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THE CHOICE OF THE BEST TECHNOLOGY FOR LAYING AN UNDERGROUND PIPE. A SUCCESSFUL CASE: CROSSING THE ADDA RIVER WITH THE DIRECT PIPE METHOD

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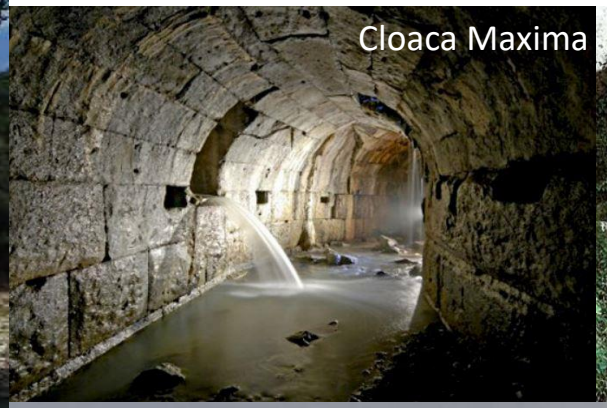
ONCE UPON A TIME … MASTERPIECES


Pont du Garde

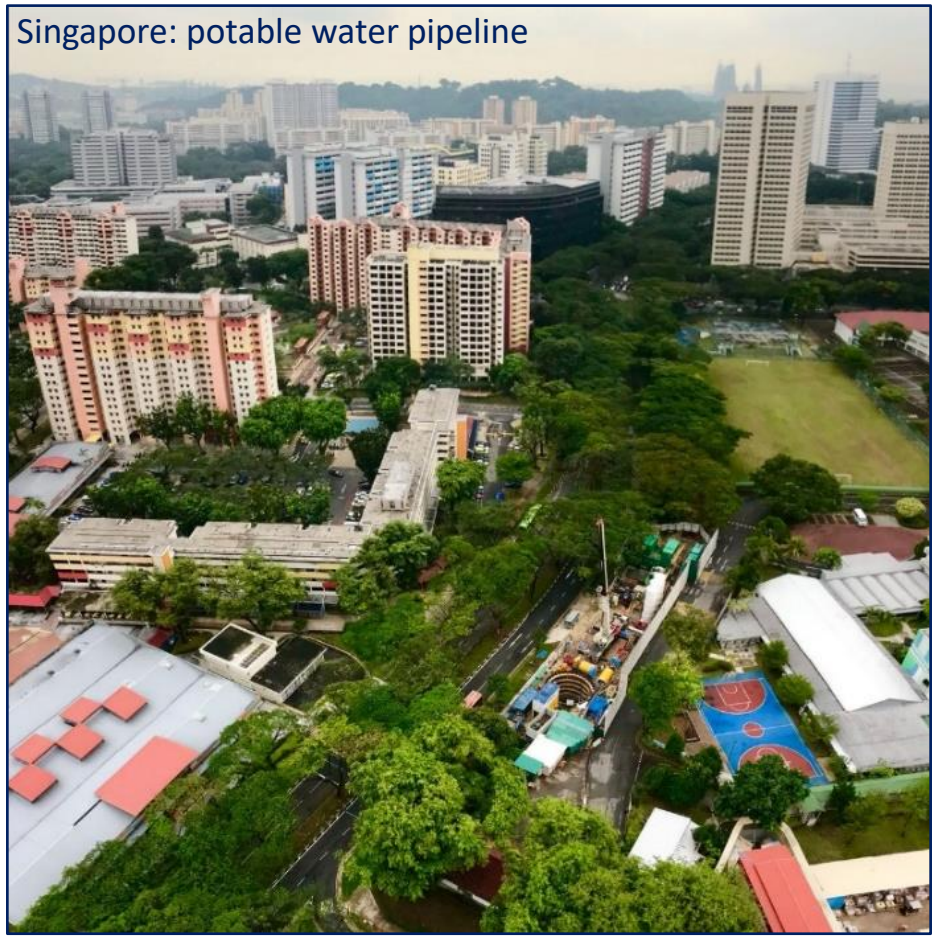

Cloaca Maxima


Cisterne Romane

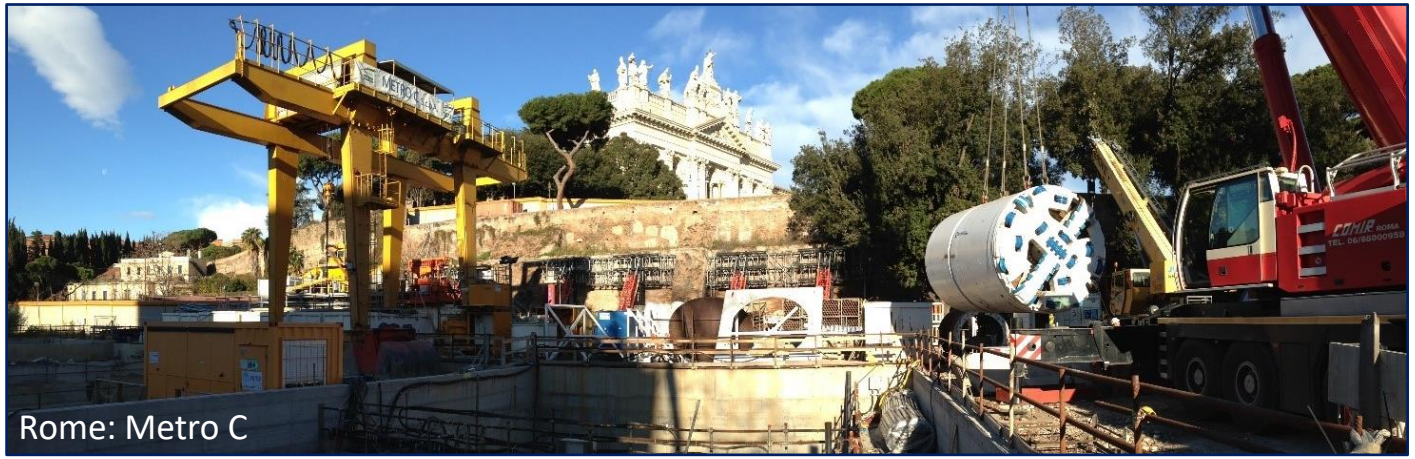

Parco degli Acquedotti

TODAY … DISAPPEARING INTO THE GROUND

Singapore: potable water pipeline



Göttingen: storm water sewer



Rome: Metro C

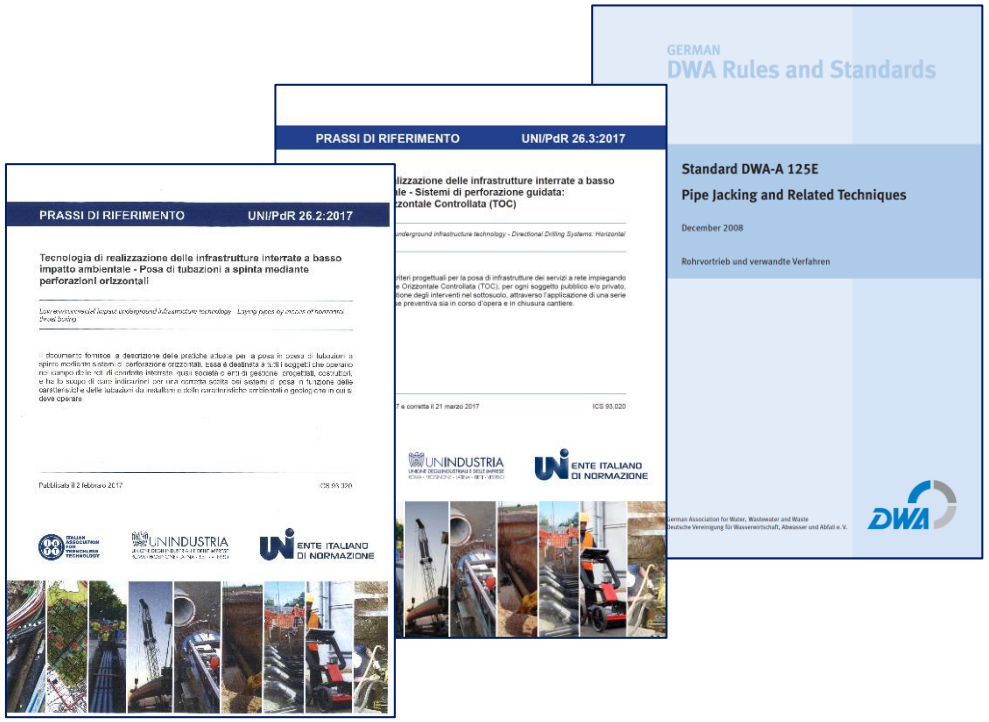
ONE TASK … MANY OPTIONS

- Several trenchless technologies available
- Selection of the best suited technology shall consider:
  - **Geological and hydrogeological** conditions
  - Local constraints (traffic, utilities, accessibility, …)
  - **Environmental** requirements
  - Pipe characteristics (material, diameter, …)
  - Crossing **geometry** (length, gradient, curvature, …)
  - Required accuracy to ensure functionality
  - Execution **time schedule**
  - Available **budget**

SEARCHING FOR GUIDANCE

Main references for a **preliminary identification:**

- **German standard** DWA-A 125-2008 "*Pipe Jacking and Related Techniques*"
- **Procedures published by UNI** (Ente Italiano di Normazione) following proposal by IATT (Italian Association for Trenchless Technology):
  - UNI/PdR 26.03:2017 – *Technology for the construction of low environmental impact, underground infrastructures. Guided drilling systems: Horizontal Directional Drilling (HDD)*;
  - UNI/PdR 26.02:2017 – *Technology for the construction of low environmental impact, underground infrastructures. Installation of jacked pipes by means of horizontal drilling*.



