URBAN GreenUP

D2.3: Technical specifications of Valladolid demo

WP 2 , T 2.3 – T 2.4 – T 2.5

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0 Executive summary

Valladolid is a front-runner city in the URBAN GreenUP project (www.urbangreenup.eu) whose aim is to act as living laboratory that demonstrate the economic, social and environmental impacts of fully functional green infrastructure, promoting citizen awareness and participation, and fostering of ecological reasoning and ecological intelligent among the citizens.

Valladolid works to validate and demonstrate the effectiveness of the URBAN GreenUP methodology. There have been planned to install 42 interventions along the city, which includes 36 Nature-Based solutions, NBS, and 6 Non-technical interventions. This report describes the technical and economic definition of the 42 interventions.

This definition is supported by a team group that is composed by the following URBAN GreenUP Consortium Members: Fundación CARTIF, SingularGreen, Confederación Hidrográfica del Duero, Fundación CENTA and Centro Tecnológico LEITAT, coordinated by Valladolid City Council.

The city of Valladolid addresses three different areas (Sub-Demos) for the integration of several complementary NBS. The three Sub-Demo Areas are the following A, B and C:

- Sub-Demo A: Green Corridor, to re-nature the concept of cycle lane in Valladolid, which crosses the city from West to East.
- Sub-Demo B: City Centre, to re-nature urban areas with low availability of space for green infrastructure.
- Sub-Demo C: New models of re-naturing urban areas. It is divided into four main locations: C1- Football Stadium area (parking), C2- Sustainable Park, C3- Floodable Park and C4- Urban farming activities.

Some non-technical interventions for environmental education, engagement, city coaching and support activities, are developed in the three Sub-Demo areas indistinctly. Non-technical interventions, help, in this way, to improve the implementation progresses of the technical interventions enhancing the co-creation and co-designing activities, and reinforcing the opportunity to create a Living Urban Laboratory in the city thanks to the experiences and lessons learnt in the development of the URBAN GreenUP project.

This report is focus on the description of the technical and economic aspects of each intervention. Co-creation processes and lessons learnt from the development of each natured based solution, will be included in following reports related to the development of the interventions, showing the complete processes. However, a general description of this approach is included in the introduction section, and in each sub-demo description for each group of interventions.

The following table summarizes the 42 interventions for Valladolid Demonstration, which are classified by nature. Every intervention is identified by a unique key (VAcX).

RE-NATURING URBAN AREAS	WATER INTERVENTIONS	SINGULAR GREEN INFRASTRUCTURES	NON TECHNICAL INTERVENTIONS
Green route	**SUDSs**	**Cycle-pedestrian infrast**	**Educational activity**
VAc1-New green cycle lane and re-naturing existing bike lanes	**VAc8**-SUDs for green bike lane **VAc9**-SUDs for re-naturing parking **VAc10**-Rain gardens	**VAc15**-Cycle-pedestrian green paths **Smart soil** **VAc16,17,18**-Smarts soil as substrate	**VAc34**-Educational path in NWTP area **VAc35**- Educational path in floodable park area **VAc36**-Urban Farming educational activities
Arboreal Interventions	**Flood actions**	**Pollinators**	**Engagement**
VAc2-Planting 1,000 trees / **VAc3**-Tree shady places / **VAc4**-Shade&cooling trees / **VAc5**-Re-naturing parking trees	**VAc11**-Floodable Park	**VAc19, VAc21**-Natural pollinator's modules **VAc20**-Compacted pollinator's modules	**VAc37**-Engagement Portal for citizen **VAc38**-Sponsoring activities
Resting areas	**Water treatment**	**Vertical GI**	**City coaching**
VAc6-Green Resting areas	**VAc12**-Green filter area **VAc13**-Natural Wastewater Treatment Plant	**VAc22-VAc23**-Green noise barriers **VAc24**- Vertical mobile gardens **VAc25**-Green Façade	**VAc39**-Promotion of ecological reasoning/intelligent
Carbon capture	**Green Pavements**	**Horizontal GI**	**Support activity**
VAc7-Urban Carbon Sink	**VAc14**-Green Parking Pavements	**VAc26**-Electro wetland **VAc27**-Green Covering Shelter / **VAc28**-Green Roof / **VAc29**-Green Shady Structures **Pollutants filter** **VAc30**-Urban Garden Bio-Filter **Urban farming** **VAc31**-Urban orchard/ **VAc32**-Composting **VAc33**-Small-scale urban livestock	**VAc40**-Single desk for RUP deployment **VAc41**-Support to citizen project of NBS **VAc42**-City mentoring strategy

