. Based on these data, a conceptual site model can be set up, providing a schematic overview of specific features and locations of contaminated soil, and other affected environmental media. This information would provide the baseline for a proper site investigation.

Step 2: Planning (intrusive) site investigation

Based on the likelihood and type of contamination, further on-site investigation and measurements must be planned. The conceptual site model can be applied to set up a respective sampling and analysis plan for the site, and to prepare the necessary health and safety measures before entering a contaminated site for drilling or physical measurements and excavations.

Step 3: Implementation of (intrusive) site investigation and assessment

A detailed investigation should be performed to confirm contamination and identify the sources, nature and extent of it. Risks to potentially exposed populations should be assessed, and appropriate remedial actions designed. Legal uncertainty for landowners and developers should be avoided and specific legislation or agreements put in place if necessary.

Establishing that a site is potentially contaminated and whether there should be remediation is the objective of the site assessment. At this stage, public outreach and participation should be initiated and health goals for the remediation should be established, based on the results of the site investigation.

Step 4: Remediation strategy

Based on a detailed risk assessment, a remediation/decontamination strategy can be established once a decision has been made that a particular site requires it. Part of the strategy includes decisions on the application of remediation and decontamination techniques (in respective site areas). Taking into account the new use or function of the site, target values for the reduction of contaminants should be set to enable a valid assessment of the remediation as adequate/sufficient, or not.



Geological site investigation at a contaminated site in Lokeren, Belgium
© Public Waste Agency of Flanders

Remediation techniques generally fall into three categories:

- physical interventions to reduce or prevent contamination exposure, including (i) removal of the contaminated material, or (ii) isolation and containment (e.g. creating a barrier between the contamination source and a receptor – such as humans, ground water or ecosystems);
- physico-chemical treatment to remove, degrade or immobilize the contaminants (e.g. using chemical additions to soil);
- biological treatment to remove, degrade or immobilize the contaminants (e.g. using plants or microorganisms to clean water or soil).

Step 6: Verification

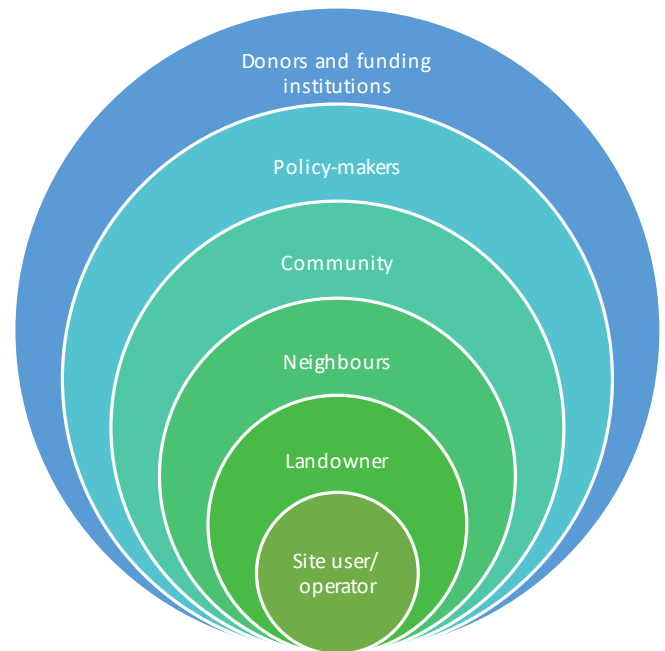
Once a site has been remediated and redeveloped, environmental monitoring should be considered to ensure that no unexpected risks arise (especially when contamination was not fully removed). Such monitoring can be time-limited to ensure that all remediation targets are achieved, but it can also continue over a longer time period to ensure that contamination levels do not rise or reappear again.

The remediation and redevelopment steps should also take into account broader aspects (such as cultural, social or recreational implications) that go beyond the site-specific environmental conditions and reflect the needs and preferences of the local community (see Fig. 4).

