# Trans Alpine Pipeline
# Tagliamento river protection

COPEX 2018

TAL
transalpine pipeline

# TAL OVERVIEW

# TAL GROUP

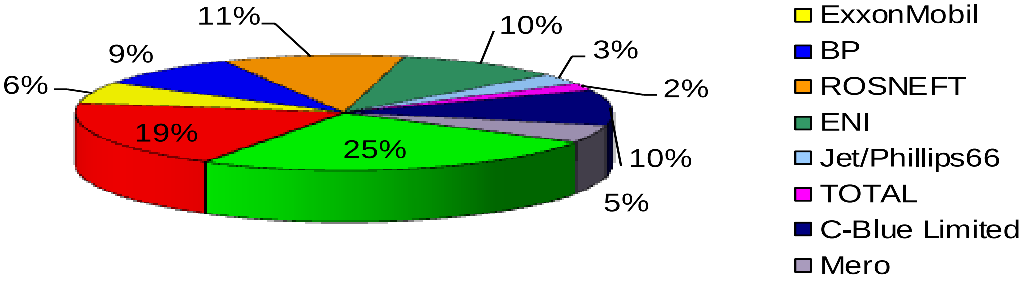
Deutsche Transalpine Oelleitung GmbH
München
**TAL D**

Transalpine Ölleitung in Österreich Ges.m.b.H.
Kienburg, Matrei in Osttirol
**TAL A**

Società Italiana per l'OleodottoTransalpino S.p.A.
San Dorligo della Valle, Trieste
**SIOT**

# TAL SHAREHOLDERS

| Shareholder | Shareholding in TAL (%) |
|---|---|
| OMV | 25 |
| SHELL | 19 |
| ROSNEFT | 11 |
| ENI | 10 |
| C-Blue Limited (Gunvor) | 10 |
| BP | 9 |
| ExxonMobil | 6 |
| Mero | 5 |
| Jet / Phillips66 | 3 |
| TOTAL | 2 |
| TAL Shareholders | 100 |



# TRANSALPINE PIPELINE

- Since **1967** the Transalpine Pipeline connects the Port of Trieste with central European countries, delivering crude oil to refineries in Austria, Germany and the Czech Republic in order to meet their energy demand

- **STRATEGIC ROLE** for the supply of energy:
  - 100% of Bavaria and Baden-Württemberg
  - 90% of Austria
  - 50% of the Czech Republic

- The pipeline starts from Trieste, runs through the Italian territory and, after crossing the Alps (where it exceeds the altitude of 1.500 m), continues its journey in Austria before reaching Ingolstadt where it is divided into two directions ending to the west near Karlsruhe and to the east by the plant of Neustadt, for a total length of **753** km.

# TAL GROUP

500 Vessels/y

8 Refineries

2 Million CM

10 Shareholders

TAL

4 Piers

50 Years

200 Employees

40 Million MT/y

**Naturally Innovative and Multicultural**

# MARINE TERMINAL - TRIESTE

- First oil terminal of the Mediterranean
- Port concession: 50 years
- Area: 48.519 m²
- Number of berths: 4 (2 finger piers)

# TANKFARM TRIESTE

| | |
|---|---|
| Tankfarm area: | 1.240.000 m² |
| Number of tanks: | 32 |
| Storage capacity: | 2.030.00 m³ |

# PIPELINE ROUTE

# TANKFARM INGOLSTADT

| | |
|---|---|
| Tankfarm area: | 207.000 m² |
| Number of tanks: | 7 |
| Storage capacity: | 350.000 m³ |

## Environment

Tagliamento river in the mid-upper section of its course is the only European river that keeps the natural morphological aspects unchanged, being the last morphologically intact river corridor of the Alps; it's a reference ecosystem for all Alpine rivers (ZSC – "zona speciale di conservazione")

*Reference*:

- European Natura 2000 network for biodiversity protection
- ZSC IT3320015 Valle del medio Tagliamento

http://www.regione.fvg.it/rafvg/cms/RAFVG/ambiente-territorio/tutela-ambiente-gestione-risorse-naturali/FOGLIA203/FOGLIA65/

