

The logo for ICA (Instituto Registral y Catastral) is located in the top left corner. It consists of the letters 'ICA' in a bold, white, sans-serif font, centered within a dark blue rectangular box. This box is positioned over a larger teal-colored background that also features a vertical dark blue bar on the left side.

EMISOR ORIENTE TUNNEL

IMIA Meeting Merida

M.S. Carlos Rodolfo de la Mora Rodríguez
September 30, 2015

SCHEDULE

1.BACKGROUND

2.TECHNICAL ASPECTS

3.PROGRAM WORKS

4.RISKS

5.INSURANCE POLICY

CONDITIONS

01.

BACKGROUND

EMISOR ORIENTE TUNNEL

BACKGROUND



- Mexico City valley is a closed basin without natural water outlet.
- As a matter of fact, Mexico City was originally built in a small island of the *Texcoco* Lake.
- Starting in the XVIIth Century, large artificial dewatering works were undertaken to avoid recurrent flooding of the city (Auvinet, 2010).

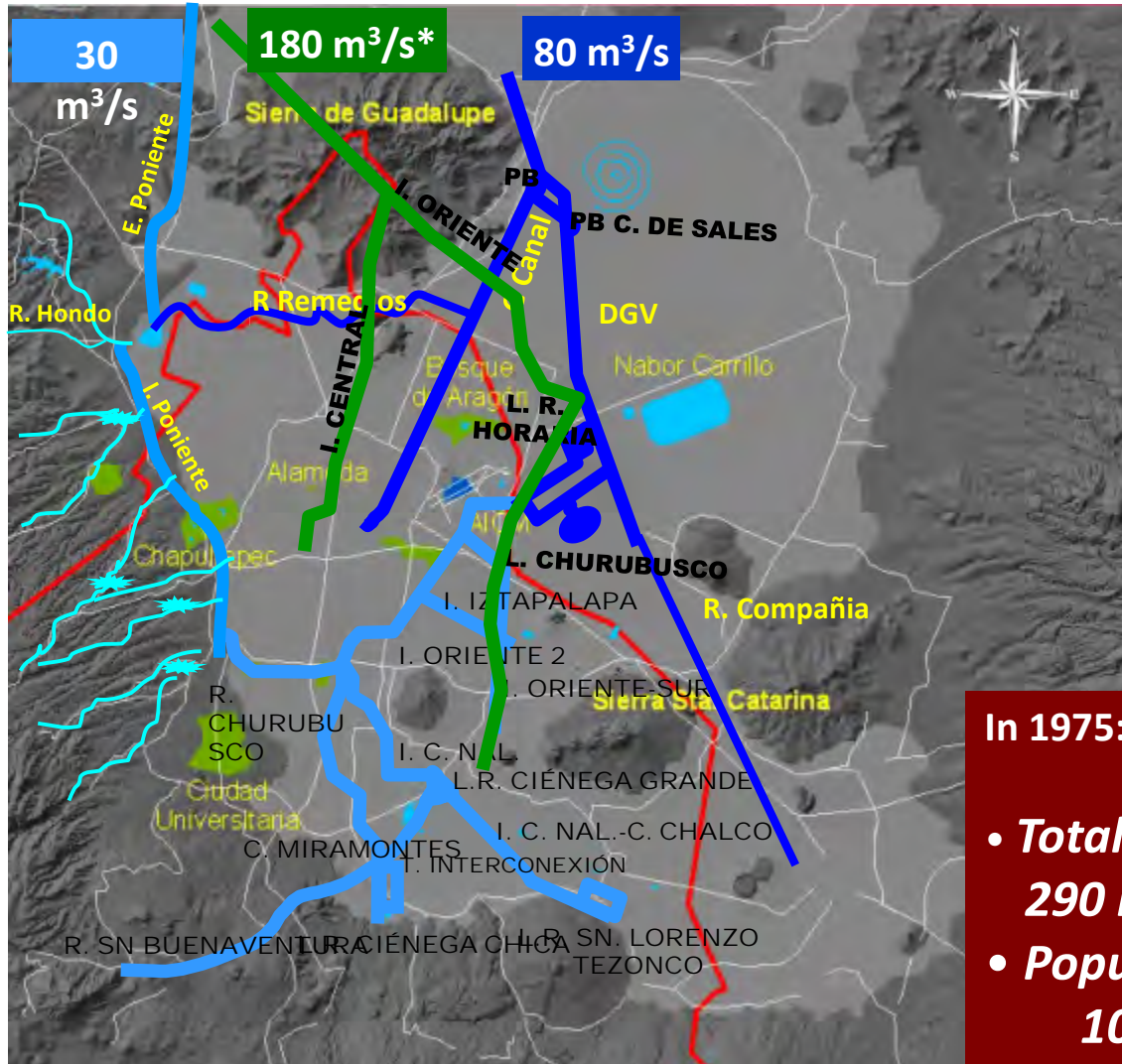
EMISOR ORIENTE TUNNEL BACKGROUND



Mexico City valley is a closed basin that was originally formed of five large lakes: Texcoco, Xaltocan, Zumpango, Xochimilco and Chalco.

EMISOR ORIENTE TUNNEL

OVERVIEW OF THE DRAINAGE SYSTEM, 1975

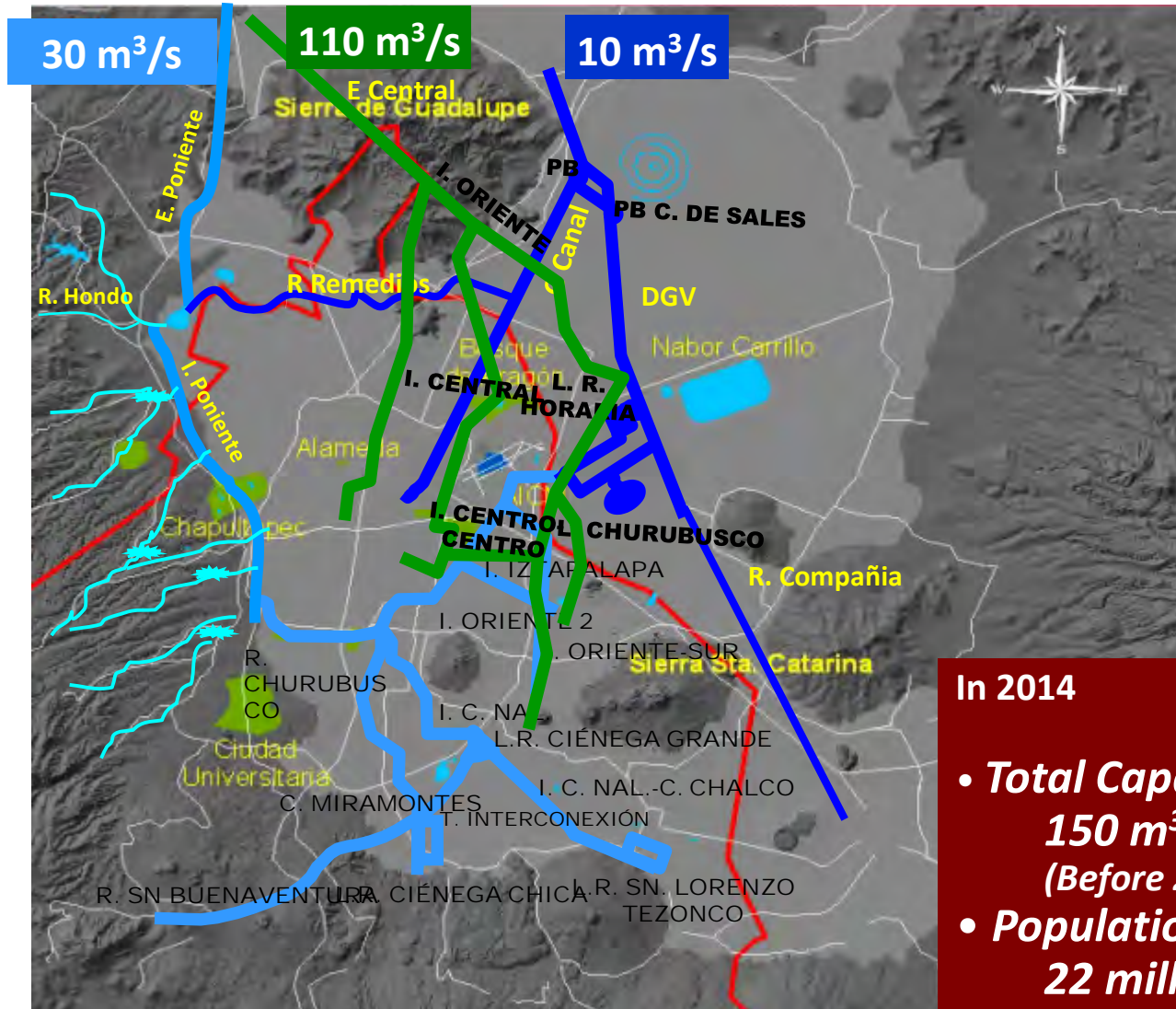


In 1975:

- **Total Capacity:**
290 m³/s
- **Population:**
10 million

EMISOR ORIENTE TUNNEL

OVERVIEW OF THE DRAINAGE SYSTEM, 2014



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OVERVIEW OF THE DRAINAGE SYSTEM



02.

