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March 13, 2019

Scott Smith, P.E.
Project Manager
Alderwood Water and Wastewater District
3626 156th Street SW
Lynnwood, WA 98087

Re: Frognal Estates Proposed HDD Sewer Installation

Scott:

Staheli Trenchless Consultants (STC) was asked to evaluate the proposed installation of a 12-inch sewer with Horizontal Directional Drilling as part of the Frognal Estates Project. As part of the evaluation, STC reviewed the following documents as they pertain to the HDD portion of the project:

1. 3620G Electronic Plans 12-18-18
2. 2018-10-17 AESI Geotech Frognal Plat
3. 2018-10-17 AESI Redi-Rock Walls Report
4. 3620G Agreement Letter and Signature Pages
5. Response to AWWD DEA Comments Frognal

The HDD as shown in the plans (12-18-18) is not constructible as designed. The depth of the bore is such that the drilling mud pressures will not be contained by the earth pressures and inadvertent returns (frac out) will occur along the side of the hill. The drilling mud, which is relied upon to remove excavated material from borehole, will follow the path of least resistance and continue to drain through the hillside. Due to the large elevation difference between the entry and exit of the bore (approximately 115-120 feet), this issue is not simply resolved by deepening the bore.

STC considered several scenarios to determine if the bore could be adjusted and built with an acceptable amount of risk; however, the risk profile for installing the pipeline with HDD is very high with any configuration. The following paragraphs provide some explanation as to why STC considers the bore to be fatally flawed as designed and extremely high risk with HDD installation methods, regardless of design profile.

The HDD process relies of maintaining drilling fluid within the borehole at all times to ensure a stable borehole throughout the drilling process. The drilling mud is pumped from the mud plant to the boring head where it assists in cutting the bore hole. The mud is then pumped back to the entry location carrying the excavated material from the borehole to the entry mud pit. The mud is then pumped from the entry pit to the soil separation plant (reclaimer) where the soil is separated from the drilling mud and the drilling mud is ready to begin the process once again.

To install a 16-inch HDD pipe, the bore will be drilled to approximately 24-inches per industry standard. If drilling commences from the top, the borehole will remain full of mud; however, the drilling mud is lifted to the entry location to remove the excavated material. The mud pressure to lift the drilling mud to remove cuttings is significant as the bore gets deeper from the top. At some depth, the mud pressure will overcome the confining pressure of the soil and mud will escape through the hillside. This will occur, even if the design is adjusted and the pipe is significantly shifted laterally into the hillside (more than 50 to 60 feet). In addition, drilling mud is certain

to escape at the bottom of the hill as the bore approaches the lower exit location and the entire borehole will drain. Besides the mud flow containment issues, the borehole will no longer be stabilized and will have the propensity to collapse.
If drilling commences from the bottom, a pressure relief valve will be required. The drilling will take place through this gasketed valve that controls the pressure in the bore, limiting it to the static pressure of the drilling mud in the bore used to hold the hole open. However, with the elevation difference on this pipeline, the full column of mud pressure acting on the hillside is very high and is likely to result in mud loss along the hillside. In addition, the pressure valve will need to be removed prior to pull-back of the pipe. When this occurs, the borehole will fully drained and the borehole will have the propensity to collapse.

Finally, applying high pressure drilling mud across potential landslide failure planes is very high risk and should be avoided. This issue is typically mitigated by installing a steel casing at the lower end of the bore that crosses the slip planes, followed by grouting between the installed casing and the soil. This is a significant concern that must be mitigated with a design that specifically addresses this issue. STC was unable to find any information addressing mitigation for managing landslides pertaining to the HDD operations in the documents provided for review. Although the document appears to be a "final" (stamped) drawings, I have concern that the design has not addressed critical slopes. If this issue has been considered in the design, the information needs review by AWWD to understand the risks that were carried in the current design by the Engineer of Record.

STC strongly encourages AWWD to reconsider the installation of the sewer with HDD and discuss risk mitigation measures with the developer prior to moving forward with the project. If you have any questions, please do not hesitate to contact me.

Sincerely,

Kimberlie Staheli

Kimberlie Staheli, Ph.D. P.E.
Principal, Staheli Trenchless Consultants