Geology and HDD

Sinkholes caused by HDD

Broken drill rod

54 inch reamer similar to one lost during an HDD in New Jersey

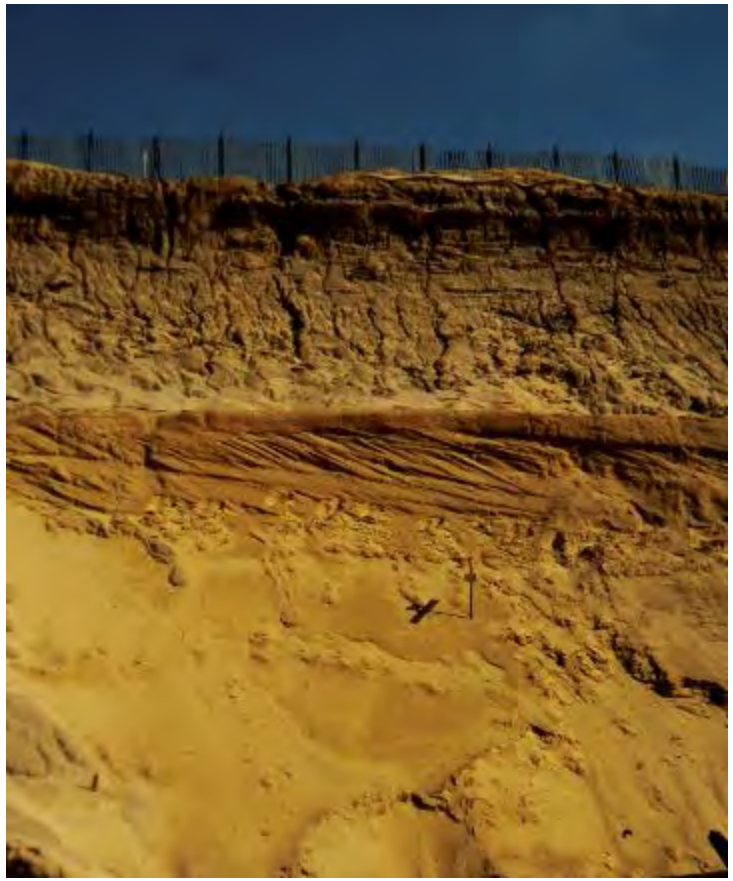
Generalized Rock Classification

		Unconsolidated	Consolidated
Igneous rocks	Intrusive rocks (plutonic)		granite, granitic pegmatite, diorite, gabbro, peridotite
	Extrusive rocks (volcanic)	volcanic ash	basalt, rhyolite, andesite
Sedimentary rocks	Mechanical	gravel, sand, silt & clay	conglomerate, sandstone, siltstone & shale
	Chemical		carbonates (limestone & dolomites), gypsum, anhydrite & salt
	Organic	peat & lignite	carbonates, coal
Metamorphic rocks	Any rock type altered by heat and pressure		gneisses, schist, amphibolite, argillite, slate, quartzite, & marble

