



Comune di Pula
Città Metropolitana di Cagliari

COURTESY TRANSLATION

TECHNICAL SPECIFICATIONS

CALL FOR TENDER - TENDER FOR THE AWARD OF A PRE-COMMERCIAL CONTRACT PURSUANT TO ART.158 CO.2 DEL D.LGS 50/2016, RELATING TO RESEARCH AND DEVELOPMENT SERVICES FUNCTIONAL TO THE DEVELOPMENT OF AN "INNOVATIVE SOLUTION FOR THE MANAGEMENT OF WATER COMMUNICATION AND FOR THE MANAGEMENT OF FISH FLOWS"– FUNDS POR FESR SARDEGNA 2014-2020, ASSE I – AZIONE 1.3.1.

In case of discrepancy between the official version of the tender documentation in Italian and the English translation, the official Italian version will prevail, and therefore will have validity

1. PROBLEM DEFINITION

The Nora Lagoon, like all coastal areas, as they all are zones of transition between inland and marine areas, is the site of delicate environmental balances, of complex geomorphological, hydrogeological, ecological and social dynamics. The need to walk a path of research and development stems from the identification of various critical issues that are threatening the lagoon production and the very survival of the existing environment:

- the lack of flexibility of the system during alluvial floods in winter, typical of Sardinian torrential rivers, with environmentally friendly methods;
- The lack of continuous monitoring of appropriate physical, chemical and biological descriptors and their correct elaboration to interpret the dynamics, predicting the direction in which the lagoon is evolving.

Following a prior search of existing patents, it was found that none of the solutions hypothesized in the documentation analysed is directly applicable to the lagoon context under study.

It is therefore necessary to search for an innovative solution, which makes it possible to achieve an integrated management system of communication between waters of continental origin, the lagoon and the sea, through the provision of an intelligent structural system at the service of the tide channels, with the biotic and abiotic monitoring of the environmental system, through:

- The search for an integrated management system of communications between marine and continental waters through the provision of an intelligent structural system at the service of the tide channels aimed at securing hydrogeological risks and limiting the decrease in fish stocks.
- The search for a technological solution to overcome the engineering gap currently existing in relation to the sea-lagoon communication structures in order to improve the reliability and efficiency of the water system regulation tools.
- The search for a solution that lays the foundations for continuous monitoring of physical, chemical and biological descriptors and their correct processing, with dynamic predictions relating to the lagoon's structure.

2. OPERATIONAL CONTEXT DESCRIPTION

2.1. GENERALITÀ E STATO ATTUALE DEL COMPENDIO

The Nora Lagoon, whose exact name is *Su Stangioni Sant'Efisio*, is located in the municipal area of Pula, in the province of Cagliari, and is about two kilometres from the town,.

Bordered to the south-west by the peninsula "*Fradis Minoris*", to the east by the *Capo di Pula*, to the north by the plain of Pula, the lagoon currently has an area of 37.6 hectares.

The area, as well as about 14 hectares of land behind it, is state-owned, and since 1988, it has been in concession to the Nora Fish Cooperative.

Between the lagoon and the inhabited centre there is a vast emerged area, of a level slightly above the marine average, of state property; at the present moment this area is not used.

Originally, the mouth of a stream was enlarged in 1957 by an artificial closure of the small bay between Capo di Pula and the peninsula of Fradis Minoris.

The lagoon, which in the past was made up of a single body of water, is currently divided into a main basin and some small adjacent water bodies, isolated by emerged bars of mud and debris.

The recently renovated lagoon-sea separation embankment extends for a length of approximately 430 m., it has an average height of 1.5 meters above sea level and a width of 14 meters.

2.1.1 WATER EXCHANGES

The exchange of the lagoon with the sea takes place through a main mouth located near the peninsula of Fradis Minoris and, to a marginal extent, through a small mouth located near the eastern end of the separator bank.

The main opening to the sea shows an orientation of the NE-SW longitudinal axis. Its width is about 22 meters and its depth about 1 meter. It is equipped with an outer breakwater with a total length of 128 m, attached to the coastline, and an inner breakwater with a length of 150 m.