Table 0.1: Demo Valladolid interventions in the URBAN GreenUP project

This report describes the technical and economical specifications of Valladolid demo interventions. Every intervention chapter is composed by 5 subchapters under a common structure: General description, location, technical specifications, operational and maintenance considerations and economic specifications.

There have not been substantial changes in the NBS defined to Valladolid, as every intervention initially planned is still ahead. However, the technical and economic definition phase is not completely finished and it has to go on during the following months.

It will be necessary to work in the following three action lines: overcome the outstanding technical challenges, adapt the technical definition to the available total budget, and finalize the technical projects delivery in Spanish language.

1 Introduction

1.1 Purpose and Target Group

Valladolid (Spain) is a front-runner city in the URBAN GreenUP project. Among the initial purpose of the city in partnership with the URBAN GreenUP Consortium, there were established the following objectives:

i. Trial living laboratories that would demonstrate the economic, social and environmental impacts of fully functional green infrastructure (GI).
ii. Promotion of the citizen awareness and participation and fostering of ecological reasoning and ecological intelligent.
iii. Provide a new evidence base and help develop an EU-wide reference framework on NBS and their benefits in addressing inclusive socio-economic regeneration in cities.

To meet these objectives, there will be deployed a set of Nature Based Solutions (NBS) in the city of Valladolid following a holistic approach. The idea is to address specific challenges identified in the report *D2.1 Report on the diagnosis of Valladolid*, by means of several pilots in well-selected areas of the city.

This document defines the technical and economic characteristics of the 42 interventions (NBS and non-technical interventions) that are going to be deployed in the city of Valladolid. These interventions will be implemented with a strong participation of Valladolid City Council, other members of the URBAN GreenUP Consortium that take part in Valladolid Demonstration as technical experts (see section 1.2), but also local stakeholders and citizens, under a co-creation approach. In this respect, non-technical actions are not independent from technical actions, moreover, they serve as support of the development progress, improving co-designing and co-creation activities.

It is necessary to state that this report does not include the whole technical-economical projects defined for every intervention. Those documents are written in Spanish language and they will be used for local tendering processes, for the construction of the interventions, starting in September 2018.

Therefore, this D2.3 report has been designed to act as a reference guide of the general characteristics of the interventions, providing the best definition scope reached at the current moment. The descriptions of the interventions here are in the context of a global document that concerns all the performances to be done in the city, so too much technical details are not included to avoid a too long extension and facilitate the understanding for everybody, specialist or not.

This document exposes, therefore, the technical-economic definition of each intervention, as a description of each NBS to be executed, the expected end result of each implementation, from a technical point of view. The details of the implementation process, which will show the particular experiences of each development from the point of view of the city as Urban

Learning Laboratory, will be described in the D2.6 *Report on implementation progresses in Valladolid*.

1.2 Contribution of Partners

The URBAN GreenUP project counts with a complete Consortium of partners. Valladolid is a front-runner city as one the main actor in the project, assuming major responsibilities and workload according our commitment. Valladolid like the other front-runner cities, Liverpool and Izmir, is and advanced city in Green Infrastructures and re-naturing strategies. Valladolid is becoming a leader to the cities involved in its region (Castilla y León), in Spain and also in all Europe.