Fig 4: Socio-spatial site dimensions to be considered during remediation and redevelopment

Step 5: Implementation of remediation and subsequent redevelopment

This step involves implementation of the remedial action plan to remove, degrade or isolate the identified contamination, and make the site ready and safe for future developments. Ideally, remediation works should be immediately followed by the planned redevelopment of the contaminated site, and the establishment of new site functions. This helps to avoid stagnation and degradation of the site, and potentially enables the use of any excavations for new infrastructure.



Mitigation measures during site remediation, Buggenhout, Belgium
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5. Good practices and lessons learned

This section provides information about good practices that can increase the likelihood of positive results and the adequate consideration of health aspects when redeveloping contaminated sites. These practices fall into three categories that, when applied together, can help to manage such projects successfully:

- ▶ **Orgware** – representing how a process is organized, coordinated and regulated, and whether there are political and technical frameworks supporting remediation and redevelopment projects (e.g. enabling policies, such as grants or specific (financial) programmes; regulations and legal mandates; communication and engagement activities);
- ▶ **Hardware** – including equipment and techniques as well as procedures for risk assessment and site cleaning (e.g. machinery and tools for remediation, and sampling techniques);
- ▶ **Software** – assuring adequate evaluation procedures and calculation instruments (e.g. data collection, risk modelling and decision-support tools).

Practices representing each of these categories should be employed in order to ensure the success of a project. Quite often the software and hardware aspects of a project are well developed, and much technical knowledge and tools (e.g. guidance reports and decision-support models) are available. Over the last decades, environmental companies have also increased their capacity and performance in the field of soil investigation and remediation. However, adequate process organization (orgware) is essential to make effective use of this knowledge and expertise. Case studies have shown that the combination of all three categories is needed for an adequate and health-enhancing redevelopment of contaminated sites.

The following good practices are derived from a European review of practice on the redevelopment of contaminated sites, and reflect these practice categories – providing planners with guidance for the rehabilitation of urban sites (WHO Regional Office for Europe, 2021).

5.1. Addressing the challenge of lack of information on old sites

Before the site investigation starts, a desk study should be carried out to provide insight into the past land use and potential sources of contamination. This provides a first overview of what risks could be associated with the site, and where these could be located. However, many contaminated site redevelopment projects face

the challenge of insufficient information on the site and its history. This is often because of missing digitalization of data and problems with locating the records – which is especially challenging when local authorities and their departmental archives have been restructured in the past.

Lessons learned from European redevelopment case studies indicate that information could be obtained from various alternative sources:

- ▶ Environmental permits from the past may provide valuable information.
- ▶ Former employees (or local residents) can be consulted, although this is difficult for contaminated sites on which activities have stopped decades ago.

- ▶ Old map data or images can be consulted to determine past industrial locations. Sometimes street names refer to former activities or companies and in this way the previous land use and potential sources of pollution can be deduced.

If no historic data or personal information on the past site activities and potential contamination are available, systematic or grid sampling of the site may be an option to get a first rough assessment of the site condition and the potential contamination.



Former military site in Boeblingen, Germany – before, during and after redevelopment
© Zweckverband Flugfeld Boeblingen / Sindelfingen

5.2. The need for a shared vision on the future function of the site

It is important for all stakeholders and actors involved in the redevelopment of a contaminated site to establish a shared vision on the future of the site, as this is often the only way common agreement can be reached. Achieving such a shared vision is an important foundation for all other decisions to come, and can be a significant benefit when it comes to technical, procedural

or regulatory conflicts of interest between stakeholders.

Early agreement on and preliminary planning for the future of the site also enables quick action, and may facilitate an integrated approach, in which remediation of the site and redevelopment of the future site functions can go hand in hand as one larger project, offering many benefits

(such as the ability to select the remediation techniques most suitable for the expected future site function).

Based on the review of European redevelopment case studies, the following actors and stakeholders should be considered for the establishment of a shared vision on the site's future, noting that in every local setting additional actors may need to be added:

- ▶ private and public entities owning, developing and investing in the site;
- ▶ public authorities in charge of spatial planning, environmental protection and public health;
- ▶ regional or national actors as necessary, noting that some sites may be governed by legal frameworks and planning requirements beyond the local level;
- ▶ local residents and communities.