The outer and inner breakwater of the main sea inlet and the sea-lagoon embankment in 2003 were renovated as part of the project *Hydraulic and biological renovation of the Pula pond, a first phase functional intervention* financed by the R.A.S. with delegation to the Province of Cagliari - Environment Department of Ecology Service.

The lagoon is not equipped with capture systems. In the main opening to the sea, there is a barrier made of PVC grids with a floor foundation, with a total length of approximately 40 m and width of approximately 16 m. The plant, of old conception, is not equipped with replacement outlets.

The structures and all their elements are rotting and deteriorated.

The second opening to the sea, also recently renovated, shows an orientation on the longitudinal axis N-S and has a width of about 16 m and a depth of less than one meter. This tide channel is equipped with gates, grates and return vents. It is not equipped with capture systems because it performs only whipping function.

2.1.2. FRESH WATER SUPPLIES

The fresh water inputs are due to the Rio Arrieras, a stream flowing into the lagoon, and the Saliu drainage canal, both coming from the plain of Pula. The Rio Arrieras, like many Sardinian watercourses, has a distinctly torrential regime, being characterized by little or no contributions during the summer season, and by abundant flows, which occur especially during floods, in the winter and spring months.

2.1.3. BOTTOMS AND DEPTHS

The bottom of the lagoon is sandy and muddy. The depth is very discontinuous with minimum values of 30 cm and maximum values of 3.5 meters.

In particular, the western area, about 15 hectares wide, has a modest depth due to the contribution of continental detrital materials by the two canals. At certain times, during low tide, the area remains completely emerged. Such a scarcity of volumes determines during most of the year an exasperation of the mesological parameters, which prevents the use of the area by the fish fauna. The substrate in this area is sapropelic in nature and this negatively affects the benthic settlements.

In addition, over the years the *Posidonia oceanica* debris has increased, coming from the sea and deposited inside the lagoon in an arch overlooking the two mouths of communication with the sea and along the embankment. It tends to occupy ever-larger areas reducing their depth, creating considerable difficulties in navigation with inevitable problems in carrying out normal fishing operations. In addition, the accumulation of debris causes a significant increase in organic matter in the sediments, which in particular periods cause episodes of anoxia with consequent negative repercussions on benthic organisms that constitute the pabulum of fish and bird species.

The eastern area, of about 22 hectares, which represents the main water body of the lagoon, is instead characterized by the presence of a large trench of about three hectares, from 2 to 3.5 meters deep.

2.1.4 WATER REPLACEMENT

The results of a survey carried out with the aim of determining the tide excursion showed a time lag of the tidal peak propagating in the lagoon of about two hours. This is due to the reduced exchange surface of the mouths, which present an efficiency of 59%.

The reduced efficiency is to be attributed to the deteriorating conditions of the weir structures and the obstruction of the seabed in front of them.

The turnover was determined by adopting an appropriate mathematical model. The results of this estimate, also reported in the "Study for the planning of water resources, Vol. III, Usi" of the R.A.S., show a relatively rapid turnover, which is a consequence of the limited size of the lagoon and the reduced depth. This condition, favourable in the summer, is a negative factor in the winter. The fact that the water mass of the lagoon is so small, in fact, makes it

susceptible to the sweetening of the water and, in case of floods, a too rapid replacement produces a dispersion of nutrients and an impoverishment of the more superficial organic sediments.

2.1.5 CHARACTERISTICS OF THE WATER

The salinity of the water undergoes sudden drops in rainy periods due to the floods of the Rio Arrieras. Sweetening essentially affects the most superficial layer of water and is therefore complete in shallow waters while, apart from exceptional cases, there is a considerable stability of the saline characteristics in the deeper areas, which gradually change allowing a gradual adaptation of the species present.

In summer, the salinity has limited excursions essentially linked to the rhythm of the tide and the influence of fresh water. In fact, near the mouth of rivers this parameter reaches its maximum values at the peak of high tide, while in areas far from the influx of fresh water the peak of high tide corresponds to the minimum values of salinity.

The dissolved oxygen content is always acceptable in the deepest areas, while in the shallows, in summer, it is subject to wide fluctuations with daytime supersaturation and drastic night-time drops.

The minimum temperature recorded was 8 degrees and the maximum 31 degrees.