The city of Valladolid is supported by several local partners, in order to create a group of stakeholders to lead the city transition. The technical and economical design of the interventions of Valladolid Demonstration in the URBAN GreenUP project is developed by a team group working together and coordinated by Valladolid City Council: Valladolid Demonstration team.

Partner	Expertise	Interventions in Valladolid Demo
Ayuntamiento de Valladolid	Valladolid City Council is a local government public entity from Spain. Demo Valladolid Coordinator.	- New green cycle lane and re-naturing existing bike lanes - Cycle-pedestrian green paths. Green Resting areas. - Arboreal interventions: Planting trees, tree shady places. - Urban Carbon Sink. - Green Parking Pavements. - Urban orchards. Small-scale urban livestock. Urban Farming Educational activities. - Educational paths. - Non-technical activities: Engagement Portal for citizen, Sponsoring activities, Promotion of ecological reasoning and intelligent, Single desk for RUP deployment, Support to citizen project of NBS, City mentoring strategy.
CARTIF Fundación CARTIF	Applied Research Centre in terms of R&D and technology transfer activities.	- Urban garden bio-filter. - Natural & Compacted pollinator's modules. - Smarts soils as substrate. - Community composting.
singular green	SingularGreen SL Company specialized in landscape architecture.	- Green roof. - Green shady structures. - Green covering shelter. - Green façade. - Green noise barriers. - Vertical mobile gardens.
Gobierno de España Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente Confederación Hidrográfica del Duero Confederación Hidrográfica del Duero	Duero River Basin Authority is a public body under the Ministry of Agriculture, Food and Environment of Spain, authority for Duero Basin water management.	- Floodable Park.
centa Fundación Centro de las Nuevas Tecnologías del Agua – CENTA	Non-profit research institution in terms of R&D&I in water management.	- Natural wastewater treatment plant (NWTP). - Drainage urban systems (SUDs) - Rain gardens. - Green filter area.
LEITAT managing technologies Acondicionamiento Tarrasense Associacion - LEITAT	Research Centre specialized in production technologies.	- Electro wetland.

Table 1.1: Partners of Demo Valladolid interventions in the URBAN GreenUP Consortium

1.3 Relation to Other Activities in Project

This Deliverable *D2.3 Technical specifications of Valladolid demo* is a twin report for the three Demonstrative Cities: Valladolid, Liverpool and Izmir. So WP3-Liverpool and WP4-Izmir are working in parallel to WP2-Valladolid. To strengthen this collaboration a cross-cutting activity was set up, common to the three WPs.

Figure 1.1: Relation between the Deliverables X.3 for the three Demo cities.

The following table shows the Tasks X.3 and Subtasks X.3.X for Sub-Demos A, B and C in Valladolid, Liverpool and Izmir.

Tasks	Subtasks		
	Valladolid	Liverpool	Izmir
Task X.3: Technical and economical definition of the interventions - SUBDEMO A	2.3.1 Green infrastructures	3.3.1: Water interventions	4.3.1: Renaturing urbanization
	2.3.2 Nature Pollinators specific.	3.3.2: Green infrastructure	4.3.2: Green Infrastructures
	2.3.3 Non-technical interventions	3.3.3: Renaturing urbanization	4.3.3: Non-technical interventions
		3.3.4: Non-technical interventions	
Task X.4: Technical and economical definition of the interventions - SUBDEMO B	2.4.1 Green Infrastructures	3.4.1: Water interventions	4.4.1: Renaturing urbanization
	2.4.2 Electro wetland	3.4.2: Green infrastructure	4.4.2: Water interventions
	2.4.3 Urban garden Bio-filters	3.4.3: Renaturing urbanization	4.4.3: Green Infrastructures
	2.4.4 Non-technical interventions	3.4.4: Non-technical interventions	4.4.4: Urban Farming-Climate-smart Greenhouses
			4.4.5: Non-technical interventions
Task X.5: Technical and economical definition of the interventions - SUBDEMO C	2.5.1 Floodable park	3.5.1: Water interventions	4.5.1: Green corridor
	2.5.2 Natural waste water plant	3.5.2: Green infrastructure	4.5.2: Water interventions
	2.5.3 Urban farming	3.5.3: Renaturing urbanization	4.5.3: Green Infrastructures
	2.5.4 Green infrastructure	3.5.4: Non-technical interventions	4.5.4: Urban Farming-Climate-smart Greenhouses
			4.5.5: Non-technical interventions

