

ThS D4.3 Megasites

TAILORED AND INTEGRATED APPROACH TO MANAGEMENT OF DEGRADED MEGASITES – Former military air base example

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Introduction

Improvement in revitalisation of postindustrial and post military areas towards sustainability requires improvements in methods and approaches to their management. It concerns both recognition of problems occurring at a given site, and planning of remediation in connection with its redevelopment. These issues are the subject of scientific project “ Tailored Improvement of Brownfield Regeneration in Europe - acronym TIMBRE, carried out in 2011-2014 and funded by the 7th European Union Framework Program for Research and Technology Development. Objective of the project is focused on development of cost-efficient remediation and revitalisation of areas (megasites) contaminated in the past. The solutions established in the project are applied in practice, at sites selected in Poland, Germany, Czech Republic and Romania.

One of the model sites is the former soviet, 500 ha army airfield in Szprotawa (Poland) contaminated with petroleum hydrocarbons originating from jet fuels and kerosene spills. Redevelopment of the site was started in the beginning of the 90-ties with remediation performed to limit the risks posed to water resources used by local community. Although, a decline in contamination is visible in the 15 years period, in 2012 the site is still characterised with complexity of contamination problems and provides an unique opportunity to analyse and understand management as a long term process with regard to protection of environmental receptors and importance of risks posed to future land use. The site is located in the watershed of Bóbr and Szprotawa rivers with predominant sandy geological layer and tertiary aquifer used for drinking water abstraction. The results of site characterisation performed in Timbre still show high level of contamination in the source areas and residual contamination in the plume areas.

The site revitalization approach developed in Timbre project tested in Szprotawa case is of holistic character as it integrates through GIS (Geographical Information System) tools different aspects of site management (Timbre, 2013). The scenarios of redevelopment are built and tested against the environmental, social and economical constraints and opportunities with strong participation of stakeholders. Furthermore, the sustainability of redevelopment scenarios is evaluated with identification of benefits and impacts on local and on general level (e.g energy use, future environmental impacts). The project results achieved in the Szprotawa case shows that integrated approach to contaminated site revitalisation is essential not only for improving the remediation process and better fitting the new functions to the inherent site potential but it also can give sustainable benefits in a long term perspective.

Timbre project site revitalization approach

Timbre management approach tested in Szprotawa case is holistic incorporates various aspects of site management such as: risks related to contamination, cost efficiency and sustainability of remediation, future benefits and impact of the redevelopment scenarios. These aspects are integrated through GIS (Geographical Information System) tool which gives an opportunity for analyzing redevelopment scenarios and remediation options. It also allows for defining environmental constraints and/or requirements for environmental acceptable state with regard to the desirable land use scenarios.

The Timbre approach is based on improved practice of site characterisation with a set of combined, quick and reliable methods: including direct push techniques, shallow probing and fitoscreening. It also concerns selection of remediation technologies or their combinations with regard to acceptable risks levels and future land uses, taking into account the issue of long term bioremediation and monitoring requirements. Finally, it helps in taking decisions with stakeholders involvement on future redevelopment which are the most desirable from social, economical, and environmental point of view.



Figure 1 Timbre project key features of brownfield redevelopment

Szprotawa air base example

Former soviet military air base is located in the South West part of Poland in Lubuskie Voivodship (Figure 2). The airfield was established in the 30th of XX century (Fliegerhorst Sprottau) changed into military air base before the Second World War. After the Second World War it was developed as Soviet military air base. After 1992, the airfield was partially turned into civil facility with residential and industrial zones.

The air base area is located nearby Bóbr River (approximately 1,5 km), its right tributary Szprotawa River (approx. 1 km), and the east territorial boundary of military zone, set by forest brook. Two significant water-bearing levels occurs in the air base area. In general the hydrogeological conditions are sensitive to contamination. Tertiary water-bearing level is composed of 3-4 water-bearing horizons, in miocene loamy gravels. The top tertiary water-bearing horizon is separated from quaternary sediments by 10m layer of loams. Quaternary water-bearing level consists of a few water-bearing horizons. In the air base area quaternary water-bearing horizon is represented by 5-10m layer of sands and gravels.