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Project specific investigations and risk assessments are necessary

CASE STUDY - ADDA RIVER CROSSING

PROJECT: Potenziamento della rete di Vaprio d'Adda gas pipeline

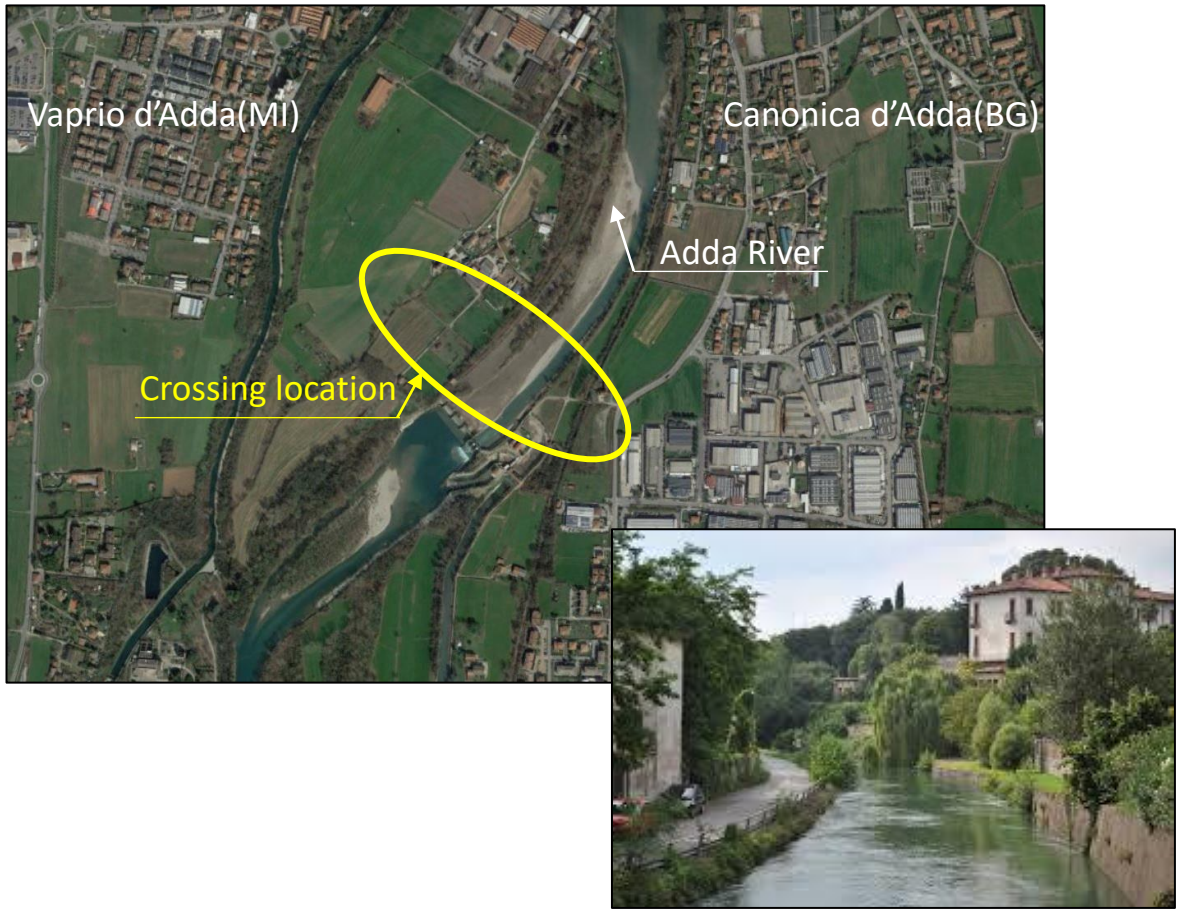
OWNER: Snam Rete Gas S.p.A.

CONTRACTOR: Pizio S.p.A.

PIPELINE DATA:
Material: Steel pipe
Nominal diameter: ND = 8" (200mm)
Design pressure: DP = 12 bar