Table 1.2: Tasks and subtasks for Deliverable X.3 for the three Demo cities.

This Deliverable *D2.3 Technical specifications of Valladolid demo* is also directly related with the *D2.4 Monitoring program to Valladolid* (linked with WP5), that is headed by GMV Aerospace and Defence S.A.U. (GMV):

- Task 2.6: Development of the monitoring program (linked with WP5) – D2.4 Monitoring program to Valladolid (D2.4), Liverpool (D3.4) and Izmir (D4.4).

Valladolid's implementation is close contact with WP1 to support the development of the renaturing strategy and serve as validation test-bed. So that, this Deliverable is also related with the following Tasks and Deliverables of the Work Package 1 in the URBAN GreenUP project:

- Task 1.1: NBS catalogue - D1.1 NBS catalogue.
- Task 1.4: Barriers and boundaries identification - D1.5 Barriers and boundaries identification.

1.4 Demo Valladolid

Valladolid (Spain) is a front-runner city of the URBAN GreenUP project. Valladolid has identified specific urban challenges for which we wish to develop NBS and to monitor the outputs, the outcomes and the process to inform both local future decision-making and an EU wide NBS National Framework.

Due to this, selected actions in Valladolid have been organized into 3 Sub-Demos. It will test specific points (economic lead, social lead and environmental lead). The scale of the work will enable to create high profile projects interventions and test the improvement in perception of city image and impacts on decision makers. Within this, our focus will be on:

- Developing innovative solutions to make more sustainable GI and to re-naturing grey areas of the city.
- Developing innovative ways of working between public/private/community sectors and with local citizens.
- Improvement economic and social performance of pedestrian and cyclist connectivity to the city centre.
- Use of monitoring techs and 'big data' solutions to engage, measure, assess and disseminate URBAN GreenUP benefits.

The city of Valladolid will address three different areas (SUBDEMOS) to mitigate, by means of the integration of several complementary NBS, a set of challenges. The following is a general description of the interventions planned for the Valladolid municipality within the URBAN GreenUP project in the three Sub-Demo Areas (A, B, C). Some non-technical interventions for engagement, city coaching and support activities, are developed in the three Sub-Demo Areas indistinctly.

- **Sub-Demo A: Green Corridor**. Actions to re-nature the concept of cycle lane in Valladolid. The green corridor crosses the city from West to East. Green interventions are integrated throughout the Green corridor.

- **Sub-Demo B: City centre**. Actions to re-nature areas with low availability of space for conventional Green infrastructure.
- **Sub-Demo C: New models of re-naturing urban areas**. It is divided into four main locations:
  - **C1. Football Stadium area (parking).** Actions to re-nature the concept of outdoor car parking, close to the Zorrilla football stadium and the fairy ground area.
  - **C2. Sustainable Park**. Actions to create a sustainable park mainly from water recovery and education activities. The main intervention is the natural wastewater treatment plant, which is complemented with educational interventions.
  - **C3. Floodable Park**. Actions to create a floodable park in Valladolid, by the La Esgueva River entrance in the city of Valladolid.
  - **C4. Urban farming**. Urban farming and related actions deployed in the municipal orchards of Parque Alameda and Santos-Pilarica.

Figure 1.2: Aerial view of the three URBAN GreenUP Sub-Demo Areas in Valladolid (Source: Google/Valladolid City Council elaboration).

