

# The German Wismut Environmental remediation Programme – Status achieved and Challenges remaining

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Gefördert durch:



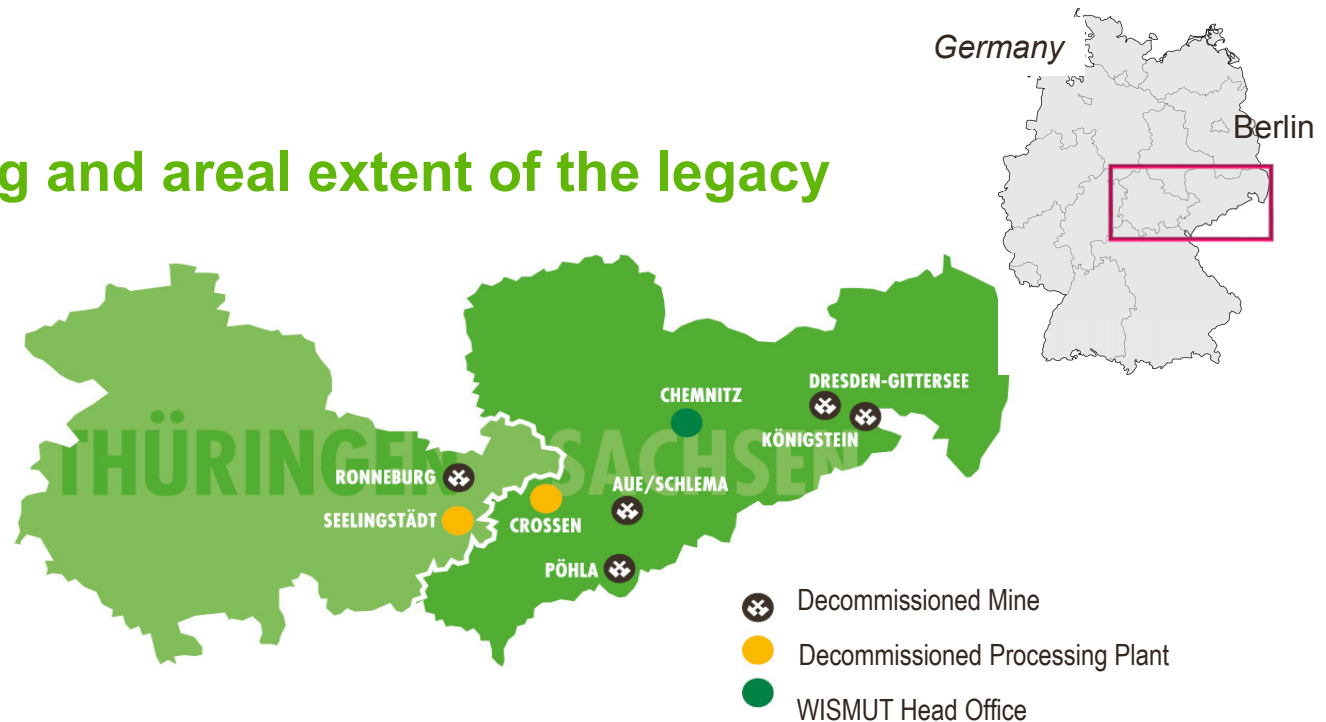
Challenges and Best Practices in Metal Leaching and Acid Rock Drainage  
BC MEND 2013, Vancouver, December 4 - 5, 2013

aufgrund eines Beschlusses  
des Deutschen Bundestages

## Introduction

- 1946 - 1990, SDAG Wismut in East Germany major foreign uranium supplier to the Soviet Union (~ 216,000 tonnes of U from 20+ deposits)
- 1990, U production terminated in the wake of the German reunification (45,000 employees)
- Rigorous production philosophy, operation in densely populated areas
- East German U industry left behind one of the most extensive uranium-mining legacies in the world
- 1991, start of the remediation program after abrupt closure
  - German government as new company owner earmarked 6.6 bn Euro to fund the project (largest European environmental remediation programme)