Total area of the site is 500 ha. There prevails the built-in area with former military facilities, an open space (air strip area) and forest sections maintained by the municipality and national forest administration. In the built-in area variety of structures are present including former military settlements aircraft shelters and auxiliary facilities. In the forested area predominant tree species are pine, spruce, birch. Part of the site is included in the NATURE 2000 area established for protection of owl species. In the abandoned parts of the mega-site interesting protected species of plants and animals are present.

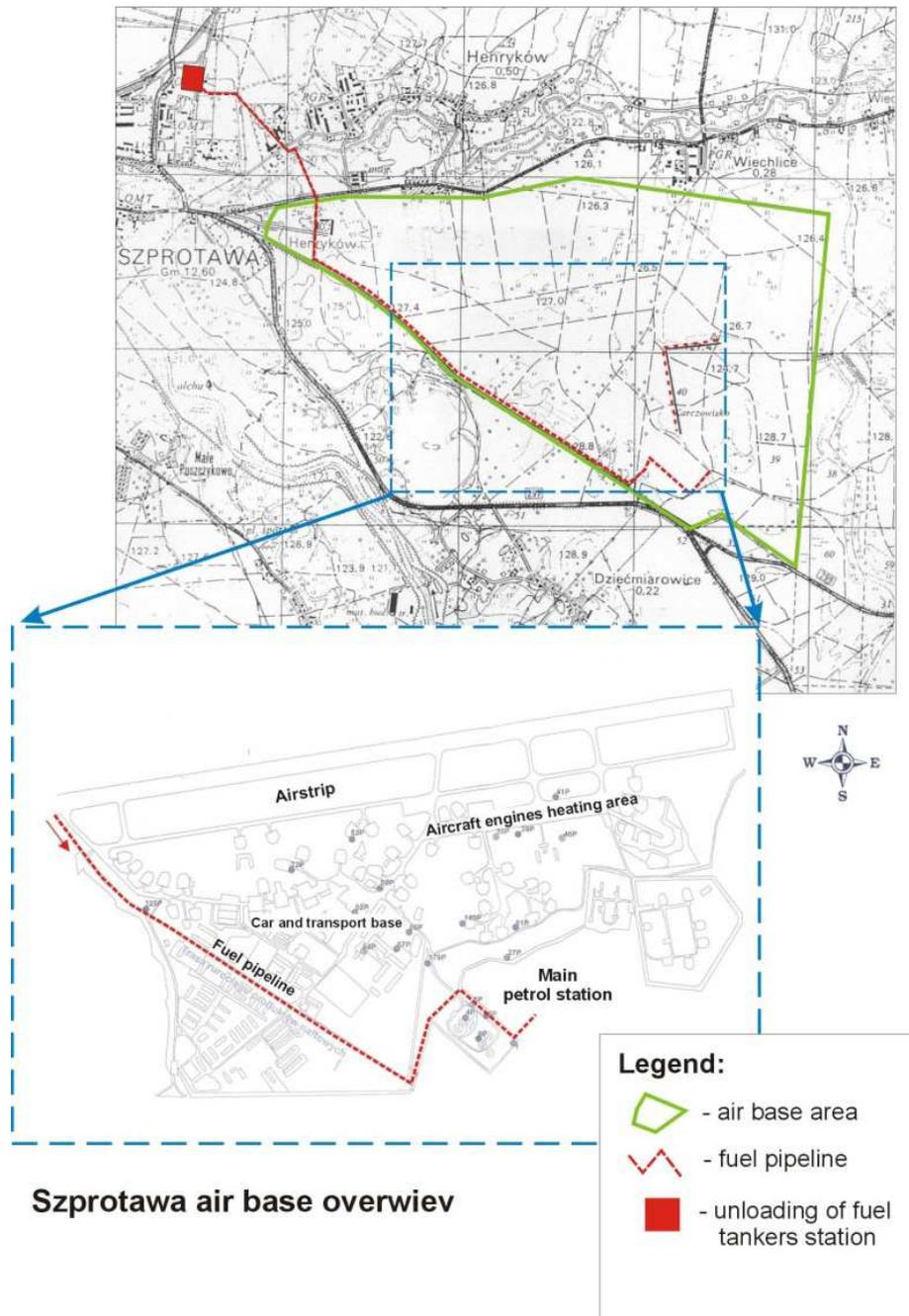


Figure 2 Overview of Szprotawa brownfield

Brownfield in Szprotawa is typical case for former military sites in Central and Eastern Europe. From the redevelopment management perspective the site is a good example of:

- long term gradual process of redevelopment – in total 50 years of redevelopment cycle is foreseen starting from the 1992 when the site was transferred to Polish authorities,
- complex revitalisation planning (mixed land use functions and functionalities) with integration of remediation with redevelopment – driven by future land use objectives and with respect to revitalisation contexts and factors, both internal and external,
- spatial zoning of redevelopment activities (depending on infrastructure, previous use, and contamination) which helps structuring revitalisation processes taking into account risk management and redevelopment objectives,
- complex patterns of reuse of infrastructure, deconstruction, decontamination and sustainable waste management to be integrated with new redevelopment projects (rubble, contaminated soil),

- coupling redevelopment with tailored remediation – combined short term remediation measures and long term natural attenuation based on tailored and smart site characterization.

Szprotawa site illustrates well long term redevelopment approach which is typical for many brownfield sites in Poland. The whole revitalisation cycle for sites transferred during the political transformation period in the 90-ties of XX century takes usually around 30-50 years. In case of Szprotawa airbase redevelopment of initial 30% of the area, before 2012, already has taken 20 years.

The following phases of Szprotawa site revitalization can be distinguished:

- years 1991-1994, phase 0 with recognition of environmental problems, and general clean up measures undertaken by municipality, identification and characterisation of soil and groundwater contamination