The following table shows the 42 Valladolid Demonstration interventions organized by Sub-Demo A, B and C.

	RE-NATURING URBANIZATION	WATER INTERVENTIONS	SINGULAR GI	NON TECHNICAL INTERVENTIONS
SubDemo A	VAc1- New green cycle lane	VAc8- SUDs for green bike lane	VAc15 - Cycle-pedestrian green paths	Common non-technical interventions: VAc37, 38, 39, 40, 41 & 42
	VAc2- Planting 1,000 trees		VAc16- Smarts soils as substrate	
	VAc3- Tree shady places		VAc19- Natural pollinator's mod.	
	VAc6- Green Resting areas		VAc22 - Green Noise Barriers	

	RE-NATURING URBANIZATION	WATER INTERVENTIONS	SINGULAR GI	NON TECHNICAL INTERVENTIONS
Sub-Demo B	VAc4- Shade and cooling trees		VAc17- Smarts soils as substrate.	Common non-technical interventions: VAc37, 38, 39, 40, 41 & VAc42
			VAc20- Compacted Pollinator's m.	
			VAc23 - Green Noise Barriers	
			VAc24 - Vertical mobile garden	
			VAc25 - Green Façade	
			VAc26 - Electro wetland Roof	
			VAc27 - Green Covering Shelter	
			VAc28 - Green Roof	
			VAc29 - Green Shady Structures	
			VAc30 - Urban Garden Bio-Filter	
Sub-Demo C	VAc5- Re-naturing parking trees	VAc9- SUDs for re-naturing parking	VAc18 - Smarts soils as substrate	VAc34: Educational path in VAc13
		VAc13- Natural wastewater treatment Plant	VAc19, VAc21-Natural pollinator's modules	VAc35: Educational path in VAc11
		VAc10- Rain gardens	VAc20 - Compacted Pollinator's modules	VAc36 - Farming Educational active.
		VAc12– Green filter area		
	VAc7- Urban Carbon Sink	VAc11- Floodable Park	VAc31 - Urban orchards	Non-technical interventions: VAc37, 38, 39, 40, 41 & VAc42
		VAc14- Parking Green Pavement	VAc32 - Community composting.	
			VAc33 - Small-scale urban livestock	

Table 1.3: Demo Valladolid interventions in the URBAN GreenUP project.

1.5 Co-creation activities

The development of the WP2 activities follows different aspects of a co-creation process, taking into account the characteristics of the different interventions to be implemented in the city (technical and non-technical actions) and the existing limits for the application of this methodology.

The URBAN GreenUP project defines, from the beginning of the project, details of location and technical aspects of the actions, so it has not been possible to establish a co-creation process to decide together with the citizens which are the best and feasible Natured Based Solutions to implement in the city as a star point. Nevertheless, different activities and processes related to co-designing, co-creation, co-development… have been carried out in order to take into account the different players involved and their views, and will be applied also in followings steps of the implementation process.

- Collaboration with other areas of Valladolid City Council: from the beginning of the project and periodically, different meetings related to each intervention have been organized with the different involved areas of the Valladolid City Council: Urban Planning, Infrastructure and Housing, Environment and Sustainability, Security and Mobility, Citizen Participation, Youth and Sports, etc. The collaboration between areas through the co-designing, allows to meet the needs of the city and the citizens in an effective way. In addition, these initiatives create a good environment of work and establish relations between the different councillorships of the council for future co-creation processes.

