SÃO PAULO
GOVERNO DO ESTADO
SÃO PAULO SÃO TODOS

SANTOS-GUARUJÁ IMMERSED TUNNEL

SÃO PAULO
GOVERNO DO ESTADO
SÃO PAULO SÃO TODOS

MINISTÉRIO DE
PORTOS E
AEROPORTOS

GOVERNO FEDERAL
BRASIL
UNIÃO E RECONSTRUÇÃO

ARTESP
AGÊNCIA DE TRANSPORTE DO ESTADO DE SÃO PAULO

ANTAQ
Agência Nacional de Transportes Aquaviários

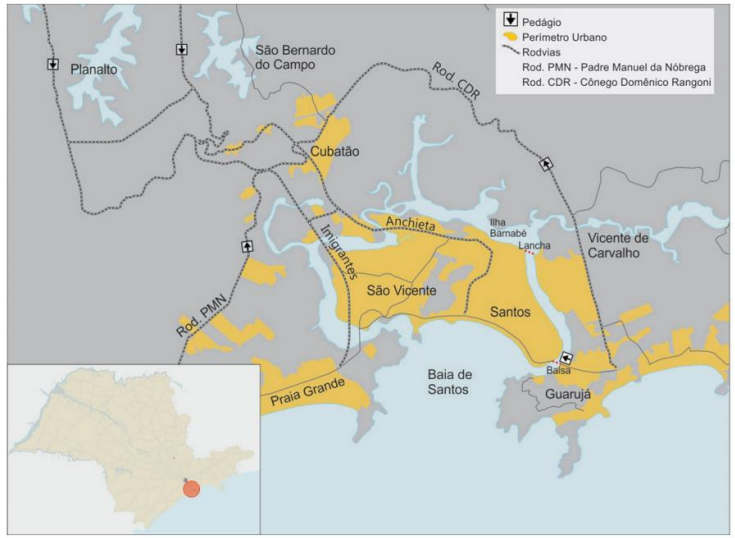
PORTO DE SANTOS
AUTORIDADE PORTUÁRIA

SANTOS-GUARUJÁ IMMERSED TUNNEL

CONTEXT

Santos-Guarujá Crossing today:

- Commercial vehicles: Cônego Domênico Rangoni
- Passenger vehicles, motorcyclists, cyclists and pedestrians: coastal ferry/boat crossing system



LOCATION OF THE CROSSING

A mobility study considered 7 possible positions:

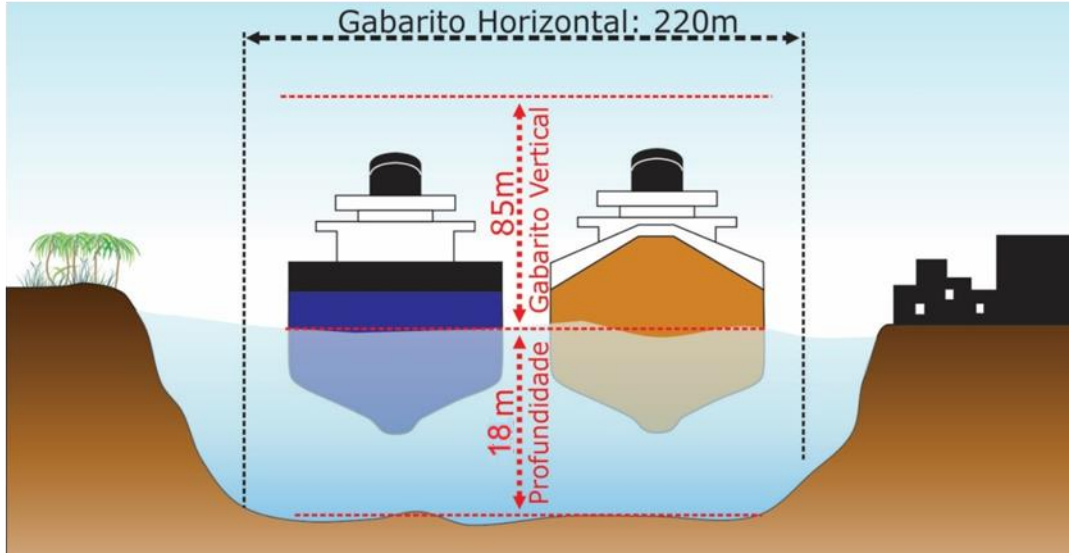
was concluded that a **location in the center of the canal would more satisfactorily meet urban development guidelines and the region's logistical needs**, as it:

I. meets the current and future demands of the various travel categories;
II. connects the regions that generate the most trips in Santos and Guarujá;
III. minimizes production and overall travel times in the region;
IV. allows the integration of public transport systems;
V. maximizes accessibility for non-motorized transportation; and
VI. serves intra-port trips and part of those originating in São Paulo to the port.

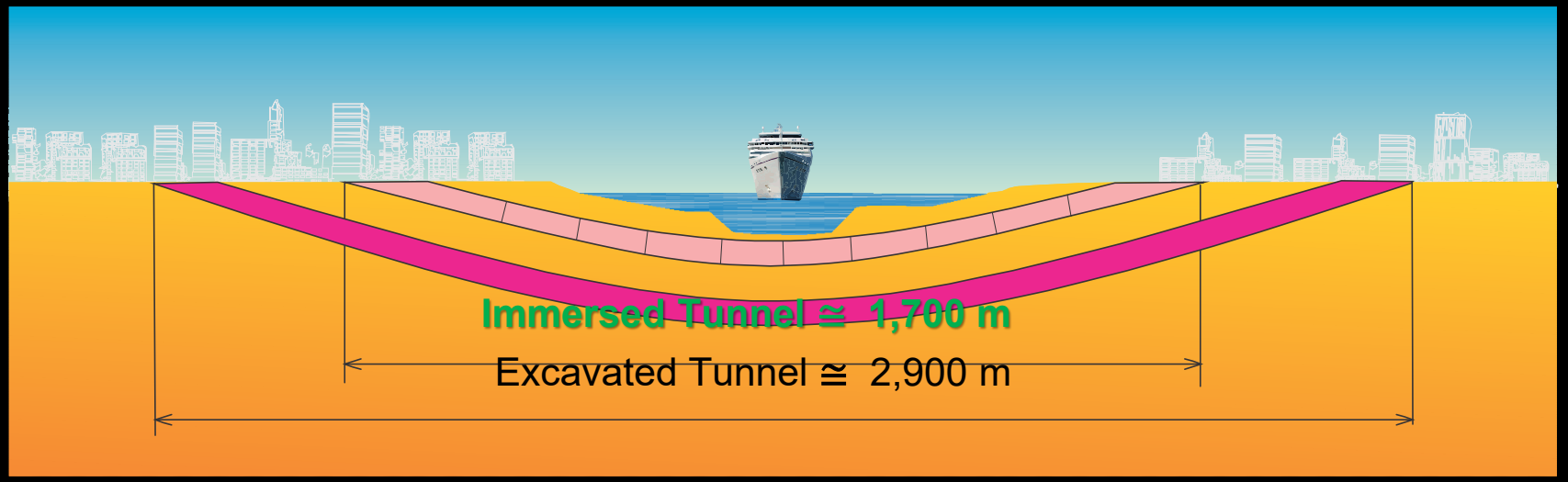
WHY TUNNEL?

It would not be possible to build a bridge: restriction of the Santos Air Base air cone and minimum vertical clearance to allow large ships to pass. In addition, bridges can be closed in adverse weather conditions.

So, the connection **had to be made through a tunnel**.



WHY AN IMMERSED TUNNEL?

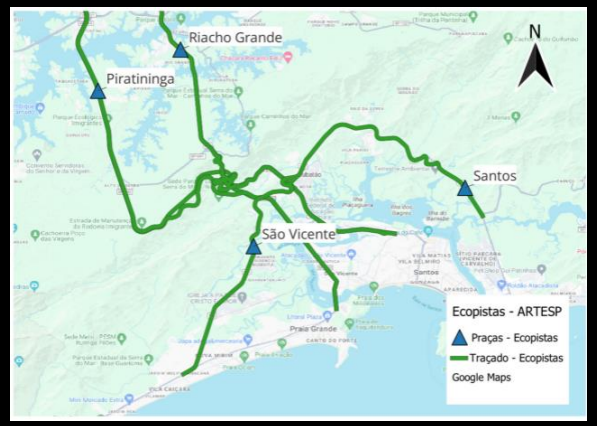


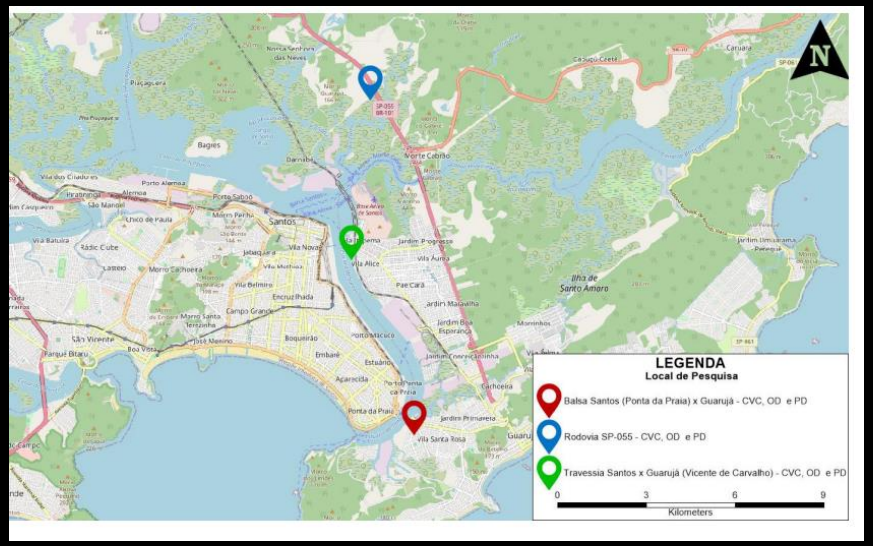
The immersed tunnel solution was adopted.