TECHNICAL ASPECTS

EMISOR ORIENTE TUNNEL

CONSORTIUM CONSTRUCTOR

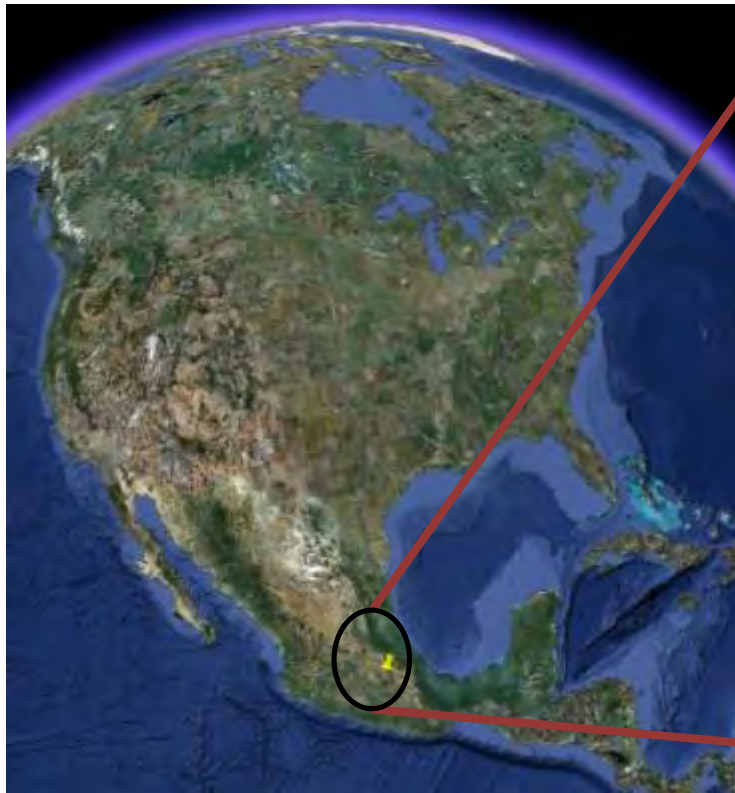


CESA
CE2V

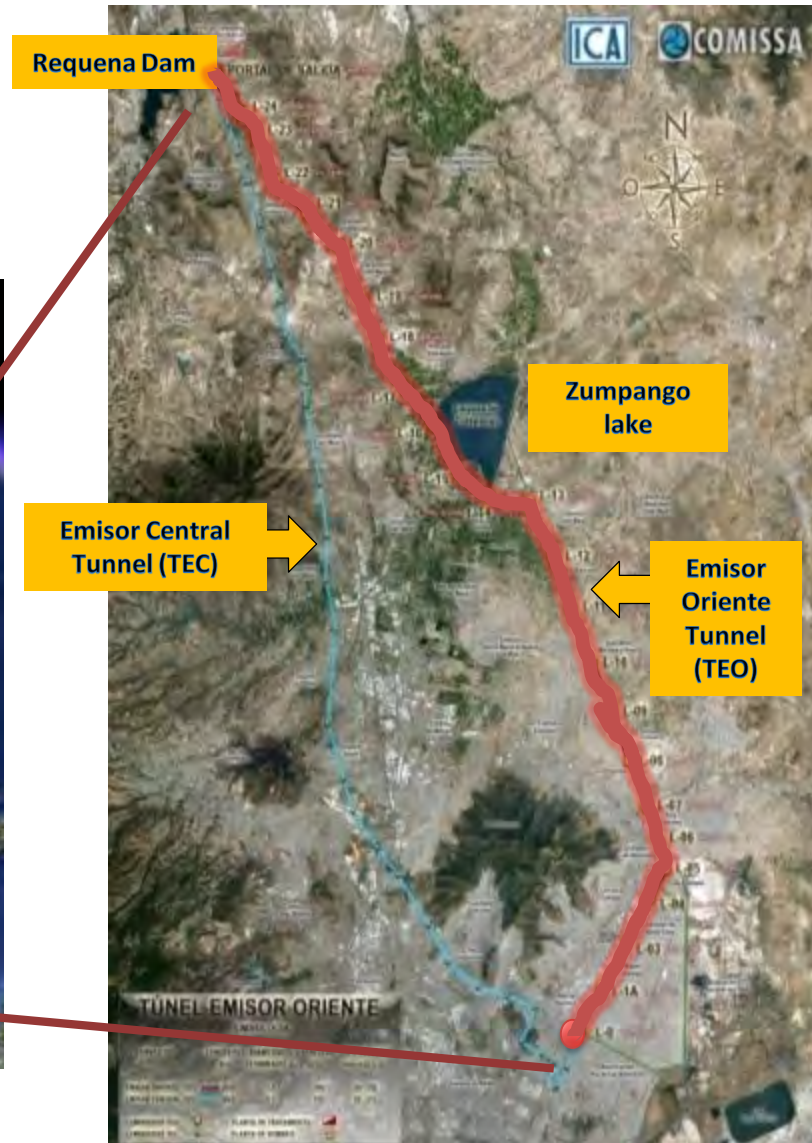
carso

INFRAESTRUCTURA Y CONSTRUCCION S.A.

EMISOR ORIENTE TUNNEL LOCATION



Northeastern of Mexico City



EMISOR ORIENTE TUNNEL PROJECT DESCRIPTION



GENERALS

-Client: **CONAGUA**

-Contractor: **COMISSA**

-TUNNEL

-Length: **62 km.**

-Excavation diameter: **8.70 m and 8.90 m**

-Diameter (internal): **7.00 m**

-Two liners (Concrete segments and final liner)

-Thickness: **35 and 40 cm**

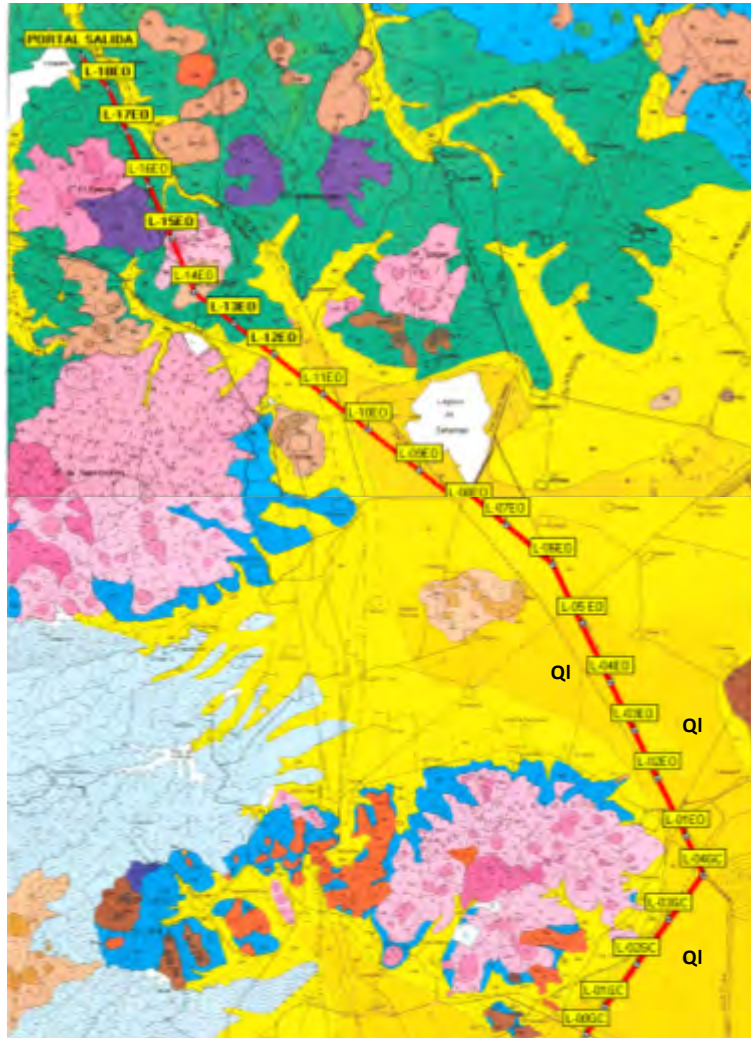
-SHAFTS

-Final diameter: **12 and 16 m**

- Depth: **variable from 28 to 160m**

-Total construction: **24 shafts**

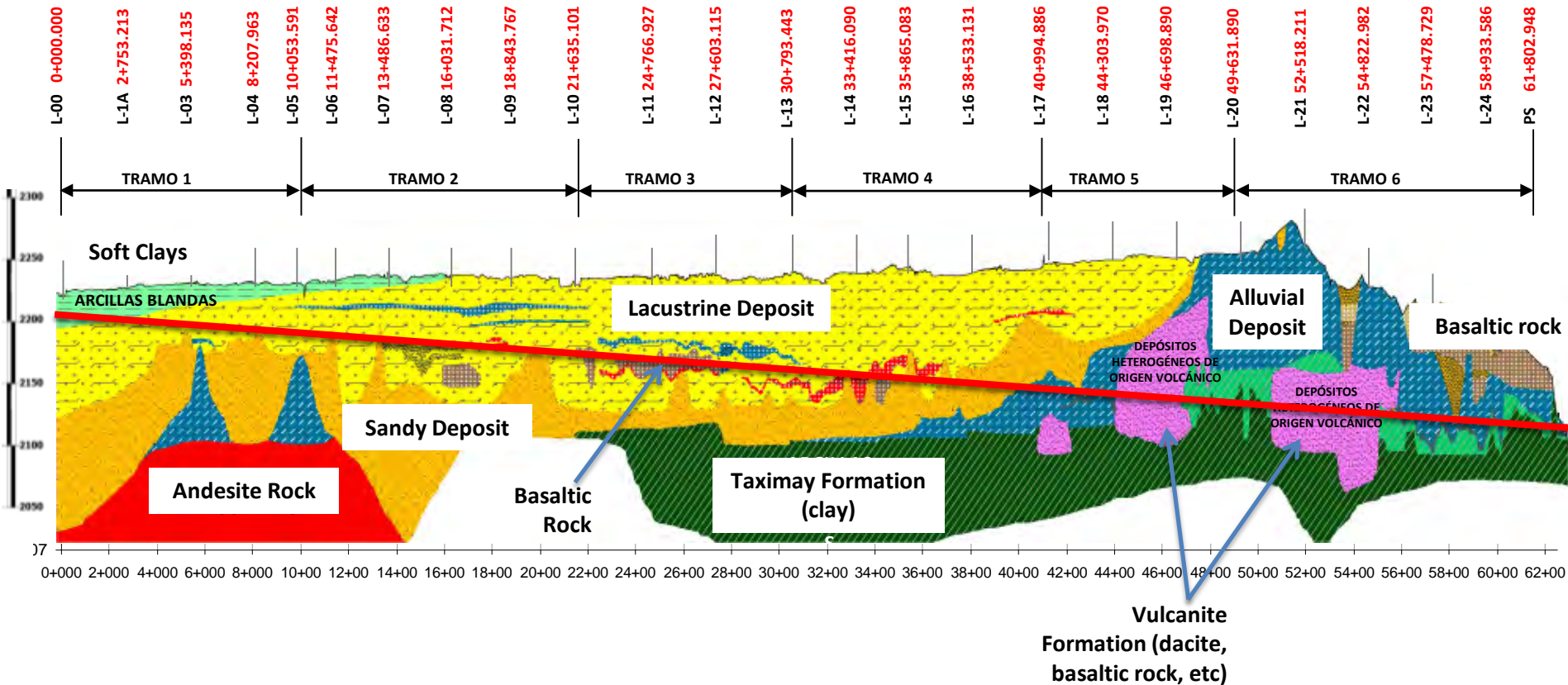
EMISOR ORIENTE TUNNEL GEOLOGICAL MAP



Nomenclature

Qal	Alluvial deposit
Ql	Lacustrine deposit
TpG2	Vulcanite, Dacite
ToV	Vulcanite, mainly
TpL	Taximay Formation (clays)

