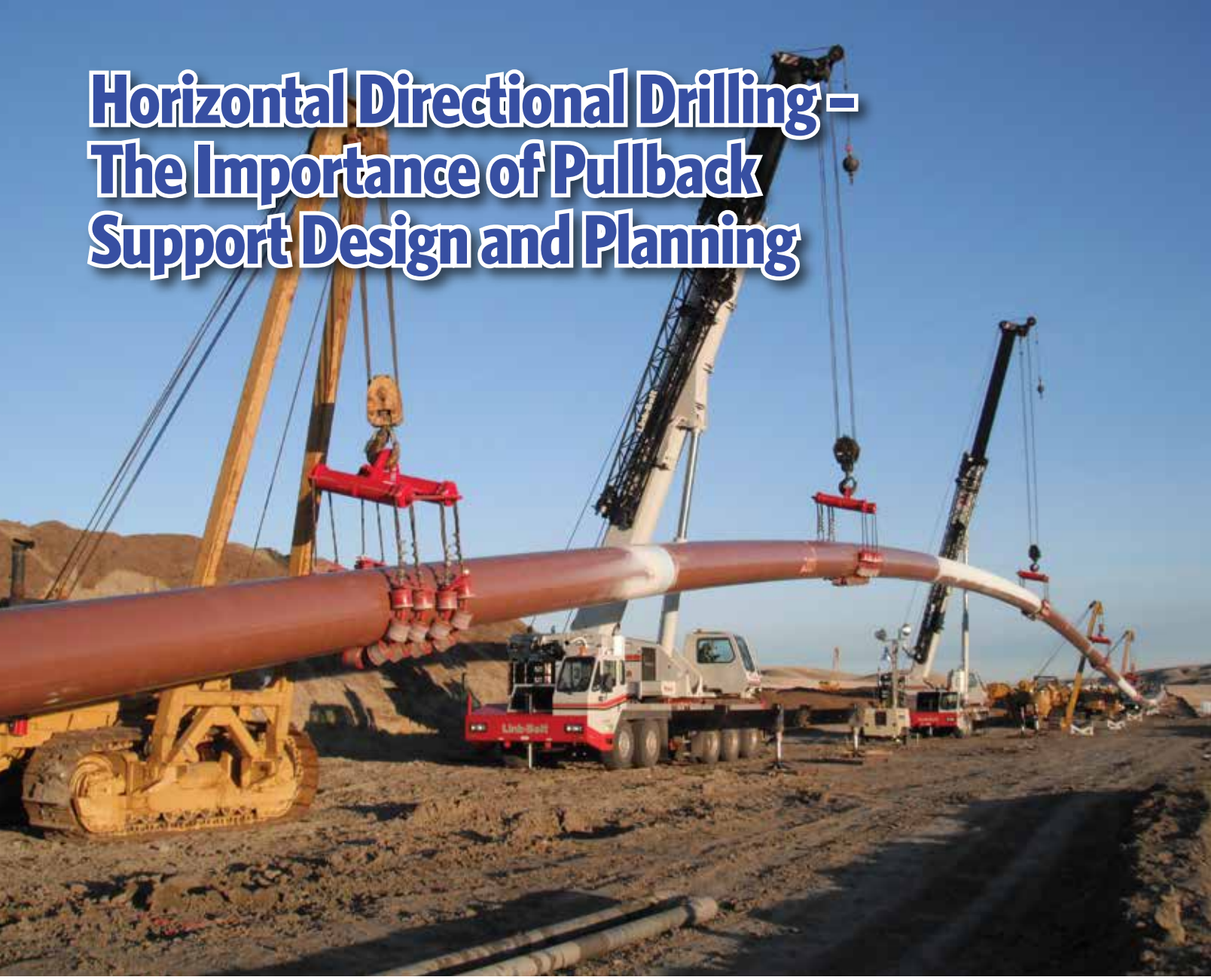
# Horizontal Directional Drilling – The Importance of Pullback Support Design and Planning



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Perhaps the most commonly overlooked part of any Horizontal Directional Drill (HDD) design is the product pipe pullback support. Although there is commonly significant engineering evaluation put into the development of the below-ground geometry (such as Annular Pressure / Hydrofracture and Inadvertent Return risk calculations, design radius and minimum allowable radius calculations, pull-force evaluations, buoyancy control calculations, etc.), in general much less thought is put towards how the product pipe is handled above ground, before it enters the designed bore-path. However, as will be discussed here, the design of this portion of the HDD process can be just as important (or more so) than the downhole design in ensuring a safe and successful installation.