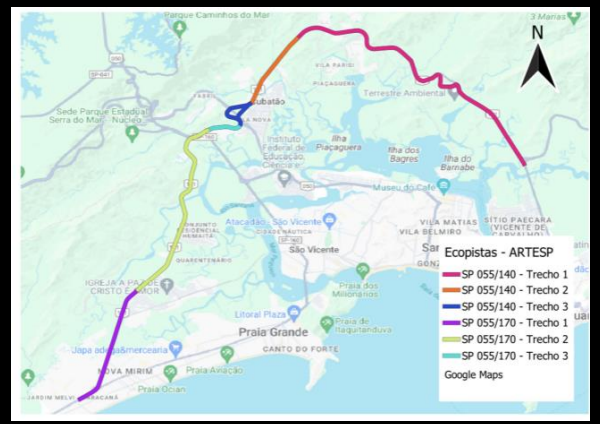
Excavated tunnels: built at a depth that allows a more rigid ground to be found that ensures stability for drilling - 70/90m below bedrock. Complexities involved in excavation stability in a soil with fluvial-lagoon sediments, such as that found in the Santos Estuary region.

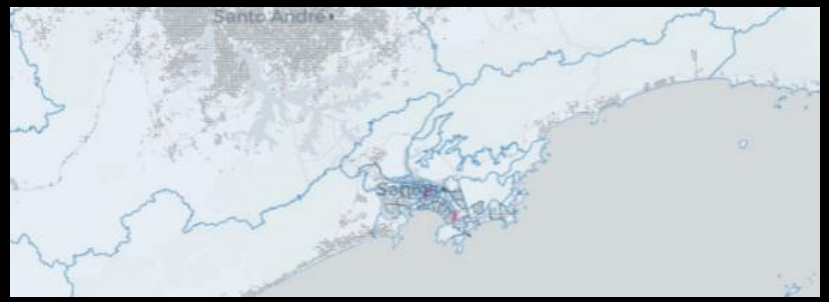
Immersed tunnels: built in bedrock, even in less resistant materials, in order to reduce the load due to hydrostatic forces. It allows for a shorter connection, with a less drastic impact and less expropriation.

DEMAND ASSESSMENT









Data source:

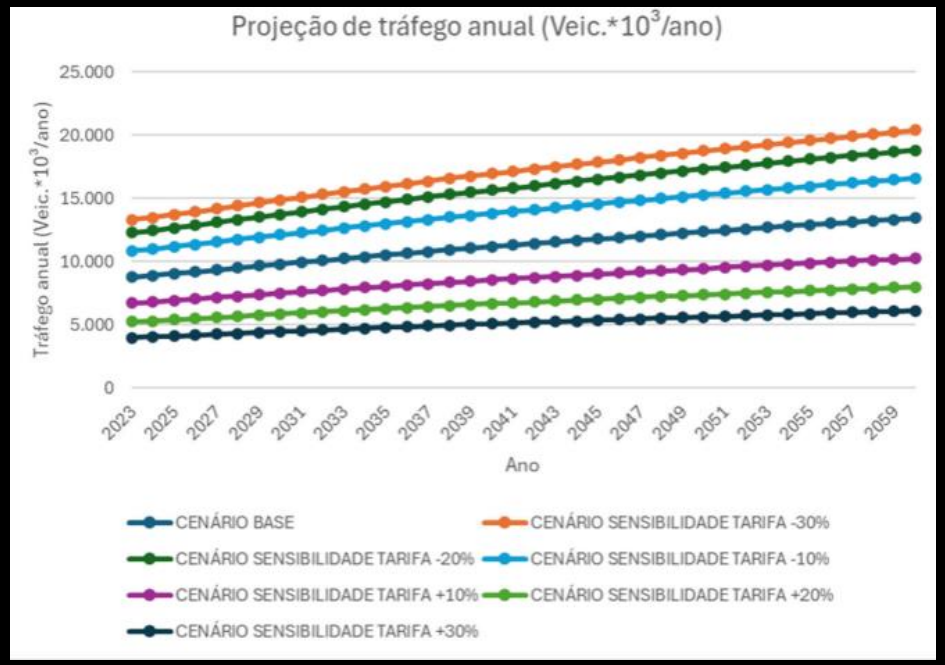
- Toll stations
- Traffic sensors
- New Origin-Destination study, vehicle counts, stated preference researches
- Mobile phone data

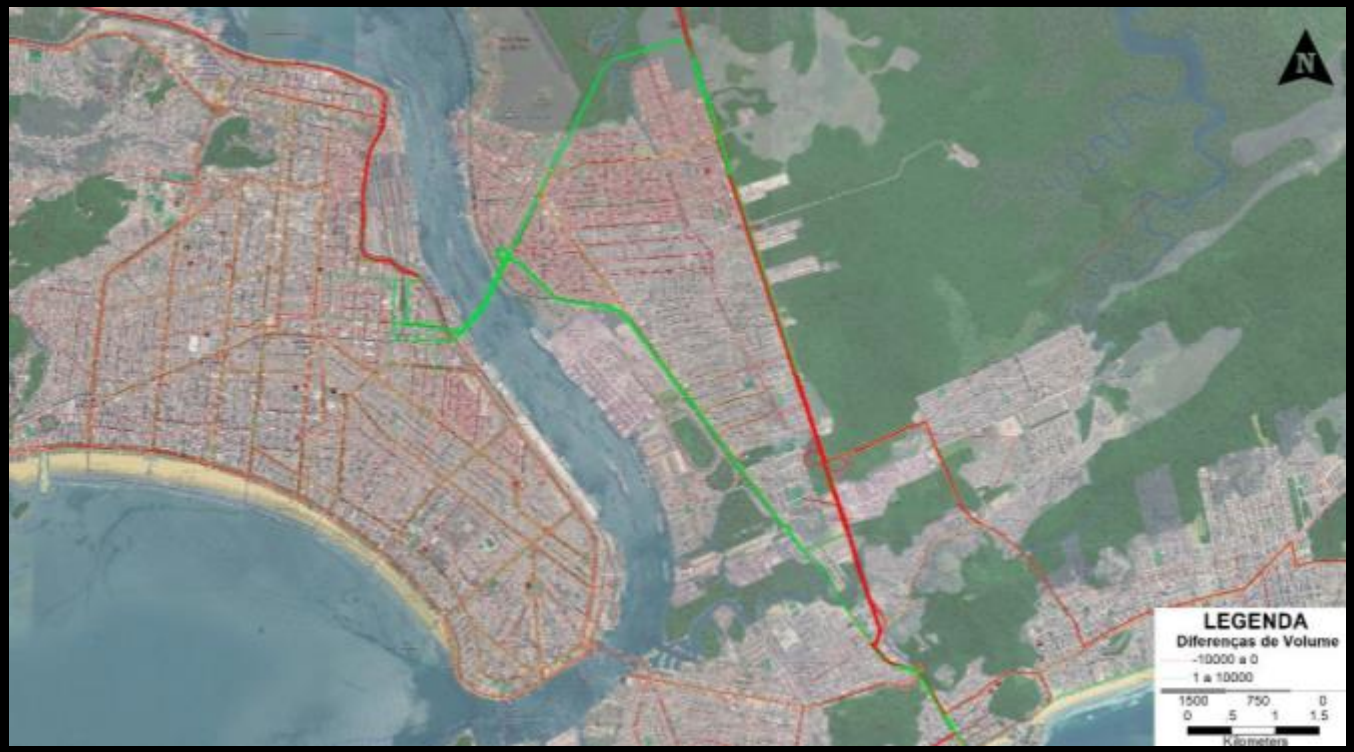
DEMAND ASSESSMENT

Simulation grid

DEMAND ASSESSMENT

Charges and projection of Fare Revenue

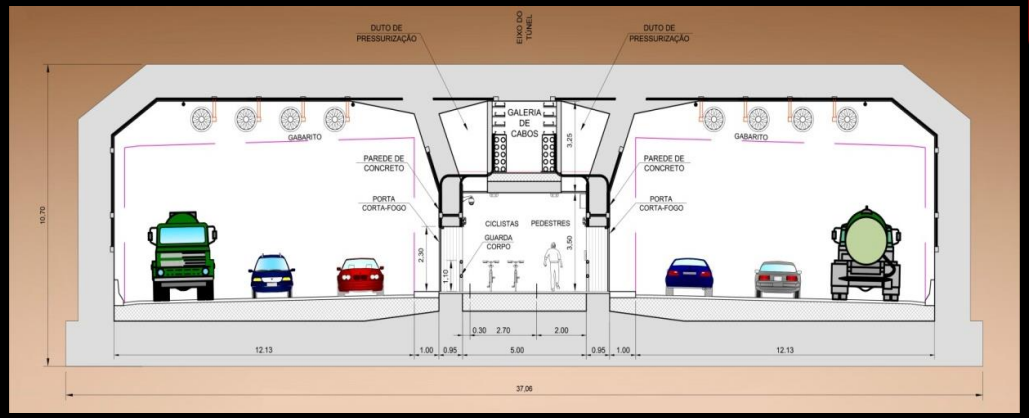




DEMAND ASSESSMENT

Evaluation of traffic flow on urban roads

ENGINEERING ASSESSMENT



Executive-level project previously prepared by DERSA.

Used as the basis for structuring the PPP:

CAPEX: more than 1,500 executive project services were quoted.

OPEX: operational services for the conservation, maintenance and operation of the tunnel are priced. Consistent with international values.