## Site setting and areal extent of the legacy



- 7 production complexes, with more than 1,000 objects:
  - 5 Underground mines (~ 80 million m<sup>3</sup> excavation volume)
  - 1 open pit (~ 84 million m<sup>3</sup>)
  - 2 Processing plants, 10 TMF, containing 160+ million m<sup>3</sup> tailings
  - 3,700 hectare operational areas with contaminated facilities
  - 60+ Waste rock piles, containing 325 million m<sup>3</sup> WR



## Situation in 1990

- 325 million m<sup>3</sup> waste rock piles (1,540 ha contact area)





## Situation in 1990

- 3,700 hectare contaminated operational areas:  
250,000 m<sup>3</sup> demolition waste  
260,000 tonnes scrap
- 160 million m<sup>3</sup> tailings





## Situation in 1990

- 1 open pit: 84 million m<sup>3</sup>
- 5 underground mines (1,500 km mine workings),  
1 in-situ-leaching mine



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## Remediation goals

- Ensure public safety
- Enable future land use
- Minimize radiation risks and hazards
  - achieve individual effective dose for public:  $< 1 \text{ mSv/a}$
- Reduce adverse effects to water resources
  - minimize WR seepage, flood mines, pump & treat tailing seepage and mine drainage to meet regulatory standards (U, Ra, As, heavy metals, Fe, Mn,  $\text{SO}_4$ )
- Destigmatize regions affected by uranium mining



## Main Activities

- Dismantling of surface structures, decontamination and site clean-up, disposal of contaminated material into containments
- Safe closure of underground mines and controlled mine flooding
- Tailings dewatering & stabilization
- In-situ stabilization or Open Pit disposal of mine waste, segregation / conditioning of reactive mine waste
- Vegetated soil covers on tailings and waste rock
- Active water treatment and safe management of residues
- Environmental monitoring & Maintenance



