

# MARINE AND COASTAL

COMPANY PROFILE AND  
STATEMENT OF CAPABILITIES 2023

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# 1 Company Profile

## About TECHNITAL

### *Description*

TECHNITAL is a private joint stock company established more than 50 years ago (in 1964) and is one of the oldest engineering consultancy companies in Italy. Thanks to its high level of expertise, its dynamic nature and versatility, management autonomy and efficiency and its sophisticated hardware equipment and software libraries, the Company has been awarded large scale international and national projects by major public and private entities and by international funding organizations.

TECHNITAL's headquarters are situated in Verona, Italy. The organization abroad includes 15 between branches and subsidiaries in Algeria, Armenia, Bosnia & Herzegovina, Croatia, Djibouti, Georgia, Iraq, Kenya, Kosovo, Qatar, Tanzania, Trinidad & Tobago, Tunisia, Uruguay and Zambia and a number of local offices which is continuously changing according to the on-going international projects (at the moment there are 4 local site offices).

### *Services*

TECHNITAL is a dynamic company whose sectors of activity cover transport infrastructure (roads and motorways, railways, inland waterways, urban transport, ports and airports), hydraulics (water treatment and desalination plants, dams, aqueducts, sewerage systems, waste water treatment), maritime and coastal engineering, environment, energy (incineration and waste to energy plants, hydroelectric plants, solar plants, biogas plants), waste treatment (recycling plants, dump sites), buildings, architecture and urban planning.

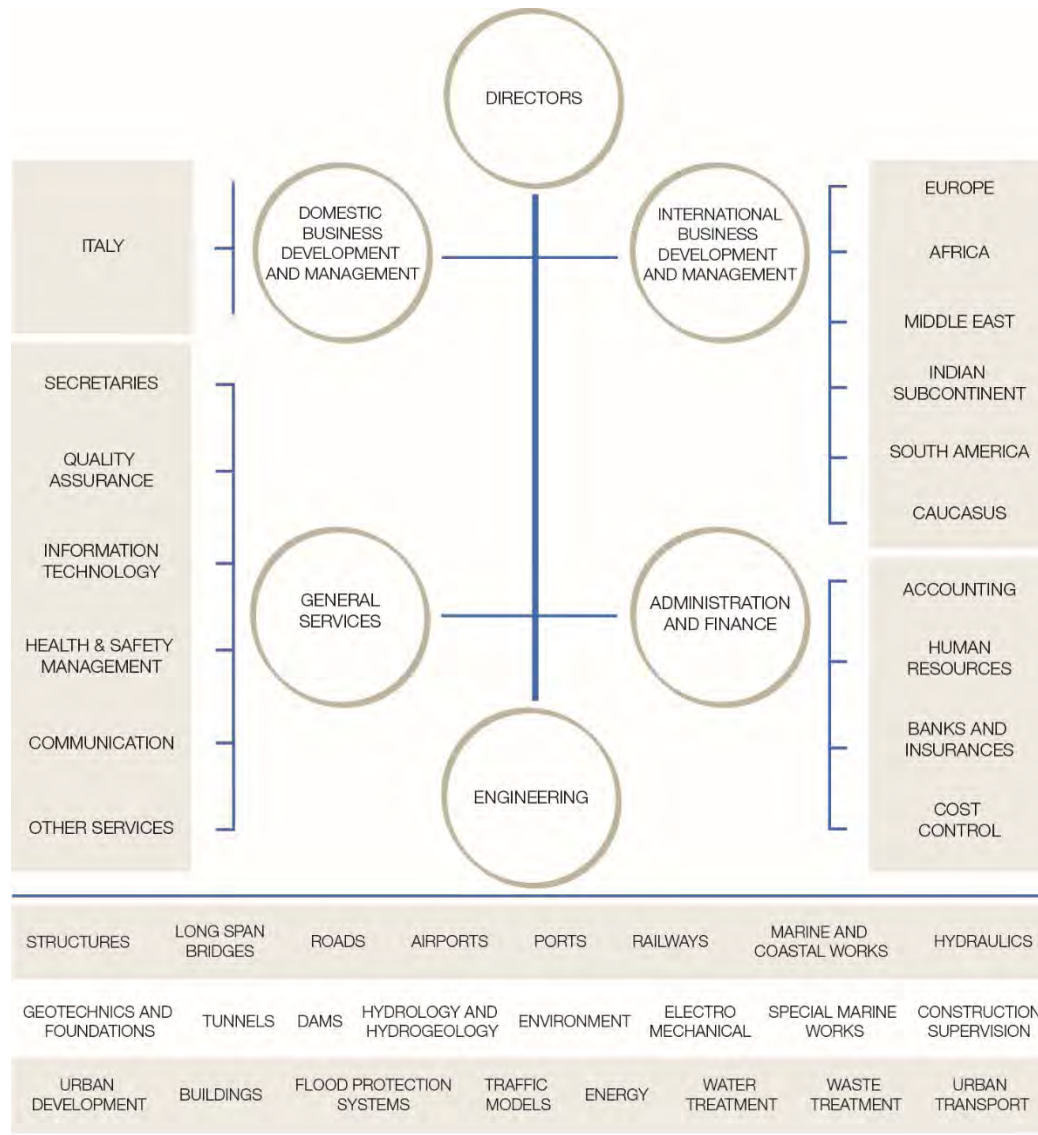
The company covers the full range of services, from planning and feasibility studies through to detailed design, works supervision and technical assistance:

- } project management
- } planning and economic-financial evaluation of investments
- } feasibility studies and technical-economic evaluations
- } all levels of design
- } environmental impact assessment and studies
- } traffic studies
- } procurement and assistance with tenders
- } construction supervision, quality assurance, testing and commissioning
- } co-ordination and supervision of research and laboratory tests
- } development of hydrodynamic and hydrogeological analysis and simulations
- } development and application of analysis methods and computer modelling.

TECHNITAL has worked in several countries world-wide: Afghanistan, Albania, Algeria, Angola, Argentina, Armenia, Australia, Austria, Bahamas, Benin, Bolivia, Bosnia & Herzegovina, Brazil, Bulgaria, Burkina Faso, Burundi, Cayman Islands, Colombia, Croatia, Cuba, Cyprus, Czech Republic, Democratic Republic of the Congo, Djibouti, Dominican Republic, Egypt, Ethiopia, Georgia, Germany, Ghana, Greece, Guatemala, Hungary, India, Iraq, Italy, Jordan, Kenya, Kosovo, Libya, Madagascar, Malawi, Malaysia, Mali, Mauritania, Monaco, Montenegro, Mozambique, Nicaragua, Niger, Norway, Panama, Peru, Poland, Qatar, Republic of Haiti, Romania, Russia, Rwanda, Saudi Arabia, Senegal, Slovenia, Somalia, Spain, Sudan, Syria, Tanzania, Togo, Trinidad & Tobago, Turkey, Uganda, Ukraine, U.A.E., United Kingdom, U.S.A., Uruguay, Venezuela, Yemen, Zambia.

*Organization and staffing*

TECHNITAL's multidisciplinary staff is organized according to the following chart:



**TECHNITAL's multidisciplinary staff includes about 250 professional employees covering the various aspects of the engineering services:** Transport, Hydraulics, Geotechnical, Marine & Coastal, Environmental Studies & Territorial Analysis, Structures, Electronic Data Processing & Systems Analysis, Quantity Surveying & Cost Estimation, Electromechanics, BIM/CAD/CAE, Works Supervision, etc.

Whenever required for the solution of specific problems, the home group is integrated by external consultants and specialists, both Italian and foreign. Seeking assistance and advice from colleagues, scientists, and academics throughout the world is part of TECHNITAL's policy of aiming for excellence.

Given the firm's considerable international experience, TECHNITAL's staff are perfectly at ease working in the main international languages (English, French, Spanish) and using international engineering codes (BS, ASTM, AASHTO, ASME, API and the like) and contract conditions (FIDIC and others).

### *Quality control*

TECHNITAL's activity is ISO 9001:2015 Quality System Management certified. The company is also certified ISO 14001: 2015 Environmental Quality Management, ISO 45001:2018 Occupational Health and Safety Management System and SA 8000:2014 Social Accountability Management System.

TECHNITAL has developed a company policy regarding quality control which is constantly being updated and applied, taking into account the costs to be sustained to achieve the objectives of quality and maximum benefit for both the Company and the Client. Thanks to its Quality Control System, TECHNITAL is capable of guaranteeing the quality of its services and of ensuring the Client that these services satisfy the required quality standards.

### *Code of Ethics*

Ethical and responsible decision making is very important for the company in terms of risk management and in order to keep actions within the ethical and legal boundaries.

For that reason, the company is adopting a Code of Ethics (available from the web site of the company) and conduct for its Executives and Directors and for all the Employees able to fulfill requirements for responsible decision taking. Such code aims at reducing the possibility of stepping outside behavioral limits set by the company.

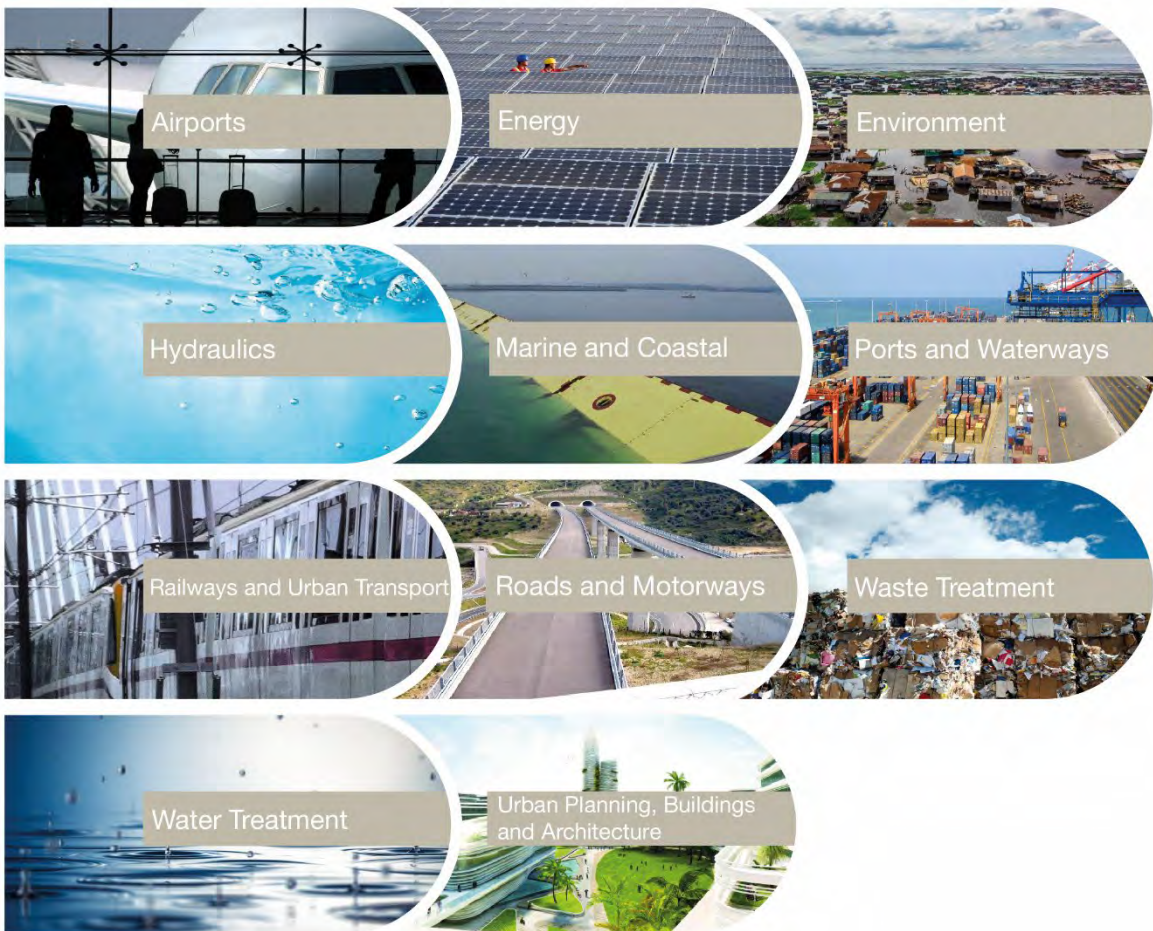
The Code of Ethics the company is adopting also meets the Organization, Management and Control Model pursuant to Italian Legislative Decree n. 231/2001.

*Sectors of Specialization*

TECHNITAL provides high-quality consultancy services in different areas of specialization: Roads and Motorways, Railways and Urban Transport, Airports, Ports and Waterways, Marine and Coastal Engineering, Environmental Engineering, Urban Planning, Buildings and Architecture, Hydraulic Engineering, Water Treatment, Waste Treatment, Energy.

In each of these sectors, TECHNITAL provides innovative project solutions to Government Agencies, International Financial Institutions and Private Sector Organizations.

Services provided by TECHNITAL include master plans, feasibility studies, techno-economical evaluations, traffic studies, mathematical and physical modeling, all phases of design from concept to detailed design, environmental impact studies and monitoring plans, tender document preparation and assistance in the procurement of works, construction supervision.



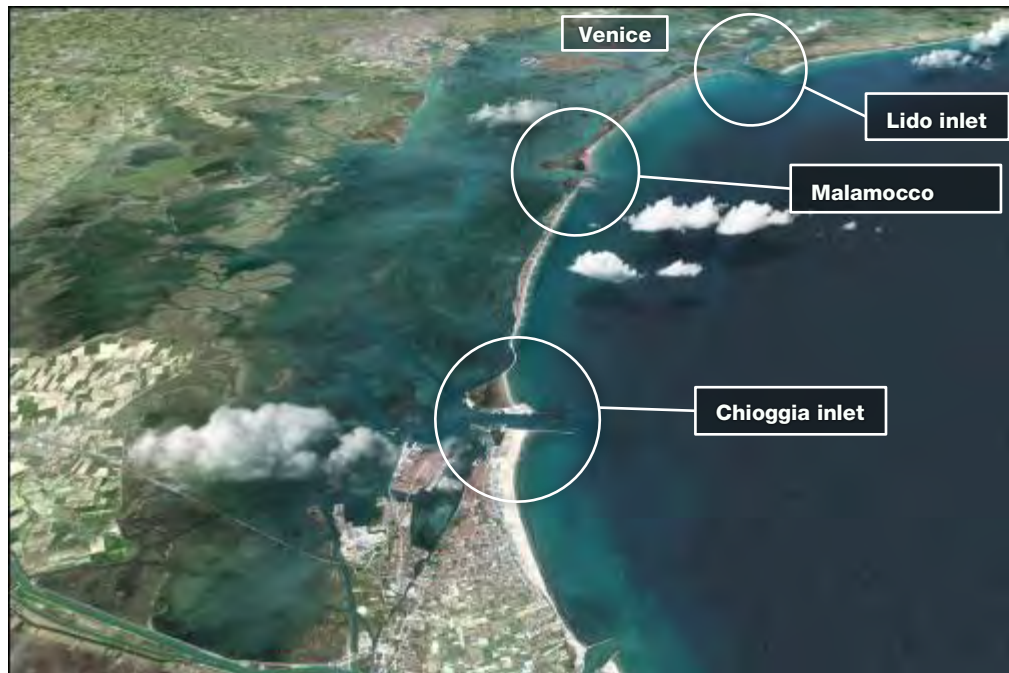
## 2 Our Experience

### Experience in Marine and Coastal Engineering

The accumulated experience of TECHNITAL in the field of Marine and Coastal Engineering dates back to the 1970s and includes numerous large scale international and national projects.

*(For ports and waterways projects, please refer to "Ports and Waterways" brochure).*

When TECHNITAL was awarded in 1986 the **huge Project for safeguarding the city of Venice and its cultural/historical heritage against the high water** (now internationally known as the **MOSE Project** - one of the most complex maritime works worldwide with a cost of 4.7 billion Euro), this could already offer a considerable and long-term experience in marine and coastal engineering. In the succeeding years this experience has been continuously enhanced through TECHNITAL's constant involvement in the design of ports, breakwaters and coastal protection works, in the execution of hydrodynamic and morphological studies of particularly complex physiographic areas, and in the planning and management of pilot interventions and model studies.



MOSE – Project location

Moreover, through recent developments, this potential is being brought up to date with the new requisites, in compliance with the Company's policy of focusing on the Client and his needs, interpreting them in the light of a scientific approach and a mastery of the latest technological discoveries at the highest levels. Thanks to the setting up of an integrated series of mathematical models, the understanding of the main phenomena interacting in coastal dynamics and the design of even unconventional marine works can be based on sound scientific foundations.

TECHNITAL provides integrated general engineering services from land and marine infrastructure planning and feasibility studies, through to final design and construction management. Besides typical engineering aspects, a very important issue in the Marine and

Costal Engineering is the study of the environment and of the effects induced by the interventions and therefore particular attention is also paid to eco-technological developments, adapted to ensure that the coastal protection works blend in as well as possible with the environment, such as the replanting of the meadows of marine Phanerogams and the reconstruction of coastal dunes.

In the firm belief, the engineering aspects must increasingly be coupled with the economic aspects and the land use, TECHNITAL has also developed an information system for coastal zone management (SIGMa) specifically aimed at the public authorities responsible.

TECHNITAL's qualifications and experience in marine engineering have been greatly enhanced by the firm's involvement over the past two decades in the scheme of Works for safeguarding Venice from tidal flooding (**MOSE**). During this time TECHNITAL has carried out numerous studies and projects, among which:

- the preliminary and detailed designs of Flood control barriers at the three inlets of the Venice Lagoon, one of the largest marine engineering projects of our times, consisting of four barriers with buoyancy flap-gates, at Lido, Malamocco and Chioggia inlets (in total 35 caissons and 79 flap-gates), including navigation locks and refuge harbors, and all maintenance and ancillary facilities;



Chioggia inlet – Precast caissons yard



Caisson under construction

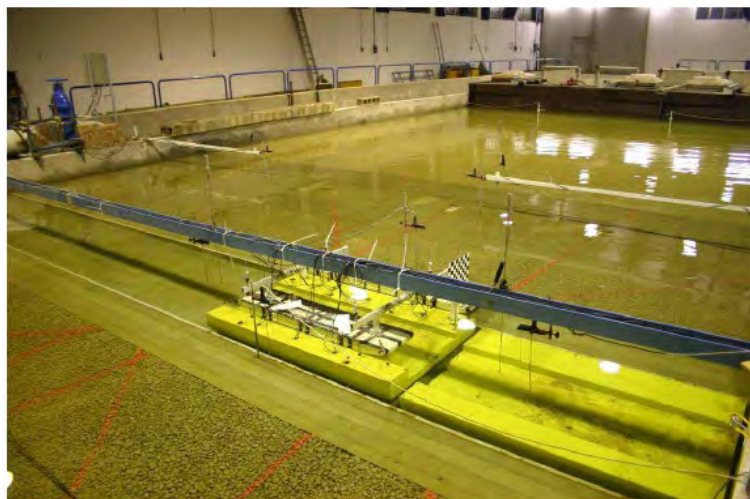
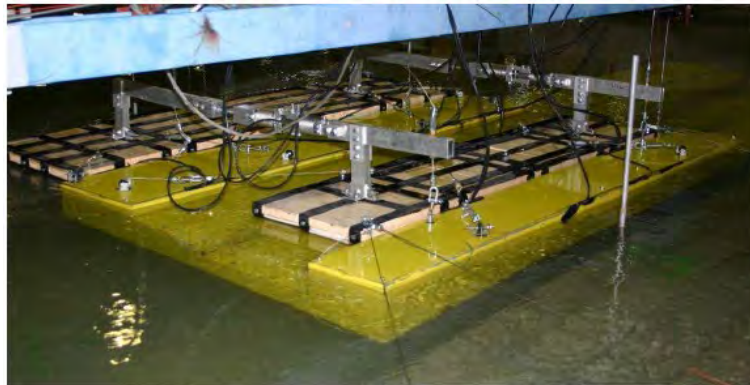


Steel mobile surge barriers

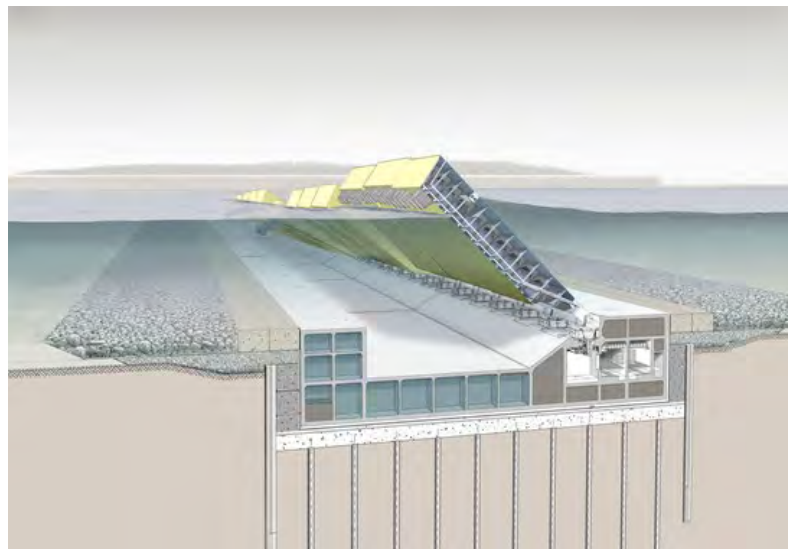


- ↳ the preliminary and final design for the restructuring of the six breakwaters protecting the three inlets of the Venice lagoon;
- ↳ the final design of the interventions of dredging the navigation channels and rebuilding the saltmarshes and the tidal flats;
- ↳ general plan and preliminary and detail designs of the works to protect the littorals which separate the Venice lagoon from the sea (approximately 40 km in total), including protected beach nourishment, reinforcement and protection of the existing sea wall, reconstruction of certain stretches of the dunes, and replanting of the flora;
- ↳ detail design of some 13,000 m of quays and shore protection works inside the lagoon.