ENGINEERING ASSESSMENT

1st) SOIL PREPARATION

2nd) CONSTRUCTION

3rd) FLOODING

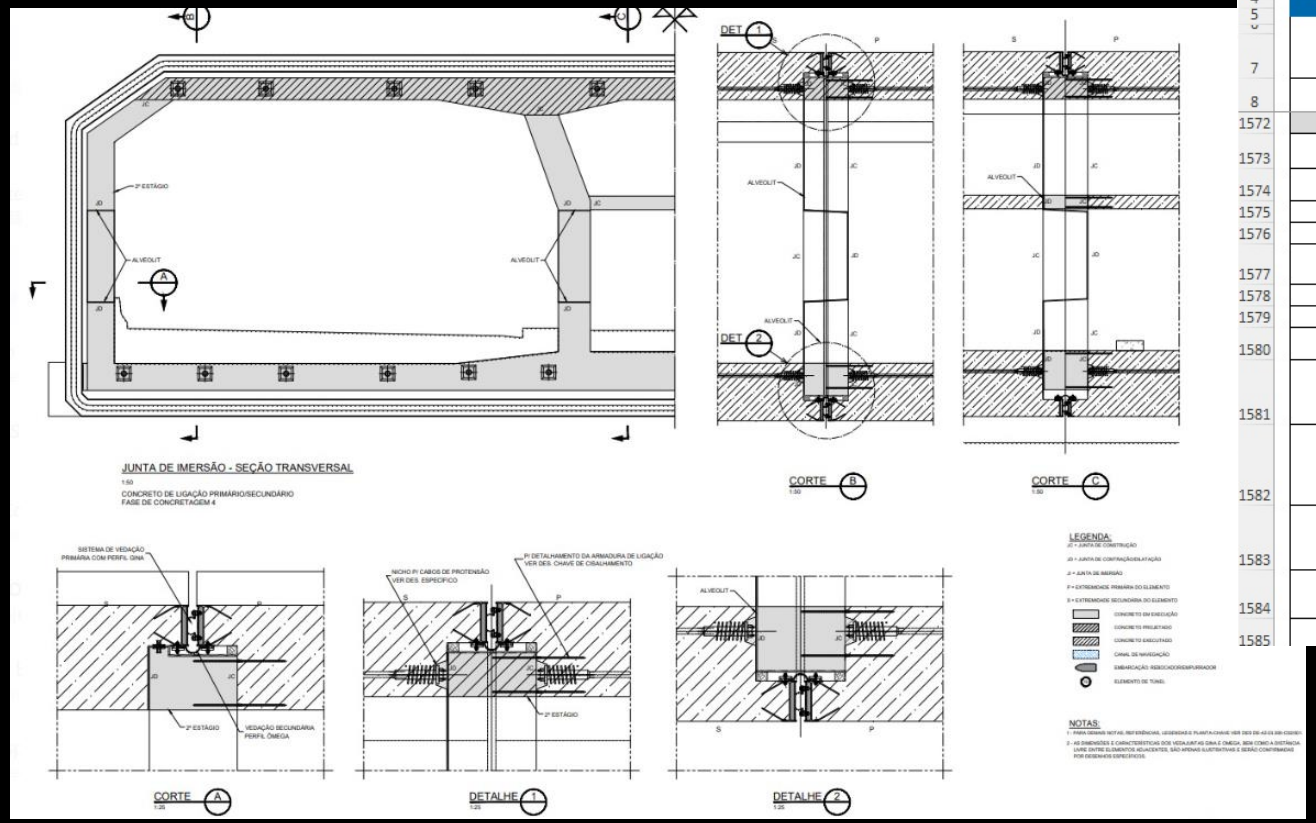
4th) TRANSPORTATION/POSITIONING

5th) IMMERSION AND COUPLING

6th) LEVELING AND PROTECTION

ENGINEERING ASSESSMENT

Executive-level project previously prepared by DERSA.



Dersa

CÓDIGO	REV.
PL-42.00.000-A07/001	B
DATA: 30/10/2015	FOLHA:

EMITENTE: CONSÓRCIO CONSULTOR ENGEVIX-PLANSERVI-THEMAG TÚNEL SUBMERSO

PLANILHA DE QUANTIDADES E SERVIÇOS

1572	27	25	OBRAS DE CONTENÇÃO GEOTÉCNICA		
1573	27.1	25.06.01	FORMA PLANA PARA CONCRETO COMUM	m³	43,912.00
1574	27.2	25.06.02	FORMA PLANA PARA CONCRETO PROTENDIDO OU APARENTE	m³	3,079.00
1575	27.3	25.07.02	BARRA DE AÇO CA-50	kg	23,494,443.00
1576	27.4	25.07.03	BARRA DE AÇO CA-60	kg	2,035.00
1577	27.5	26.09.01	CONCRETO FCK 10 MPA	m³	790.00
1578	27.6	26.09.09	BOMBEAMENTO P/ CONC. QUALQUER RESIST.	m³	177,540.00
1579	27.7	26.09.13	CONCRETO FCK 40 MPA	m³	190,251.00
1580	27.8	29.88.05.13.04	CONCRETO SUBMERSO	m³	9,396.00
1581	27.9	25.88.04.06.01.01	FORNECIMENTO, INSTALAÇÃO E RETIRADA DE TUBO METÁLICO EM AÇO CARBONO COM RESISTÊNCIA CARACTERISTICA SUPERIOR A 350 MPA - EXECUÇÃO DE ESTRONCAS	kg	8,228,143.00
1582	27.10	25.88.04.06.02.01	FORNECIMENTO, CRAVAÇÃO E RETIRADA DE PERFIL COMBINADO EM AÇO CARBONO COM RESISTÊNCIA CARACTERISTICA SUPERIOR A 430 MPA, INCLUSIVE CONECTORES E JUNTA SELANTE POLIMÉRICA ENTRE ELEMENTOS	kg	2,076,214.28
1583	27.11	25.88.17.02	EXECUÇÃO DE PAREDE DIAFRAGMA EM SOLO COM CLAMSHELL HIDRAULICO COM ESPESSURA 1,00 METRO, INCLUINDO ESCAVAÇÃO E DEJEITO EM SOLO COM SPT < 50	m³	97,183.86
1584	27.12	25.88.17.05	EXECUÇÃO DE PAREDE DIAFRAGMA COM HIDROFRESA COM ESPESSURA 0,80 A 1,20 METROS, INCLUINDO ESCAVAÇÃO E DEJEITO DE MATERIAL	m³	27,912.15
1585	27.13	25.88.18.09	VOLUME DE SOLO TRATADO - JET GROUTING	m³	30,098.58

SOCIO-ENVIRONMENTAL STUDY

Executive-level project previously prepared by DERSA.

- Mitigation works planned;
- Wildlife crossings;
- Estimated expropriation values;
- Environmental programs

FINANCIAL MODELING

Term: 30 years

INVESTMENTS OVER

~USD 1.16 billion

in the works

INVESTMENTS OVER

~USD 261,8 million

for operation and maintenance

INTERCONNECTION SYSTEM consisting of:

- TUNNEL;
- URBAN ACCESS; and
- ACCESS BUILDINGS

TIMELINE:

YEAR 1: Optimized Project and Installation Environmental License. The Previous Environmental License will be provided before the auction date.

YEAR 2 to YEAR 5: Implementation of the works with payment of the DISBURSEMENT EVENTS of the PUBLIC CONTRIBUTION

YEAR 6: Start of collection of the TOLL FARE and payment of the CONSIDERATION

YEAR 7 to YEAR 30: Maintenance and renovation of the INTERCONNECTION SYSTEM

FINANCIAL MODELING

MAXIMUM PUBLIC CONTRIBUTION

~USD 972.5 million

Payment according
to works progress

MAXIMUM PUBLIC CONSIDERATION (in 30 years)

~USD 1.50 billon

Monthly payment
Annual value of ~USD 59,8 million

Fare Revenue: **~USD 424 million** from year 6 onwards

Existing ferry price

Basic Fare per direction: **~USD 1.21**

Free-flow tooling at the tunnel entrances

Pedestrians and cyclists are free of charge

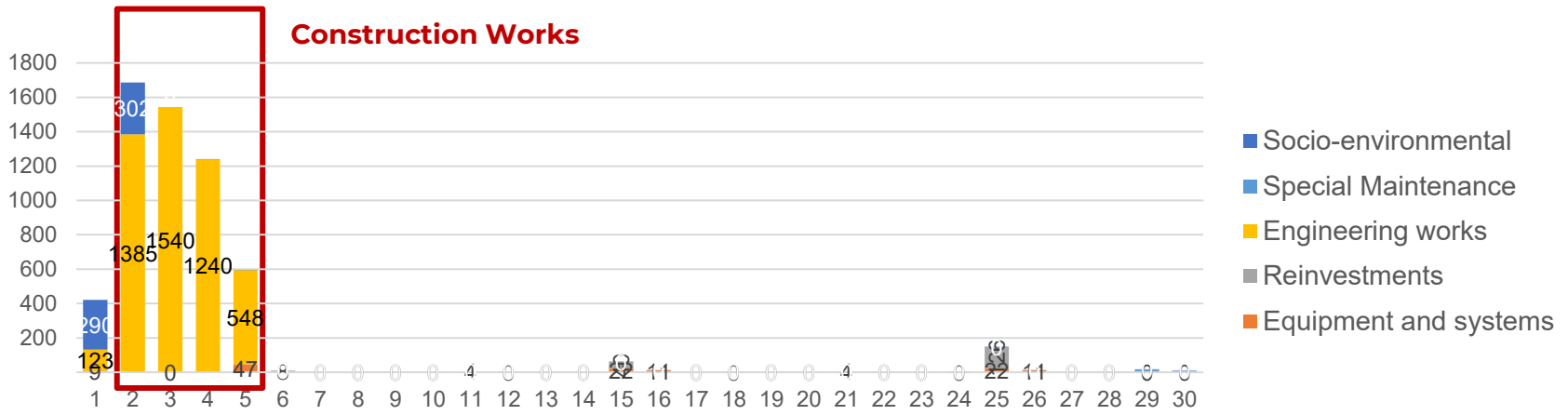
Ancillary Revenue

CAT	TYPE	NO. OF AXLES	ROUTING	MULTIPLIER OF THE BASIC FARE
1	CAR, PICKUP TRUCK, TRICYCLE AND VAN	2	SIMPLE	1
2	LIGHT TRUCK, MINIBUS, BUS, TRACTOR TRUCK, TRACTOR TRUCK WITH SEMI-TRAILER, TRUCK WITH TRAILER AND VAN	2 and 3	DOUBLE	3
3	TRUCK WITH TRAILER, TRACTOR TRUCK WITH SEMI-TRAILER	4 or +	DOUBLE	8
4	CAR OR PICKUP TRUCK WITH SEMI-TRAILER	3	SIMPLE	1.5
5	CAR OR PICKUP TRUCK WITH TRAILER	4	SIMPLE	2
6	MOTORCYCLES, SCOOTERS AND MOTORIZED BICYCLES	2	SIMPLE	0.5
-	**OFFICIAL VEHICLES OF THE STATE OF SÃO PAULO, ARMED FORCES AND MILITARY POLICE - EXEMPTED**	-	-	0

