Restoration of Alluvial Forests and Cladium mariscus habitats in Ramsar and Natura 2000 sites

# Executive plan of the hydraulic works

## Deliverable number:DA2.2

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# Indice

## Abstract

FORESTALL main objectives are: conservation and restoration of priority habitats, improving water level management and circulation inside the Valle Averto Oasis' channels, reducing the occurrence of invasive species and increasing the occurrence of breeding species.

To achieve these objectives, concrete actions which will involve the hydraulic works (C1) and the habitats and species targeted by the project (C2,C3,C4,C5,C6) have been planned.

Based on a preliminary review and analysis of existing environmental data and documents on WWF Oasis and Valle Averto (A1), on a preliminary survey on the current on hydro-geological, surface water and soil situation (A6), on the current vegetation (A7) and on preliminary bird monitoring (A8), two executive plans will be realized with the action A2: the "Executive plan of habitat and species management works and permits" (A2.1) and the "Executive plan of the hydraulic works" (A2.2)

The two executive plans are necessary to define in detail the activities foreseen in each action, the scheduled works, the equipment and the consumables to be used.

# 1 Introduction

This document is the result of work done in the Action A2" Executive Plans" and in particular in the sub-action A2.2 "Executive plan of the hydraulic works".

The objective of this sub-action is to prepare the executive plan of the hydraulic works foreseen in the concrete action C1: "Hydraulic works to improve water circulation and quality" and in the preparatory action A6: "Hydro-geological, water and soil characterization of intervention sites".

From the morphological point of view "Valle Averto" is characterized by a variety of environments ranging from large stretches of brackish water, dissected riverbanks, to large areas of reeds and numerous fresh water channels.

The project area does not have any water pumping station and the communication with external lagoon waters is entirely governed by the tides and regulated manually by means of special sluice gates, called "chiaviche", occurring in the embankments. The freshwater comes by gravity from the "Novissimo Channel" through a sluice gate located on the west border, feeds a wide area of inland channels and reedbeds and then flows into four main ponds, mixing with the brackish waters and, finally, flowing into the lagoon and in particular cases, into the lakes (external to the project area).

The discharge in the lagoon takes place through a sluice gate which is inside a neighboring property; it is possible only when the water level in the lagoon is lower than the water level inside the Valle Averto.

The water level, its circulation and salinity are constantly adjusted through opening and closing of sluice gates that connect the protected area with the surrounding water bodies.

Several channels inside the project area are filling up, thus reducing water exchange with the large ponds inside the Oasis and the small sluice gates which connect internal channels are mostly in poor conditions and are in urgent need of repair or replacement because water can infiltrate even if they are closed, preventing the possibility of maintaining different water levels in adjoining basins or ponds.

For this reason in the southern sector of the Oasis, one channel will be dredged (Par. 2.1) and new sluice gates will be installed (Par. 2.2), in order to create three hydraulic sectors which will be flooded whenever needed and independently one from the other to obtain a better regulations of water levels in channels and ponds inside the Oasis. To control and manage the water level inside each sector a piezometric station will be installed (Par.2.4).

This control of water levels will favor the growth of new *Cladium mariscus* stands (C2). At the same time, the regulated flooding will naturally control and reduce the occurrence of *Rubus* spp. and *Robinia pseudoacacia,* two species which now are invading the reedbed or the areas potentially suitable for the 91E0* habitat. In addition, water levels must be at the right levels according to the season, in order to provide waterbirds with suitable feeding sites during winter, migrations and the breeding season.

Some stretches of banks are affected by erosion which may open gaps inside the banks, causing unwanted short circuits in water circulation. For this reason 500 m of river banks will be protected (Par 2.3) using soil bioengineering works, such as the laying of fascines (wooden branches tied together with nets and cords).

To control and manage the water level inside the channels network, three depth water sensors will be installed (Par.2.5).

The Fig. 1 shows the localization of the activities foreseen in the action C1: channel to dredge, 9 new sluices gates, 3 hydraulic sectors, river banks protected with fascines, 3 depth sensors.