Furthermore, in relation to the realization of the flood control barriers TECHNITAL has gained a unique and highly specialized experience through the execution of very specific marine, structural and environmental studies and designs, often posing peculiar problems which have required innovative solutions.



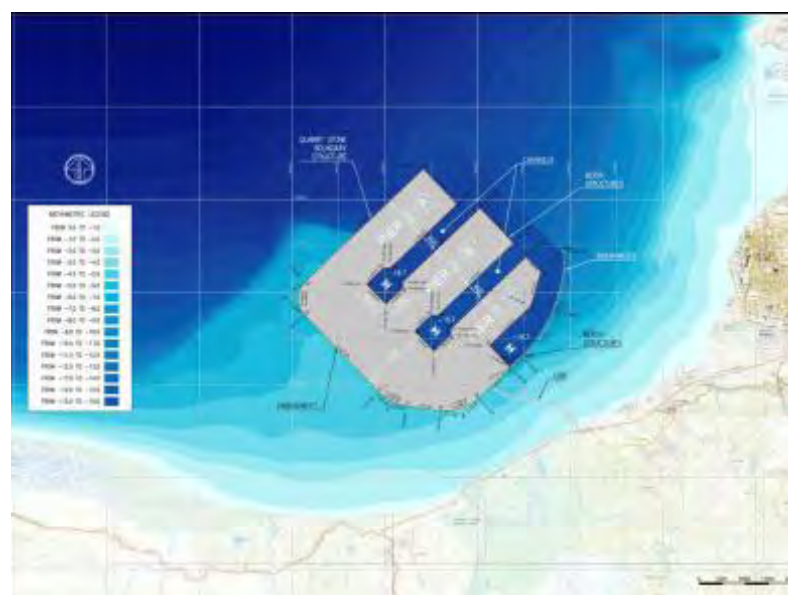
Physical Model for caisson sinking procedure



Section of the mobile surge barriers

A very important assignment in the specific field of Marine and Coastal Engineering has been the **Oropuche Bank Reclamation Project in Trinidad & Tobago**. The subject is a large land reclamation of 1,600 Ha in the form of an artificial island to be built for the relocation of the industrial activities in Trinidad and therefore to avoid consuming land side areas, thus reducing the impact on the population.

Several environmental studies were developed to define location and shape of the new island. The studies included extensive numerical modelling analysis on the local conditions as well as on the general conditions of all the Gulf of Paria in order to highlight possible impacts. The proposed reclamation site is located in a sensitive area, from the morphological and ecological point of view; it is characterised by the presence of the Godineau river mouth, extensive mangrove swamps and is presently a very important fishing ground for shrimps; all these aspects were considered in order to find the more sustainable layout of the new island. Among the aspects studied were: sediment transport, waves, littoral currents, river discharges, coastline evolution, benthic life, fishing activities. As a consequence, the final layout of the island was defined.



Oropuche Bank Reclamation Project – selected location of the new island

Once the place, the shape and the size was decided, a Master Plan of the industrial development on the new island was performed. Industrial planning necessary to define the characteristics and the reciprocal position of the industries that will be installed in the new island and of the relevant port facilities were defined for different development scenarios, considering different combinations of heavy and light industries as well as of tertiary sector.

Among the international projects in the specific field, it has to be certainly mentioned the **Land Reclamation and Revetment Works for New Doha International Airport in Qatar**. The assignment consists to provide design and tender documents for the reclamation of a platform of about 110 Ha of land and mostly sea and for the related measures of controlling erosion.



Land Reclamation scheme at NDIA (Qatar)

TECHNITAL has undertaken the **Feasibility Study for the Dredging of Dar es Salaam Port Entrance Channel and turning basin in Tanzania** and it has recently awarded the **related Detailed Design**. The project aimed at ensuring the possibility for post-Panamax to access to the port facilities. The activities have covered all surveys (bathymetry, hydrodynamics, geotechnics, water quality), mathematical models for the hydrodynamic and sedimentation aspects, real-time simulation of manoeuvring, alternatives assessment and their comparison by a cost-benefits analysis.



Entrance Channel and turning basin of Dar es Salaam – Tanzania

An Italian important assignment carried out by the company has been the **Master Plan of the Works to Protect the Coasts of Calabria Region in Italy**. Besides the scale of the project which was covering whole region in the south of Italy, the project is important because represents an application on planning large scale of the concepts related to the coastal protection and because it was involving 740 km of coast and about 40 ports including Gioia Tauro (the largest transshipment port in the Mediterranean Sea), Villa S. Giovanni, Reggio and Crotona-Porto Nuovo.



A section of the Coast of Calabria Region

Finally, of absolute relevance are also various projects along the littorals protection which are complementary to the MOSE and are located in the area of Venice Lagoon.

Such **General Plan for the interventions along the littorals of the Venice Lagoon in Italy** covers about 60 km of coastline (sections are in Sottomarina, Pellestrina, Lido, Cavallino, Isola Verde and Jesolo) includes the organization and management of extensive measurement surveys; the examination of the coastal regimen using mathematical models of the hydrodynamic, wave motion and sediment transport phenomena as well as the definition and design of the defense works.

Services provided by TECHNITAL include:

1. Consulting
  - } Master Plan
  - } Technical-economic feasibility studies
  - } Financial analyses
  - } Socio-economic analyses
  
2. Design
  - } All phases of design from preliminary up to construction design
  - } Preliminary and final design of plants and equipment
  - } Preliminary and final design of electrical and mechanical installations
  - } Technical specifications, contracts, construction planning, cost estimates
  - } Environmental impact studies
  - } Tender documents preparation
  
3. Supervision
  - } Construction management and supervision
  - } Technical assistance during tender stage
  - } Works supervision
  - } Coordination and supervision of research and laboratory tests
  - } Environmental monitoring

It is worth to say that the design of marine and coastal structures normally requires the ability to analyze the environmental conditions to properly define the design criteria and evaluate environmental effects and stresses on the works. To support these studies TECHNITAL uses physical models and a series of state of the art well tested mathematical numerical models which enable the interpretation of the data collected in the field and the prediction of the likely effects on the new structures as well as induced by the new structures on the marine environment and on the coast/water.

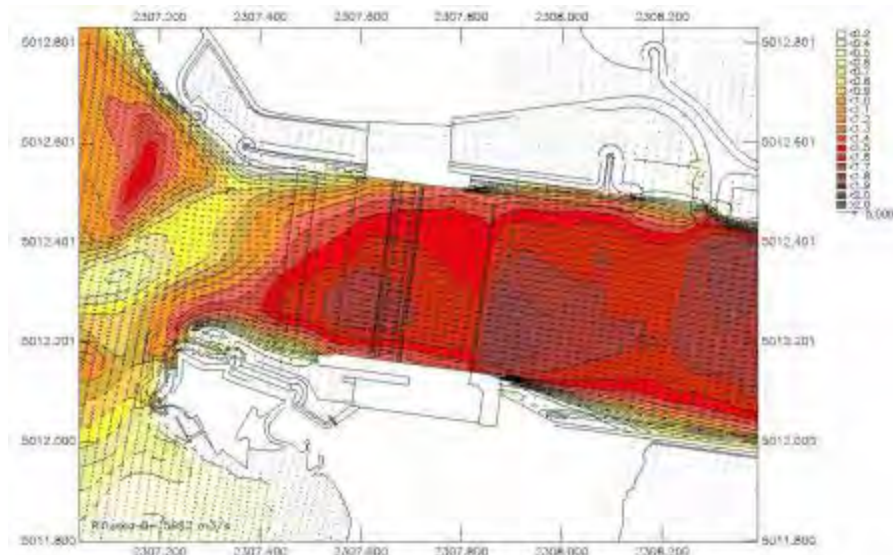
As far as physical models are concerned, company's staff is normally involved in the design of the models and in the numerical results interpretation and analysis. On the contrary mathematical models are managed directly by the company's staff and they can be operated in a 2D or 3D configuration depending on the type of phenomena to be studied

Among the numerical models usually applied, are:

- } hydrodynamic models, able to reproduce the all the main hydrodynamic phenomena (drying and flooding of tidal flats, density driven flows, wave induced stresses and mass fluxes, flow through hydraulic structures wind driven flows including cyclonic / hurricane / typhoon winds etc.);
- } morphological models, to study the solid transport, the sediment distribution patterns, the erosion /deposition phenomena;
- } shoreline evolution model used in the analysis of the large-scale morphology of coastal systems to provide insight into the causes of coastal erosion or to predict the impact of planned coastal infrastructure, such as a port on the coast. It is

possible to evaluate the shoreline evolution around coastal protection works, such as groynes, revetments, river mouth training works and to some extent detached breakwaters;

- } numerical model based on the wave SMB hindcasting procedure to reconstruct in a defined location a wave time series when local wind measurements are available. The model also allows to transfer directional wave recordings between two points having a similar exposition to prevailing winds;
- } wave propagation model for the simulation of waves in deep, intermediate and shallow water. The model is a 3rd generation spectral model that accounts for (refractive) propagation due to current and depth and represents the processes of wave generation by wind, dissipation due to bottom friction, depth-induced wave breaking and non-linear wave-wave interactions;
- } wave propagation model into harbors and lagoons, able to predict the short wave penetration around coastal structures (e.g. breakwaters) and the resonant behavior of enclosed areas to incident long waves. This model allows defining the wave disturbance at the berthing facilities and the downtime in the loading/unloading operations.



Numerical Model for wave speed distribution at Chioggia Inlet (MOSE Project)

The following table and related projects sheets give full details of the main projects performed in this field.

TABLE A – COMPANY’S EXPERIENCE (For titles in **bold** type see project sheets in Appendix A)

PROJECT	CLIENT	PERIOD		ACTIVITIES	COST OF SERVICES €	COST OF WORKS €
		FROM	TO			
<b>COASTAL ENGINEERING WORKS</b>						
Defense and beach nourishment interventions in the Gulf of Salerno coastline – 1 <sup>st</sup> part: construction of the cellular defense system between the mouth of the river Picentino and Magazzeno shoreline – Italy	Municipality of Salerno	01/2022	Ongoing	Engineering Studies; Detailed Design	637,000	17,801,759
<b>Safeguard and rehabilitation works of the coastal area of 14 municipalities in Sicily facing the Tyrrhenian Sea – Italy</b>	Government Commissioner against hydrogeological instability in Sicily	05/2021	Ongoing	Geological study; Preliminary design; Detailed design; Mathematical Modelling	366,076	5,000,000
<b>Batumi Coastal Protection – Georgia</b>	Municipal Development Fund of Georgia	10/2014	02/2022	EPCM, Works Supervision	1,880,779	18,250,000
<b>EPIC for the Coastal Erosion and Shoreline Protection of Halul Island - Qatar</b>	Consolidated Engineering Construction Co (CECC)	12/2016	06/2020	Detailed Design	550,268	50,000,000
<b>Engineering consultancy services related to the construction of the cruise ship docking facilities at the Ocean Cay MSC marine reserve - Bahamas</b>	GLF Construction Corporation	07/2016	10/2019	Detailed Design; Site Supervision; Technical Assistance during Construction	530,640	25,000,000
Project Management and Post Contract Quantity Surveying Services for Expansion of the Navigation Channels & Turning Basin at Simaismah and Marine Protection Works, Beaches and Access Channels for Lusail Islands 1, 2, 3A, 3B, 3C and 3D – Qatar	Private Engineering Office	01/2014	02/2017	Construction Supervision; Technical Assistance; Contract Management	2,400,000	815,025,439

PROJECT	CLIENT	PERIOD		ACTIVITIES	COST OF SERVICES €	COST OF WORKS €
		FROM	TO			
Post Contract Consultancy Services for Design & Build of Four Beaches (Lusail, Al Wakra and two in Simaismah) - Qatar	Private Engineering Office (PEO)	11/2014	05/2016	General Supervision; Site Supervision	948,500	199,267,043
<b>Design Review and Post-Contract (General Supervision, Site Supervision and Quantity Surveying) Consultancy Services for Navigation Channel, Coast Guard Base and Secondary Navigation Channel, Qatar</b>	Private Engineering Office	10/2012	01/2014	Design Review; Works Supervision; Technical Assistance	765,000	135,765,541
<b>Beach development at Ras Ushayriq peninsula – Qatar</b>	Al-Ali Projects	07/2011	05/2012	Concept, Preliminary and Detailed Design	400,000	31,400,000
<b>Coastal protection works in the Municipality of Lecce and neighbouring areas affected by erosion phenomena – Italy</b>	Municipality of Lecce	04/2001	12/2011	Preliminary and Detailed Design; Works Supervision	323,462	4,322,000
New Marina and Requalification of the waterfront at Vado Ligure, Italy	Port Authority of Savona	10/2008	02/2010	Feasibility Study; Preliminary Design	710,000	63,349,249
<b>Sea defenses to protect Lido littoral (11.5 km) - Venice, Italy</b>	<i>Venezia Nuova</i> Consortium for Ministry of Public Works - Water Board - Venice	10/1998	12/2008	Preliminary and Detailed Design	1,583,800	20,143,600
<b>Chiva Som health resort &amp; spa – Qatar</b>	Qatari Diar Real Estate Investment Company	08/2006	12/2006	Concept, Preliminary and Detailed Design; Tender	318,000	59,460,000
<b>Master Plan &amp; Detailed Design of Public Beaches - Qatar</b>	Ministry of Municipal Affairs & Agriculture (Department of Technical & Economic Studies)	08/2003	05/2005	Master Plan; Preliminary and Detailed Design	225,000	12,000,000



PROJECT	CLIENT	PERIOD		ACTIVITIES	COST OF SERVICES €	COST OF WORKS €
		FROM	TO			
Sea defenses to protect Isola Verde littoral (2.5 km) - Venice, Italy	<i>Venezia Nuova</i> Consortium for Ministry of Public Works - Water Board - Venice	05/1996	03/2005	Preliminary and Detailed Design	412,800	8,215,000
Master plan of the works to protect the Calabrian coasts – Italy	Public Works Department for Calabria Region	03/2001	09/2003	Master Plan	1,151,690	170,000,000
Sea defenses to protect Jesolo littoral (12.5 km) - Venice, Italy	<i>Venezia Nuova</i> Consortium for Ministry of Public Works - Water Board - Venice	03/1994	10/2003	Preliminary and Detailed Design	706,000	12,391,700
Sea defenses to protect Sottomarina littoral (3.5 km) - Venice, Italy	<i>Venezia Nuova</i> Consortium for Ministry of Public Works - Water Board - Venice	04/1994	05/1999	Preliminary and Detailed Design	303,000	4,462,000
Sea defenses to protect Pellestrina littoral (11 km) - Venice, Italy	<i>Venezia Nuova</i> Consortium for Ministry of Public Works - Water Board - Venice	04/1990	09/1998	Preliminary and Detailed Design	2,458,250	118,851,000
Sea defenses to protect Cavallino littoral (13 km) - Venice, Italy	<i>Venezia Nuova</i> Consortium for Ministry of Public Works - Water Board - Venice	04/1990	04/1997	Preliminary and Detailed Design	1,382,650	42,171,000
Environmental recovery and protection of the coastal wetland of Molentargius and protection of Poetto littoral - Sardinia, Italy	Ramsar-Molentargius Consortium for Ministry of Environment	06/1992	10/1993	General Master Plan; Preliminary and Detailed Design	621,500	61,974,800
Sea defenses to protect the Venice ports and lagoon - Venice, Italy	<i>Venezia Nuova</i> Consortium for Ministry of Public Works - Water Board - Venice	01/1988	12/1990	General Master Plan; Concept Design	6,846,500	206,234,300

PROJECT	CLIENT	PERIOD		ACTIVITIES	COST OF SERVICES €	COST OF WORKS €
		FROM	TO			
<b>DREDGING &amp; RECLAMATION WORKS</b>						
Restoration of sediments basin located at Vigliena in the Port of Naples, including dredging from the harbour's bed and their discharge into the basin – Italy	Central Tyrrhenian Sea System Authority - Naples	09/2022	ongoing	Design review, Detailed Design, Works Supervision, Safety coordination during design phase	860,000	12,000,000
Maritime defense works and dredging for the construction of the platform "Europa" in the port of Leghorn – 1st phase – Italy	Northern Tyrrhenian Sea Port System Authority – Leghorn	01/2022	ongoing	Detailed design	1,681,041.55	411,000,000
Al Ruwais Port: deepening of access channels, making good of basins and extension of outer quay wall – Qatar	Mwani Qatar	12/2021	ongoing	Preparation of Market Study; Development of Design Report (Preliminary Design); Detailed Design and Tendering Package; Works Supervision	3,935,000	n.d.
Construction of the Infrastructures Phase 1 - Dredging and Reclamation Works - Al Faw Grand Port in Iraq	Ministry of Transport of the Republic of Iraq (GCPI)	12/2020	Ongoing	PMC, Works Supervision	11,692,859	594,414,135
Construction of the Infrastructures - Phase 1 – Construction of Navigation Channel - Al Faw Grand Port in Iraq	Ministry of Transport - General Company Ports of Iraq (GCPI)	12/2020	Ongoing	PMC, Works Supervision	2,556,795	258,122,302
<b>Consulting services for Ravenna Port Hub Project: dredging of Candiano and Baiona channels, adaptation of existing quays, new terminal container, sediment management– Italy</b>	Consorzio Stabile Grandi Lavori s.c.r.l – Dredging International s.v.	08/2020	Ongoing	Detailed Design	1,773,752	197,848,915

PROJECT	CLIENT	PERIOD		ACTIVITIES	COST OF SERVICES €	COST OF WORKS €
		FROM	TO			
Preliminary design of the dredging of the Oil "Darsena" inside the Port of Naples, Italy	Kuwait Petroleum Italia S.p.A.	10/2019	03/2021	Preliminary Design	107,823	3,500,000
Detailed dredging design and disposal of dredging material for dredging of the entrance channel, harbour basin and turning circle of Dar Es Salaam Port – Tanzania	Tanzania Ports Authority	08/2018	07/2019	Detailed Design, Tender documents, Environmental Investigations	1,099,640	109,833,044
Land Reclamation and Revetment Works for New Doha International Airport (Contract NDIA-2/0001) – Qatar	New Doha International Airport (NDIA)	04/2008	05/2018	Concept and Detailed Design; Tender Documents	2,831,118	71,425,000
Consulting services for feasibility study including bathymetric hydrodynamic and geotechnical surveys for Dredging of Dar es Salaam port entrance channel and turning basin – Tanzania	Tanzania Ports Authority (TPA)	12/2015	12/2016	Feasibility Study; Concept Design; EIA	2,683,847	To be tendered (confidential)
Oropouche Bank Reclamation Project – Trinidad & Tobago	National Energy Corporation of Trinidad & Tobago Limited (NEC)	08/2008	12/2010	Master plan; EIA; Detailed Design; Tender Documents	3,070,000	1,870,911,000
Cleaning of Al Dakhira Channel – Qatar	PWA-Building Affairs	05/2009	11/2010	General and Site Supervision	133,000	2,804,400
Construction of Doraleh Container Terminal on Steel Pipe Piles (Land Reclamation) – Djibouti	Dubai Ports World	06/2007	12/2009	Design Review; Works Supervision	500,000	10,412,328
Deepening of Al Wakrah port and access channel – Qatar	Public Works Authority – Building Affairs, State of Qatar	03/2006	02/2009	General and Site Supervision	298,700	9,660,600