WORK: Underground crossing of Adda River and Parco dell'Adda Nord area

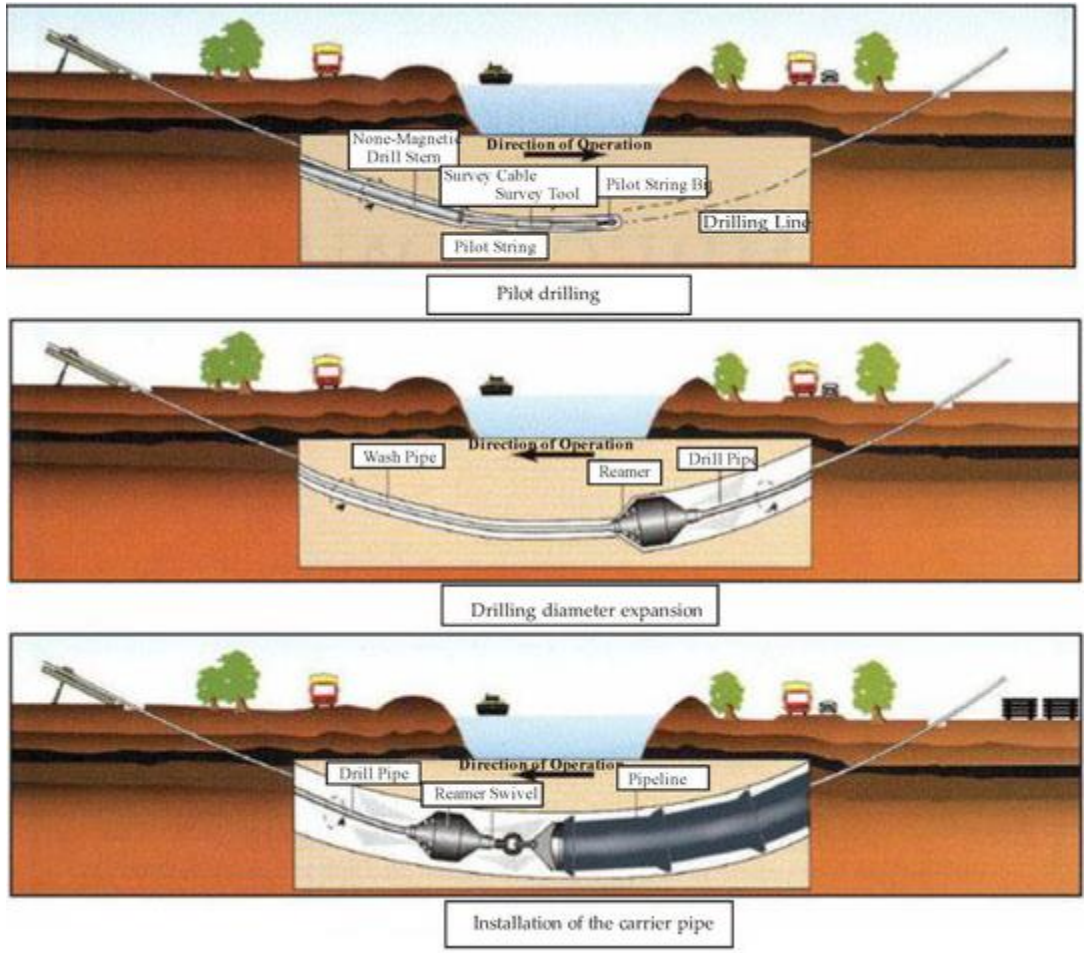
LOCATION: Vaprio d'Adda (MI) - Canonica d'Adda (BG)



FIRST APPROACH - HDD

DESIGN PHASE

Horizontal Directional Drilling (HDD) selected technology to install 8” gas pipeline directly



FIRST APPROACH - HDD

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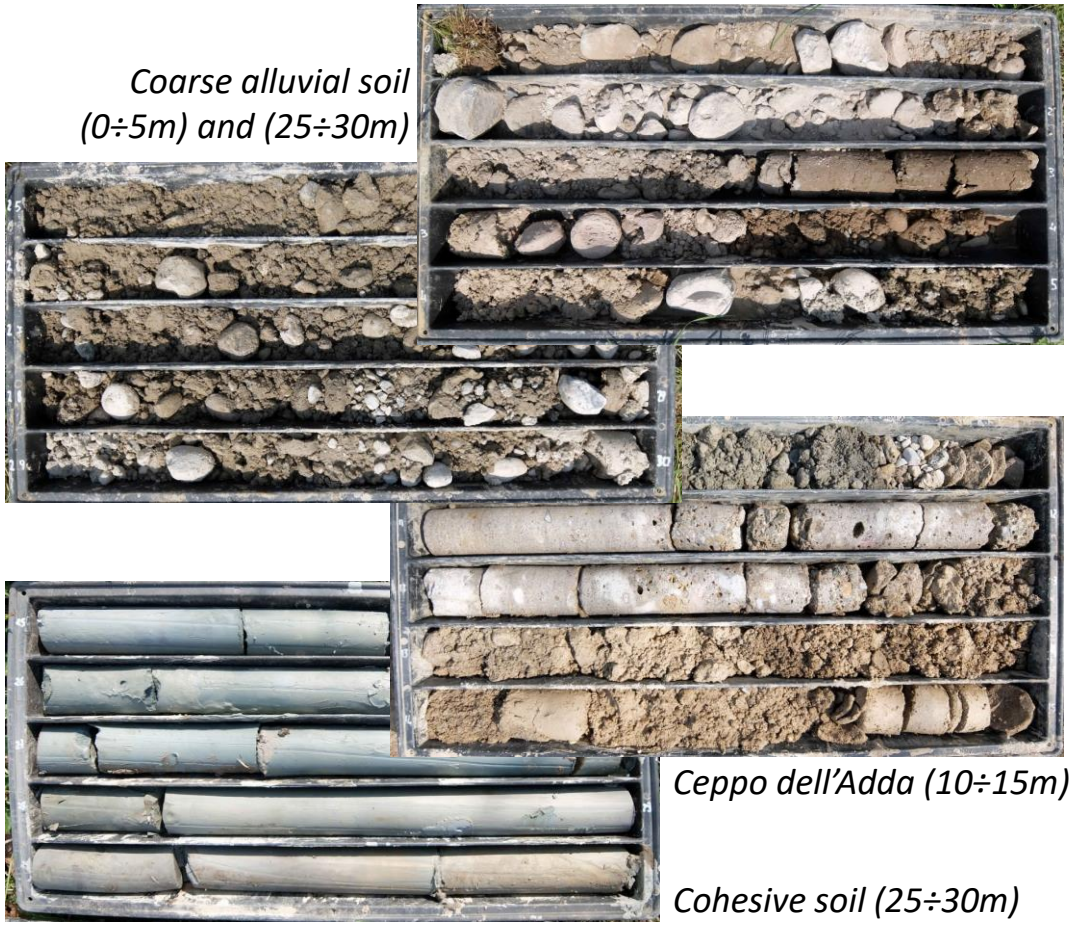
Horizontal Directional Drilling (HDD) selected technology to install 8” gas pipeline directly

