Geology and HDD
Sinkholes caused by HDD
Broken drill rod

54 inch reamer similar to one lost during an HDD in New Jersey
<table>
<thead>
<tr>
<th>Rock Type</th>
<th>Generalized Rock Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Igneous rocks</td>
<td>Unconsolidated: Intrusive rocks (plutonic)</td>
</tr>
<tr>
<td></td>
<td>Consolidated: granite, granitic pegmatite, diorite, gabbro, peridotite</td>
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<tr>
<td>Extrusive rocks (volcanic)</td>
<td>Unconsolidated: volcanic ash</td>
</tr>
<tr>
<td></td>
<td>Consolidated: basalt, rhyolite, andesite</td>
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<tr>
<td>Sedimentary rocks</td>
<td>Unconsolidated: Mechanical</td>
</tr>
<tr>
<td></td>
<td>Consolidated: conglomerate, sandstone, siltstone &amp; shale</td>
</tr>
<tr>
<td></td>
<td>Consolidated: carbonates (limestone &amp; dolomites), gypsum, anhydrite &amp; salt</td>
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<tr>
<td></td>
<td>Organic: peat &amp; lignite</td>
</tr>
<tr>
<td></td>
<td>consolidated: carbonates, coal</td>
</tr>
<tr>
<td>Metamorphic rocks</td>
<td>Unconsolidated: Any rock type altered by heat and pressure</td>
</tr>
<tr>
<td></td>
<td>Consolidated: gneisses, schist, amphibolite, argillite, slate, quartzite, &amp; marble</td>
</tr>
</tbody>
</table>
Coastal Plain unconsolidated formations

- Fine sand and dark clay
- Thin clayey gravel at surface, below is a clean coarse sand
Clay formation with limonite filled fractures. In New Jersey some clays clay formations contain sulfide minerals such as pyrite and marcasite which can weather by groundwater and be deposited in fractures in the clay. Pyrite and especially marcasite can begin decomposing as soon as exposed to the air and produce sulfuric acid creating acid soil conditions.
Stratified glacial deposit of gravel over coarse cross-bedded sand
Consolidated sedimentary rock, quartzite/sandstone showing bedding and joints
Cleavage and fault in slate

Foliation and fault in gneiss
Volcanic rock, basalt with shear zones
Metamorphic and sedimentary rock

gneiss

quartzite/sandstone
Open solution joint

Filled solution joint/sinkhole
Borings showing cavities in dolomite

Borings are about 50 feet apart
Black areas are cavities
Based on core examination the cavities followed bedding and joints
Geology mapped by R.A. Parker (USGS) and H.F. Houghton (NJGS), 1985-88
Some data compiled from H.B. Kummel, 1896
This map is an interim product of the "Early Mesozoic Project," part of the New Jersey COGEO MAP program
diabase sill

Unsuccessful drill area

Successful drill area
Passaic Formation
sandstone, siltstone, and shale
Notice change in joint spacing and direction in shale beds

Joint spacing several feet
Joint spacing several inches
Monksville HDD

Green line is approximate location of HDD
Summary:
Conditions that can affect HDD project and boring requirements

• The drilling must be able to create an open hole in the rock or cohesive soils or fluidized condition of cohesionless soils such as sand or silt. Coarse grained materials, excessive rock strength/hardness (+50,000 psi) and solution cavities in bedrock may prevent HDD.

• Coarse Grained-- gravel, cobbles & boulders cannot be fluidized for removal nor stablized for open hole.

• Excessive rock strength-- may deflect drill string, wear bits, slow drill rates extending construction duration and costs.

• Poor rock quality—Vertical rock fissures can cause frac-outs.

• Depth of cover minimum 30 feet.

• Borings should be 30 to 50 feet. off drill path. The should be 20 feet. deeper than pipe depth. Split spoon samples should be taken every 5 feet and continuous rock core.

Glacial till
Sources of Geologic Information:

- State geological surveys. On the Association of American State Geologists (AASG) website is a link that lists all the geological surveys.  [http://www.stategeologists.org/](http://www.stategeologists.org/)
- US Geological Survey
- National Geologic Map Data Base  
  [https://ngmdb.usgs.gov/ngmdb/ngmdb_home.html](https://ngmdb.usgs.gov/ngmdb/ngmdb_home.html)
- Site visit by geologist
- Borings
- Split Spoon samples (2 foot samples every 5 feet or continuous) of the unconsolidated materials.
- Continuous core samples of consolidated materials.
- Notes from: Directional Drilling Best Practices by Dennis M. Walsh, PE and Daniel D’Eletto, PE. April 10, 2015  
  [https://www.northeastgas.org/pdf/d_walsh_directional.pdf](https://www.northeastgas.org/pdf/d_walsh_directional.pdf)