## Findings - January 2013

- TAL telecommunication cable discovered
- repellent excavation

Solution:
- A small repellent in boulders is built upstream of the pipeline
- Carter built to protect the telecom cable

## Findings - July 2013

- Cable duct with carter discovered over the head of the repellent

Solution:

- The small repellent is prolonged in boulders upstream of the pipe where cable was exposed

## Findings – April 2014

- Exposed pipe top section (about 30cm)

Solution:
- Urgent intervention of protection in boulders and re-covering needed, definitive resolutive action required; start of feasibility study

***Target***
- securing the pipeline by the river crossing, exposed and subjected to erosion

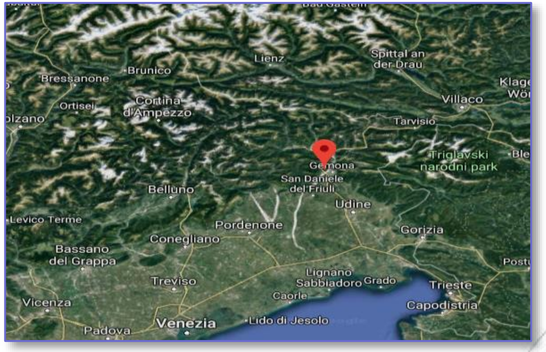
***Methods***
- Analysis of the river bed evolution, future trends
- Identification of possible interventions, comparison

***Intervention***
- Implementation of the selected solution
- Analysis of the first evolutionary trends following the intervention

# Methods - Analysis of the river bed evolution, future trends

*Morphological evolution of Tagliamento river*

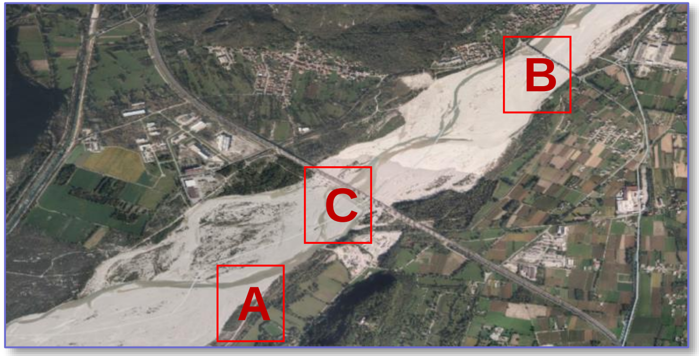
- Until end XIX century: overall stability, minimal interventions along the river
- Between XIX and XX century: embankment of the river without particular effects on the gravels plane
- First half of the XX century: transversal works and hydraulic-forest arrangements; shrinking/engraving process begins
- Years '50 - '80: further works of defense and hydraulic-forest arrangement and above all significant excavations in the riverbed for the building sector; intense changes in the profile of the riverbed
- ‘90s - today: reduction in sediment withdrawals, evolutionary inversion characterized by a general over-flooding tendency

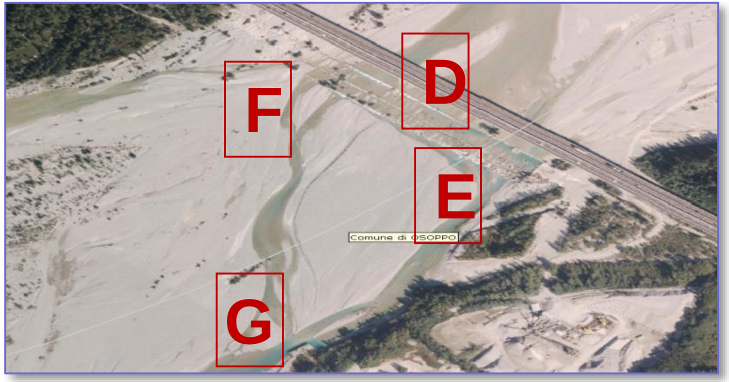



## Methods - Analysis of the river bed evolution, future trends

*Works realized in the stretch of interest*

A) Embankment on the left bank
B) Road crossing (Braulins bridge)
C) Motorway crossing (A23)
D) Stabilization threshold
E) Dissipation basin
F) Gabion
G) Repellents



