Mining- and Environmental Rehabilitation

A sustainable investment into future

Rehabilitation of former state-owned Lignite Mining in Eastern Germany – results and tasks

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Note: All pictures are under authorship of LMBV mbH. www.lmbv.de

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Xuzhou
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Look back on the mining industry of German Democratic Republic

Böhlen bei Leipzig 1989
Serious environmental problems

Bitterfeld 1992
Non-rehabilitated and devastated area on over 30,000 ha (300 km²)
Open pits in direct vicinity to villages
Open pits, unsafe slopes, acid mine water
Responsibility of LMBV

- Thermal Power Plants: 46 (1989) vs. 3 (2019)

2000 – finishing of active mining by LMBV

One generation later

Rehabilitation and re-use of these mining industry sites
... with heavy social impacts

Last shift of workers in plants in Lauchhammer

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Structure

- LMBV – the company
- Involvement of the government and the public in the rehabilitation process
- Geotechnical tasks
- Rehabilitation of the water household
- Groundwater resurgence - conflicts
- After use of post-mining landscapes
- Conclusion
LMBV – the company

- State owned company (Ministry of Finance)
- Responsibility: Decommissioning and rehabilitation of sites used by the lignite mining industry of the GDR
- Includes:
  - the re-cultivation of dumps feasible for re-use in the public interest
  - the restoration of a self regulating water balance according to water quantity and quality
Starting position for the establishment of LMBV 1995

- 32 open-cast mining areas with 224 open pits
- 1,200 km unsecured slopes
- 13 billion m³ groundwater deficit with cone of depression of 2,000 km²
- 97,000 ha property of areas used by mining activities
- 5 active mines to be closed until 3.12.1999
- 46 refinement- and 42 thermal power plants
- app. 1,200 legacy areas
Involvement and Transparency
Involvement and Transparency in planning and execution process

- Participation of public interest bodies in planning and approval processes
- Regional planning committees (Regionale Plannungsausschüsse / RSB)
- Permanent checks by the Federal Audit Office and the Audit Offices of the states
- Questions from members of parliament
- Comprehensive and detailed website presence
- Wide range of information materials
- Public discussions on rehabilitation topics and necessary steps to solve problems
- Information of parties concerned
- Guided tours on construction sites
- Information of the press
- Scientific conferences on rehabilitation issues

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Geotechnical tasks
Geotechnical tasks

In total: compaction of 1,167 bill. m³ of masses on LMBV dump slopes

Open-cast Meuro 2013
Geotechnical issues

Nearly flooded lake

Harbour under construction
Site collapse inner-dump Spreetal in October 2010, 170 ha
New technology: gentle blasting compaction

- Gentle blasting compaction 10,000 ha (only 7-22 kg explosive material per borehole)
- Vibrating pressure compaction 840 ha
- Earthworks 20,000 ha
Solving the new geotechnical problems

Handlungsempfehlung für eine „Schöne Sicherung der Kippe mittels Sprengverdichtung“
on Grundlage wissenschaftlich unterstellter Dimensionierungsregeln und bei praktischen Anwendungen der Sprengverdichtung gewonnener Ergebnisse und Erfahrungen

Freiberg / Februar 2014

Senftenberg, Januar 2015

Dr. Keller
BIUG

Dr. Donnerhütz
CDM Smith

Geschäftsführer

Bezirksleiter Technik

Anwenderempfehlung
für Belastungsversuche als Bestandteil von
Standsicherheitsnachweisen von Innenkippenflächen

Freiberg, Senftenberg, 09.12.2016

37 Seiten - Anlagen - 6 Tabellen - 8 Abbildungen

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Rehabilitation of the water household
Groundwater deficit in 1990 and resurgence until 2017

- Post-mining lakes:
  - Post-mining lakes: -4.5
  - Aquifers:
    - 1990: -8.2
    - 2000: -9.0 bill. m³
    - 2016: -2.2 bill. m³