2.2. MANAGEMENT AND PRODUCTION ACTIVITIES

The Nora Fish Cooperative, which deals with the management of the lagoon area, has promoted over time various initiatives related to both fishing activities, such as, for example, research in the field of aquaculture, and to the protection of the ecosystem of the lagoon, with the possibility for visitors to access the site through guided tours.

In the Nora lagoon only wandering fishing is carried out because the catching systems serving an opening to the sea are not currently functional for fishing.

There are currently three employees involved in the fishing activity, one of which full-time and two dedicated to fishing tourism activities supplementary to fishing itself.

The production activities make use of two “*ciu*” a characteristic local type of boat. Fishing is carried out with gill nets (trammel and monofilament) in the period between June and March. *Bertavello* fishing is carried out exclusively in the period permitted by regional legislation.

From a qualitative point of view, the fish species object of fishing and marketing that are found in the Nora Lagoon are represented by:

- *Mugil cephalus* (L.) , *Chelon labrosus* (Risso), *Liza aurata*, (Risso) , *L. ramada* (Risso) e *L. saliens* (Risso);
- *Sparus aurata* (L.) , *Lithognathus mormyrus* (L.), *Diplodus annularis* (L.), *Diplodus sargus* (L.), *Sarpa salpa* (L.)
- *Dicentrarchus labrax* (L.)
- *Anguilla anguilla* (L.)

The highest yields of the overall production are given by the mugil, which in some years even represented 65% of the production.

The average of fish production, referring to the last five years, presents values between 60-70 kg / ha.

3. THE FUNCTION OF THE OPENING TO THE SEA OF THE COASTAL LAGOONS

The quality of the lagoon waters depends on the water exchanges that take place through the tide channels, or openings to the sea, thanks to which the marine water inflows and lagoon outflows occur.

These water exchanges influence important ecological factors such as oxygenation, temperature and salinity of the waters which together with the contributions of waters of continental and groundwater origin and the winds, which strongly affect the hydrodynamics, determine the mixing of nutrient-rich sediments and the consequent development of the cyclization processes of organic matter.

The particular importance of the tidal channels, or openings to the sea, also consists in their function of biological connection between the lagoon and marine environments.

Through the tide channels numerous organisms of marine origin penetrate the lagoon, both passively (planktonic forms) and actively (fry of euryhaline fish species, in the so-called whipping phase). In this phase, the repopulation of the lagoon takes place thanks to the natural migrations of juvenile individuals of euryhaline fish species, which, swimming against the current in moments in which water flows out of the lagoon towards the sea (low tide), rise from the sea and play there much of their life cycle.

The tide channels or openings of the lagoon also constitute the corridor through which the adult specimens of the euryhaline fish species that populate this environment, responding to reproductive stimuli, return to the sea.

This phenomenon of migration towards the sea is determined by the lure exerted on the adult specimens by the streams of seawater that enter the lagoon during the high tide phase.

These dynamics make coastal lagoons very productive ecosystems, with a biomass production higher than the marine one and among the highest in nature, offering a wide availability of food resources for the development of different euryhaline fish species typical of these environments.

The management of the lagoon fish resource is traditionally implemented by exploiting the tidal flows for fishing through the installation of fixed capture systems (weirs) designed to intercept the fish species during their migration to the open sea and channelling the ascent of the juvenile ones from the sea to the lagoon.

The structure of the traditional weir, serving the lagoons' openings, consists of a fixed wedge-shaped structure with a capture chamber placed at the apex. Made with grid systems, it allows the circulation of water and at the same time the ascent of juveniles towards the lagoon and the trapping of adult fish migrating from the lagoon to the sea.

3.1. CURRENT STATE OF THE OPENING TO THE SEA IN THE NORA LAGOON

In the Lagoon of Nora, the connection with the seawaters is guaranteed by two openings, located in an almost opposite position.

3.1.1. MAIN OPENING (OPENING A)

The main opening to the sea (openingA), oriented in a north east / south west direction, separates the rocky peninsula of Fradis minoris from the beach of the Agumu bay, located at west of the lagoon.

It is designed to fulfil the dual role of restocking and capturing the fish product.

The channel of the opening to the sea is equipped on the seaside, on both sides, with reef protection piers with a length of 150 m (outer breakwater) and 128 m (inner breakwater).