EMISOR ORIENTE TUNNEL GEOLOGICAL PROFILE



GEOTECHNICAL INFORMATION:

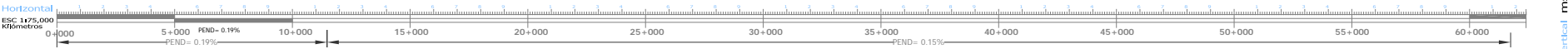
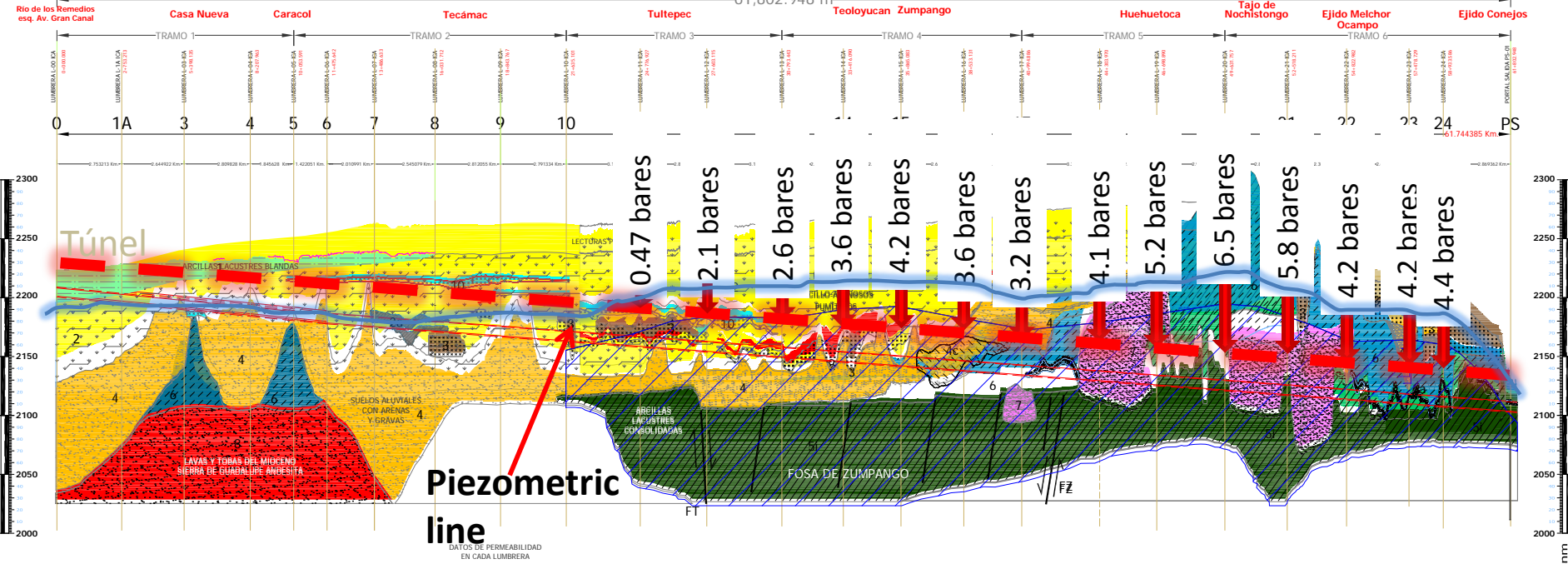
- 350 boreholes (aprox. 1@250m)

EMISOR ORIENTE TUNNEL HYDRAULIC CONDITIONS

SECCION GEOLÓGICA GENERAL

Sierra de Guadalupe

61,802.948 m



- Simbología**
- 1 ARCILLAS BLANDAS CON ELEVADO CONTENIDO DE AGUA (C) = 200-350% IMPERMEABLES
 - 2 DEPOSITOS LACUSTRES ARCILLO-ARENOSOS PUMITICOS BAJA CONTENIDO DE AGUA POCO PERMEABLES 2a ARENAS FLUVIALES Y DE PLAYA PUMITICAS Y BASALTICA
 - 3A x 3 BASALTOS PERMEABLES 3A= TOBA BASALTICA
 - 4 SUELOS Y ARENAS ALUVIALES CON GRAVAS, POCO PERMEABLE 4a= TOBA PUMITICA ALUVIAL 4b= RELLENIO ALUVIO-FLUVIAL 4c= COLUIONES O DEPOSITOS DE ESCOMBROS DE ORIGEN VOLCANICO
 - 5s ARCILLAS LACUSTRES CONSOLIDADAS DEL PLOCIENO MEDIO IMPERMEABLES 5s= TAXIMAY SUPERIOR 5s= TAXIMAY INFERIOR
 - 6 ABONICOS ALUVIALES SUELOS Y TOBAS PUMITICAS MEDIANAMENTE PERMEABLES 6a= CONGLOMERADOS Y FRAGMENTOS DE ROCA (DEPOSITOS FLUVIO-ALUVIALES)
 - 7 VII CONITAS HUEHUETOCA DEL PLOCIENO SUPERIOR LAVAS FRACTURADAS CONGLOMERADOS Y BRECHAS VOLCANICAS CON DEPOSITOS ALUVIALES, BAJA PERMEABILIDAD
 - 8 LAVAS ANDESITICAS SIERRA DE GUADALUPE
 - 9 CENIZAS VOLCANICAS, PERMEABLES EN PARTES ALTERADAS A ARCILLA.
 - 10 CAPAS DE POMEZ, PERMEABLES EN PARTES ALTERADAS A ARCILLA.

FZ: Falla Zumpango Norte: W-E
FT: Falla Tepozotlán: W-E

vertical msnm

EMISOR ORIENTE TUNNEL

SHAFT: DESIGN AND CONSTRUCTION

DEPENDING ON THE STRATIGRAPHIC CONDITIONS, THREE CONSTRUCTION PROCEDURES FOR THE CONSTRUCTION OF SHAFT ARE USED:

- **Diaphragm wall (total length)**
- **Mixed-procedure (Diaphragm wall + conventional construction procedure)**
- **Conventional construction procedure (total length)**

DIMENSIONS:

Two types of shaft:

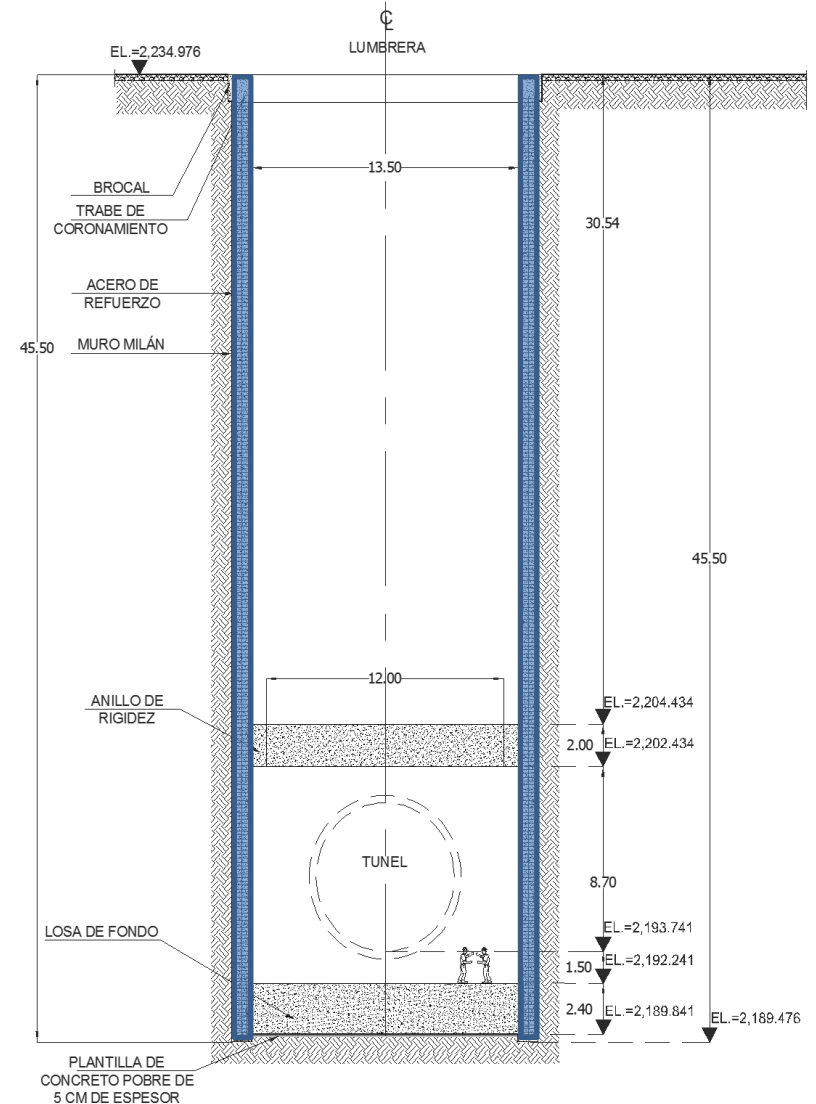
- 1) Mounting Shaft Internal diameter: 16.0m Shaft: L0, L05, L10, L13 and L20
- 2) Service Shaft Internal diameter: 12.0m

The distance between shafts is around 2.5km, and depth varies from 28 to 160m.