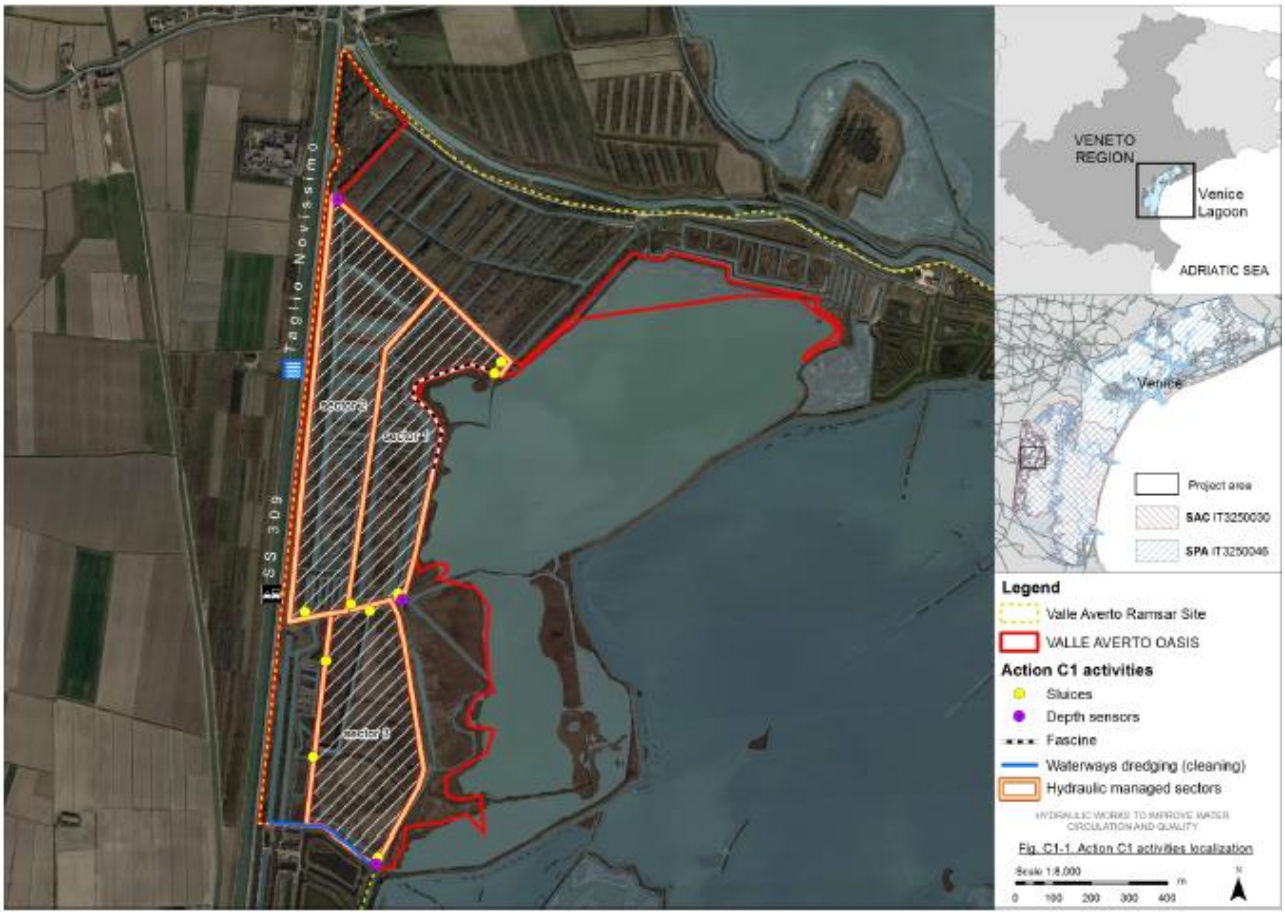



Fig. 1. Action C1, activities localization.

# 2 Description of the intervention

## 2.1 Dredging/excavation

In the southern sector of the Oasis, one channel, about 340 m long, will be dredged (Fig. 1,Fig. 2) to remove about 50 cm of silt deposited on the bottom in order to obtain a better circulation of water inside the channel itself.

The dredged material will be used in situ for the consolidation of the banks (Fig. 3).

The preparatory project action A6, plans to carry out also a bathymetric survey in the most significant points of the hydrographic network: Fig. 4 shows the results of the survey carried out along the channel that will be dredged.

The details on key sections of the channel are shown in the Fig. 5,Fig. 6.

In Fig. 7,Fig. 8 are shown the profiles of the terminal part of the channel.

Of particular importance is the profile A-A' because, approximately in the point A a new sluice gate will be positioned at the elevation of 0.39m.