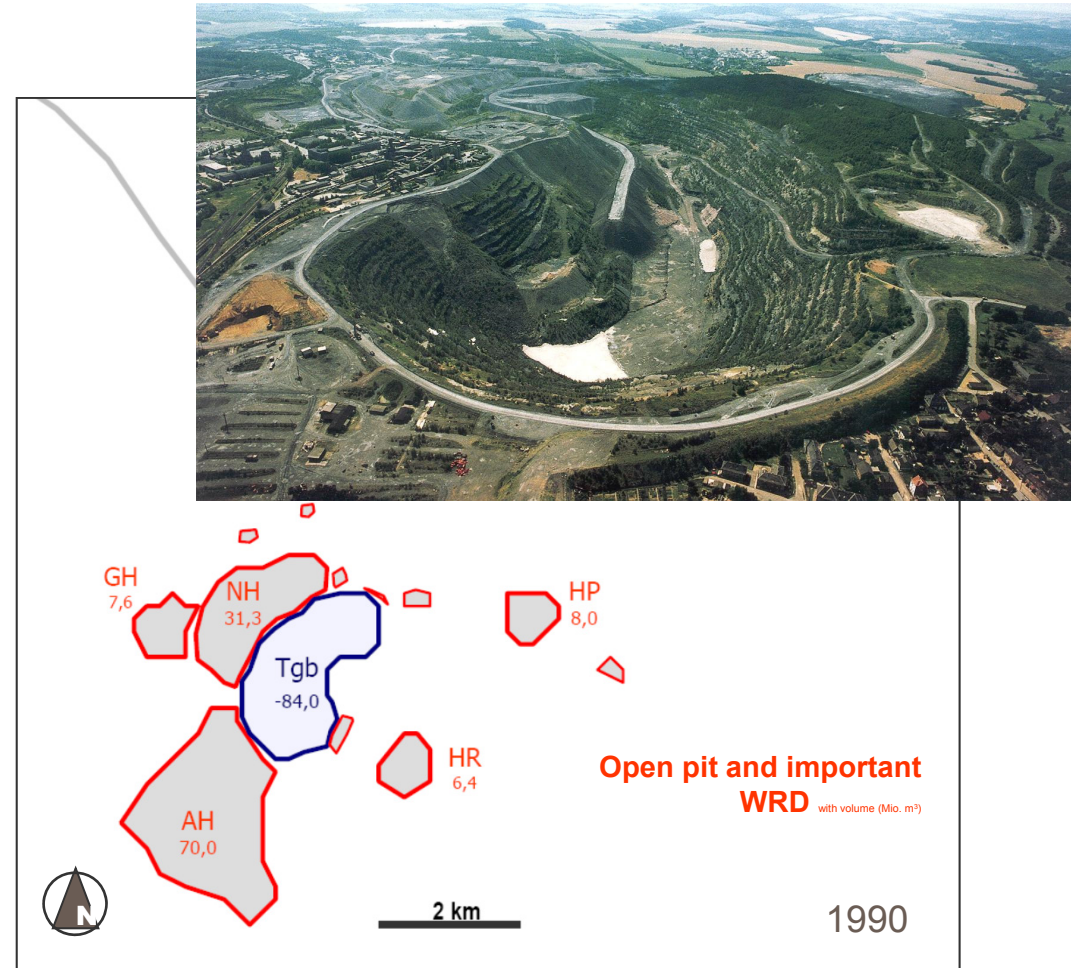
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