PROJECT	CLIENT	PERIOD		ACTIVITIES	COST OF SERVICES €	COST OF WORKS €
		FROM	TO			
<b>Reconstruction of saltmarshes in Venice lagoon – Italy</b>	<i>Venezia Nuova</i> Consortium for MoPW - Water Board - Venice	12/1989	12/2007	Model studies; Preliminary Design; EIA; Detailed Design; General Supervision	20,000,000	400,000,000
<b>Development of Al Khor port and channel (Contract: BUC 2005001) – Qatar</b>	Public Works Authority – Building Affairs, State of Qatar	03/2006	11/2007	General and Site Supervision	660,000	15,000,000
<b>Land Reclamation for LNG Tank Farm in Ras Laffan– Qatar</b>	GLF Middle East for Qatar Petroleum (QP)	02/2002	12/2002	Detailed Design and As Built Drawings	90,000	15,500,000
<b>Dredging works, land reclamation and disposal of polluted soils for the shaping of the navigation channels of the Venice ports and lagoon – Italy</b>	<i>Venezia Nuova</i> Consortium for Ministry of Public Works - Water Board - Venice	04/1987	09/1997	Preliminary Design, EIA; General Supervision	9,259,200	232,405,600
<b>SPECIAL MARINE WORKS</b>						
<b>Mobile surge barriers at the three inlets of the Venice lagoon (Mo.S.E.) – Italy</b>	<i>Venezia Nuova</i> Consortium for Ministry of Public Works - Water Board - Venice	01/2005	Ongoing	Detailed Design, Technical Assistance	110,000,000	8,000,000,000
Tender Design Services for The Fehmarnbelt Fixed Link – Contract Tus & Tun – Production Facilities – Denmark and Germany	SI-S-BU (JV Salini Impregilo – Samsung C&T Corporation – Bunte)	10/2013	06/2016	Preliminary Design	292,000	150,000,000
Detailed design of the barrier caissons at the four Venice lagoon inlets - Italy	Consorzio Venezia Nuova, concessionary of the Ministry for Infrastructure and Transport - Venice Water Authority	01/2007	12/2013	Detailed Design	40,000,000	905,000,000
Detailed design of hinge-connector units at the Venice lagoon inlets - prototype specifications and assistance for testing activities (full-scale model) - Italy	<i>Venezia Nuova</i> Consortium concessionary of the Ministry for Infrastructure and Transport - Venice Water Authority	01/2004	12/2013	Detailed Design	8,500,000	220,000,000

PROJECT	CLIENT	PERIOD		ACTIVITIES	COST OF SERVICES €	COST OF WORKS €
		FROM	TO			
Barrier steel flap gates in the Venice flood defense system - Italy	<i>Venezia Nuova</i> Consortium for Ministry of Public Works - Water Board - Venice	12/2003	09/2013	Feasibility Study; Preliminary and Detailed Design	4,580,000	126,000,000
Venice flood protection barriers – M.O.S.E. system: Lido San Nicolò inlet – civil works - Italy	<i>Venezia Nuova</i> Consortium	09/2008	03/2013	Detailed Design	10,629,000	247,364,000
Venice flood protection barriers – M.O.S.E. system: Chioggia inlet – civil works - Italy	<i>Venezia Nuova</i> Consortium	09/2008	02/2013	Detailed Design	9,141,000	212,737,000
<b>Offshore platform for a construction site with syncrolift for 25,000 ton structures in Venice lagoon - Malamocco Inlet- Italy</b>	Venezia Nuova Consortium - Ministry of Public Works	02/2005	12/2011	Feasibility Study, EIA, Detailed Design, Technical Specifications; Technical Assistance during Construction	4,200,000	70,565,800
<b>Bottom protection works for the flood control barriers at the three inlets of Venice Lagoon – Italy</b>	<i>Venezia Nuova</i> Consortium for Ministry of Public Works - Water Board - Venice			Detailed Design, Tender Documents,	4,496,800	172,603,400
<ul style="list-style-type: none"> <li>▪ Bottom protection works for the flood control barrier at Lido inlet</li> </ul>		02/2006	12/2011		919,000	39,253,700
<ul style="list-style-type: none"> <li>▪ Bottom protection works for the flood control barrier at Malamocco inlet</li> </ul>		02/2006	12/2011		2,015,000	74,436,300
<ul style="list-style-type: none"> <li>▪ Bottom protection works for the flood control barrier at Chioggia inlet</li> </ul>		02/2006	12/2011		1,562,800	58,913,400
Embankment for the construction of the flap gates caissons in the Venice flood defense system - Italy	<i>Venezia Nuova</i> Consortium for Ministry of Public Works - Water Board - Venice	12/2003	11/2011	Feasibility Study, Preliminary Design, Detailed Design, Technical Assistance during Construction	1,330,000	45,000,000

PROJECT	CLIENT	PERIOD		ACTIVITIES	COST OF SERVICES €	COST OF WORKS €
		FROM	TO			
Venice flood defense system – assistance to the site engineer during construction activities - Italy	<i>Venezia Nuova</i> Consortium	11/2007	12/2011	Assistance to the Site Engineer during Construction	2,000,000	n.a.
Facilities to transfer and float-out the barrier flap gate caissons in the Venice flood defense system - Italy	<i>Venezia Nuova</i> Consortium for Ministry of Public Works - Water Board - Venice	09/2004	12/2011	Design Criteria; Preliminary and Detailed Design; Technical Assistance during Construction	1,140,000	46,500,000
<b>Self-propelled jack-ups for gate substitution in the Venice flood defense system – Venice Lagoon - Italy</b>	<i>Venezia Nuova</i> Consortium for Ministry of Public Works - Water Board - Venice	07/2003	07/2011	Definition of Technical Requirements; Detailed Design	3,820,000	97,000,000
New naval carpentry at the arsenal of Venice workshop for the maintenance ship operations in the arsenal of Venice - Italy	<i>Venezia Nuova</i> Consortium	05/2010	11/2010	Preliminary and Final Design	883,955	4,070,000
New quay structures at the arsenal of Venice for loading and unloading of the M.O.S.E. barriers - Italy	<i>Venezia Nuova</i> Consortium	05/2010	11/2010	Preliminary and Final Design	416,043	10,070,000
Hopper dredgers for sediment removal in caisson troughs in the Venice flood defense system – Venice Lagoon - Italy	<i>Venezia Nuova</i> Consortium for Ministry of Public Works - Water Board - Venice	01/2008	02/2009	Definition of Technical Requirements; Detailed Design	695,000	57,000,000
<b>New marine structures to modify the internal layout of Lido Port - Venice Lagoon – Italy</b>	<i>Venezia Nuova</i> Consortium for Ministry of Public Works - Water Board - Venice	09/2004	12/2008	Detailed Design, Tender Documents	5,504,800	223,533,800
<b>New Cooling Water System and seawater intake for the east Naples power station and urgent measures for protecting the water table - Port of Naples – Italy</b>	Port Authority of Naples	06/2003	07/2006	Preliminary, Final and Construction Design; EIA	2,199,100	33,194,900

PROJECT	CLIENT	PERIOD		ACTIVITIES	COST OF SERVICES €	COST OF WORKS €
		FROM	TO			
<b>Sea Water Intake works for Cooling Water System in Ras Laffan – Qatar</b>	GLF Middle East for Qatar Petroleum (QP)	11/2001	05/2002	Detailed Design	320,000	30,000,000
<b>Luminous navigation aids for the Malamocco-Marghera seaway – Venice lagoon - Italy</b>	VeneziaNuova Consortium for Ministry of Public Works - Water Board - Venice	01/1991	12/1996	Preliminary and Detailed Design	571,900	10,180,400

## Appendix A – Company’s Experience



## Coastal Engineering Works

# SAFEGUARD AND REHABILITATION WORKS OF THE COASTAL AREA OF 14 MUNICIPALITIES IN SICILY FACING THE TYRRHENIAN SEA

Location:	Italy
Client:	Government Commissioner against hydrogeological instability in Sicily
Services:	Preliminary and Detailed design
Period:	05/2021 – ongoing
Construction cost:	€ 5,000,000

## Project Description:

The feasibility project for the development and protection of a stretch of coast of over 32 km, in the province of Messina, identified the need to nourish the coastline in 16 locations with material taken from the rivers. In this phase the volumes of material available along the river courses has been evaluated and the arrangement of the materials in the areas identified as the most at risk of stability has been planned. There are no structural interventions, at least in the present stage, along the coast but only the nourishment with material coming from the 3 rivers that flow into such beaches.



With regard to the mathematical modelling studies, the following tasks have been developed:

- Study of the area, wave climate off the coast and statistics of the extremes;
- Propagation of the wave climate and extreme storms along the coast;
- Local coastal dynamics: wave propagation, hydrodynamic circulation;
- Coastal solid transport: evolution model of the shoreline;
- Transversal evolution of the beach profile and evaluation of wave set-up;
- River hydraulic modelling.



Among others, the services to be provided include:

- Archaeological investigations;
- Geological, sedimentological and characterization investigations;
- Coastal biocenoses;
- Topographic and bathymetric surveys.



# ENGINEERING, PROCUREMENT, CONSTRUCTION MANAGEMENT AND SUPERVISION OF BATUMI COASTAL PROTECTION

Location:	Georgia
Client:	Municipal Development Fund of Georgia
Services:	Review of feasibility studies and cost benefit analysis; Detailed design, Tender documents Work Supervision
Period:	11/2014 – 02/2022
Construction cost:	€ 18,250,000

## Project Description:

Batumi is the capital of the Autonomous Republic of Adjara (Georgia) and one of the major cities on the Georgian Black Sea coast. For centuries, the Chorokhi River (just south of Batumi) transported sediment (both sand and pebbles) towards the coast. Due to this, a delta was created. The City of Batumi is situated on the delta of the Chorokhi River. For decades now, part of the coast where Batumi is located is eroding. The erosion is caused by: autonomous development, sediment mining from the Chorokhi River mouth, construction of power dams along the Chorokhi River and underwater landslides in submarine canyons close to the coastline.

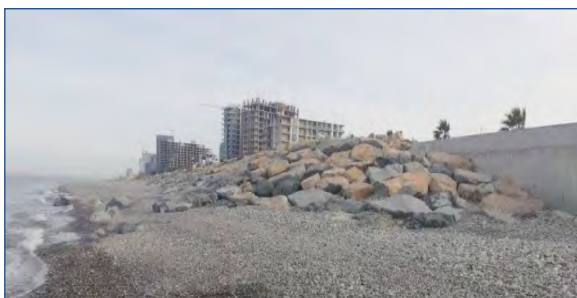


An adequate solution accounting for these very complex physical and land-use settings was needed to solve the erosion problems of the coast.

TECHNITAL was appointed by Municipal Fund Development of Batumi (Georgia) to carry out the design of Batumi coastal protection system and execute services for construction supervision during implementation of the project. The project was financed by the Asian Development Bank. According to the Terms of Reference of the project, the stretch of coast to be protected, composed of sand and gravel, extended for about 7.5 km.

The design process was articulated in the following phases:

- Review of the existing design
- Definition of the baseline situation, including: metocean and coastal conditions (winds, waves, water levels, currents, sediment transport patterns, coastal evolution trends), supported by modelling studies; geological, geotechnical and seismic features of the project area. In particular the canyon stability conditions were analysed, supported by modelling analysis.
- Development of design alternatives and cost benefit analysis



of the selected alternative: during this stage, a number of alternative design options were studied and tested by means of numerical models, including also the original groynes solutions at the base of the Contract. The solution deemed the most appropriate was the recirculation of sediment from the areas in accretion to the areas undergoing erosion. A suitable dredging system was studied, capable of working in very shallow areas. This sediment recirculation was complemented with a revetment along the stretch under erosion and beach enlargement along the same section.

- Sizing of the marine structures and execution of structural and hydraulic calculations of the same
- Development of the dredging system
- Preparation of Technical Specifications, BoQ and Cost Estimate
- Preparation of the Initial Environmental Examination
- Preparation of Tender documents



The design was completed at the end of 2016 but at mid-2017 it had to be reviewed due to the new unexpected local conditions caused by violent sea storms.

New stability and hydraulic calculations, BoQ and all documents were prepared for the new revetment that was built in stones of 3-7t category (instead of 1-3t as previously foreseen).



The Construction Supervision process started at the beginning of 2018 and the Works have been completed in January 2021.

The final arrangement included the embellishment of the coast line, the construction of new waterfront with beach renourishment and revetment consolidation, the architectural set up of hard and soft landscaping plus the rearrangement of water outfalls from the town.

# EPIC FOR THE COASTAL EROSION AND SHORELINE PROTECTION OF HALUL ISLAND

Location:	Qatar
Client:	Consolidated Engineering Construction Co (CECC)
Services:	Detailed Design
Period:	12/2016 – 06/2020
Construction cost:	€ 50,000,000

## Project Description:

The project concerns the topics of coastal erosion and shoreline protection of Halul Island, which is part of the State of Qatar and is located in the Arabian Gulf approximately 80 km Northeast of Doha. The island is roughly oval in shape and occupies an area of approx. 1.5 square km, with the longest length in a north/south direction of 1.7 km and 1.3 km in the east/west direction.



Due to Halul being a small island, there is a substantial amount of infrastructure built within close proximity to the shoreline. Considered the exposure of the island to wave attacks, in particular to the prevailing north/north-westerly wind and Shamal storm events, and the considerable retreat of the coastline being known to have taken place due to coastal erosion, coastal defences in several areas are needed to prevent damage to this strategic infrastructure from erosion, from wave overtopping and the inundation of low-lying areas.



The coastal defenses and shoreline protection works included in the project are to be implemented under the following schemes:

- a) North Cliffs Frontage – approx. 564 m – Edge Protection at foot of cliffs and cliff re-grading: Located on the north of Halul where the coastline is characterized by rapidly eroding cliffs. Coastal protection works are required due to the erosion and stability of the cliffs.

- b) North West Coast Road – approx. 224 m – Edge Protection and rising of the present temporary road level: Located on the north west of Halul along the shore side track road. Coastal protection works are required due to erosion, flooding of the track road and associated undermining of the NSS Tower foundations.
- c) Turtle Nesting Beaches – Management Plan for the Turtle Beaches: Located on the west coast of Halul, management of the beaches is required to preserve the Turtle Nesting areas.
- d) Proposed Sub-station Frontage – approx. 301 m – Edge Protection works with reclamation at the southern end: Located between the northern flare and the causeway carrying the formation water pipeline. This frontage is divided in two portions either side of the currently under construction shore protection associated with the sub-station construction. Coastal protection works and reclamation are required due to erosion and flooding risks to the substation.
- e) Power Station Frontage – approx. 150 m – Edge Protection: Located between the two flares on the west of Halul. Coastal protection works are required due to erosion of the compound area and fence as well as flooding and disruption to operations.
- f) Radioactive Materials Store Frontage – approx. 349 m – Edge Protection with areas of reclamation: Located on the south west corner of Halul between the southern flare and the alternative jetty. This frontage is divided in two sections. Coastal protection and reclamation works are required to provide appropriate level of defence to the radioactive material store due to erosion and overtopping.
- g) Southern and Eastern side of Centralized Industrial Area (CIA) Blasting Booth – approx. 50 m – Shore protection construction, partly with Mechanically Stabilized Earth (MSE) retaining wall and partly with RC wall, reinstating the existing shore protection at the transition with the proposed RC/MSE shore protection wall.
- h) South Helipad Frontage – approx. 157 m – Edge Protection with reclamation: Located directly east of the harbour, reclamation and edge protection are required to develop the proposed south helipad.
- i) Export Metering Station Frontage – approx. 18 m – Splash wall to protect key infrastructure: Located on the south east of Halul the Export Metering Station and associated 2 SPM pipelines are key infrastructure. A splash wall is required due to overtopping.
- j) BBQ Area Frontage – approx. 193 m – Edge Protection, reclamation and protection of cliffs at BBQ headland: Located on the south east corner of Halul. Coastal protection works are required to protect and stabilize the cliffs from erosion and provide a recreational land from reclamation.
- k) Club House Frontage – approx. 184 m – Edge Protection with reclamation: Located on the east of Halul. Coastal protection works are required to provide an edge protection to the recently reclaimed land.



# ENGINEERING CONSULTANCY SERVICES RELATED TO THE CONSTRUCTION OF THE CRUISE SHIP DOCKING FACILITIES AT THE OCEAN CAY MSC MARINE RESERVE

Location:	Ocean Cay, Bahamas
Client:	GLF Construction Corporation
Services:	Detailed Design, Site Supervision, Technical Assistance during the Construction
Period:	07/2016 – 10/2019
Construction cost:	€ 25,000,000 approx.

## Project Description:

The scope of work is the development of the Detailed Design (Engineer of Record) of all civil structures and the design of provision of plants works necessary for the construction and functionality of the Marine Structures at Ocean Cay Island (Bahamas) and in particular:

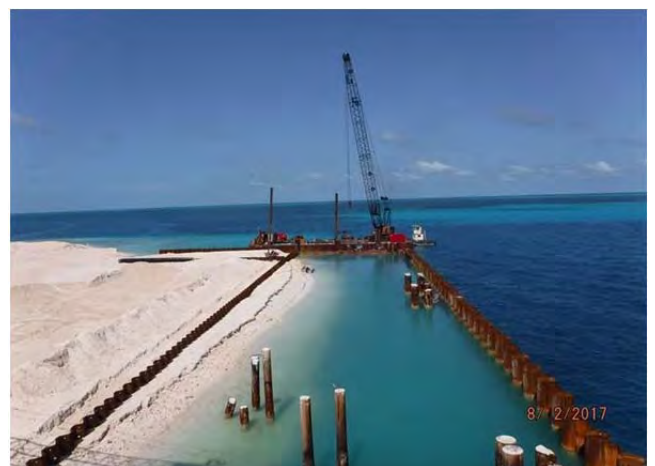
- The bulkhead structures design to accommodate Cruise Ship Berthing and Mooring;
- Design of the lateral bulkhead structures and backfill which will connect the island to the berthing line;
- Detailed design of the steel and concrete structures of the bulkhead;
- Additional mooring dolphins and any ancillary structure related to the Design Ship Berthing and Mooring;
- Design of the marine equipment.



- Design of the bulkhead backfill with settlement analysis and completed with concrete paving;
- Detailed Drawings of the construction stages to be prepared in coordination with the Client's representatives;
- Technical Specification preparation for the construction of the structures;
- Client's Shop Drawings review;
- Technical assistance during the construction stage (mostly performed from Italy).
- Pile driving criteria and recommendations.
- Design for accommodation of utilities in the structures as required for the only bulkhead wall area (design of the utilities to be performed by others).
- Technical assistance after Irma hurricane and post storm reconstruction design review.

The main scope of the design job, will consist of matching budget constraints with the Employer's Requirements, Soil Conditions and Meteorological Design Criteria which are given by the Employer. In detail, the engineering consultancy services include:

- Development of the technical specifications for the site investigations (geotechnical) to be carried out under Client expenditures and interpretation of the site investigation findings;
- Analysis of the construction methods and selection of the preferred ones in coordination with the Client's representatives;
- Berthing layout arrangement definition and Fendering system definition;
- Mooring layout arrangement to be defined by means of a specific mooring analysis;
- Development of specific geotechnical and structural models to verify the operational ultimate limit states behaviour of the ground soil and of the structures;



# DESIGN REVIEW AND POST-CONTRACT CONSULTANCY SERVICES FOR NAVIGATION CHANNEL, COAST GUARD BASE AND SECONDARY NAVIGATION CHANNEL

Location:	Qatar
Client:	Private Engineering Office
Services:	Design Review / Re-design Construction Supervision; Quantity Surveying; Technical Assistance Services
Period:	10/2012 – 01/2014
Construction cost:	€ 135,765,541 (approx.)

## Project Description:

The project is located in the Qatari Eastern Coastline North of Doha between Simaysmah and Lusail and the work is basically consisting of three major parts:

- Excavation of the base harbor up to a depth of -6.88 QND level and -8.88 QND level in the quay wall portion. This area is approximately 320,000 m<sup>2</sup>. Further a land area adjoining the base of roughly 250,000 m<sup>2</sup> is to be reclaimed and backfilled with approved material up to a level of +3.50 QND.
- Excavation of Secondary Navigation Channel connecting the base harbor to the main Navigation channel. The Secondary Channel is 80 mt wide with a depth of -6.88 QND and a total length of about 1.17 km.
- Dredging of Main Navigational channel: 80 mt wide with a depth of -6.88 QND and a total length of about 9.48 km.

Disposal of excavated material at approved location on land is also involved in the scope of works.



# BEACH DEVELOPMENT AT RAS USHAYRIQ PENINSULA

Location:	Qatar
Client:	Al-Ali Projects Co.
Services:	Concept, preliminary and detailed Design of a beach development including a small marina
Period:	7/2011 - 5/2012
Construction cost:	€ 31,400,000

## Project Description:

The engineering consultancy service started from a preliminary study of alternative solutions for the identification of the conformation and location of a new beach for private use along Ras Ushayriq Peninsula. Based on the main requirements affecting quality and technical feasibility of artificial beaches and the due acquaintance of site conditions obtained by data collection, site visits, specialist studies and field investigations, the main dimensions and layout of the beach was defined and the preferable location at the north-western side of Ras Ushayriq peninsula was identified.

Within the concept design, a suitable beach development scheme at the selected location was conceived allowing for the following purposes:

- Fulfilling the engineering design requirements to ensure proper performance as good quality and stable artificial beach: adequate dredging to accommodate a suitable and attractive sandy beach profile and to allow swimming and comfortable access to water; shoreline orientation towards the prevailing waves direction to ensure longshore stability of the beach; provision of protection structures to prevent loss of sand out of the site and shelter the area from meteomarine forcings.
- Developing the engineered beach concept toward an attractive, multifunctional, well landscaped waterfront system, to conceive a prospective overall development allowing the best conditions for living and enjoying the beach as well as its surrounding sea and land environment.