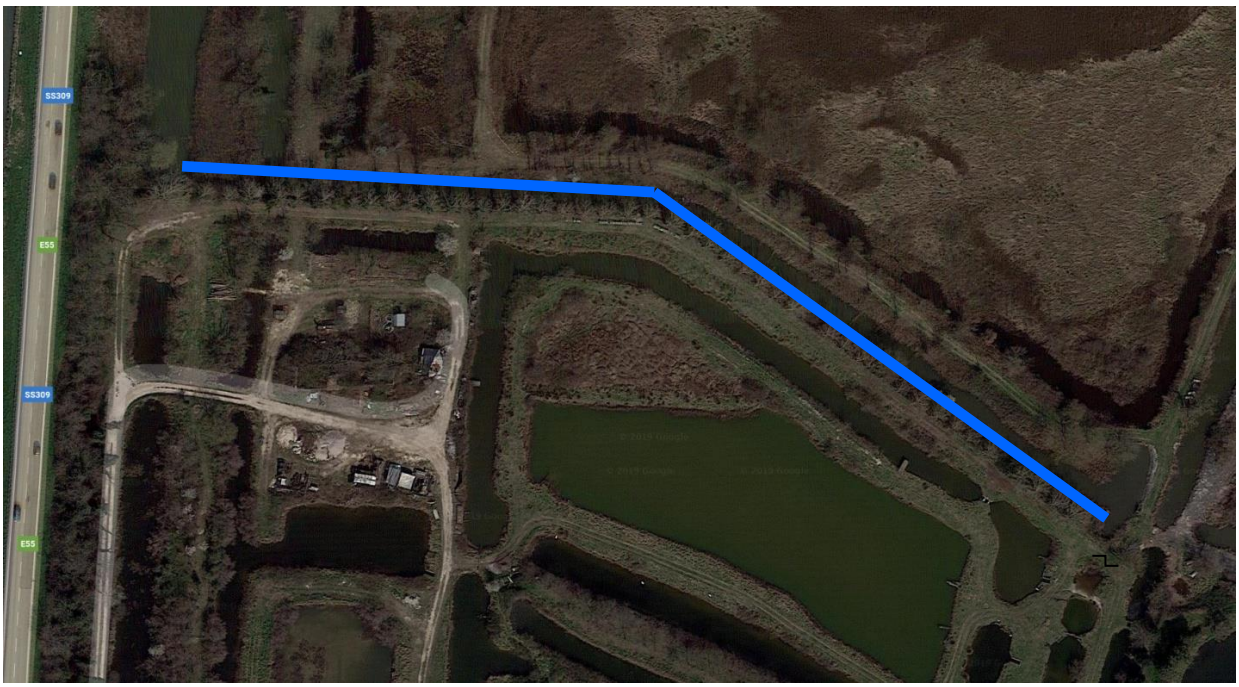



Fig. 2. Channel to dredge, 340m long

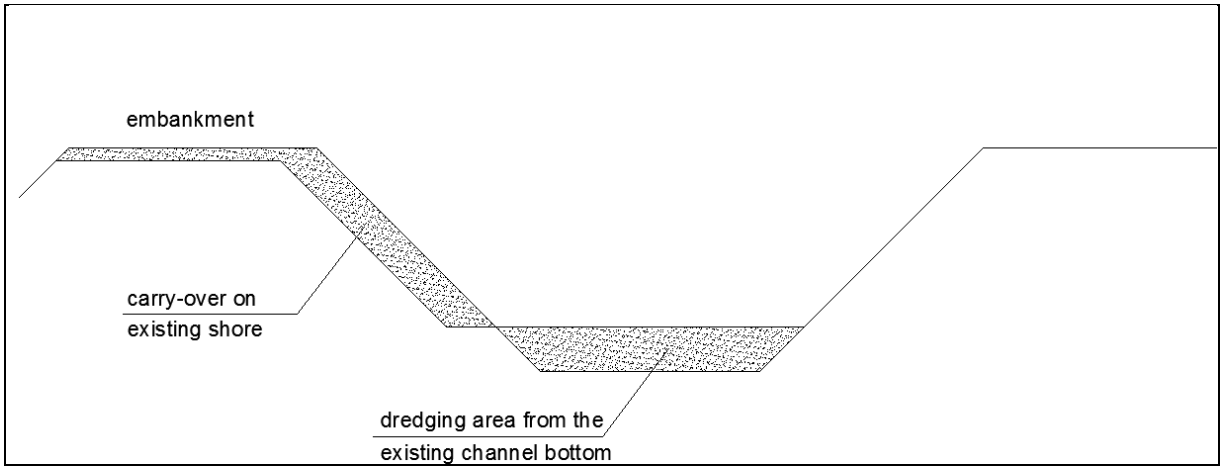



Fig. 3 Type section of the channel to dredge: dredged material is used for the consolidation of the banks

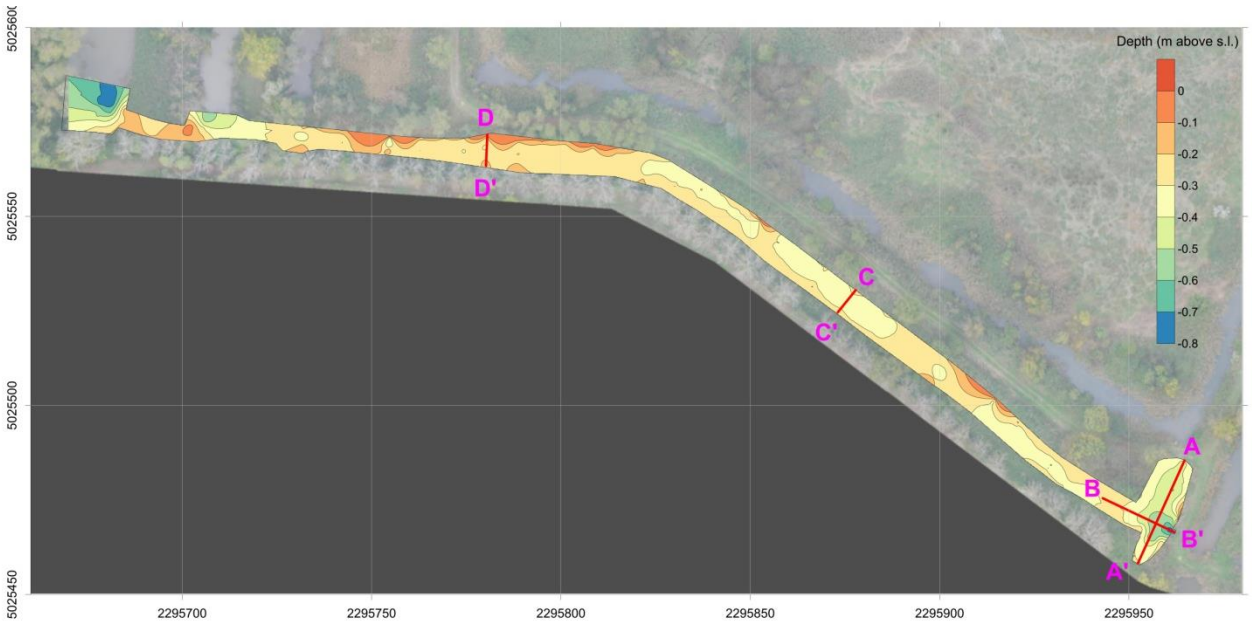



Fig. 4 Bathymetric survey results of the channel to dredge

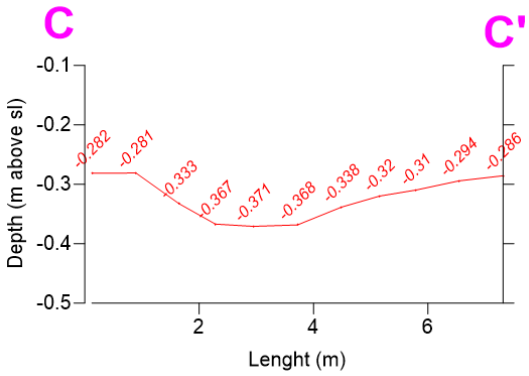



Fig. 5 Section C-C'

