Grafenwoehr Class III Yard Bioremediation

Grafenwoehr Garrison

Leading Change for Installation Excellence

Grafenwoehr Major Training Area

- Military training facility since 1908
- 9160 ha (22,000 acres) Royal Bavarian Army
- 1937/38 extended to present size of 23,364 ha (56,600 acres)

History of Class III Yard

- Existing since the 1950's
- Supply for tenant and training units
- Maximum per month amount in the past:
  3 Million gal JP 8; 17,000 gal Mogas
- Currently 400,000 gal/month JP 8, and 1,500 gal/month Mogas
- Delivery via railway from central USAREUR depot Speyer (400 km west)
- 2 AST's for JP 8, 218,000 gal and 105,000 gal,
- Railway trailor for Mogas (16,000 gal)

History of Class III Yard

- Pipeline leakages, handling losses and accidents in the past 60 years

History of Class III Yard

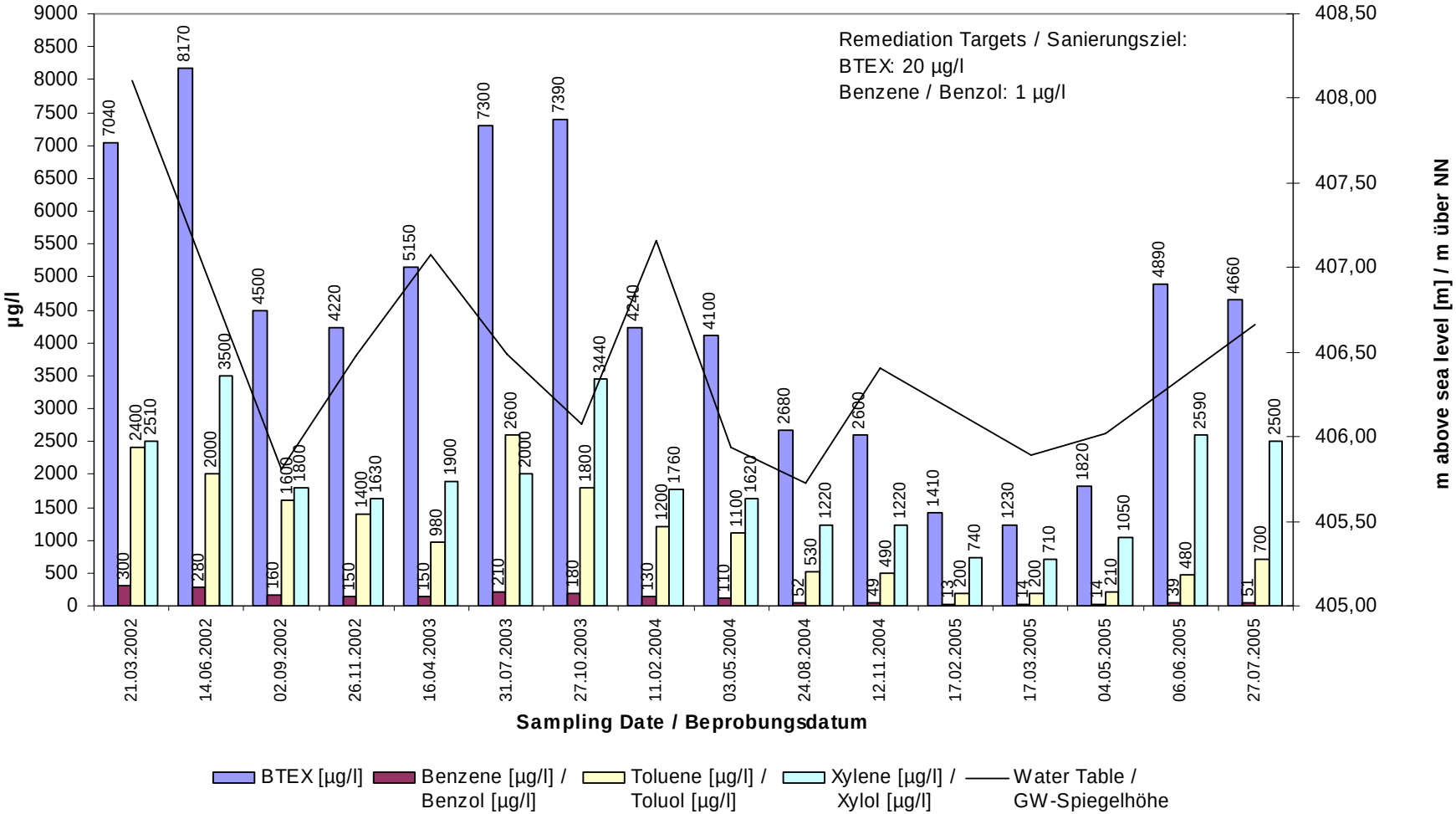
- First groundwater monitoring well in 1993: severe groundwater contamination with BTEX ~ 16,800 µg/L and TPH ~ 28,000 µg/L
- Studies, investigations for delineation of groundwater pollution in the following years
- Remedial design in 1997: combination of air sparging and pump & treat
- Remediation start in 1999 with 4 remediation wells