WORK EXECUTION

Unexpectedly difficult geological conditions

- very **heterogeneous** soils: coarse **alluvial** soils, cemented **conglomerate** layers and **cohesive** soils



Coarse alluvial soil (0÷5m) and (25÷30m)

Ceppo dell’Adda (10÷15m)

Cohesive soil (25÷30m)

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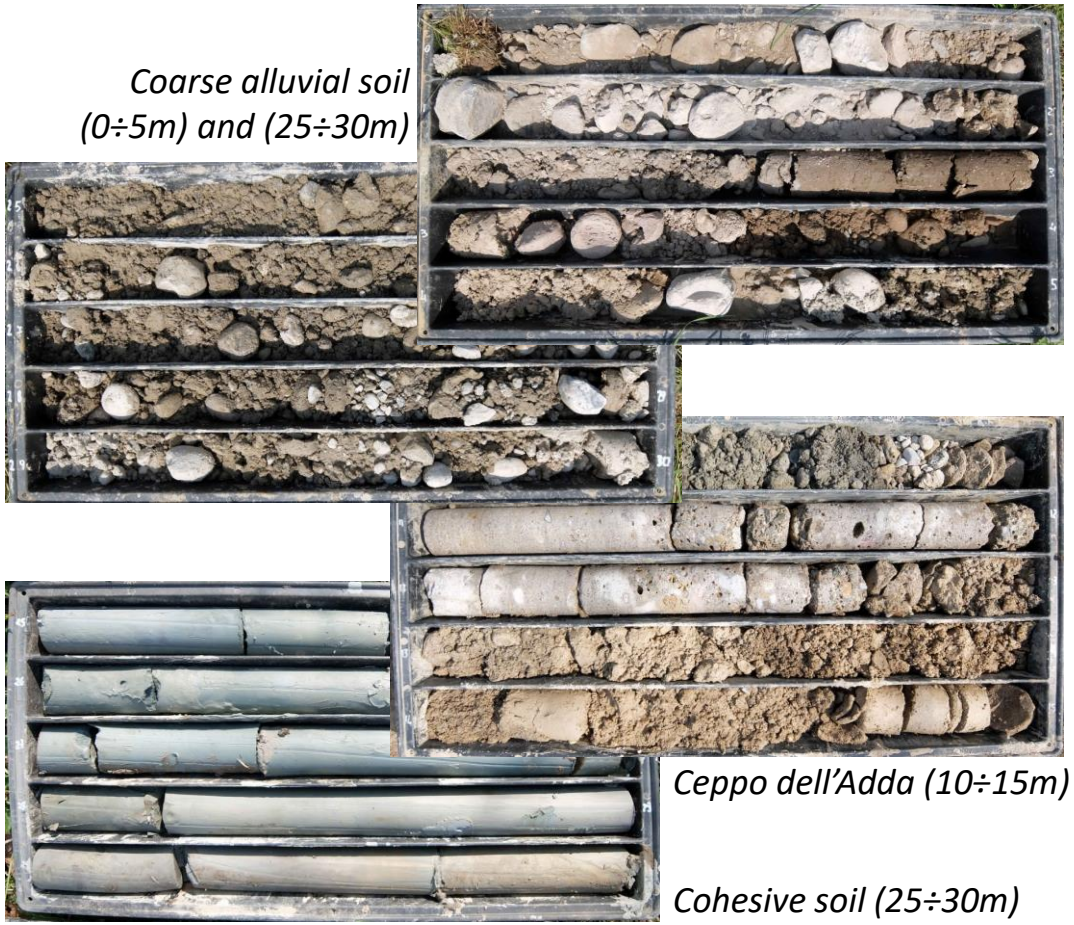
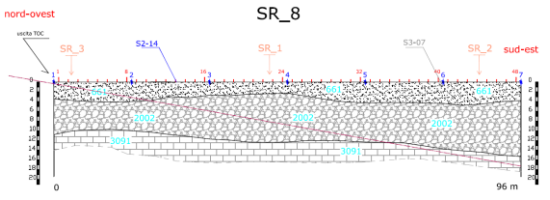
⇨ **Execution by HDD could not be completed**

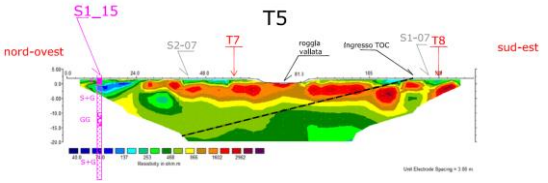


INVESTIGATION OF ALTERNATIVE TECHNOLOGIES

ON SITE INVESTIGATIONS

Execution of **additional geognostic** investigations which revealed **greater presence of loose soils** than previously expected