EMISOR ORIENTE TUNNEL

SHAFT: DESIGN AND CONSTRUCTION

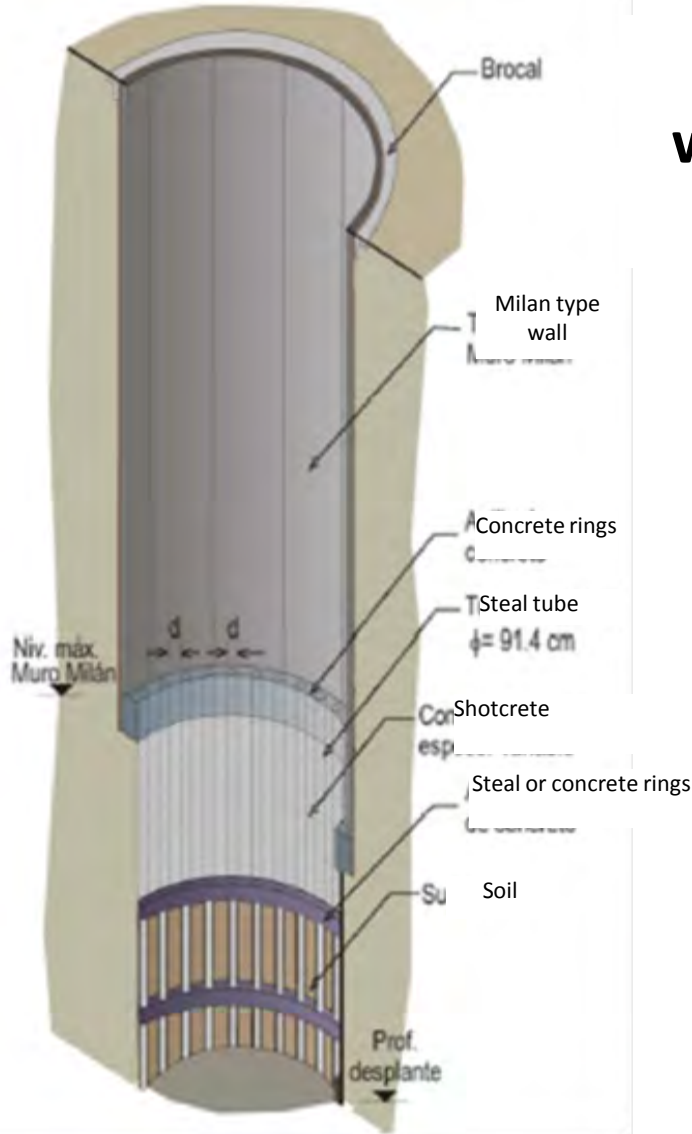
- Diaphragm wall (total length)



EMISOR ORIENTE TUNNEL

SHAFT: DESIGN AND CONSTRUCTION

- Mixed-procedure (Diaphragm wall + conventional construction procedure)



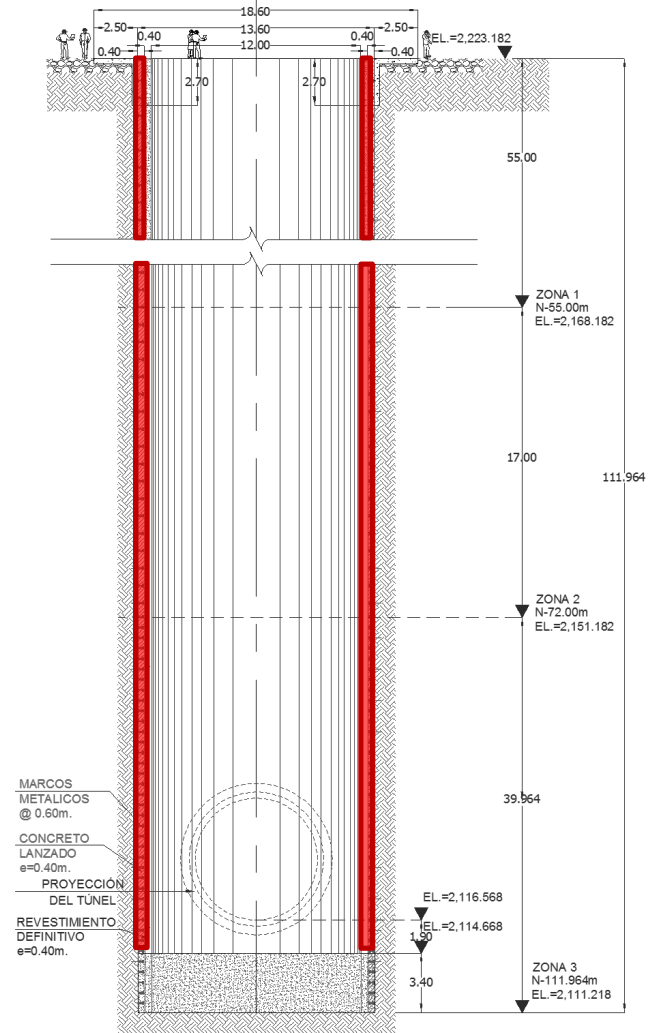
TEO

EMISOR ORIENTE TUNNEL

SHAFT: DESIGN AND CONSTRUCTION



- Conventional construction procedure (total length)



EMISOR ORIENTE TUNNEL

SHAFT: DESIGN AND CONSTRUCTION



For the deepest shafts we used a trench cutter in order to build diaphragm walls up to 120 m depth.

ie. Shaft L20: Excavation Diameter 22m, Length walls: 120m

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TUNNEL: EXCAVATION



S-497 | Emisor Oriente | Mexico

Escudo EPB

Diameter: 8.70m

Length: 10,000 m

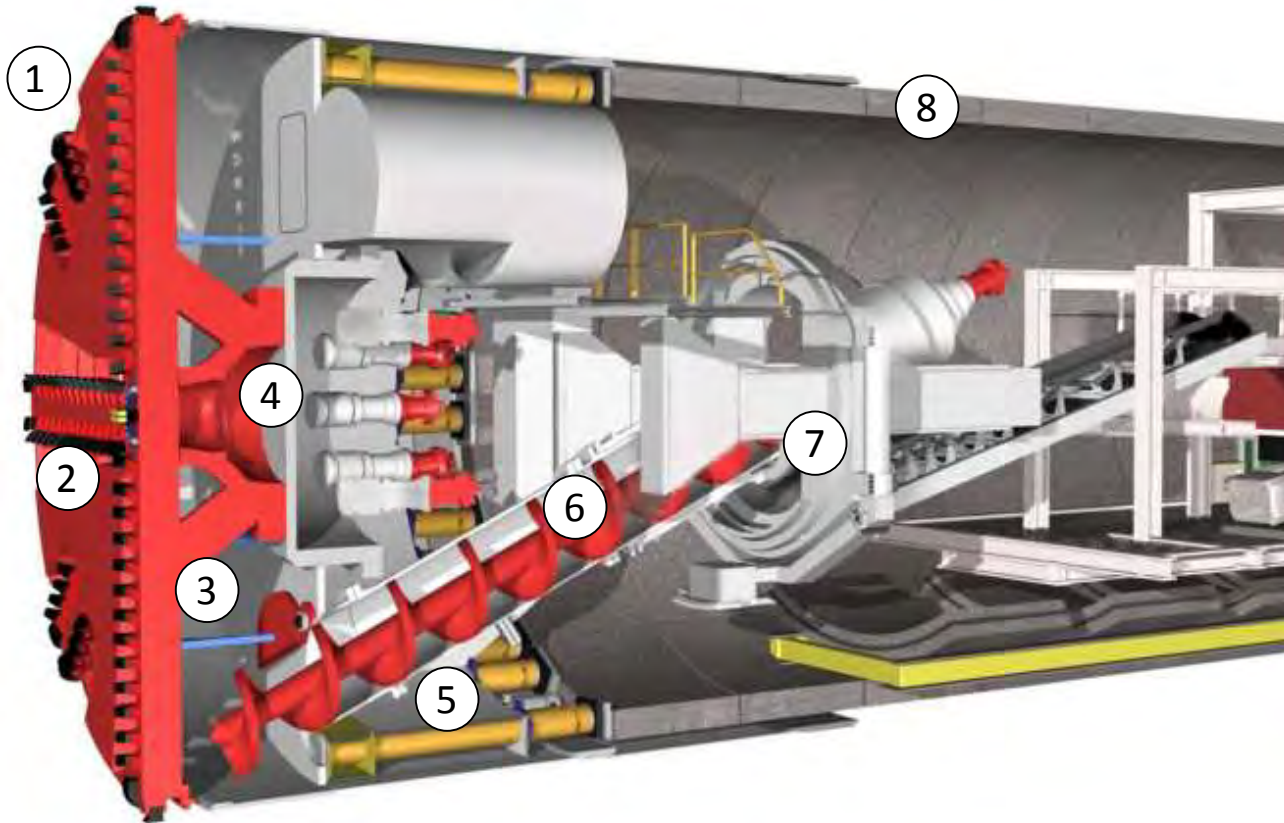
Usos: sewer drainage

Geology: soft clays / sandy clays,

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TUNNEL: EXCAVATION

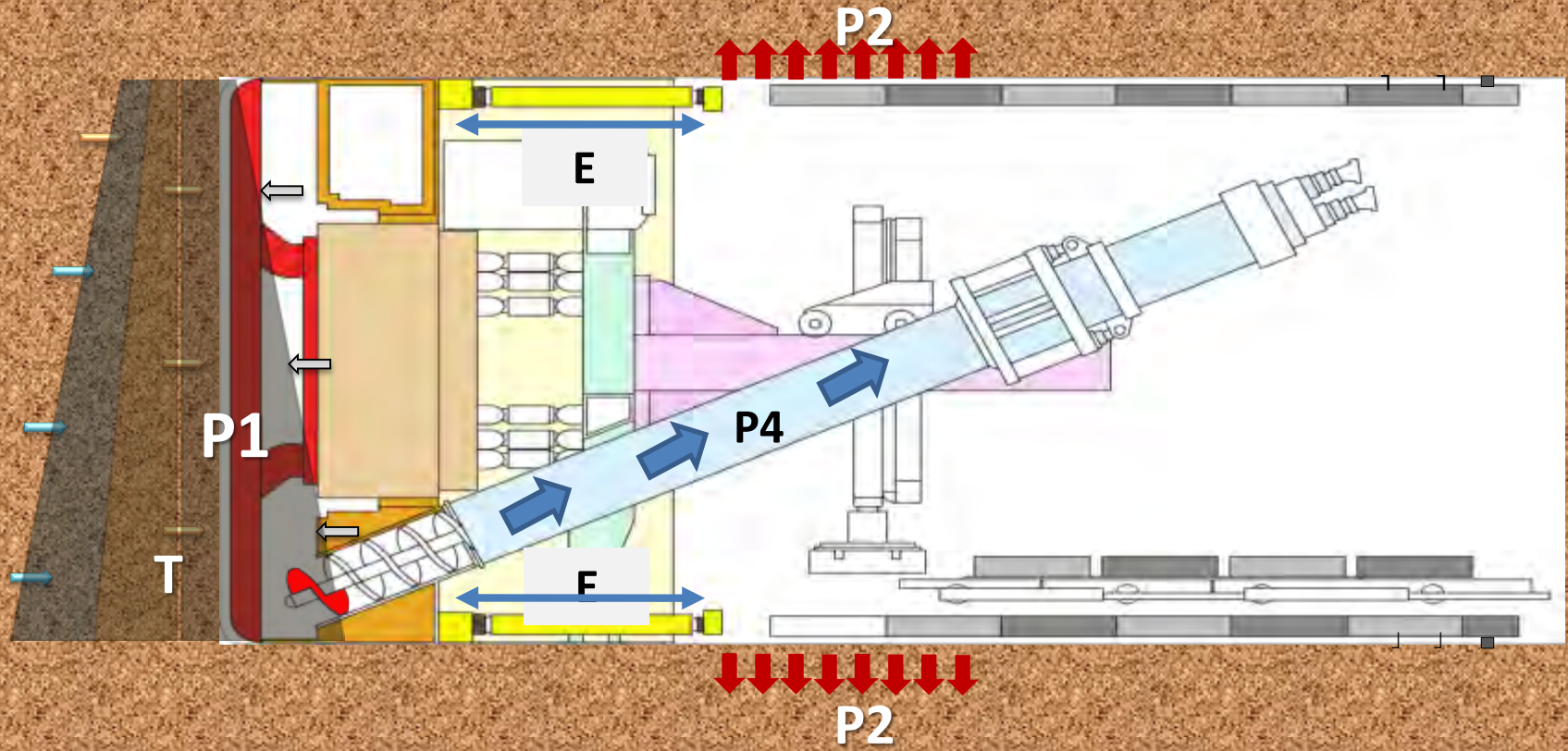
EPB (Earth Pressure Balance)



