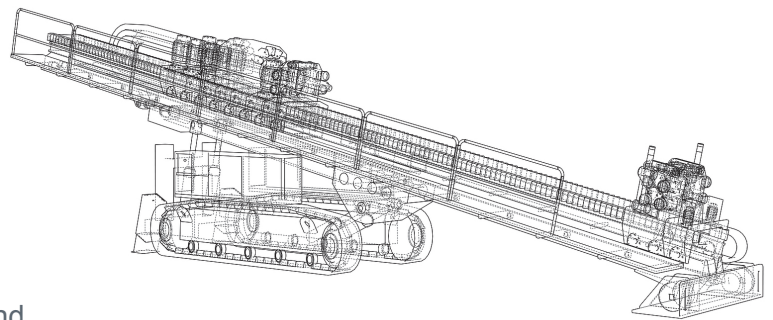




HORIZONTAL DIRECTIONAL DRILLING

INTRODUCTION

EN Engineering has designed hundreds of Horizontal Directional Drilling (HDD) crossings and is an industry leader in the identification, planning, design, and support during installation of HDDs. The use of HDD in the pipeline industry began in the 1960s and was fully established by the 1980s as a way to install pipelines while utilizing trenchless technology with minimal impact to the feature being crossed. These features, including roads, railroads, waterbodies (rivers, streams, and wetlands) or other environmentally or culturally significant areas are typically sensitive in nature and cannot be disturbed by conventional open trench construction methods.



PRELIMINARY ACTIVITIES

Whether part of a larger overall pipeline installation or a stand-alone maintenance/replacement project, EN Engineering completes a preliminary front-end assessment of all HDD crossings. Due to the potential risk and cost associated with an HDD, the assessment checks to see if other construction techniques (including open cutting and conventional boring) can be utilized instead. If it is determined that because of construction, permitting, or other issues a conventional crossing technique is not feasible, our team will begin its HDD planning process.

Utilizing maps, drawings, aerial photography, elevation data, and other technology, we will develop possible HDD alignments, workspace layouts (including pipe pull back), entry and exit points, considerations for drilling mud management, and a preliminary plan and profile. Once this desktop analysis is done, we typically conduct a site visit to confirm actual site conditions support this preliminary design and adjust it as necessary.

GEOTECHNICAL SURVEY

Based on the location and complexity of the HDD, EN Engineering determines the quantity, locations, and depths of exploratory soil bores needed to complete the detailed design of the HDD crossing. These borings show the depth of the water table and identify soil and rock properties. A hydraulic fracture analysis may be performed using geotechnical data to minimize the risk of inadvertent mud release during the drill. This analysis is sometimes required by the governing permitting and/or regulatory agency and uses the Delft equation as described in the “Guidelines for Installation of Utilities Beneath Corps of Engineers Levees Using Horizontal Directional Drilling” USACE, 2002. EN Engineering partners with geotechnical service firms that can complete the geotechnical field investigations, laboratory testing, and associated reports we need to complete the HDD design.

SURVEY

EN Engineering will coordinate a topographic survey of the proposed project area based on the recommended alignment for the final engineering design effort. In addition, a boundary survey can be performed to accurately identify the property owners affected by the project. If required, property plats can be developed for land negotiations. EN Engineering also provides the survey support to assist the construction contractor and to capture any as-built information. We maintain relationships with established survey firms that can complete the required design, boundary, pre-construction staking, and as-built survey activities.



DETAILED DESIGN

Next, EN Engineering will advance the preliminary engineering for the HDD through the detailed design phase. This includes determining the appropriate drill path to ensure that bending, pullback, and testing stresses are within industry standards. For challenging or unique crossings, we can have layouts for each HDD location and workspace reviewed by a reputable HDD contractor to ensure that constructability is optimized.

EN Engineering utilizes the Pipeline Research Council International (PRCI) guidelines in its design of HDDs, which involves modeling the drilled path to define its shape and properties during installation. Utilizing these guidelines, we develop a design that governs pipe specifications (wall thickness, grade, and corresponding D/t ratio), depth of drill, entry/exit angles, radius of curvature and tangents, and overall drill length. Based on the pipe specifications, operating pressures, and site elevations, we can develop pre- and post-installation hydrostatic testing parameters. Our team will also develop a detailed material list (primarily pipe and coating), identify qualified vendors, develop bid packages, analyze quotations, and cut requisitions as needed, with purchase orders typically issued on client's letterhead.

PERMITTING AND RIGHT-OF-WAY SUPPORT

When requested, EN Engineering provides the drawings, exhibits, data tables, and other information required in support of the permitting process. Our team understands the permitting process as it relates to the Federal Energy Regulatory Commission (FERC), the US Army Corps of Engineers (USACE), US Fish and Wildlife Service (USFWS), and other state and local agencies related to environmental, historic preservation, and non-environmental permits. We can also provide exhibits, sketches, and plats needed for the acquisition of both temporary and permanent easements for the construction and operation of the installed HDD crossing. Using a subcontracted land services company or the client's internal land department, we can investigate current ownership of all affected properties the project may encroach on where amended or new easements may be required. This investigation includes the study of tax maps, property deed records, and similar sources of information.

CONSTRUCTION SUPPORT

EN Engineering provides support related to the construction bid phase, including the identification of qualified contractors, development of a scope of work and overall bid package, responding to RFIs, and selection of a construction contractor. We can also help with the pre-bid meeting, the associated job site review, and staking of the final route and workspace layout for the bidders.

We also review the HDD design and drilling plan with the awarded contractor to determine if the method and equipment meet the project's requirements. Risk mitigation strategies may be implemented at this time, including but not limited to: increasing the annular space during the pilot hole, decreasing drilling fluid density and/or fluid pump rate, specifying mud additives to maintain tunnel stability, or lowering the alignment.



When requested, EN Engineering can review the drill pilot-hole profile prior to pullback of the pipe string in order to determine if the drill alignment/geometry appears to be acceptable and the pipe will not be overstressed. We can review the pilot-hole drill data daily in order to monitor the progress and ensure the drill is being installed per the design plan.

Our team can provide an as-built plan and profile and pipe joint/weld map, utilizing information from the HDD contractor, including the X, Y, Z location (or the azimuth/inclination and distance) of each drill string joint. We will record the entry and exit points for the pilot-hole drill string and any exposed drill string joint ends, and capture the top centerline of pipe along the portion of the pipeline from the tie in points to the entry and exit points of the HDD.

POST-CONSTRUCTION

Upon completion of the HDD, EN Engineering can assemble and provide a project completion package, consisting of the as-built drawings, boring logs, design calculations, material test reports (MTRs) and other documents necessary to meet the client/owner recordkeeping requirements.