Case Study: VC7

Vertebrae Well System Installed Despite Difficult Drilling Conditions

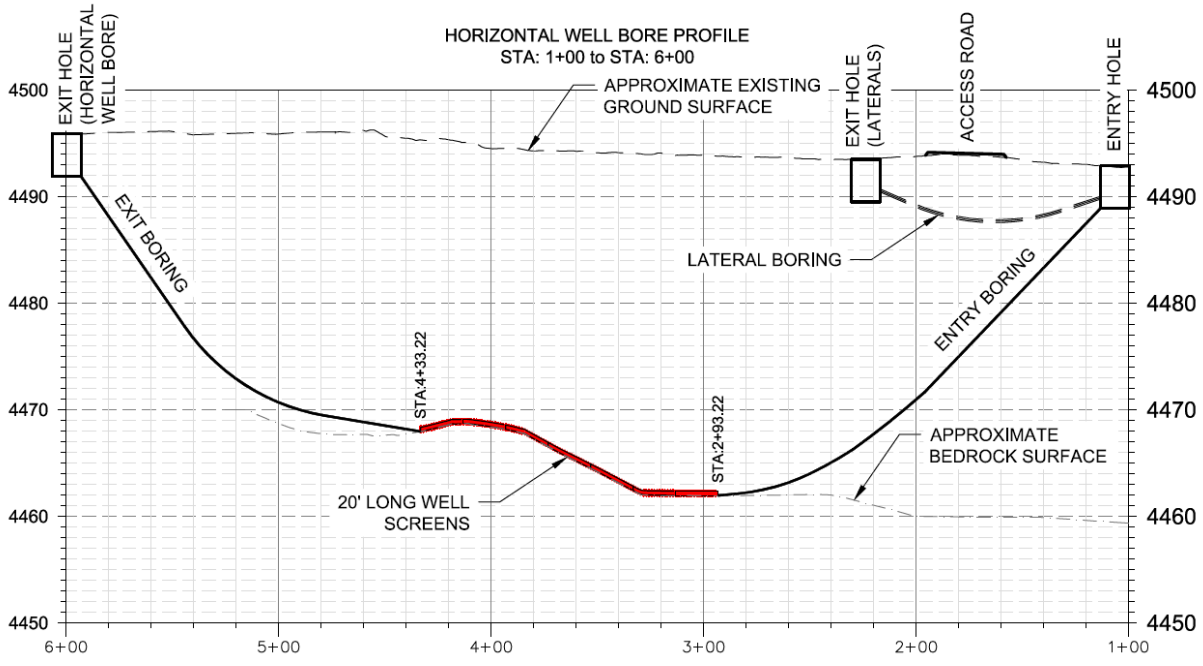
SITE LOCATION:
Montana

CONTAMINATION:
Dissolved phase Chlorinated Volatile Organic Compounds (CVOC's).

OBJECTIVE:
Installation of a horizontal air sparge (AS) curtain to create a hydraulic containment barrier to mitigate the downgradient transport of contaminants. This case study illustrates how a Vertebrae™ Well System can be installed in challenging drilling conditions.

BACKGROUND:
The installation involved Horizontal Directional Drilling (HDD) in an alluvial aquifer comprised of very coarse sand, gravel and cobbles (as much as a foot in diameter) while following the contact surface with the underlying bedrock. The underlying bedrock required the bore to be drilled up slope hugging the bedrock surface with an elevation change of 7 feet over 150-foot drilling distance at depth. The site conditions made drilling and well installation extremely difficult at this site in Montana.

The contaminants associated with the site range from petroleum constituents to chlorinated solvents. Several remedial strategies have been deployed at the site to address the large and variable contaminant plume(s). A vertical well AS/SVE system was installed at the site to create an AS curtain to reduce the CVOC's in the alluvial aquifer and to control offsite plume migration from the facility. The AS/SVE system reduced and controlled the dissolved CVOC plume except during times of a reduced saturated thickness, overlying the bedrock. At that point the air flow was disproportionally being directed to the vertical AS wells with the least saturated thickness. To overcome the issues related to air flow, a Vertebrae™ Well System was selected due to its horizontal screen orientation and the ability to install several independent well segments in one horizontal bore. Even though the Vertebrae™ Well System offered a solution to the air flow issues, all involved parties were still concerned by the extremely difficult drilling conditions for installing the horizontal bore and the Vertebrae™ Well System. However, EN Rx was confident that once installed, the Vertebrae™ well system could successfully administer the air sparging treatment.



INSTALLATION ACTIVITIES

The first mobilization in November 2018 proved to be very challenging. Despite familiarity with the area and experience drilling in cobble, the initial HDD contractor broke tooling and was unable to finish the bore after only 60 feet of drilling. They were surprised by the difficulty and demobilized with winter weather approaching. This unsuccessful first event directed EN Rx to contract with a new, local HDD contractor to return to the facility in the spring of 2019. The local HDD contractor had a larger sized bore machine, more robust equipment for the drilling conditions, and familiarity with this specific environment allowing them to complete the directional bore in this very challenging lithology. The contractor described the site conditions as some of the most difficult HDD conditions he had ever experienced.

The Vertebrae™ well system consisted of seven independent well segments, 20 feet long each with 2-inch nominal screens plumbed to land surface with 1.25-inch conveyance tubing. The installation of the seven independent Vertebrae™ wells at the site involved 515 feet of HDD and was completed in five days, followed by one day of well development, one day of grouting, and one day of field testing.

The HDD contractor utilized a Vermeer 60 x 90 drill rig and a cobble bit to establish the pilot bore. The bore was then swabbed with a modified 10-inch roller bit. The picture below shows a comparison of a new drill bit on the right and the same drill bit after 150 feet of drilling at depth, on the left. Three bits were used to accomplish the 515-foot pilot bore.

SYSTEM PERFORMANCE RESULTS

EN Rx field tested the Vertebrae™ Well System to verify air flow rates for the AS treatment. Each individual Vertebrae well segment achieved >30 cfm at 15 psi (>1.5 cfm per linear foot of screen) exceeding the design flow rate.

CONCLUSIONS

The Vertebrae™ Well System provided an effective solution for administering the AS curtain and solved the air flow problems. Despite extremely challenging drilling conditions, the horizontal well system was successfully installed. The Vertebrae™ Well System is a cost-efficient option for installing wells in difficult drilling conditions and provides enhanced control because each well segment is independently plumbed to land surface. As a result of this successful installation and verified air flow rates, the Vertebrae™ AS curtain became operational in the summer of 2019. Initial data indicates that the system is functioning well, increasing dissolved oxygen and decreasing CVOC concentrations downgradient of the curtain wall. The ability to vary the air flow to small sections of the sparge curtain helps optimize curtain wall effectiveness across the area where saturated thicknesses vary considerably.