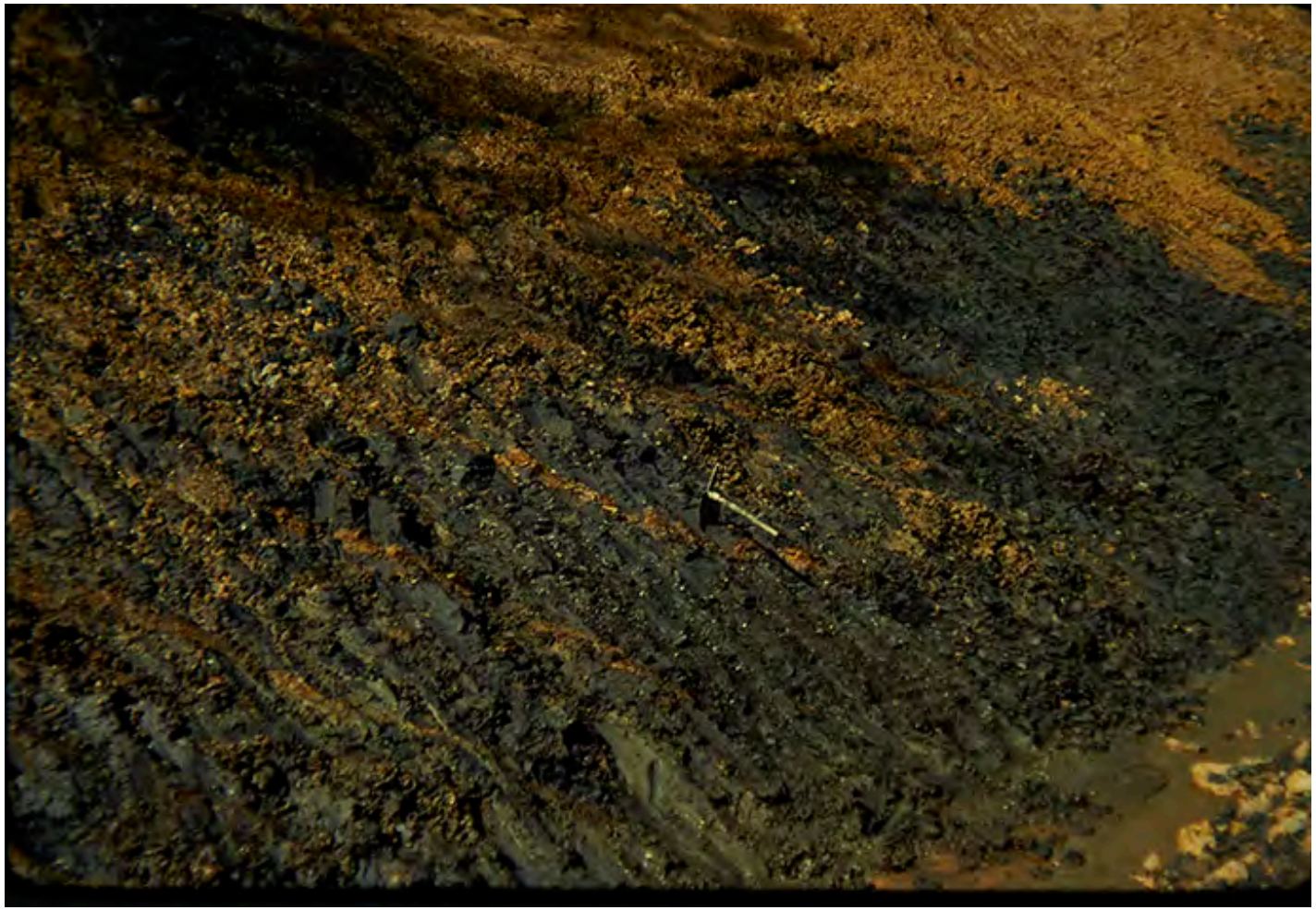
Coastal Plain unconsolidated formations

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

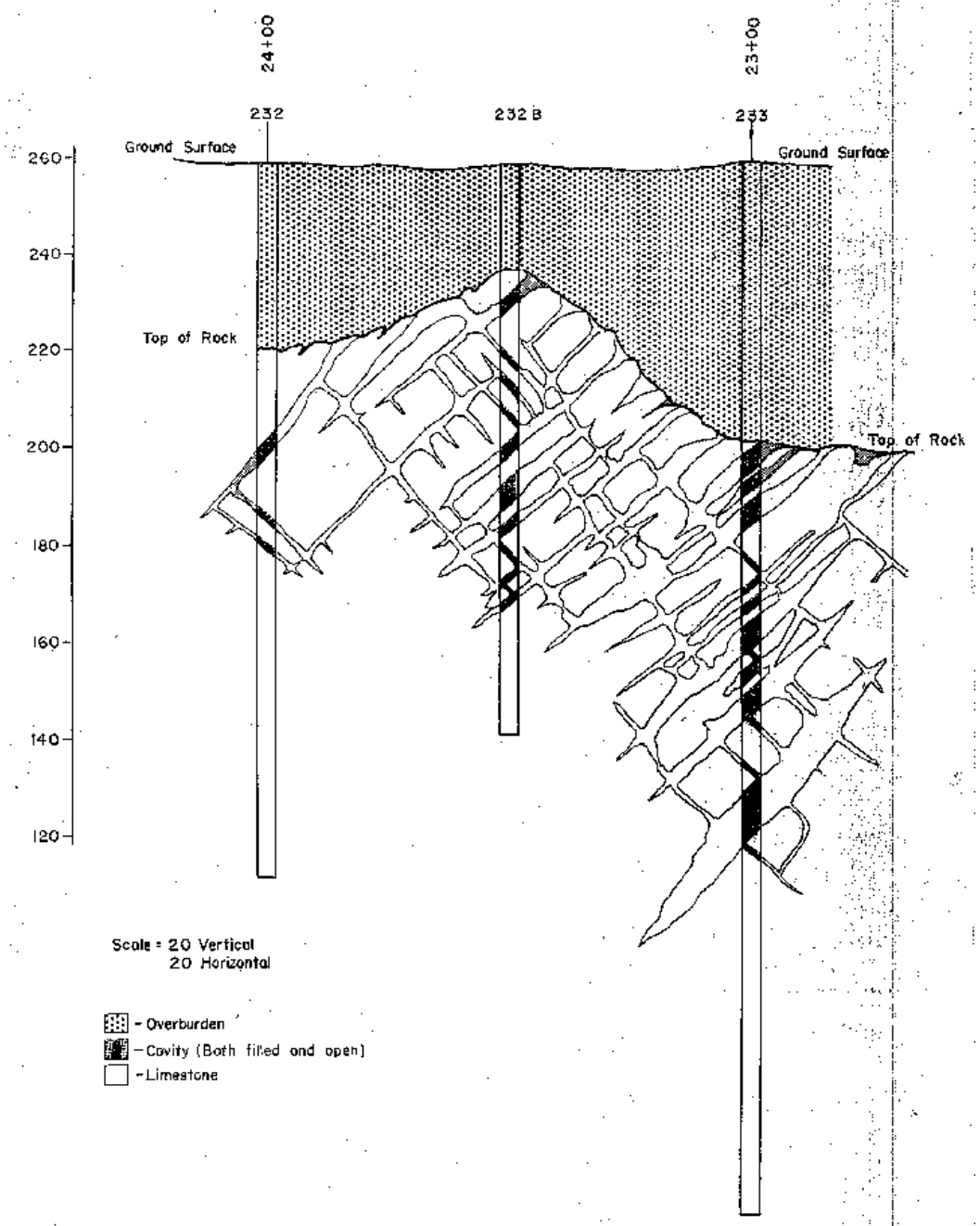
Filled solution joint/sinkhole

Borings showing cavities in dolomite

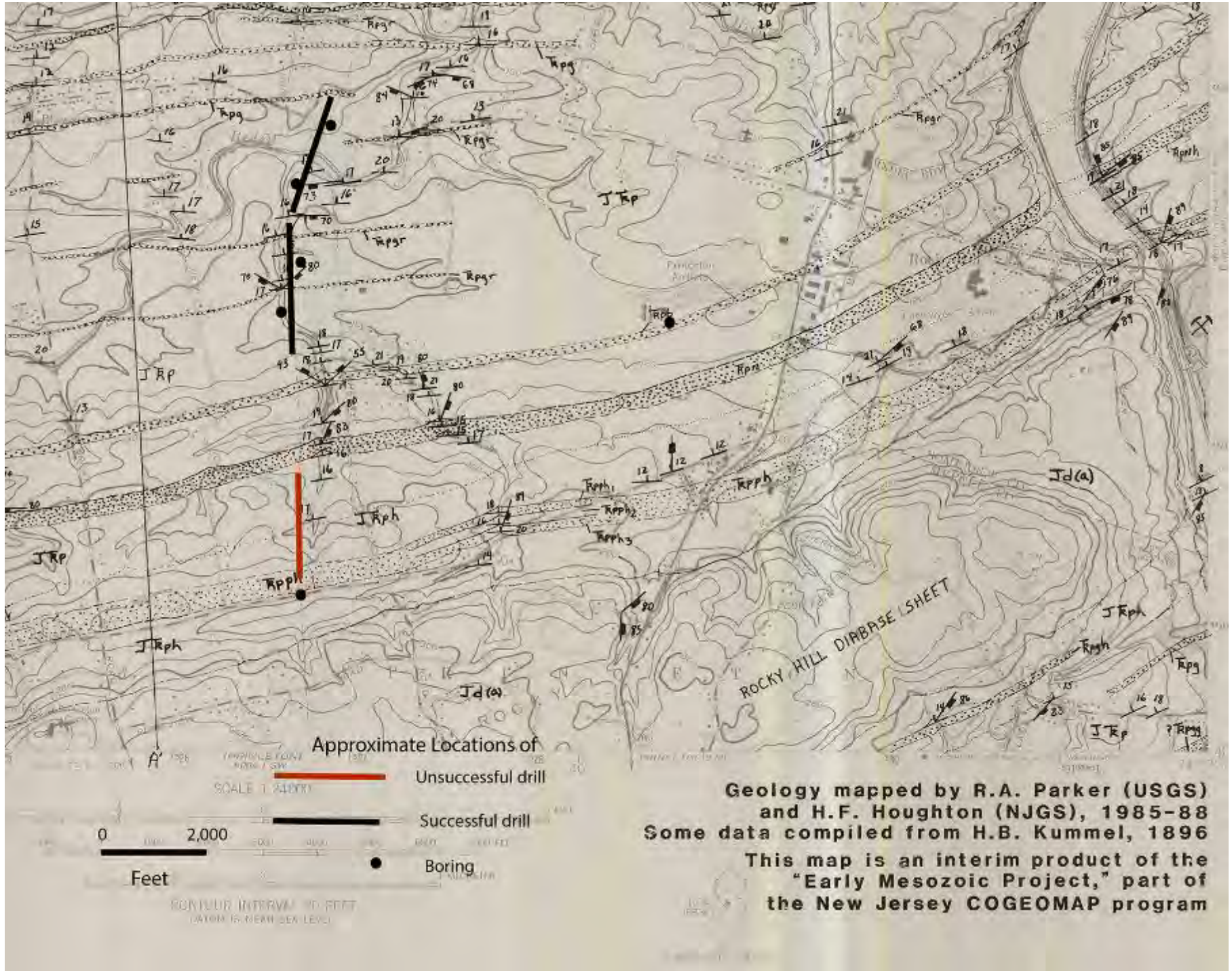
Borings are about 50 feet apart

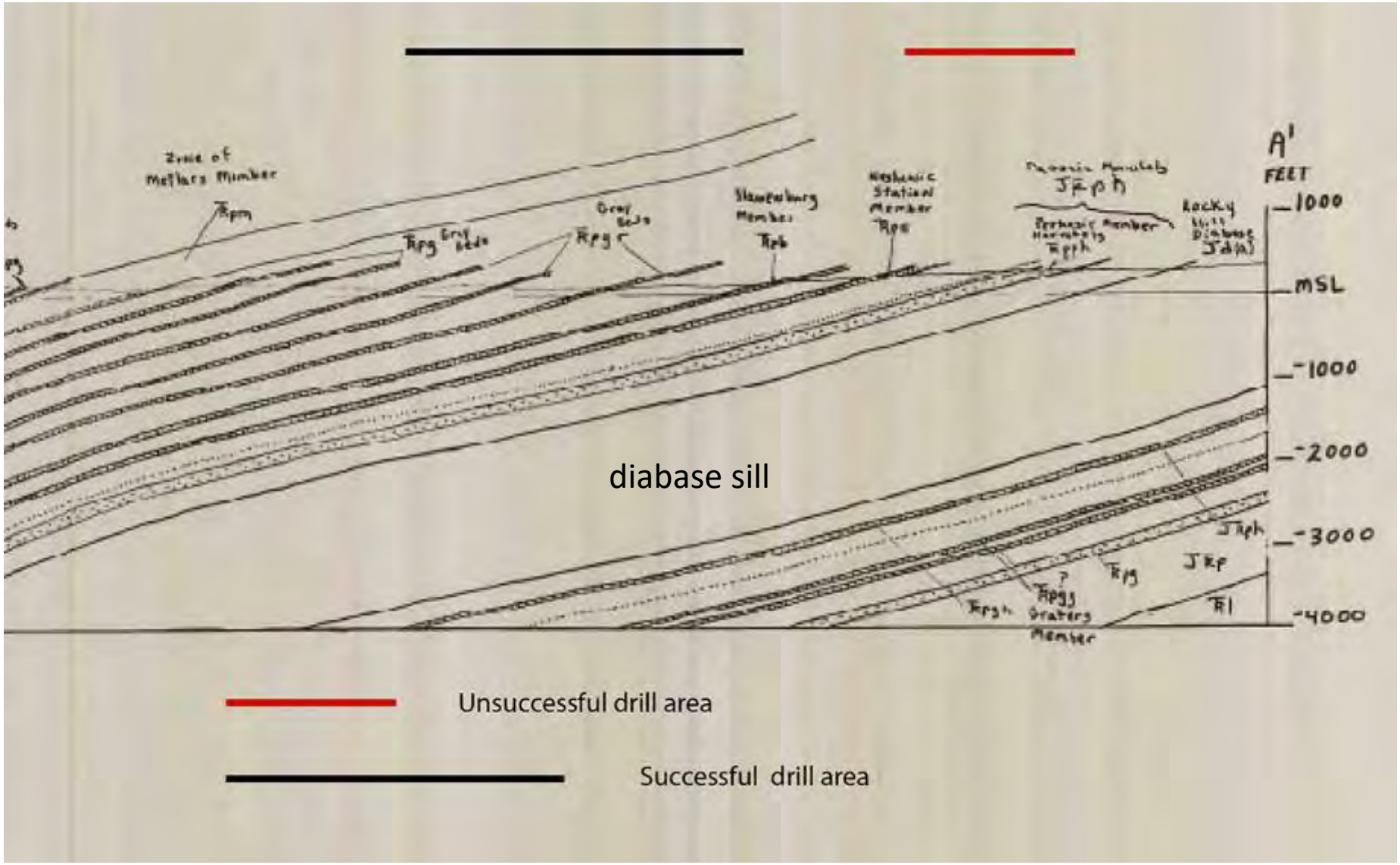
Black areas are cavities

Based on core examination the cavities followed bedding and joints



INFERRED INTERPRETATION OF SUBSURFACE CONDITIONS FROM DRILL HOLES


ROCKY HILL DIABASE SHEET
Approximate Locations of
Unsuccessful drill
Successful drill
Boring
0
2,000
Feet
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 COGEOMAP program