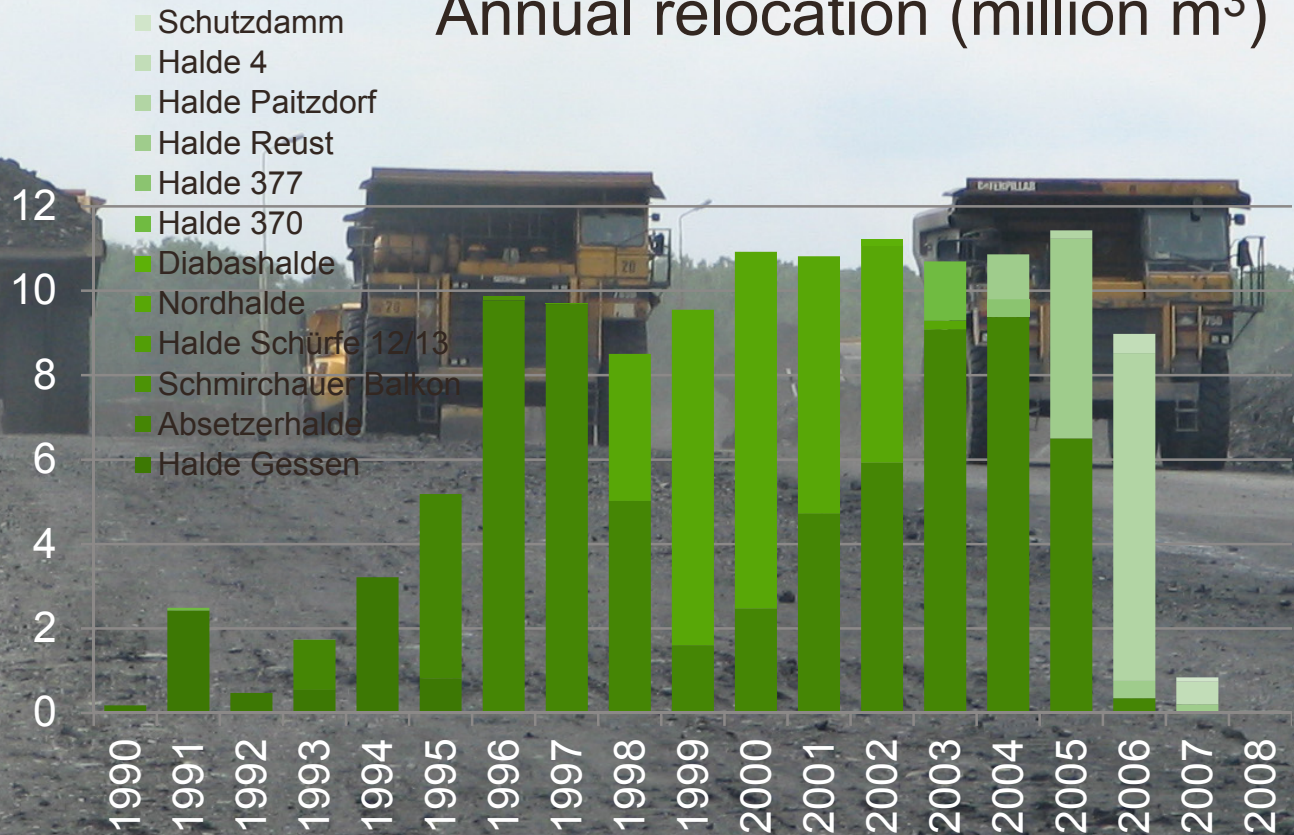
## Open pit disposal of mine waste