- 1. Excavation front
- 2. Cutterhead
- 3. Chamber
- 4. Wall
- 5. Jacks
- 6. Screw conveyor
- 7. Erector
- 8. Concret Segments

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TUNNEL: Excavation-Operation

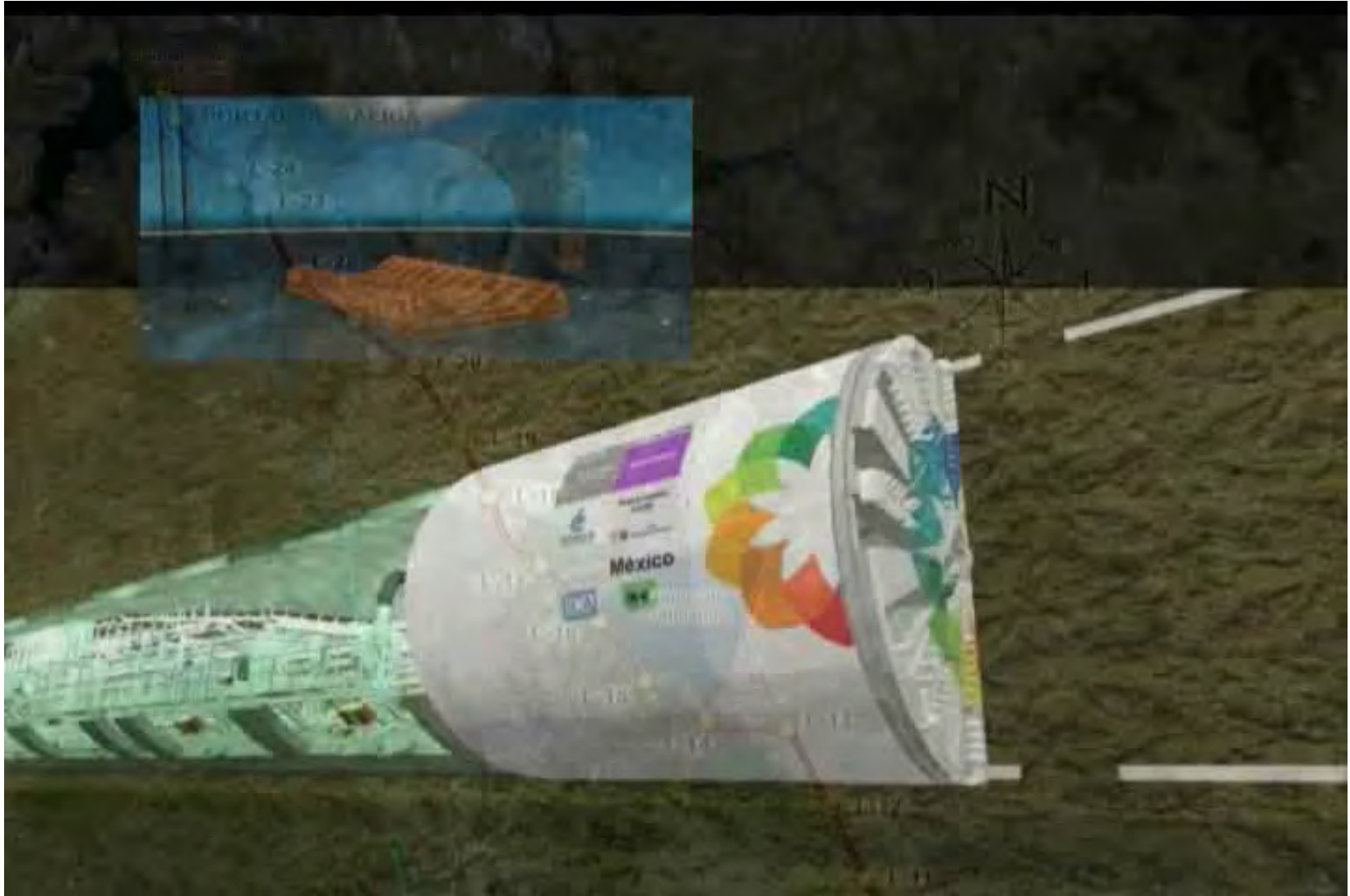


P1: Front pressure
P2: Injection pressure
E: Length of jack

P4: Mucking

EMISOR ORIENTE TUNNEL

TUNNEL: Excavation-Operation



ESCHEMATIC

EMISOR ORIENTE TUNNEL

TUNNEL: DESIGN AND CONSTRUCTION

The tunnel lining is formed by two liners

- 1) Concrete segments
- 2) Cast in place lining

Between shafts L0 and L10 (21+600) the tunnel has an external diameter of 8.7m and the thickness of each liner is 0.35m.



From shaft L10 to PS (62+000) the tunnel has an external diameter of 8.9m and the thickness of each liner is 0.40m.

EMISOR ORIENTE TUNNEL

TUNNEL: LINER CONCRETE SEGMENTS



[CLICK 1](#)

[CLICK 2](#)

DIMENSIONS:

- Thickness: 35cm and 40cm
- Type: Universal ring
- Numbers: 6+1 and 7+1

- External Diameter: 8.40m and 8.6m
- Internal Diameter: 7.70m and 7.80m
- Length: 1.5m

CONSTRUCTION:

- Total concrete segments: 42,000



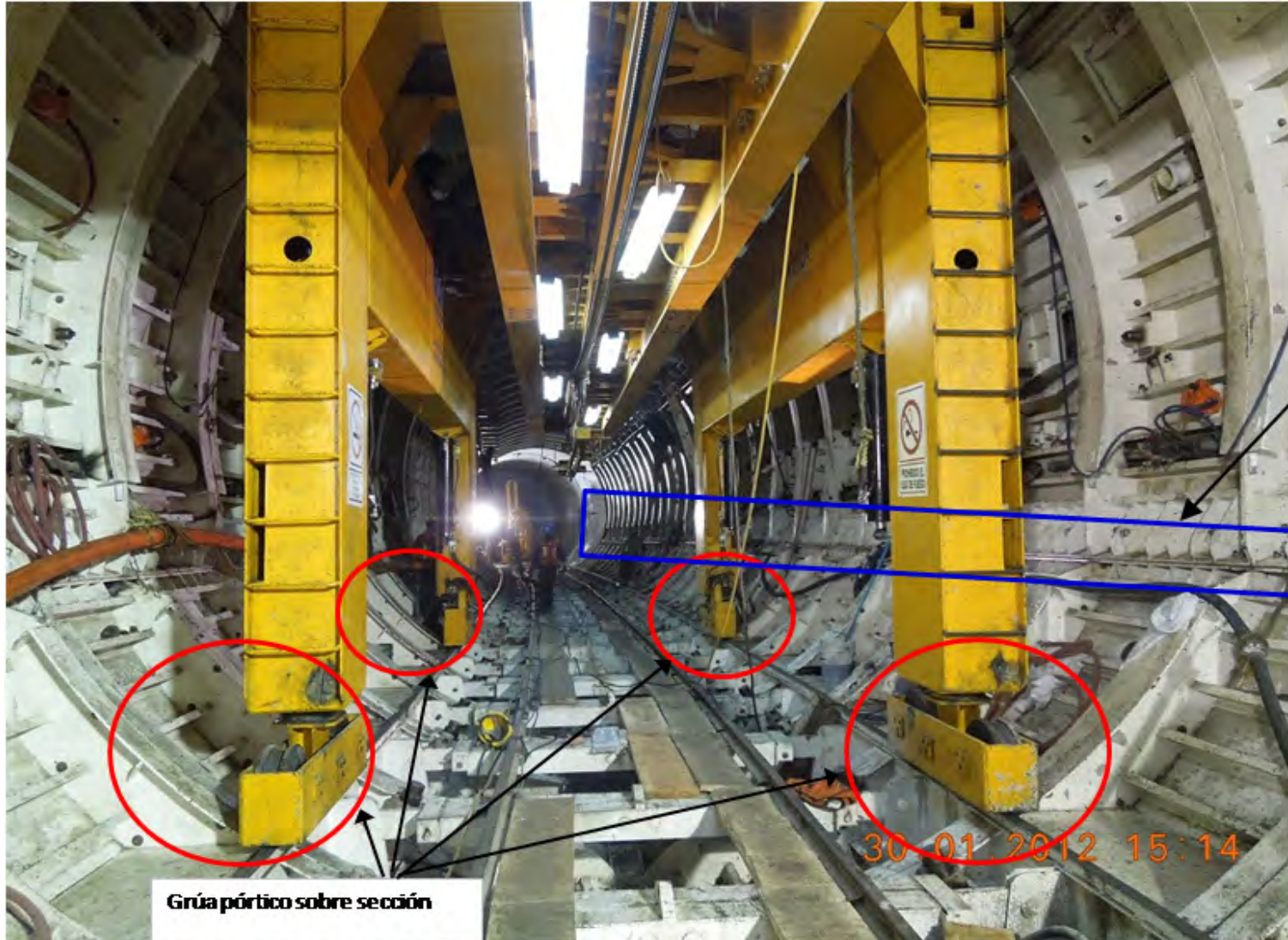
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TUNNEL: SECOND LINER CAST “IN SITU”



EMISOR ORIENTE TUNNEL

TUNNEL: SECOND LINER CAST "IN SITU"