- years 1994 – 1999, phase 1, in which remediation related to environmental risk took place and was focused on contamination sources with cost-efficient risk oriented measures reducing threat to groundwater resources. Partial redevelopment of the site with housing, hotel, school facilities and transferring of military buildings for business activities of SMEs was undertaken, Spatial plan for the area was established setting the main future land use functions.
- years 2011 – 2012, phase 2 was oriented on future land use revitalization. It is focused on limiting of residual contamination impact and risks for future land uses - activity undertaken in TIMBRE. It is also a period of building conditions for private investments, actions undertaken towards enlargement of Special Economical Zone.
- Years 2012 – 2020, in the phase 3 further plans for redevelopment of the airstrip area and the airbase fuel depot area forested area are shaped. Activities aimed at promotion of investments grounds among private investors are carried out.

Clean up of the main contamination sources carried out in the 90-ties was successful in reducing the main environmental risks related to groundwater resources. It was carried out under local government mandate. Local government as the site owner was responsible for the activity with the National Fund for Environmental Protection and Water Management supporting the action. In the next phase, after 2012, further upgrading of soil quality might be needed as crucial for future development of the site. It might be motivated by redevelopment needs related to changes of the land use functions from industrial to service or housing land use. In this phase the private sector will be responsible for further remediation activities. This will depend on factual future development in the Szprotawa area setting the conditions and requirements of further development.

Analysis of the situation in Szprotawa gives also an interesting view on revitalization as an ongoing process agreeing with the circular land use cycle concept (Preuß, Ferber, 2008). The redevelopment of the site up to 2012 was a mixture of actions performed by the public authorities, local entrepreneurs and governmental agencies. In the 90-ties the former area of the airbase site was partially transferred from municipality to local entrepreneurs for the purpose of production and services. Continuous development of the structures and buildings according to business plans of SMEs with complementing upgrading of the infrastructures by public authorities is observed up to 2012. In areas with no economical interest at the moment temporary uses of the site are established. They include recreation paintball grounds, and production montage of wind turbines.

