optirisk®

RECOMMENDATIONS FOR ACTION

FOR OPTIMIZATION OF REDEVELOPMENT CONCEPTS FOR ENVIRONMENTALLY BURDENED SITES

Guide for Municipalities and Planners

Redevelopment:
New Construction:
Fitness Center
Noise Protection Barrier
Trade / Industry
Solar Energy
Parking
Indoor Playground

Waste Disposal Risk
Contamination
Waste
Remediation

RECOMMENDATIONS FOR ACTION

FOR OPTIMIZATION OF REDEVELOPMENT CONCEPTS FOR ENVIRONMENTALLY BURDENED SITES

Guide for Municipalities and Planners

assigned by the
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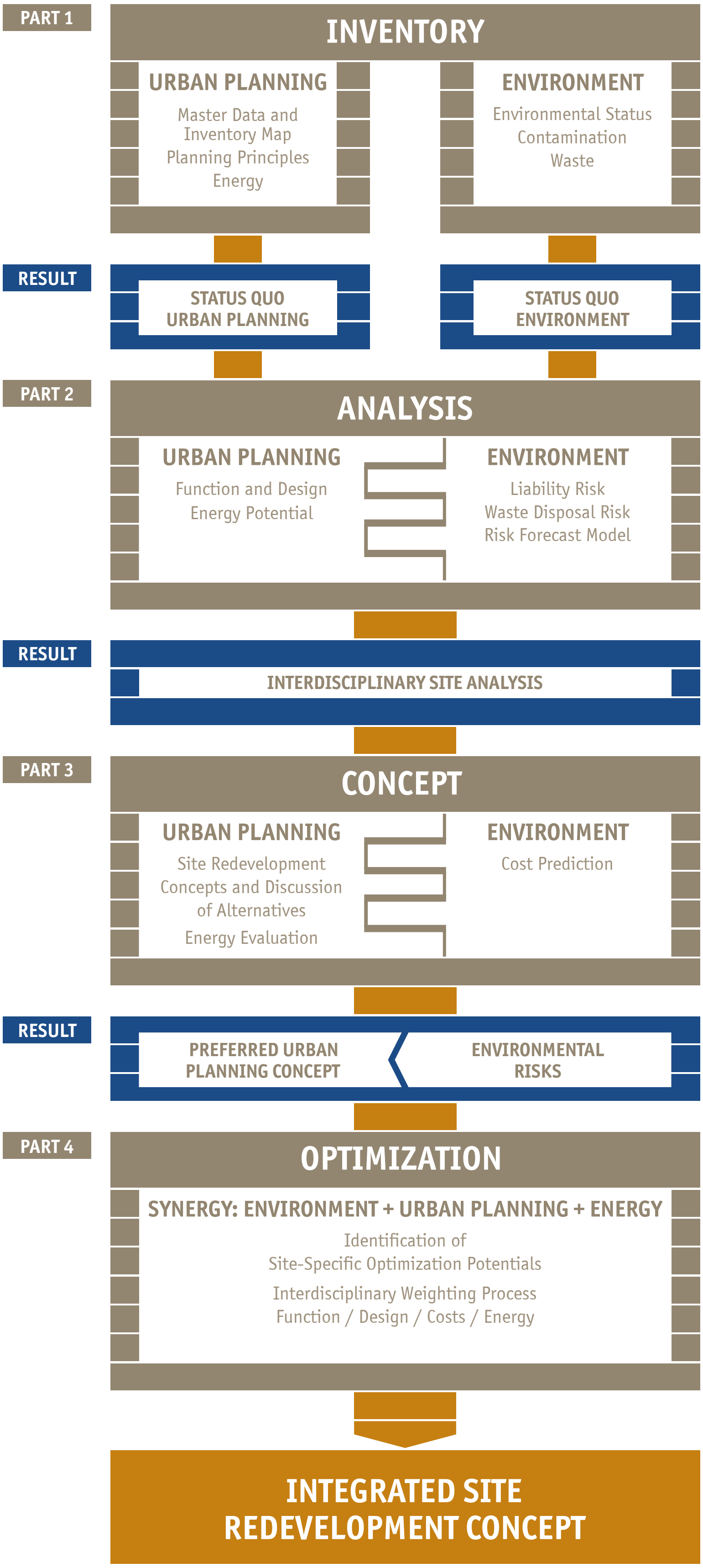
within the framework of
REFINA: RESEARCH FOR THE REDUCTION OF LAND CONSUMPTION
AND FOR SUSTAINABLE LAND MANAGEMENT



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PREFACE

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are available for download at: www.optirisk.de

FORWARD BY DOUGLAS C. MACCOURT, ESQ., ATER WYNNE LLP

In less than 40 years since the adoption of the first national laws establishing liability for improper waste disposal and hazardous substance releases, science and policy have been forcibly and unevenly merged to create an imperfect but important mandate for reducing the myriad of potential health and ecological risks from environmental contamination. During this time, advances in analytical technology have made it possible to identify and quantify chemicals and other conditions in soil, groundwater and air at levels previously thought undetectable. Development of public access and legal rights to enforce environmental regulations have permanently changed the way industry and commerce functions across the globe. With these advances, it would seem that the human condition, and indeed the planet, is safer and more sustainable.

One problem is that these optimizing conditions are shared with global land consumption that continues to grow at an alarming rate, even in countries with regions and great urban areas whose population is shrinking. The global economic crisis of 2008 permanently altered the stability of countries and institutions that were believed immune from unpredictable market forces, with the result that credit and financing has become significantly reduced and economic risks once thought to be manageable are avoided. Simply put, the pressure for greenfield development is escalating and low risk tolerance is preventing much brownfield redevelopment from ever getting off the ground. It has never been more important to unlock the profitability of recycling brownfield sites. Overcoming the obstacles to brownfield renewal is not easy, but it is made easier – and more cost effective – with tools like optirisk®.

optirisk® is one of the most advanced predictive modelling tools developed to date for brownfield redevelopment. I can say this because after over 30 years in the environmental remediation and restoration field, it is clear to me that every successful clean-up and redevelopment project shares several things in common. One of those attributes is creating and applying a design for reuse that integrates the best building and landscape architecture (informed by effective public input) with a comprehensive environmental risk assessment to form a new type of human and ecological terrain. In 2003 I coined this concept "Brownscape Design" – and took part in several projects to test the concept in the US and Germany during the remainder of the decade through the work of the US German Bilateral Working Group. Testing optirisk® in the City of Troutdale confirms the power of the innovation under real brownfield conditions in the US.

optirisk® allows the user to formulate cost effective redevelopment scenarios by comparing alternatives with different risk and cost profiles. It is a user-friendly application that requires the basic data that every brownfield site will generate or assemble in the process of site characterization and feasibility analysis. It is a tool that can be applied in a wide range of settings, from explaining development proposals in public meetings, to presenting development options to town councils and government officials, and to demonstrate financial feasibility and risk management to potential investors. optirisk® will play a role in the critical discussion of land recycling for years to come.

PREFACE

PREFACE

Sustainable land use

The reduction of land consumption for new areas of housing and transportation infrastructure development is an indispensable component of sustainable land use. Instead of extended development of settlements on greenfield sites, the focus is on recycling land, particularly the revitalization of contaminated industrial, military and commercial properties or “brownfields” within cities and communities. The realization of the vision of an extensive land re-use requires the inclusion of all brownfields according to their development potential. In this case, their potential must be evaluated in a differentiated manner and the brownfields must be restored to a state that permits an appropriate re-use. This requires transparent and innovative approaches in dealing with contamination. For many industrial and military brownfields, the perception of contamination delays revitalization, causing these sites to often lie fallow for a long time and investments to fall back on greenfields on the periphery of the city.

Revitalization constraint: Stigma of hazardous contamination

Go for revitalization!

Our practical recommendations for action for the optimization of integrated site redevelopment concepts, especially for these problem sites, can help overcome hurdles on the way to revitalization. A key factor is the extent to which urban planning and land use concepts are not necessarily in conflict with the contamination of the site. Simply put, there is no reason to shy away from redeveloping contaminated sites. The optirisk® recommendations for action, together with the flexibility of intended alternative use in terms of urban planning, are designed to encourage the optimization potential of the brownfields and, together with experts, offensively tackle their redevelopment. This interdisciplinary approach, together with focused analyses of energy potentials can open up extensive synergies for brownfield redevelopment. As a result, potential monetary savings can arise, resulting in a less exensive revitalization project than originally assumed.

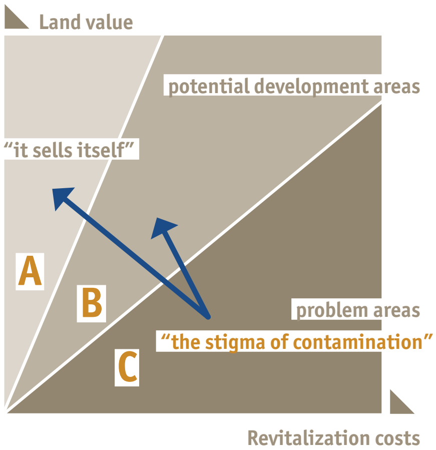
JENA-GEOS® in the east German state of Thuringia developed the innovation known as **optirisk®**. After the fall of the Berlin Wall, JENA-GEOS® assessed, investigated and cleaned-up approximately 2,000 brownfields. In doing so, we found that approaching brownfield redevelopment solely from the perspective of environmental hazards or urban planning, without careful analysis of risk and integration of design and environmental limitations create a major development constraint for contaminated sites and that interdisciplinary cooperation of all experts involved leads to superior and cost-effective redevelopment. In cooperation with the Bauhaus-University Weimar and the Thuringian Association of State Development, we developed **optirisk®** in the context of a national research initiative. **optirisk®** has already been applied successfully in Germany and has been modeled on a site in the City of Troutdale, Oregon in the USA.

In the context of the cooperation between American and German environmental experts (US-German Bilateral Working Group), **optirisk®** was selected for practical testing in the United States. The results of the application on an U.S. site are presented in the English version of **RECOMMENDATIONS FOR ACTION FOR OPTIMIZATION OF REDEVELOPMENT CONCEPTS FOR ENVIRONMENTALLY BURDENED SITES**. The cooperation project was supported by the project team TASK – The Centre of Competence for Soil, Groundwater and Site Revitalization at the Helmholtz Centre for Environmental Research. All results and documentations of **optirisk®** can be also found at www.optirisk.de or at the website of the US German Bilateral Working Group, www.bilateral.org/smarte.

PLEASE NOTE
www.optirisk.de
www.bilateral.org/smarte
www.ufz.de/task

Brownfields are underutilized, potentially contaminated properties, often blighted "eyesores", the redevelopment of which are in the public interest.

Introduction



A-B-C - Model of the European Brownfield Research Association CABERNET (edited)

The following recommendations for action refer to the reintegration of brownfields in the circulation of land development for housing and transportation. This involves the so-called "C-sites" where remediation exceeds the current land value due to the presence, or even the stigma of contamination. From an economic point of view, the re-use of these sites is generally assumed to be excessively risky or not possible due to threat of liability risks and high remediation costs. The necessary return of these brownfields to the beneficial use requires a significant reduction in remedial costs. The application of renewable energy generation, such as capturing waste heat or using roof space for solar photovoltaic panels, can additionally help to alleviate the economic disadvantages.