History of Class III Yard

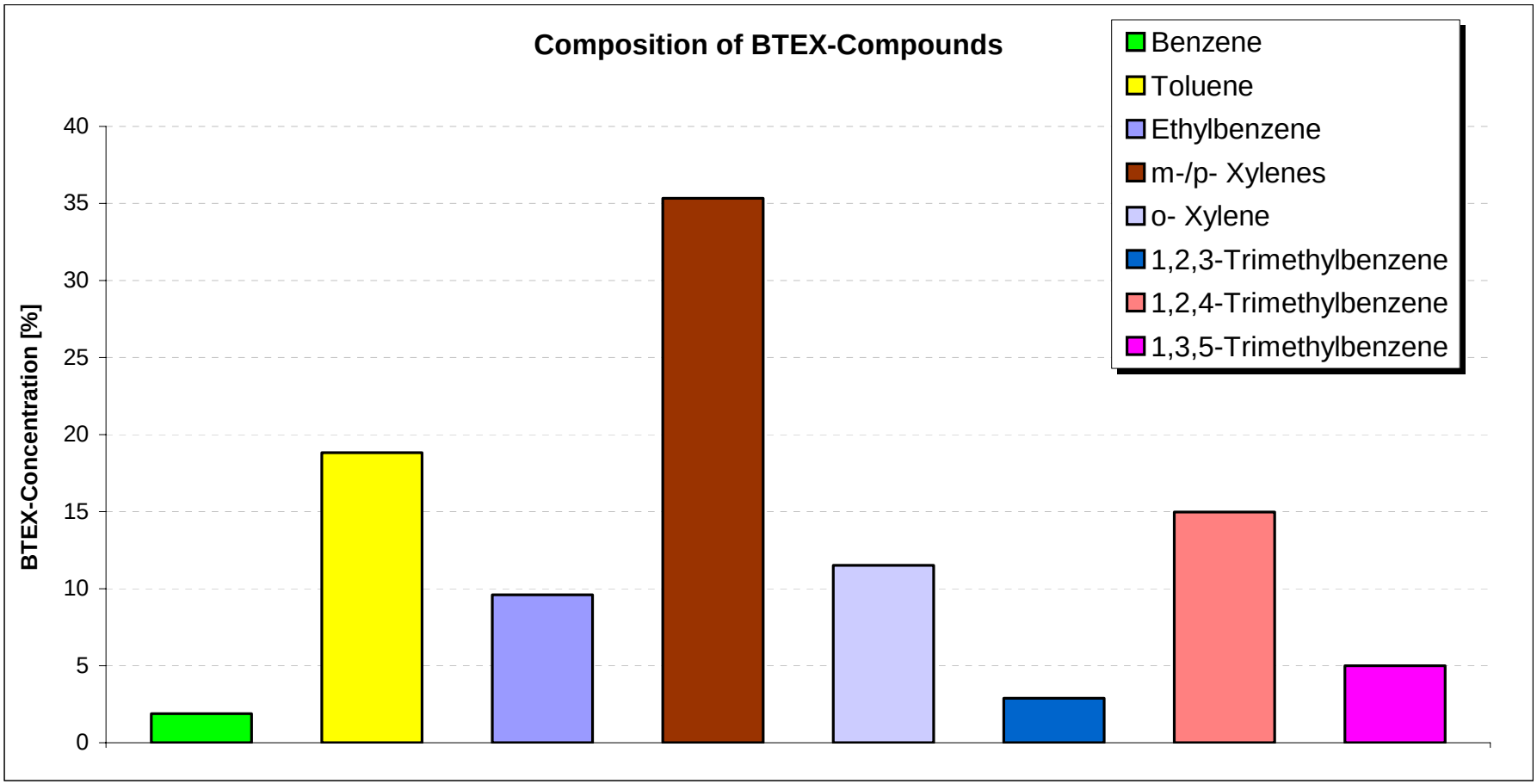
- New winterized system, O&M, sampling, consulting by ERM since 2002
- Since 2004 operation of 12 remediation wells, hydraulic barrier
- To date 180,000 m^3 groundwater treated and re-infiltrated
- Contaminant removal approx. 300 kg POL, 240 kg BTEX, 42 kg MTBE, 4 kg PAH
- January to July 2005: In-Situ Bioremediation Pilot Test