Megasite remediation

In Szprotawa airbase there were initially identified various sources of contamination: fuel depot, car park and workshops, aircraft heating area, pipelines, fuel reloading facility (Figure 3). Soil and groundwater contamination was caused by neglectful long term military activities as well as illegal actions of local people. The main contaminants are petroleum hydrocarbons (jet fuel). Other contaminants such as chlorinated compounds cannot be excluded. In the 90-ties hydrocarbon plume in the water bearing horizon was detected threatening local water resources.

At the site three perspectives are distinguished by the stakeholders as important in decisions on remediation activities:

- risks to environmental receptors, e.g migration of contaminants to nearby groundwater resources and surface water,
- soil and groundwater quality from the point of view of regulatory requirements,

- land use related quality of the environment reflecting risks to new land-use functions.

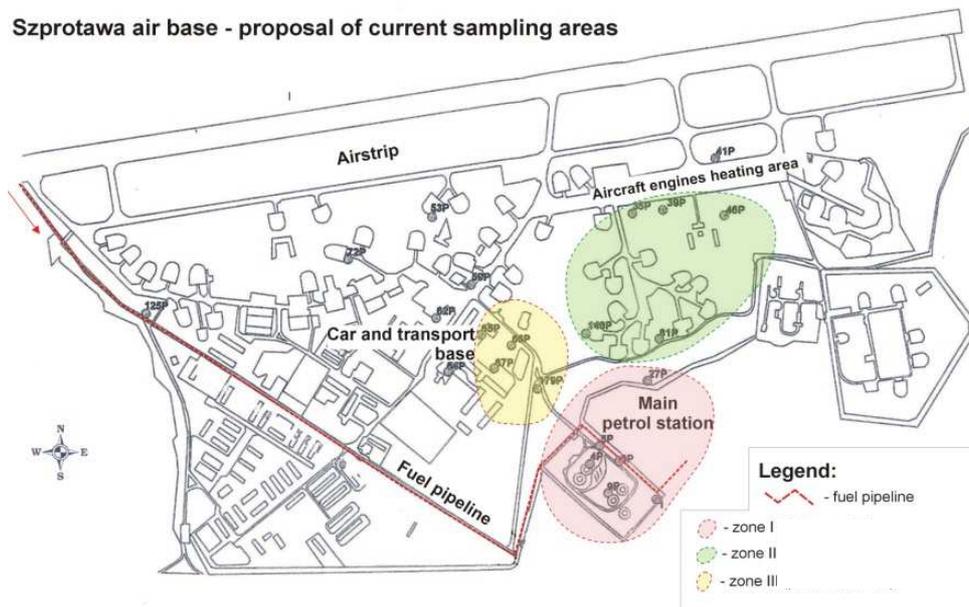


Figure 3 Main contamination sources at the former airbase in Szprotawa

For megasites characterised with large extent and variety of sources there is a need for strategies of rapid site investigation and cost-effective monitoring. It has to provide arguments for approval of natural attenuation and determining the needs and possibilities for in-situ techniques application (Krupanek, Kalisz, 2012). In the initial stage in the 90-ties investigation was performed to target contaminants plume development with the use of soil-gas measurements and monitoring based on water samples taken from installed monitoring wells.

Risk to groundwater receptors and surface water was tackled in the first phase of Szprotawa site redevelopment. The remedial activities carried out in the period between 1997 - 1999 reduced the risk of hydrocarbons plume migration towards – Bóbr River which is running to the south of the site and groundwater resources used as drinking water source in the nearby Dziećmarowice village. Around 2.7 m³ of pure fuel was stripped and 2200 m³ of groundwater was cleaned up. The operation was performed in the area of the main airbase fuel depot and the pipeline area. The efficiency of stripping was 99%. To reduce the risk of contaminants migration, an aeration barrier was built to intensify processes of natural biodegradation. In-situ installation comprised barrier of 24 wells, installation for aeration and system of 15 control wells. The barrier was operating from June 1997 till the third part of 1998. As the final stage bioremediation was used with indigenous bacteria. Injecting of biogens and inoculants and aeration lead to essential reduction of concentrations of Total Petroleum Hydrocarbons parameter.