Integrated Site Development Concept

The fundamental approach of these recommendations for action for site redevelopment consists of the close association of urban planning and environmental aspects at an early planning stage. Step by step, the urban development objectives and contamination risks are balanced against each other in order to permit revitalization in an economically and ecologically balanced ratio in terms of effort required and benefits achieved. Against the background of a policy which increasingly focuses on sustainable energy, the feasible energy potential of each site is also integrated into the analysis and planning process, which can be achieved in the context of clean-up and site development.
The recommendations for action provide a means to structure the sometimes lengthy and often difficult process involved in the revitalization of brownfields. The risk potential of various redevelopment scenarios can be realistically estimated and facts can be provided for profitability studies.
optirisk® serves to inform decision makers, facilitate the interest of investors and co-financing and provides supporting arguments for negotiations with property owners. Potential users of the recommendations for action are all those stakeholders who play a role in the redevelopment of brownfields.

Users
- *Owners*
- *Municipalities*
- *Agencies*
- *Planners*
- *Investors*

optirisk® is to be viewed as a starting point or precursor for further planning and feasibility determination process, but cannot replace the classic site development process. The feasibility of technical recommendations cannot be described in detail here.

Handling

The planning sector is oriented to the systematics of spatial planning as well as the inventory and analysis of environmental hazards for contaminated brownfields. For the purpose of clarity and applicability, only the essential content is described in the following text passages. Example questions at the end of each passage serve as a self-check.

The **EXAMPLES** using real sites illustrate the methods developed and applied by the authors. The **PRACTICE TIPS** are intended to convey the experiences gained in the process of applying optirisk®.
In addition, **PLEASE NOTE** provides further tools in the optirisk® research project or in the appendix and lists the **RESOURCES** of information.

The fold-out hard cover serves for orientation in the phasewise analysis and planning process and permits a lateral entry into the planning sequence.

The possibilities for utilization of funding for urban development, development of energy potential and site assessment and remediation are not part of these considerations. Further information and numerous funding resources can be found on the internet.

DEFINITION OF ESSENTIAL TERMS

Key essential terms are described in the following. Additional terms are explained in the glossary.

In the frame of present recommendations for action, **environment** and **environmental issues** are limited to contamination and the potential presence of hazardous substances. In the following, **contamination** is understood as accumulations of pollutants in soil, water and buildings. Again, the presence of **hazardous substances** (can) lead to hazard-relevant contamination. The kind and quantity of contamination present on a given site and the risk of mobilization / migration thereof are crucial to the evaluation of whether a hazard is actually present and whether remediation is required. In general, if regulatory "action" or acceptable risk levels are exceeded, the site must be remediated by the responsible party, typically the owner, operator, or generator. In this context, **liability risk** is incurred if contaminants are present in quantities warranting remediation and costs arise for the remedial activities. A property where remediation was implemented is free of hazardous substances and hazardous contamination, but not free of contamination per se. Contamination which causes no danger for the environment is referred to as **waste disposal risk**. There is no obligation for their removal. However, if such lower level of contamination is excavated or if such lower contaminated building structures are demolished, they must be disposed of according to waste disposal regulations. Additional clean-up costs arise in this case.

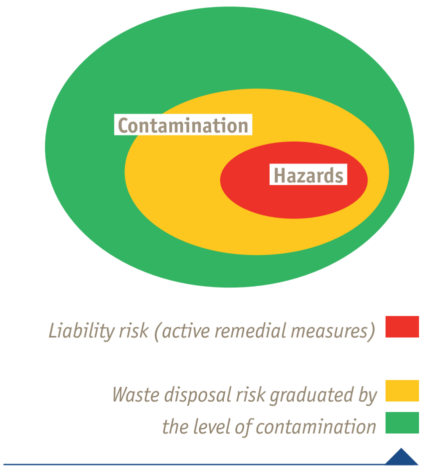


Illustration of Environmental Burdens

The inclusion of urban development aspects in the optimization of site redevelopment concepts for contaminated properties covers the entire range of regional planning – from the specifications of regional planning, the level of community site management, and other overall urban or partial development plans to specific property-related statements regarding the **function and form** of possible uses.

In addition, during the redevelopment of contaminated sites, potential **energy applications** may be feasible, which can include measures for the improvement of energy efficiency or for generation or storage of electricity.

PART 1 Inventory Fundamentals

The concept of integrated site development represents a synergy of urban development and the environmental condition and regulation of the site. By geographically superimposing both components, you can achieve an optimization through the use of cost saving potential. For this, several steps are required: First, all data must be recorded that could be relevant for the nature of the task. This includes general master data for the property, statements regarding reclamation, use and development as well as data regarding circumstances relevant to nature and the environment.

PLEASE NOTE
Detailed version of a registration sheet (cf. Appendix 1 at www.optirisk.de)

Recording and documentation of the status quo includes both the physical and the essential parameters, the historical and planning-related information within the scoping area, as well as the legal conditions.

PRACTICE TIP — If this involves large sites with differentiated circumstances or the processing of a site portfolio, it makes sense to document the as-built data in a GIS-linked database. In this case, data collection can be performed by means of a database program.

PLEASE NOTE
Cf. www.optirisk.de

MASTER DATA AND AS-BUILT MAP

The master data forms the basis of further investigation as well as the exact cartographic orientation and graphical representation. In addition to designating the site and the address, it primarily provides information regarding the owner and contact persons as well as public easements. Along with data about the geographic location (including heights) and the land register, information about the standard land value must also be provided.
The most important planning documents are detailed maps for representing the status quo and drafts of development concepts, preferably in digital form.

- Is the master data incorporated in a GIS?
- Does the parcel map / GIS information agree with the land registry?
- Is the as-built representation up-to-date?

RESOURCES
- *Land registry*
- *GIS services (community / municipality)*
- *Department Planning and / or Community Development*
- *Brownfield register, state, region, municipality*
- *Archive*
- *Documentation*
- *Market value*
- *Surveyor*
- *Planner*

PRACTICE TIP — Early clarification of ownership is imperative for site development!

CONNECTION

This includes information about the location within the landscape, settlement patterns and structure, connection to the regional and local transportation networks as well as existing utility and waste disposal facilities. Quantitative and qualitative measurements and evaluations of the development conditions are necessary for further conceptual processing.

RESOURCES

As-built registry —
Department Planning and / or Community Development —
Topographic maps —
Street atlas —
City map —
Utility companies —
Electronic data-bases, both public and proprietary —

USE AND DEVELOPMENT

The uses of the buildings and open spaces must be recorded and documented in detail in a differentiated manner in order to be able to generate the realistic cost forecast needed later for clearing the site. Also, with respect to environmental risks, both the original use as well as the current or most recent use of each individual building, including basements, any other structural facility and each open space must be recorded. In addition, exact details must be provided regarding size, construction, material, structural condition, etc.

PRACTICE TIP — A mapping of site use, categorized according to the nomenclature of the registration sheet, as follows,

B — Development (existing buildings)
P — Other physical structures
F — Former buildings and plants
S — Sealed areas
U — Unsealed areas

has proven to be effective in combination with sequential numbering.

In view of the site development concept, the usage patterns and structure of the surrounding area as well as existing usage restrictions (protection of historic building or monument / historic landmark, project planning law, administration acts, etc.), if applicable, and obligations by regional and urban land-use planning and overlays must also be recorded.

RESOURCES

Owners —
Local government (e.g.: planning authority) —
District authority (e.g.: Historic Preservation Agency) —
Regional offices (e.g. surveying) —

- Which obligations for the site arise due to the regional, metropolitan and federal state planning requirements?
- Which objectives and regulations have been established for the site by the local or city planning codes?
- Are there any other laws, studies, or additional statutes of project planning, site management, or site development, as well as informal area planning, to be taken into account?

ENERGY

RESOURCES
- *Regional supply and waste management companies*
- *Responsible Housing and Planning Offices*
- *U.S. and State Departments of Energy*

The basis for energy planning options is the evaluation of existing utility infrastructure as well as an analysis of additional energy potential. Supply networks have to be viewed as technical resources and can serve for feeding of locally provided energy sources or for energy supply of local consumers. Larger systems such as regional transmission lines may also be relevant to the energy analysis of the property.

- Which supply, sewage lines and other infrastructure are available (local heating, district heating, gas, electricity, drinking water, waste water)?
- Can usable heat be extracted from the waste water of a large waste water pipe by means of heat exchangers and heat pumps?
- Can running water be used for water power generation?
- Which legal requirements or restrictions on use are present?

LANDSCAPE AND NATURAL SPACE POTENTIAL

RESOURCES
- *U.S. Environmental Protection Agency*
- *State and Local Environmental Agency*
- *U.S. Geological Survey*
- *Natural Resources Conservation Service*
- *U.S. State Department of Agriculture*
- *National Weather Service*
- *Topographic, hydrological and geological maps*
- *Subgrade reports*

Information on landscape and natural or open space potential, topography, water protection zones, nature reserves, water management uses, as well as climate and hydrology are evaluated at this step. In addition, the geological and hydro-geological site conditions, as well as subgrade properties must be explicitly surveyed. A detailed data collection serves as the basis for the assessment of hazardous substance issues related to environmental law and contamination, and also for the preparation of environmental risk forecast.

PRACTICE TIP — Detailed knowledge of nature conservation-related regulations at the brownfield can prevent additional costs in the course of further planning.

Course of the Sandy River east of the Property overlooking the Water Tower and Buildings of Former Rendering Facility

Model Site in Oregon, USA

The former site of a municipal wastewater treatment plant and adjacent animal rendering facility is located close to the inner city of the small town of Troutdale in Oregon, USA. The Sandy River flows east of the property and periodically floods smaller parts of it in the Southeast. In the frame of redevelopment, requirements of flood protection associated with construction demands have to be considered, especially during redevelopment of the riverfront. The Sandy River also contains a number of rare and endangered species of salmonid fisheries, which limit impacts to riparian and in water habitat.

EXAMPLE

HAZARDOUS SUBSTANCES AND CONTAMINATION

The data collection on aspects of hazardous substances and contamination is essential for the preparation of an environmental risk forecast and provides the basis for an estimation of clean-up costs related to removal of environmental risks. Both technical, regulatory and legal expertise is essential in this regard. A clarification of questions in terms of environmental law issues, as well as detailed documentation of the current ecological situation, is required for the property. In addition, the site-relevant surrounding uses must be recorded from an environmental point of view in order to define hazards within / going out from the area under investigation.
In the exemplary registration sheet (cf. Appendix 01) the collection of analyses of soil, soil air, building structures, ground water and surface waters, as well as plants, are provided. At larger sites with differentiated problems, it is useful to set up an analysis database that can be linked with GIS. In addition, a historical evaluation of site analytical data is important in this connection.

- Is the contamination situation of the site known or are there results of environmental investigations available? Are there contemporary witnesses, former employees or occupants?
- Is the site recorded in the land register?
- Has responsibility for liability due to hazardous facts been clarified?
- Are there ordinances of a regulatory agency with respect to the contamination situation and / or disposal of hazardous substances?