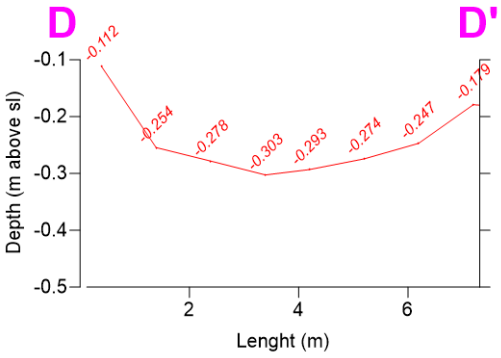



Fig. 6 Section D-D'

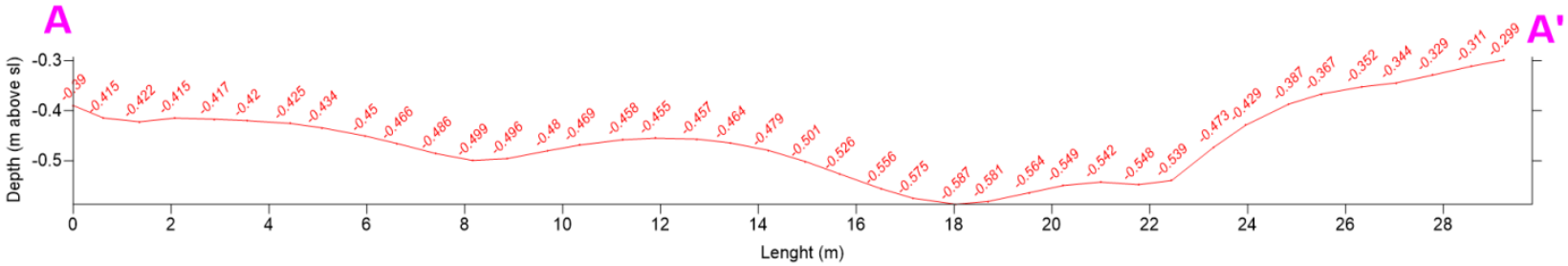



Fig. 7 Profile A-A'

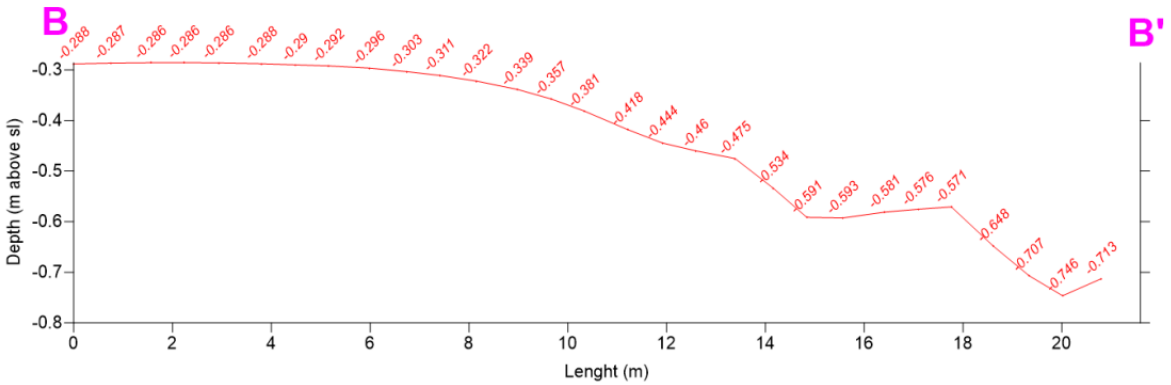



Fig. 8 Profile B-B'