New mixed-use development on a former industrial site in Bristol, United Kingdom
© Danielle Sinnott

5.3. Managing stakeholder involvement

Contaminated site redevelopment projects also need to acknowledge the views and interests of a broad range of stakeholders to find adequate and implementable solutions and enable healthy future functions on the site. The identification of the different stakeholders and their needs is a necessary step for all redevelopment projects, and is particularly important to enable adequate

project implementation on privately owned sites and/or sites financed by private funds. In such cases, public authorities may often need to find compromises to enable the redevelopment and ensure that investors have optimal incentives, while not compromising on environmental and health standards.

Beyond the local communities, major stakeholders include:

- site owners, companies and operators using the site or redeveloping it;
- project funders, investors and insurers;
- governmental and public authorities to be involved in the planning, remediation and redevelopment of the site;
- environmental experts, contractors and external consultant companies involved in planning and redevelopment.

It is important to consider the contaminated site in the broader context of roles and interests, similar to the wider socio-spatial context (Fig. 4). Fig. 5 shows the variety of functional expectations to be fulfilled, and helps to identify the various stakeholders on and beyond the site itself.

As there can be strong conflicts of interest between the different stakeholders and their objectives, multiple stakeholder management is a challenge for many public authorities coordinating contaminated site redevelopment projects. Effective stakeholder management requires a systematic approach of identifying, managing, controlling and communicating with all parties who may affect or be affected by the project, treating their interests duly and equally while trying to find common denominators. This also includes the interests and objectives of financial institutions and donors that may be involved in funding large-scale redevelopment projects.

Irrespective of the type of stakeholder, the following practices have been shown to be relevant in European redevelopment case

Fig. 5. Roles and interests to be considered during site remediation and redevelopment



studies and provide a rule of thumb for multiple stakeholder management:

- ▶ Think beyond the site when identifying your stakeholders.
- ▶ Initiate contact at the earliest opportunity to identify potentially conflicting expectations.
- ▶ Understand the interests, concerns and expectations of each stakeholder.
- ▶ Establish a stakeholder management plan and use it as a living document, updating it regularly and staying in touch with the respective stakeholders throughout the process.

Irrespective of stakeholder expectations, it should be clarified that the public and its safety is the most important stakeholder to be served. Local authorities must be committed to achieving the best affordable outcome for the local citizens in terms of environmental conditions and health protection, and to enabling a sustainable future for the site.

5.4. Coordination and leadership by public authorities

The role of public authorities might vary from being formally in charge of managing remediation and redevelopment on public grounds, to overseeing, regulating and approving similar activities on private sites. Especially in large projects, it is important to acknowledge the complexity of such projects and the technical relevance to various departments, requiring a coordination of roles and mandates within the public authority (stressing the relevance of a shared vision on the future function of the site).

Lessons learned from European redevelopment case studies on the empowerment of local authorities to manage contaminated site redevelopments have shown the following good practices to be considered:

- ▶ Anticipate the opportunities that local sites with potential contamination history may present for urban development, and be ready with ideas and proposals for new functions when action on and modification of these sites becomes possible.
- ▶ Be transparent and consistent in decision-making, and act quickly and transparently on public concerns regarding environmental safety and health impacts of contaminated sites to maintain public trust.
- ▶ Involve health authorities actively in the site investigation and the planning of remediation work, as well as in the consideration of long-term site monitoring.
- ▶ Ensure protection of the environment and local population at all times throughout the remediation and redevelopment process, and request or carry out respective inspections and assessments
- ▶ Provide a focal point or case manager to oversee site-specific project work and harmonize project procedures and decisions within the public authority and across the involved departments, ensuring effective project management (acknowledging that different departments follow different objectives and are governed by different regulations).
- ▶ Provide training and capacity-building on remediation and redevelopment to empower local staff, and recruit – when needed – external experts to support at the local level.
- ▶ Establish specialized public entities to deal with contaminated sites and coordinate respective projects (possibly at higher jurisdiction levels as joint entities with other public authorities or stakeholders), which helps to concentrate expertise and experience on redevelopment projects.
- ▶ Establish national or regional programmes to support local work on contaminated sites, which may provide useful guidance, procedures and resources that local authorities may not have the resources to establish on their own.