# Methods - Analysis of the river bed evolution, future trends

*Effect of the motorway bridge upstream - general scour*

- "clear-water" erosion in the contracted section (without movement of material at the bottom) where water speed greater than the critical water speed
- "live-bed" erosion in the contracted section (with movement of material at the bottom) where water speed smaller than the critical water speed

The analysis carried out show that general erosion is "live bed" type and is calculated 0.86 m

*Critical speed*

$$v_c = k_u {y_1}^{1/6} {D_{50}}^{1/3}$$

| | |
|---|---|
| $k_u$ | 6.28 (International System) |
| $D_{50}$ | 50% average flowing particle size |
| $y_1$ | average depth |

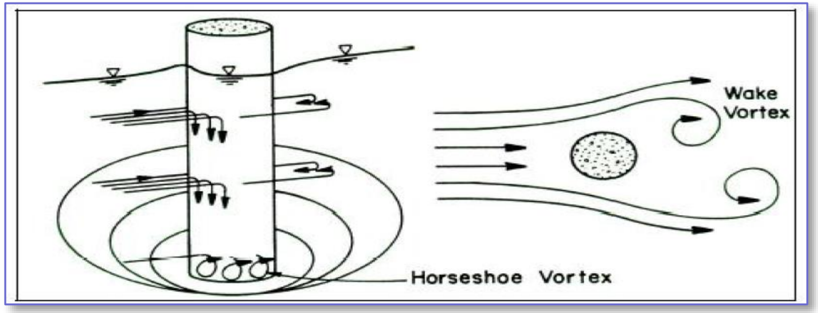
# Methods - Analysis of the river bed evolution, future trends

*Effect of the motorway bridge upstream - bridge scour*

Effect of local erosion, due to the presence of bridge piles: from the analysis and calculations, the local erosion at the pile is about 4 m, such as to expose the foundation plinths.

In this case the HEC-18 procedure provides for the separate calculation of the erosion components due to pile and plinth.

The local erosion value calculated in this way is equal to 5.6m: adding this to the generalized scour, the total erosion can be estimated about 6.5m (bridge scour prevailing).




$$\frac{y_s}{y_1} = 2.0 \cdot K_1 K_2 K_3 K_4 \left(\frac{a}{y_1}\right)^{0.65} Fr_1^{0.43}$$

| | |
|---|---|
| $y_s$ | erosion |
| $y_1$ | average upstream depth |
| a | pile width |
| $K_1$ | pile shape correction factor |
| $K_2$ | incidence angle correction factor |
| $K_3$ | riverbed shape correction factor |
| $K_4$ | armoring correction |
| $Fr_1$ | upstream Froude number |