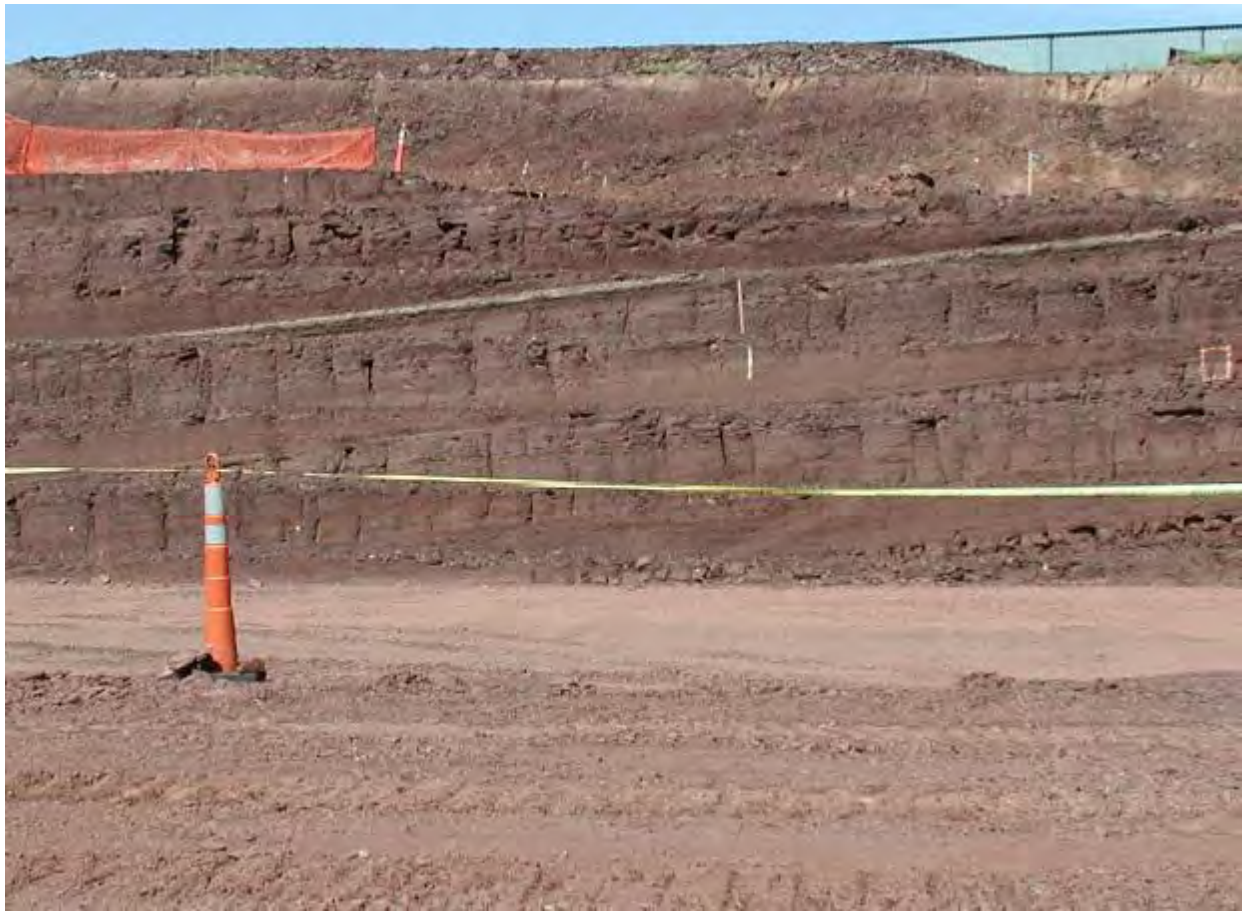

A'
FEET
1000
MSL
-1000
-2000
-3000
-4000
diabase sill
Unsuccessful drill area
Successful drill area