- Participation of citizens: Valladolid City Council organizes, every year, a participatory budgeting. This is a process of direct, permanent, voluntary and universal intervention through which the citizenry, together with the authorities, deliberates and decides the allocation of public resources. The selected proposals have been analysed in order to establish synergies with the URBAN GreenUP project and to respond to the requirements of the citizens. In this respect, also a competition of ideas for improvement the city on aspects of urban restoration and resilience to climate change, as well as related to sustainability and the use of public spaces improvement was organized in the year 2018, and the idea is to repeat it very year. The contest was open to the general public and the topics were related to URBAN GreenUP project on green and blue infrastructures. The proposals have been also analysed in order to improve the Urban GreenUP project interventions, and the idea is to repeat the competition every year. Different meetings with citizens and neighbours are also important to engage and to include the people in the co-creation process.
- Public-private collaboration: this project offers the opportunity to collaborate with the private sector in the development of different nature based solutions to improve the urban spaces, through co-financing, co-designing or sponsoring processes. The social cooperative responsibility of the private sector can be reinforced for these collaborations, helping to reduce the environmental footprint and meet the different sustainability commitments of companies. The most important example in this Demo, is the collaboration with El Corte Inglés, a very important commercial Spanish company, which owns different commercial centres in different points of the country. Its collaboration in the implementation of the green façade has been very important in order to develop this architectural solution in the historical city centre.
- Synergies with other innovation projects: in the city of Valladolid, different innovative initiatives to improve the quality of life of the citizens and re-naturing the urban space are being carried out. Synergies with European R&D projects, private initiatives, municipal urban plans, etc., related with the reduction of the climate change effect, are being analysed with the aim to join efforts in the achievement to similar objectives.

2 Definition of Interventions in Sub-Demo A (Green Corridor)

The proposed green corridor will serve as an important communication route between the City Centre and other populated areas with important recreational areas, from the Zorrilla football stadium in the West, to the Floodable park in the East, seeking to facilitate sustainable transport in the city in a transversal axis and provide important ecosystem services for urban biodiversity.

Re-naturing urbanization	Water interventions	Singular green Infrastructures	Non-technical interventions
VAc1- New green cycle lane and re-naturing existing bike lanes	VAc8- SUDs for green bike lane	VAc15 - Cycle-pedestrian green paths	Common non-technical interventions[1]: VAc37, VAc38, VAc39, VAc40, VAc41 & VAc42
VAc6- Green Resting areas		VAc16- Smarts soils as substrate	
VAc2- Planting 1,000 trees		VAc19- Natural pollinator's modules	
VAc3- Tree shady places			

Table 2.1: Interventions in Sub-Demo A 'Urban green corridor'

The Nature Based Solutions (NBS) of Sub-Demo A are:

- New green cycle lane with Cycle-pedestrian green paths areas.
- Green resting areas.
- Plantation of trees along the Green Corridor, over Smart soils as substrate.
- Installation of a tree shady place in funfair site next to Zorrilla football stadium.
- Some Natural pollinator's modules.
- Construction of SUDs for the green bike lane.
- Green noise barriers in Sub-Demo A are located closer to Sub-Demo B.

Figure 2.1: Location map of Sub-Demo A interventions "Green corridor" (Source: Google/Valladolid City Council elaboration).

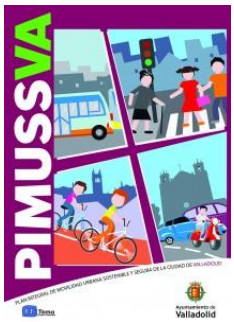
[1] Common non-technical interventions for the three Sub-demos are included in section *5. Non-Technical Interventions*.

The location of this group of interventions is not exactly defined in the Grant Agreement of the project. So that, it is possible to decide with the different technical departments of the Valladolid City Council and the citizens where are the best places to locate green resting areas, pollinators, trees or the cycle route. Participatory budgeting processes and contests of ideas for renaturing the city help to know the citizen's opinion and find together the best solution. When the interventions will be implemented, different strategies will be used in order to enhance the use of the green corridor and to show the benefits for the climate change and health of the actions: surveys, gamification, interactive information…

2.1 New Green Cycle Line (VAc1)

2.1.1 General Description

Valladolid City Council works under the Comprehensive Sustainable Urban Mobility Plan for the City of Valladolid (PIMUSSVA, 2015). This is a strategic planning tool and an instrument for the awareness for citizens, public administrations and the rest of the agents involved in mobility. PIMUSSVA represents a new way of planning urban mobility that should define a policy framework to be developed, whose general objectives are:



- Promotion of the most efficient transport modes.
- Reduction of energy consumption.
- Improvement of the accessibility and security levels.
- Improvement of the quality of life of citizens.