It presents the remains of a now dilapidated reinforced concrete capture system (weir) built in the early 1950s.

The conformation of the structure is of a traditional and rests on a foundation in reinforced concrete, with a length of 40 m x a width of 16 m. It is composed of pillars with single guide rails for housing the grids with a distance of 130 cm, arranged with a glass opening of about 50 degrees and a distance from the banks of about 1.5 m.

The pillars for grating, made of reinforced concrete, had an original section of 40x40 cm, but are currently in an advanced state of decay with cracks and detachments of the concrete and exposed reinforcement bars.

This system of pillars supports the barrier structure between the lagoon and the sea, made with rigid PVC grids each measuring 160 cm high by 130 wide. This structure is not functional as a capture system (weir) and has the sole function of containing the fish product and the water exchange between the lagoon and the sea.

The water head of the channel of the main inlet on the reinforced concrete bed stays, in the different phases of the tide, in a level range between 50 and 80 cm in depth.

3.1.2. MOUNTING OR RESTOCKING OPENING (OPENING B)

The mounted or restocking opening (opening B), is oriented in a north / south direction and it separates the eastern end of the sea-lagoon separating embankment from the mainland (loc. Sa Guardiania).

It is designed to fulfil the role of restocking only.

The mouth to the sea has a total length of 11.10 m and a width of 5.50 m. It is equipped with a wooden driveway bridge with an adjacent pedestrian walkway for managing the grids.

The structure insists on a foundation in reinforced concrete slab measuring 15 m long by 6.5 m wide, on which, on the side facing the sea, there are 7 grid supporting pillars in concrete Rck 25N / sq mm. having a section of 60x40 cm and a height of 300 cm, equipped with double guide rail for the insertion of rigid PVC grids and gates.

The structure as a whole separates the lagoon from the sea through 6 grids interspersed between the pillars made of rigid PVC measuring 180 cm high x 135 cm wide. The water head of the channel of the mounted mouth on the reinforced concrete bed shows in the different phases of the tide in an interval between 50 and 80 cm in depth.

The entire plant has on the seaside, on both sides, cliff protection piers with a length of 12 meters.

4. DESCRIPTION OF FUNCTIONAL REQUIREMENTS

The functional and performance requirements that must be designed, developed and implemented in the phases of the pre-commercial contract for the purpose of testing the technological solution are listed below.

STAGE OF ORDINARY OPERATION	APPLICABILITY
Functional requirements (RF)	
<p>RF1. The solution sought must represent a dynamic and lasting system for managing hydraulic and fish flows between the lagoon and the sea.</p> <p>The opening to the sea is a place of communication between the lagoon and the sea, in fact it allows the natural hydraulic flows entering the lagoon (at high tide), and the natural hydraulic flows exiting the lagoon towards the sea (at low tide).</p> <p>It must also ensure that the fish flows entering and leaving the lagoon are manageable.</p> <p>The system will be located in the tidal channels, called inlet A and inlet B, having the following dimensions respectively:</p> <p>Opening to the sea A section of 15.00 m, for a length of 40.00 m, and a depth of 80.00 cm on a platform with an average leaf.</p> <p>Opening to the sea B total length of 11.10 m and a width of 5.50 m.</p>	<p>Opening A Opening B</p>
<p>RF2. It must not constitute an element of alteration of the natural tidal movement of the lagoon basin, therefore it must not represent a water pumping system.</p> <p>The solution sought must exploit the natural dynamism of the lagoon-sea system, and therefore it must not force normal water inflows / outflows to and from the lagoon compendium.</p>	<p>Opening A Opening B</p>
<p>RF3. The solution sought must be easily manageable and contain the costs necessary for its maintenance.</p>	<p>Opening A Opening B</p>
<p>RF4. It must dynamically allow the management of natural migrations between sea and lagoon of juvenile individuals (juveniles) and adults of the euryhaline fish species that typically populate the Mediterranean coastal lagoons.</p> <p>All information collected must be recorded, filed and made available in DATA OPEN format.</p> <p>It will have to present a system for monitoring the flows of juvenile specimens of incoming fish species and a system for monitoring and interception of adult specimens.</p> <p>This interception operation is aimed partly at the insertion of the fish product on the market, and partly at the programmed reintroduction / release into the sea of mature breeding specimens for a natural repopulation of the surrounding marine area.</p> <p>This solution is geared towards sustainable fish production and aims at managing the wild fish heritage, which favours conditions of equilibrium for exploiting the resource and restocking the surrounding marine area.</p>	<p>Opening A Opening B</p>
<p>RF5. It must allow the passage of small boats.</p> <p>The solution sought must have characteristics of general flexibility and dimensions suitable for the</p>	<p>Bocca A</p>