Unión entre secciones
superiore inferior

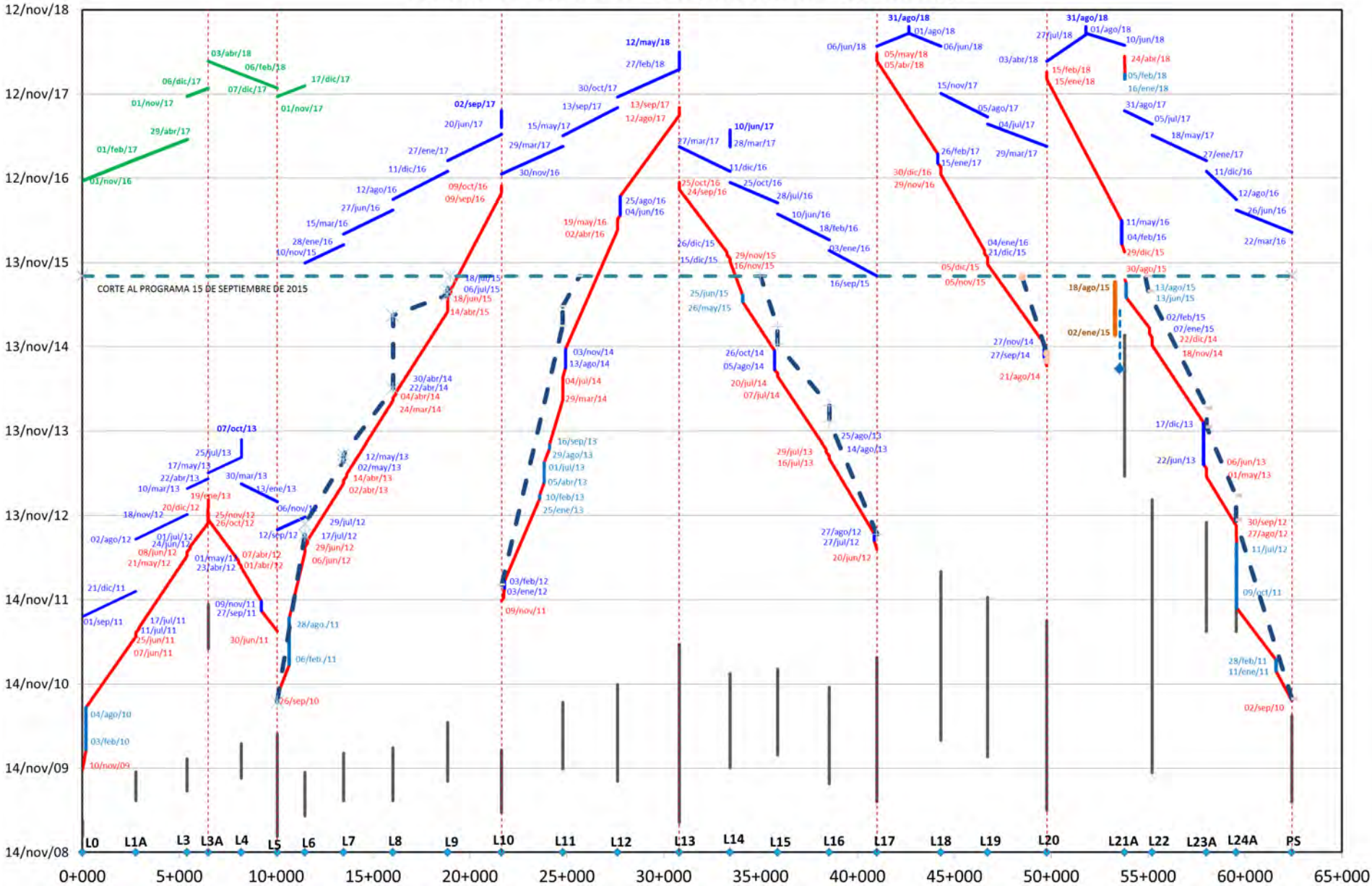
Grúa pórtico sobre sección

[CLICK](#)

03.

PROGRAM OF WORKS

DIAGRAMA DE PICOS TEO (CONVENIO ADICIONAL)



04.

RISKS

EMISOR ORIENTE TUNNEL

RISKS

In this type of project, there are several risks associated with geological conditions, however, there are also constructive aspects which results in risks. Main constructives risks can be grouped in the following way:

- **Geological risks.** Changes in the initial geological conditions. Impact: Change in cutting tools or design of the machine
- **Construction risks.** Changes in the initial construction procedures. Impact: Damage to nearby structures.
- **Enviromental and natural risks.** Flood damages

EMISOR ORIENTE TUNNEL

RISKS: EXAMPLE: Construction risks



SUBWAY: Sao Paulo, Brasil. Enero, 2007

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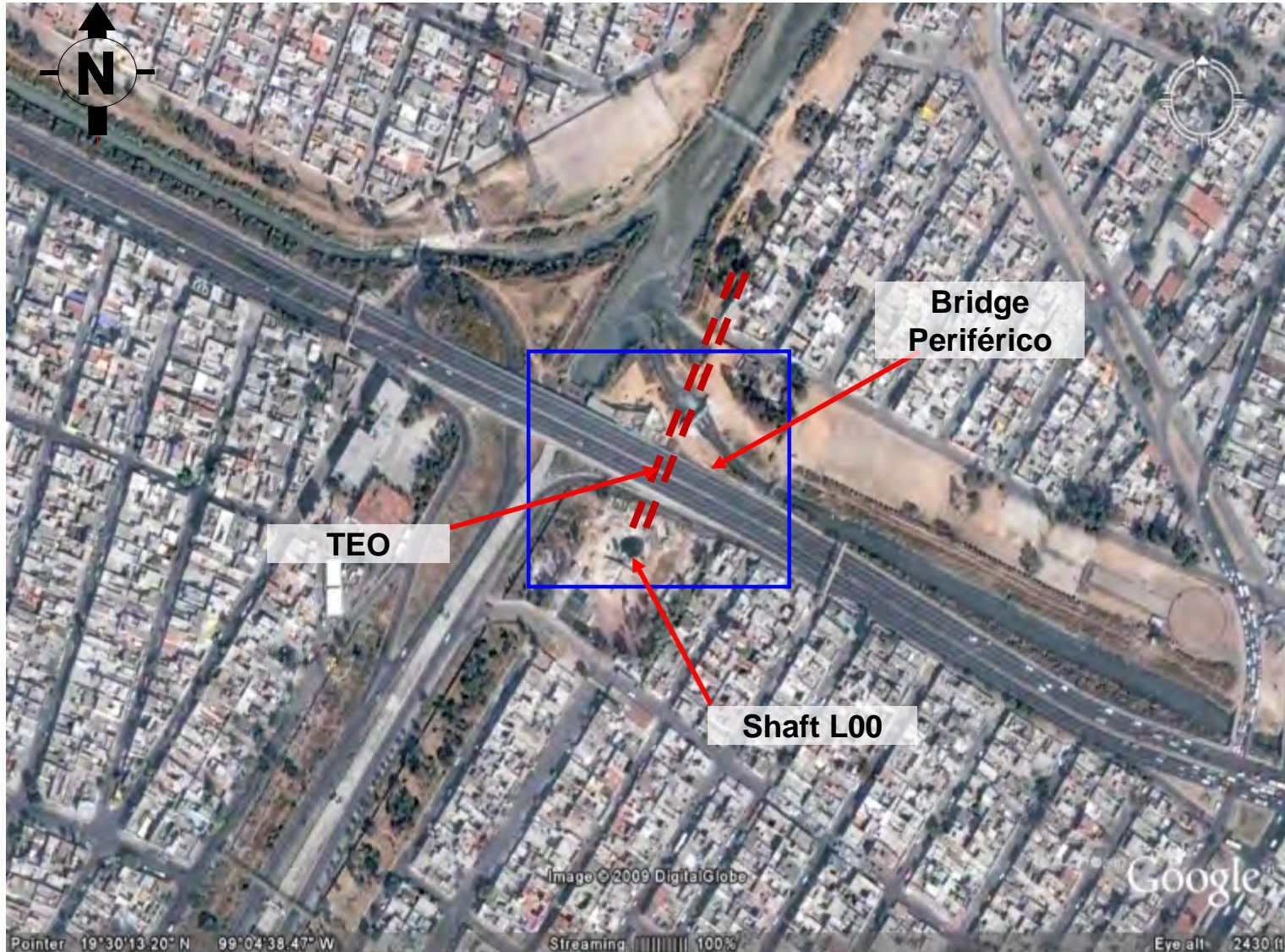
RISKS: Bridge intersection (example)



SHAFT 10. EMISOR ORIENTE TUNNEL. 2006

EMISOR ORIENTE TUNNEL

RISKS: Bridge intersection (example)