5.5. Transparent and open risk communication is necessary

Remediation and redevelopment of contaminated sites most often takes place in or close to residential settings. The redevelopment of contaminated sites therefore affects the near-by communities, and is often associated with fears and concerns among the local residents. These fears can originate from past experiences with

the site and its contaminating practices, and/or the perception of lack of action and commitment by responsible authorities. This explains the strong sensitivity in many local communities when it comes to the establishment of new functions on contaminated sites, and the need for transparent and open communication on the risks

of contamination and site remediation (see also WHO, 2017). In this context, the following lessons have been learned from European redevelopment case studies:

- ▶ Community perceptions and concerns should be addressed with respect and understanding.
- ▶ Existing risks and the respective actions to manage them (as well as the benefits of the remediation and redevelopment plans) need to be communicated in a transparent and inclusive way and at an early stage to the local community.
- ▶ Providing consistent and transparent information throughout the remediation and redevelopment process can establish trust and acceptance in the community towards local authorities.
- ▶ The involvement of independent experts and external institutions can be helpful in providing the necessary evidence and risk assessments, and separating the hard facts from political decision-making.

5.6. Ensuring public participation and involvement

Local citizens are increasingly aware and active concerning the environmental conditions in and around their neighbourhood, and local civil society organizations will often play an important role in representing the community's expectations. It is paramount to actively involve local residents and community groups at an early stage of contaminated site redevelopment projects to better understand their expectations and preferences regarding the site remediation, ensuring that the site redevelopment aligns with local community needs (see also Office of the High Commissioner for Human Rights, 2018).

Lessons learned from European redevelopment case studies suggest the following:

- ▶ Local discussion fora and participatory planning instruments, such as environmental or health impact assessments, provide useful procedures for effective public participation.
- ▶ It is important to ensure that different local groups and stakeholders are heard (as some groups may be much better organized and more proactive than others).
- ▶ Adequate involvement of local communities in the remediation and redevelopment process may also help to generate an increased sense of ownership and ensure that the new function of the site is in line with local demands.
- ▶ Some contaminated sites may host infrastructure that represents cultural heritage or reflects local industrial history, leading to a public interest in preserving some of these elements and embedding them into new site functions.



Public participation and exchange (workshop, Serbia)
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5.7. Quality assurance, use of external expertise and the need to establish professional structures

The assessment and redevelopment of contaminated sites is a complex challenge, and each site has unique characteristics related to its history. The redevelopment of contaminated sites is not a routine task for public authorities, and standard operating procedures and workflows are usually not available. Depending on the complexity of the contaminated site and the redevelopment process, public authorities may therefore need the assistance of external experts and specialized service providers to perform some or even most of the activities required to investigate, remediate and redevelop a contaminated site.

An integrated approach, drawing on a range of external skills and expertise, is recommended to create environmental, societal and economic added value during the rehabilitation process.

Across the activities performed by external actors, it is important to ensure that health aspects are adequately considered, and the site investigation findings are evaluated from both environmental and health perspectives.

External expertise is often sought from:

- environmental practitioners with diverse expertise (e.g. in chemistry, geosciences, engineering, field sampling, redevelopment and other disciplines);
- soil sampling and analytical laboratories;
- environmental contractors (e.g. engineering companies, remedial enterprises);
- redevelopers (e.g. planners, real estate companies, building companies).

Lessons learned from European redevelopment case studies suggest that, for those tasks which cannot be managed with internal resources, public authorities should ensure the following:

- ▶ Experienced and accredited professional consultants and contractors need to be selected to carry out site investigation and remediation work on contaminated sites.
- ▶ Regulatory standards on environment and health need to be applied as a consistent and reliable baseline for local measurements, assessing the need for remediation and evaluating its success.
- ▶ Competent authorities should be established (possibly at regional or national level) and involved at local level to provide expertise, procedures and standards (and potentially funding schemes) on contaminated site management, remediation and redevelopment.