## 2.2 Sluices gates

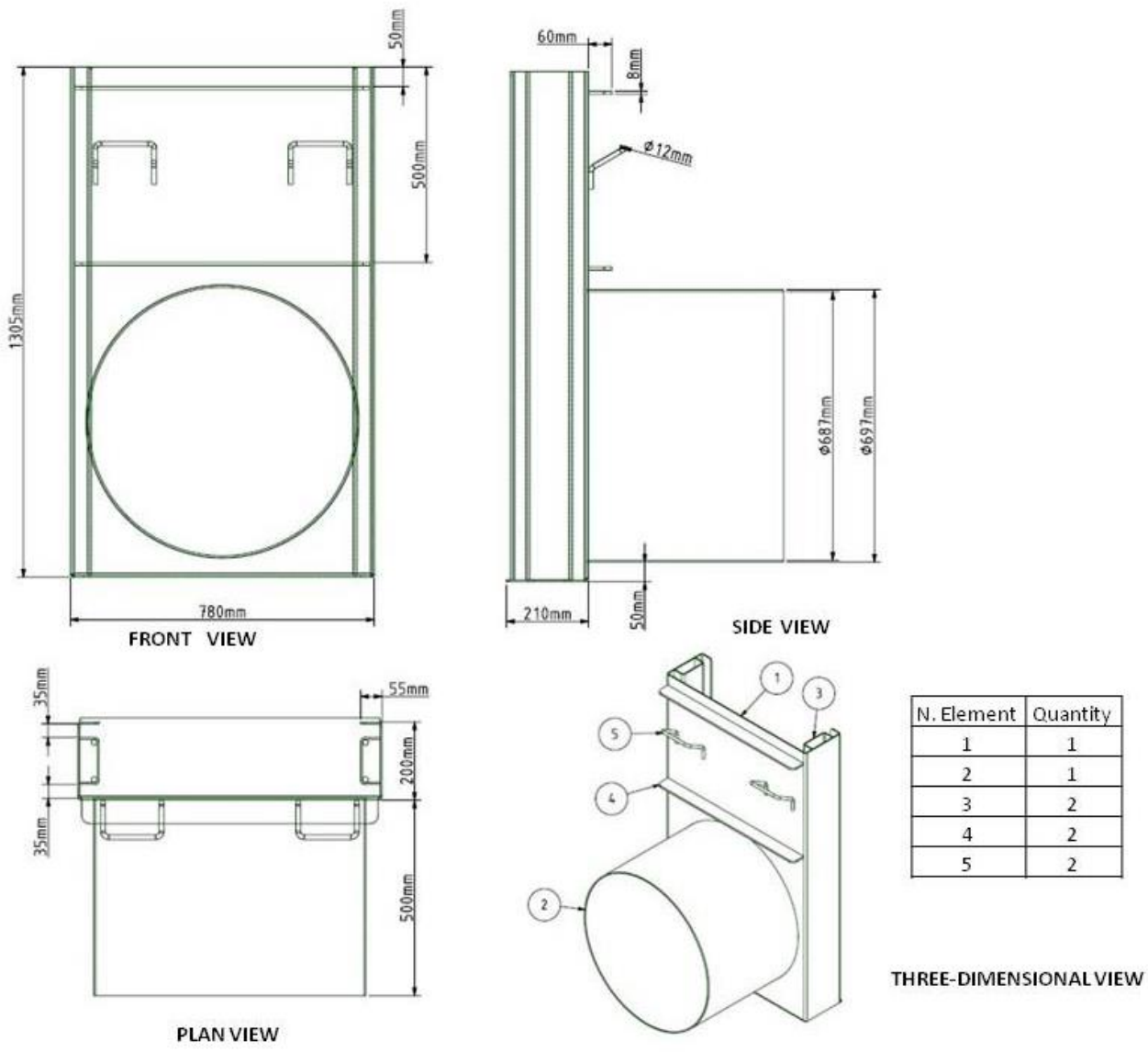
Nine concrete existing sluice gates (Fig. 9), positioned in different channels of the Oasis will be dismantled and replaced (Fig. 1) with new ones in galvanized iron (instead of the originally planned aluminum ones) in order to ameliorate the water circulation, to improve the connection between the channels, to create 3 hydraulically independent sectors (Fig. 1) and to obtain a better regulations of water levels in channels and ponds inside the Oasis. Some sluice gate, when needed, will be equipped with a grate and an aluminum door.

Construction detail of sluices gates are shown in Fig. 10

Fig. 9. Existing concrete sluice gate.

To each sluice gate will be applied a corrugated polyethylene pipe high resistant (Fig. 11), 6 m long and with a diameter of 0.60 m (Tab. 1) to allow crossing of paths and embankments. The existing concrete pipes, in particular critical conditions (Fig. 12), will be replaced.

The consolidation of the banks will be provided at both sides of sluice, by means of laying of 24 wooden chestnut poles (12 for each side) with a diameter of 15-20 cm and length up to 7m and anti-washout geotextile.




| N. Element | Quantity |
|---|---|
| 1 | 1 |
| 2 | 1 |
| 3 | 2 |
| 4 | 2 |
| 5 | 2 |

Fig. 10. Construction detail of sluice gate.

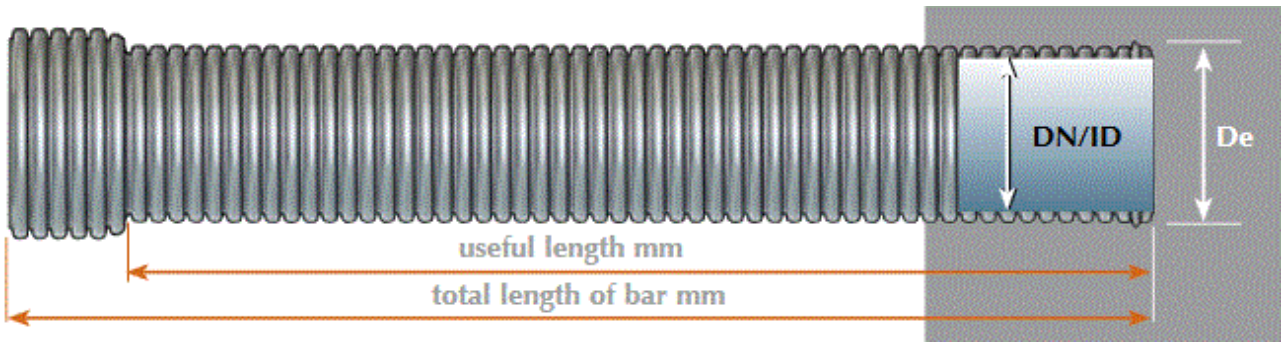



Fig. 11. High modulus polypropylene double wall corrugated pipe for underground discharge in conformity with standard NF EN 13476-3 normalised on the inside diameter.