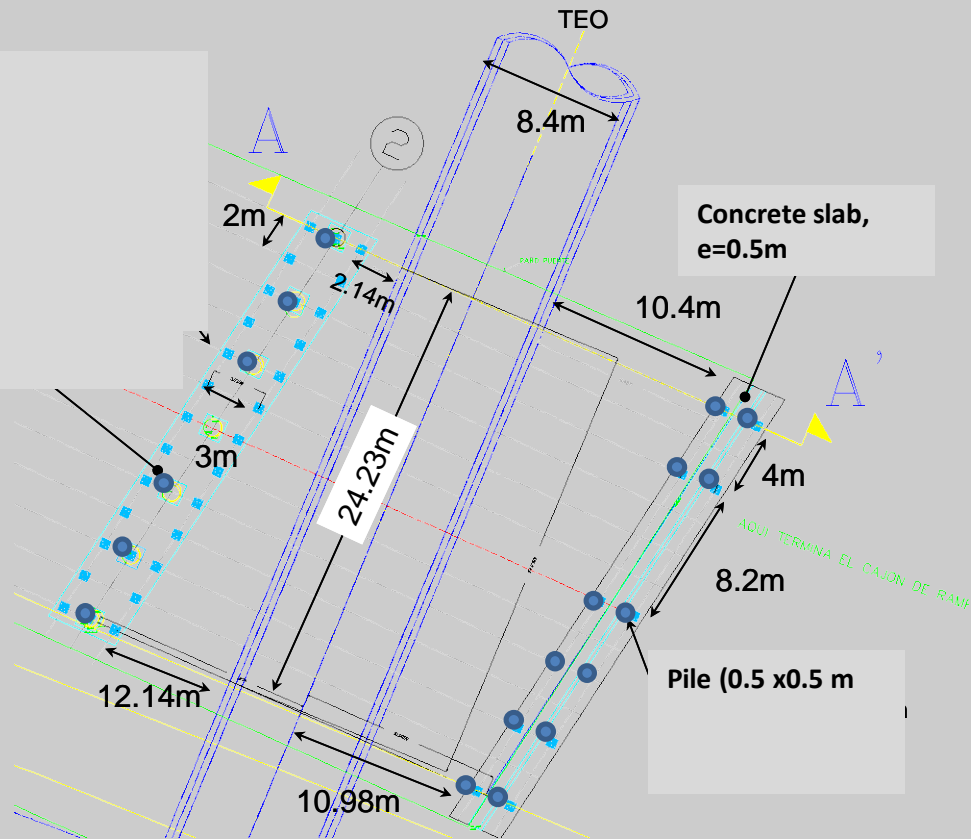


SHAFT L0. EMISOR ORIENTE TUNNEL. 2006

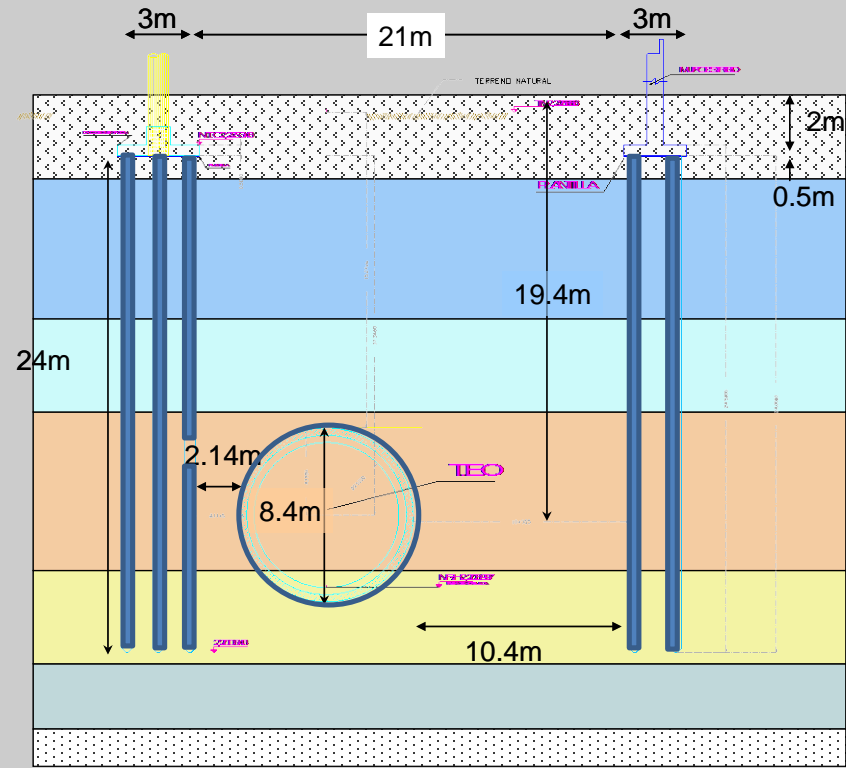
EMISOR ORIENTE TUNNEL

RISKS: Bridge intersection (example)

Layout

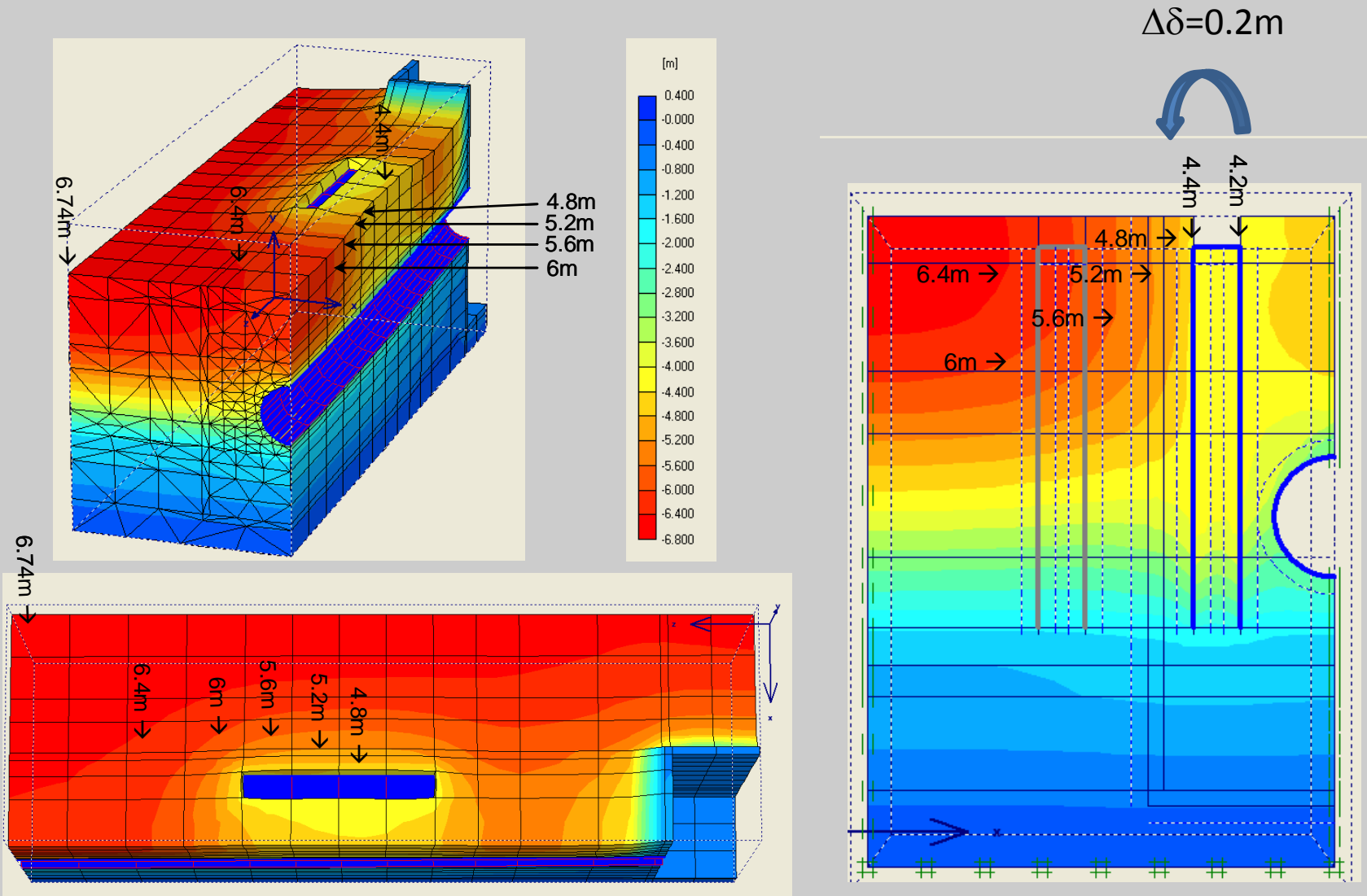


Cross Section



EMISOR ORIENTE TUNNEL

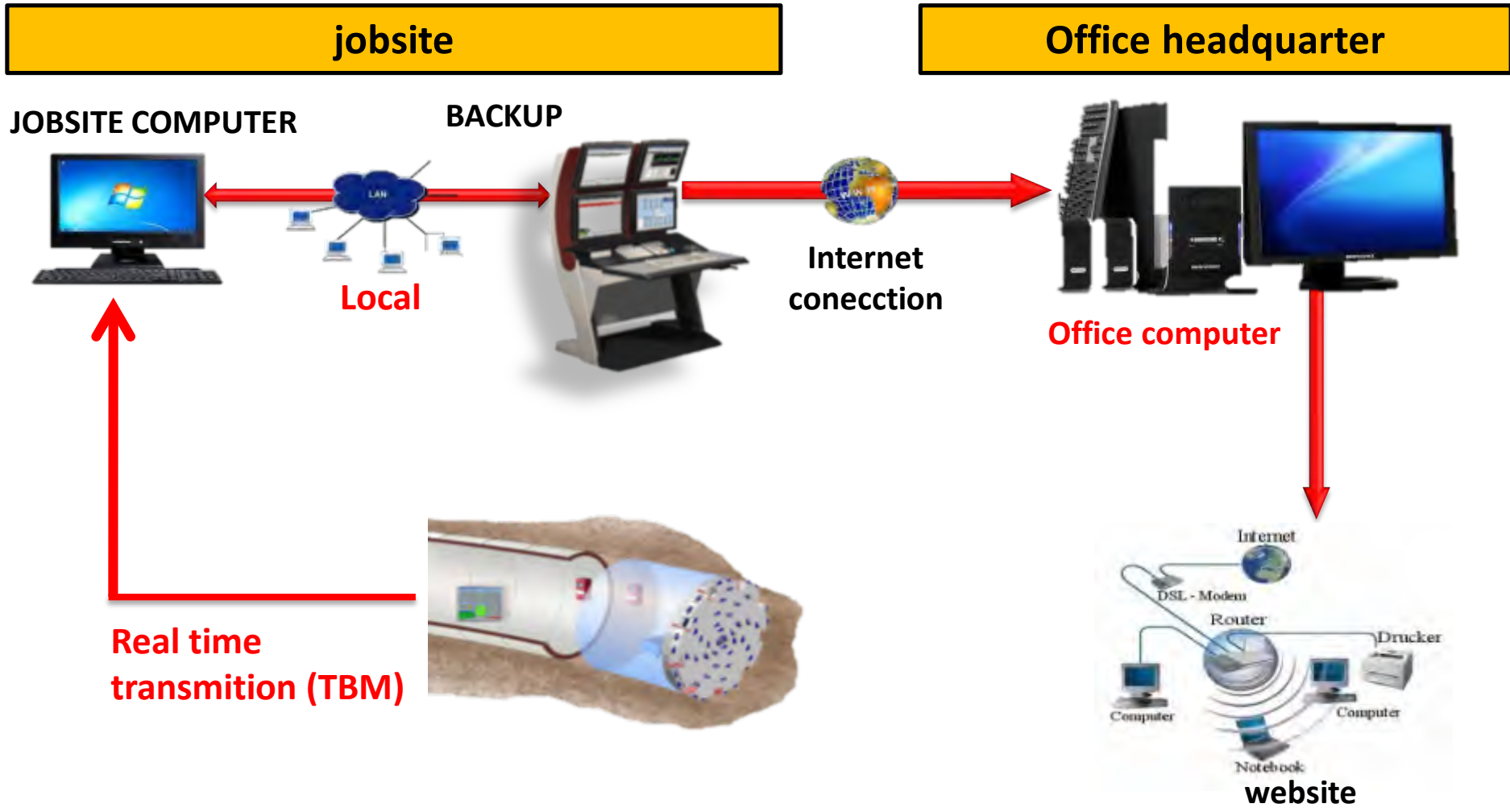
RISKS: Bridge intersection (example)



EMISOR ORIENTE TUNNEL

RISKS: mitigation measures (example)