Within the plan there is a specific section for non-motorized transport modes: on foot and by bicycle. In this section, Valladolid City Council made a deep diagnosis about the transport behaviour in Valladolid, whose conclusions are supported by an action plan for the non-motorized transport modes. Non-motorized transport contributes to improving the adaptation of the city to climate change; it constitutes a sustainable means of transport.

One of the first evidences identified is that the Valladolid bike lanes network is quite extensive, but has connection problems between the different existing bike lanes mapping. For that reason, VAc1 will be composed by a new green cycle lane, foreseen 5 km, but also re-naturing 3 km of current cycle lane, so that this green corridor with the sustainable transport will be a natural biodiversity line, which will connect isolated green areas in the city.

The definition of the cycle lane layout is based on the PIMUSSVA. There are identified the following two types of cycle lane, depending on the lane layout:

- Cycle lane (*Sp. Ciclo-carril*): Specific public infrastructure for the circulation of bicycles. This is an independent lane for cyclist.
- Shared road (*Sp. Ciclo-vía*): Coexistence lane between motorized vehicles and bicycles. The layout is painted on the roads. The speed limitation of the vehicles is 30 km. They were implemented in Valladolid in April 2017.

On the other hand, the revision of the General Urban Planning Plan of Valladolid (PGOU, 2017, pending approval) provides a complete report about Urban Mobility (*PGOU. Annex II. Urban Mobility report. Chapter 3*). This instrument integrates PIMUSSVA considerations. Among the objectives of sustainable mobility, there is the bicycle and non-motorized transport reinforcement, improvement accessibility and reducing transport by private vehicle.

Figure 2.2: Cycle lane in Avenida Salamanca (Source: Bici metro Valladolid http://82.223.216.113/visorva/).

Figure 2.3: Cycle track in Puente Mayor (Source: El Norte de Castilla, 2018).

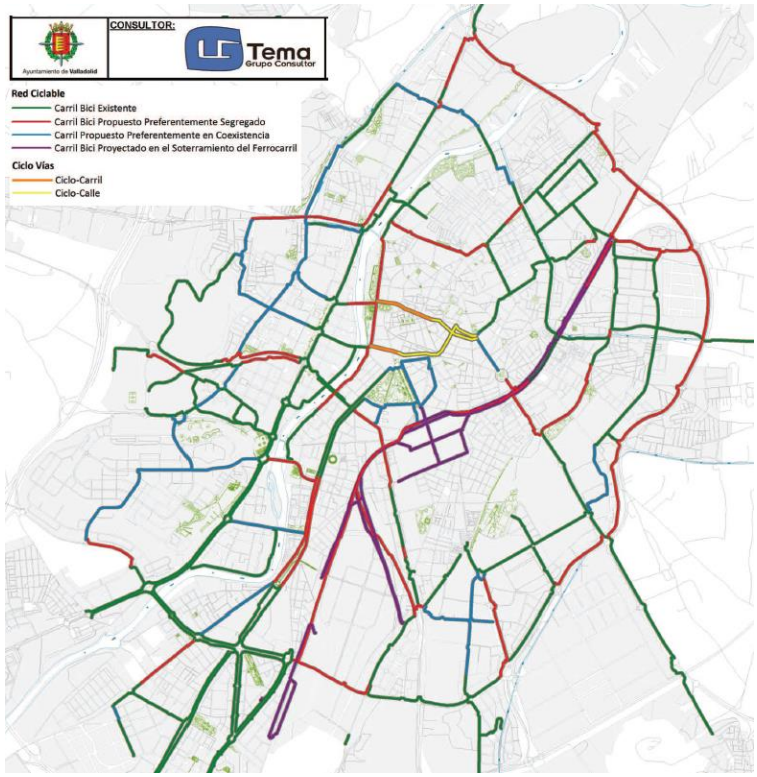


Figure 2.4: Current and planned cycle lanes and tracks (Source: PIMUSSVA, 2015).