Tab. 1. Pipes dimensional data

| | |
|---|---|
| Ø nominal Inside DN/ID (mm) | 600 |
| Ø Outside (mm) | 677.00 |
| Stiffness class (KN/m$^2$) | SN 4 |
| Total length of bars (mm) | 6000 |
| Useful length (mm) | 5765 |

Fig. 12. Existing concrete pipe to be replaced

## 2.3 Fascines

Five-hundred meters of channels with eroding banks (Fig. 1, Fig. 13, Fig. 14, Fig. 15) will be protected with 500 fascines (Fig. 16), a naturalistic engineering technique used in the Venice lagoon to protect the salt marsh edges (Fig. 17). These fascines will be manufactured with a similar technique adopted in the LIFE 12 NAT/IT/001122 VIMINE (Fig. 18), using wooden branches tied together with galvanized iron (a non-biodegradable material but still degradable in brackish water).

The fascines will be 2 m long, with a diameter of about 35 cm, laid in two superimposed rows and realized, using poplar branches and twigs coming from the ordinary maintenance of the Valle Serraglia fish farm, near Valle Averto Oasis. The choice is linked to the need to find the material in the nearest areas to limit transport times and costs.

Each fascine will be supported by 4 wooden poles with a diameter of about 8-10 cm, driven into the soil manually or with the use of manual pile drivers.

The Fig. 19 shows the construction detail of fascines.

They will be manufactured near the visitor centre, giving visitors the opportunity of seeing the whole process.

During the manufacturing of fascines, it is necessary to minimize the presence of empty spaces between the branches; when then the branches dry out, giving up, they go to occupy the empty spaces causing a significant compaction of the fascine, which leads to the loss of effectiveness of its protective function (Greghi et al, 2018).

Fig. 13 Localization of channels with eroding banks to be protected with fascines.

Fig. 14 Channel to be protected with fascines.

Fig. 15 Eroding banks of channel to be protected with fascines.

Fig. 16.Fascines

Fig. 17. Fascines side view protecting salt marsh edge in Venice Lagoon

Fig. 18. Fascines in Venice Lagoon protecting salt marsh edge realized in LIFE VIMINE project

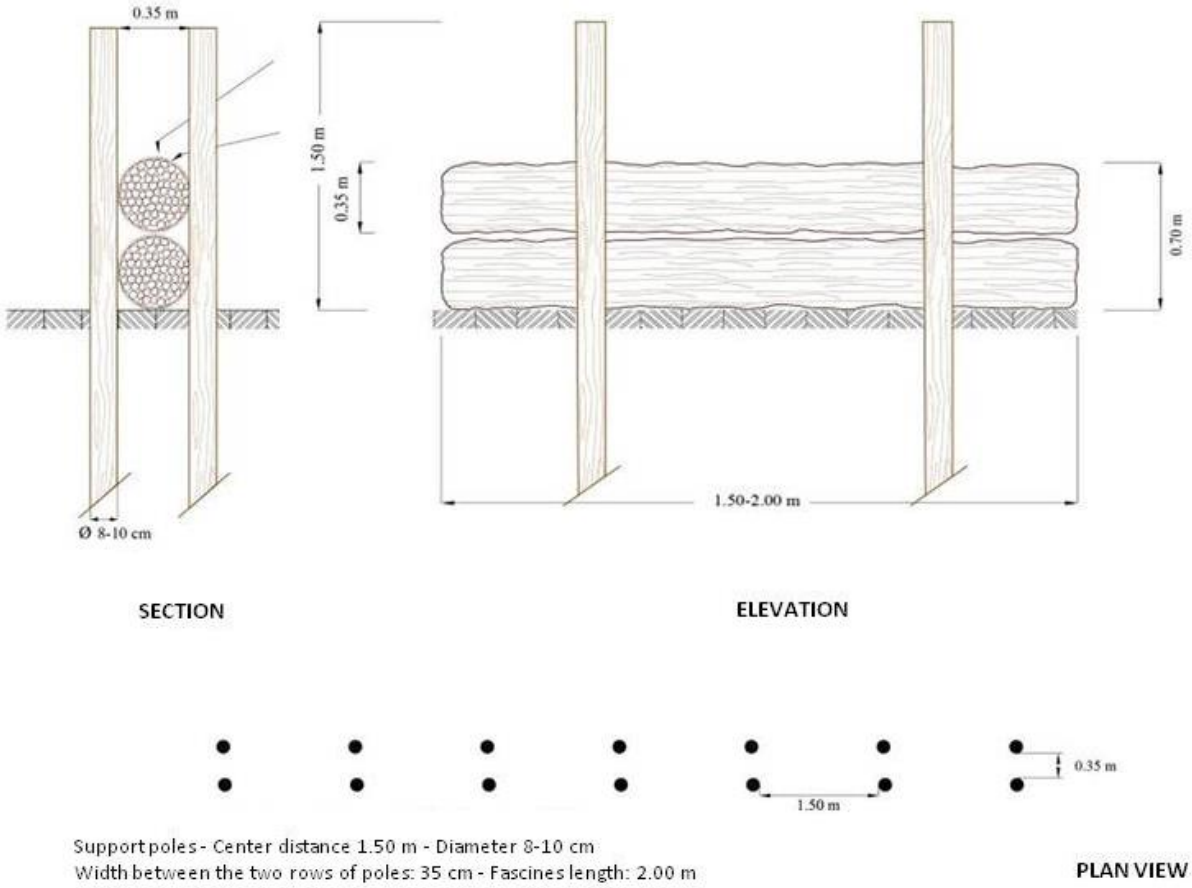



Fig. 19. Construction detail of fascines

## 2.4 Piezometers for groundwater levels

A piezometric station will be installed within each of the three newly created and hydraulically independent sectors (Fig. 1,Fig. 20).


Fig. 20. Piezometers position

The Tab. 2 shows the Gauss Boaga coordinates of the piezometeres position.