The new coastal development envisages a pleasant artificial beach ("Beach Bay"), delimited at north by a smaller and confined bay ("Laguna Bay") and at south by a rubblemound breakwater which forms a sheltered area which provides docking space to yachts and tenders ("Yacht Basin").

The new beach development project includes:

- 450,000 m<sup>2</sup> of total project area

At the northern side of the new beach a "Sea Arena" provides access to the sea and a "Wooden Pier" overhang the water. From the "Laguna Bay" till the "Yacht Basin" a promenade allow to enjoy the seafront and the beach basin design to give a blue water impression. At landside a rest house faces the "Yacht Basin" and green dunes enhance the landscape.



- 430 m long and 110 m wide beach
- 130,000 m<sup>3</sup> of beach sand fill
- 400 m of concrete blocks quay wall
- 600,000 m<sup>3</sup> of total dredging (beach up to 3 m deep, yacht basin 3 m deep, laguna bay around 1 m deep, "Yacht Basin" access channel 4m deep)
- 700 m long promenade
- Sea arena and wooden pier to access the sea
- Landscaping with green dunes.



# COASTAL PROTECTION WORKS IN THE MUNICIPALITY OF LECCE AND NEIGHBOURING AREAS AFFECTED BY EROSION PHENOMENA

Location:	Puglia, Italy
Client:	Municipality of Lecce
Services:	Identification of critical sections of coast; Preliminary and Detailed Design of works to stabilize the coastline and, locally, to protect coastal dunes. Works supervision
Period:	04/2001- 02/2009 (Design) - 12/2011(Supervision)
Construction cost:	€ 4,322,000

## Project Description:

The sandy coasts of Puglia region have been so severely eroded in the past decades that in some locations there is a high risk of flooding to the hinterland. For long stretches the coastline has receded noticeably and the historic dunes are precarious.



The municipal authorities of Lecce, aware of the threat posed by the erosion process, and in order to block its evolution, advertised a private tender for the design of the engineering works for the coastal protection, which was awarded to Technital in March 2001. The Preliminary Design, Final and Detailed Designs were completed and delivered to the Client within the year.

In the over 25 km of coastline in the Lecce municipal area, some critical stretches were identified where severe erosion has been occurring for a long time. The protection works were designed for those stretches at greater risk.

The solution chosen to protect the inland areas consists in beach replenishment with lateral retaining groynes in natural stone. The works affect 7 stretches of coast for a total of approximately 4 km. The most important stretch is the San Cataldo beach some 1500 m long, which is the closest beach to the city of Lecce.

All together the design included 12 groynes projecting into the sea, perpendicular to the coast, of lengths varying from 45 to 100 m, on depths of up to 2.30 m.

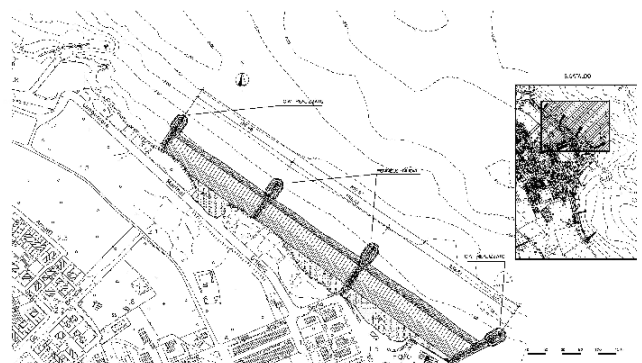
The replenishment is foreseen in "cells" confined by the groynes or, where longitudinal drift is modest, without any containment, using appropriate material quarried especially for the purpose and having suitable sedimentological properties and homogeneous with the existing beach material.

The total volume of replenishment is expected to be over 200,000 m<sup>3</sup>. Less important in terms of quantity but nonetheless significant are the works envisaged to maintain and protect the dunes in certain highly degraded areas.

The contract included a number of specialist climatic hydrodynamic, wave motion, and statistical studies of extreme offshore events. For each of the seven coastal strips, the net and gross solid transport, and the trend of the wave action were studied using a mathematical model called MORFO, developed by Technital. For the bigger beaches (San Cataldo north and Torre Chianca north) the mathematical model BEACHPLAN, developed by Hydraulic Research of Wallingford (UK), was also used. Supplied with the input data (wave action, the characteristics of the beaches, the sediments and any structures present along the coast), the model made it possible to calculate the evolution of the coastline (advancement or recession) within established time spans and describe the variation in the course of time of the solid transport. Simulations of various schemes of works were carried out and through the analysis of their results it was possible to define the best solutions.



The works began when the first funds became available in January 2003 and most of the groynes have been built. The replenishment works, however, have been delayed due to the not forthcoming authorization for the quarries. Even so, the beaches, better protected with the groynes, are slowly advancing.





# SEA DEFENCES TO PROTECT LIDO LITTORAL IN THE VENICE LAGOON

Location:	Venice, Italy
Client:	Venezia Nuova Consortium - Ministry of Public Works
Services:	Preliminary and Detailed Designs
Period:	10/1998 – 12/2008
Construction cost:	€ 20,143,600

## Project Description:

In 1990 Technital drew up a General Plan for the interventions along the littorals which separate the Venice lagoon from the sea (approximately 40 km.) including the organization and management of extensive measurement surveys; the examination of the coastal regimen using mathematical models of the hydrodynamic, wave motion and sediment transport phenomena; and the definition of the defence works for the four coastal sections of Sottomarina, Pellestrina, Lido and Cavallino.

Subsequently TECHNITAL was commissioned to extend the services to cover the littorals of Isola Verde to the south, and Jesolo in the north, for a total extent of about 60 km of coastline.



Satellite view of Lido littoral

At the time of the contract award, Lido littoral, once extending the whole 12 km of the island's length, was reduced to two beach areas at the ends, the middle section in front of the sea wall having been severely eroded and posing increasing risk of flooding to the inhabited areas behind it.

In the general plan and basic design drawn up in 1990 TECHNITAL had combined the objective of sea defence with that of the environmental recovery of this very popular tourist area. At that time the plan already envisaged protected beach nourishment which would have guaranteed the recovery of the original morphology of the island and at the same time encouraged

seaside tourism even in the central part of the littoral.

Following the series of meteorological surveys and model studies, the chosen solution for Lido littoral was submerged artificial beach nourishment, using sand taken from depths of about 20 m to ensure the attainment of adequate safety standards. This solution, which is new for the Venetian littorals, was chosen to satisfy the Municipality of Venice, who preferred to maintain the coastal landscape unaltered with only the rigid structural defence works. A wide-topped submerged barrier, capable of reducing the wave energy in the wave-breaking area, was therefore studied using mathematical and physical models.



Lido beach devastated by the record tides in November 1966

Some 400,000 m<sup>3</sup> of sand will be poured into the area between the barrier and the shoreline, forming a platform at a depth of -2 m. This will be done using special machines which move the sand spreader on the dredger in accordance with the design. On the sea side the barrier therefore acts as a support for the sand, which has a further damping effect on the waves overtopping the barrier.

The newly replenished beach is anchored using groynes of an unconventional structure, with the outer end submerged and a cladding of uniformly arranged blocks so as to favour tourist access and blending into the landscape.



Lido beach today

# CHIVA SOM HEALTH RESORT & SPA

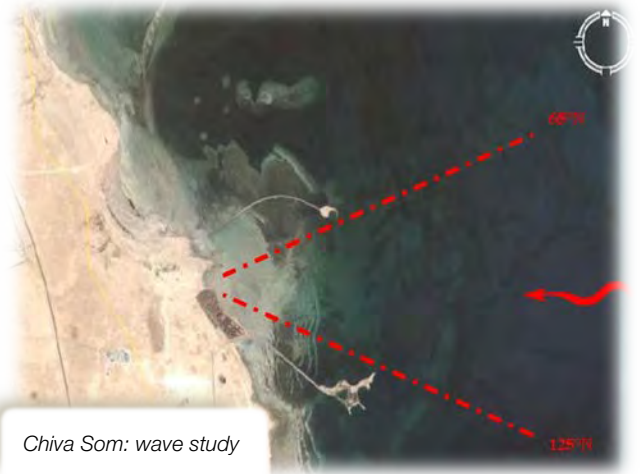
Location:	Qatar
Client:	<i>Qatari Diar Real Estate Investment Company</i>
Services:	Concept, Preliminary and Detailed Design; Tender Documents
Period:	08/2006 – 12/2006
Construction cost:	€ 59,460,000

## Project Description:

Technital has been appointed by QATARI DIAR REAL ESTATE INVESTMENT COMPANY to undertake the consultancy services related to the design of the marine works of the CHIVA SOM HEALTH RESORT & SPA. The resort will be realised in Ras Qutaifan, which is located 15 km north of Doha City



*Chiva Som: natural mangroves*



*Chiva Som: wave study*

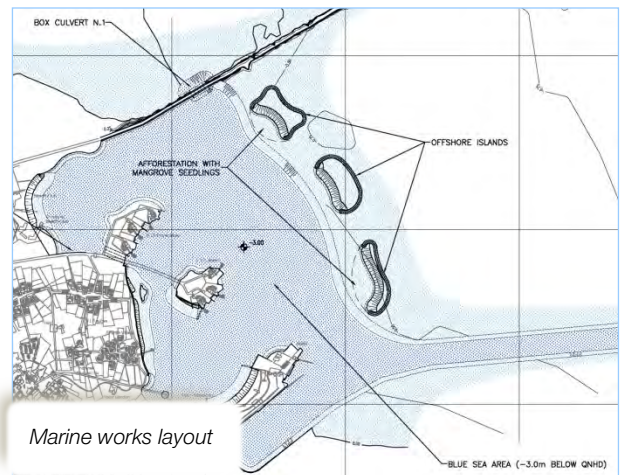
The consultancy services requested by QATARI DIAR comprise the following:

1. Topographic and bathymetric survey of land and sea area;
2. Geotechnical investigations of land and sea area;
3. Concept design of the marine works;
4. Detailed Design of the marine works;
5. Tender documents for negotiated procurement.

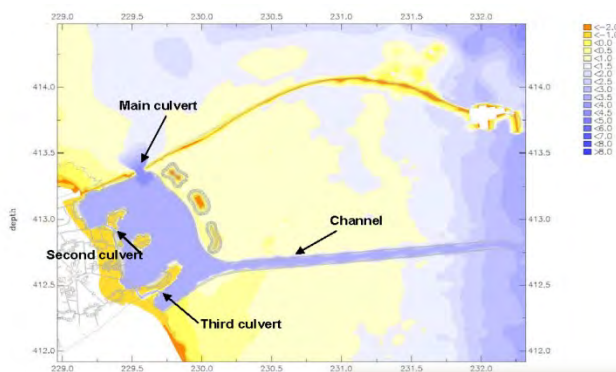
The concept design included also the hydrodynamic study, the water quality study and wave study and the EIA.

series of vertical walls to accommodate the promenades along the coastline;

- three offshore islands.



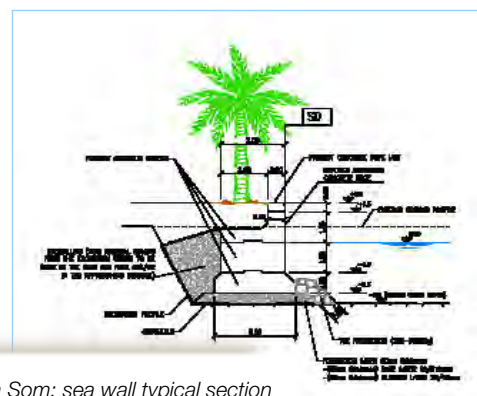
*Marine works layout*



*Hydrodynamic model: bathymetry*

The main marine works foreseen in the resort are the following:

- rehabilitation of the south side of the existing causeway;
- sandy beaches;
- n. 3 box culverts to improve the water quality inside the lagoon;



*Chiva Som: sea wall typical section*

# MASTER PLAN AND DETAILED DESIGN OF PUBLIC BEACHES

Location:	Qatar
Client:	Ministry of Municipal Affairs & Agriculture - Department of Technical & Economic studies
Services:	Master Plan, preliminary and detailed design of two public beaches
Period:	08/2003 – 05/2005
Construction cost:	€ 12,000,000

## Project Description:

During the inception phase, the Consultant studied 25 beaches along the coastline of Qatar.



The Sites Identification Report was conducted with marine and environmental experts, including the following parts:

- Description of selected sites
- Advice on Surveys, Studies and Tests
- Budget Cost Estimate for site preparation works

The selected planning area defines two beaches, Simaisma South and Al Dhayyen Umm Salal, located on the coastline of Simaisma town about 24km from Doha Golf Course by taking the North Relief Highway.



Both Beaches, with an approximate shoreline of 800m each, require major reclamation and dredging works in order to achieve a coherent and adequate shoreline that is suitable for swimming.

The scope of work includes a Master plan and detailed design of both beaches, consisting of a sandy shoreline of not less than 100m in depth and including the following design components:

- Pedestrian paths;
- Landscaped lawns and picnic areas;
- Beach furniture;
- Accessible toilets and showers;
- Leased shops;
- Cafeterias and
- Refreshment Kiosks.



Site boundaries

The studies carried out include the following activities:

- Geotechnical Investigation report;
- Topographic and Bathymetric survey reports;
- Services survey report;
- Beach user survey report;
- Environmental assessment report;
- Wave Climate modelling report;
- Hydrodynamic modelling report;
- Master Plan Layout;
- Preliminary design and
- Detailed design.



# SEA DEFENCES TO PROTECT ISOLA VERDE LITTORAL OF VENICE

Location:	Venice, Italy
Client:	Venezia Nuova Consortium - Ministry of Public Works
Services:	Preliminary and Detailed Design
Period:	05/1996 – 03/2005
Construction cost:	€ 8,215,000

## Project Description:

Following the preparation of the general master plan of the interventions along the littorals which separate the Venice lagoon from the sea (approximately 40 km.), TECHNITAL was also awarded the contracts for carrying out the same services for the littorals of Isola Verde to the south, and Jesolo in the north (thus for a total extent of about 60 km of coastline).

The services, originally carried out for the for the four coastal sections of Sottomarina, Pellestrina, Lido and Cavallino, included the organization and management of extensive measurement surveys; the examination of the coastal regimen using mathematical models of the hydrodynamic, wave motion and sediment transport phenomena; and the definition of the types of intervention for the protection of the Isola Verde littoral.



*Example of severe erosion of Isola Verde coast*

The principal type of intervention selected was artificial beach nourishment, contained by a groyne system and submerged breakwater.



The protection of the coast of Isola Verde was designed on the basis of the experience acquired between 1997 and 2005.



The defence works consist in the replenishment of the whole coast protected by 8 groynes in natural stone. This solution also favoured the tourist development of the littoral in areas where the erosion of the beach had compromised the stability of the coastline and of the settlements behind it.



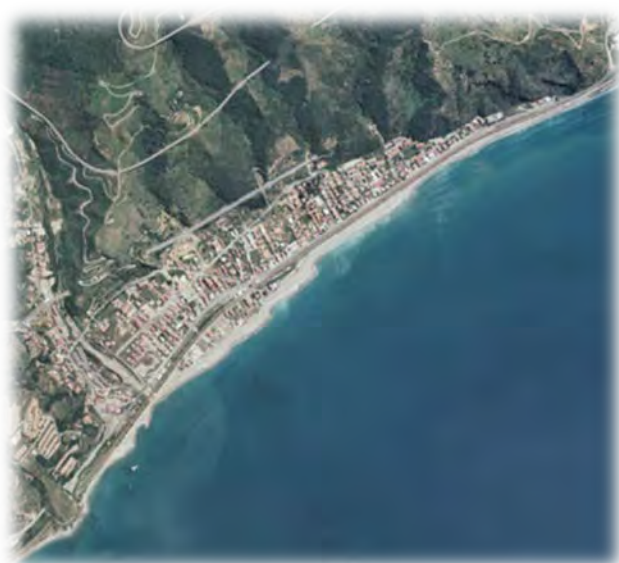
# MASTER PLAN OF THE WORKS TO PROTECT THE COASTS OF CALABRIA REGION

Location:	Calabria Region, Italy
Client:	Public Works Department for Calabria Region
Services:	Study of coastal evolution and erosion phenomena, preliminary design of urgent defense works
Period:	03/2001 – 09/2003
Construction cost:	€ 170,000,000

## Project Description:

All the studies and investigations prior to the drawing up of the master plan of the works along the Calabrian coastline, in relation to both defence works and the identification of suitable locations for developing pleasure-boat harbours, will have three phases:

- Data collection: in this phase all available information will be examined and checked;
- Analysis: this phase will provide an overview of the coastal dynamics on the basis of which it will be possible to identify the problems and those sections of coastline affected by erosion and in critical condition;
- Recommendations: in the final phase a functional programme of large-scale intervention will be drawn up.



The first two phases of this part of the project have already been completed and the results of the analysis are available, with particular reference to the evolutionary trend of the coastline. This information has been organized in a databank for future use by the Regional authority as a decision support system in relation to the execution of urgent protection works.

The preliminary studies revealed that the coastline of Calabria has an extent of over 740 km and an enormous variety of morphological-environmental situations. Consequently, the problems related to the use and protection of the coastal areas also vary widely.



Some 80% of the coast consists of beaches of highly varied features in terms of both morphology and exposure. Alongside the flat sandy beaches of the Tyrrhenian coast, formed by high seas, are the little pebbly beaches exposed to the short fetches of the Gulf of Taranto and the narrower sandy strips nourished by the streams on both the eastern and western coasts of the region.

While the conditions of 65% of the beaches were found to be reasonably stable, and a further 5% actually growing, the remaining 30% - for a total of some 200 km - are eroding.

The morphological evolution of the beaches has often and in many places given rise to serious consequences, determining not only the loss of bathing areas but also damage to port structures and the filling in of berths, various types of damage to the protection works, coastal roads, rail and road embankments, tourist and bathing facilities, utility structures and networks, as well as public and private buildings.

As far as port facilities are concerned the Region has 40 ports including the 4 major industrial/commercial ports of Gioia Tauro, Villa S. Giovanni, Reggio and Crotona-Porto Nuovo and 11 pleasure-craft harbours of various sizes which can offer shelter throughout the year. The present sailing boat demand shows how the lack of facilities affects the development of boat tourism in the Region.

On the basis of this framework of existing problems the third phase, the real planning phase, is in progress. The outcome of this phase will be the definition, in collaboration with the Regional authority, of the project objectives and the drawing up of a large-scale programme of works. Subsequently, in certain critical areas, a further work phase is foreseen. This will consist of a series of bathymetric and topographic surveys, sedimentological investigations, and specialised studies using mathematical models of the wave regime both off-shore and along the coast and of the littoral drift, in order to identify the appropriate remedial works and make a preliminary estimate of their entity.

# SEA DEFENCES TO PROTECT JESOLO LITTORAL

Location:	Venice, Italy
Client:	Venezia Nuova Consortium - Ministry of Public Works
Services:	Preliminary and Detailed Design of defense works
Period:	03/1994 – 10/2003
Construction cost:	€ 12,391,700

## Project Description:



*Jesolo littoral before and after the works*

Following the preparation of the general master plan of the interventions along the littorals which separate the Venice lagoon from the sea (approximately 40 km.), TECHNITAL was also awarded the contracts for carrying out the same services for the littorals of Isola Verde to the south, and Jesolo in the north (thus for a total extent of about 60 km of coastline).

The services, originally carried out for the for the four coastal sections of Sottomarina, Pellestrina, Lido and Cavallino, included the organization and management of extensive measurement surveys; the examination of the coastal regimen using mathematical models of the hydrodynamic, wave motion and sediment transport phenomena; and the definition of the types of intervention for the protection of the Jesolo littoral.

Jesolo littoral, between the mouths of the rivers Sile to the south and Piave to the north, is about 13 km long and owing to the high tourist presence in the summer months is classed as Italy's no. 2 beach.

The littoral had lost much of its natural characteristics, and was reduced to a beach contained by an almost continuous "comb" of small groynes, which in spite of constant annual maintenance, was slowly but steadily being deprived of its natural deposits due to the reduced contribution of solids from the River Piave. At the outlet of this river, located to the north of the littoral, there were still significant remains of the dune system which once extended all along the littoral- At the Sile mouth to the south, the continuous silting up of the access channel had become an impediment to the transit of pleasure craft and fishing boats using the docks built along the final stretch of the river.

The design took into due account the environmental impact and landscaping aspects, as well as the heavy tourist demand on the coast.

The project envisaged the following works:

- the reorganization of the Sile mouth, reinforcing the breakwater which protects the lighthouse, and building protective groynes
- the restoration of the dune system near the Piave mouth, for some 2.5 km;
- the lengthening of the existing piers the building of new ones to contain the new beach;

- beach nourishment over a 30 m wide stretch using some 600,000 m<sup>3</sup> of sand;
- the reinforcement of the seawall, with a 4 km stretch of staggered defence works.



*Jesolo beach during the works*

So as to meet the local Authority's request to maintain the same hazel colour of the surface sand, considering that such sand was very hard to find and also that sand from the sea after long exposure to the sun tends to assume the same colour, a novel solution was found. This consisted in, firstly, storing some 600,000 m<sup>3</sup> of the existing top sand taken from temporary pits, protected on the land side by Larsen piles and on the sea side by Longard pipes filled with sand and drained with a system of geo-drains. These pits were then partially filled with sand dredged at sea and subsequently covered with the stored sand, thereby extending the width of the beach by over 50 m.