- ARD, 16 dumps
- Spatial concentration of waste rock in open pit
- 132 million m<sup>3</sup> = 230 million tonnes
- Transport capacity 10 million m<sup>3</sup>/a
- Necessary investment in powerful transport fleet (1993, 1995)
- Backfill concept includes zonation according to waste rock acid / neutralizing potential



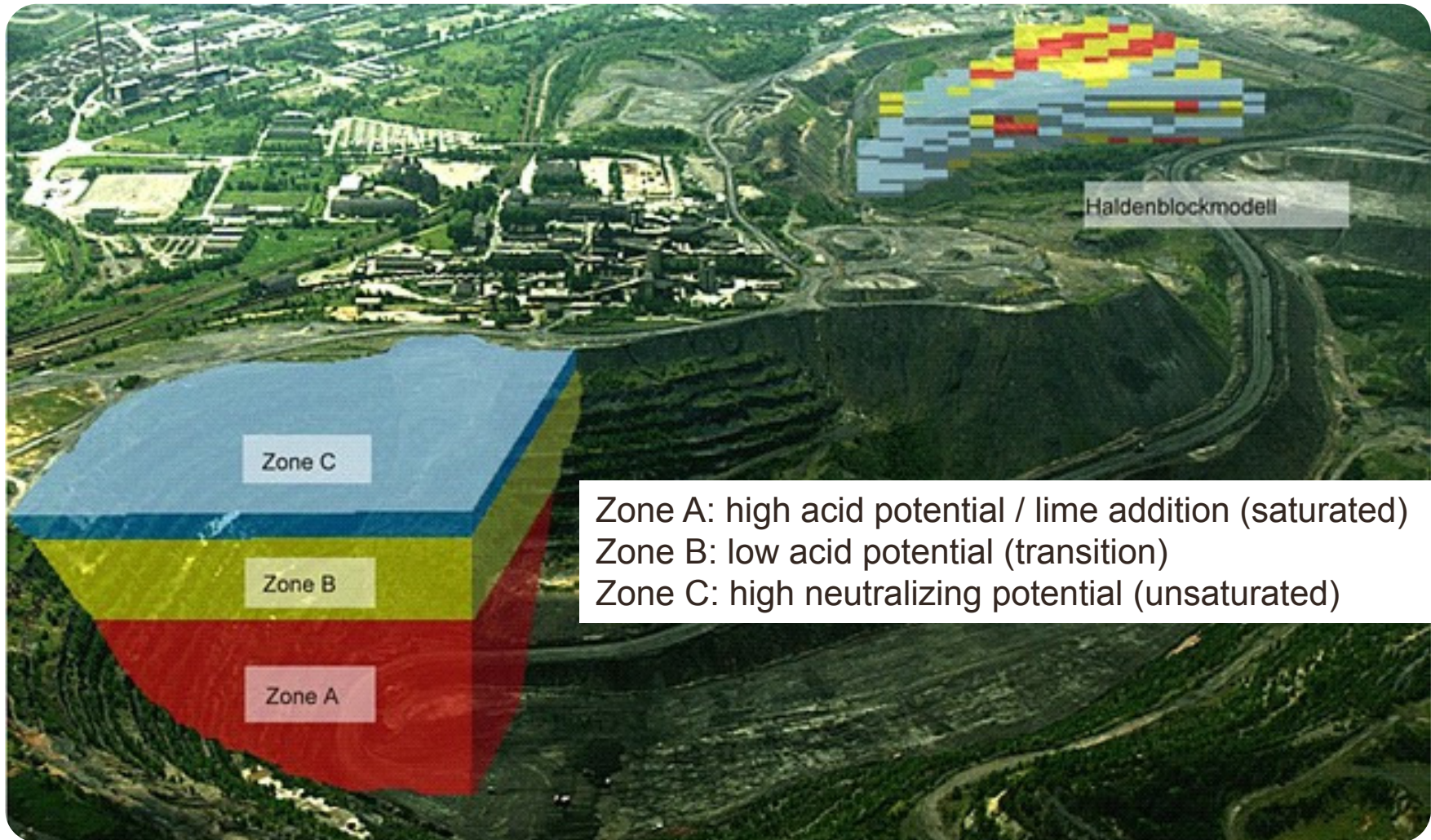


## Annual relocation (million m<sup>3</sup>)



## Waste Rock relocation, 2006





## Backfilling concept

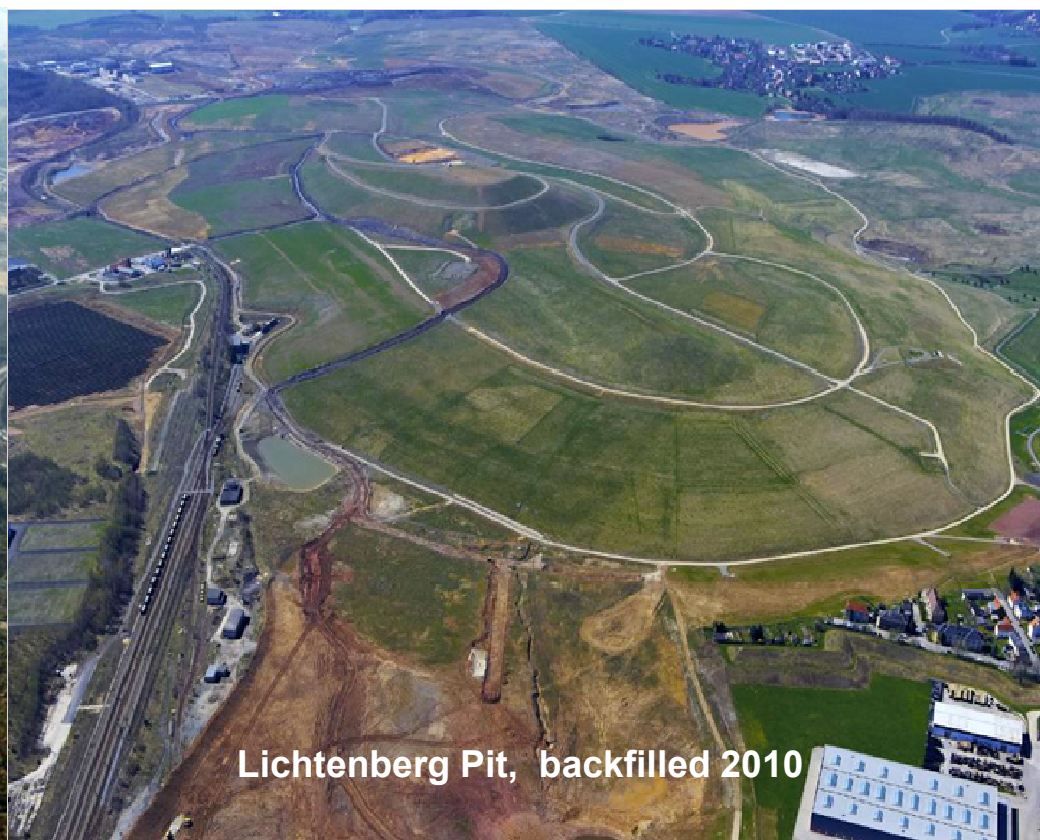


# Remediation result

Operation: 1958 – 1977



Remediation: 1991 - 2010



**Waste concentration, reduction of environmental impacts, enable future land use**



## Vegetated soil covers

- Encapsulation of artificial landforms
- Total area to be covered > 1,100 ha
- Predominant use of natural soils