Analytical Results: Source Area Well 11

GW POL CL 3/11: BTEX



Analytical Results: Source Area Well 11 (cont'd)



Achievements

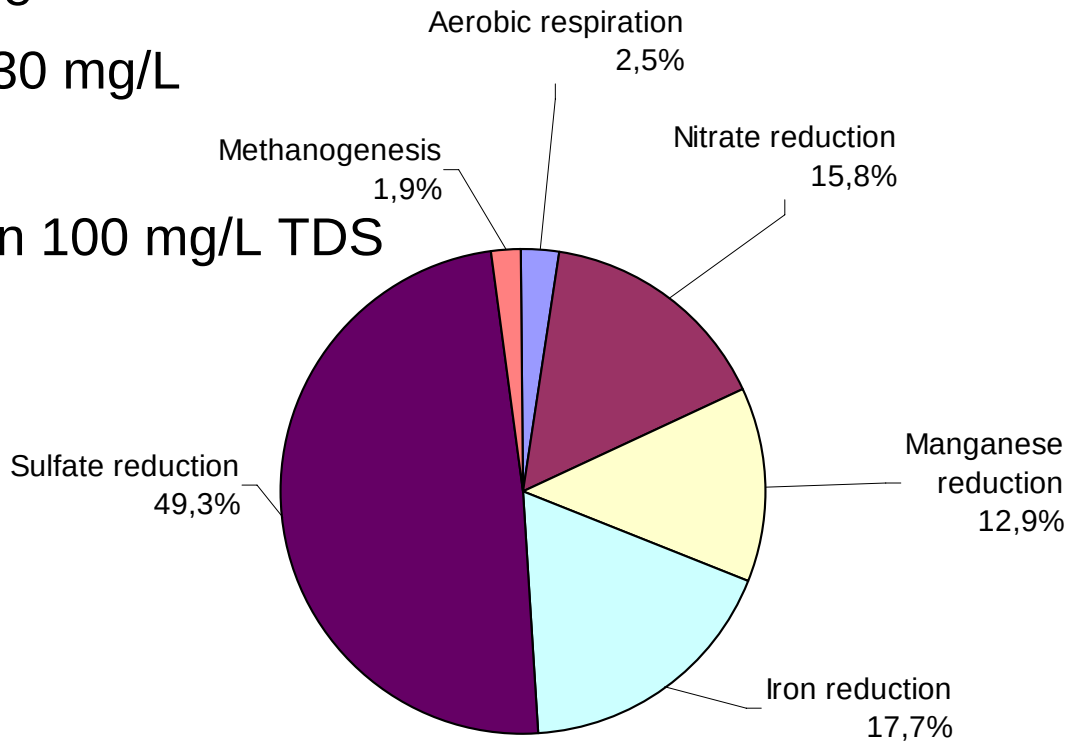
- No clean-up of site by P&T within reasonable time frame (operational since 1999)
- Excavation of hot-spots technically difficult and very expensive due to area size (20,000 m² to a depth of 6 to 10 m bgs)