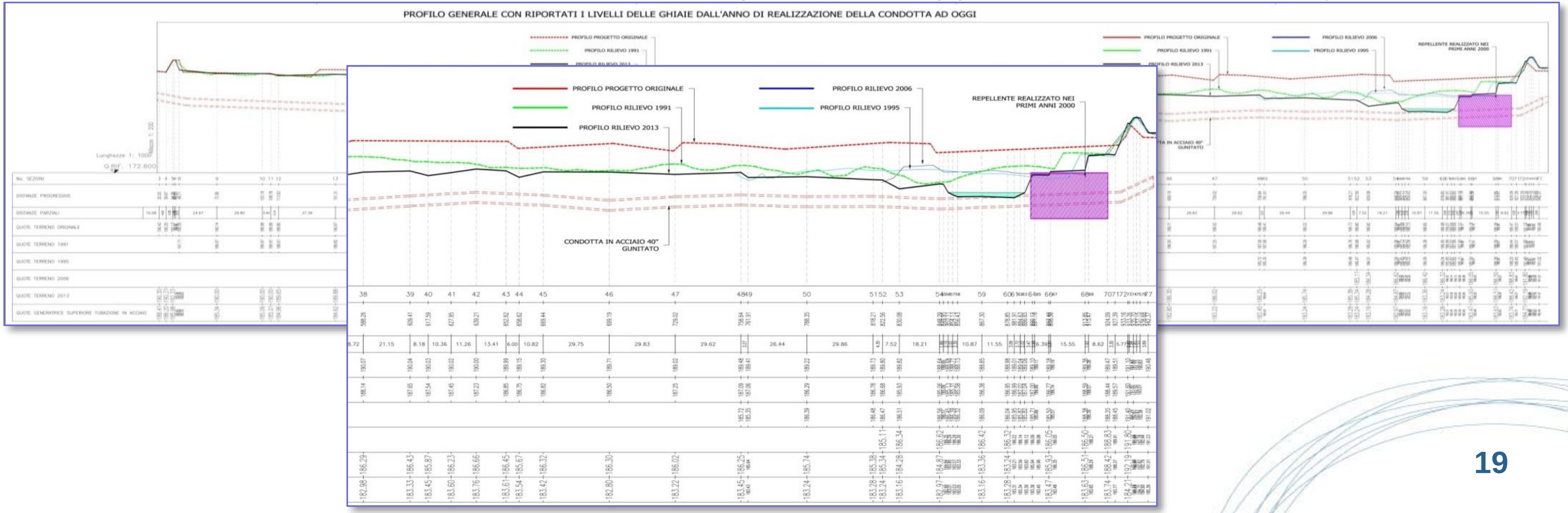
## Methods - Analysis of the river bed evolution, future trends

*Effect of the motorway bridge upstream – flow deviation*

Another problem generated by the bridge and the cross built subsequent years: not being perpendicular to the flow direction, the vein was shifted to the left side, aggravating erosion that side

# Methods - Analysis of the river bed evolution, future trends

Influence of the realized works -
Evolution of the cross section of the riverbed in correspondence of the pipeline from construction to today



## Methods - Analysis of the river bed evolution, future trends

Influence of the realized works -
Evolution of the cross section of the riverbed in correspondence of the pipeline from construction to today

# Methods - Analysis of the river bed evolution, future trends

Situation before the intervention

## Methods - Identification of possible interventions, comparison

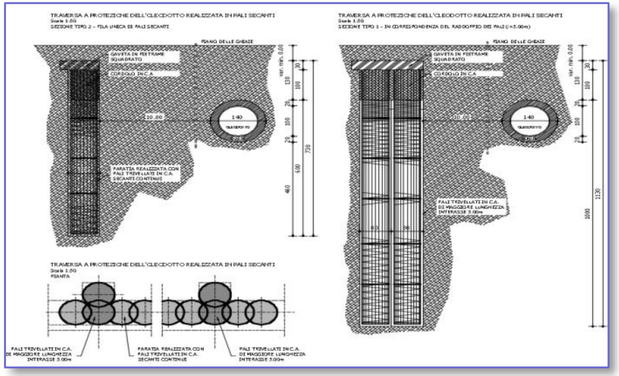
*Solutions for the main target of TAL:  restoring the adequate pipe coverage*

1. Restoration of the previous watercourse quota
   - Creation of a cross beam downstream of the crossing
   - Improvement of the dissipation dike downstream the motorway bridge crossing
2. Pipe protection
   - Creation of a box protection around the pipe
3. Moving the pipeline away
   - Relocation of the pipeline upstream of the motorway bridge
   - Deepening of the piping

# Methods - Identification of possible interventions, comparison

Restoration of the previous watercourse quota - creation of a cross beam downstream of the crossing

| **PROS** | **CONS** |
|---|---|
| Certainty on the effectiveness of the intervention<br>No intervention on the piping<br>No interruption of service<br>Completely working inside the riverbed | Deviation of water during work<br>Gravel handling |
| Correction of the inclination of the transverse work<br>Elimination of excavation at the head of the brush<br>Benefit also for upstream structures<br>Invisibility of the work once buried<br>Replacement of upstream channels | Engraving of downstream channels<br>Over-flooding of the area<br>Interference with subalvous circulation |