# SEA DEFENCES TO PROTECT SOTTOMARINA LITTORAL

Location:	Venice lagoon, Italy
Client:	Venezia Nuova Consortium - Ministry of Public Works
Services:	Preliminary and Detailed Design of defense works
Period:	04/1994 – 05/1999
Construction cost:	€ 4,462,000

## Project Description:

In 1990 Technital drew up a General Plan for the interventions along the littorals which separate the Venice lagoon from the sea (approximately 40 km.) including the organization and management of extensive measurement surveys; the examination of the coastal regimen using mathematical models of the hydrodynamic, wave motion and sediment transport phenomena; and the definition of the types of intervention for the four coastal sections of Sottomarina, Pellestrina, Lido and Cavallino. Subsequent contracts extended the commission for services to cover the littorals of Isola Verde to the south, and Jesolo in the north, for a total extent of about 60 km of coastline.

The principal type of intervention selected was artificial beach nourishment, contained by a groyne system and submerged breakwater.



*Sottomarina beach before the works*

The Sottomarina Littoral is bounded in the south by the mouth of the Brenta river and in the north by the Chioggia port inlet. The problem of erosion of the littoral was concentrated at southern end, near the mouth of the Brenta. The decreased contribution of sediment from the river had caused the steady recession of the shoreline, in some places to a serious degree.

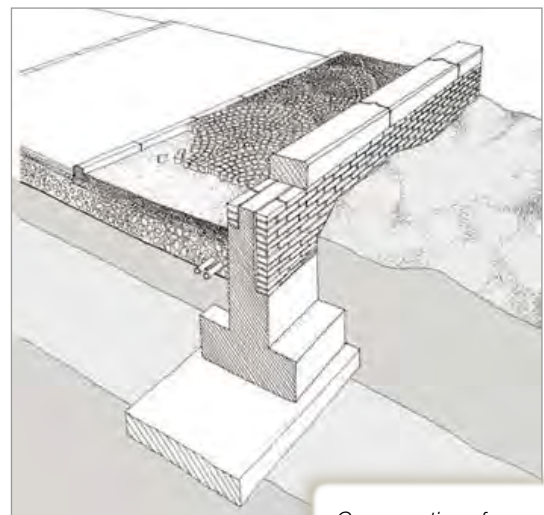
Following a series of studies and investigations and in compliance with need to reutilize the existing structures and the sphere of competence of the local municipal authority, the Detailed Design of the works was drawn up.



The interventions designed for the protection of Sottomarina littoral included:

- the promulgation of legislative and environmental restriction measures to restore, in time, a certain recovery of the river sediment transport;
- restructuring of the two river outlets with breakwaters
- artificial beach nourishment up to +2m asl, for 500 m north of the Brenta mouth;
- sea wall of 380 m to contain the beach with 80 m of perpendicular groynes extending into the sea.
- reconstruction of some areas of the dune belt and planting of typical flora.

The works to protect the town of Sottomarina also included the creation of a footway of some 620 m parallel to the existing coastal road (*Strada Valentino*), located 300 m from the shoreline.



*Cross section of sea wall*

# SEA DEFENCES TO PROTECT PELLESTRINA LITTORAL

Location:	Venice lagoon, Italy
Client:	Venezia Nuova Consortium - Ministry of Public Works
Services:	Preliminary and Detailed Design of defense works
Period:	04/1990 – 09/1998
Construction cost:	€ 118,851,000

## Project Description:

In 1990 Technital drew up a General Plan for the interventions along the littorals which separate the Venice lagoon from the sea (approximately 40 km.) including the organization and management of extensive measurement surveys; the examination of the coastal regimen using mathematical models of the hydrodynamic, wave motion and sediment transport phenomena; and the definition of the types of intervention for the four coastal sections of Sottomarina, Pellestrina, Lido and Cavallino. Subsequent contracts extended the commission for services to cover the littorals of Isola Verde to the south, and Jesolo in the north, for a total extent of about 60 km of coastline.

The principal type of intervention selected was artificial beach nourishment, contained by a groyne system and submerged breakwater.

*Pellestrina littoral before the interventions*



*Works to reinforce the sea wall*



*The first three sections of after the completion of the works (the submerged berm is visible on the right)*

Pellestrina is a narrow and very vulnerable strip of land forming a strategic section of the lagoon rim between the inlets of Malamocco and Chioggia.

The new interventions for the defence of the Pellestrina littoral started in 1990 with the design and construction of a submerged breakwater protecting the historic "murazzo" at the weakest point of the whole littoral belt. Technital performed the Preliminary and Detailed Design of the intervention and then co-ordinated a campaign for monitoring the evolution of the seabed, to obtain full knowledge of the local regimen of solid transport.

The submerged breakwater, about 30 m long and with a summit level of -0.50 m., has proved to be effective in causing wave breaking though without modifying the physical appearance of a stretch of coast greatly admired for its landscape.

The model study is considered among the most innovative and complete performed up to now in the field of coastal engineering: the continuous interaction among the four models created (2-D and 3-D mobile bottom physical models, mathematical models of longitudinal and transverse transport) allowed the examination of the efficacy of the various design alternatives in relation to the principal indicators selected.

In 1990 Technital drew up a General Plan for the interventions along the littorals which separate the Venice lagoon from the sea



# SEA DEFENCES TO PROTECT CAVALLINO LITTORAL

Location:	Venice lagoon, Italy
Client:	Venezia Nuova Consortium - Ministry of Public Works
Services:	Preliminary and Detailed Design of defense works
Period:	04/1990 – 04/1997
Construction cost:	€ 42,171,000

## Project Description:

In 1990 Technital drew up a General Plan for the interventions along the littorals which separate the Venice lagoon from the sea (approximately 40 km.) including the organization and management of extensive measurement surveys; the examination of the coastal regimen using mathematical models of the hydrodynamic, wave motion and sediment transport phenomena; and the definition of the types of intervention for the four coastal sections of Sottomarina, Pellestrina, Lido and Cavallino. Subsequent contracts extended the commission for services to cover the littorals of Isola Verde to the south, and Jesolo in the north, for a total extent of about 60 km of coastline.



View of the littoral before the works

The principal type of intervention selected was artificial beach nourishment, contained by a groyne system and submerged breakwater.



Cavallino littoral during the works

The Detailed Design for the restructuring works to protect Cavallino littoral started in 1990 with a pilot intervention, consisting in the beach nourishment of a sample zone approximately 200 m. long, protected from the sea by a submerged barrier of sandbags located on the bottom about 2 metres deep.



The ultimate works designed for the entire littoral included:

- artificial beach nourishment, for a length of approximately 11 km., by depositing about 2 million m<sup>3</sup> of sand obtained at sea and contained laterally by 32 groynes at right angles to the shore;
- reshaping of the existing sea wall, along a length of about 3000 m., with a cladding of concrete blocks with a 2.5:1 gradient;
- an anti-siphoning/filtration diaphragm about 3500 m. long located behind the existing sea wall created by installing metal sheet piling or by jet-grouting;
- rehabilitation of the existing chain of dunes along a stretch of about 4000 m., to be achieved by depositing sand and planting suitable vegetation to stabilise the work.



Reconstruction of the coastal dune system

# ENVIRONMENTAL RECOVERY AND PROTECTION OF THE COASTAL WETLAND OF MOLENTARGIUS AND PROTECTION OF POETTO LITTORAL - SARDINIA

Location:	Cagliari, Sardinia - Italy
Client:	Ramsar – Molentargius Consortium for Ministry of Environment
Services:	General plan and Preliminary Design of environmental recovery works; Detailed Design of coastal protection works
Period:	06/1992 – 10/1993
Construction cost:	€ 61,974,800

## Project Description:

The wetland of Molentargius is considered a very peculiar and fragile ecosystem and therefore is included in the Ramsar list of areas to be protected and conserved. This Project launched by the Italian Government to rehabilitate this area includes: hydraulic rearrangement, phyto-purification plant, redevelopment of the area as a nature reserve, protection of the littoral, surface waters depuration, ecological dredging of the top layer of polluted sediments, coastal protection works.

Within this Project, TECHNITAL was entrusted with the definition of the general plan of the intervention, the environmental impact assessment study, the detailed design of coastal works.



The Poetto littoral is a long strip of beach of some 7 kilometres located close to Cagliari. The closeness to the city, its inclusion in a highly appreciated and unusual environmental context, which also includes Molentargius salt-pans and pools, and the quality of the sand, quartz-bearing and pale coloured, are the principal elements which give the Poetto great appeal, from both touristic and landscape/naturalistic points of view. Since the end of the war, however, successive human interventions carried out without due respect for the delicate morphology of this narrow beach have created problems of widespread erosion and environmental decay.

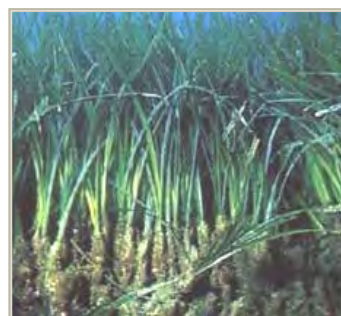
As part of a broader programme for the environmental rehabilitation of the hydrographic basin behind the littoral, TECHNITAL was commissioned in 1992 to carry out the specialist studies and the designs of the interventions needed to restore conditions of morphological stability and environmental balance throughout the Poetto.



The studies involved the use of mathematical and physical models. Models were used to study the propagation of wave motion, reproduce the current field and calculate sediment transport and coastline evolution. On the basis of the acquired information a balance of the sediments along the littoral was formulated, both reconstructing the recent past and predicting the future trend, for several reference frames corresponding to various intervention proposals. The study with the physical model served to define and check the new interventions.

The works foreseen on the coastal strip in the Preliminary Design included:

- rebuilding the coastal dune and moving the littoral road inland;
- artificial beach nourishment with sand taken from the sea;
- moving a water inlet currently located on the shore-line out to sea;
- removal of some of the illegal buildings present along the littoral and overlooking the shore-line;
- transplanting *Posidonia Oceanica* to restore, in part, the meadows which were once very extensive and which are now greatly reduced due to anthropic action



At the end of the assessment and approval stage of the Preliminary Design, the Detailed Design was developed for the 1st section, consisting of the rebuilding of the first part of the dune belt and a pilot operation for transplanting *Posidonia Oceanica*

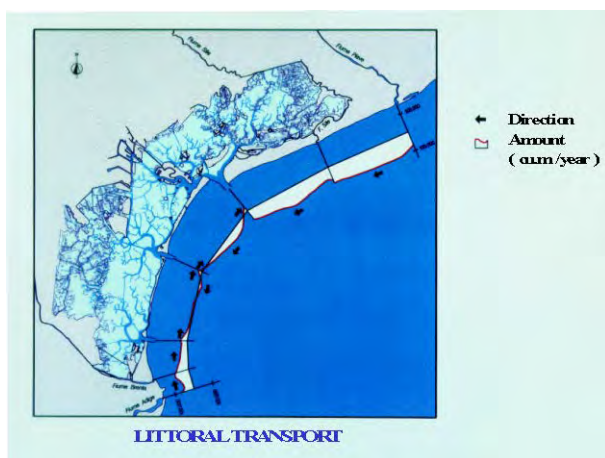
# SEA DEFENCES FOR THE PROTECTION OF VENICE PORTS AND LAGOON

Location:	Venice lagoon, Italy
Client:	Venezia Nuova Consortium - Ministry of Public Works
Services:	General Master Plan and Basic Design of the defense works for some 40 km of coastline
Period:	01/1988 – 12/1990
Construction cost:	€ 206,234,300

## Project Description:

The Venice lagoon is separated from the sea by narrow strip of land some 40 km long, interrupted only by the three port inlets of Lido, Malamocco and Chioggia. Man's interventions since mediaeval times to guarantee navigation and control the river courses have fostered erosion phenomena along these littorals, exposing the coastal towns to increasing flood risk. In 1988, in the context of the Project to Safeguard Venice and its lagoon, TECHNITAL was commissioned to develop the detailed study of the hydrodynamic and morphological regime of the Venetian coastline, with the purpose of defining a master plan of the protection works.

TECHNITAL first planned and coordinated the measurement campaigns which were carried on for two years and included bathymetric and sedimentological surveys, the installation and management of fixed measuring stations for wave action, wind, currents and littoral drift, float tests to identify flows in the areas of interaction between coastal and offshore currents at the inlets, and geo-seismic investigations of the sea bottom.



The results of all these surveys and investigations provided the basic input data for the calibration of a series of mathematical models capable of interpreting and analysing the main phenomena present and evaluating the efficacy of the various solutions proposed. From these model studies it emerged that the steady reduction of river sediment transport, due to the control of the river beds coupled with the obstruction to sediment transport caused by the building of the breakwaters at the inlets, have led to an irreversible trend of sediment loss, especially in the central part of the coastline.

The various interventions schemes examined and evaluated on the basis of the field investigations and the model studies, included:

- unconfined beach nourishment
- beach nourishment with containing works
- restructuring of the existing fixed defence works
- construction of new fixed works.

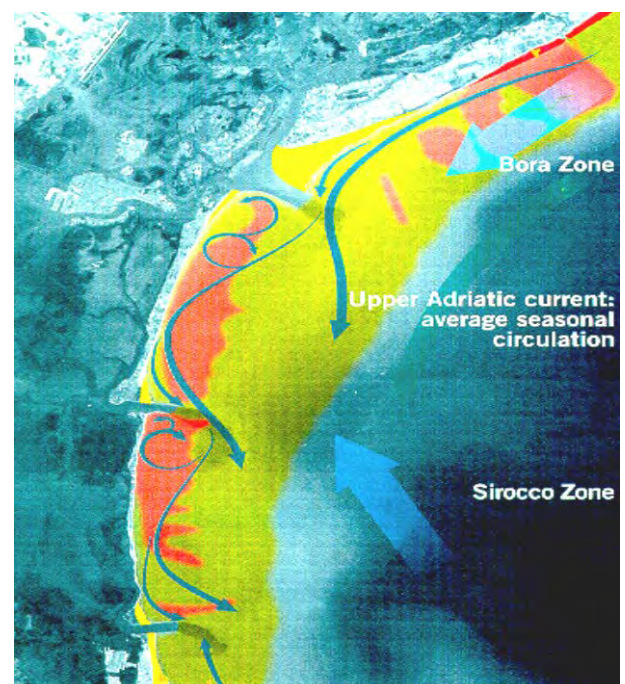
In 1990, in accordance with the findings of the above studies and investigations, and taking into account the characteristics of each section of littoral and their intense tourist use, TECHNITAL drew up the General Plan for the interventions for the littorals which

separate the lagoon from the sea, defining the specific works for each of the 4 coastal sections of Cavallino, Lido, Pellestrina and Sottomarina. The principal type of intervention selected was artificial beach nourishment, contained by a groyne system and submerged breakwater.



In particular, the following activities were performed:

- analysis of available data on waves and tides and definition of wave data to be used in the design;
- study of the present situation of the beaches to define the littoral transport rate and characteristics of the native sand;
- location of suitable borrow area for sand to be used for nourishment;
- definition of working methodology for dredging, transport and placing of sand;
- design of the beach nourishment profiles and of the containing structures;
- checking of designed structures by mathematical and physical modelling.



## Dredging and Reclamation Works

# RAVENNA PORT HUB PROJECT: DREDGING OF CANDIANO AND BAIONA CHANNELS, ADAPTATION OF EXISTING QUAYS, NEW TERMINAL CONTAINER, SEDIMENT MANAGEMENT

Location:	Italy
Client:	Consorzio Stabile Grandi Lavori s.c.r.l – Dredging International s.v
Services:	Final and Detailed Design
Period:	02/2020 - ongoing
Construction cost:	€ 197,848,915

## Project Description:

The assignment consists of the "Deepening of the Candiano and Baiona channels, adaptation of existing operational quays, new terminal on the peninsula Trattaroli, dredging of the port of Ravenna and the reuse of the dredged material".

The activities include the Final and Detailed Design of the dredging of the port of Ravenna - 1st phase (4.7 million cubic meters), management of sediments (emptying of reclaimed areas and land reclamation of logistic areas), structural adaptation of existing quays (2.9 km of quays), new container terminal (about 0.6 km); geotechnical and seismic investigations; quay and apron surveys (sonar, 3D multibeam, lidar, 3D laserscan, seismic refraction), aerial photogrammetric surveys with drone, and bathymetric surveys (with multibeam), sub-bottom profiler, sides scan sonar; sedimentation tests.

The Detailed Design was divided into functional stages.

The **1<sup>st</sup> stage** consists in functional and structural adaptation works of the existing quays of the Candiano channel and of the San Vitale channel, new terminal container for an overall development of about 3.6 km.

In this stage is also included the emptying of the Trattaroli area, functional to the construction of the new container terminal, and the reclamation of the S3Sud logistics area.

The works of the **2<sup>nd</sup> stage** concern:

- Emptying of the reclaimed area Nadep;
- Land reclamation of Logistics area L2 and logistics area S3 Sud with dredged sediments;
- Filling of Bosca Quarry with dredged sediments.

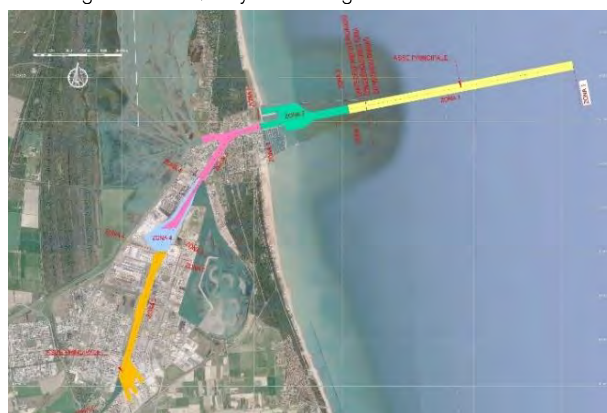


The **3<sup>rd</sup> and 4<sup>th</sup> stages** consist in the following works:

- Dredging of 4,7 million cubic meters: outer and inner channel, and internal harbour, till -13.5 and 12.5 m.s.l. wader depth
- Management of dredged sediments: most of dredged materials from outer channel (zone 1) into the sea; for the remaining zone

1 and Zones 2-5 the dredged sediments will be transported in the reclaimed areas (logistic areas);

- Land reclamation of Logistics areas L2 and logistics areas S3 Sud S3Nord with dredged sediments
- Filling of Bosca Quarry with dredged sediments.



The services provided include the Final and Detailed design of existing quays, new terminal container, and dredging, as well as site investigation and laboratory analysis:

- topographic surveys (aerial photogrammetric and topographic) of existing quays, land for the new terminal container, reclaimed areas and logistic areas for land reclamation.
- geoelectric and seismic spreads with electro magnetometer
- 3D georadar surveys
- Geotechnical investigations to define the stratigraphic structure, geotechnical parameters, seismic classification and the groundwater level (SCPTU, CPTU, survey with piezometer, dissipation tests, sampling, laboratory analysis, geophysical tests and penetration tests)
- Bathymetric survey with Multibeam survey of the existing seabed of outer and inner channel and harbour
- Side-scan sonar surveys.

The following activities have been performed to support:

- the definition of the geotechnical characteristics of the foundation soils, with the elaboration of the geological and geotechnical models
- resistance parameters in seismic conditions
- definition of the basic seismic hazard and study of local seismic response
- study of liquefaction
- structural analysis and checks (Plaxis)
- checks on the existing plants for the preparation of new plants
- check of the fenders
- calculation via STR on the cloud platform
- detailed design of dredging, volume calculation based on the results of multibeam echosounder bathymetric survey and on the planned dredging layouts, sediment management and use plan (dredging methodology and the inland and offshore disposal area)
- Traffic impact study.

# DETAILED DREDGING DESIGN AND DISPOSAL OF DREDGING MATERIAL FOR DREDGING OF THE ENTRANCE CHANNEL, HARBOUR BASIN AND TURNING CIRCLE OF DAR ES SALAAM PORT

Location:	Dar es Salaam, Tanzania
Client:	Tanzania Ports Authority (TPA)
Services:	Detailed design of dredging including: environmental site investigation and laboratory analysis (physical, chemical and eco-toxicological test); Preparation of bidding documents.
Period:	08/2018 – 07/2019
Construction cost:	€ 109,833,044

## Project Description:

The Port of Dar es Salaam (DSM) (pictured below) is the main port of Tanzania and is located at the mouth of rivers Kizinga and Mzinga within the Dar es Salaam bay. Port traffic volumes are growing by 9 per cent per year, with containerized volumes increasing even faster. This rapid growth is placing considerable strain on Dar-es-Salaam Port. As a consequence, Dar-es-Salaam Port has implemented plans to develop Port capabilities including facilitating access to Panamax and, in the future, possibly Post-Panamax capacity container vessels as well as larger dry bulk vessels. At the moment this kind of vessels are constrained by the width and depth of the channel, the depth at the quay, and the available turning basin. These plans require the entrance channel and the port basin to be dredged, and the dimensions of the entrance channel and the turning basin(s) adapted accordingly. The Consultant has already carried out the feasibility study and the preliminary design for the upgrade of the port area, which foresees the dredging of approx. 16 million m<sup>3</sup> of sediments from the port and the approaching channel and their disposal offshore. A preferred design option supported through economic evaluation and appraisal was accepted by the TPA. This assignment however, concerns the dredging detailed design of only phase 1 of this preferred design option, which includes the dredging (widening / deepening) of the Port Entrance Channel, First Turning Circle and Harbor Basin up to Berth 11.