The establishment of competent authorities, accreditation systems and/or clear standards for local risk assessment is an important task for national governments, as public authorities at local level need such guidance to seek technical support and evaluate its quality. However, local and regional authorities can also jointly establish public bodies that help to manage local projects on contaminated sites, and internally accumulate the respective knowledge and experience.



Excavation of a former waste dump, Buggenhout, Belgium
© Public Waste Agency of Flanders

5.8. Ensuring environmental protection and adequate coverage of health aspects

Any local remediation and redevelopment process should aim at a final site that is sustainable and safe from both environmental and health perspectives. It is important that, throughout the process of remediation and redevelopment, health and environment are protected and respective standards and guidelines are observed. Environmental health considerations should therefore be a priority to be considered during the multistakeholder engagement process (described in section 5.3), noting that different actors may have different perceptions of a “safe site”.

Lessons learned from European redevelopment case studies indicate that the following steps are paramount to ensure that environmental aspects and health requirements are fully observed when considering redevelopment of contaminated sites:

Site investigation before intervention

- ▶ Assess environmental contamination immediately after site operation closure, or as early as possible, and take precautionary measures if needed to avoid the potential spread of contamination.
- ▶ Carry out solid risk assessments before remediation and redevelopment activities begin.
- ▶ Inform local communities transparently about the risk assessment findings, the risks and benefits of the planned measures, and how such risks will be managed.

During remediation and redevelopment measures

- ▶ Protect workers and the local community and fully inform them about the remediation and redevelopment activities and available self-protection measures.
- ▶ Dispose of toxic material safely, in accordance with national regulations.
- ▶ Monitor specific substances or media (as required) during site interventions to ensure that remediation and redevelopment do not create environmental or health risks.

After redevelopment and during the use of new site functions

- ▶ Monitor specific environmental parameters (as required) in the redeveloped area for a certain period to ensure that no environmental risk occurs.
- ▶ Be aware of the site history and potential risks. Health authorities, local residents and site users should be especially sensitive to reported health concerns and potential clusters of symptoms or diseases.

It is important to note that all of the above steps should involve health authorities to ensure that health aspects are adequately considered throughout the whole project period. Based on the WHO review of European redevelopment case studies, health authorities were only involved in less than half of all remediation and redevelopment projects, and health impact assessments were applied less often during redevelopment projects than environmental impact assessments (WHO Regional Office for Europe, 2021).

5.9. Monitoring risks

Contaminated sites often have a long history of pollution and the removal or isolation of contaminants is a technical challenge. Various cases have shown that unexpected contamination can still be found after remediation action. Depending on the type of contamination, the scale of the site and various other factors, health effects may only occur years after the site redevelopment has been finalized. It is therefore important that any remediation and redevelopment plan also considers measures to detect environmental problems after the new site function is implemented, and that health impacts related to environmental conditions of the site can be identified and addressed.

In order to take mitigating measures in good time, monitoring should be installed from an early stage and transparently communicated to all involved



Degassing of a former landfill area, Schelle, Belgium
© Public Waste Agency of Flanders

stakeholders. It is important to note that the monitoring is not an indication of unsuccessful remediation, but rather a precautionary approach that is often stipulated by environmental regulations and, therefore, an integral part of the remediation concept. More than half of the European contaminated site redevelopment case studies reviewed by WHO included site monitoring after the redevelopment was finalized. These local experiences suggest the following:

- ▶ Monitoring should be specific to the sites' contamination history and remediation actions.
- ▶ An action plan with defined thresholds should be established in advance to ensure an appropriate and quick response if monitoring results require rapid actions.
- ▶ Specific attention should be paid to exposure pathways via aerial deposition and groundwater transport, which can lead to contamination beyond the site itself.

The use of human biomonitoring should – due to its cost and complexity – not be considered as a standard monitoring feature, and only applied in specific cases to support decision-making. Before application of human biomonitoring, clear guidelines should be established on the respective response actions if certain contamination levels are exceeded.