Strategy

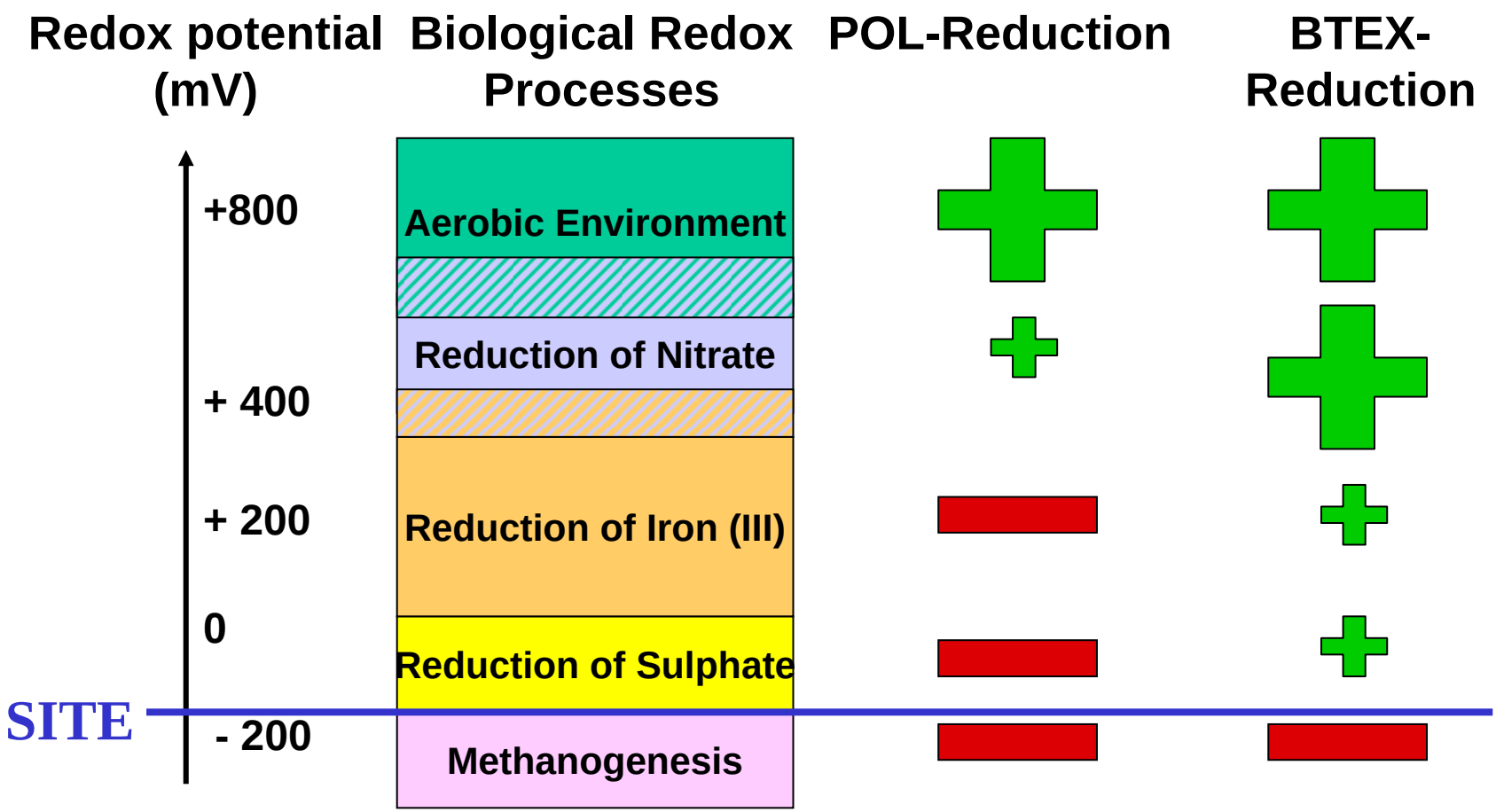
- Groundwater will be treated in-situ → energy and cost effective
- Reduction of remediation time
- Nutrient poor groundwater situation
- Starting at wells 4, 11, and 14 and continue step-by-step downgradient facilitates clean-up of entire site
- Hydraulic Barrier ascertains that no contaminants or nutrients migrate downgradient (ie. off-site)