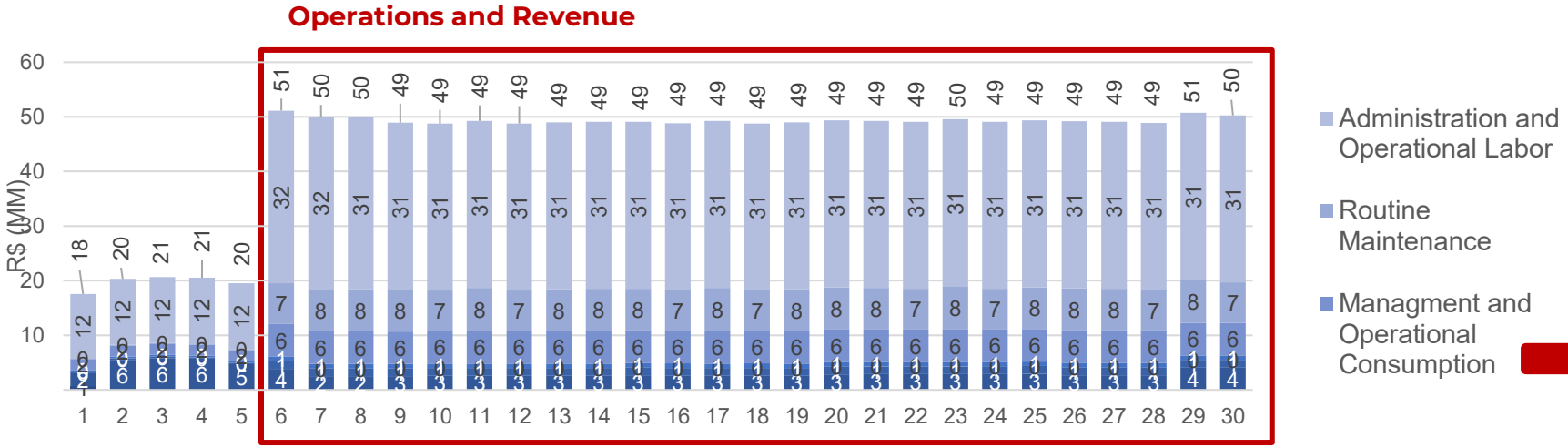
FINANCIAL MODELING

CAPEX

R$ MM

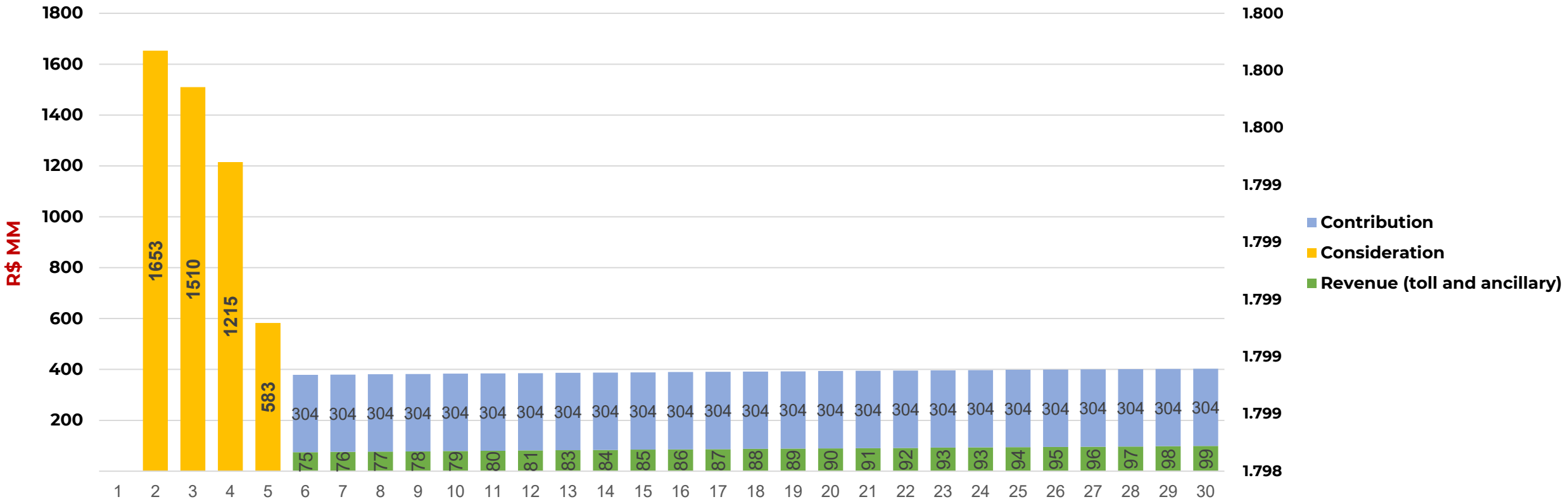


OPEX



FINANCIAL MODELING

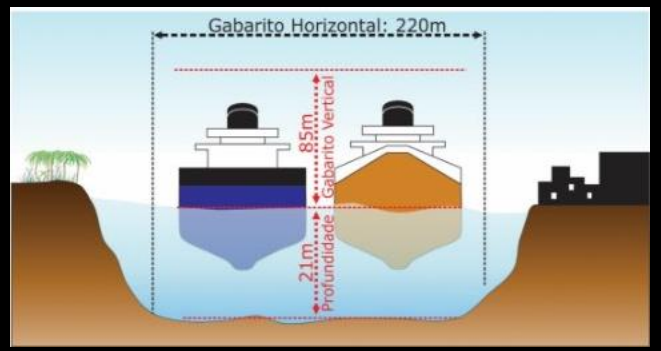
Revenue



TECHNICAL ANNEXES

Items set out in the Agreement:

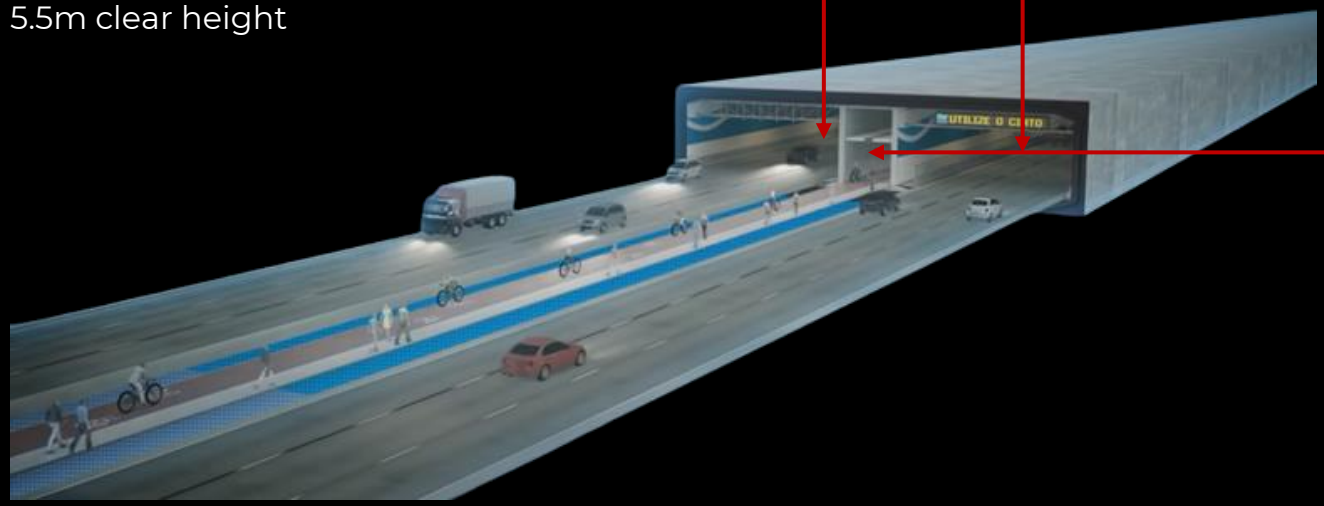
- Location that crosses the Santos Estuary fixed - adaptation of up to 100 meters allowed;
- Immersed tunnel (construction method);
- Navigation restrictions:
  - Minimum horizontal gauge: **220 m**
  - Minimum depth: **21 m**

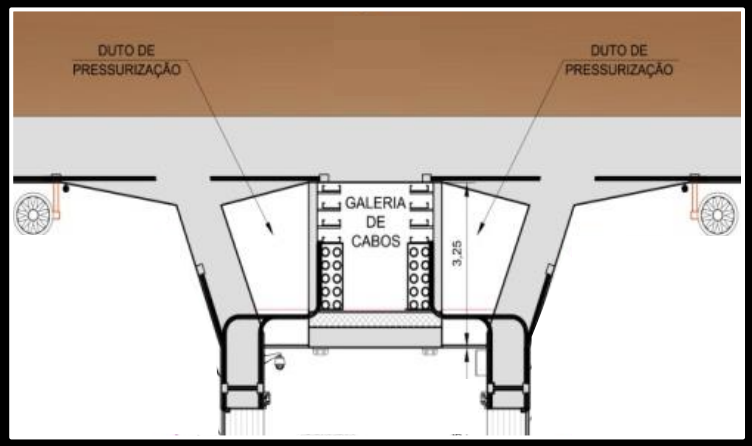


TECHNICAL ANNEXES

For vehicles: 3 lanes per direction, one of which have to be adapted for LRVs.