## Methods - Identification of possible interventions, comparison

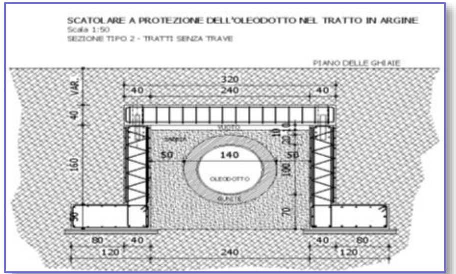
Restoration of the previous watercourse quota - improvement of the dissipation dike downstream the motorway bridge crossing

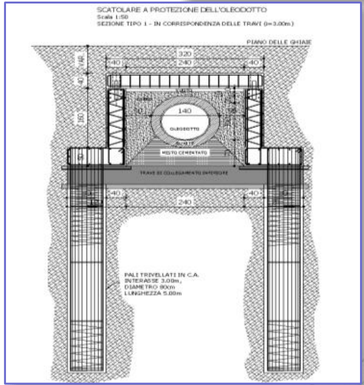
| PROS | CONS |
|---|---|
| Exploitation of existing works<br>No intervention on the piping<br>No interruption of service<br>Completely working inside the riverbed | Minimum coverage<br>Need for continuous monitoring<br>Deviation of water during work<br>Does not raise the current gravel plan (need for protection works of the parts already discovered) |
| Continuity with existing works<br>Correction of the inclination of the transverse work | Possibility of further lowering<br>Modification of an existing work of different properties<br>No benefits for existing facilities |

## Methods - Identification of possible interventions, comparison

Pipe protection - creation of a box protection around the pipe

| PROS | CONS |
| --- | --- |
| No intervention on the piping<br>No interruption of service<br>Completely working inside the riverbed | Deviation of water during work<br>Noteworthy excavation volumes<br>Possible siphoning<br>Significant costs and risks (operations in contact with the pipeline) |
| Benefit also for upstream facilities<br>Correction of the inclination of the transverse work<br>Elimination of excavation at the head of the brush<br>Invisibility of the work once buried<br>Replacement of upstream channels | Operations carried out near the pipeline<br>Engraving of downstream channels<br>Over-flooding of the area |

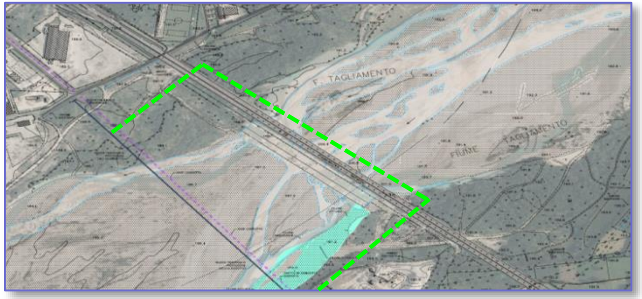


# Methods - Identification of possible interventions, comparison

Moving the pipeline away - relocation of the pipeline upstream of the motorway bridge

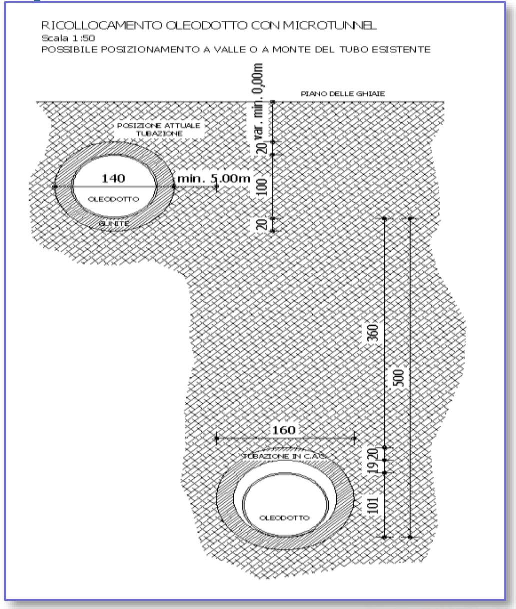
| PROS | CONS |
|---|---|
| Certainty on the effectiveness of the intervention<br>Exploitation of existing works<br>No interference with the riverbed once the work is finished<br>Maximum durability | Deviation of water during work<br>Occupation of private areas<br>Need for new easements of passage<br>Dismissal of the existing pipeline<br>Service interruption<br>Increasing pipeline length<br>Significant costs<br>Significant excavation volumes (existing pipe removal) |
| Invisibility of the work | No benefits for existing facilities<br>No correction of the inclination of the transverse work |