Natural Attenuation Potential

- Current Expressed Biodegradation Capacity (EBC): 2.1 mg/L
- Low electron acceptor concentrations virtually no nitrate, 5 mg/L sulphate, <10 mg/L Fe^{2+}
- Total iron and manganese >30 mg/L
- 10 - 20 mg/L methane
- Low mineralization - less than 100 mg/L TDS



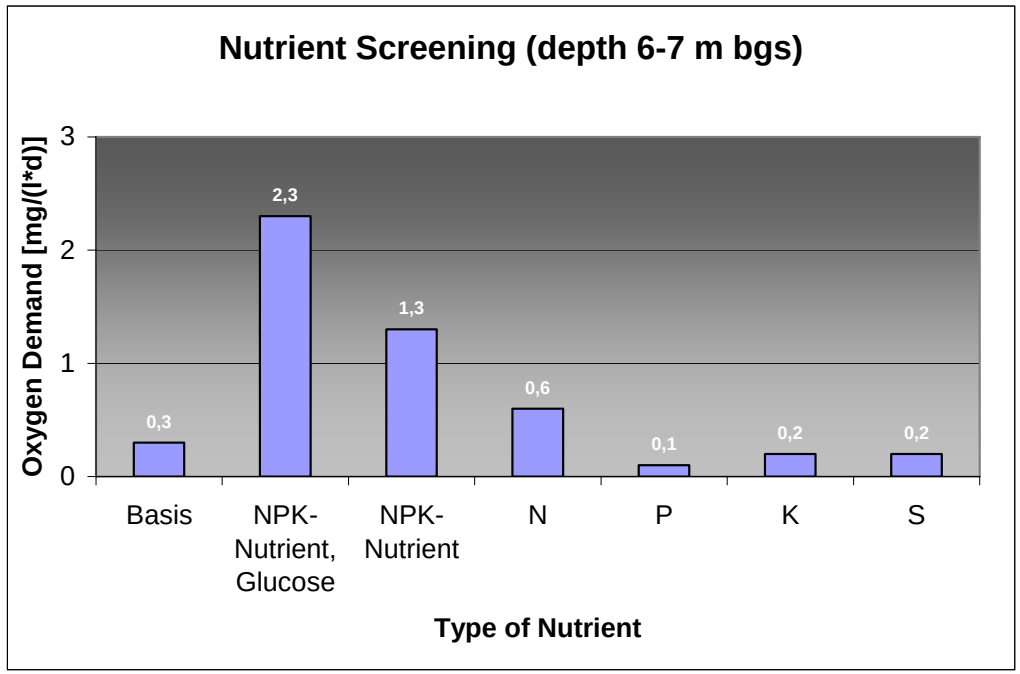
In-Situ Bioremediation Pilot Test



In-Situ Bioremediation Pilot Test - Soil Laboratory Tests

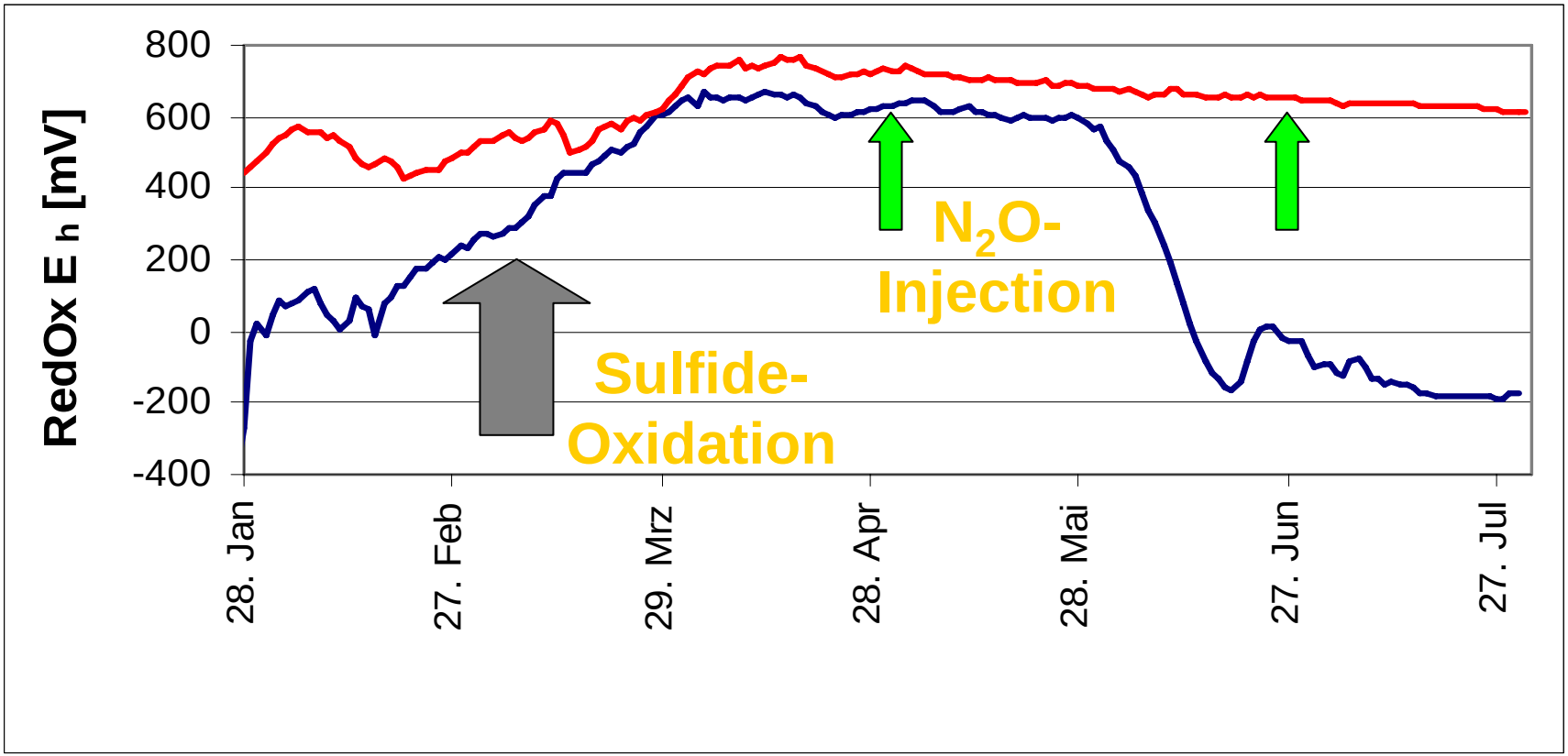
- Soil samples were taken at well 3/37 and analyzed for their nutrient conditions (nutrient screening)

  → Results revealed significant lack of nutrients (like phosphate, nitrogen and potassium)



- Conclusion – adding nitrogen enhances microbiological activity → N_2O Injection

In-Situ Bioremediation Pilot Test



- Significant increase in Redox Potential → Aerobic Environment

In-Situ Bioremediation Pilot Test – Processes

N_2O may:

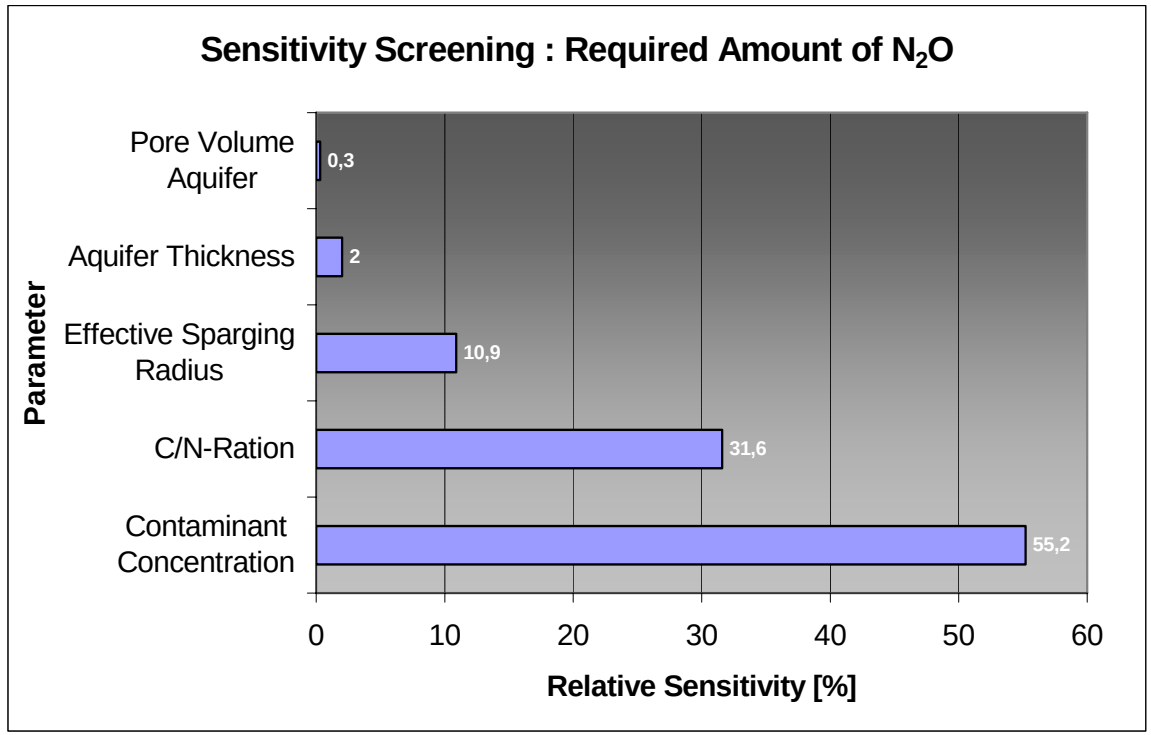
- Stimulate a certain bacteria (Thiobacillus) which leads to oxidation of the omnipresent sulfide (as PbS)
  → increase in SO_4 as electron acceptor for BTEX
  → increase of redox potential
- Act as general bacteria stimulans and support for population growth
- Act itself as an electron acceptor
- Act as nitrogen source

➢ Extension of tests are necessary (eg. “microcosmic studies”)

In-Situ Bioremediation Pilot Test – Processes (cont'd)

N_2O dosing dependent on:

- N_2O solubility in groundwater (2.2 mg/L)
- Areal extent
- Amount of ground-water to be treated
- Amount of contami-nants to be treated
- C/N ratio



In-Situ Bioremediation Pilot Test – Processes (cont'd)

N_2O advantages:

- Low Costs - 4 ct / L
- Low maintenance – due to density of N_2O
  one 7.5 kg bottle provides about 3,500 L of N_2O (less than $200)
- Estimations at present range from 25,000 L to 50,000 L of N_2O required for entire site
- Easy hook up into Air Sparging System

Thank you for listening!

I know you had no choice, but if you have questions, please ask!

ERM

Delivering sustainable solutions in a more competitive world