STAGE OF ORDINARY OPERATION	APPLICABILITY
Functional requirements (RF)	
passage of a low draft boat (e.g. POONTONBOAT) with ideal dimensions of 3.00 m wide and a draft of 40.00 cm.	
<p>RF6. It must not obstruct the normal water exchange between the lagoon and the marine sector; it must therefore guarantee water flow regimes in line with the natural parameters of the compendium. In general terms, a lagoon is a highly dynamic environment, with constant water exchange relationships with the marine compendium.</p> <p>The solution sought must not hinder this natural exchange of hydraulic flows entering the lagoon (at high tide), and of hydraulic flows leaving the lagoon towards the sea (at low tide).</p> <p>The average value comparable to this water exchange in the opening to the sea can be estimated, in ordinary conditions, in the moments of maximum tidal flow / outflow, to be around 6 mc / s.</p>	<p>Opening A Opening B</p>
<p>RF7. It must not represent an ecological detractor for the ecosystem of the lagoon compendium. The solution must be made with environmentally friendly materials that over time do not alter the chemical-physical structure of the water.</p>	<p>Opening A Opening B</p>
<p>RF8. It will have to represent a driving force for enriching the biodiversity of the lagoon and the surrounding marine area.</p> <p>Through the planned release of mature spawners of the various fish species populating the lagoon, it will be possible to increase the biodiversity of the marine compendium in front of it.</p> <p>Thanks to the selectivity of the solution sought, it will be possible to program the containment or release of specimens in different stages of maturity, for example by preferring the nursery function towards the juveniles within the lagoon compendium and selectively releasing mature specimens in order to enrich the biodiversity of the sector in front of the lagoon itself.</p>	<p>Opening A Opening B</p>
<p>RF9. The solution may lead to an increase in public knowledge of the compendium in relation to naturalistic and production data.</p> <p>All information collected must be recorded, filed and made available in DATA OPEN format.</p> <p>The solution must include a multi-parametric detection system able to identify:</p> <ul style="list-style-type: none"> - Temperature; - Salinity; - Dissolved oxygen. 	<p>Opening A Opening B</p>
<p>RF10. It will have to allow the increase of knowledge regarding the fish resource produced in the lagoon.</p> <p>All information collected must be recorded, filed and made available in DATA OPEN format.</p> <p>The solution must include a detection system capable of identifying:</p> <ul style="list-style-type: none"> - Numerical estimate of juveniles; - Estimate of no. of individuals per single species; - Adult and sub-adult population flows of fish species. 	<p>Opening A Opening B</p>
EXTRAORDINARY OPERATION PHASE	
Functional requirements (RF)	
<p>RF11. It must allow the rapid emergency drainage of water in the event of exceptional flood events. In the event of extraordinary flood events, the solution sought must provide a drain, which allows the surplus of water introduced into the lagoon by the Rio Tintioni and Canale Cristallu waterways to reach the sea without obstacles. It has been calculated through the probabilistic TCEV model (inherent to intense precipitation in Sardinia), that the flow load of these two watercourses in the event of exceptional events, calculated over a period of 100 years, is equal to 132, 37 mc / s.</p> <p>The aforementioned emergency runoff can take place through a rapid opening system, which can occur when a maximum threshold established in terms of water level in the lagoon basin is exceeded. This threshold can be identified in exceeding 50 cm with respect to the maximum level values in conditions of high tide.</p>	<p>Opening A Opening B</p>
	<p>Opening A</p>