Fifteen years ago, pullback (or lift-plan) designs were almost non-existent. It was up to the general pipeline contractor to provide equipment to lift the pipe such that it entered the borehole at the specified angle. As long as the side-booms could lift the pipe to align with the hole, there was not much additional analysis or thought put into the process. With the increasing capabilities of HDD equipment and planning, larger and longer pipe crossings started to become more common, and with some large pipe and challenging geometry in HDD designs, site-specific lift-plans started to become a project requirement. Although not always the case, within the United States lift plans are predominantly prepared by the general pipeline contractor or their subcontractors who are responsible for the lifting of the pipe, well after the design of the HDD drillpath itself has been finalized. HDD designers may draft up plans to show required pullback alignment for temporary

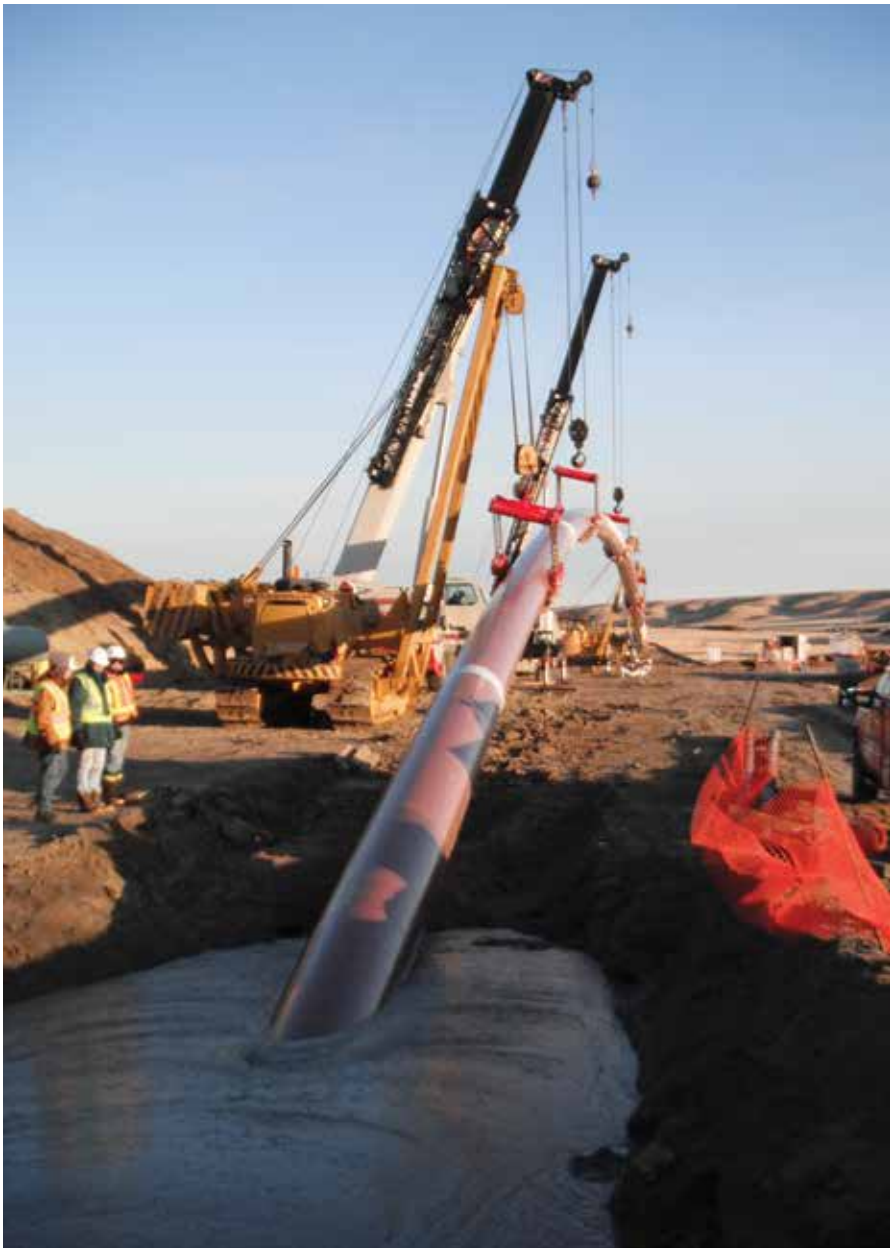
> *The goal of the design is to ensure safe, efficient, and cost effective HDD installations*

workspace consideration, but in many cases, the design of the pullback support does not go beyond this preliminary stage during the detailed HDD design. For a multitude of reasons that are discussed below, this really should not be the case if the ultimate goal of the design is to ensure safe, efficient, and cost-effective HDD installations.

## WHY ARE LIFT PLANS UNCOMMON IN HDD DESIGN?

Before we can talk about why things could be done better, first we need to know why they are being done the way they are. So, why are lift plans not included within all HDD designs? There could be many logical reasons. Among them: It is outside of the HDD designer's skillset. Or, it is preferred to leave scoping of equipment and liability for the pipe lift in the pipeline contractor's hands rather than the Owner's or Designer's. Or, sometimes, it may just be the old way of thinking: that the lift above ground is a minor concern in relation to the HDD installation overall.