Scope of this assignment is to perform an additional environment assessment and analysis to determine practicable solutions for the disposal of dredged polluted /unpolluted sediments related to the envisaged expansion works and establish a detailed working methodology for dredging and disposal of dredged material, detailed dredging design as well as tender documents for the dredging works:

- Site investigation and laboratory analysis: physical, chemical and eco-toxicological characterization of polluted sediments to better understand the potential environmental risk of their disposal in the ocean
- Analysis of the dispersion patterns of the sediments dumped in the Ocean: Dispersion study of the dredged sediments (improving numerical models - 3D models- of the area where the sediments have to be discharged); Assessment of dispersion mechanism & comprehensive assessment of the risk, identifying the optimised depth at which the sediments will have to be discharged; turbidity monitoring plan to minimize the risk of impairing marine.



Detailed design of dredging of the port of Dar es Salaam: Option B – Phase 1 – General layout

In the **detailed design the option B phase 1** will be developed starting from the results of the Environmental Assessment: the deepening of the 5km long approach channel to -16.50m and of the 3.0km long inner channel/harbour basin to -15.50m in order to safely receive a Post-Panamax design ship 305m long, 40m wide and with a draft up to 14.5m without tidal restrictions. The total dredging volume of the phase 1 amounted to approx. 10,35 million m<sup>3</sup> (considering vertical and horizontal dredging tolerances) consisting mainly of clayey silt, sand and coral deposits.

The assignment also included the **preparation of bidding documents for works**.

# LAND RECLAMATION AND REVETMENT WORKS FOR THE NEW DOHA INTERNATIONAL AIRPORT (NDIA)

Location:	Qatar
Client:	New Doha International Airport Steering Committee
Services:	Concept and Detailed Design; Tender Documents
Period:	04/2008 – 05/2018
Construction cost:	€ 71,425,000

## Project Description:

In order to accompany the exploitation of the gas resources of TECHNITAL has been appointed by the Government of the State of Qatar, represented by the NDIA Steering Committee, to provide the design and tender documents for the expansion of the NDIA reclaimed platform over an area of 107 ha. of land and sea, partially covered by construction and bulky waste.

The project includes the following main works:

- site preparation to receive fill, including the removal of 1,150 m of existing revetment, site clearance from bulky wastes, preliminary spreading and levelling of in-situ materials;
- land reclamation with approx. 2.5 million m<sup>3</sup> of granular material to be placed as engineered fill capable of carrying shallow foundations and pavements;
- construction of approx. 700 m of rock revetments, including reinforcement of the existing bund located on the site's northern boundary, to protect the reclamation platform from wave action and flooding risk;
- construction of approx. 1,200 m of buried concrete box culvert, with a gravity outfall through the revetment, to allow the discharge into the sea of surface runoff discharging through an existing outfall located at the lower east boundary of the site.

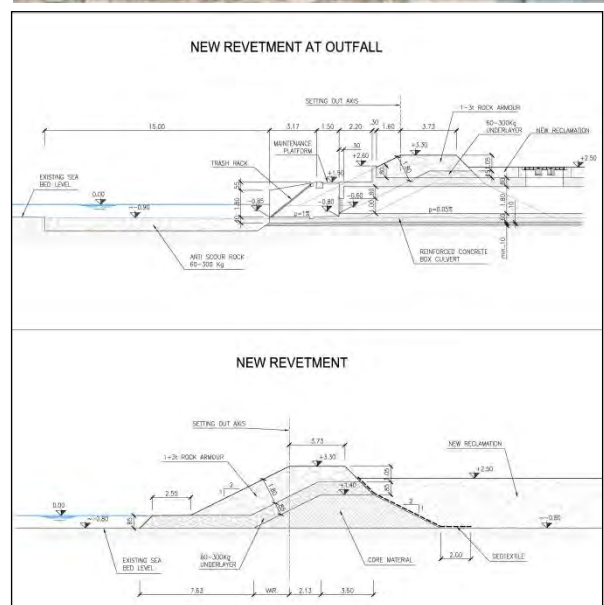


The engineering services carried out comprise the following:

- desk study for the identification of sources for supply of fill and rock materials;
- topographic and bathymetric surveys, geotechnical and environmental investigations;

- desk study including the preliminary assessment of design conditions and the conceptual design of the works, based on site surveys and investigations, collection and analysis of environmental data, wave, hydrodynamic and hydraulic modelling studies;
- comprehensive detailed design of the works;
- preparation of tender documents for construction.

In addition to the above, TECHNITAL has been appointed to provide factual assistance to the Client during the whole tendering process, from the pre-qualification phase to the evaluation of bids.

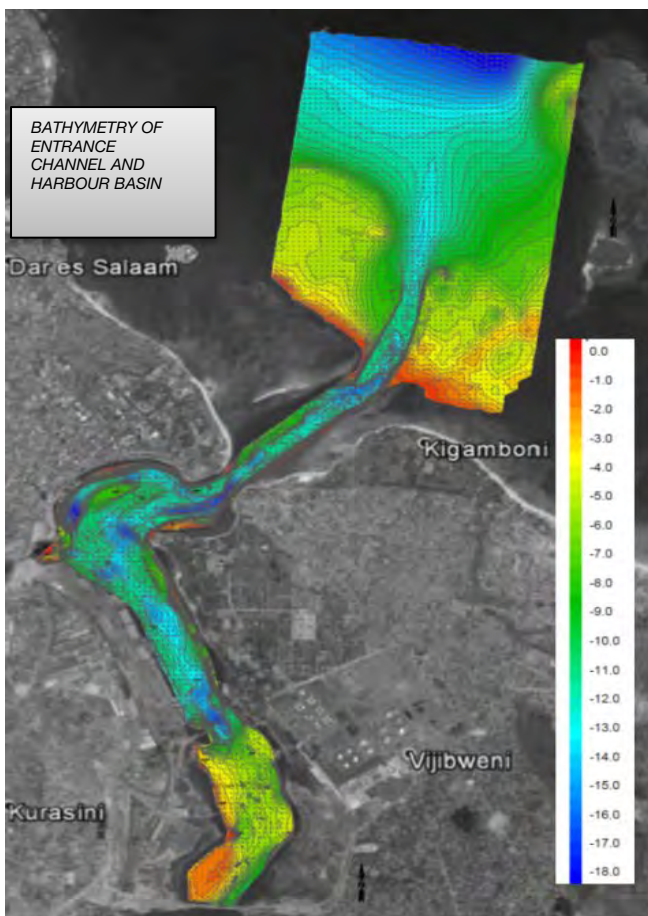


# CONSULTING SERVICES FOR FEASIBILITY STUDY INCLUDING BATHYMETRIC, HYDRODYNAMIC AND GEOTECHNICAL SURVEYS FOR DREDGING OF DAR ES SALAAM PORT ENTRANCE CHANNEL AND TURNING BASINS

Location:	Port of Dar es Salaam, Tanzania
Client:	Tanzania Ports Authority (TPA)
Services:	Field Data Collection, Bathymetric and Geotechnical Surveys, Feasibility Study, Concept Design of Entrance Channel, Real Time Navigation Simulations, Hydrodynamic and Sedimentation Study, Cost Estimates, Scoping of the ESIA (by Technital), Financial feasibility and Economical Appraisal (by Others).
Period:	12/2015 – 12/2016
Construction cost:	To be tendered (confidential)

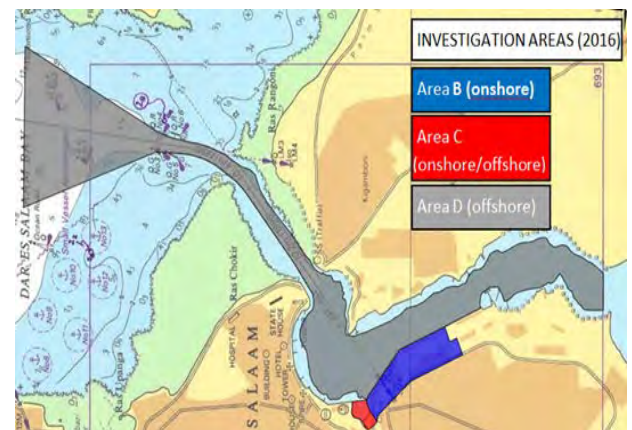
## Project Description:

The Port of Dar es Salaam (DSM) is the main port of Tanzania. Volumes handled reached 14.5 million tons in 2013/14 and are growing by 10% per year, with containerized volumes increasing even faster. The port has 11 berths (for a total length of approximately 2,000m), two tanker berths and handles a vast array of cargo, including containerized, dry bulk, Ro-Ro, and liquid bulk cargo. As part of the port development plan, the Tanzania Port Authority (TPA) has developed plans to ensure the access of Panamax and, in the future, possibly Post-Panamax capacity container vessels, as well as larger dry bulk vessels, which are currently constrained by the width and depth of the channel (currently -10.0m/-10.2m CD), the depth at the quay and the available turning basins. These plans require the 5km long entrance channel and port basin to be dredged, and the dimensions of the entrance channel and turning basins adapted accordingly.



Scope of the assignment was to assess the current and future demand of DSM port aimed at defining the size of future vessels

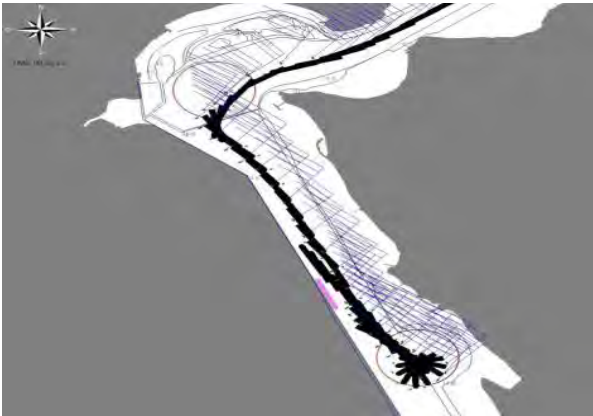
calling at the port and to undertake the feasibility study of **several dredging options** of the port basin and entrance channel, comprising the concept design of each option, the definition of the most suitable dredging and disposal methodology taking into account technical, economic and environmental aspects including **water quality assessments**, a hydrodynamic and sedimentation study to determine the most viable strategy for maintenance dredging, a cost-benefit analysis of the proposed options and the selection of the optimum alternative to be recommended to TPA for further action. The assignment also included the execution of bathymetric, hydrodynamic, environmental and geotechnical surveys of the access channel and harbour basin to thoroughly assess the properties of the soil to be dredged and to determine the most appropriate dredging and disposal methods.



**AREAS OF SITE INVESTIGATIONS**

Three dredging design options associated with different development alternatives of port infrastructures were investigated, considering the access to the harbour in both tide restricted and tide unrestricted conditions for several design vessels. The most promising option in terms of technical, financial and economic feasibility implied the deepening of the 5km long approach channel to -16.50m and of the 3.0km long inner channel/harbour basin to -15.50m in order to safely receive a Post-Panamax design ship 305m long, 40m wide and with a draft up to 14.5m without tidal restrictions. The recommended option also included the provision of two new turning circles of 500m and a 1.2 km long extension of the inner channel to enable the access to new Berths 12-14. The total dredging volume amounted to approx. 20 million m<sup>3</sup>, consisting mainly of clayey silt, sand and coral deposits, 1.7 million m<sup>3</sup> of which were contaminated sediments. The management of dredged material included the transport of contaminated sediments to an upland confined disposal facility to be built along the coast, the re-use of suitable material within planned port reclamation projects and the discharge of the remaining soil in open water at dedicated offshore disposal areas. Suitable offshore dumping sites located 10km and 15km NE of the existing channel were selected through a specific hydrodynamic study.





REAL TIME NAVIGATION SIMULATION

**Description of actual services provided:**

The consultancy services included the following tasks:

Feasibility study, including: field data collection inside and outside the port basin (site recorded metocean and meteorological data), geotechnical (off-shore, on-shore) and bathymetric surveys, assessment of the current and future traffic demand, entrance channel concept design, real time navigation simulations, hydrodynamic and sedimentation study, dredging and disposal methodology, dredging cost estimates, environmental aspects, and scoping of the ESIA

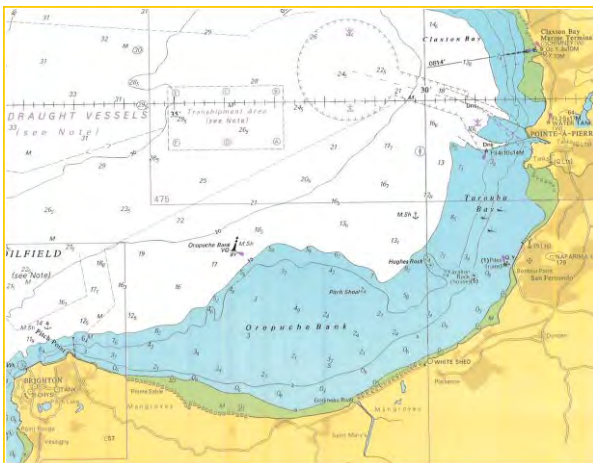


OPTION B) LAYOUT WITHOUT TIDAL RESTRICTIONS

# ORPOUCHE BANK RECLAMATION PROJECT

Location:	Trinidad & Tobago
Client:	National Energy Corporation of Trinidad & Tobago Limited (NEC)
Services:	Master plan, EIA , Detailed Design and Tender Documents
Period:	08/2008 - 12/2010
Construction cost:	€ 1,870,911,000

## Project Description:



In order to accompany the exploitation of the gas resources of Trinidad & Tobago, the Government has charged the National Energy Corporation (NEC) to identify and develop new industrial sites. A series of preliminary studies have been undertaken and as a result of these studies three possible sites seems to give the possibility to allocate new industrial parks as requested by the Government. One of these is the Oropouche Bank, located off the south-west coast of Trinidad, between Pointe a Pierre in the North, and Brighton in the south west, which has been identified as a potential site for locating gas based industries. The idea of creating new industrial sites by building reclaimed areas allows the Government to avoid consuming land side areas, thus reducing the impact on the population.

In the framework of this contract TECHNITAL has developed various activities:

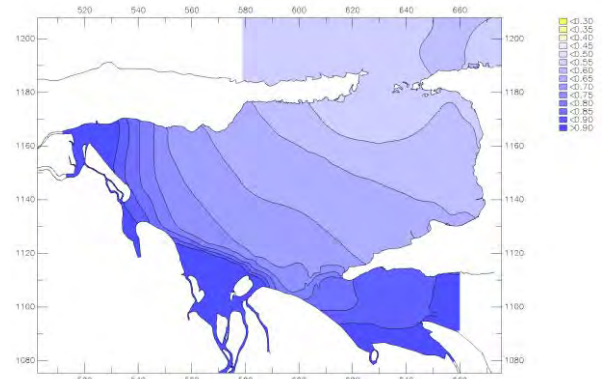
In the first Phase several environmental studies were developed to define location and shape of the new island. The studies included extensive numerical modelling analysis on the local conditions as well as on the general conditions of all the Gulf of Paria in order to highlight possible impacts. The proposed reclamation site is located in a sensitive area, from the morphological and ecological point of view; it is characterised by the presence of the Godineau river mouth, extensive mangrove swamps and is presently a very important fishing ground for shrimps; all these aspects were considered in order to find the more sustainable layout of the new island. Among the aspects studied were: sediment transport, waves, littoral currents , river discharges, coastline evolution, benthic life, fishing activities. As a consequence the final layout of the island with a total surface of 1600 ha was defined

In a second phase a Master Plan of the industrial development on the new island was performed. Industrial planning necessary to define the characteristics and the reciprocal position of the industries that will be installed in the new island and of the relevant port facilities were defined for different development scenarios, considering different combinations of heavy and light industries as well as of tertiary sector

In the third phase it was developed the preliminary design of the new island; the design included

- identification of the most appropriated source of the filling material (roughly 100 million m<sup>3</sup>), analysing the different possibilities offered by Trinidad & Tobago , by the neighbouring countries by offshore marine sites
- definition of construction methods to minimise the environmental and anthropic impacts, the construction time and, as a consequence, the final cost of the work;
- identification of the most appropriated engineering solutions for the quays, the jetties, the boundary protection structures (sheet piles, concrete caissons, rubble mound protections, etc.) as well as for soil compaction and rainfall drainage
- identification of the most appropriated engineering solutions for the link connecting the new island with the mainland (a viaduct approx. 2 km long), including a traffic study of the connection with the existing road network

Finally, a scoping document was prepared, to serve as a guide for the conduct of the future EIA study .



# CLEANING OF AL DAKHIRA CHANNEL

Location:	Qatar
Client:	Public Works Authority, Building Affairs
Services:	Post Contract Professional General & Site Supervision and Quantity Surveying for Marine Works – Dredging
Period:	05/2009 - 11/2010
Construction cost:	€ 2,804,400

## Project Description:

The works comprise the removal of silt, sand and any loose obstacles in accordance with the bathymetric survey report and drawings for an area of approximately 80,000 sqm within Al Dakhira Port and Channel, as well as supply and development of No. 10 Navigation Aids. The works are scheduled to be complete in 150 days.

The works have to take care of mitigation measures required by SCENR (Supreme Council for the Environment and Natural Resources); a suitable disposal area for the dredged material has been allocated.



# DEEPENING OF AL WAKRAH PORT AND ACCESS CHANNEL

Location:	Qatar
Client:	Public Works Authority of Qatar - Building Affairs
Services:	Post Contract Professional General and Site Supervision, Quantity Surveying
Period:	03/2006 – 02/2009
Construction cost:	€ 9,660,600

## Project Description:

The project site is located at Al Wakrah, about 100 km South from Doha. Originally a tiny fishing and pearling village, it has evolved into a small town with a population of less than 30,000.

The works include the development of Al Wakrah Port and the deepening and widening of the entrance channel.

The Site Team is composed of:

- No. 1 Resident Engineer
- No. 1 Site Inspector
- No. 1 Site Surveyor



Various phases and highly specialized activities are involved:

- Dredging of a basin area to -3.00 m CD and of the channel to -4.00 CD
- Transportation of the dredged material to the final stockpile
- Provision and installation of navigational aids.



# RECONSTRUCTION OF SALTMARSHES IN THE VENICE LAGOON

Location:	Venice, Italy
Client:	Venezia Nuova Consortium for Italian Ministry of Public Works – Water Board, Venice
Services:	Model studies, Preliminary Design, EIA, Detailed Design, general supervision
Period:	12/1989 – 12/2007
Construction cost:	€ 400,000,000

## Project Description:

The project is part of a general plan of the Italian Government aimed at preserving the environmental quality of the lagoon of Venice (one of the most significant coastal ecosystems in the Mediterranean sea) by reducing the ongoing erosion processes and the loss of habitats of natural value.

So far more than 9 million cubic meters of fine sediments, which would have been lost to the Adriatic sea, have been reused and some 800 hectares of saltmarshes and tidal flats have been constructed using the sediments obtained by dredging the lagoon channels.



The basic strategy is to reuse of dredged sediments deriving from maintenance dredging of existing navigation channels, to rebuild natural saltmarshes and tidal flats lost due to erosion.

The results obtained have been quite satisfactory since the vast majority of the new saltmarshes are spontaneously colonised by the natural vegetation in three to five years after completion.

The activities performed have included studies to define the geographical location and the shape of the new morphological structures from an hydrodynamic and landscape point of view as well as to find innovative environmentally friendly techniques that could guarantee both the stability of the new morphological structures and their insertion in the lagoon landscape

Specific attention has been devoted to the selection of specific equipment to carry on the works that is often performed in remote areas and in difficult operating conditions (i.e. depth less than 50 cm, distance from navigation channels etc.)



# CONSULTANCY SUPERVISION SERVICES FOR THE DEVELOPMENT OF AL KHOR PORT AND CHANNEL

Location:	Qatar
Client:	Public Works Authority - Building Affairs
Services:	Post Contract Professional General and Site Supervision, Quantity Surveying
Period:	03/2006 – 11/2007
Construction cost:	€ 15,000,000

## Project Description:

The project site is located at Al Khor, an ancient fishing town, located some 30 km north of Doha, well known for its old harbour.

The focus of the North Field Gas industry, Al Khor is poised to become Qatar's second largest urban centre and as such is not only being developed as an industrial complex but will also become a major residential area.



The works include the development of Al Khor Port and the deepening and widening of channel.

Various phases and highly specialized activities are involved:

- dredging,



- stockpiling
- provision and installation of navigational aids,
- construction of quay wall,
- revetment,
- floating pontoons,
- construction of roads and car park,
- installation of street lighting,
- provision of water, electricity and telecommunications services.