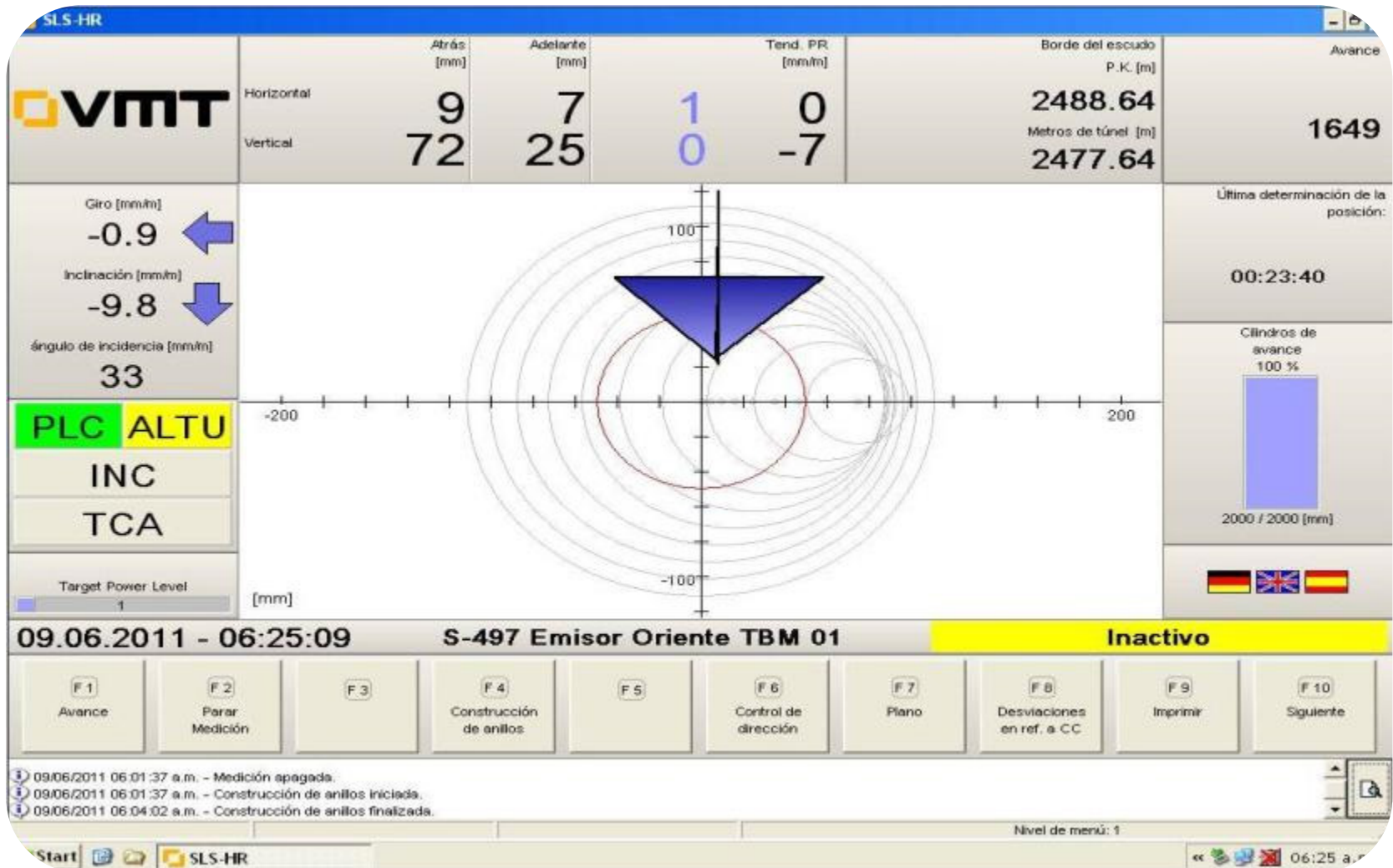
PROCESS CONTROL



EMISOR ORIENTE TUNNEL

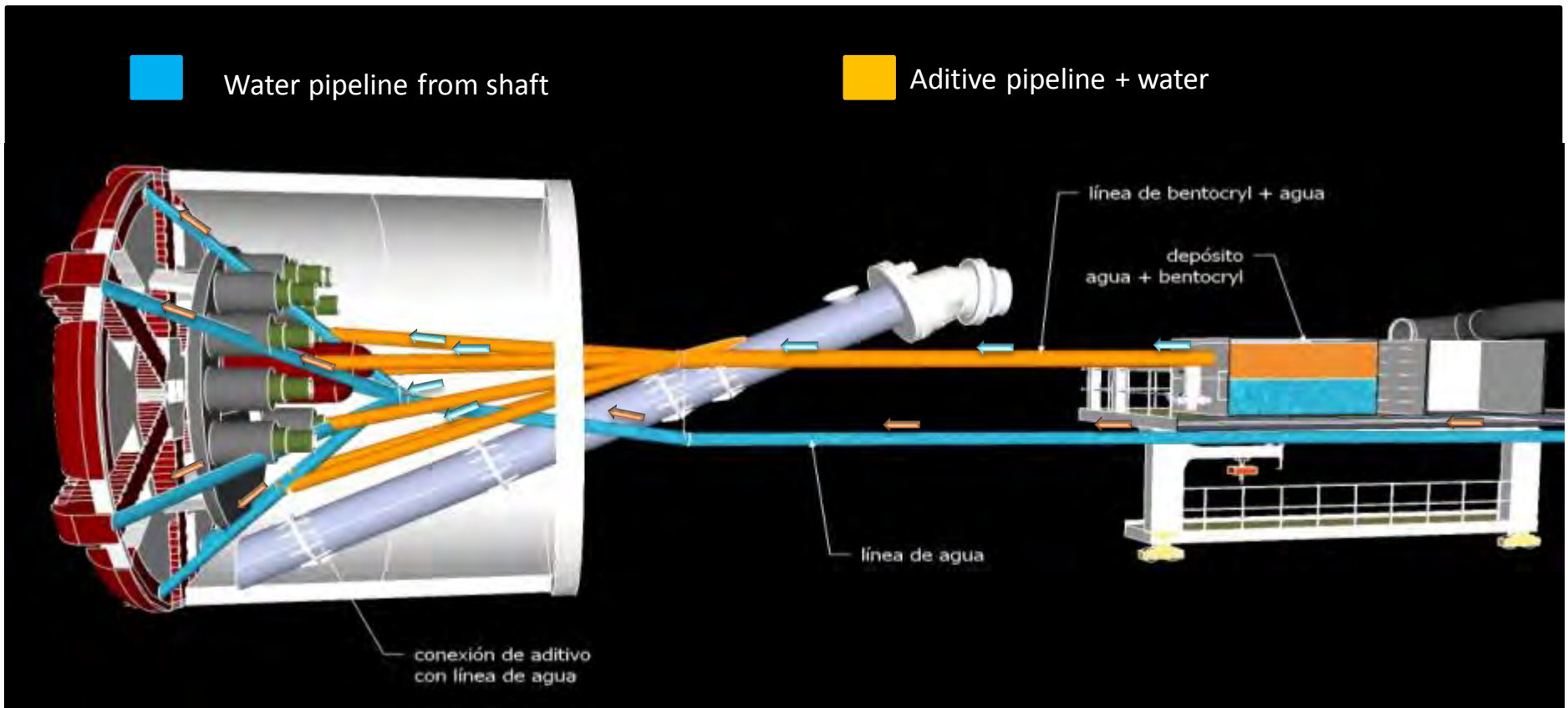
RISKS: mitigation measures (example)

GUIADANCE SYSTEM



EMISOR ORIENTE TUNNEL

RISKS: acondicionating of soil (example)



05.

INSURANCE POLICY CONDITIO

EMISOR ORIENTE TUNNEL

INSURANCE POLICY CONDITIONS

Sum Insured Section 1

Insured Values	USD 737'701,582.45.
Limit each and every loss and in the aggregate	USD65'000,000
Covered Risk	Included but not limited to natural catastrophes (Earthquake and Hydro-Meteorological risks), Under ground construction, Endorsement MR 101 – 110%, Fire, Extended Maintenance).

EMISOR ORIENTE TUNNEL

INSURANCE POLICY CONDITIONS

Sub limits and Clauses

Removal of Debris	10% of the value of the loss, maximum USD 13'000,000.
Overtime, Express Freight, Night work	20% of the value of the loss, maximum USD \$ 975,000.
Air Freight	20% of the value of the loss, maximum USD \$ 650,000
Professional Fees	USD \$ 422,500.
Drawings, documents and data	USD \$ 214,500.
Remote storage outside site	USD \$ 4'225,000
Inland Transit	USD \$ 4,225,000.

EMISOR ORIENTE TUNNEL

INSURANCE POLICY CONDITIONS

Sub limits and Clauses

Strike, Riot and Civil Commotion in the aggregate	USD \$ 42'250,000.
Fighting Equipment	USD \$ 4'250,000.
Time Schedule	8 weeks
Underground cables & pipes	Limit of open trenches 1,000 meters.
Hot and cold testing	8 weeks
Losses in Series	100%, 100%, 80%, 60%; 4th onwards, 0%
Safety Measures	Return period, 20 years.

EMISOR ORIENTE TUNNEL

INSURANCE POLICY CONDITIONS

Sub limits and Clauses

Maintenance	18 Months.
Inflation Entorsement	5%

Deductibles

Natural Castrophes (Eathquake and H.R.)	USD \$ 650,000 each and every loss.
Test and Underground construction.	USD \$ 455,000 each and every loss.
Errors in Design, labour, Material and Maintenance	USD \$ 455,000 each and every loss.
Other Risk	USD \$ 97,500 each and every loss.

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INSURANCE POLICY CONDITIONS

LOSSES

Loss	Description
Damage by Flood (flood) to shaft L-0	<u>On 5th February 2010, due to the swelling of the river Rio de los Remedios, shaft L-0 was flooded, Excavation works relating to the tunnel “Tunel Emisor Oriente” were underway at the time of the loss. (Loss below deductible).</u>
Damage to Bauer BC40 hydro-mill, located at shaft L-19.	During the excavation of shaft No 19, the Bauer, model BC40 Hydro- mill cutter became JAMMED at depth of 88.70 meters during the second shift of 30th March 2010. This loss belong to another policy CPM.

A perspective view of a long, circular tunnel. The walls are made of concrete segments with visible reinforcement. A series of bright lights are mounted along the right side of the tunnel. In the center, a yellow, segmented structure hangs from the ceiling. On the left, a large, dark, cylindrical pipe runs parallel to the tracks. The tracks themselves are visible in the foreground, leading towards the end of the tunnel.

THANK YOU