Passaic Formation

sandstone, siltstone, and shale

Notice change in joint spacing and direction in shale beds

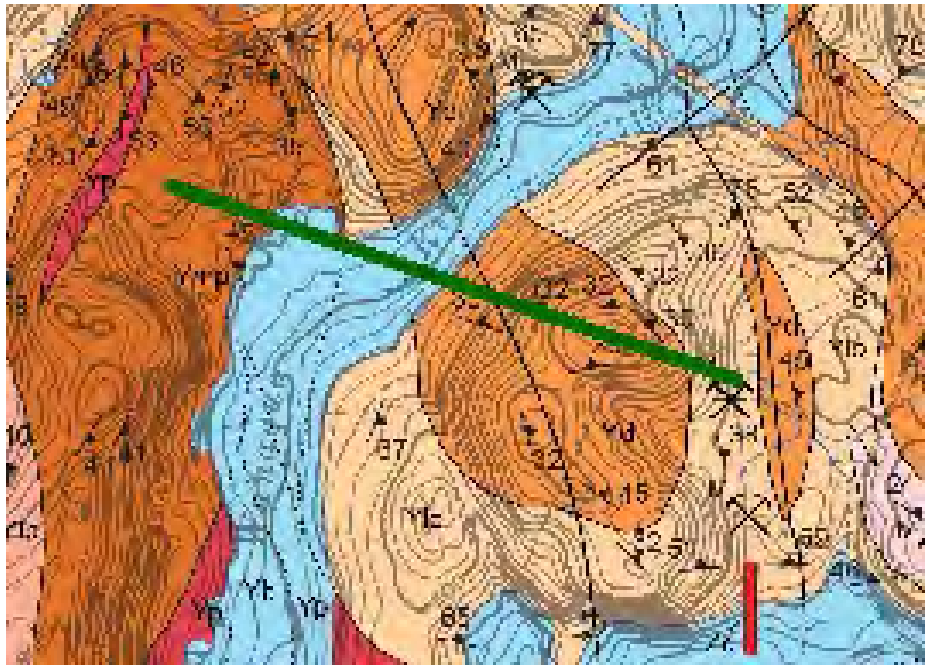
Joint spacing several feet



Joint spacing several inches

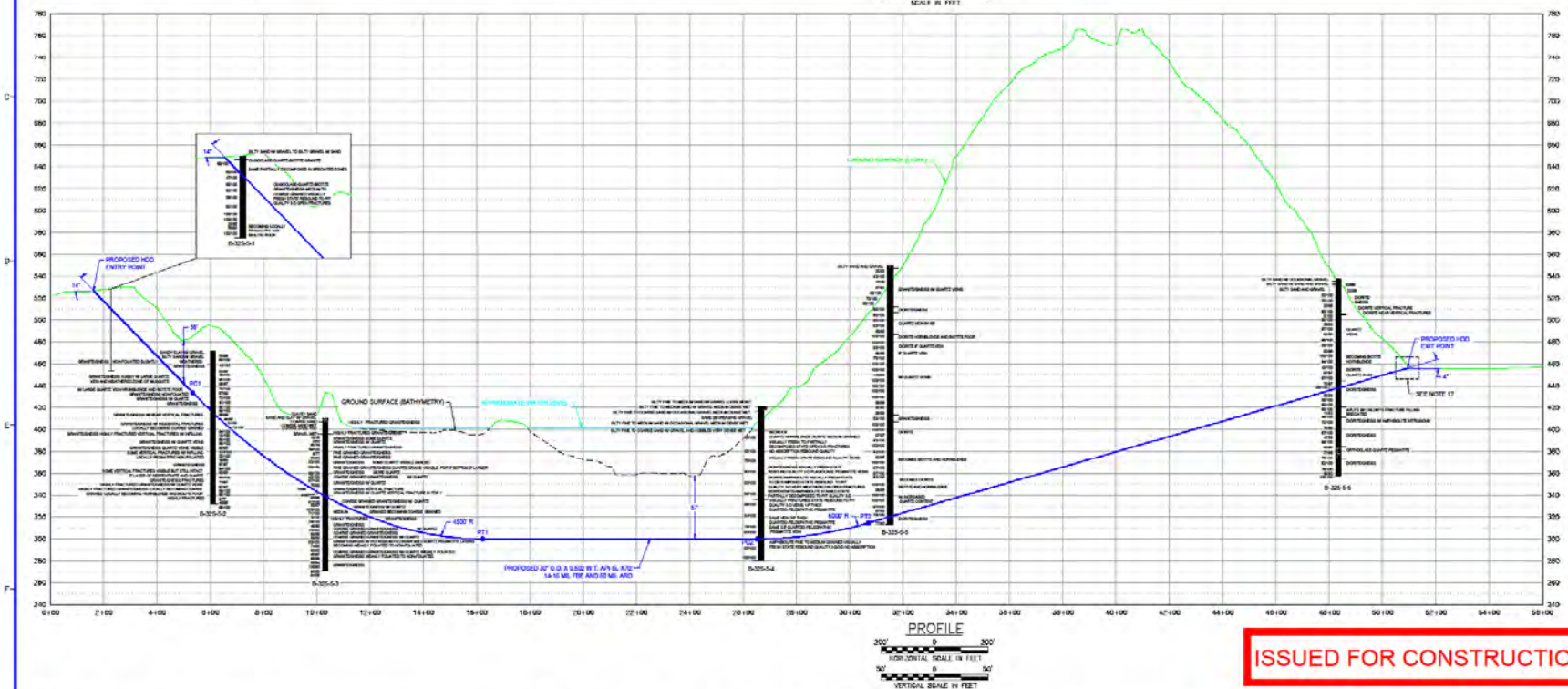
Monksville HDD

Green line is approximate location of HDD



PLAN

200' 0 200'
SCALE IN FEET



PROFILE

200' 0 200'
HORIZONTAL SCALE IN FEET
50' 0 50'
VERTICAL SCALE IN FEET

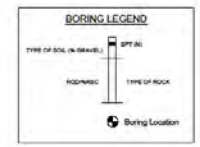
DIRECTIONAL DRILL DATA MONKSVILLE RESERVOIR HDD		
DESCRIPTION	STATION + (ft)	ELEVATION (ft)
ENTRY @ 14°	1+00.00	526.72
P C T (14.00° @ 5,500 ft R.)	5+33.19	433.67
P T 1	16+21.83	300.00
P C 2 (4.00° @ 5,000 ft R.)	25+51.33	300.00
P T 2	30+69.87	314.62
EXIT @ 4°	50+91.82	456.00
HORIZONTAL DISTANCE = 4931.82 ft		
DIRECTIONAL DRILL PIPE LENGTH = 4959.43 ft		

* STATIONING IS BASED ON ARBITRARY REFERENCE POINT

DESIGN BASIS:

1. PRODUCT PIPE WILL CONSIST OF 30" O.D. X 0.502" W.T., API-5L X-70 PIPE WITH 14-18 MILS OF FUSION BONDED EPOXY (FBE) AND A MINIMUM OF 60 MILS OF ABRASION RESISTANT OVERLAY (ARO).
2. MAXIMUM ALLOWABLE OPERATING PRESSURE (MAOP) = 1176 psi.
3. ASSUMED MAXIMUM OPERATING TEMPERATURE = 70° FAHRENHEIT.
4. MINIMUM ALLOWABLE THREE JOINT RADIUS SHALL BE NO LESS THAN 2,400 ft, AS CALCULATED BY THE METHOD INCLUDED IN THE HDD SPECIFICATION. THIS MINIMUM ALLOWABLE RADIUS IS BASED ON A WALL THICKNESS OF 0.502".