An important related consideration to keep in mind is that the Contractor's goals and the pipeline Owner's goals, although the same in the big picture, can be coming from different perspectives. The Owner's goal is likely the efficient, safe installation of their utility in a way that ensures it is not compromised and can successfully operate. They are concerned with the stresses on their pipe during installation and operation, essentially the protection of their assets. Things such as weld and coating quality, steering specifications, and minimizing coating damage may be primary concerns in what they consider



*Proper alignment with the drilled hole is critical for safe installation*

the successful installation of the pipe. On the other hand, the Contractor will be coming from a similar "protection of their assets" frame of mind. Therefore, Contractors will generally be more focused on the loads and forces on their equipment to ensure the product can be installed successfully without failure of their tooling, drill stem, rig anchors, and/or pipe support equipment. It is this inherent understanding of these differences in priority that lead to the creation of specific steering tolerances within the below-ground HDD design that the Contractor must adhere to, along with other prescriptive requirements around tooling and processes that the Contractors must follow in order to be allowed to complete the installation. So why does this not extend to the pipe when it is above ground?

## WHY ABOVE-GROUND PIPE SUPPORT DESIGN IS IMPORTANT

Ensuring pullback pipe support design has been included within the HDD design

*Pullback plans should minimize public impact where possible*

has many benefits. One of the most basic benefits is the determination of the amount of additional temporary workspace that may be required for the preparation of the pipe section. A full support design would include evaluation of horizontal curves (or "roping") along the pullback section to confirm if the pipe section can fit within the constraints of existing right of way (ROW) and temporary workspace inflections. This evaluation at the design stage can allow for additional temporary workspace to be obtained that would allow for the line pull to be completed in one continuous section and which would otherwise not be obtained prior to construction. If ROW and workspace cannot achieve layout in a single section due to other impediments such as elevation differences, roads or rails, alternatives such as culverts or temporary supports above roadways can be evaluated at the design stage to assess construction challenges and impacts to the public. The avoidance of unnecessary additional intermediate welds during HDD pullback due to lack of sufficient workspace can eliminate risks to the successful installation of the pipe in most cases. In addition, the confirmation of whether or not intermediate welds would be required and where could be a significant factor in determining the overall feasibility of the HDD installation, and may necessitate design modifications in order to mitigate these risks.

Another reason the pipe lifting design could directly play a significant role in the HDD design geometry is for consideration of pullback pipe support equipment requirements. A designer may be able to optimize an HDD drillpath with slightly higher entry and exit angles, reducing overall length and therefore schedule and cost of the HDD. However, if this higher exit angle significantly increases equipment requirements to support the pipe adequately without over-stressing it, the relative savings in drilling costs may be irrelevant to the overall cost of the crossing. In many cases, optimal downhole HDD geometry will be at odds with optimal above-ground support requirements and costs. Having a design that considers BOTH, and finds an optimal middle ground, is a necessity in ensuring overall cost and schedule efficiency with HDD designs, in addition to minimizing safety concerns that may be present with extremely large-scale pipe lifts that require long lengths of very high suspended loads.

Another benefit of completing a design that balances the HDD drillpath considerations with the above-ground support requirements is that there will be a clear understanding of the pipe support requirements at the design stage, and therefore at the bidding stage. Without detailed pipe support designs, pipeline contractors may severely underestimate or overestimate the support equipment requirements. This can lead to significant unexpected costs at the time of construction and contractual disagreements that may be passed to the pipeline owners. A clear understanding of the equipment requirements will allow for the Contractor to be more accurate in their pricing, and ensure less price variance for the Owner.

Perhaps most importantly, having an engineered design for the pipe support

*Both vertical and horizontal loads on pipe must be evaluated*

ensures that the product pipe will not be overstressed during handling above-ground and therefore safety issues that may develop from overstressed pipe in operation are avoided. Previous studies have shown that the stress on product pipe above ground during pullback can far exceed the stress on the pipe once it is within the HDD borehole (see technical paper: Goerz, B., Taylor, J., & Martens, M. "Longitudinal & Circumferential Pipe Stress in Horizontal Directional Drills", NASTT No-Dig Show, 2014). With a lift plan in place that is designed to ensure there is sufficient support equipment at suitable spacing and heights so as to not over-stress the product pipe (with suitable safety factors to account for actual in-field variations), excessive loads and stresses on the pipe prior to entry into the HDD borehole can be avoided.

## PULLBACK DESIGN CONSIDERATIONS

There are many things that need to be taken into account when developing a pullback lift plan. The means and methods for how the plans are developed (hand calculations and/or finite element analysis, etc.) are effective as long as they are done competently and take into consideration several important factors. These include, but are not limited to: the break-over radius, the effects of combined horizontal and vertical bending stress, the length of unsupported pipe at the leading and tailing end of the pullback section, the local stresses at the supports, the buoyancy control measures being implemented, the frictional forces from the pipe section on cradles/rollers; etc.

## THE GOAL: SAFETY AND EFFICIENCY

The goals of the Owners, the designing engineers, and the Contractors completing the work are all the same at the end of the day. All parties want to ensure that the pipe is installed successfully, as efficiently and cost effectively as possible while maintaining the required level of safety within the design and the installation processes. Having ALL aspects of the HDD designed accordingly allows for the achievement of these goals.

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