Tab. 2. Gauss Boaga coordinates of the piezometers position

| Piezometer | Est | Nord |
|---|---|---|
| S1Pz1 | 2295906 | 5026476 |
| S2Pz2 | 2295970 | 5026184 |
| S3Pz3 | 2295833 | 5025702 |

Drilling activities will be carried out by means of a rotary drilling machine on crawlers, with continuous drilling using a sample corer (diameter = 101.6 mm; length = 150 cm) suitable for the collection of all the material involved; coating liners follow the drilling to ensure the stability of the walls of the hole.

During the drilling operations all the extracted material will be examined by a geologist and the stratigraphic reports will be drawn up.

The extruded carrots, after each recovery maneuver will be housed in storage trays (m 1.00 x 0.60 x 0.15).

At the end of the drilling, an open-tube piezometer will be installed, consisting of a column of micro-slotted PVC pipes, male-female threaded, with a 3'' diameter and 0.5 mm slot. They will be placed inside the lining column providing for the insertion, in the column-pipe interspace, of washed granular material (calibrated siliceous gravel with a diameter of 1-2 mm) in order to create a porous filter around the slotted section of the piezometer.

The piezometer thus created will be completed with a protective cover and a 30 cm long cement extension, with a B125 cast-iron cover, all made integral with the ground by pouring concrete.

The Fig. 21 shows the construction detail of piezometers.

At the end of the installation of the piezometers, the equipment will be cleaned in order to improve the hydraulic connection with the aquifer through the removal of fine particles suspended in the water and the rearrangement of the grains of gravel that act as the filter.

For the cleaning of piezometers the method of extraction will be used, by extracting the turbid water due to the presence of the fine material in suspension, through a submerged pump until clarification is obtained.

Each piezometer, starting from October 2020, will be equipped with two sensors (for superficial and average readings) for the continuous monitoring of conductivity, temperature and groundwater level. All data will be transmitted, via mobile data connection, to WWF Oasi manager and will be used for the hydraulic management of the Oasis and for the regulation of the water levels of the three sectors.

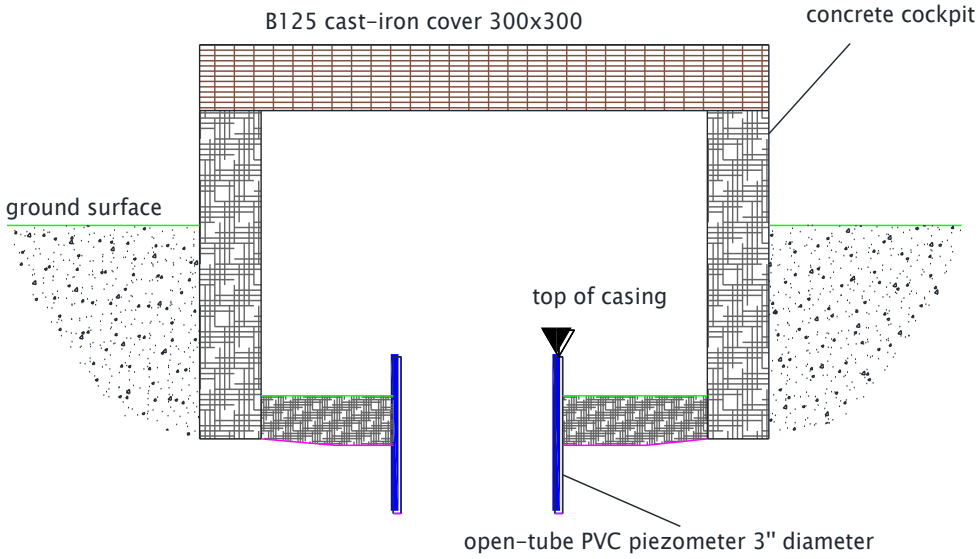



Fig. 21. Construction detail of piezometers

## 2.5 Water depth sensors

In order to maintain the water level as homogeneous as possible in the hydraulic network of the Oasis 3 water depth sensors will be installed in the channels (Fig. 1) in three strategic position:

A. Discharge point in the lagoon sensor (Fig. 22): it is positioned at 500 m before the discharge point in the lagoon because the discharge takes place through a sluice gate (controlled by an electric motor and equipped with a float) which is not in the Oasis but inside a neighbouring property.

B. Discharge point in the lakes sensor (Fig. 23): it is positioned in the channel which connects the sector 1 (Fig. 1) with the external brackish ponds. Water is discharged in the brackish ponds especially in the summer when there is a strong evaporation or when the tides are too high and it is not possible to discharge into the lagoon.

C. Load sensor: (Fig. 24) is positioned at the end of the fresh water loading channel. It will be used to measure the water level when the sluice gates on the "Nuovissimo channel" is opened.

The measured data will be transmitted, via mobile data connection, to WWF OASI manager.