5.10. Funding and the polluter pays principle

Due to the significant cost of site remediation, economic aspects have a huge impact on the probability of remediation and redevelopment of contaminated sites. Legal frameworks should put the responsibility for contamination (and associated impacts) on the entity responsible for the pollution, and include rules for managing possible legal conflicts. Although this is the case in most legal frameworks, practice shows that

with each passing year after the site closure it is increasingly unlikely that the polluters will be made legally accountable for the contamination and the related remediation cost. In cases where the polluter cannot be held accountable, the current landowner or the state may be responsible for the remediation, although the specific regulations governing liability vary between countries.

Another funding challenge arises from contaminated sites situated in areas with low economic value, where private or public stakeholders cannot gain a financial benefit from redevelopment. This often leads to such sites being abandoned and unused, becoming areas of environmental and social degradation, and affecting urban planning and development. Environmental remediation, paid from public budgets, is often the only opportunity to make the site usable for new functions.

Given these challenges, it is essential that economic aspects are a part of the discussion on the redevelopment of the site at an early stage to ensure solid funding. In specific cases, cost–benefit or cost–effectiveness analyses may even be carried out to identify the best solution.

Experience from European case studies on the redevelopment of contaminated sites suggests the following considerations:

- ▶ Legal frameworks should ensure the accountability of the polluter for all

environmental damages and the associated financial consequences, irrespective of timelines.

- ▶ Local authorities should duly implement all generally applicable environmental inspections to detect contamination issues, and carry out relevant measurements when site functions or ownership structures change. This way potential environmental remediation needs can be raised at an early stage and while the accountable entity is still available/functional.
- ▶ Economic incentives and national or regional funding schemes could be considered to attract private sector investments to less attractive sites where the cost of remediation and redevelopment cannot be compensated for by the future function.
- ▶ A budget buffer should be established for unexpected events (e.g. newly discovered contamination), which may require significant changes to remediation and redevelopment plans and thereby increase project costs.

5.11. Addressing small local sites that may not be considered as typical contaminated sites

In many cases, contaminated sites are large land areas where polluting activities took place and/or harmful materials were managed or produced – such as industrial complexes, or military sites. Yet, small operations, such as local companies, dry cleaners and petrol service stations are omnipresent in urban residential areas, and may have contaminated the soil as well.

A similar challenge is represented by small (and often illegal) waste dumps where local residents and companies dispose of household or commercial waste, which can also lead to contamination of soil or groundwater. Such dump sites often occur on public land or “no man’s land”, and also require public authorities to take action using public finances.

Lessons learned from European case studies suggest that small local sites may still be important to consider, even though they may not be formally listed as registered contaminated sites. For such small and local sites with potential contamination, it is important to:

- ▶ set up soil investigations (e.g. when ownership or site function is changing) to determine potential risks;
- ▶ implement remedial actions depending on the results before the respective plot can be redeveloped for other functions.

However, smaller sites in residential areas (and especially areas with low economic value) may often be less interesting for external investors, and require public authorities and public funding for remediation.

6. Key messages

Contaminated sites are part of a changing socioeconomic reality in an urban area, often covering more than a century of urban development and industrial heritage. Similarly, the process of redevelopment of such sites can take a long time, but often determines the image of the city for the coming century. The redevelopment of urban contaminated sites is not only an environmental duty, but also opens opportunities for land recycling, sustainable urban planning and renewal, and establishing healthy environments.

Redeveloping contaminated sites provides environmental, economic, social and health benefits to local communities as well as to local authorities. Based on lessons learned from past site redevelopments, the following key messages are extracted for urban planners and stakeholders considering future interventions:

Redeveloping contaminated sites is a promising public health intervention.

The remediation and redevelopment of contaminated sites are complex and challenging, but can have significant benefits for environment and health.

The conversion of contaminated sites requires careful management to ensure that potential removal of contaminants does not lead to risks in other places. Public health considerations should be fundamental for all negotiations on site interventions, and the compliance with environmental and health standards should be a prerequisites for all discussions with site owners, investors and other stakeholders.

A sound site investigation is the baseline for all decision-making.

A detailed site investigation, leading to a good understanding of the contamination and site characteristics, is essential to develop effective remediation strategies and ensure healthy and sustainable site redevelopment. Site investigation should therefore not only consider environmental dimensions, but also include health risk assessment.