5.5m clear height





Cable gallery: safe transposition of the Itatinga Power Plant transmission line

pedestrians and cyclists: Central gallery

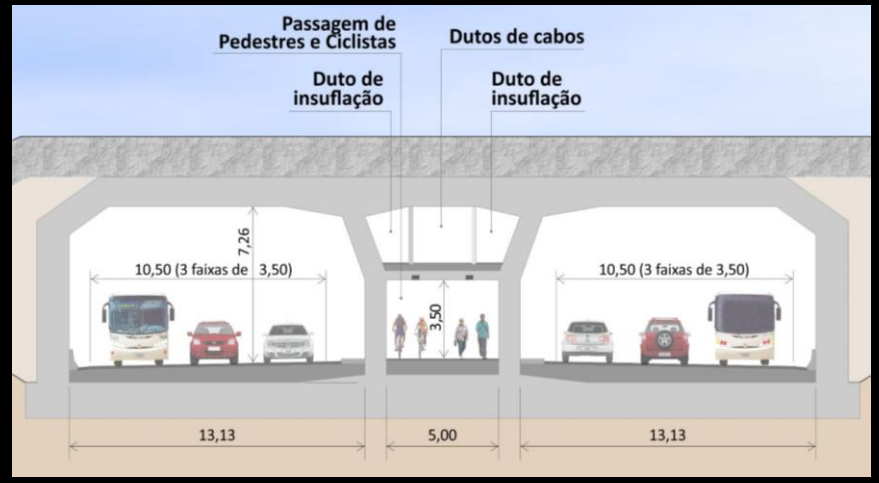
TECHNICAL ANNEXES

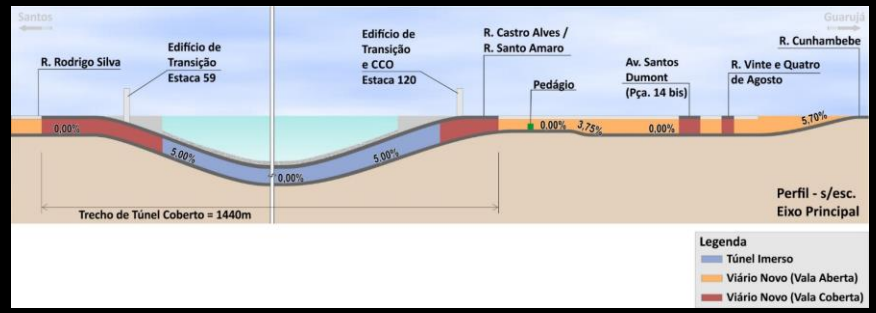
Transverse section:

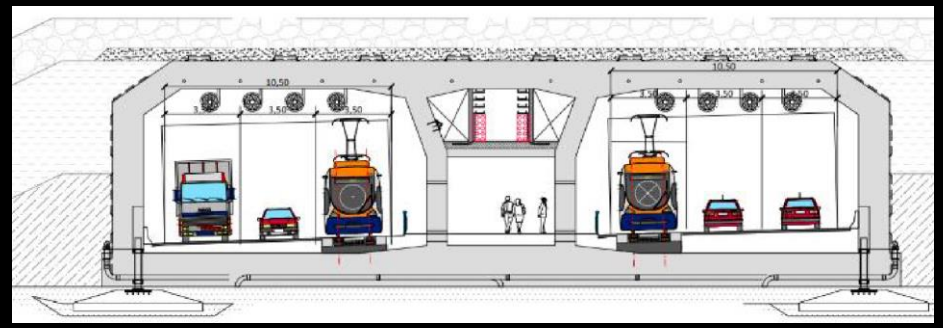
- Central pedestrian gallery with horizontal and vertical dimensions of 5.0 m and 3.5 m.
- 3 lanes of at least 3.5 m, with the inner lane for the LRV;
- Minimum clearance of 0.6 m on each side;
- Minimum walkway of 1.0 meter, next to the pedestrian and cyclist gallery;
- Minimum vertical gauge clearance: 5.5 m;

Slopes and turns:

- Maximum slope: 5%
- Project's guideline speed: 60 km/h.







TECHNICAL ANNEXES

Precast concrete elements:

- Control of concrete cracks that could create a water leak to the inside of the TUNNEL.
- Method of cooling concrete, using coils or other similar technology, based on specific thermal studies.
- Joints between the elements must be a GINA gasket, associated with an Omega seal, which will ensure the connection sealing between the elements.
- Cathodic protection system to protect exposed metal structures located at joints from corrosion.
- Evaluate the need to install an external membrane to ensure that the concrete elements are completely watertight.
- They must withstand failure of the pumping and drainage system, risk of incompleteness or loss of material from the ballast layer below the structure, sunken ships and sedimentation that reduces the draft to up to 15 meters.

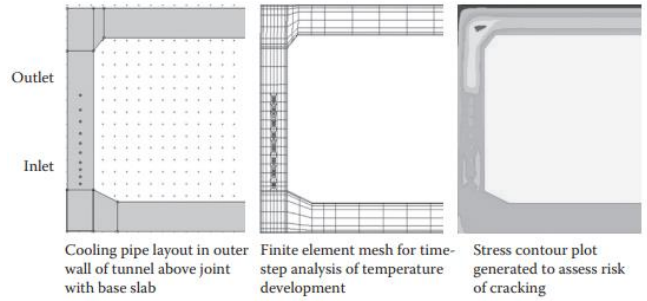
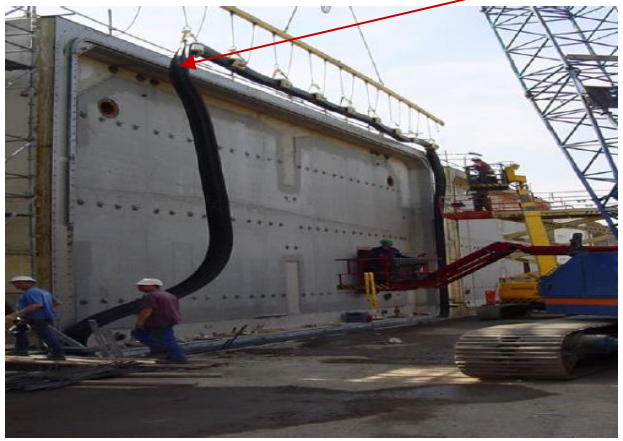


Figure 3.2 Cooling arrangement and stress analysis.



GINA gasket

Omega seal

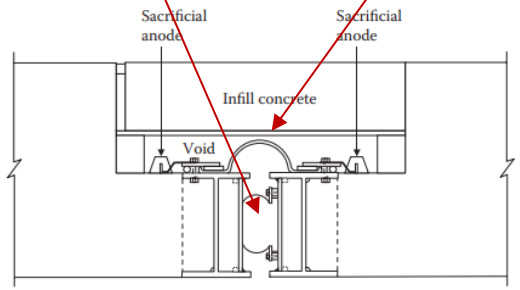


Figure 10.7 Omega protection detail.

Joints between elements

TECHNICAL ANNEXES

Backfill at the bottom of the estuary:

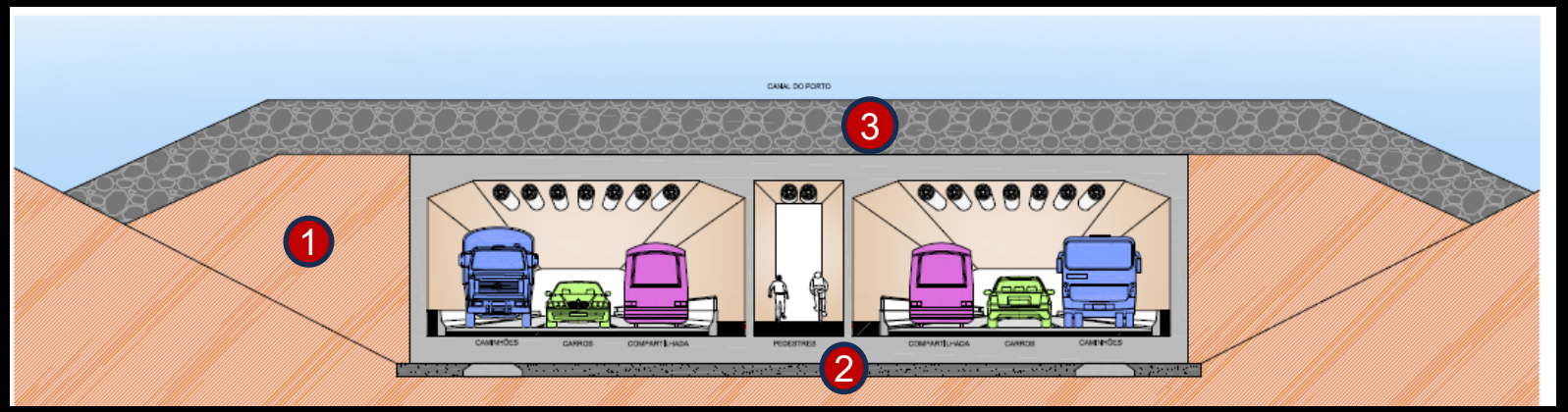
1. lateral backfill to lock the elements in place,
2. ballast layer, ensuring uniform support
3. protective layer above the TUNNEL.

Hydraulic and hydrological studies:

- consider rainfall and tidal variations for a recurrence period of 100 years.

Dock:

- The Grantee may propose an alternative location in the proximity of the works.



TECHNICAL ANNEXES

CLOSING THE CANAL

- Plan for navigation restrictions in the Santos Estuary: must be submitted 60 days in advance and approved by the Santos Port Authority (APS) and ANTAQ.
- Closures or restrictions to navigation of the canal are pre-approved in 288 hours. However, the GRANTEE must seek to optimize the interference intervals for navigation on the canal.
- The monthly installments paid as PUBLIC CONTRIBUTION will be increased or reduced according to the time the SANTOS ESTUARY is closed.
- The Santos Estuary Navigation Restriction Needs Plan may be updated up to 24 hours in advance if unfavorable conditions are predicted, for example due to weather conditions.