RESOURCES

- *Knowledge of previous owner / user*
- *Contemporary witnesses*
- *Sale contracts*
- *Land register*
- *State and Local Environmental Agency*
- *Local Planning and Development Offices*
- *Reports on Brownfield / Environmental Assessment*
- *Local consultants and attorneys who specialize in environmental risk*

Model Site in Thuringia, Germany

The former metal processing site is located in Southern Thuringia, Germany. An ordinance for site clean-up was issued by the responsible authority. The removal of all hazardous substances and contamination is the regulatory requirement for redevelopment of the site. A remedial action plan has to be developed by the clean-up manager. The clarification of clean-up responsibility is important in respect to accruing costs. At the model site, the generator of existing hazards could not be held liable. Thus, the property owners have to pay for clean-up.

EXAMPLE

View from the Courtyard onto the Main Building

WASTE

RESOURCES
- *Local and regional waste management companies*
- *State or Local Environmental Agency*

The documentation of environmental site conditions includes the assessment of all waste stored on-site compliant with its waste class, composition, origin, kind of treatment and disposal, quantity, and location at the site.
That involves all moveable goods which are no longer used in compliance with their originally intended purpose and which must be disposed of according to legal regulations.

PRACTICE TIP — Legal regulations on solid waste and hazardous waste management are specified in the Resource Conservation and Recovery Act (RCRA). Please consult your State or Local Environmental Agency for further information.

PART 2 Interdisciplinary Site Analysis

Integration of specialist disciplines

The complexity of the subject matter generally requires an interdisciplinary processing of site redevelopment concepts for contaminated properties. This indicates that to the extent possible, the recording of as-built data, analyses and concepts for the disciplines of urban development, energy, and environment must occur simultaneously. Only in this way can reliable statements be generated during the subsequent phase of optimization.
The coordination of disciplines is incumbent on city planning / urban development of the community and can be supported by third parties.

PRACTICE TIP — Early transparency with respect to environmental burdens provides broad cost assurance and is the prerequisite for the use of optimization potential during site development.

URBAN DEVELOPMENT: FUNCTION AND FORM

In the assessment of as-built data and the superimposition of legal and urban development stipulations and objectives, the general conditions for sustainable site development are defined – sustainable especially in relation to the urban development regulations for future uses and the integration of regulated development into the existing environment with minimal conflicts. In addition to design-related and functional criteria, economic, ecological and social aspects must also be incorporated in the evaluation of site potential on a regular basis. Through the integration of different specialty areas, a comprehensive view of Strengths, Weaknesses, Opportunities and Threats (SWOT-Analysis) can be successfully conducted in the context of regional and local development perspectives.

The result of the analysis is site-specific information on the type and amount of land usage, open space usage and on urban development and regional building qualities. The concrete planning approaches are presented together, possibly also in development scenarios, and form the basis for developing concept variants.

- Are there – possibly also concurrent – development objectives for the brownfield?
- Which uses are generally permitted and which are realistic in view of the demand for such use?
- What stimuli or adverse effects can arise for the surrounding environment and urban development as a result of the planned brownfield revitalization?
- What steps are required or possible in order to realize the desired use of the brownfield?

ENERGY POTENTIAL

Renewable energy sources

- *Geo-energy (e.g. geothermics, groundwater, hydroelectric potential from surface waters)*
- *Environmental energy (e.g. exhaust air, waste water heat, processes)*
- *Solar energy*
- *Wind energy*
- *Water power*
- *Biogas, biomass*

In the course of climate change and scarcity of fossil fuels, subjects of energy efficiency and use of renewable energy sources are of great importance. The analysis of renewable energy potential at the brownfield is in accord with a sustainable urban development and generates economic potential. On some sites, it is possible to reduce the energy requirement in order to cover the remaining requirement with highly efficient renewable energy sources.

For that purpose, the energy optimization and analysis of energy potential must be considered, which can be subdivided as follows:

- **A)** Minimization of energy requirement
- **B)** Efficient energy supply
- **C)** Use of renewable energy sources

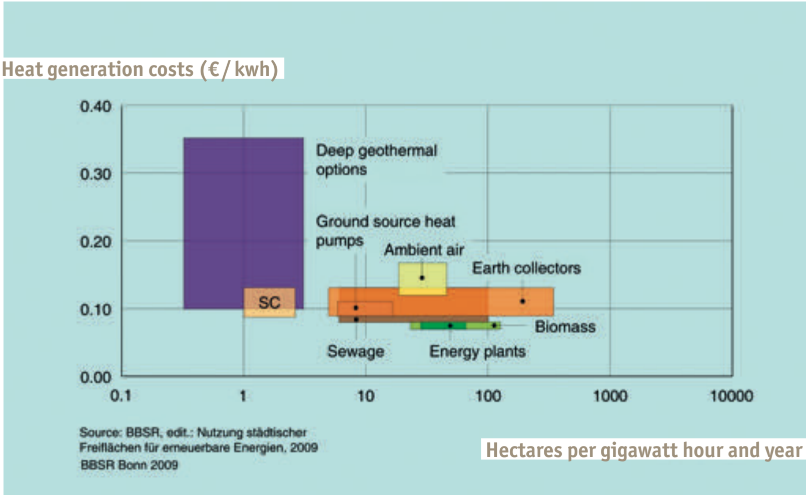
Important limiting conditions that have to be assessed in the frame of site-specific energy potential analysis are:

- Energy supply (according to kind of energy)
- Energy requirement (according to demand, kind of energy, and load time)
- Possible uses of renewable energy sources
- Possible uses of existing energy networks

Site-specific Heat Generation Costs at a Decentralized Energy Production from Renewable Sources

The area required is a decisive factor in determining the energy potential at the site. Shown is the area required in hectares for annual production of one gigawatt hour of heat.

SOURCE *Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) within the Federal Office for Building and Regional Planning (BBR), ed., (2009): "Nutzung städtischer Freiflächen für erneuerbare Energien, Bonn, Abb. 3.7 Stadtraumbedarf für die jährliche Erzeugung einer Gigawattstunde Wärme" ("Use of urban open spaces for renewable energies", Bonn, Fig. 3.7 Urban space required for annual production of one gigawatt hour of heat).*



The demand of urban space to produce one GWh heat per year

EXAMPLE

- Feasibility of marketing wholesale energy to the local or regional utility grid
- “In-Any-Case” costs related to energy applications, e.g. excavation works / installation of an underground geothermal storage
- Legal regulations, e.g. rights of use, pipeline easements, property boundaries, etc.
- Short-, medium- and long-term feasibility

PLEASE NOTE
Possible support provided by the tool EPASch – Energy Potential Analysis of Site Development Concepts (cf. Appendix 2 at www.optirisk.de)

PRACTICE TIP To minimize line losses, heat should be supplied near consumers. This primarily concerns inner-city sites. Supply and demand should be ensured during period of the investment.

As a rule, the complex subject matter of energy efficiency or energy generation requires consultation of engineering offices for supply engineering and energy planning in order to determine site-specific energy potentials. For some information, further investigations must be performed (e.g. subgrade reports, measurements of process energy, etc.). Not all sites provide optimal conditions for all opportunities for action. Especially in open spaces, a non-energetic solution also could be the optimum from an environmental point of view.

PLEASE NOTE
Addresses of energy consultants or further information are available from state or regional energy agencies or at
- *U.S. Energy Information Agency*
- *National Renewable Energy Laboratory (NREL) at www.nrel.gov*
- *State Department of Energy*
- *www.epa.gov/energy*

PRACTICE TIP On the basis of energy site analysis, energy consultants or energy planning offices are able to create an energy potential map. The National Renewable Energy Laboratory (NREL) assists with strategic energy planning.

PLEASE NOTE
Further information is available at www.bbsr.bund.de

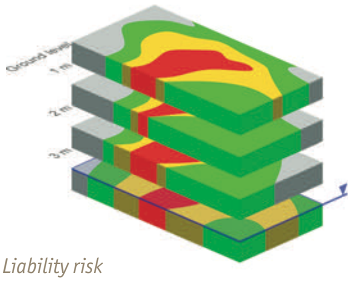
Coverage rate heat / electricity: *>= 0 %* *>= 25 %* *>= 50 %* *>= 75 %* *100 %* *Open spaces* *Agricultural land* *Remaining areas*

Energy Potential Maps

Through illustration and overlay of different energy potentials, energy drains, contaminated areas and registration of appropriate sites for energy applications, preferential models arise, which serve as basis for weighing of interests.

SOURCE *Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) within the Federal Office for Building and Regional Planning (BBR), ed., (2009): “Nutzung städtischer Freiflächen für erneuerbare Energien, Bonn, Karte 4.47 Wärme- und Strombereitstellung nach Szenario V in Sondershausen” (“Use of urban open spaces for renewable energies”, Bonn, Map 4.47, “Heat and electricity provision for scenario V in Sondershausen”)*

EXAMPLE



Liability risk (active remedial measures)

Waste disposal risk graduated by the level of contamination

Groundwater level

Illustration of a Risk Forecast Model

PLEASE NOTE
Further information may be available via State or Local Departments of Environmental Quality and at www.rsmeans.com

RESOURCES
- *MESOTES (www.optirisk.de)*
- *www.epa.gov*

PLEASE NOTE
Support provided by Check List Liability Risks (cf. Appendix 3 at www.optirisk.de)

ENVIRONMENT: RISK FORECAST

The preparation of a risk forecast requires expert know-how. Especially for the risk forecast model, wide experience is necessary in order to assess the three-dimensional demarcation of existing risks.

Aims and contents of the environmental risk forecast are:

- **A)** Assessment of liability risks
- **B)** Assessment of waste disposal risks
- **C)** Development of a risk forecast model

Basis for developing an environmental risk forecast is the detailed evaluation of the documented inventory data, of available reports and other environmentally relevant information for the site (cf. chap. 1 Inventory Fundamentals).

PRACTICE TIP — Information on contacts for cost predictions may be available at your State or Local Department of Environmental Quality. Additionally, RS Means provides annually updated handbooks on unit prices in the frame of environmental clean-up and related construction costs. Please note unit prices can greatly vary in different regions and states. In the frame of risk forecast, a general overview of site-specific clean-up costs is necessary, which usually includes uncertainties.

PRACTICE TIP — Guides for identification and assessment of environmental risks are:
- MESOTES – a test and decision-making system developed within the framework of research project optirisk®
- U.S. EPA Risk Assessment Guidance
- IRIS – Integrated Risk Information System of U.S. Environmental Protection Agency

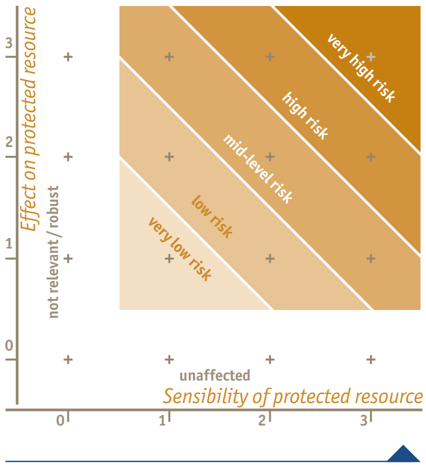
A) Assessment of Liability Risks

Through the assessment of liability risks, clean-up costs associated with removal of hazardous substances and hazardous contamination are estimated. In order to be able to assess those risks, an overview of active remedial measures is required.

STEP 1

Initially, claims under private law and under public law, which can arise from contracts or from public responsibility of the owner, the operator, or the governing authority, have to be identified. Liability risks due to environmental site conditions can arise from these authorities. The associated required and appropriate active remedial measures, as well as related costs can be deduced directly as a rule (cf. Step 4).