- Object specific approach, cover thickness 0.5 – 2.5 m



Physical stability, reduction of environmental impacts, enable future land use

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## Tailing try in-situ stabilization

area 250 ha  
thickness 72 m  
volume 85 million m<sup>3</sup>

temporary cover  
drain drills  
permanent cover

- Total tailing volume 160 million m<sup>3</sup>
- Removal of surface water
- Dewatering of sludges
- Mechanical stabilization
- Cover and vegetation



TMF Culmitzsch 1991



TMF Culmitzsch 2013



## Main Activities

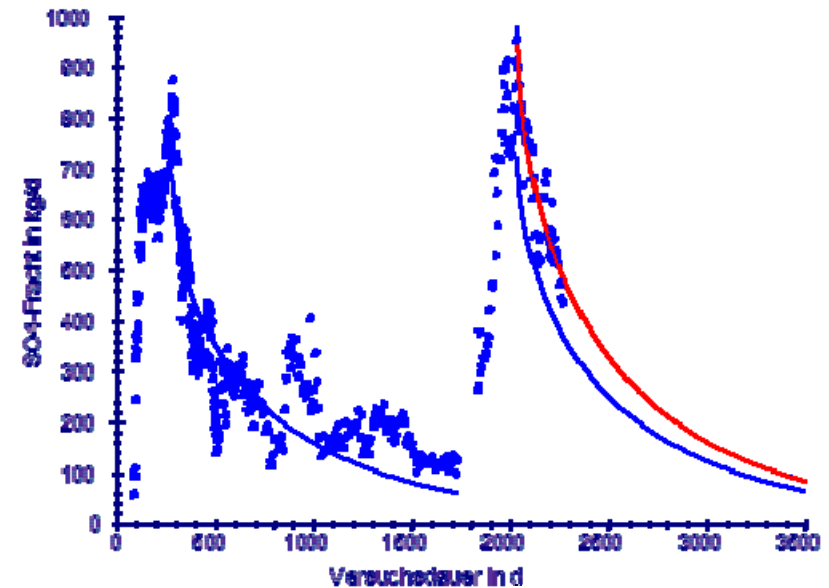
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## Closure of underground mines and water treatment



- Mine Königstein, 11 million m<sup>3</sup>
- Experimental flooding 1993 - 2000
- Flooding since 2001; stopped in 2012