Variation in the canal closure time pre-appoved	Variation on the installments to be paid of the PUBLIC CONTRIBUTION of item 1.1.3 of ANNEX 21
Reduction of more than 45% of the time	Increase of 10% on the monthly installment of the MONTHLY CONTRIBUTION
Reduction of 30% to 45% of the time	Increase of 6% on the monthly installment of the MONTHLY CONTRIBUTION
Reduction of 15% to 30% of the time	Increase of 4% on the monthly installment of the MONTHLY CONTRIBUTION
Reduction of 5% to 10% of the time	Increase of 2% on the monthly installment of the MONTHLY CONTRIBUTION
Increase of 5% to 10% of the time	Reduction of 5% on the monthly portion of the MONTHLY CONTRIBUTION
Increase of 10% to 20% of the time	Reduction of 10% on the monthly portion of the MONTHLY CONTRIBUTION
Increase of 20% to 30% of the time	Reduction of 15% on the monthly portion of the MONTHLY CONTRIBUTION
Increase of more than 30% of the time	Reduction of 20% on the monthly portion of the MONTHLY CONTRIBUTION

TECHNICAL ANNEXES

Connections **in the selected area**

Between the R. Conselheiro Rodrigues Alves and R. José do Patrocínio streets, without exceeding the limit of Av. Senador Dantas, so that they will be as far away as possible from the buildings that will not be expropriated.

Securing access to urban lots

Reorganization of the directions of the neighborhood's roads - **improving vehicle circulation**

Allow the **connection of the LRV modal**;

Redistribution of **light vehicles to the main arterial roads**

Redistribution of **trucks to the Perimetral road** - other movements are prohibited

Plan for **integration with the cycling system**

Noise and vibration monitoring

Assessment of the condition of existing buildings - after the work they shall be returned in the same condition

URBAN ACCESSES - Santos

TECHNICAL ANNEXES

URBAN ACCESSES - Guarujá

URBAN ACCESSES on the Guarujá side must consider:

I. a direct connection from the TUNNEL to Av. Santos Dumont, connecting to the existing device near the Santos Brasil Terminal (23°57'42.70“S/ 46°17'9.20”O);
II. a new road with two segregated directions of traffic in open and closed ditches between R. Mato Grosso and R. Guilherme Guinle, from the TUNNEL to R. Duque de Caxias;
III. connecting ring on the sloping road of item (ii) with Av. Santos Dumont at 14 Bis Square, for vehicles heading in the direction of Av. Santos Dumont - TUNNEL;
IV. adjusting flows in the 14 Bis Square area; and
V. connection with the SPA-248/055 highway at km 2.0 (coordinates 23°55'47.05“S / 46°17'3.71”O).

In order to adjust the flows in the 14 Bis Square area, the segregation of the various movements will have to be assessed, to reduce the number of traffic lights at the intersections, as well as the opening of a new road continuing along R. Maranhão to R. Mato Grosso with access to Av. Santos Dumont. The following road connections from item (ii) must also be provided:

Exits to R. Dr. Guilherme Guinle: a ramp near R. Treze de Maio, for access to Av. Santos Dumont, with 2 lanes in one direction towards the avenue; and another ramp at R. Álvaro Parente (flows into the future municipal road system), with the same geometric characteristics.

Entrances from R. Mato Grosso: a ramp on the stretch between R. Goiás and R. São Paulo, also with 2 traffic lanes; and another between Av. Guilherme Backeuser and R. Castro Alves.

TECHNICAL ANNEXES

URBAN ACCESSES - Guarujá

TECHNICAL ANNEXES

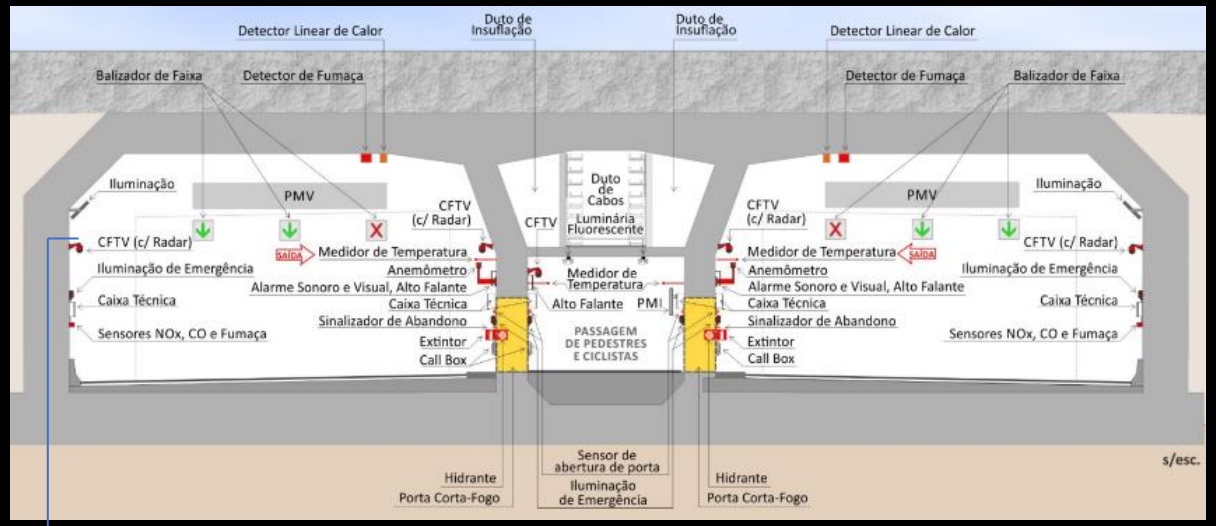
ACCESS BUILDINGS

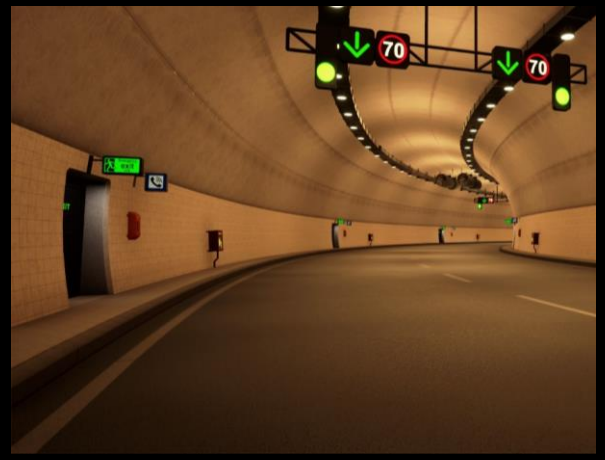
Pedestrian and cyclist access to the Tunnel

It can be used as an **Operational Control Center** and a place to park operational vehicles

TECHNICAL ANNEXES

OPERATING SYSTEMS

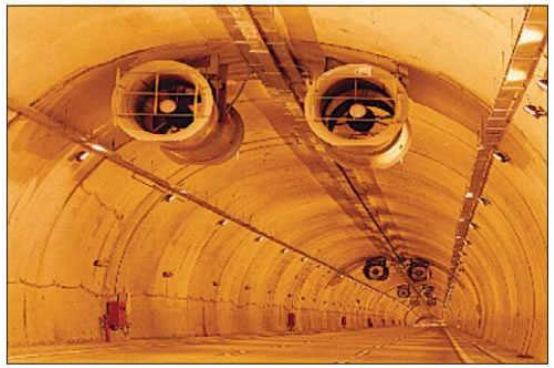


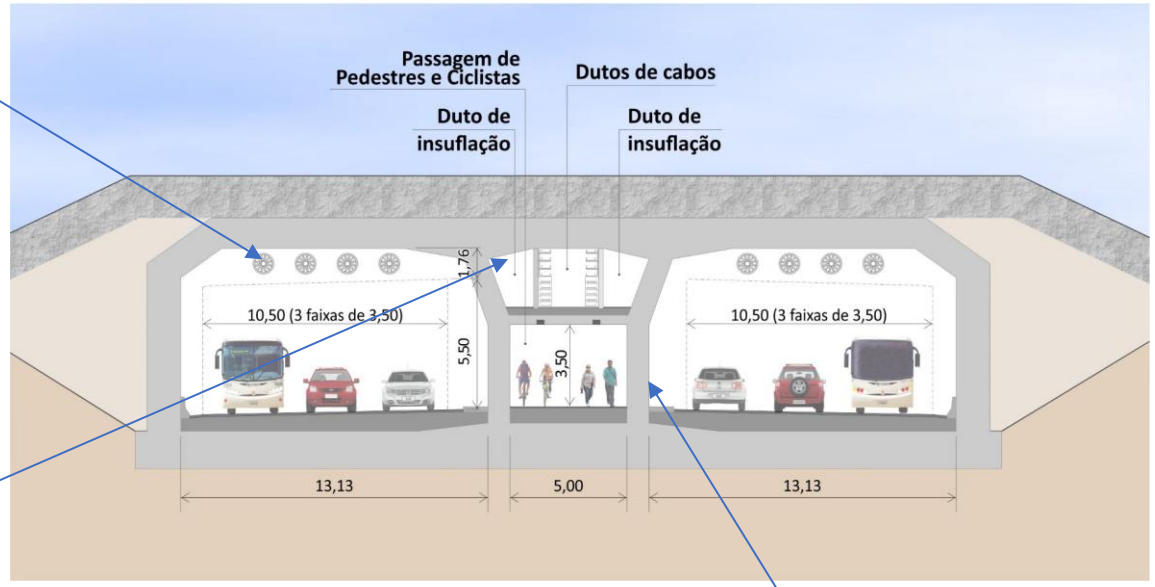


TECHNICAL ANNEXES

VENTILATION SYSTEM

Longitudinal ventilation





Pedestrian gallery: permanently ventilated with air insufflation:
a centrifugal fan at each end and two concrete ducts in the gallery ceiling, with grilles on the underside of these ducts.