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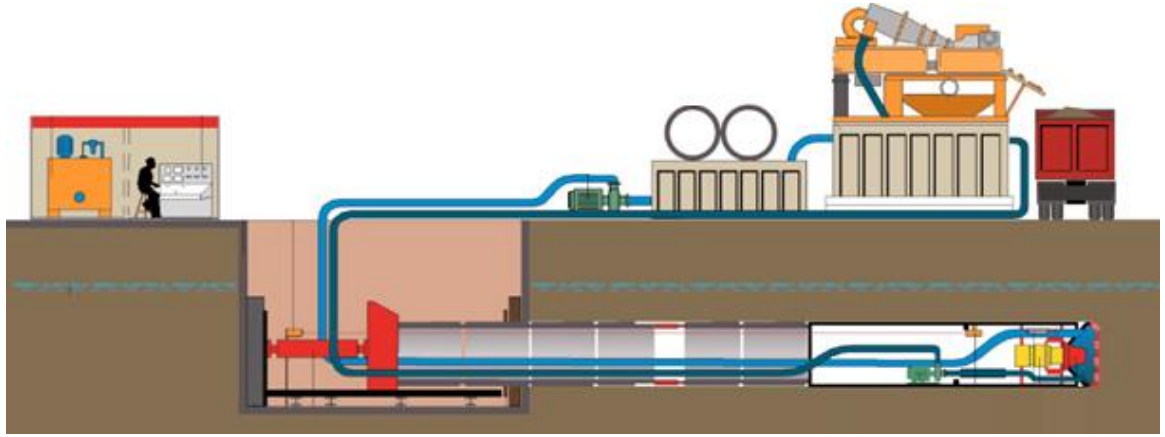
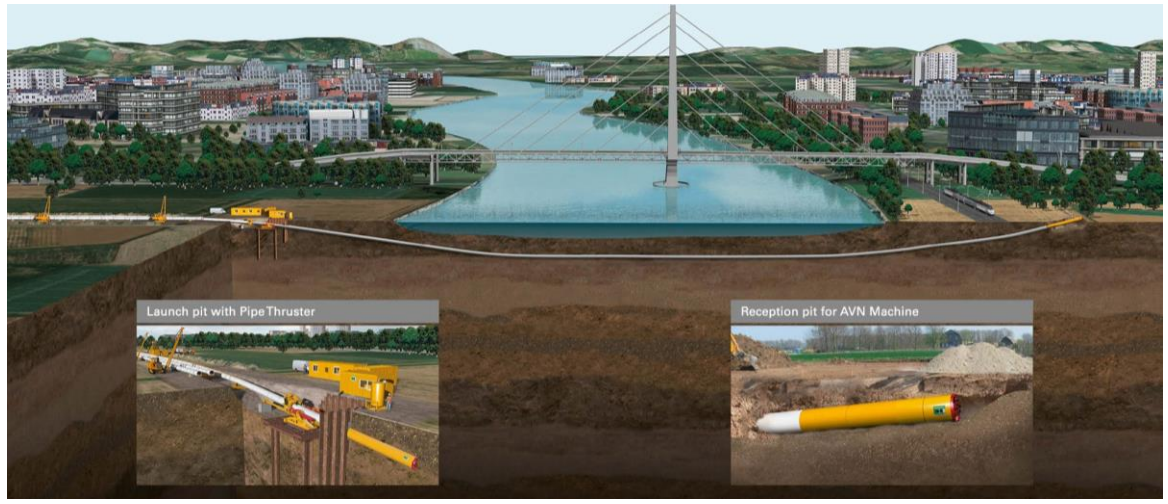


FEASIBILTY AND RISK ASSESSMENTS

Evaluation of applicability and performance of alternative technologies:

- **microtunnelling** (concrete casing pipes)
- **direct pipe** (steel casing pipe)



INVESTIGATION OF ALTERNATIVE TECHNOLOGIES

DIRECT PIPE	MICROTUNNELLING
Closed shield, full face excavation, **slurry support**	**Closed shield**, full face excavation, **slurry support**
Steerable and **remotely controlled** machine	Steerable and **remotely controlled** machine
Permanent **borehole support**	Permanent **borehole support**

INVESTIGATION OF ALTERNATIVE TECHNOLOGIES

DIRECT PIPE	MICROTUNNELLING
= **Closed shield**, full face excavation, **slurry support**	= **Closed shield**, full face excavation, **slurry support**
= Steerable and **remotely controlled** machine	= Steerable and **remotely controlled** machine
= Permanent **borehole support**	= Permanent **borehole support**
+ **Continuous** advancement	- **Interruption** to connect pipes after each jacking cycle
+ **Shallow** starting **shaft** (less groundwater interference)	- **Deep** starting **shaft**

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− Narrower drilling capability range	+ Wider drilling capability range (difficult soils with rock and boulders)

FINAL CHOICE - DIRECT PIPE

DIRECT PIPE	MICROTUNNELLING
= **Closed shield**, full face excavation, **slurry support**	= **Closed shield**, full face excavation, **slurry support**
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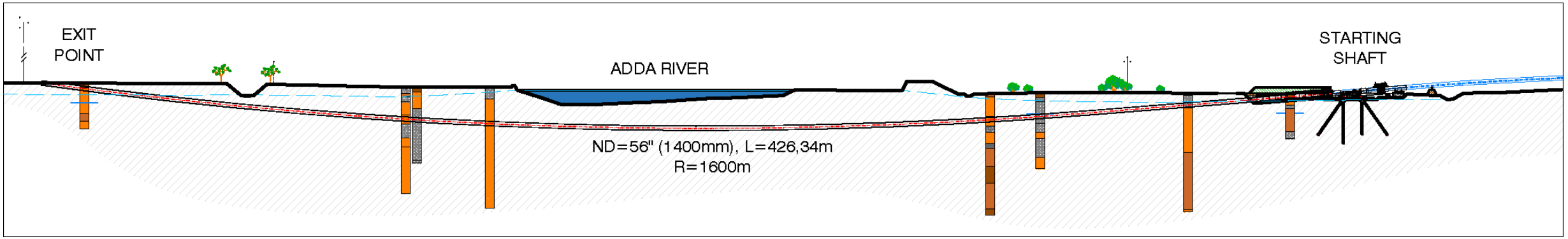
DIRECT PIPE CROSSING DESIGN