BORING LEGEND



ISSUED FOR CONSTRUCTION

NOTES

1. ALL EQUIPMENT MUST ACCESS THE SITE ALONG THE CONSTRUCTION RIGHT-OF-WAY OR FROM APPROVED ACCESS ROADS.
2. WORK SPACE, MAXIMUM WORK SPACE LIMITS ARE DEPICTED. RESTRICT CLEARING TO THE WORK SPACE INDICATED AT THE ENTRY AND EXIT POINTS AND PRODUCT PIPE STRINGING AND FABRICATION AREA ALONG THE CONSTRUCTION RIGHT-OF-WAY. CLEARING BETWEEN THE ENTRY AND EXIT POINTS REQUIRES PRIOR APPROVAL FROM THE ENVIRONMENTAL INSPECTOR AND IS LIMITED TO THE AMOUNT NECESSARY TO STRING SURVEY WIRES AND INSTALL PUMPS AND PIPING TO OBTAIN WATER (WHERE APPROVED).
3. WATER SOURCE: DRILL WATER AND HYDROSTATIC TEST WATER SHALL BE OBTAINED FROM AN APPROVED SOURCE.
4. HYDROSTATIC TEST: PRE-INSTALLATION AND POST-INSTALLATION HYDROSTATIC TESTS SHALL BE CONDUCTED IN ACCORDANCE WITH THE HYDROSTATIC TEST PLAN. TEST WATER SHALL BE SAMPLED AND TESTED IN ACCORDANCE WITH PERMIT REQUIREMENTS. THE TEST WATER SHALL BE DISCHARGED IN AN UPLAND AREA INTO AN EROSION CONTROL STRUCTURE, OF STRAW BALES AND/OR SILT FENCES, GEOTEXTILE FILTER BAG, OR COLLECTED IN A TRUCK AND HAULED TO AN APPROVED DISPOSAL SITE. UPON COMPLETION OF DEWATERING AND DRYING, A CALIPER PIG SURVEY SHALL BE COMPLETED IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.
5. SPILL PREVENTION: REFUELING OF ALL EQUIPMENT SHALL BE COMPLETED IN ACCORDANCE WITH THE SPCC PLAN.
6. EROSION AND SEDIMENT CONTROL: CONTRACTOR SHALL SUPPLY, INSTALL AND MAINTAIN SEDIMENT CONTROL STRUCTURES IN ACCORDANCE WITH CONTRACT DOCUMENTS. CONTRACTOR SHALL INSTALL ADDITIONAL EROSION CONTROL STRUCTURES AS DIRECTED BY THE ENVIRONMENTAL INSPECTOR.
7. INSTALLATION: THE PIPE SECTION FOR THE DRILLED CROSSING SHALL BE MADE UP WITHIN THE APPROVED CONSTRUCTION RIGHT-OF-WAY AT THE DRILL EXIT POINT AS SHOWN. AFTER THE PILOT HOLE IS COMPLETE, CONTRACTOR'S ACTUAL DRILL PROFILE SHALL BE SUBMITTED TO KINDER MORGAN FOR APPROVAL. CONTRACTOR SHALL ASSESS THE NEED FOR AND SUPPLY APPROPRIATE BALLAST DURING PULLBACK.
8. DRILLING FLUID DISPOSAL: CONTRACTOR SHALL DISPOSE OF EXCESS DRILLING FLUID AS DIRECTED BY THE COMPANY REPRESENTATIVE IN ACCORDANCE WITH PERMIT CONDITIONS. UNDER NO CIRCUMSTANCES SHALL DRILLING FLUID BE DISPOSED OF IN WATER BODIES OR WETLANDS. ANY DRILLING FLUID WHICH INADVERTENTLY SURFACES AT POINTS OTHER THAN THE ENTRY OR EXIT POINTS SHALL BE CONTAINED AND COLLECTED TO THE EXTENT PRACTICAL AND DISPOSED OF AS DIRECTED BY THE COMPANY REPRESENTATIVE IN ACCORDANCE WITH PERMIT CONDITIONS.
9. CLEANUP/STABILIZATION/RESTORATION: ALL DISTURBED AREAS SHALL BE RETURNED TO THE ORIGINAL CONTOURS. DISTURBED AREAS SHALL BE SEEDED AS SPECIFIED IN THE CLEAN-UP AND RESTORATION REQUIREMENTS. IF THE TERRAIN ALLOWS AND ACCESS IS PERMITTED, CONTRACTOR SHALL UTILIZE LOW GROUND PRESSURE EQUIPMENT OR OTHER EQUIPMENT APPROVED BY OWNER, TO FACILITATE CONTAINMENT AND CLEAN-UP OF ANY INADVERTENT RETURNS THAT OCCUR DURING THE HDD INSTALLATION PROCESS.
10. GEOTECHNICAL DATA: BORE HOLES ARE OFFSET FROM THE PIPELINE CENTERLINE AS SHOWN ON THE PLAN VIEW. THE GEOTECHNICAL INFORMATION PROVIDED ON THIS DRAWING IS A GENERAL SUMMARY. REFER TO THE APPLICABLE GEOTECHNICAL REPORT IN THE CONTRACT DOCUMENTS FOR MORE DETAILED INFORMATION.
11. AERIAL PHOTO DOWNLOADED FROM HTTP://NEMAILESS.USGS.GOV.
12. GROUND SURFACE LIDAR PROVIDED BY WILLIAMS ENGINEERING.
13. CONTRACTOR IS RESPONSIBLE FOR CALLING NEW JERSEY ONE-CALL AND LOCATING ALL UNDERGROUND UTILITIES PRIOR TO BEGINNING CONSTRUCTION. IF ANY UTILITY IS LOCATED WITHIN 15 FEET OF THE DESIGNED HDD PROFILE AND ALIGNMENT, CONTRACTOR SHALL OBTAIN APPROVAL FROM WILLIAMS MIDSTREAM PRIOR TO INITIATING HDD OPERATIONS.
14. IT IS THE CONTRACTORS RESPONSIBILITY TO IDENTIFY AND PROTECT ANY FOREIGN UTILITY THAT MAY BE AFFECTED BY THE HDD OPERATIONS.
15. PLACEMENT OF THE HDD RIG IS NOT FIXED BY THE DESIGNATION OF THE ENTRY AND EXIT POINTS. THE USE OF DUAL HDD RIGS DURING CONSTRUCTION MAY BE AT THE DISCRETION OF THE HDD CONTRACTOR, TO BE APPROVED BY THE PROJECT TEAM.
16. CONTRACTOR SHALL NOTE AND FOLLOW ALL REQUIREMENTS AS OUTLINED IN THE HDD CONTINGENCY PLAN.
17. FOR PROPOSED HDD EXIT POINT GRADING SEE TG-N16-300-3H00-PA0.

NO.	DATE	BY	DESCRIPTION	PROJ. ID	APP'D
3	10/14/13	RBM	ISSUED FOR CONSTRUCTION	51804	JLP
2	08/08/13	RBM	ISSUED FOR CONSTRUCTION	51804	JLP