Legal regulations on liability for hazards at brownfields are subject of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA), as well as similar state laws. The state Departments of Environmental Quality provide information and processes for dealing with regulatory liability, while legal expertise is required to evaluate and contain or minimize the costs of these requirements.



Risk-based Testing System of MESOTES

STEP 2

If hazards are present, the responsible authority may require an environmental assessment at the site. In this frame, risks both to human health and ecological receptors resulting from hazardous substances and / or contamination must be evaluated. With the method MESOTES, developed in the frame of risk assessment in Germany, site-specific risks can be deduced.

- In which areas of the site are hazardous circumstances present, for which the generator or owner is liable according to environmental law?

PRACTICE TIP — Risk assessment is regulated by state agencies for most sites in the US, and for larger, federal sites, by of the U.S. Environmental Protection Agency. The risk-based testing system of MESOTES provides support in evaluation of site-specific risks to human health and ecological receptors. Please consult an environmental expert for questions on risk assessment.

Definition of clean-up goals considering the proportionality principle

STEP 3

On the basis of risk assessment, clean-up activities and appropriate clean-up goals which take into account the proportionality principle (cf. MESOTES) must be derived necessary. In the case of characterization as "mid-level risks" or higher classes, active remedial measures may be required for certain brownfields (cf. following example).

STEP 4

Finally, the costs for removal of liability risks are determined ("monetization"). The fixing of unit prices should be in line with usual local and regional engineering, disposal and construction costs.

RESOURCES

- *www.epa.gov*
- *State or Local Departments of Environmental Quality*
- *Engineering offices*
- *www.rsmeans.com*

PLEASE NOTE

Cf. www.sinbra.de

PRACTICE TIP — You can obtain a realistic value for clean-up costs if you engage an engineer with the monetization who plans and monitors such clean-up activities. The result is the hazard-related reduced market value of the property, or the "cost to cure" the environmental conditions of the site. Taking local and regional disposal criteria and costs is important for the monetization.

PRACTICE TIP — Additional depreciation of a hazard-burdened property can emerge from "mercantile reduced market value" which refers to the subjectively perceived stigma of hazardous circumstances. A method for calculating the "mercantile reduced market value" was developed in the frame of German project SINBRA. In the US, there is no generally accepted approach to evaluating "stigma" liability, and the "cost to cure" approach is applied.

Application at a specific Model Site

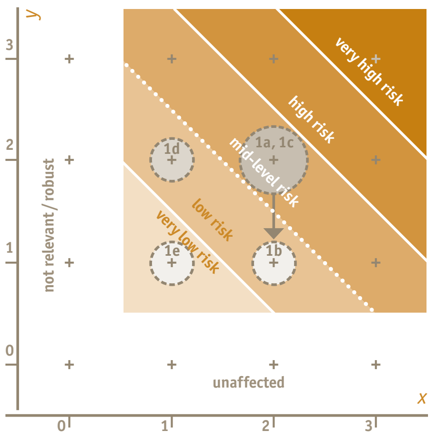
With the application of decision matrix MESOTES, a "mid-level risk" is deduced for the site in Oregon / USA for protected resources 1a, 1c, 2b, and 2c. Potential impairment primarily is caused by limited areas of soil and groundwater contamination, as well as the presence of solid, non-hazardous waste at subsurface (animal waste). The clean-up goal "commercial re-use" (= dashed line) can be achieved through reduction of impairment of protected resources up to one risk class (= arrows). Proportionate active remedial measures are the targeted removal of soil contamination and of solid, non-hazardous waste in the underground (source remediation). Lower contamination may remain on-site through risk assessment and evaluation.

Protected Resources have to be evaluated in View of its Impairment in the Frame of Risk Assessment: **1) Human Health and Ecological Receptors — 1a** *Residents* **— 1b** *Workers* **— 1c** *Recreational Visitors* **— 1d** *Children* **— 1e** *Ecological Receptors (Animals, Plants, Microorganisms)* **— 2) Environmental Media — 2a** *Surface Waters* **— 2b** *Groundwater* **— 2c** *Soil* **— 2d** *Air*

1) Human Health and Ecological Receptors

y
Risk faktor Effect on human health or ecological receptor / **Graduation** Extent of effect

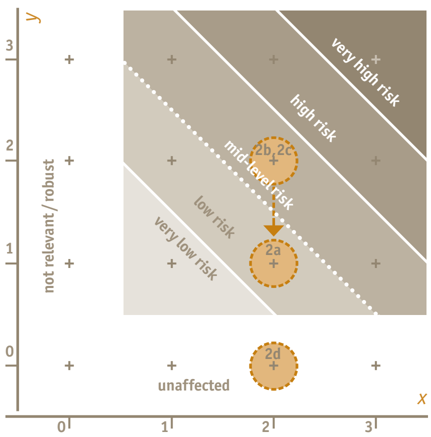
x
Risk faktor Sensibility of human health or ecological receptor / **Graduation** Level of sensibility (dependent on type of re-use)



2) Environmental Media

y
Risk faktor Effect on environmental medium / **Graduation** Level of contamination and tendency of spreading

x
Risk faktor Site-specific degree of worthiness of protection of environmental medium / **Graduation** Presence and protection status



EXAMPLE

B) Assessment of Waste Disposal Risks

Waste disposal risks are understood as those costs that arise in addition to liability risks due to environmental obligations in the context of future uses. The simplest examples are the so-called "contamination-related additional costs" that result from legal requirements with regard to waste disposal due to lower contaminated structures – and not from hazardous circumstances.
Waste disposal risks only emerge if investment-related soil interventions or demolition measures are implemented. Consequently, the aim is to optimize urban planning development concepts in a way that, for example the positioning of buildings is modified such that the minimal waste disposal risks take effect. In order to exploit the full optimization potentials, you need an overview of which waste disposal risks are present in which site areas.

STEP 1

The waste disposal risks have to be identified and to be registered quantitatively, where the following basic classification has been tried and tested:

- Stock of buildings and facilities (waste disposal-related amount of technical demolition costs)
- Soil , deposits, waste (waste disposal risks due to anthropogenic impairments)
- Groundwater and surface waters (waste disposal risks due to anthropogenic impairments)

PLEASE NOTE
Support provided by Check List Waste Disposal Risks (cf. Appendix 4 at www.optirisk.de)

PRACTICE TIP — Risks due to contamination from military uses can also be documented in this context if there is a history of military use and presence of related contamination for the site.

STEP 2

For the ascertained waste disposal risks, unit prices (mostly for site-relevant waste categories) must be researched. In terms of costs for the urban redevelopment concepts, only those measures must be estimated which arise in addition to "In-Any-Case" project costs. Using the example of "contamination-related additional costs", that means the difference between costs for disposal of contaminated soil and costs for disposal of non-contaminated soil.

- Which disposal costs must be fixed for the different waste categories of the waste disposal risk?
- Were regional cost differences for different disposal channels taken into account?
- How far is the nearest authorized waste disposal facility?
- How will characterization of the waste type impact handling, transportation and disposal costs?

Model Site in Oregon, USA

The site of a former municipal waste water treatment plant and adjacent private animal rendering facility in Oregon / USA has an area of approx. 20 acre. The rendering facility was closed many decades ago, and in the early 1990's the municipal water treatment facility was closed. After demolition of parts of each facility, many buildings and facility components remained on-site. In the frame of its deconstruction and demolition within redevelopment, additional costs regarding waste law may arise due to (lower) contaminated building and facility structures, pipes at subsurface, etc. (waste disposal risks).

EXAMPLE

Facility Components of a Former Clarifier

C) Development of a Risk Forecast Model

All site conditions, from which liability risks and waste disposal risks have to be deduced, and which are known on the day of deadline, are illustrated in a three-dimensional risk forecast model (also referred to as risk forecast maps). The monetary expenditures for removal of environmental hazards can be deduced from the model considering the permitted re-use and development of the property according to planning requirements and other applicable law.

PRACTICE TIP — With the aid of a risk forecast model, it is possible to position an investment (new construction) in such a way that the least possible costs emerge. The risk forecast is supposed to enable a decision on an Integrated Site Development Concept.

STEP 1

The required foundation depths must be deduced from the urban planning concepts for re-use.

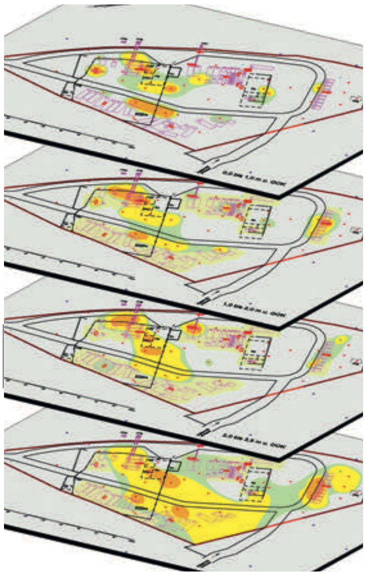
PRACTICE TIP — At mainly flat sites, the differentiated foundation depths have to be considered in several intervals, for example:

- Flat foundations / strip foundations up to 1 m depth
- Simple basements up to 2 m depth

The areas above and below groundwater level must be illustrated separately, because a cost explosion arises in the case of water control measures (particularly with regard to contamination).

STEP 2
Essential cost items (unit prices) are summarized clearly; these are primarily the disposal costs of several waste categories.

STEP 3
Employing the assessment of a) and b), the spatial distribution of liability risks and waste disposal risks are defined corresponding to different depth intervals (cf. Step 1).



Risk Forecast Model for several Foundation Depths

Disposal Costs for Soil Excavation, classified with Waste Disposal Risks and Liability Risks

Liability risk (active defence measures)

Waste disposal risk graduated by the level of contamination

— 1) *Reintegration on-site with geo-technical applicability* — 2) *Disposal price according to market conditions in 2007, including all ancillary services (declaration, transport, engineering services), assumed density 1,8 g/cm³* — 3) *Disposal charged to "In-Any-Case" costs if reintegration is not possible*

Risk		Waste Disposal Risks				Liability Risks
Consequence		Reintegration on-site 1)	Disposal with Investment			Active Remedial Measures (Decontamination / Safeguards)
Disposal Classes		Z 1.1	Z 1.2	Z 2	> Z2	Hazardous Waste
Disposal Price 2) €/m³	Diesel / Oil				36	36 – 90
	VOC	3)	18	26	40	40 – 160
	BETX				36	36 – 90
	Dioxins / Furans		-	-	-	36 – 500

Tank Storage in Southern Thuringia, Germany

The overview of spatial distribution of risks in the risk forecast model (see left) together with the disposal costs (same coloring) forms the basis for optimization of positioning of buildings resp. investment-related soil interventions.

EXAMPLE

PART 3 Integrated Site Redevelopment Concepts

Minimization of risks

A key part of the integrated concept preparation is the discussion of different redevelopment alternatives including cost estimates for the respective liability risks and waste disposal risks. By combining environmentally driven factors with urban planning and energy considerations, it is possible to incorporate up front the risks of brownfields re-use into the redevelopment process from the beginning and to minimize them as far as possible.

PRACTICE TIP — The consideration of energy applications always requires an interdisciplinary approach. Optimized results are achievable through an early involvement of participants into the planning process. For this purpose, a common forum should be established for energy planners and energy users.