DESCRIPTION	DATA
CROSSING LENGTH	426,34 m
CROSSING PROFILE	STRAIGHT SECTION (start): L = 98,37m - p = -7% CURVILINEAR SECTION: L = 327,97m - Rv = 1600 m
PIPE MATERIAL	STEEL + POLYURETHANE COATING
PIPE DIAMETER	**ND = 1400mm (56'')** Thickness = 21,2mm

SOIL CONDITIONS ALONG THE DRIVE

- Coarse gravel with pebbles
- Coarse gravel with pebbles and presence of boulders
- Cemented layers of the *Ceppo dell'Adda* formation
- Coarse sand with gravel
- Groundwater depth: 1,5÷2,5m below ground elevation

GETTING READY FOR THE JOB

A CHALLENGING SITUATION

- Complex, highly heterogeneous, soil conditions
- Shallow groundwater depth
- High ground permeability

AD HOC SOLUTIONS

- **Cutterhead** design: rock type specifically fabricated
- Special attention to **drilling parameters**
- Optimization of starting shaft design

WORKING ON SITE

A SHALLOW STARTING SHAFT …

Minimizing interference with groundwater

- Concrete bottom slab at ground elevation
- **Concrete casing** to launch TBM and prevent drilling fluid losses (low coverage)

… AND A LOW PIPELINE LAUNCH WAY

- No. 2 approx. 215m long pipeline strings
- No. 16 **rollers** on **concrete pillars** (1-2,2m)

WORKING ON SITE

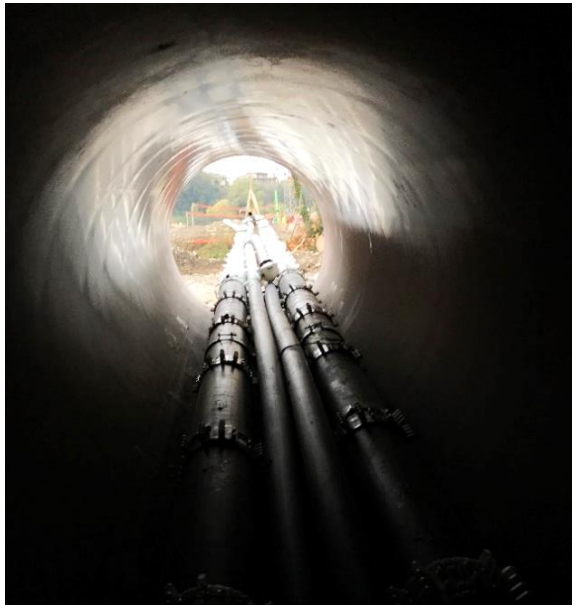
DIRECT PIPE INSTALLATION

EQUIPMENT	TYPE
MACHINE	AVN1200TC
CONTROL CABIN	M1427C
PIPE THRUSTER	HK750PT (7500 kN)
SEPARATION PLANT	Desander: BE425 + desilter Centrifuge: HK D46150F Flocculation: AFU 3000
MIXING PLANT	MAT SCW 14/25