REVISIONS

Tennessee Gas Pipeline Company, L.L.C.
a Kinder Morgan company

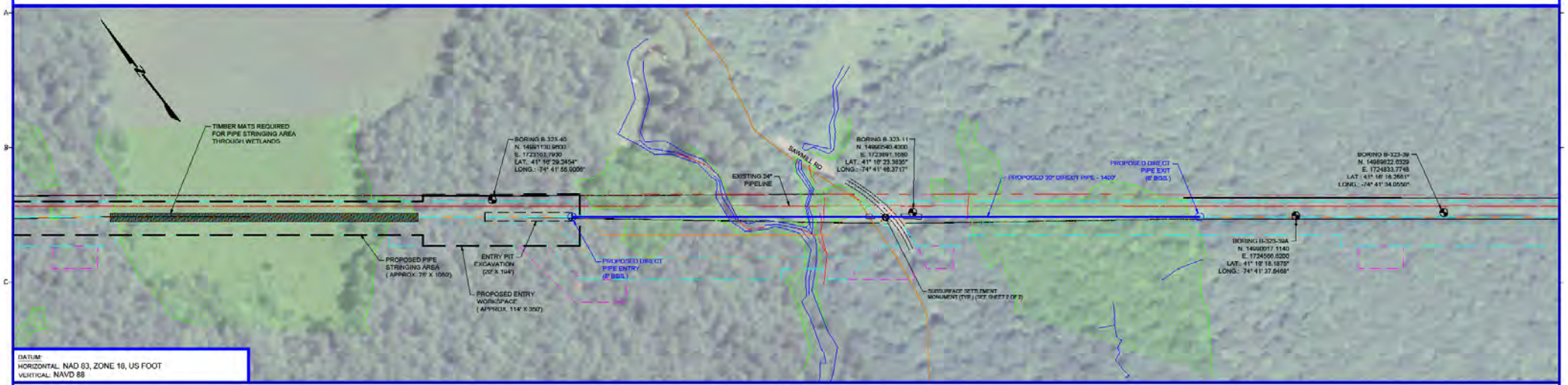
300 SYSTEM EXPANSION PROJECT
PROPOSED 30" LOOP 325
MONKSVILLE RESERVOIR HDD

Division		Op. Area:	ADA/AMA
State:	NEW JERSEY	Co./Par.:	PASSAIC COUNTY
Section:		Township-Range:	/ Range:
Drn: RBM	Date: 08/01/13	Project ID:	51804 Type:
Chk'd: RBM	Date:	Scale:	AS SHOWN
Appr: JLP	Date:	Filename:	TG-N16-300-2-3H00
		Sheet:	Rev: 1 of 1

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 coasts.
- 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.

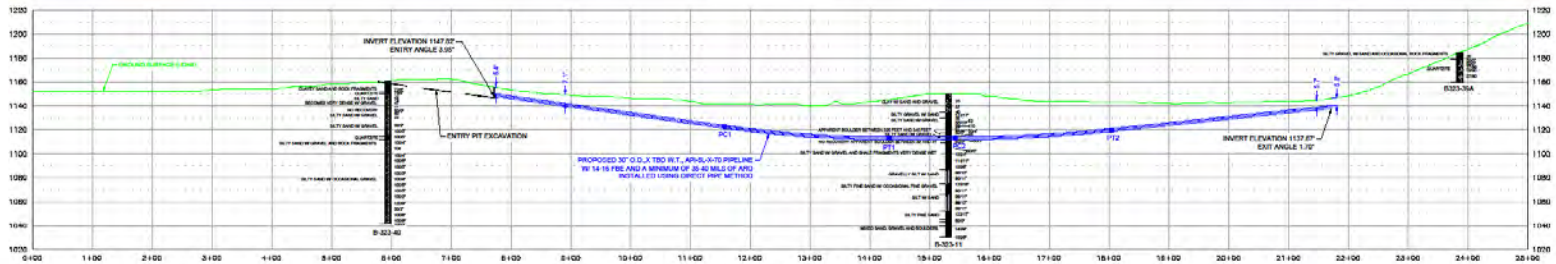
Notes from: Directional Drilling Best Practices by Dennis M. Walsh, PE and Daniel D'Eletto, PE. April 10, 2015 https://www.northeastgas.org/pdf/d_walsh_directional.pdf



DATUM:
HORIZONTAL: NAD 83, ZONE 18, US FOOT
VERTICAL: NAVD 88

PLAN

100' 0 100'
SCALE IN FEET



PROFILE

100' 0 100'
HORIZONTAL SCALE IN FEET
50' 0 50'
VERTICAL SCALE IN FEET

NOTES

1. ALL EQUIPMENT MUST ACCESS THE SITE ALONG THE CONSTRUCTION RIGHT-OF-WAY OR FROM APPROVED ACCESS ROADS.
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5. SPILL-PREVENTION: REFUELING OF ALL EQUIPMENT SHALL BE COMPLETED IN ACCORDANCE WITH THE SPCC PLAN.
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7. CLEANUP/STABILIZATION/RESTORATION: ALL DISTURBED AREAS SHALL BE RETURNED TO THE ORIGINAL CONTOURS. DISTURBED AREAS SHALL BE SEEDED AS SPECIFIED IN THE CLEAN-UP AND RESTORATION REQUIREMENTS.
8. GEOTECHNICAL DATA: APPROXIMATE LOCATION OF THE PROPOSED BORINGS ARE SHOWN ON THE PLAN VIEW.
9. WORKMATS OR OTHER APPROVED PROTECTION TO BE INSTALLED OVER FOREIGN LINES, THROUGH WETLAND AREAS FOR PIPE STRINGING AREA, AND AS REQUIRED.
10. THE OWNER HAS MADE AN EFFORT TO LOCATE UNDERGROUND FACILITIES NOW EXISTING BUT DOES NOT GUARANTEE THE ACCURACY OF THE INFORMATION SHOWN ON THIS DRAWING NOR DOES IT ACCEPT ANY RESPONSIBILITY FOR ERRORS IN THE LOCATION OR FOR THE FAILURE TO INDICATE ANY SUCH FACILITIES. CONTRACTOR(S) TO LOCATE ALL UNDERGROUND UTILITIES PRIOR TO BEGINNING CONSTRUCTION AND MONITOR EXISTING UTILITIES DURING CONSTRUCTION.
11. THE DIRECT PIPE INSTALLATION SHALL BE CONSTRUCTED IN ACCORDANCE WITH PROJECT SPECIFICATION.
12. THESE STANDARDS AND MINIMUM REQUIREMENTS SHALL APPLY UNLESS OVER-RIDDEN BY MORE STRINGENT LOCAL, STATE, OR FEDERAL STANDARDS REQUIREMENTS, OR PERMIT CONDITIONS.
13. DIRECT PIPE OVERCUT SHALL BE LESS THAN 1.5" INCH.
14. END SEALS SHALL CONTAIN DEVICES THAT MECHANICALLY SEAL THE PIPELINE PERIMETER FROM INFLOW OF SPOIL OR FOREIGN MATERIALS.
15. INSTALLATION: THE PIPE FOR THE DIRECT PIPE INSTALLATION SHALL BE MADE UP WITHIN THE APPROVED PRODUCT PIPE STRINGING AND FABRICATION AREA AS SHOWN IN ONE CONTINUOUS STRING.
16. CONTRACTOR SHALL UTILIZE SURVEY EQUIPMENT CAPABLE OF MEASURING LINE AND GRADE OF BORING MACHINE TO WITHIN 1/2 INCH DURING INSTALLATION OF DIRECT PIPE.
17. DIRECT PIPE SHALL BE INSTALLED WITHIN 3 INCHES OF DESIGN LINE AND GRADE.
18. PHOTO IMAGERY DOWNLOADED FROM HTTPS://SEAMLESS.USGS.GOV/WEBSITE/SEAMLESS. LIDAR ELEVATION DATA PROVIDED BY MILLBROS ENGINEERING.