RF12. In the event of exceptional flood events, it must allow the rapid restoration of ordinary management of the fish flows entering and leaving the lagoon.	Opening B
RF13. It will have to possess and allow for a containment of public spending following flood events. In the course of flood events in the sector there has been damage to infrastructures, crops, public and private artifacts, etc. During the flood of 2005, the effects on public spending were estimated at around € 200,000.00, without considering the damage to fish production.	Opening A Opening B
RF14. Capacity of the solution to minimize the environmental and landscape impact a) The proposal must be harmoniously integrated with the lagoon context, ensuring the lowest landscape and environmental impact. b) Operation must result in low energy consumption and respect environmental compatibility characteristics through the self-production of a portion of the energy necessary for its operation	Opening A Opening B

TECHNICAL AND PERFORMANCE ELEMENTS

STAGE OF ORDINARY OPERATION	
TECHNICAL AND PERFORMANCE ELEMENTS (RP)	
RTP1. The maximum energy requirement of the solution sought must be less than 6 KW / h.	Opening A Opening B
RTP2. At present, there are on average about 10 grids replacement events per year, which have an estimated cost of 1,500.00 Euros per piece; during the last flood event of some importance, (October 2018) n. 12 out of 24 grids were damaged. The solution sought must therefore contain ordinary costs for maintenance and extraordinary costs due to sudden disasters; in this case, ordinary weekly maintenance is envisaged through manual cleaning by brushing the structure in water for fouling removal and a reduction of 100% / year for extraordinary maintenance.	Opening A Opening B
EXTRAORDINARY OPERATION PHASE	
Performance Requirements (RP)	
RTP3. The start of the emergency outflow will have to take place following the detection of exceeding the aforementioned level threshold. The time range within which this must start is desirable to be between the instant in which the maximum level threshold value is detected, and a maximum interval of 20/30 seconds: 20/30 sec > Start flow \geq instant threshold max	Opening A Opening B
RTP4. In light of the flexibility of the solution sought, it must therefore allow the ordinary management of fish flows entering and leaving the lagoon to be restored in a time between 2 minutes and 30 minutes from the moment in which the reference level considered ordinary is re-established.	Opening A Opening B
RTP5. The solution sought must therefore allow for a decrease in public spending in the amount greater than / equal to 90% / flood event.	Opening A Opening B

5. PRELIMINARY INFORMATION ABOUT THE OPERATIONAL CONTEXT FOR THE PHASE III EXPERIMENTATION

The operational context identified for the experimentation of the innovative solution is identified as follows:

- The main opening to the sea (opening A), oriented in a north east / south west direction, separates the rocky peninsula of Fradis minoris from the beach of the Agumu bay, located at west of the lagoon, as described in the previous paragraph 3.1.

and

- The mounted or restocking opening (opening B), is oriented in a north / south direction and it separates the eastern end of the sea-lagoon separating embankment from the mainland (loc. Sa Guardiania), as described in the previous paragraph 3.1.2

In phase III, aimed at executing the testing services in the real operational context described in the previous paragraph, the compliance with the requirements of the solutions presented by the two Phase 3 contractors will be basically assessed alternatively in the main opening (A) or in the mounted or restocking opening (B).

Without prejudice to the verifiability of some requirements in both openings, as indicated above in the table, the Contracting Authority reserves the right to indicate in the Phase 3 Invitation Letter the testing organization approach, alternatively in opening A or in opening B, thus providing the execution of Phase 3 services by the two successful bidders, partially in parallel.

Other functionalities may need to be tested in port B only, as indicated above.

The assignment of the test areas (A or B) to the Phase 3 awardees will be defined in the Phase 3 Letter of Invitation, possibly established with a public draw, to be carried out before the execution of the phase services.

It should be noted that, if they are works or interventions of common use for both the Phase 3 contractors, the related expenses should be divided equally among them. Unless otherwise established by the Parties, at the end of the experimentation, each operator must remove the installed prototype ensuring the restoration of the initial conditions of the testing site.

Annexes:

- Contesto_Foto_Laguna di Nora (*Context_pictures_Nora lagoon*)
- Contesto_Video_Bocca A (*Context_Video_Opening A*)
- Contesto_Video_Bocca B (*Context_Video_Opening B*)
- Tav. Bocca A_principale (*Figure_Opening A_ The main opening*)
- Tav. Bocca B_di montata (*Figure_Opening B_Mounting opening*)