WORKING ON SITE

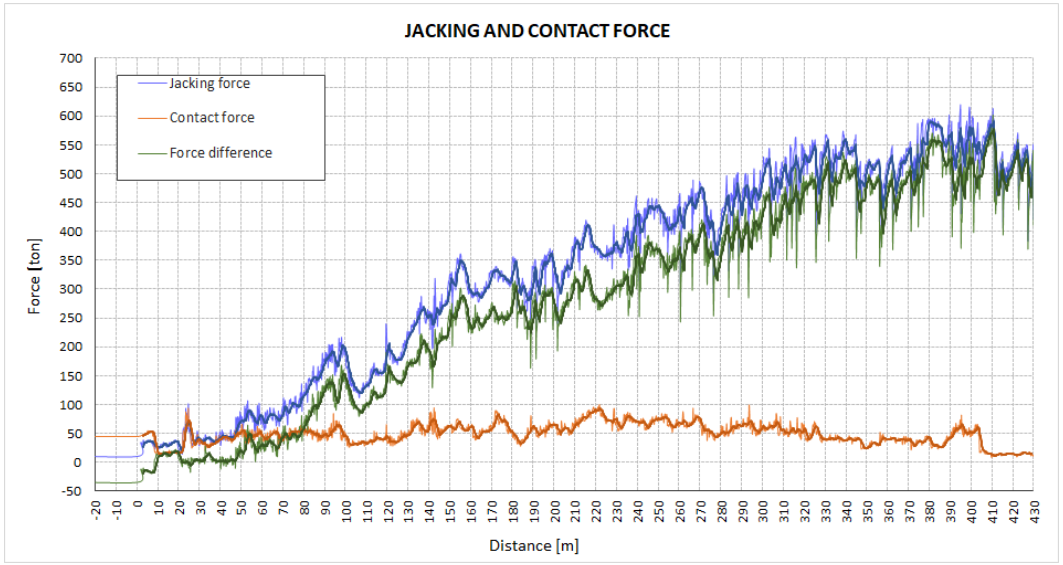
PIPELINE PULL-IN AND TUNNEL GROUTING

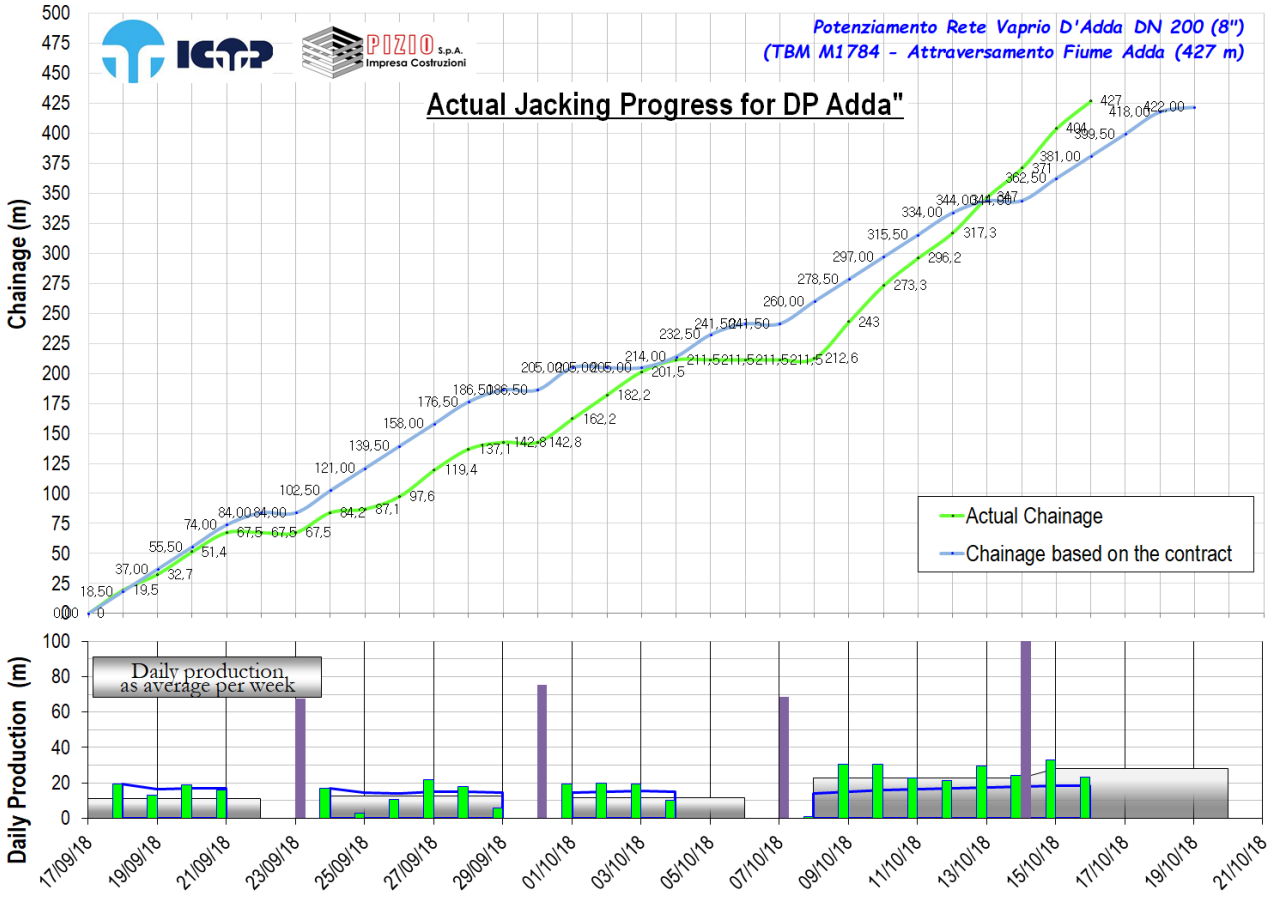
- Two 8'' pipes were pulled inside the 56'' casing pipe
- Annular space between the casing pipe and the two 8'' pipes was grouted with a **cement-bentonite mixture**



A FEW DATA

- Entire project duration: **90 days**
- Average production: **18.5 m/day** on single shift
- Peak production: **33 m/day** on single shift
- Jacking force: 420 tons av. / **620 tons max.**





ADDA RIVER – A CHALLENGING JOB

MAIN GOAL : "**Invisible** services"

MAJOR CHALLENGE: Choosing **best suited** no-dig technology

ALLIES: **Regulatory** Instruments

Lessons Learned

Thorough **Investigations**

Accurate **Assessment**

… zero risk solutions do not exist but experience helps!

THANK YOU FOR YOUR ATTENTION

"To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advance in science."

Albert Einstein