A well-defined quantification of the site contamination can help to create a clear baseline for discussion with various stakeholders, including future site developers. Regular screening and monitoring during remediation as well as after the redevelopment should be considered to identify and mitigate unexpected problems occurring at the site.

Effective and transparent coordination and communication is a key requirement.

The redevelopment of contaminated sites requires careful planning and coordination. Multiple public agencies need to collaborate effectively across the entire process, and harmonize their objectives, processes and legal frameworks. It is essential to liaise with project stakeholders at an early stage and aim towards a common understanding of future site functions, which may help to find compromises and solutions on specific problems and overcome obstacles arising during remediation and redevelopment.

Transparent communication and effective community involvement are essential to gain public trust, and develop a feeling of ownership of the redevelopment process among local residents.

Knowledge and experience must be shared and capacities built.

The redevelopment of contaminated sites is not a daily routine for most local authorities. Standard operating procedures often do not exist and legal frameworks vary from country to country. Networking across cities on relevant experiences and examples of local interventions is therefore an essential approach to learn and save time and resources. It is important that public agencies publish such information and share their knowledge.

Beyond the exchange of local practices, cities need to develop professional capacities to manage redevelopment activities and to collaborate effectively with external specialists and contractors – especially when support from national agencies is not available. Joint public bodies, established by various local or regional authorities, are one way to address this challenge and build capacities on contaminated site redevelopment.

De Krook, Ghent, Belgium, during soil remediation
© BSV-nv contractor

Site diversity must be acknowledged and tailored responses found.

Legal frameworks often tend to apply to larger sites and/or industrial plants, which are obvious sources of contamination. Yet, there is a range of small, potentially contaminated sites in urban settings that do not necessarily fall under respective legal frameworks (e.g. petrol stations or dry cleaners). Local authorities should be aware of the potential contamination in small and non-industrial sites, and identify local solutions for remediation and redevelopment.

Sites may also have different levels of economic value, depending on size and location. Contaminated sites in disadvantaged areas might be financially unattractive for developers, leaving them as vacant lots without required remediation. Urban planning schemes, financial incentives and public funding mechanisms are often required to solve specific challenges posed by low-value contaminated sites and ensure their clean-up.



National structures and frameworks are essential to support local authorities.

There is a lack of European or international standards on soil in general, and on the remediation and redevelopment of contaminated sites specifically. Therefore, national governments – or even subnational authorities – need to establish their own frameworks and entities to support local authorities by providing technical guidance, operating procedures, contamination limits and clear measures on the accountability of polluters. These frameworks should ideally include national grants and funding schemes for the required remediation of contaminated sites for which no private or external entity can be charged.

Certification or accreditation schemes for specialist companies working on environmental remediation and decontamination would be helpful to support local authorities in the selection of skilled partners to perform site investigations, risk assessments and remediation work.

Lessons learned from the past can help inform the management of future site closures and contamination scenarios.

The conversion and redevelopment of contaminated sites deals, by definition, with sites that have a history of pollution. In many cases, contaminating activities may have stopped several decades ago, but the sites were left unattended for a long time – making redevelopment even more challenging.

Learning from past experiences, local and regional authorities need to prepare for future site closures and enable an efficient management of forthcoming redevelopment projects. The following actions should be taken:

- ▶ Anticipate closure of still active contaminated sites and plan future functions and redevelopments early, also considering the economic aspects of redevelopment.
- ▶ Assess environmental contamination immediately after site closure and in relation to land sales and changing ownership to make the polluter accountable for required clean-up interventions.
- ▶ Ensure that records on contaminated sites and their contamination history are archived properly (in digitalized format).
- ▶ Act quickly on abandoned sites and avoid longer time periods of stagnation (potentially implementing interim site management during periods of nonaction).
- ▶ Establish local capacities and/or seek competent partners and national schemes that can support the assessment and management of remediation and redevelopment of contaminated sites.



Remediation work and capping to prevent asbestos exposure at Parc de l'Alba, Spain
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Contaminated docklands redeveloped for residential and commercial functions, Lyon, France
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ISBN 978-92-890-5634-2



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