

SITE BACKGROUND

Hexavalent chromium (Cr^{+6}) contamination was detected in vadose zone soils beneath a large manufacturing facility.

The vadose zone was characterized by fine-grained soils (saprolitic material, described as micaceous clayey silts or silty clays) that required fracturing to increase bulk permeability and facilitate ZVI distribution within the contaminated soils.

REMEDIAL APPROACH

Chromium is a common groundwater and soil contaminant particularly in industrial areas. The feasibility of the chromate reduction with Fe^0 using zero valent iron is well demonstrated with a large number of documented laboratory and field studies.

In the full-scale application, a 3,200 square-foot area (40 ft. by 80 ft.) extending from approximately 2 to 20 feet below ground surface was targeted for treatment with Ferox Flow ZVI reactive iron powder.

SITE CHALLENGES

The presence of low permeability geologic materials limited possible in situ treatment options. The Ferox pneumatic emplacement process involves a patented, innovative in situ delivery system which includes the injection of nitrogen gas as a carrier to emplace the atomized ZVI slurry. Ferox Flow ZVI reactive iron powder was selected as the technology that could best treat the Cr^{+6} in situ, while not adversely impacting the overlying facility.

In low permeability geologic materials, the gas induces fractures within the formation through pneumatic fracturing prior to emplacing the reactive ZVI. The ZVI slurry is then introduced into the formation using atomized liquid injection, based on the results that the injection of gases, or "aerosols," into the subsurface is more effective than injecting an incompressible liquid into the subsurface.

This innovative injection method allows for the safe and effective emplacement of the ZVI material in areas containing buildings and subsurface utilities where other delivery methods and surface intrusive processes are not feasible.

INJECTION BY THE NUMBERS

- » 30 temporary injection points
- » 64,000 lbs. of Ferox Flow ZVI reactive iron powder (1% soil mass) within the impacted vadose zone

Ferox Flow ZVI reactive iron powder was injected at a rate of 3,000 to 5,000 lbs. per day at a loading of 200 to 400 lbs. per 2 ft. vertical interval.

The Ferox process was used at 18 boring locations not located directly adjacent to walls or load bearing columns.

The ZVI was applied using hydraulic injection at the remaining borings where structural concerns prevented the use of pneumatic fracturing.

TREATABILITY RESULTS

Bench-scale treatability tests were conducted to evaluate the effectiveness of ZVI powder in reducing the hexavalent chromium in site soils.

The tests evaluated the effectiveness of several dosages of ZVI powder in reducing the Cr^{+6} to Cr^{+3} , with synthetic precipitation leaching procedure (SPLP) analyses used to evaluate the effectiveness of the treatment.

The tests demonstrated up to 99% effective reduction of Cr^{+6} in vadose zone soils at low moisture contents (<7.0 wt.%) using the ZVI powder.

CONCLUSIONS

In situ treatment of Cr^{+6} in low permeability vadose soil beneath an existing building was completed in 21 days.

The radius of influence during injection was estimated to be 12 to 15 feet, based on pressure readings in nearby monitoring wells, thereby providing adequate coverage of the treatment area.

The treatment activity met the requirements of the Record of Decision for the vadose zone soils at the site.