In Timbre project in 2011 the former remediation efforts were followed with investigation focused on future use of the parts located in the source zones. The renewed investigation is also a good opportunity for evaluation of natural attenuation processes on the site, which have took place in the 10 years time after the first remediation. It should help in prognosis of future environmental changes at the site and determining natural attenuation potential. At this stage it is important to integrate site characterisation with remediation and future land-use planning. To achieve that tailored investigation and iterative, step wise approach based on screening and problem specific surveys are applied.

The following aspects are resolved for the purpose of further planning at the site:

- delineation of current source and plume zones and determining contamination levels,
- understanding of the hydrogeology in the source area including groundwater level seasonal changes, changes of the plumes and groundwater contamination levels, and the ensuing environmental risks,
- evaluation of the risks for the planned land uses.

In Timbre site characterisation approach designed for investigation of large areas the following techniques are used:

- Screening in large area with delineation of source and plume zones
 - o Shallow Soil Probing (SSP),
 - o Fitoscreening (chemical parameters),
- Targeted investigation is based on direct-push-based technologies including:
 - o Membrane Interface Probe (MIP),
 - o laser induced fluorescence (LIF) probe used for determining the thickness of contaminated soil layer.

Based on the obtained information, conceptual models and numerical multi-component transport models serve the purpose of optimizing the solutions both of site characterisation and of further remediation. The results of various models are related to each other, compared and integrated to allow the environment quality being assessed from perspective of risks to future land uses.

Soil and groundwater quality has to be determined from the point of view of regulatory requirements. Complex patterns of soil and groundwater contamination needs clarification. Interpretation of the environmental quality data in the context of legal requirements is the matter of practice both on administration part and consultants. Different methods serve variety of purposes in the context of administrative decisions, assessing remediation needs and preparing remediation scenarios. For the purpose of controlling the environmental quality with the focus on regulatory requirements there are performed the following baseline methods:

- o soil sampling with Geoprobe and hand drilling,
- o wells installment used for water sampling and physical parameters measurements.

Further remediation in this phase has to serve the purpose of future redevelopment of the site appropriately to proposed land uses. It has to be highly selective with regard to future land uses and with regard to sustainability objectives and criteria (Ellis, Hadley, 2009). Active short term remediation can be required only in cases of plans and construction projects in zones highly contaminated. These plans are still under consideration and will depend on the interests of potential investors. With regard to this, for highly contaminated spots in the source areas coupling of "in-situ" technologies can be considered: e.g. Direct Push based strategies. This approach can be potentially used in the former main air base fuel station, and aircraft fueling stations. Furthermore, in land use planning, remediation has to be integrated with future construction activities taking into account risk management principles – removal of soil and demolition wastes and on-site treatment.

Natural attenuation in long term remediation has to be considered for most of the remaining contamination in plume and source areas. The natural potential exists and enhancement measures can be considered including use of low grade groundwater by local entrepreneurs, fitoremediation and monitoring and evaluation of the situation.

Apart from technology selection, the technical aspects are investigated for chosen technologies to improve their practical application. Among the long term technologies fitoremediation is evaluated. In Szprotawa site case, it is interesting to evaluate efficiency of diffuse contamination removal in areas being already forested or covered with plant canopy. Fitoremediation and bioremediation are efficient in degradation of organic components. These technology requires characterisation of site conditions. Adaptation of the technology to concrete conditions of application is based on mathematical modeling. It allows for qualitative analysis and simulation of the remediation process. In Szprotawa case, research on natural processes of fitoremediation and bioremediation are interesting in the context of previous remediation activities. The results obtained so far shows that decrease of contamination is observed in source and plume zones. The processes are investigated using the results of the measurements of chemical and physical parameters.