# LAND RECLAMATION FOR LPG TANK FARM IN THE PORT OF RAS LAFFAN

Location:	Qatar
Client:	Grandi Lavori Fincosit Middle East (Contractor) for Qatar Petroleum
Services:	Detailed Design & As-Built Drawings
Period:	02/2002 – 12/2002
Construction cost:	€ 15,500,000

## Project Description:

The Project concerns the “Engineering, Procurement and Construction” of the New Land Reclamation for the future LPG Storage Tanks at Ras Laffan Port, on the northeast shores of the Industrial Area adjacent to the existing Lee Breakwater.



The engineering activities include the Detailed Design of:

- Reclamation of an area inside the revetment to the extents and levels given;
- New berm revetment;
- Removal of rock armour from the existing lee breakwater;
- Surface water drainage system including two outfalls and a new culvert under the existing road.

The Project regards the design and verifications for the proposed structures, according to different Milestones, as per the Specifications and drawings supplied by the Client.

Milestone 1 was divided as follows:

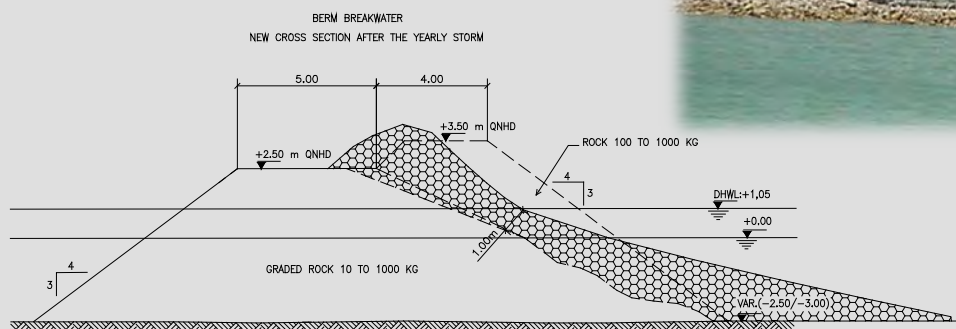
Phase 1: Execution of a narrow strip of land reclamation, parallel to the lee breakwater, in order to remove the armour rocks on it, including the stability check of the underlying core material.

Phase 2: Execution of the land reclamation, except for the last 30 m on the sea side, which will be completed once the berm revetment has been executed, during Milestone 2. It also includes the design of the culvert, the northern drainage channel and outfall.

All design activities of Milestone 1 have been completed.

Milestone 2: Construction of the containment revetment to a certain length, and completion of northern drainage channel, including outfall design. In this regard Technital proposed an alternative solution consisting of gabions and a mattress, which was finally implemented. The design and the verifications of the new berm revetment were carried out up to a certain depth, corresponding to the end of this Milestone.

Milestone 3: Completion of all remaining construction works of the project, namely the completion of the land reclamation to its maximum extent and the prosecution of the berm revetment up to the existing rock groyne. It also includes the design for the southern drainage channel, its outfall and the supplementary channel.



# DREDGING WORKS, LAND RECLAMATION AND DISPOSAL OF POLLUTED SOILS FOR THE SHAPING OF THE NAVIGATION CHANNELS OF THE VENICE PORTS AND LAGOON

Location:	Venice lagoon, Italy
Client:	Venezia Nuova Consortium - Ministry of Public Works
Services:	Dredging planning, model studies, Preliminary Design, EIA Study and general supervision
Period:	04/1987 - 09/1997
Construction cost:	€ 232,405,600

## Project Description:

The Project included:

- dredging of more than 3.5 million m<sup>3</sup> of fine sediments, often polluted by heavy metals;
- land reclamation using most of the a.m. dredged materials, with construction techniques adequate to the relevant pollution level;
- treatment of sediments and waste water;
- final disposal of the most polluted materials.

In the six years between 1987 and 1993 TECHNITAL produced the Detailed Design for more than ten interventions for dredging canals, reconstructing marshlands and tidal flats, and rehabilitating islands, which were carried out by the Venezia Nuova Consortium and constitute the beginning of an ambitious programme of morphological recovery of one of the most significant coastal ecosystems in the country.



The main objectives of the project are:

*Dredging of navigation channels and reconstruction of saltmarshes and tidal flats.*

This includes all interventions involving movement of materials within the lagoon, namely the reconstruction of saltmarshes and tidal flats the rehabilitation of natural canals and the reduction of some artificial canals. The basic objective is to keep the sediments obtained from dredging for navigation purposes within the lagoon. It is planned to replace about 15 million cubic metres in the "barene", "velme" or on the bottom of artificial canals in the next 10-15 years.

These interventions aim to

- ◇ create morphological and hydrodynamic conditions unfavourable to the growth and accumulation of the macroalgae, whose decay in summer produces anoxic episodes in the water column;



- ◇ reduce the risk of release of pollutants from the sediments into the water column and in the trophic chain.

*Artificial introduction of sediments from the sea with fixed bypass plant.*

It is proposed to partially remedy, and only for those aspects where intervention is possible today, to the drastic reduction in the natural input of sediments. The pumping plant would be installed on a quay North of the Lido inlet, at a depth of between 4 and 6 metres.

*Restoration of the flora typical of the lagoon floor.*

It is basically proposed to increase the natural resistance to erosion of the bottoms themselves, by the transplantation of marine phanerogams, in areas where human intervention had eliminated them.

*The morphological rehabilitation of the lesser islands.*

This part of the design contemplates the protection and environmental development of islands which are currently in a state of severe neglect, mainly using dredged material for which it is necessary to locate depot sites.





## Special Marine Works

# MOBILE SURGE BARRIERS AT THE THREE INLETS OF THE VENICE LAGOON (MO.S.E.)

Location:	Venice lagoon, Italy
Client:	Venezia Nuova Consortium - Ministry of Public Works
Services:	Detailed Design of surge barriers to regulate the tidal flows, including a navigation locks, refuge harbours, foundations, and ancillary structures; Technical Assistance
Period:	01/2005 – ongoing
Construction cost:	€ 8,000,000,000

## Project Description:

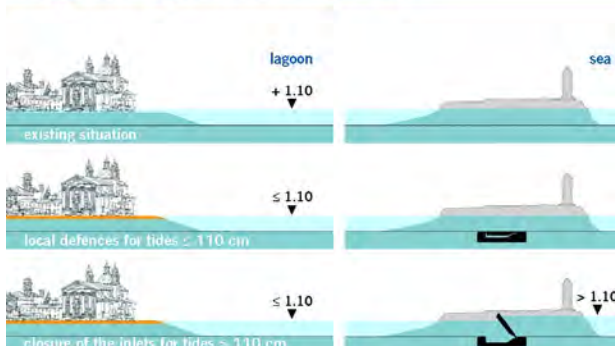
The objective attributed by legislation to the design for Mobile Barriers is of the utmost importance - defence of the cities of Venice and Chioggia and other historic towns and villages in the lagoon together with the entire lagoon basin itself from the damaging effects of medium-high tides and the devastating effects of exceptional tides



The solution chosen to provide a full response to the complex problem of the high tides involves a combined system of interventions including: temporary closure of all three lagoon inlets by means of a row of mobile gates; local measures to raise shores and banks, compatible with the architectural and socio-economic structure of the individual built-up areas; and wide area morphological measures compatible with the environment to protect against the most frequent flooding.

The works at the lagoon inlets for the defence of Venice and its lagoon from tidal flooding represent one of the largest hydraulic engineering projects of our times.

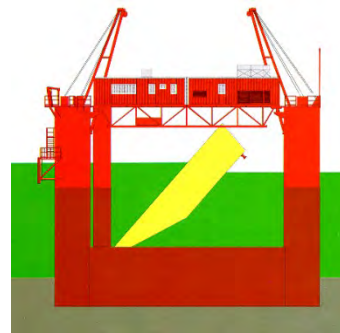
## High tide protection system



The preliminary design of these works was performed by Technital 1990-1992, with the co-operation of numerous specialised national and international institutes which, under the designer's co-ordination, carried out innumerable tests on physical models, studies with mathematical models and measurement campaigns.

Following the analysis of the results of the physical and mathematical model tests and of those derived from monitoring the full-size prototype of a flap-gate, the MO.S.E. (*MOdulo Sperimentale Elettromeccanico* - Electromechanical Experimental

Module) the buoyancy flap-gates, the "heart" of the system, were designed.



The definition of the functional and structural dimensions, the selection and scaling of special components and of the corrosion protection system, and the definition of the tolerances on the basis of the construction methods to be used were performed separately for each inlet.



The optimal solution to solve this problem, as identified by the Preliminary and Basic Design phase, is the construction of four fixed barriers with buoyancy flap-gates, two at the Lido mouth, one at the Malamocco mouth and one at the Chioggia mouth, with the following dimensions:

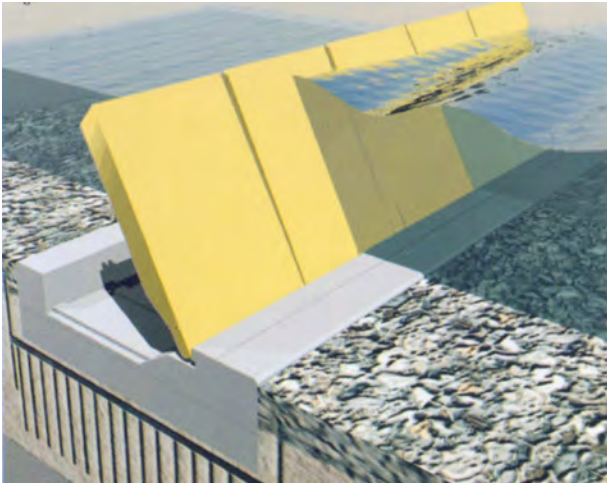
	Width	Depth	No. of gates
o Lido S. Nicolò:	400 m	11 m.	20
o Lido Treporti:	420 m	6 m.	21
o Malamocco:	400 m	15 m	20
o Chioggia:	360 m	11 m	18

Each mobile barrier consists of a row of gates installed on the seabed at the lagoon inlets. They are defined as "mobile" as under normal tidal conditions they are full of water and rest in recessed caissons on the seabed. Each gate is attached to the caisson via hinges. When tides above the established height are forecast (if the height is 100 cm, an average of 7 times a year; if the height is 110 cm, an average of 3-5 times a year), compressed air is introduced into the gates to expel the water. They thus rise, rotating around the axis of the hinges, to emerge and block the tidal flow.

Each flap-gate will consist of a rectangular metal caisson, 20 metres wide, 4 metres high and of variable length depending on the depth of the canal.

The inlets remain closed for the duration of the high water only and for the time required to manoeuvre the gates (on average, a total of

four and a half hours). The feasibility and effectiveness of the proposed solution have been studied during years of tests on mathematical and physical models with the contribution and control of leading hydraulic model laboratories.



The four sets of buoyancy flap-gates, with an overall length of almost two kilometres, will be anchored to pre-cast concrete foundation caissons floated to the site place and laid in special trenches, and will be raised by the introduction of compressed air during exceptional tidal conditions to prevent the lagoon from flooding.

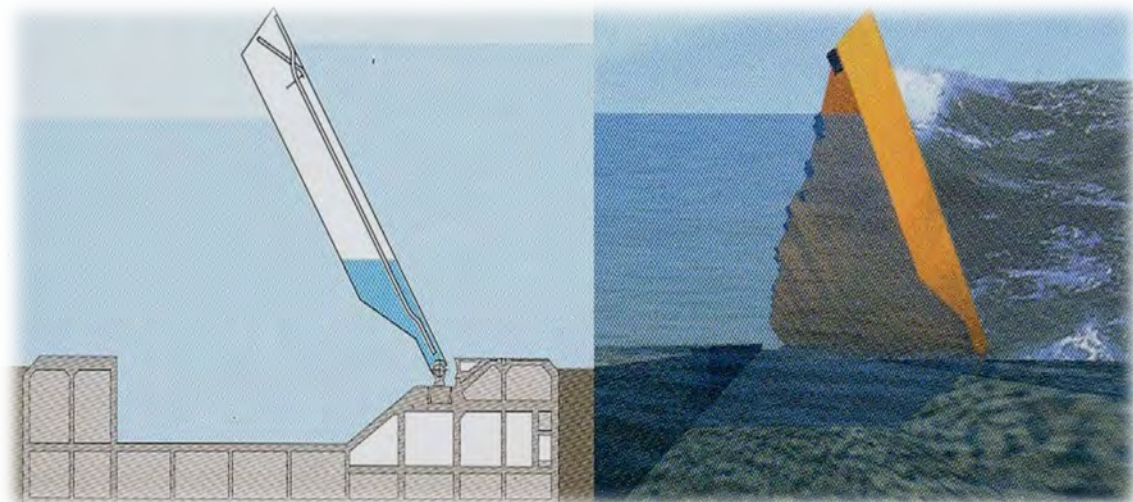
Refuge basins, with navigation locks for small and medium sized craft, will allow the harbouring and transit of marine traffic even when the flap-gates are raised. The design of these refuge basins and their connection with the mobile works and that of the locks for small craft involved, in addition to the hydrodynamic and wave motion model studies and the traditional dimensioning, the use of models for simulating the successive arrival of craft and models for the access and evolution manoeuvres within the internal basins.

The dimensions of the principal structures of the barrier were then defined: these include the flap-gate housings, the fixed works on either side of the barriers, the gantry crane shelters and the control building. Since these are the only above-ground structures of the complex, a special study was carried out for their insertion in the environment resulting in the definition of singular architectural solutions for the buildings, compatible with local morphology and the historical tradition of the city.

By means of mathematical solutions of the problems of building-ground interaction, the related settlements and the safety coefficients for various alternative solutions, a type of foundation was selected consisting of caissons pre-cast off-site and sunk in situ with flexible watertight joints.



The design of the bottom protection, the auxiliary technical plants and the study of the most suitable realisation stages in relation to the construction methods and to minimal interference with the anthropic activities concluded the design activities.



# OFFSHORE PLATFORM FOR A CONSTRUCTION SITE WITH SYNCROLIFT FOR 25,000 TON STRUCTURES

Location:	Venice lagoon, Italy
Client:	Venezia Nuova Consortium - Ministry of Public Works
Services:	Feasibility Study, EIA studies, Detailed Design, Construction specification documents. Technical Assistance during construction.
Period:	02/2005 – 12/2011
Construction cost:	€ 70,565,800

## Project Description:

A construction site for huge concrete cellular caissons has been planned in the Venice lagoon. After a feasibility study of alternative locations an area near the Malamocco port was selected. In that area, the traditional dry basin excavated up to a depth compatible with the dimensions of the concrete units to be built, flooded upon completion of the construction, proved very expensive. A solution with a construction site on an embankment was therefore adopted.

The embankment is 400x450 metres and is built with dredged material up to + 0.5 metres above mean water level. The remaining 2 metres to reach the design elevation, has been properly sized to support very heavy loads (80 kPa average). A sequence of thin layer of granular materials with specified grain size compacted up to the required grade has been adopted. The overall embankment stability has been further improved by a system of wells acting as a preload system.



Reclamation activities



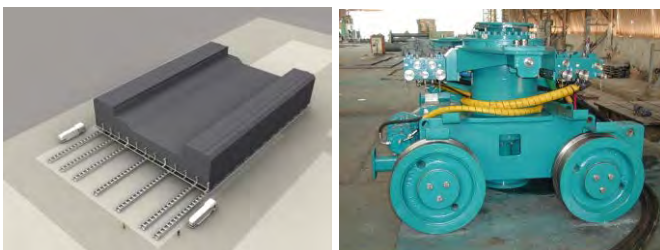
Aerial view of the embankment

The platform is designed to support a caisson load of 25.000 t each and it is 63x52.5 metres in size.

A monitoring system has been adopted to control the construction system and to instruct the contractor in order to obtain the optimum result.

The contract included the provision of the following services:

- Feasibility study of the jacks and of the Syncrolift platform
- EIA studies
- Detailed design of the embankment and its containment works, quays to accommodate the platform and prefabrication slabs.
- Platform, rails and trolleys design check
- Bill of quantities and cost estimate
- Construction specification documents
- Groundwater flow analysis to optimise the number and the position of the wells
- Three-dimensional non-linear geotechnical models to define the settlement during the embankment construction, the concrete cellular caisson construction, their translation, transfer and float-out on the Syncrolift platform.



The concrete cellular caisson are built, on concrete slabs, at an elevation of + 5 metres and therefore 2,5 metres above the embankment elevation in order to allow the installation underneath of special transfer trolleys (with jacks) running on rails for the translation of the caissons.

The caissons are then transferred to the sea side boundary of the embankment, where a Syncrolift platform is located.



# BOTTOM PROTECTION WORKS AT THE THREE ENTRANCES OF THE VENICE LAGOON

Location:	Venice lagoon, Italy
Client:	Venezia Nuova Consortium - Ministry of Public Works
Services:	Detailed Design, Tender Documents, geological-geotechnical and bathymetric surveys, hydrodynamic model studies
Period:	02/2006 – 12/2011
Construction cost:	€ 172,603,400

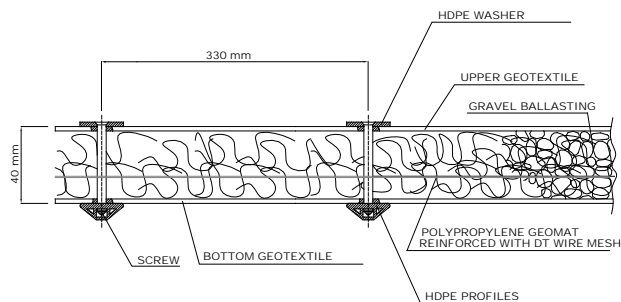
## Project Description:



The entrances of the three port of the Venice Lagoon have been protected against erosion induced by the currents.

The protection is designed to be stable for currents up to 4 m/s, is extended for an area of 400X350 metres in the Lido San Nicolò port, 420x350 m in the Lido Treporti port, 550x400 metres in the Malamocco port and 370x420 metres in the Chioggia port, and has a maximum thickness of 2,90 metres due to the presence of the following layers, described from the bottom to the top:

- a prefabricated 40 mm thick ballasted filtering mattress (BFM) consisting of a 350 gr/m<sup>2</sup> geotextile as bottom filter, a central body consisting in a geomat in polypropylene filaments, internally strengthened with a double twist wire mesh, a ballasting of the central body with small crushed rock, grading 4-8 mm, a geotextile for the upper closure, a side band in filtering geotextile and a quilting with HDPE profiles and steel screws.

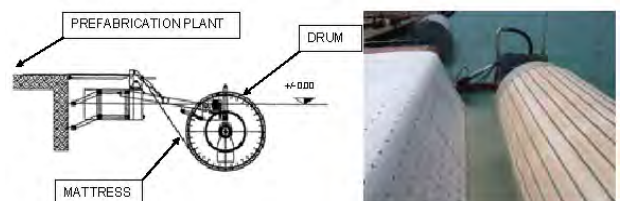


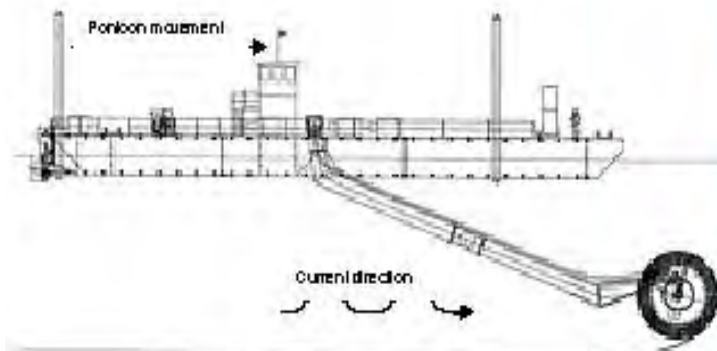
- a filter layer 60 cm thick made with 10-60 kg natural rock
- an upper layer of natural rock, with maximum grading 1000-3000 kg and thickness 230 cm.

The design has been based on extensive mathematical and physical models to establish the stability of each layer. Scale 1 to 1 tests were also performed to verify the capabilities of the mattress to accept installation of the upper layers without damaging the mattress.



The prefabricated mattress is assembled in strips 10 metres wide and 150 meters long, in a specific plant, with average daily production of 1500 m<sup>2</sup>, wound onto a floating cylinder and transported to the site where it is laid on the seabed by means of a an accurately positioned pontoon 48x24 m





Immediately after the start of the ebb-tide the mattress is unwound from the cylinder in a direction parallel to the current at a speed of approx. 4 m per minute in the same direction as the current.

During construction continuous surveys were performed to make available the following information:

- the changes of the water depth and of the sea bed morphology during construction; these information have been used to verify the design assumption and to introduce, when necessary, the required modifications

- the alignment of the mattress to guarantee the efficiency of the lower filter of the bottom protection

The contract included the provision of the following services:

- Detailed Design of the structures described
- Bill of Quantities and cost estimate
- Tender Documents.