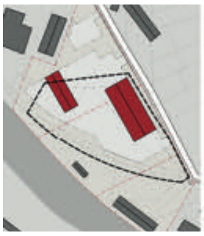
SITE REDEVELOPMENT CONCEPTS AND DISCUSSION OF ALTERNATIVES

Usually, several alternative redevelopment concepts exist for any site, especially brownfields. Except for limitations on residential uses for exposure to levels of contamination that exceed acceptable human health risks, the number of permissible alternative uses is not strongly limited. The best approach is to continue with at least two alternatives which differ from one another to the greatest extent possible. A broad discussion of alternatives is additionally suited for constructive communication with respect to urban development goals and options for alternative use between the respective stakeholders and decision strategies among the stakeholders.

PLEASE NOTE
Option for an evaluation matrix for urban development (cf. Appendix 5 at www.optirisk.de)

The next step is to evaluate redevelopment options according to standardized criteria to be determined, resulting in a preferred urban development alternative being selected. For this alternative, cost predictions for the removal of hazardous contamination can be created. An evaluation and cost prediction should also be performed if only one redevelopment alternative is to be considered in order to verify possible gaps in meeting urban development objectives and to be able to sound out optimization potential.

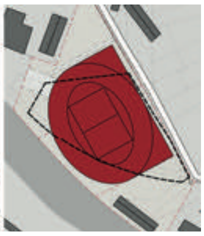
- Which is the optimal concept in terms of site redevelopment?
- Which alternative has the best chance of realization?
- Which thoroughgoing alternative or visions are conceivable?



Recycling Depot

Car Dealership

Institute



Basketball Stadium

Concept Alternatives for the Fuel Depot Model Site in Thuringia, Germany

Four different concept alternatives were developed for a former fuel depot. Here, the uses as a recycling depot and an automobile dealership are the realistic concepts. The institute represents the preferred site redevelopment alternative. As a thoroughgoing alternative, a basketball stadium is proposed.

EXAMPLE

PRACTICE TIP — For revitalization projects, sometimes a design competition can be recommended. From the multitude of designs submitted, an optimal solution can be determined from an urban development, economic and environmental point of view. In addition to exact information regarding the as-built status and concrete objectives, the prerequisite for a successful approach is the provision of a risk forecast model with regard to existing contamination. For competent evaluation of environment-relevant design elements, the incorporation of an expert is essential. In the process, the requirements of efficient energy usage and the use of renewable energy sources should be taken into consideration.

Risk Forecast (Excerpt)

Competition Design (Excerpt)

Urban Development Realization Competition

The example involves finding optimal solutions for dealing with contamination as part of an architectural competition. The prize-winning design illustrates that considerable cost savings can be achieved in securing the contamination and the re-use of the building, compared to demolition and removal.

EXAMPLE

ENERGY EVALUATION

Besides compliance with environmental and other regulations, energy applications are oriented towards the respective demand for the site and the benefits redevelopment provides. Good energy concepts are characterized by a balanced combination of modern installation engineering and energy requirement reductions. The increase of energy efficiency is not only part of minimum-cost solutions but is also regarded as one of the most sustainable solutions. In addition, further development of the site and the energy potential may be created to meet demand for energy used off site.

Within some redevelopment concepts, surplus energy accrues which can be used efficiently other locations. A typical example of such synergy effects is the use of waste heat from an ice rink for a neighboring indoor swimming pool, as already has been implemented in Davos and St. Gallen (Switzerland).

For energy consideration of the different redevelopment concepts, site-related energy concepts should be created by an energy consultant or an energy planning office.

- Based on the type of energy sources (heat, cooling, electricity, others) available, how is the energy requirement calculated?
- Which on-site energy potentials can be considered (geothermics, wind power, water power, and biomass)?
- Which environmental energy potentials can be used (exhaust air, waste water, others)?
- Which solar energy supply is available (photovoltaics, solar thermal energy)? Are large roof and facade areas oriented to the south?
- Can shadowing be prevented through the choice of location of buildings?

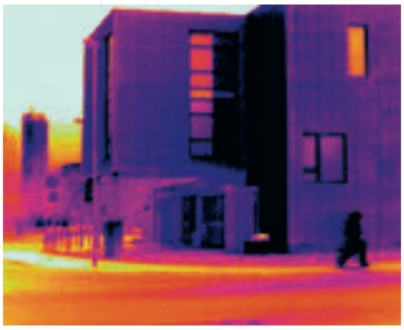
PRACTICE TIP — Discuss and evaluate legal requirements and financing related to energy generation and corresponding funding needs with your planner and also in close cooperation with responsible authorities and local energy suppliers and providers.

PRACTICE TIP — Some energy efficiency measures can be financed via performance contracting. In the course of this, energy systems and equipment, including costs for maintenance, are supplied by an external provider for a usage-dependent charge. The costs incurred are refinanced via energy savings.

PLEASE NOTE

More information at

- *U.S. Department of Energy*
- *International Institute for Sustainable Development U.S. Environmental Protection Agency*



Redevelopment & Energy Production

Redevelopment and energy production are not mutually exclusive. For example, geothermal heat extraction can be realized underneath a building and solar energy can be installed on the roof and facade of the building. The building itself should meet modern energy efficiency standards.

SOURCE *(Thermography): Building Diagnostics St. Kind / (Thermographie): Bauwerksdiagnostik St. Kind*

Geothermal Collector Thermography of a School

EXAMPLE

Revitalization a Former Mining Facility in North Rhine-Westphalia, Germany

In non-shadowed areas, elevated solar panels provide economically usable energy production potentials and theoretically can be installed at non-remediated areas, too. In the course of revitalization of a partially contaminated mining facility in North Rhine-Westphalia, Germany, a 10,000 square meter solar system, including a storage battery for electricity feed-in and a mine gas-driven combined heat and power station for production of heat and electricity, were brought into service.

SOURCE *Herne Building Management / Herne Gebäudemanagement*

View onto the Roof of the Main Building of Revitalized Mining Facility

EXAMPLE

ENVIRONMENT: COST ESTIMATES

Cost estimates can be prepared for each urban redevelopment concept on the basis of spatial overlay of the urban redevelopment design with the analyzed environmental issues (environmental risk prediction and cost forecasting). The costs that have to be calculated are composed of three essential items:

I. Costs for Removal of Liability Risks:

These costs have already been calculated (cf. Section “Environment: Risk Forecast”, A) Liability Risk, Step 4).

II. Costs for Removal of Waste Disposal Risks:

From the redevelopment alternative-specific configuration of excavation pits, the amount of each waste disposal risk can be deduced with the aid of the risk forecasting model. For this purpose, the researched unit prices can be used (cf. Section “Environment: Risk Forecast”, B) Waste Disposal Risk, Step 2).

III. “In-Any-Case” Costs:

These include costs for services that do not involve active remedial measures or investment-related additional costs, but must inevitably be incurred and are equally necessary for the planned investment (e.g. building site facilities, ground disturbance and fill and lift of soil for new construction)

PRACTICE TIP With regard to the analysis of optimization potentials, it is appropriate to calculate separately those costs which accrue through the removal of liability risks and waste disposal risks, and costs incurred as “In-Any-Case” costs.

PART 4 Optimization of Site Redevelopment Concepts

Fundamentals

The basis for the optimization of your Site Redevelopment Concept should be following the results of part 1 through 3 of recommendations for action:

- An urban planning design (preferred concept) that is the optimal solution in terms of spatial planning and general principles of urban development
- An environmental professional risk forecast model with statements on risks concerning the removal of environmental hazards for all affected areas of the site
- General recommendations on possibilities of inclusion of energy production, storage, conversion or distribution into the urban planning design, which consider environmental issues

SITE-SPECIFIC OPTIMIZATION POTENTIALS

Cost savings through intelligent planning

The essential result of **optirisk®** is the assessment and classification of different optimization potentials that arise from a holistic view of site redevelopment in terms of an interdisciplinary integration of urban planning and environmental aspects. The implementation of optimization strategies implies significant cost savings that permit a profitable revitalization of brownfields. In addition, energy efficieny or generation can lead to an extra revaluation of the site.

Optimization potentials for the site redevelopment concept result from a skillful handling of environmental hazards. Optimization potentials can be realized within the following areas:

- **A)** Optimization Potential of Liability Risk
- **B)** Optimization Potential of Waste Disposal Risk
- **C)** Optimization Potential of Property Exposure
- **D)** Optimization Potential “In-One-Go”

Further optimization potentials can result from their respective implementation, the so-called “In-Any-Case” Costs **[E)]** that are not directly associated with environmental hazards.

For the above-mentioned optimization potentials, the following **RECOMMENDATIONS FOR ACTION** are described and elucidated by a good practice **EXAMPLE**.

PRACTICE TIP — A significant increase of cost savings can result from the use of several optimization potentials for site redevelopment.

A) Optimization Potential **LIABILITY RISK**

With regard to liability risk, the greatest optimization potential exists

- **I.** where the required active remedial measures (decontamination) can be used as part of the redevelopment, or
- **II.** where the active remedial measures can be carried out as safeguards adapted to the intended re-use.

I. Use of Active Remedial Measures for Investment Considerations

A-I

The required active remedial measures can be combined with planned investments at the site.
An example is the use of excavation pits generated by measures to remove liability risks (active remediation).
In this way, new basement levels can be designed or systems for energy provision (latent heat storage systems, near-surface geothermics, etc.) can be installed in areas where soil remediation is required.

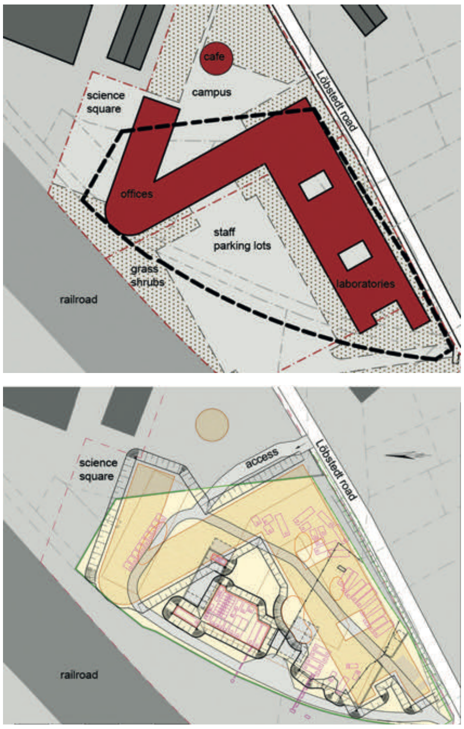
RECOMMENDATIONS FOR ACTION

- Discuss with those responsible for the clean-up whether building foundations / basements can be relocated to areas of excavation.

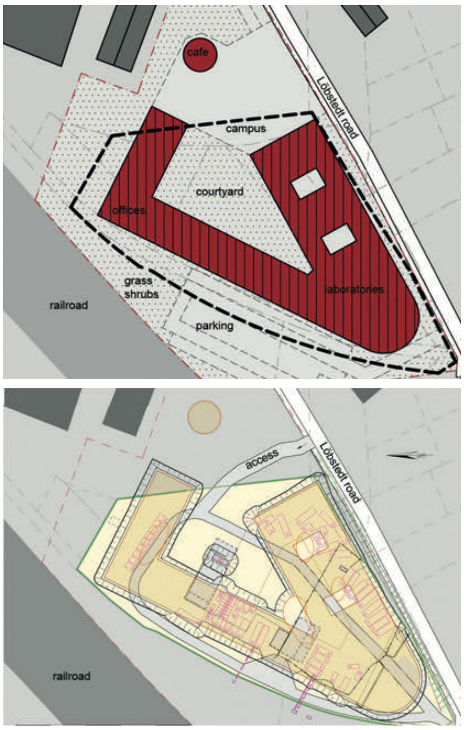
  Obtain an abstract of costs for these savings.