Emergency doors every 150 m

TECHNICAL ANNEXES

OPERATING SYSTEMS

Ambulances for pre-hospital care with maximum service time

Operational Control Center

Winch trucks (heavy and light) to support users with guaranteed service time

Fire brigade team - small actions to receive the FB

TECHNICAL ANNEXES

Payment of the Contribution:

Notification of completion by the Grantee

↓

Notification of Inspection of INDEPENDENT AUDITOR

↓

PUBLIC REGULATORY AGENCY's decision

↓

Notification of Disbursement

↓

Grantee

PAYMENT OF THE CONTRIBUTION

- 100% of the Contribution is deposited when the Agreement is signed:
- 50% in the Federal Funding Account
- 50% in the State Funding Account

TECHNICAL ANNEXES

PAYMENT OF THE CONSIDERATION

Payment of the Public Consideration Due: made monthly

Downpayment adjustment

$$CPD_m = CP_m + T \times AD_{i-1} + T \times AUI_{m-3} - AA_i$$

Demand **Default User Adjustment**

Default Protection Mechanism

Default User Adjustment:

- 95% of paying axles from valid transactions
- 100% of paying axles from fraudulent invalid transactions.
- 0% of paying axles for transactions invalid for other reasons.

*Carried out every 3 months

Demand Protection Mechanism:

100% band used:

- Below 100% of Estimated Demand: The Granting Authority ensures 100% of the Estimated Demand;
- Above 100% of Estimated Demand: The Granting Authority keeps 80% of the surplus.

*Carried out at the end of each contract year - paid every 3 months

TECHNICAL ANNEXES

PAYMENT OF THE CONSIDERATION

Payment of the Public Consideration Due: made monthly

$$CPD_m = CP_m + T \times AD_{i-1} + T \times AUI_{m-3} - AA_i$$

Demand

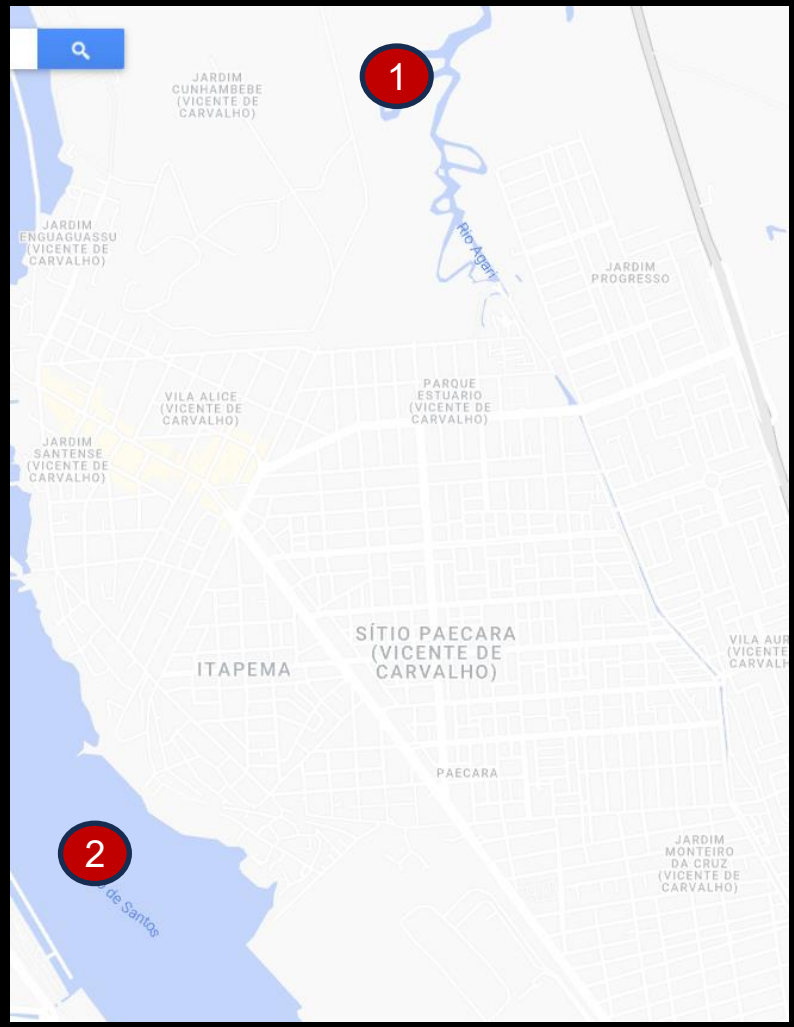
Default User Adjustment

Downpayment adjustment

Downpayment adjustment:

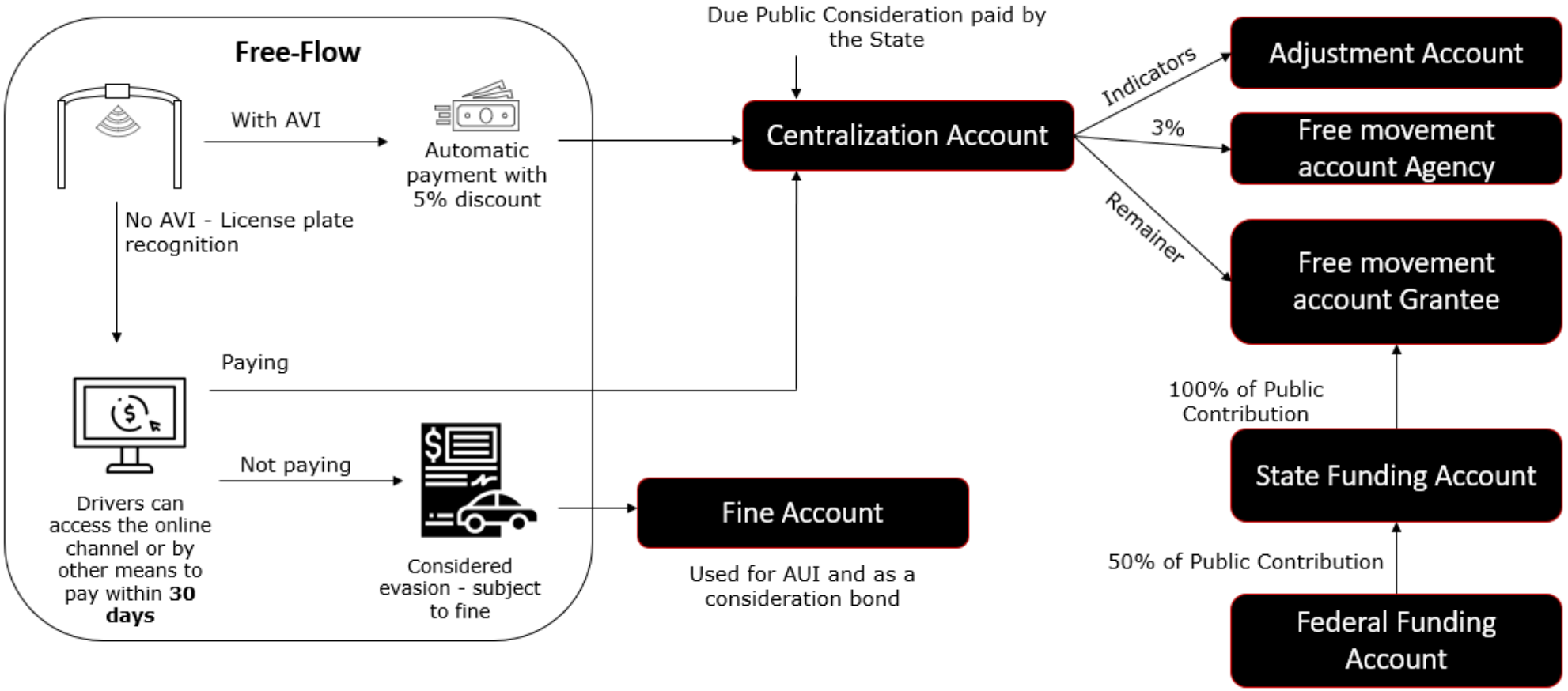
The Concessionaire can begin the Tunnel Operation and Toll Collecting before finishing urban access 1 and 2. But the payment of the consideration will be reduced by the following annual values

Year of the Operational Start	Annual Reduce of the consideration payment by not finishing the urban acess 1	Annual Reduce of the consideration payment by not finishing the urban acess 2
3	21.836.129,81	18,968,534,41
4	34.615.770,95	30.069.909,28
5	73.098.123,51	63.498.627,42
6 or more	8.787.620,29	7.633.599,88



CONCESSION

ACCOUNTS



CONCESSION

INDICATORS

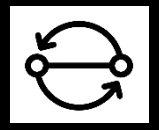
Topic	Topic Weight	Indicator	
1. Special Pavement Maintenance	20%	1.1	Compliance Indicator for Sidewalk Management System Periodic Update
		1.2	Condition Indicator for Pavement Comfort
		1.3	Condition Indicator for Pavement Safety
		1.4	Condition Indicator for Pavement Surface
2. User Service	15%	2.1	Time Indicator for Winch Truck Service Arrival
		2.2	Time Indicator for Mechanical Rescue Service Arrival
		2.3	Time Indicator for Medical Service Arrival
3. Routine Maintenance	22%	3.1	Compliance Indicator for Routine Conservation Programs
4. Fluidity	20%	4.1	TUNNEL Travel Time Indicator
5. Signaling	8%	5.1	Indicator for Vertical Signaling Integrity and Conservation
		5.2	Indicator for Horizontal Signaling Integrity and Conservation
6. Operational Equipment	15%	6.1	Indicator for PMV Operability
		6.2	Indicator for CCTV Operability
		6.3	Compliance Indicator for User Communication System's Availability with Wireless Network
		6.4	Operational Indicator for the Travel Time Control System

LEGAL DOCUMENTS

Tendering method

International Competition

Selecting criteria:
Greater discount of the consideration and then of the contribution



Dynamics of the competition

It begins with the evaluation of the commercial proposal, with the possibility of a tendering phase (auction)

Participation

Participation open to Brazilian and foreign companies, alone or in consortia - with no restrictions, except those arising from legislation

No minimum or maximum number of consortium members

Qualification of tenderers

Evidence of financial health

Technical qualification to prove the ability to manage infrastructure assets (certificate on behalf of companies in the economic group is allowed) that has generated minimum operating revenue to be indicated in the public notice and related to the construction and operation of an immersed tunnel (detailed below)

Conditions for signing the agreement

Incorporation of an SPE
Payment of minimum share capital
Presentation of the performance bond
Contracting insurances

CONCESSION

Technical experience envelope D

(i) Proof of capacity to manage infrastructure assets (a certificate on behalf of companies in the economic group is acceptable) that has generated minimum operating revenue of R$ 49.006.571,37;

(ii) Experience in the administration, management and operation of highways with at least 1 (one) immersed tunnel, with a minimum length of 500 (five hundred) meters;

(iii) Experience in the transportation and immersion of concrete modules in immersed tunnels;

(iv) Experience in infrastructure works containing the items indicated in the Table;

(iv) Experience in elaborating project of (a) immersed tunnel design using reinforced and/or precast concrete modules; and (b) diaphragm and/or barrel wall design using hydromill.

