

## Ejlskov BioRemediation, barrier treatment

**With regards to treatment of soil and groundwater contaminations by means of injection of BOS injectates, different aspects have to be taken into consideration both in terms of design (site investigation phase) and installation (remediation phase).**

### **Barrier treatment – design**

The data which are of relevance when performing a site investigation focused on a plume or site boundary area are:

- Soil contaminant mass
  - High frequency soil data to be collected to define
    - Lateral and vertical extent of contamination
    - Total contaminant mass to assess potential total mass which will transit as dissolved phase contaminant across the site boundary / plume area within a specific time frame
  
- Soil type / geology
  - Soil description is critical in order to assess potential preferential pathways and layers where most of the contaminant mass may be present (e.g. sand vs. clay)
  
- Groundwater conditions
  - Assess where soil is saturated in order to install monitoring wells screens at correct depths
  - Cluster wells are relevant to assess different levels of dissolved phase contamination at different depths
  - Groundwater dissolved phase mass flux across a specific section is needed to estimate the total contaminant mass leaving the site over a specific timeframe

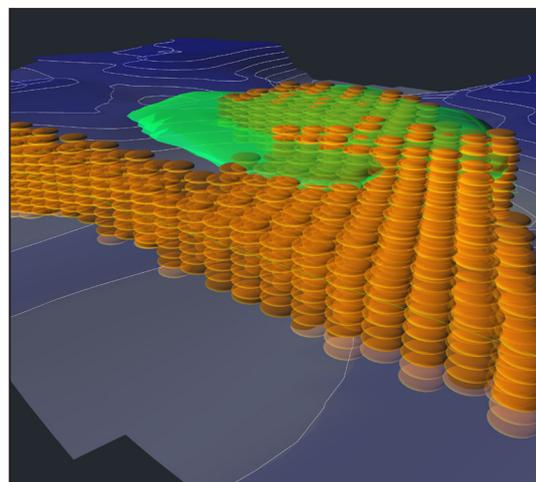
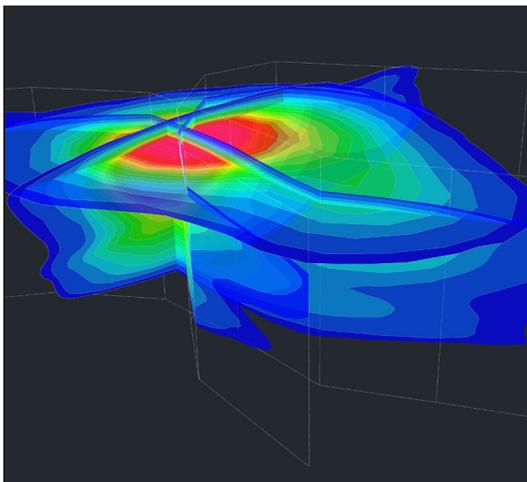
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## Barrier treatment – design

The outputs of the investigation phase will provide the following information for the design of the remediation:

Soil contaminant mass estimate needed to design the correct loadings of injectates needed to achieve both absorption and complete biodegradation of contaminants of concern. If a source treatment is combined with a barrier treatment the design of the source treatment will indirectly reflect on the residual needs across the barrier zone

Soil type / geology will define the injection spacing grid and volumes to be injected per interval. Groundwater conditions will define in conjunction with soil contaminant mass and geology the correct loadings to achieve dissolved phase contaminant clean up over the expected longevity timeframe the barrier is planned to last for. Different levels of dissolved phase contamination concentrations at different depths will drive different loadings during the installation phase.



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### Barrier treatment – installation

Installation of BOS can be achieved by:

Direct push injections: 2-1/4" rods with internal hydraulic hoses are advanced into the formation and injection of BOS is performed within the depth intervals assessed to be in need of treatment during the design / investigation phase. Injections are performed with high pressure / high flow pumps and customized injection system

Soil mixing: if contamination is assessed to be present within the first 1 or 1.5 meter below ground and no underground installations are present, soil mixing of BOS can be performed by spraying slurry while mixing with an excavator the soil in need of treatment. This operation, generally requires stabilization of soil by means of lime or cement after installation of BOS. Compared to injections, this solution allows the application of higher quantities of BOS hence allowing treatment of extremely highly contaminated soil

Soil mixing / trenching: BOS may be installed dry within a trench opened along the assessed barrier zone in order to reduce the footprint of the barrier whilst achieving maximum distribution and loadings to increase the longevity of the barrier. This solution would be normally linked to a barrier treatment only where source treatment is not achievable due to infrastructural constraints and large amounts of BOS are needed to treat extensive plumes of dissolved phase contaminations

Regardless of the installation method additional installation events can be planned over time to maintain the effectiveness of the barrier alive for extremely long periods of time (20-50 years or more).