- Jointly carry out a consideration to determine to what extent relocation and modification of the planned buildings, including functionality and aesthetic requirements, is feasible.

- Discuss with an energy planner and, if necessary, with the local energy supplier whether the excavation pit that results due to soil excavation can be used for installation of technical facilities (e.g. heat storage systems, geothermal collectors, etc.).



Preferred Site Redevelopment Concept "Institute" (left) in Overlay with the Model of Excavation Pits for Removal of Environmental Hazards (below)



Optimized Site Redevelopment Concept "Institute" (left) in Overlay with the Model of Excavation Pits for Removal of Environmental Hazards (below)

Fuel Depot in Thuringia, Germany

For more than 60 years, the fuel depot site in Thuringia, Germany served as aboveground and underground storage of fuel. The 74 underground tanks were the greatest obstacle in terms of redevelopment (= liability risks). Implementation of the preferred site redevelopment concept "Institute", necessitates a basement foundation up to a depth of approx. 2.0 m bgl. The locality of the institute building will be adapted to the configuration of excavation pits resulting from removal of liability risks (underground tanks). The excavation pits will be used as part of the redevelopment, thus creating cost saving potentials.

EXAMPLE

A) Optimization Potential **LIABILITY RISK**

II. Implementation of Active Remedial Measures as Safeguards Adapted to the Re-Use

In certain cases, active remedial measures can be implemented as safeguard measures. In doing so, pollutants remain in the soil. Surface contaminants that cause danger to human health can be capped via surface sealing (e.g. installation of streets, parking lots, buildings, etc.), which may already be required as part of the redevelopment. Flexibility as to where these features will be located on the site, may result in considerable cost savings compared to expensive soil remediation. That optimization potential is often very high.

Disadvantages of this option are that

- the regular monitoring of contamination and cap may be required, which has to be counted against the optimization effect,
- deed restrictions can be filed,
- the property owner must maintain awareness of institutional or engineeringcontrols,
- in case of malfunction of the safeguard measure, soil remediation may be necessary, and
- if there is a future change of use (sale, change of owner, etc.), soil remediation may be required.

A-II

RECOMMENDATIONS FOR ACTION

- Ask your consultant whether the hazardous contamination can be dealt with via safeguard measures.

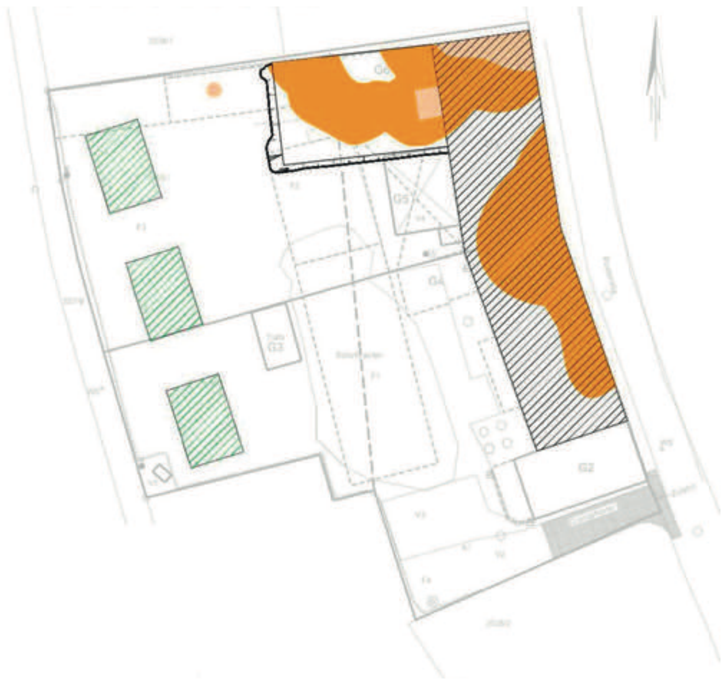
  Review with your architect or engineer to what extent the areas to be sealed can be integrated into the redevelopment concept.

  If the above is achievable, evaluate placement of safeguard measures (e.g. traffic or storage areas) in terms of functionality and aesthetic requirements of the redevelopment concept, as well as effective sealing of hazardous contaminated areas. This should be done in cooperation with the consultant, engineer and architect.
  Obtain the approval of the responsible environmental agency to install safeguard measures and request a decision regarding monitoring requirements and associated reports.

- The remedial action plan details site clean-up and has to be approved by the responsible environmental agency.

- Discuss with the clean-up consultant which energy concepts are feasible and financially viable at the sealed, contaminated areas.

Optimized Concept "Mixed Use Area"



Building stock
New construction
Liability risks (environmental-relevant need for action ascertained)

Model Site in Thuringia, Germany

For the former metal processing site in Southern Thuringia, the hazardous soil contamination located in the courtyard (former VOC washing unit) represent the hazards that must be removed. With the optimization of the preferred site redevelopment concept "Mixed Use Area" in which the area of the courtyard is sealed as an active remedial measure, clean-up costs are significantly reduced as compared to the removal of the liability risks. From the consultant's and agency's point of view, this method is sufficient as an active remedial measure (prevention of volatilization of pollutants and prevention of possible pollutant mobilization).

EXAMPLE

B) Optimization Potential **WASTE DISPOSAL RISK**

On brownfields waste disposal risks are often the largest cost factor, but also provide the greatest optimization potential. Waste disposal risks can be optimized and minimized by following options:

- **I.** Interventions in areas with hazardous soil contamination are generally minimized as low as possible and / or building foundations and basements are relocated to site areas where no soil contamination exists (reduction of disposal and transportation costs).

- **II.** Under certain conditions, excavated contaminated soil material is permitted to be reintegrated on-site.

B-I

I. Minimization of Interventions in Site Areas with Soil Contamination

Generally, the redevelopment concept should be planned in such a way that soil excavations and unsealing is minimized in areas with tolerable soil contamination, or that sealing is performed as a part of new construction.

RECOMMENDATIONS FOR ACTION

- Discuss with those responsible for your clean-up, your architect and engineer, whether building foundations / basements for new construction can be relocated from contaminated to clean areas.

  Jointly discuss to what extent relocation and modification of the planned buildings, will affect their functionality and aesthetic requirements.

- When considering large structure to be built, the excavation amount can be optimized through a variation of the defined height of the new building / structure. Interactions with measures for subgrade improvement must be weighed by an expert.

- Also require from your engineer or consultant information with regard to geotechnical risks and its consequential environmental law-related costs, already in the early design phase.
  For construction of a load-bearing subgrade, soil exchange is not suitable, for example. There are a range of methods available by which a load-bearing foundation can be created without any excavation.

- Usually, energy applications have low requirements for the ambient soil quality. Thus, energy generation facilities are preferentially installed in areas with (residual) contamination.
  At sites with (residual) contamination, geothermal uses can only be carried out near-surface in the vicinity of areas destined for soil exchange measures. Drillings realized for deep geothermal uses, in addition to extra costs due to disposal of contaminated soil, can cause the hazard of contamination spread into the deep underground.

Parking Lot of the Supermarket, 2008

Former Nationally-Owned (VEB) Thermometer Factory, 1960

Supermarket in Thuringia, Germany

At the site the main building of the Former Nationally-Owned (VEB) Thermometer Factory was completely demolished. Although a previously executed site assessment found no hazardous soil impairments, it could be assumed that, excavated soil could be significantly contaminated with mercury. This industrial brownfield was completely sealed by new construction. The remaining residual contamination is now considered to be cleaned-up.

SOURCE *Geyer: "Liquid Glass Thermometers. Historical Overview Part I" / "Flüssigkeits-Glasthermometer. Historischer Überblick Teil I", Leipzig, 1968*

EXAMPLE

B) Optimization Potential **WASTE DISPOSAL RISK**

II. Reintegration of On-site Excavated Soil

For effective cost optimization, the technical and legal possibilities of on-site recycling of excavated soil should be scooped out. In general, the possibilities for reintegration of on-site excavated soil should be considered already within the re-use concept.

RECOMMENDATIONS FOR ACTION

B-II

- Estimate amount and contamination levels of excavated soil. Check which contaminants at which levels are permitted to be reintegrated on-site, taking into account the environmental legal requirements.

  Obtain an estimate of cost savings through reintegration.

  Consider that soil material destined for reintegration on-site also has to meet geotechnical requirements.

- Discuss with your architect or engineer the possibilities of integrating the landscape modeling into the re-use concept for open spaces.

  In order to avoid conflicts, consider the exact location of underground utilities (gas, electricity, heating).

- With your energy consultant and your architect or engineer, discuss the possibilities of integrating landscaping or earth walls for solar-technical and geothermal systems.

  Verify whether long-term heat storage can be integrated into the areas of excavation based on conceptual and economic aspects.

- Discuss with your responsible environmental agency whether the reintegration of excavated, contaminated soil is permitted to be used for landscaping, noise protection barriers and similar uses.

  Have the different terms for reintegration stipulated in an appropriate document (e.g. the remedial action plan confirmed by the agency or an agreement under public law).

PRACTICE TIP — In regions with natural or settlement-related increased contaminant levels, possibilities of deviations from relevant technical regulations and standards can be discussed together with the responsible environmental agency or department.

Angular Support Wall for Creation of Reintegration Capacities

Support Wall Backfilling

In specific cases, geotechnical-difficult substrates with a high ratio of fine-grain material can also be used for backfilling.

EXAMPLE

C) Optimization Potential **PROPERTY EXPOSURE**

PLEASE NOTE

Check if reintegration of construction waste is permitted in your state and what the permitting process, if any, is!

RESOURCES

- *State Environmental Agencies*
- *U.S. Environmental Protection Agency*
- *Engineering companies*

Generally, property exposure costs can be minimized if responsible parties decide that existing buildings or parts of buildings are to be retained and to be integrated into the re-use concept.

If property exposure or demolition of certain structures is agreed upon, the greatest optimization potential arises where the largest amount of materials from demolished buildings can be reused in a recyclable form for new construction or landscaping. For example, low-level contaminated construction debris can be reintegrated in a noise protection barrier, as a foundation for surfaced areas (e.g. traffic areas), or for landscaping.

In principle, the use of recycling material has to be compatible with its application (noise protection barrier, component backfilling, landscaping). The use of same-site construction waste for reintegration on-site is regulated differently within the U.S. states with respect to environmental and planning law.

RECOMMENDATIONS FOR ACTION

C

- Make your expert create a property exposure concept including cost estimates and considering the intended re-use. In this context, it is important to compile the quantities of waste to be generated and reintegrated (recycling material classified to waste categories) which can be done by specialist in case of missing analyses.

- Clarify with the responsible environmental agency, whether and in what quantity recycling material is permitted to be reintegrated on-site. If necessary, obtain a permit for this purpose.