- Mine Schlema, 36 million m<sup>3</sup>
- Flooding 1991 - 2011

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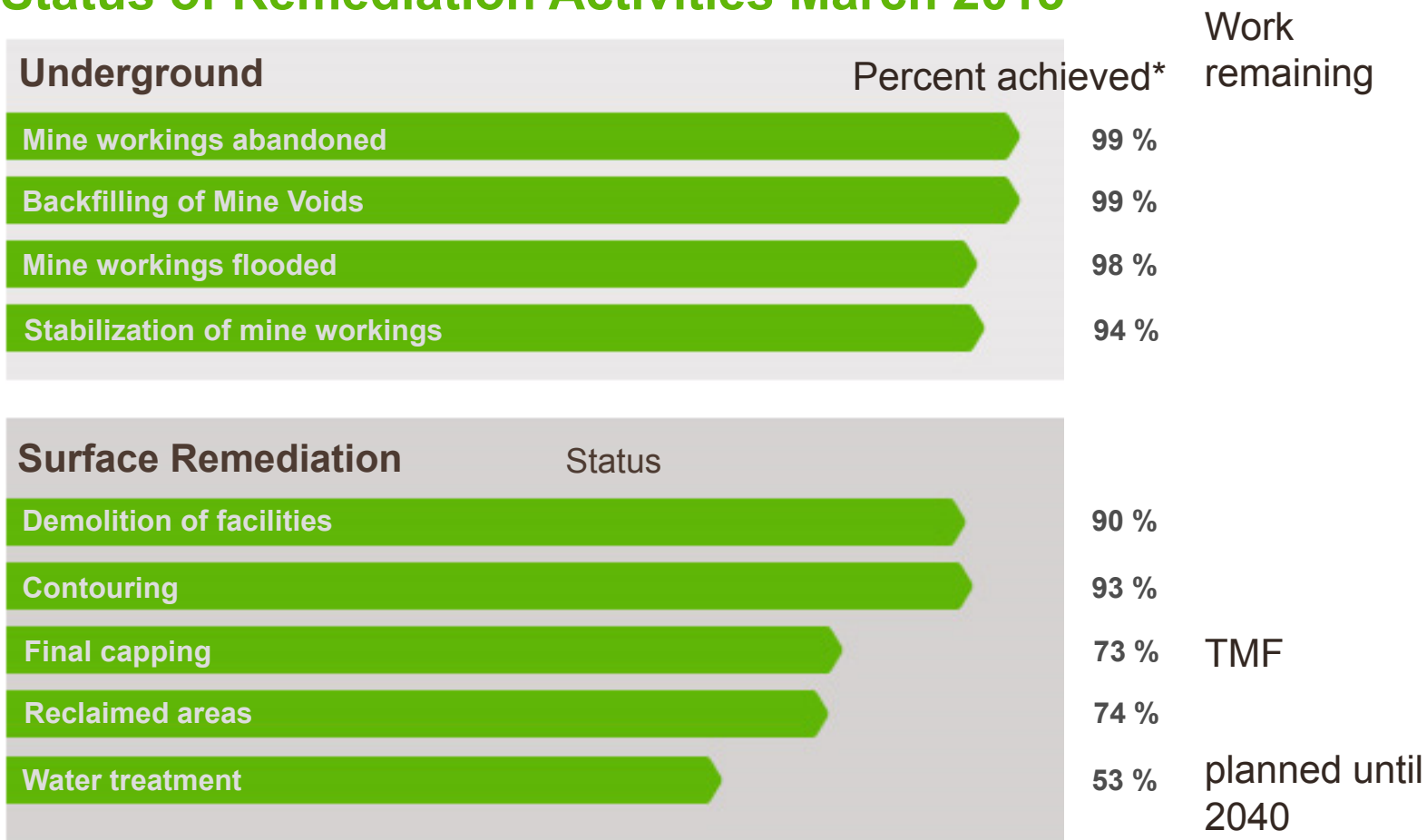
- 7 water treatment plants (2 at TMF, 5 at flooded underground mines)
- mine flooding since 1991; water treatment since 1995
- Water treatment technology: modified or HDS lime precipitation / ion exchange
- Discharge limits for U, As, Ra, heavy metals, Fe, Mn,  $\text{SO}_4$
- German water legislation / european water frame work directive
- treatment capacity of individual plants  
100 - 700  $\text{m}^3/\text{h}$  (max. 1,200  $\text{m}^3/\text{h}$ )
- total throughput  $\sim 20$  million  $\text{m}^3 / \text{a}$
- water treatment cost  $\sim 35$  million  $\text{€} / \text{a}$