BORING LEGEND

TYPE OF SOIL — SPT (N)
Boring Location

LEGEND

WETLANDS

DIRECT PIPE DATA
SAWMILL ROAD DIRECT PIPE

DESCRIPTION	STATION (ft)	ELEVATION (ft)
ENTRY @ 3.95°	7+72.19	1149.09
P.C.1 (3.95° @ 5,000 ft R.)	11+57.20	1122.50
P.T.1	14+32.75	1113.00
P.C.2 (3.00° @ 5,000 ft R.)	15+42.77	1113.00
P.T.2	18+04.45	1119.85
EXIT @ 1.7°	21+72.19	1139.12
HORIZONTAL DISTANCE = 1400.00 ft		
DIRECTIONAL DRILL PIPE LENGTH = 1401.76 ft		

PRELIMINARY

NO.	DATE	BY	DESCRIPTION	PMLL ID	APPD.
C	7/30/18	RBM	PRELIMINARY		
B	6/15/18	BTL	PRELIMINARY		
A	3/28/18	RBM	PRELIMINARY		

REVISIONS

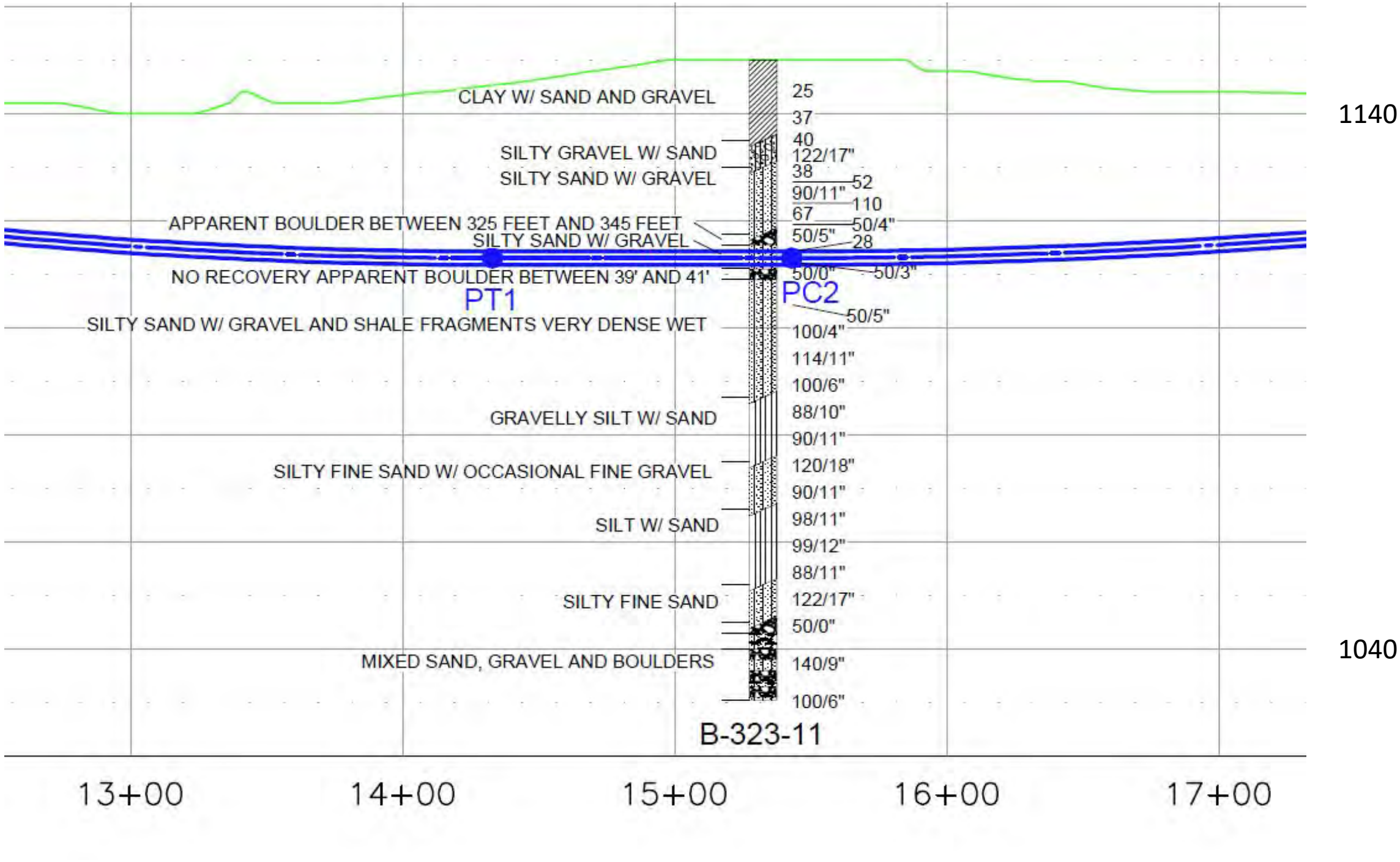
Tennessee Gas Pipeline
an El Paso company

LOOP 323 NORTHEAST UPGRADE PROJECT
SAWMILL ROAD DIRECT PIPE

Division		Op. Area	
State	NEW JERSEY	Co./Parish	SUSSEX COUNTY
Section		Township	Range
Drn. RBM	Date 03/28/18	Project ID	Type
Chk'd AES	Date	Scale NO SHOWN	
Appr. JLP	Date	Filename SAWMILL ROAD	

TD-N16-300-2-13DP

Sheet No. 1 of 2 | Rev. B


1140
1040
CLAY W/ SAND AND GRAVEL
25
37
SILTY GRAVEL W/ SAND
40
122/17"
SILTY SAND W/ GRAVEL
38
52
90/11"
110
APPARENT BOULDER BETWEEN 325 FEET AND 345 FEET
67
50/4"
SILTY SAND W/ GRAVEL
50/5"
28
NO RECOVERY APPARENT BOULDER BETWEEN 39' AND 41'
50/0"
50/3"
PT1
PC2
50/5"
SILTY SAND W/ GRAVEL AND SHALE FRAGMENTS VERY DENSE WET
100/4"
114/11"
100/6"
GRAVELLY SILT W/ SAND
88/10"
90/11"
SILTY FINE SAND W/ OCCASIONAL FINE GRAVEL
120/18"
90/11"
SILT W/ SAND
98/11"
99/12"
88/11"
SILTY FINE SAND
122/17"
50/0"
MIXED SAND, GRAVEL AND BOULDERS
140/9"
100/6"
B-323-11
13+00
14+00
15+00
16+00
17+00

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/
- US Geological Survey
- National Geologic Map Data Base 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