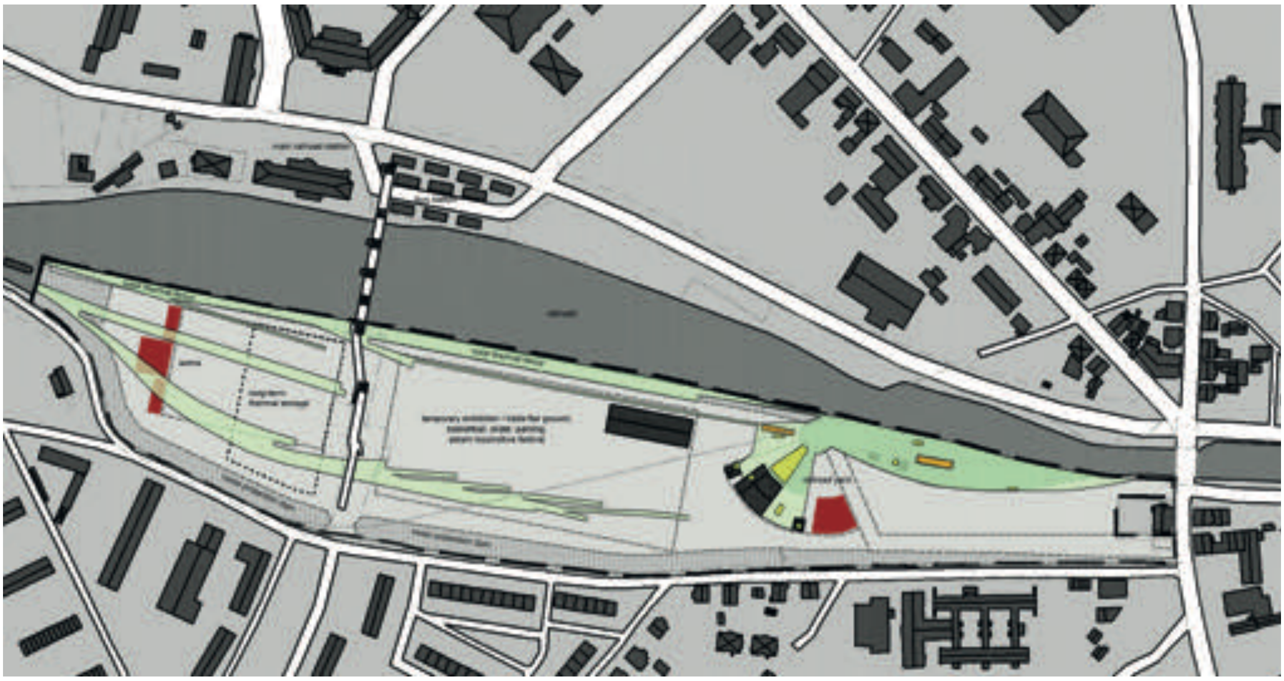
- Make your architect or engineer integrate the authorized quantity of recycling material into reasonable landscaping at the site.

  In order to avoid conflicts, consider the exact location of underground utilities (gas, electricity, heating).

- Within the course of planning and implementation, consider that the reintegration of recycling material qualitatively (analyses) and in terms of stability (plate load bearing test) must be supervised and documented (costs).

- Check with your energy consultant and your architect or engineer whether possibilities of energy applications (e.g. geothermal uses, open space solar systems, or wind power) can be created through landscaping employing backfilling of recycling material.

Optimized Concept: "Fairground with Temporary Exhibition Site"



- *Building area (outside AOI)*
- *Building area (inside AOI – sealed)*
- *Building area (inside AOI – unsealed)*
- *Railroad system*
- *Road / street / pedestrian*
- *Planed buildings*
- *Long-term thermal storage*
- *Existing buildings*
- *Liability risk*
- *Waste disposal risk > Z2*
- *Waste disposal risk = Z2*
- *Parcel boundary*
- *Usage boundary*
- *Area of Interest (AOI)*

Former Freight Station in Thuringia, Germany

Within the redevelopment of a former Freight Station in Thuringia, the largest costs emerged with respect to property exposure due to demolition of the extensive existing old building structures. In this region, reintegration of contaminated construction waste is legally regulated. With the optimization alternative a re-use concept was designed that provides the construction of a noise protection barrier in the southern site area, where all demolition wastes can be reintegrated. In this way, significant cost savings could be achieved during site redevelopment.

EXAMPLE

D) Optimization Potential "IN-ONE-GO"

In practice, active remedial measures (clean-up of hazardous contamination) and structural investments are often carried out as individual measures, separated from each other.
If the two measures are performed "In-One-Go", a great optimization potential can be realized. These synergy effects consist of:

- the one-time building site facilities and construction supervision,
- the simultaneous implementation of hazardous soil clean-up in the course of investments for redevelopment (e.g. resulting excavation pits that do not need to be backfilled)

For the following reasons, such measures are not carried out "In-One-Go":

- As future re-use plans and investors / developers are often not available immediately, the clean-up and property exposure is performed as a funded measure in order to be able to offer a remediated property to an investor (e.g. industrial areas).
- Responsible parties shy away from an implementation "In-One-Go" if the financing of both measures originates from different sources. The splitting of costs "at the construction site" seems to be difficult.

D

RECOMMENDATIONS FOR ACTION

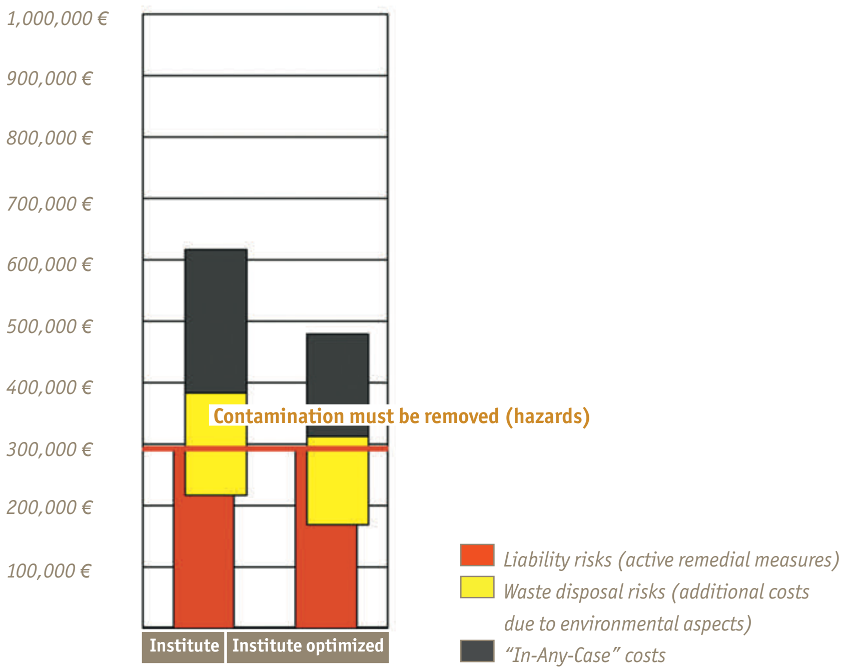
- Endeavor to perform construction measures "In-One-Go". Coordinate the construction sequences and consider the cost benefits.

- Make your consultant clarify whether the identified liability risks must be immediately removed due to reasons of active remedial or whether it is possible to wait with the implementation of remedial measures until redevelopment, because re-use is imminent. This must be discussed with the responsible environmental agency.

  For experienced engineers, the cost splitting of active remedial measures and investment is routine.

- The rebuilding and / or relocation of all required energy power plants and utilities also should be coordinated "In-One-Go".

Cost Estimation



Integrated Site Redevelopment Concept for a Former Fuel Depot in Thuringia, Germany

At the model site, an optimization of the original preferred site redevelopment concept "Institute" could be achieved by the simultaneous implementation of active remedial measures and structural investment. The overlap of liability risks and waste disposal risks (cf. figure) illustrate the cost savings that can be attained through combination of both measures. In this optimized concept, the site redevelopment design is adapted to accommodate the location of basements in excavation pits caused by removal of liability risks (hazardous contaminated soil) and the civil engineering measures are carried out "In-One-Go". Thus, cost savings of approx. 214 thousand Euros (31%) can be achieved for the model site.

EXAMPLE

E) Optimization Potential "IN-ANY-CASE" & (F) Further Information

E

E) OPTIMIZATION POTENTIAL "IN-ANY-CASE"

The described optimization potentials A) to D) above are based on environmental issues. A further optimization potential can result from its respective implementation – the so-called **"In-Any-Case" costs**.

"In-Any-Case" costs are understood as expenditures for measures that by themselves do not represent active remedial measures or investment-related additional costs, but the completion of which are necessary for the intended re-use regardless of contamination; those activities that are indispensable and equally necessary for the planned investment (e.g. soil excavation for building construction, if the area of investment is inter-sected with the area of demolition or soil removal).

If optimization potentials from A) to D) are implemented, additional cost benefits related to "In-Any-Case" costs can possibly arise in the context of investment.

(F)

(F) FURTHER INFORMATION

With the previous analyses of site-relevant optimization potentials, you have laid the foundation for effective cost benefits in terms of revitalization. In doing so, the following items should be considered:

— **I.** Every brownfield site will present specific and varying optimization potentials (type and amount; cf. following example).

— **II.** Due to the variety and differences between individual U.S. states, the type and extent of available funding for revitalization was not considered within the framework of this guide.

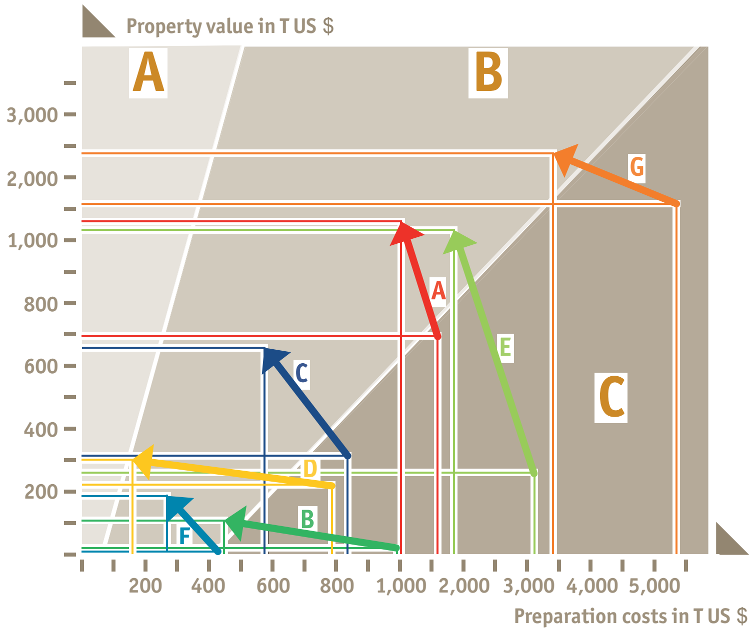
— **III.** The optimization – for example the waste disposal risk – can also be performed with the aid of GIS. In doing so, it is possible to spatially geo-reference the investment-related waste classes with the disposal costs. Through a positional change of a building, the respective total disposal costs can then be deduced.

— **IV.** The developed evaluation methods for urban development concepts and the environmental risk forecast are tools for complex solutions, but are not "automatized" techniques. The complex task is only solvable with corresponding expertise in environmental science and regulatory requirements.