Deconstruction and reuse

Plans of deconstruction and reuse of existing infrastructures and buildings have to be integral part of site redevelopment (Krupanek, Kalisz, 2012). They are related to requirements for remediation and

future land use at the site. Identification of environmental hazards: presence of asbestos, tars, building material contaminated with hydrocarbons, PAHs has to be performed in the initial phase in the context both of the infrastructures reuse and waste management.

The post military site in Szprotawa is characterized with various types of infrastructures and constructions: common structures such as military barracks, headquarters and special military constructions, infrastructures and buildings. Identification of barriers and opportunities for reuse of military constructions is linked to planning of future site redevelopment – many examples of reuse exists at the site as result of the first phase redevelopment (Figure 4).

Requirements for infrastructure deconstruction and demolition are defined appropriately to site specific situation with full regard to national regulatory requirements. Operational rules and good practices of contaminated materials management have to be incorporated in the planning along with selection of technologies: recycling and processing of wastes – on-site approaches: use of the rubble by local entrepreneurs and public authorities as construction materials. Taking into account that the site is redeveloped by private investors to whom all the liabilities are transferred upon selling of the plots they are finally responsible for proper reuse of constructions or waste management. Establishing good practice with guidance on future reuses of constructions, buildings and waste management are crucial in Timbre approach.

In Szprotawa site, reuse of existing buildings and deconstruction or demolition and subsequent management of rubble and other material useful on the site are equally considered. The existing buildings in Szprotawa megasite can be classified into:

- universal structures and buildings – housing, offices,
- unique infrastructures and buildings typical for post-military sites: aircraft garages, fuel stations, bunkers, weapon, armory depots and shelters, tarmac.

The reuse of typical buildings is performed according to general rules and technical specifications. It is more challenging for military objects such as aircraft shelters taking into account their technical specifications. The improvements for waste management are pursued through better characterisation of existing structures, assessing the streams of wastes, investigation and analysis and classification of the demolition material. At the same time appropriate reuse of the demolition material as useful material or hazardous waste utilisation is considered.



Figure 4 Example of reuse of military construction



Figure 5 Poor technical state of military constructions

Planning of redevelopment of the site

Different visions and opportunities have been formulated in a long process underwent within the local community. Importance of site redevelopment is recognized by local government. The initial site redevelopment began with quick transformation of the former housing area, being in relatively good condition and without environmental liabilities, into settlements, with school, hotel and services. Partially the military constructions were also reused by the local entrepreneurs to whom the allotments were sold by local government. The construction remaining in the undeveloped areas are after 20 years of neglect in poor conditions caused by weathering and human illegal activities (Figure 5).

The key driver of future development of the site is the economical development of the town with regard to social problems such as shrinking population (20000 inhabitants in 2012) and high unemployment in the area. A set of internal and external factors defines future development and is considered by the local government.

For planning of further redevelopment of the site the following internal factors are of importance:

- previous land use and infrastructure,
- contamination of the site and environmental liabilities,
- nature protection and cultural heritage,
- environmental impacts of potential new land use functions,
- socio-economical –factors on–site inhabitants, public and private services.