SERVICE DESCRIPTION	UNIT	REQUIREMENT
Mechanical excavation for construction sites without explosives	m³	218,000
Execution of diaphragm walls thickness ≥ 0.80 meter with height ≥ 40.00 meters with hydromill or other alternative	m³	qualitative
Volume of soil treated with jet grouting with a diameter ≥ 1.60 meters	m³	qualitative
Supply and crimping of carbon steel Combined Profile or other temporary containment alternative that allows dry working in a previously flooded area, with proof of appropriate methodology	kg	3,800,000
Execution of a tunnel using the NATM or Cut & Cover method with a minimum section of 60 m²	m	qualitative
Inverted method excavation	m³	120,000
Execution of maritime and/or river works with nautical support, using tugs, ferries and/or pontoons, in port areas or in navigable areas with ship traffic.	un.	qualitative
Dredging of marine or river bottom material	m³	1,400,000

For the purposes of item **(ii)** and **(iii)** proof by more than one certificate will not be accepted. For the purposes of items **(iv)** and **(v)** proof of experience of the service or group of services identified by more than one certificate will be accepted, and the sum of certificates for quantitative purposes of the same service is prohibited, when applicable. Proof of prior experience, related to items **(ii), (iii), (iv)** and **(v)** may also be made by means of certificate(s) of aptitude in the name of a subcontracted company, classified as a QUALIFIED SUBCONTRACTOR.
In the item **(iii)** the QUALIFIED SUBCONTRACTOR can be indicated by more than one consortium.

LEGAL DOCUMENTS

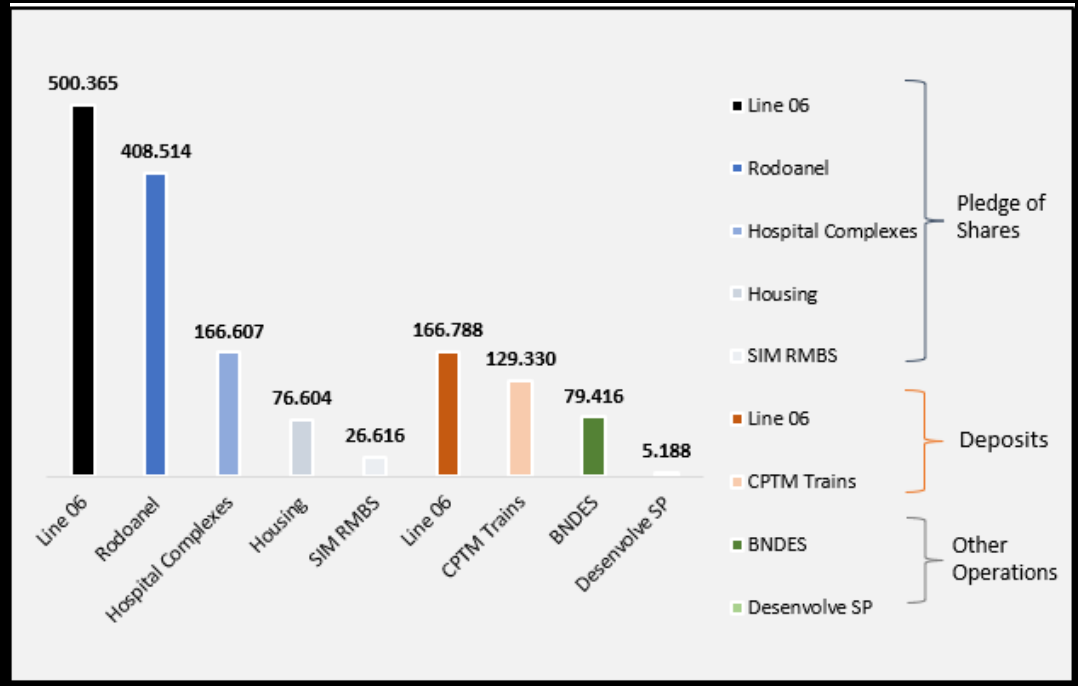
Companhia Paulista de Parcerias – CPP Bond

- Non-dependent state company

The bond will be secured by a pledge that can be allocated to the following assets:

- National public debt securities owned by CPP
- Fixed-Income Investment Funds backed by National Public Debt securities, or by Bank Deposit Certificates (CDBs), or other credit securities issued by financial institutions, or by Securities and Bonds, as long as they are rated with a low credit risk rating (AA on a national scale, or equivalent) issued by one of the rating agencies: Standard and Poor's (S&P), Moody's or Fitch Ratings.
- Bank Deposit Certificate - CDB, as well as other securities issued by a financial institution, with low credit risk, with a risk rating equivalent to or higher than AA on a national scale, issued by one of the credit rating agencies listed here: Standard and Poor's (S&P), Moody's or Fitch Ratings

TOTAL BONDS AND OTHER OPERATIONS: R$ 1,559 MM | JAN/25



** The CPP bond granted under the Litoral Paulista project is in the process of being set up (R$ 185 million)*

LEGAL DOCUMENTS

- Evasion: Shared (Consideration)
- Engineering work/project: Grantee
- Demand: Shared (Consideration)
- Geological: Shared
- Expropriations: Shared
- Transportation and immersion costs: Shared
- Interference: Shared

Geological Risk:

Geological conditions unknown to the PARTIES, as per APPENDIX F:

Restoring economic-financial balance: The Grantee must characterize and detail the materialization of the respective risk, describe the treatment it intends to adopt, with an indication of the respective engineering solution, as well as provide an estimate of values, based on a survey, and deadlines for the implementation of the proposed solution, as well as demonstrate the exact measure of the imbalance caused by the materialization of the risk.

Risk of Expropriation, Transportation and Immersion Costs and Interference:

Values set out in ANNEX 21.

100% < Amount ≤ 110% - GRANTEE will bear 100% of the surplus;

110% < Value ≤ 140% - The GRANTING AUTHORITY will bear 80% and the GRANTEE 20% of the surplus;

Value > 140% - The GRANTING AUTHORITY will bear 95% and the GRANTEE 5% of the surplus

The INDEPENDENT CERTIFIER is used for the expropriation mechanism.

TECHNICAL ANNEXES

GBR

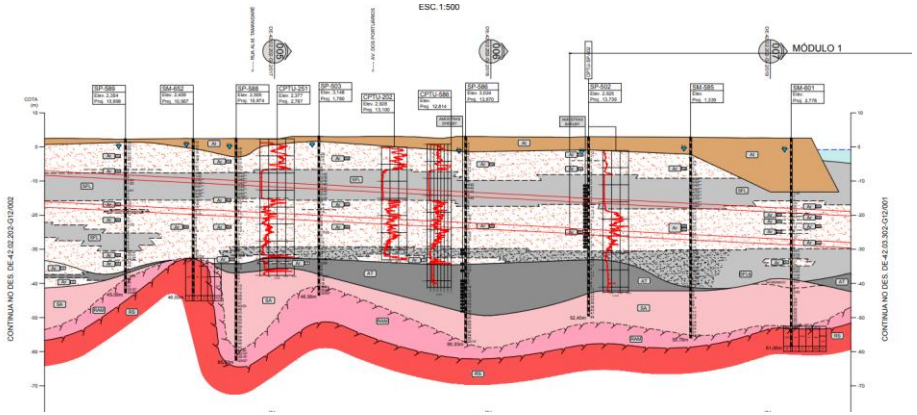
Coeficiente linear (*a*)	Universo de Parâmetros Geotécnicos					
	Doca Seca/Guarujá		Canal		Santos	
	SFL	AT	SFL	AT	SFL	AT
médio	403	760	416	1360	490	1284
desvio padrão	65	120	77	165	101	258

Coeficiente angular (*b*)	Universo de Parâmetros Geotécnicos					
	Doca Seca/Guarujá		Canal		Santos	
	SFL	AT	SFL	AT	SFL	AT
constante	32	32	32	32	31	31

Coeficiente	Universo de Parâmetros Geotécnicos					
	Doca Seca/Guarujá		Canal		Santos	
	SFL	AT	SFL	AT	SFL	AT
N_{ot}	3,4	3,3	3,4	2,7	3,2	3,2

Solos	Ar_1	SFL	Ar_2	AT	Ar_3	SA
γ_n (kN/m³)	18,0	15,0	16,0	16,0	18,0	18,0

- Boreholes - 190 boreholes and 9489.46 m of drilling and sampling;
- Mixed boreholes - 75 boreholes and 4000.2 m of drilling and sampling;
- CPTUS - 63 boreholes and 2313.66 m of tests;
- Cluster - (site with SP/SM, CPTU, Vane Test, shelby sampling) - 12 sites;
- Shelby samples - 79 samples;
- Multilevel piezometers - 5 sites and 14 piezometers;
- Infiltration tests - 52 tests;
- Water loss tests - 9 tests.



- Backfill (At) - miscellaneous materials;
- River and lagoon sediments (SFL) - very soft to soft marine clay, with sandy intercalations;
- Transitional clays (AT) - silty or sandy clay, **pre-compacted**, more resistant and less deformable than SFL clay;
- Sandy sediments (Ar);
- Rock alteration soil (SA) - sandy silt/slightly clayey sand;
- Soft altered rock (RAM)
- Hard altered rock (HAR)
- Sane rock (RS).
- Tunnel foundation predominantly in AT clay

THANK YOU