# Methods - Identification of possible interventions, comparison

Moving the pipeline away - deepening of the pipeline

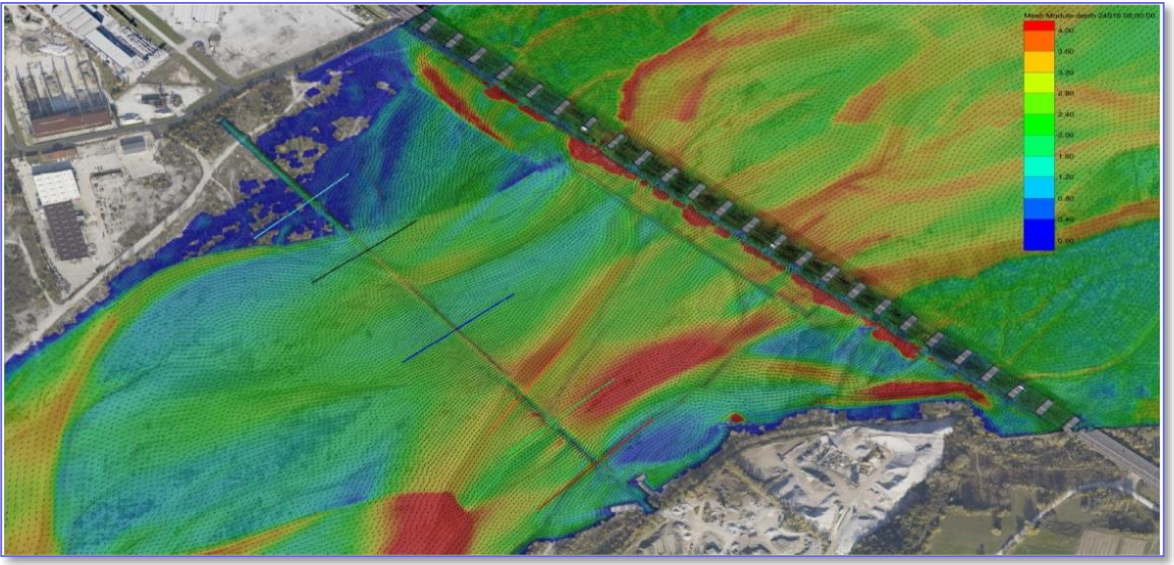
| PROS | CONS |
|---|---|
| No interference with the riverbed once the work is finished<br>Maximum durability | Occupation of private areas<br>Dismissal of the existing pipeline<br>Service interruption<br>Workings outside the riverbed (thrust pit)<br>Significant excavation volumes (existing pipe removal)<br>Significant costs and uncertainty on the timing |
| Invisibility of the work | No benefits for upstream facilities<br>No correction of the inclination of the transverse work |



# Intervention – Solution proposed: cross beam downstream of the crossing

*Hydraulic insights on the chosen solution*

Simulation of the effects of the transversal dam: graphical representation of the water rod at the end of an alluvial event: there is a general tendency to rebalance the riverbed.



The impact on groundwater circulation, given the power of the alluvial mattress, is not considered significant.

In the event that there is a deepening of the gravel plan downstream of the work, boulders have been arranged to protect it.