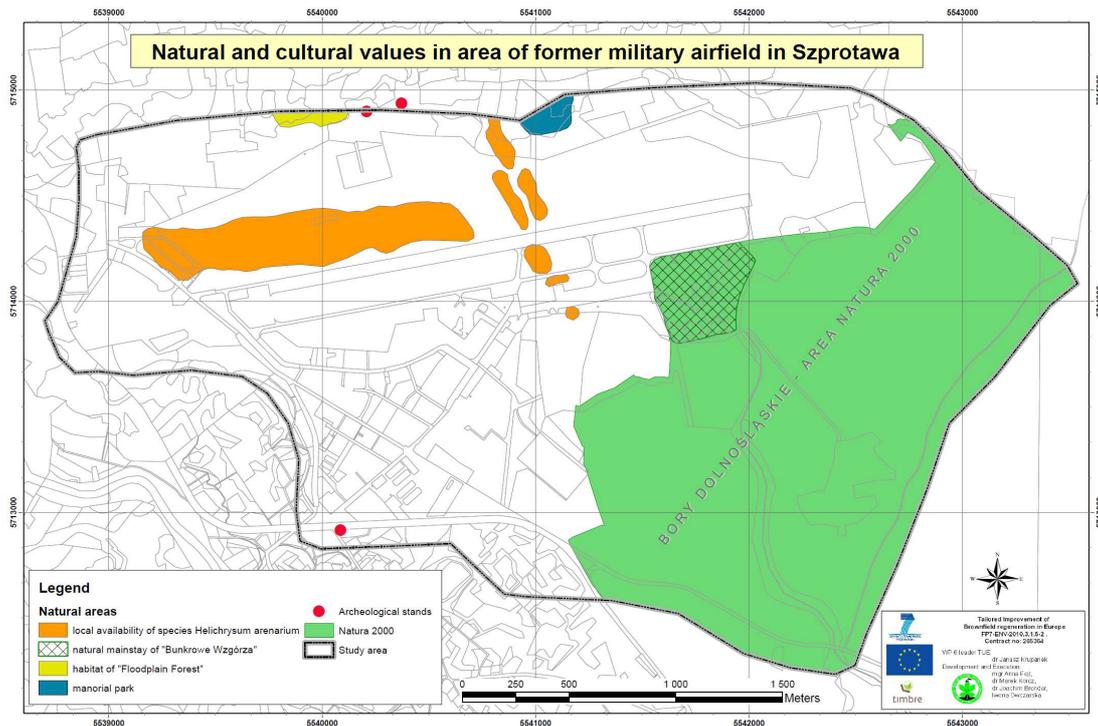


Figure 6 Nature protection values in the airbase area

According to representatives of local government the issue of environmental liabilities is getting to be very important. There is strong need for clarifying the situation with determining the needs, and setting the requirements and goals of remediation. It requires integration of revitalisation scenarios with remediation strategies which are based on effective site characterization.

Szprotawa site redevelopment is influenced at the same time by external factors such as:

- plans for new national road construction,
- establishment of Special Economical Zone,
- local and regional socio-economical impacts and needs.

In Timbre project improvement of decision making process is pursued through:

- identification of obstacles caused by specific socio-economic conditions,
- risk communication, clarification of legal requirements and redevelopment options,
- local, regional and national administrative and legal aspects,
- defining decision structures to support decision making processes.

Having in regard the variety of factors influencing sustainability of future site redevelopment conflict analysis is performed in Timbre approach to identify main negative impacts and to look for opportunities of moderating the conflicts between different interests. The key drivers of redevelopment are the economical zone development and the new national road plans which has to be considered in

the view of nature protection, historical values and service and recreational functions of the area and relations to housing areas.

Next phase of the site development started in 2011 concerns 200 ha area of the former airstrip on which Special Economical Zone development is under planning process. The Special Economical Zone is a mechanism for stimulating investments in underdeveloped areas in Poland. The local government interest is to attract investors to the zone (Figure 7). Within the local government there are formulated desirable patterns of investments. Investment offers are analysed and selected carefully by the municipality. The key criteria are: economical development including local government income, social aspects such as rate of unemployment, environmental criteria and impacts considered from the local community point of view and attractiveness for investments.

One of the important features of future site redevelopment is the holistic approach. It is pursued by the local government through changes in the spatial plan to combine extension of housing development in the area with development of production, services, communication, and supporting infrastructure. In that way the key land use functions of redevelopment are well balanced. Timbre approach facilitate planning processes allowing for building up and assessing various redevelopment scenarios. The Megasite Management Tool based on Geographical Information System is used for this purpose (Morio *et al.*, 2011). It gives understanding of long term conflicts, impacts and benefits of these scenarios. In a result the discussion among local stakeholders can be enhanced leading to selection of the optimal solutions.