# SELF-PROPELLED JACK-UPS FOR GATE SUBSTITUTION IN THE VENICE FLOOD DEFENCE SYSTEM

Location:	Italy
Client:	Consorzio Venezia Nuova
Services:	Definition of technical requirements, Configuration Study, Detailed Design, Cost Estimate, Health and Safety Co-ordination Plan, definition of and assistance to Tank Test
Period:	07/2003 - 07/2011
Construction cost:	€97,000,000 (2 units)

## Project Description:

A special vessel was designed to remove and install the flap gates in the Venice barrier caisson, which assures:

- operational flexibility (all barriers and all gates), through two hull and lifting frame configurations;
- tight operational tolerances (50 mm in positioning) and minimization of navigational constraint during operation on the barrier, through a DP system;
- autonomy and safety, through self-propulsion;
- draft suitable for navigation in the lagoon by pump jet propulsion.

### Operational procedure for removable gates handling

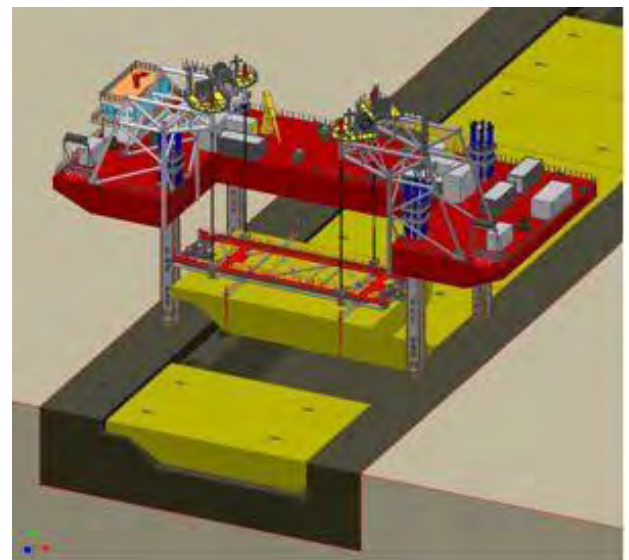
The standard procedure employs 2 units: the first to remove the gate to be replaced and the second to install the refurbished gate: the total elapsed time for the operation is about 15 hours.

The jack-up sails to the barrier and reaches the required position, lowers the 4 legs into receptacles in the caisson roof, raises the hull, lowers the spreader frame (guided against the hull and, under keel, the legs), hooks up (removal) or releases (installation) the gate through 4 twist locks to be engaged in the holes predisposed in the gate, lifts the gate, regains floating conditions and departs.

### Main equipment

- POWER: N° 4 main generators under deck, about 2 MVA each, and N° 2 auxiliary generators on the deck, 1,3 MVA each (total installed power 10,3 MVA)
- PROPULSION: N° 4 water steering pump-jets, 1600 kW each, with electric motors,
- POSITIONING: DP type IMO Class 1 (RINA Dynapos AM/AT)
- CONTROL AND MANAGEMENT: Power Management System(PMS), leg handling system, spreader frame handling system, ballast system, ROV (Remote Operated Vehicle)
- Navigation aids, utility systems, safety equipment.

MAIN FIGURES	Long Configuration	Short Configuration
Length Over All	69.6 m	60.25 m
Beam	30.25 m / 14.25 m	30.25 m / 14.25 m
Height	4.6 m	4.6 m
Hull opening	16.0 m * 33.6 m	16.0 m * 24.25 m
Deck surface	1519 m <sup>2</sup>	1386 m <sup>2</sup>
Max displacement	44672 kN	42302 kN
Light ship weight	27846 kN	25548 kN
Max design draft	3,23 m	3,37 m
Max oper./min draft	3,16 m / 2,53 m	2,92 m / 2,55 m
Max speed	5 knots	5 knots



Jack-ups - 3D view



Jack-ups - View

# NEW MARINE STRUCTURES TO MODIFY THE INTERNAL LAYOUT OF LIDO PORT

Location:	Venice Lagoon, Italy
Client:	Venezia Nuova Consortium - Ministry of Public Works
Services:	Detailed Design, Bill of Quantities and Cost Estimate, Tender Documents for new port entrance layout in view of the flood protection barriers at the inlet
Period:	09/2004 – 12/2008
Construction cost:	€ 223,533,800

## Project Description:

The marine works at the Lido port inlet consist of the abutments and foundations for the mobile flood protection barriers, including an artificial island between the two shipping channels of Treporti and S. Nicolò.



General scheme of the works at Lido Inlets

The new island, midway between the two channels, connects the two rows of mobile gates. Thus the barrier for the regulation of tidal floods at the inlet is separated into two blocks divided by this central artificial island. The island houses the control buildings and the gate operation system. It will be realized in shallow depth and permits the functional separation of the barrier into two parts, each at a different depth, according to the original configuration of the channel.

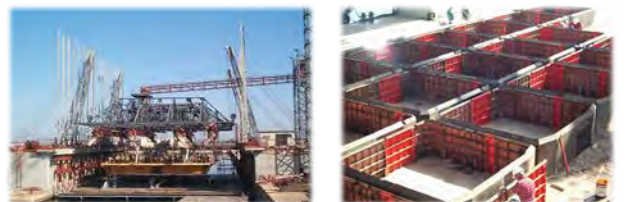
The design of the **artificial island** is divided into three parts: the first concerns the central core, the second and the third concern the bank and the connection with the gates abutment on Treporti and S.Nicolò sides. The first phase deals with the construction of the central core of the island, and with the creation of an embankment bounded by breakwaters. After the realization of the breakwaters, the core is filled with dredged materials coming from the civil works carried out during the excavations for quay walls and buildings foundation activities. The rubble mound breakwaters have a length of about 200m each. The face exposed to the sea and to the lagoon is protected by heavy rock protections. The front sea side has a top elevation of +3.50m above mean sea level and is designed to contain wave overtopping effects. The toe berm has a width of about 15m and is designed to prevent damage resulting from scour induced by currents during tide flow and ebb conditions.

The project of the *containment quay wall* along Treporti channel consists in the realization of a double sheet pile wall anchored at the top, with a length of about 320m. The double sheet pile wall acts also as a retaining system capable of sustaining more than 20m of difference in level between the sea bottom and the surface, during the work phases for the realization of the barrier foundation.



Different phases in the realization of the island core

The main control building for the whole barrier and Lido inlet operational plants will be set in the island on S. Nicolò channel side. Due to a difference in the sea bottom level, the earth retaining walls are realized with pre-cast cellular reinforced caissons. The *caisson quay wall* links the island core to the barrier abutment. The construction of the prefabricated elements in reinforced concrete takes place in proper floating facilities prepared for a 'floating' prefabrication process; the caissons are towed in flotation to their final destination. Before the transportation, the caissons are covered and protected with pre-cast concrete panels in order to ensure their tightness during the journey. The cellular caissons have typical dimensions of 19x25x16m. Their caissons foundation level is at about - 15.20 below msl, with the exception of the abutment area where a special sheet pile leads to -24.0m below msl.



Typical phases of construction, launching and transportation of prefabricated elements



# NEW COOLING WATER SYSTEM AND SEAWATER INTAKE FOR THE EAST NAPLES POWER STATION AND URGENT MEASURES FOR PROTECTING THE WATER TABLE

Location:	Naples, Italy
Client:	Naples Port Authority
Services:	Preliminary, Final and Construction Designs, Environmental impact assessment study, Coordination of safety
Period:	06/2003 – 07/2006
Construction cost:	€ 33,194,900

## Project Description:

The embankment for the transformation of eastern quay (*Darsena di Levante*) into a Container Terminal brings about the need to readjust the seawater cooling system of the East Naples power plant "Tirreno Power".



Fig. 1 – Naples Gulf and location of Darsena di Levante

In the current configuration, the power plant receives seawater from an intake work located in front of the *Darsena di Levante* quay. A pumping system conveys sea water through pressured pipelines to the plant, and then back to the sea on the east side of the quay, far enough from the intake work to avoid the mixing of warm and cool water.

The current location of the intake work is incompatible with the shape of the new Terminal Container platform. Also the water outlet has to be moved because a new tourist harbour is being built nearby.

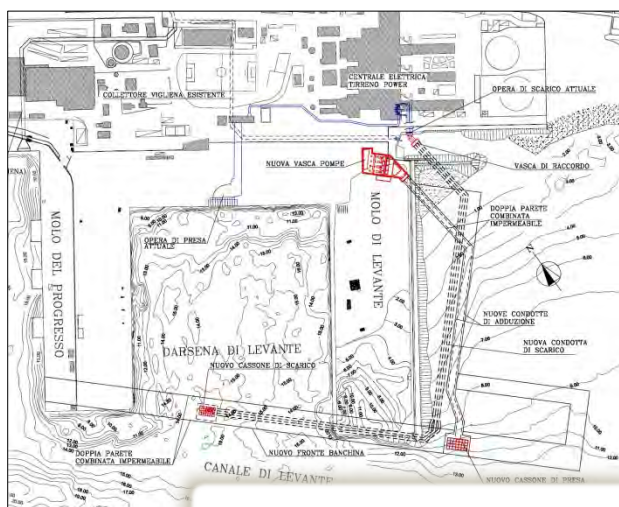


Fig. 2 – Works location in the Darsena di Levante

The location for the new works has been examined by taking into account several factors: energetic efficiency, integration with quay structures, feasibility of using the platform for container handling, pump power to be installed, and interference with reclamation activities in some seabed areas.

The optimal solution has been found in placing both outlet and intake works on the front of the new quay, at a distance of 300m from each other.

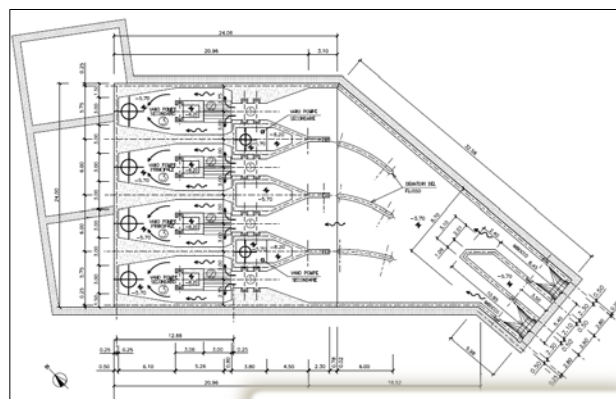


Fig. 3 – Pumping station – structural plan

The works consist in special cellular r.c. box structures. The design criteria of the new system have been decided together with the Client and Tirreno Power Company. The pumping station is located near the power plant and connected to the intake work by pressured pipelines. The system is designed for a maximum capacity of 14 m<sup>3</sup>/s, divided among 4 pumps, i.e. for a normal capacity of 7 m<sup>3</sup>/s and a 100% redundancy of pumps and pipelines.

The intake work is a 14.0x25.5m based box structure set at level -12.5m. Seawater is taken from 7 entrances placed between depths -8.9m and -11.0m and it is conveyed to the pipelines level through an "S" shaped path that allows internal confluence. Maximum intake velocity is 0.25m/s to avoid disturbing moored boats.

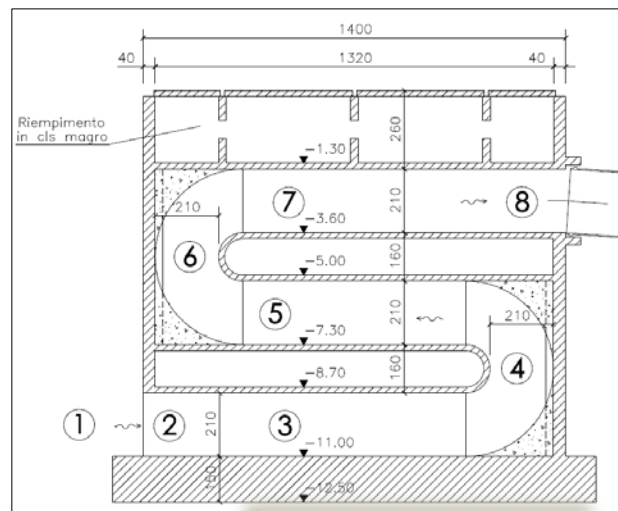


Fig. 4 – Intake work – vertical section

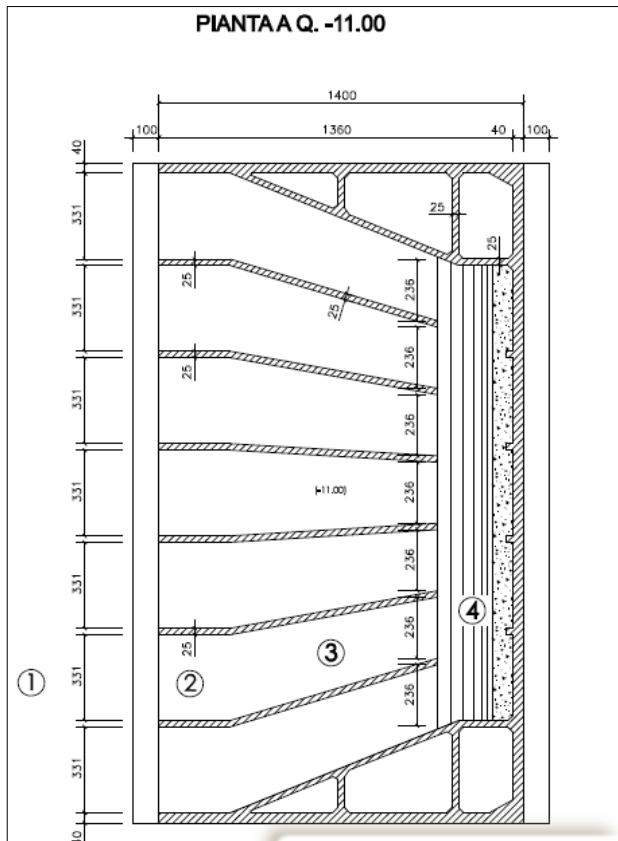


Fig. 5 – Intake work – structural plan

The new outlet is located about 660m from the current position. Warm water comes from the station through 3 main pipes 2.5x2.0 m (L = 660 m). Each pipe can be put off-duty separately for maintenance purposes.

The outlet work consists in a 20.0x11.5m based box structure set at level -15.0 m. Inside the 3 main pipes are connected to 6 exits placed between depths -8.9m and -11.0m. This depth is necessary to dissipate heat in a relatively small sea area. The exits form a 45° angle in order to minimize disturbance to mooring boats.

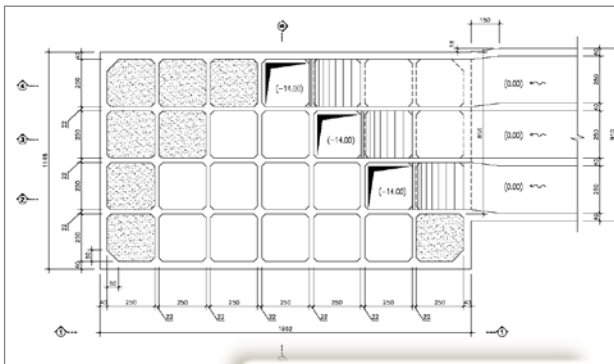


Fig. 6 – Outlet work – vertical section

which combines motion and thermal diffusion equations, taking into account thermal dispersion and the density flows due to it, and considering different operating scenarios.

Tirreno Power also demanded a physical model test in order to assess the calculation accuracy of friction losses in the intake work. The Port Authority paid heed to the request due to the peculiarity of the proposed design solution.

Tests were performed in the experimental laboratory of Voltabarozzo (PD). The intake work was reproduced in 1:20 scale and put along the wall of a cistern full of water. The test was carried out by sucking in the design capacities (reduced to the proper scale) and monitoring the piezometric levels at the entrance of the pipes. The results fully confirmed the hydraulic calculations.



Fig. 7 – Physical model of the intake work (laboratory)

Hydraulic efficiency is a fundamental requirement in design. Hence, thorough analyses have been performed to guarantee the design demands fulfilment in the most critical environmental and operating conditions.

For an efficient cooling water system it is necessary that discharging warm water does not increase seawater temperature around the intake work. Such variation in temperature was estimated by means of a 3D mathematical model performed in “FLOW-3D”, software developed by WL-Delft Hydraulics (Holland)

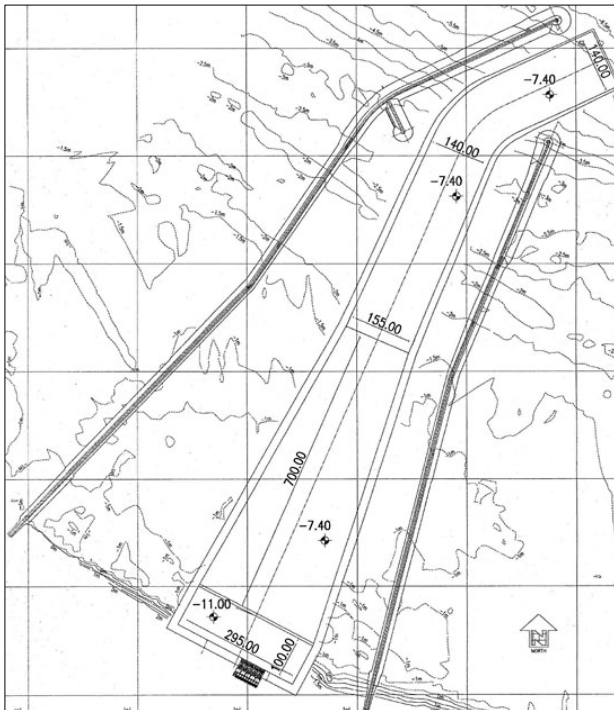
The marine works at the Lido port inlet consist of the abutments and foundations for the mobile flood protection barriers, including

# SEA WATER INTAKE WORKS FOR COOLING WATER SYSTEM IN THE PORT OF RAS LAFFAN

Location:	Qatar
Client:	Grandi Lavori Fiincosit Middle East – GLFME (Contractor), on behalf of Qatar Petroleum
Services:	Studies, Modelling and Detailed Design of Marine Works of the Sea Water Intake in Ras Laffan
Period:	11/2001 - 05/2002
Construction cost:	€ 30,000,000

## Project Description:

The Project dealt with the Detailed Design of the cooling water system, including sea water intake, pumping station, distribution and discharge for the future industries and the expansions of existing LNG plants operating inside the Ras Laffan Industrial City (RLIC), in Qatar. The intake is a dredged basin protected by two long breakwaters and the outfall a concrete diffuser structure.



Two phases for the pumping discharge of the intake have been foreseen:

- phase 1 – 296000 m<sup>3</sup>/h
- phase 2 - 966 000 m<sup>3</sup>/h



The Engineering activities included the design of:

- Two breakwaters (2000 and 1400m length) armoured with core loc concrete blocks;

- A dredging channel to discharge 966000 m<sup>3</sup>/h (2<sup>nd</sup> Phase);
- Intake basin;
- Outfall consisting in a diffuser concrete structure and a rubble mound apron.

Different dredging and breakwater configurations were analysed with mathematical and physical model.

- mathematical model to study the wave transformation from deep to shallow water
- wave disturbance mathematical model, calibrated against the results of the 3D physical model, to study the wave penetration inside the intake channel
- currents mathematical model, verified against the results of the 3D physical model, to study the current pattern along the dredging channel
- sediment transport mathematical model to define suspended sediments concentration near the intake entrance
- morphological mathematical model to study erosion and sedimentation
- 3D model tests of the whole basin and breakwaters to study wave penetration and current pattern for the verification of the mathematical models
- 3D model tests for the breakwater stability verification.



The Project regarded the design and verifications for the final configuration, as per the Specifications.



# NAVIGATION AIDS FOR MALAMOCCO-PORTO MARGHERA SEAWAY – VENICE LAGOON

Location:	Venice Lagoon, Italy
Client:	Venezia Nuova Consortium - on behalf of Ministry of Public Works
Services:	Preliminary and Detailed Design of a system of navigation lights, with remote control and management system, to guide shipping from Malamocco inlet to Marghera industrial port
Period:	01/1991 – 12/1996
Construction cost:	€ 10,180,400

## Project Description:

The main navigational route connecting the industrial port of Marghera (located on the inner limit of the Venice lagoon) with the open sea is travelled by over 8000 cargo ships/year.



This waterway is 10 nautical miles long and is characterised by a reduced width with respect to sailing vessels' beam (60m at the bottom of the channel).



To allow safe navigation and the possibility of the harbour operating even during the night or in unfavourable weather conditions (meteorological optical range of 300 m), the Malamocco-Marghera waterway has been equipped with a series of special featured lights along the entire way, in addition to the existing conventional flashing red/green marine lights.

On either side of the navigational path a series of 14-25 meter long poles (projecting 8 m above water level) has been installed at 80 m intervals, for a total of some 360 illumination points.

A purpose-built sealed light fixture, containing two 36 W low pressure sodium lamps, is mounted vertically inside the open-faced light support at the head of each stainless steel pole. The light fixture is designed for easy maintenance directly from boats by means of a system of internal cables which make it possible to accede to the lamp at the base of the pole.



The entire system is energised at 660 V ac by two submersible and armoured cable mains, laid by a special machine in a trench 3 meters deep on either side of the channel, which feed 16 secondary switchboards.

The system can be remotely operated by radio from the Pilot Control Tower or the main office of the Port Authority but normally is automatically controlled and activated for specific zones according to the visibility level signalled by four fog detectors and photoelectric switches located along the channel





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