Revaluation of the Model Sites

Model site	Optimized preferred alternative (Integrated Site Redevelopment Concept)	Kind of optimization potential					Amount of achieved optimization		
		Liability	Disposal	Exposure	‚In-One-Go'	‚In-Any-Case'	in T US$	in %	
		I	II	III	IV	V		of original variant	of property value
A	‚Housing & Recreation'	-	x	x	-	-	590	35	45
B	‚Forest & Viewpoint'	-	x	x	-	-	550	54	532
C	‚Institute'	x	-	x	x	x	257	31	39
D	‚Mixed Use Area'	x	-	x	-	-	661	84	219
E	‚Festival Ground / Fair'	-	x	x	x	-	1189	38	105
F	‚Photovoltaics'	x	x	x	-	-	170	39	87
G	‚Outpost'	x	x	x	-	-	1982	37	128

— **1)** *With reference to the "remediated site"* — **2)** *Concept 2 was preferred due to urban development aspects; the optimization was implemented for concept 3 as a result of better modeling capability*



Optimization Potential of the Model Sites

The model sites processed within the framework of **optirisk®** *realize a significant reduction of clean-up costs with simultaneous revaluation of the respective property through the use of different optimization strategies (cf. table). With the methods described, cost saving potentials of up to 1.89 million US$ could be achieved for the named sites.*
Optimizing the preferred site redevelopment concepts by applying integrated site development concepts, leads to the model sites realizing a revaluation towards the so-called B Sites (potential development sites, also "Public Private Partnership Sites"). Thus, chances for the sites to return into the property market increase.

EXAMPLE

Appendix

EPILOGUE

With these recommendations for action, we would like to motivate you to address the revitalization of brownfields with existing contamination.
Results for the model sites of the optirisk® project, as well as other implemented projects, show that "the stigma due to existing contamination" is not always an obstacle to the revitalization of a brownfield.

The integrated approach of the simultaneous implementation of urban development and environmental remedial measures provides many opportunities for action and possibilities for optimization. With the aid of the optirisk® method, transparency regarding environmental issues as well as cost certainty with respect to financial risks are achieved.
On this basis, statements on profitability of different re-uses of brownfields are possible – the brownfield site is becoming competitive in the redevelopment process.

The implementation of energy applications additionally adds to a revaluation of the site. Some forms of renewable energy can be sited over contaminated soil without increasing risk or liability. Many brownfield sites can be used jointly for installation of facilities for production, transformation, and / or distribution of energy.

GLOSSARY

Active remedial measures Measures must be taken for removal of existing (environmental) hazards at a property to protect human health and the environment in the frame of redevelopment (= clean-up operations)

BMBF *Bundesministerium für Bildung und Forschung, Deutschland* (Federal Ministry of Education and Research, Germany)

BMU *Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Deutschland* (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Germany)

Brownfield A property on which expansion, redevelopment or reuse may be complicated by the (potential) presence or perceived presence of hazardous substances, pollutants, or contamination (EPA)

Contamination Accumulations of pollutants in soil, water and buildings

Energy applications Systems for the use of energy sources (e.g. solar systems), for energy transport (e.g. electricity pipe) and for energy transformation (e.g. engine) are collected under this term

Energy efficiency A dimension for the utilization of various energy types for obtaining useful energy such as heat as well as the effectiveness of transformation, e.g. from light to electricity

Energy networks Serve for transformation of energy from various energy sources to an energy consumer or energy converter

Energy potential A dimension for specific energy sources, with the focus on renewable energies as well as the potential for an increase in energy productivity [kWh]

Energy sources Systems which provide energy through the transformation from another energy type. Examples include: Electricity from wind power, heat from natural gas burning

Energy sinks Transformation processes of high-grade energy types to a lower level (e.g. electricity to light)

Environment / Environmental issues In these recommendations for action, limited to contamination and hazardous substances

Environmental risk forecast Definition and assessment of all risks resulting from legal issues with regards to environmental aspects (liability risks and waste disposal risks)

Geotechnical requirements All required soil characteristics that the building material must satisfy, depending on the intended reuse (e.g. stability)

GIS Geographic Information System – A computer-assisted information system with spatially related data that can be digitally recorded, stored, modeled, analyzed, linked together, and graphically presented

Hazardous soil changes Hazardous impairment of soil that can induce danger or significant harmful effects to human health, ecological receptors, or the environment

Hazardous contamination
Contamination that cause danger or significant harmful effects to human health, ecological receptors, or the environment, and thus must be removed due to liability aspects

Hazardous substances The existence and / or the handling of dangerous substances at a property which lead or can lead to hazard-relevant contamination of protected resources

"In-Any-Case" Expenditures for measures that by themselves do not represent active remedial measures or investment-related additional costs, but the completion of which are indispensable and are equally necessary for the planned investment

"In-One-Go" Active remedial measures (removal of liability risks) and structural investment (new construction) are simultaneously carried out within the framework of building operations

Land recycling Redevelopment of unused properties and reintegration into the property market

Liability risks Those costs which arise from risks due to existing hazardous substances and / or hazardous contamination at a property and the liability to its removal

Mercantile reduced value The theoretical loss in value of a property solely due to the presence of environmental damage. Associated with it is a financial risk that is difficult to calculate, which additionally complicates or inhibits the sale of the property.

Non-hazardous contamination
Contamination that cause no danger to human health and the environment, and thus must not be removed. However, in case of its removal, additional costs arise for disposal.

Property Exposure
All measures related to demolition and deconstruction of buildings, (underground) facilities, and sealed surfaces

Protected resources Human health, natural resources, entire ecosystems, and the environment with which they interact. Summarizes all natural and cultural goods

Risk The chance of harmful effects to human health or to ecological systems resulting from exposure to an environmental stressor (EPA)

Risk assessment Concludes the identification of hazards as well as information about how pollutants behave in the future and its effects on protected resources

Safeguard measures
Active remedial measures that involve a securing of contamination without its removal, so that pollutants remain in soil (e.g. surface sealing)

Soil air The gas phase in the pore space of the soil that is not filled with water

TASK *Terra-, Aqua-, Sanierungskompetenzzentrum*
(Centre of Competence for Soil, Groundwater and Site Revitalisation)

Waste disposal risks Costs which arise from environmental protection obligations in addition to liability risks in connection with redevelopment (e.g. contamination-related additional costs)

IMPRINT & PHOTO CREDITS

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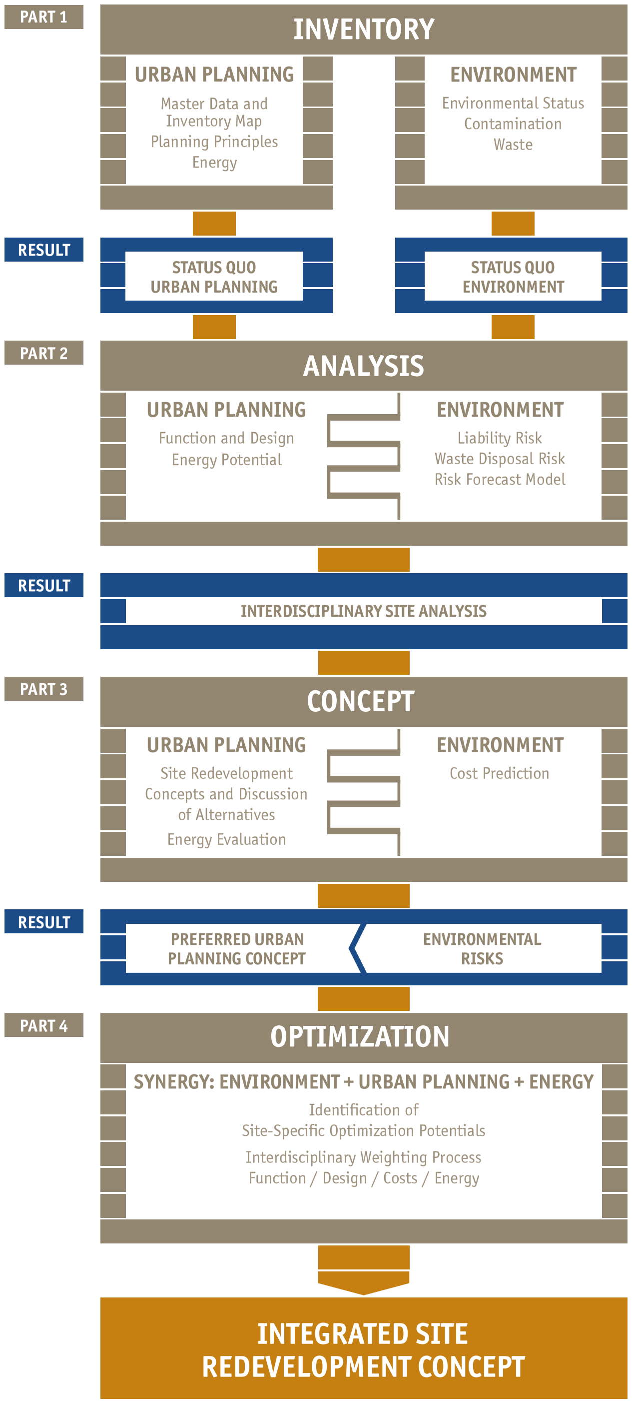

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App. 1: Registration Sheet

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App. 2: EPASch (Energy Potential)

App. 3: Check List Liability Risks

App. 4: Check List Waste Disposal Risks

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App. 5: Urban Development Evaluation Matrix

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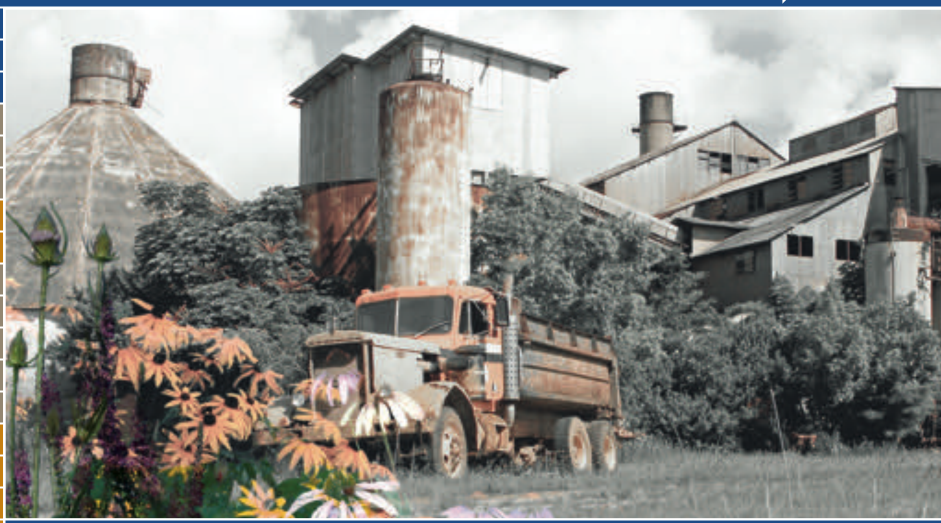
within the framework of
REFINA: RESEARCH FOR THE REDUCTION OF LAND CONSUMPTION
AND FOR SUSTAINABLE LAND MANAGEMENT

Heat storage
Building rubble
Playground
Open space



Hazardous substances
Liability risk