The key decisions of redevelopment have to be optimal from economical, social and environmental perspectives. The last undeveloped part of the site is the most contaminated area of fuel station of the airbase and a group of hangars to be considered by the local government. Up to 2012 there were no concrete plans considered. The new national road construction which was in 2012 under planning and will run through this area will be the decisive factor and has to be included in the planning process.

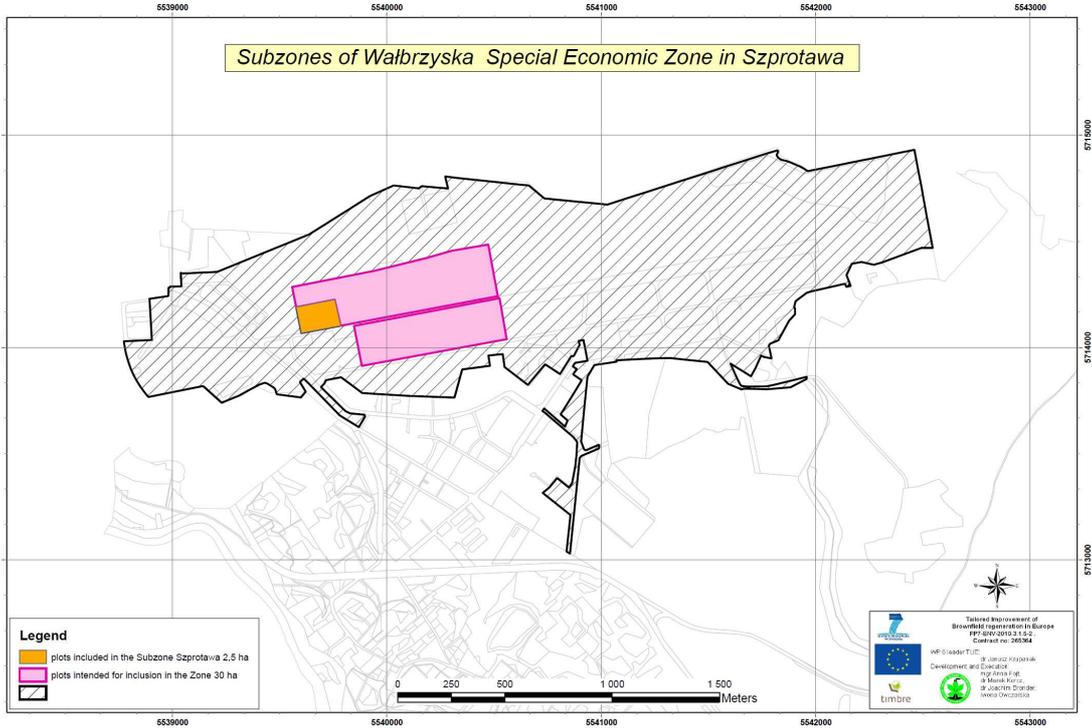


Figure 7 Second phase of redevelopment of the former airbase - special economical zone plan

Conclusions

Timbre project approach applied in Szprotawa brownfield can be considered as being in line with activities undertaken at the site so far and useful in further planning of its future redevelopment. It tackles the following key aspects and processes of successful and sustainable remediation and revitalisation of the site:

- step by step integration of remediation and deconstruction with future redevelopment plans,
- good recognition of problems and opportunities with regard to stakeholders needs, spatial and time aspects,
- stakeholders involvement within bottom up and top down redevelopment schemes,
- shaping up revitalisation scenarios taking into account risks, internal and external conditions, stimulating discussion among stakeholders and structuring the decision making process.

Testing of TIMBRE approach in the case of former military airfield shows high potential of improvement in revitalisation management as integrated, tailored and holistic procedure leading to sustainable revitalisation of the site.

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