Tab. 3. Gauss Boaga coordinates of the water depth sensors position

| Sensor | Est | Nord |
|---|---|---|
| A | 2295856 | 5027214 |
| B | 2296027 | 5026162 |
| C | 2295958 | 5025471 |

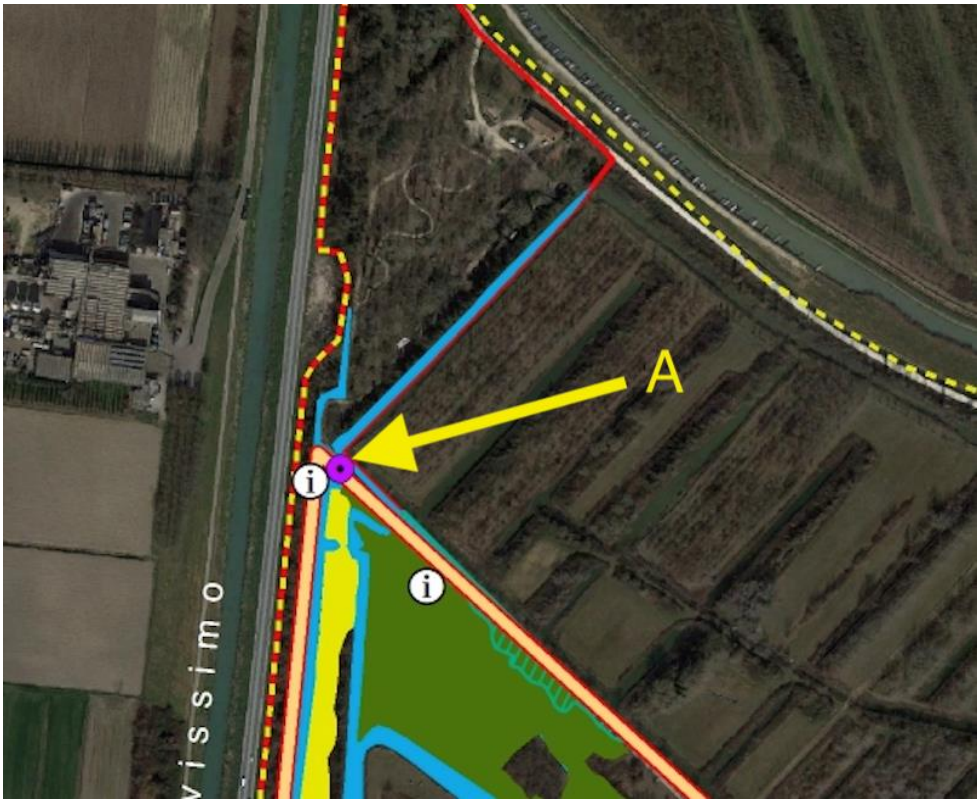



Fig. 22. Sensor A position (purple circle)

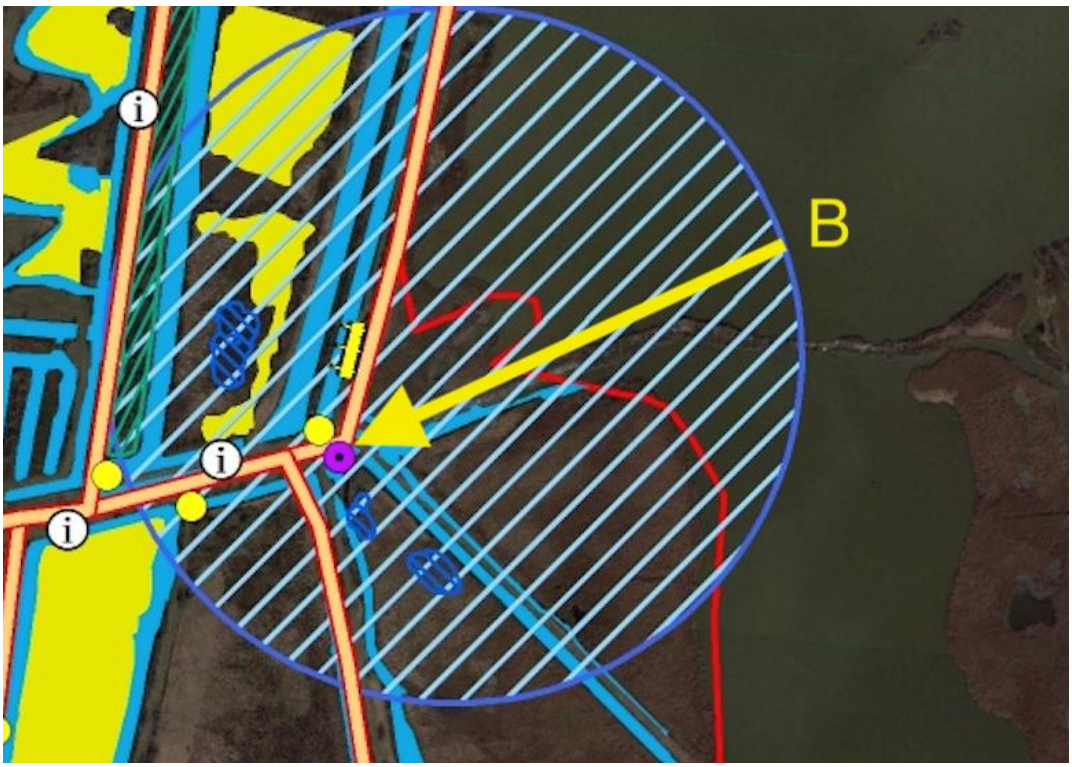



Fig. 23. Sensor B position (purple circle).


Fig. 24. Sensor C position (purple circle).

# 3 References

Grechi L., Zangaglia A., Baldan D., Barausse A., Cavalli I., Hoceine K., Musner T., Smania D., Palmeri L., 2018. Linee guida per la conservazione e il ripristino di ambienti lagunari interni soggetti ad erosione tramite un approccio integrato basato sull'ingegneria naturalistica e la manutenzione ordinaria. Progetto LIFE VIMINE, Padova.

# 4 Annexes

Annex 1- Bill of quantities

Annex 2- Work schedule

Annex 3- POS Action C1

Annex 4 – POS Action A6