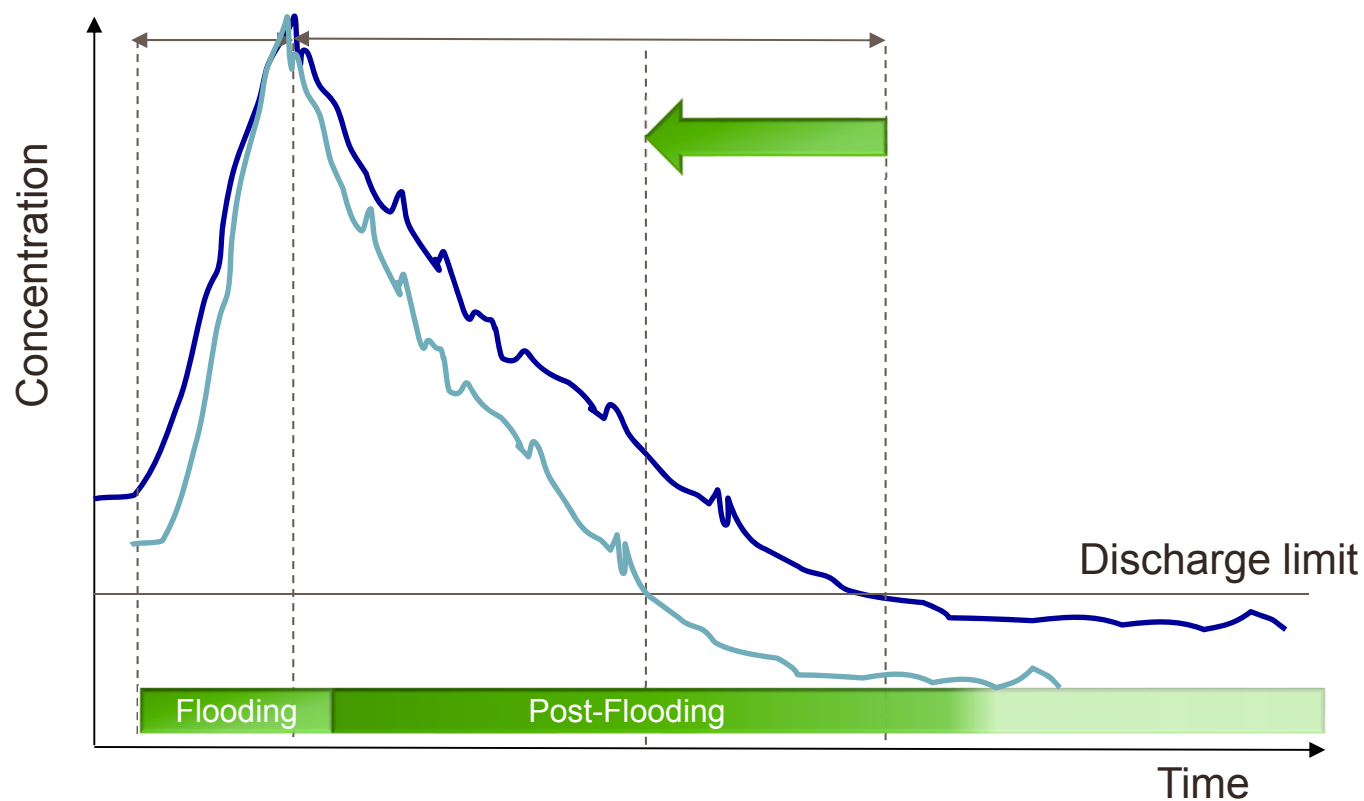
## WISMUT Remediation Programme

### Status of Remediation Activities March 2013



\* Based on the 2010 revision of the remediation programme

## Challenge: In-situ contaminant immobilization





## Summary

- Per 10/2013: Remediation of the legacies of uranium mining in East Germany to **> 85 % successfully completed**
  - **Total expenditures: 5.7 bn EURO**
- Sustainable **limitation of radioactive and other emissions** in compliance with permits
  - Decrease of radionuclide discharge into surface waters by 90-99% (27.5 t U in 1989 → 2.4 t U in 2007)
- **Following land reclamation**, some 1,150 ha sold or leased out of a total of ca. 3,700 ha appropriated land
- **Core remediation** tasks to be completed by 2022
- **Long-term tasks** dominated by water treatment, maintenance, and environmental monitoring planned until 2040





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**WISMUT**

**1991-2011**



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