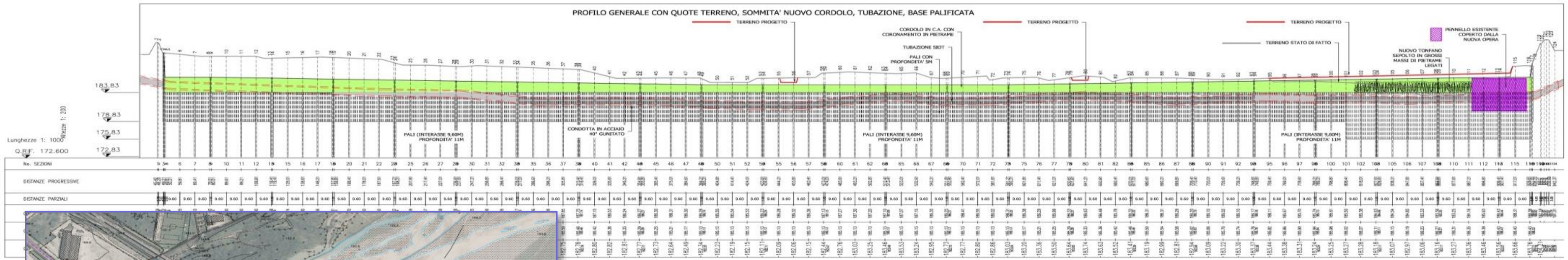
The adaptation of the river to the work will have to be verified over time and it will be necessary to provide for the possibility of intervening to recombine the discoveries in particular on the left bank.

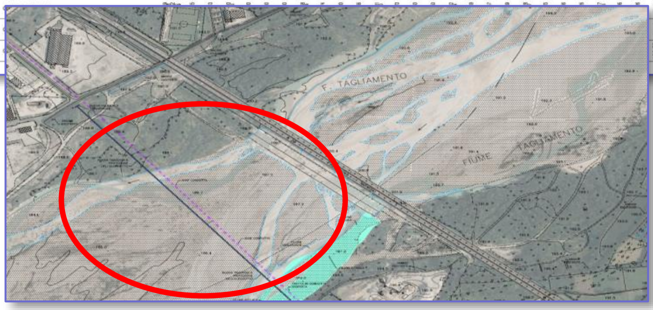
The calibration of the strands of soft should induce the flow to remain more central to the bed.

# Intervention – Solution proposed: cross beam downstream of the crossing

*Hydraulic insights on the chosen solution*

General stabilization of the riverbed and of existing works with maintenance on the basis of the pipeline and has a minimal impact both during construction and service time




The pipeline always has a suitable covering (minimum 80cm in the floodplain area, in the riverbed at least 130cm)

The diaphragm reaches min. -6.3m from the top of the crossbar and presents some triplets of poles that are headed to depth -12.3m every 9.6m

# Intervention – Solution proposed: cross beam downstream of the crossing

*Implementation of the selected solution*
Creation of the summit guide curb


# Intervention – Solution proposed: cross beam downstream of the crossing

*Analysis of the first evolutionary trends following the intervention*

Alluvial events followed by recombination of the work, with direct flow from the left side of the river bed:

- April 27, 2017
- May 7, 2017
- June 30, 2017
- September 10, 2017
- December 11, 2017

## Intervention – Solution proposed: cross beam downstream of the crossing

*Analysis of the first evolutionary trends following the intervention*

May 2017: following the intervention the strand of the left has moved away from the bank.

## Intervention – Solution proposed: cross beam downstream of the crossing

*Analysis of the first evolutionary trends following the intervention*

December 2017: even at full events the shore is protected, there was an excavation downstream of the crossbar as required by the modeling as a result of the floods occurred

## Intervention – Solution proposed: cross beam downstream of the crossing

*Realization planning*

- 3 years (2016-2018)
- period of suspension because of environmental requirements (nesting): March - July

*Actual data*

- start of works: September 2016
- end of works: December 2017

## Conclusion

- The realized work makes it possible to guarantee the covering of the upstream pipeline
- The soft strands have been shaped so that the stream keeps away from the banks
- The work is recombined and further protected by a buried brush that tends to divert the vein from the left bank towards the center in order to avoid deepening downstream of the crossbar at the point where the flow tends to concentrate
- The work, created in the context of one of the most "living" rivers in Europe, will be subject to the movements of the gravel and in particular to the tendency to digress towards the left bank, its cover will then be monitored and possibly integrated, but the upstream pipeline will always be kept properly buried

Thank you for your kind attention

Vielen Dank für die Aufmerksamkeit

Grazie per l‘attenzione

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www.tal-oil.com