- LMBV:
  - Total deficit: -12.7 bill. m³
  - Resurgence: +10.6 bill. m³
  - Deficit of 2.1 bill. m³
FeS$_2$ + 3,75 $O_2$ + 3,5 $H_2O$ $\rightarrow$ 2 $SO_4^{2-}$ + 4 $H^+$ + Fe(OH)$_3$

Pyrite + Oxygen + water $\rightarrow$ Sulphate + acid + Iron-hydroxide

Water influenced by mining

- high sulphate concentration
- low pH-value
- high iron concentration
Commissioning of LMBV-rehabilitation ship „Klara“ am 02.09.2016
Start of In-lake-Initial neutralisation of lake Partwitz
In future the whole chain of lakes will be application area

**Push-boat (Schubboot)**
- length: 12,80 m
- width: 5,02 m
- draught (Tiegang): 1,05 m
- weight: 23 t

**Push-barges (Schubleichter)**
- length: 14,30 m
- width: 5,02 m
- draught: 1,02 m
- load capacity: 25 t lime products
Modern water treatment plants

- Mobile and flexible water treatment plants in the catchment area of rivers
- Avoidance of inflows of acid groundwater into the rivers

1. Reaktionsbecken mit Kalksilos
2. Flockenreichbecken
3. Sedimentationsbecken
4. Dekanter
5. Schlammendicker
6. Aufenthalts-/Ents/JEMSR-/Sanitärcontainer
Groundwater resurgence - Conflicts
Impacts of the groundwater resurgence

Area of groundwater lowering

Conflict between groundwater level after mine closure and

Infrastructure
Abandoned mining
Building structure
Legacies
Rivers

app. 5.800 affects, thereof app.
- 2,400 still activities necessary,
- 1,400 secured,
- 1,000 in planning

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Groundwater lowering as result of over hundred year of lignite mining,
Former receiving waters (trenches, brooks, small rivers) dried-up or were filled and became construction sites.

Over 800 buildings had to be investigated
Horizontal-filter-wells in city of Senftenberg und Brieske

- target: lowering of the groundwater level from 99,5 to 98,0 m NHN
- construction: 2012 until 2017
- secured objects in Senftenberg and Brieske:
  - buildings / constructions: 395
  - properties industrial park Laugfeld: 30

[Map diagram showing wells and flow rates with labels for Senftenberg and Brieske areas]
Erection of south trench Altdöbern – securing of 431 objects

- Trench: 1.285 m
- Width on surface: 19 to 52 m
- Width of bottom surface: 1 to 1.3 m

Foto: P. Radke, August 2017
After – use of former mining sites
Afforestation and Nature protection
Touristic investments

- Derivation of river Schwarze Elster
- Construction of canal under the river to connect two post-mining lakes
- Tunnel under state road
- Construction of a lock
Touristic Investments

Harbour of Senftenberg
- Public investment and
- Private investments
Touristic investments

Canal and sight seeing point “Rusty Nail”
Touristic Investments

Explanation of rehabilitation work by LMBV during official harbour opening

Former lignite mine 1921 - 1993

Harbour Zwenkau
- Public investment
- Private investments
(Olympic) canoe park near city of Leipzig
Conclusions

- After 25 years of mining rehabilitation by LMBV significant changes are visible:
  - most of the contaminated sites have been cleaned and re-used by new owners;
  - the restoration of a self regulating water balance according to water quantity and quality will be reached. New technologies are developed for securing unstable dump-sites and the treatment of iron-hydroxide contaminated waters;
  - former open-cast mines develop into attractive tourist destinations;
  - post-mining landscapes are extremely worthy for nature protection goals;

- Mining rehabilitation on time, during the excavation is necessary for acceptance and far cheaper than starting afterwards.

- Creating a market for rehabilitation is an ongoing success story.

- There are no standard solutions – science & technological innovation are crucial.

- Have visions and underpin the visions with feasible solutions.