Valladolid cycle lane network is yearly being improved. More kilometres have been introduced in order to improve current service and increase the non-motorized transport in the city. The following map shows the new cycle tracks that are going to be implemented during 2018 by Valladolid City Council[2].

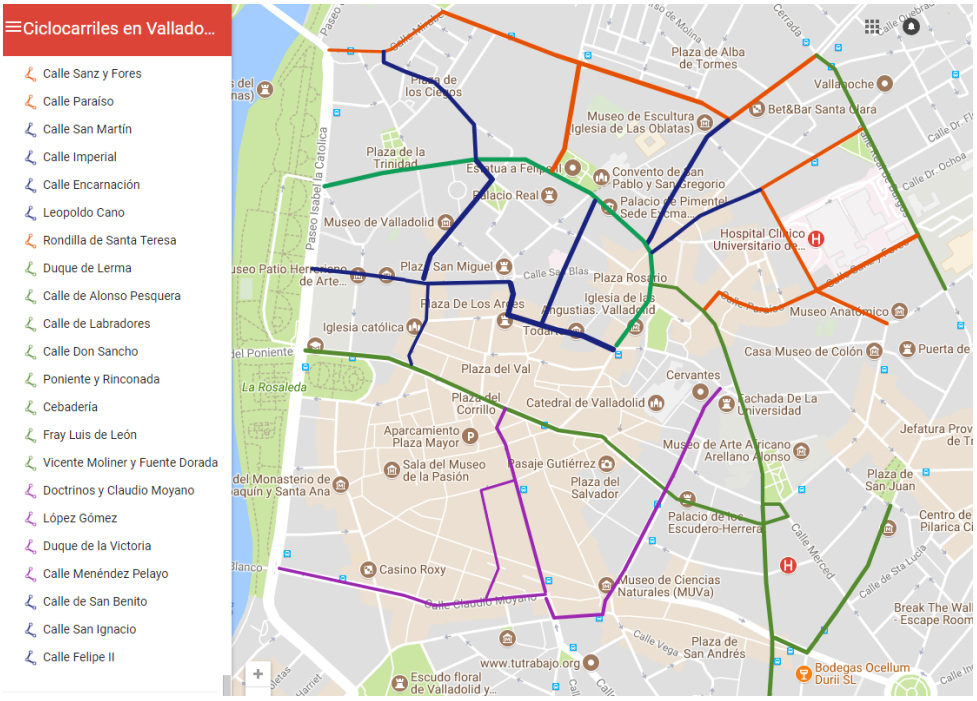


Figure 2.5: Planned cycle tracks (Source: Google/Valladolid City Council elaboration).

Related actions

The *VAc1- Green cycle lane* is key part of the URBAN GreenUP Green Corridor. Thus, VAc1 is related to the following other actions (See the corresponding sections for more details):

- VAc2- *Plating 1,000 trees.*
- Vac3- *Tree shady places*.
- VAc6- *Green resting areas*.
- VAc15- *Cycle-pedestrian green paths*.
- VAc16- *Smart soils* as substrate.
- Vac19- *Natural pollinator's modules*.

2.1.2 Location

The intervention *VAc1- New green cycle lane and re-naturing existing bike lane sections*, is the Urban Green Corridor core. This cycle lane (new and re-natured) connects the city of Valladolid from West to East, opposite to the main transport roads that have North-South direction.

The Mobility Department has supported the design of the bicycle track that will be part of the Urban Green corridor. The following map shows the whole intervention (Key legend: Green line = VAc1 along the urban Green Corridor).

[2] Source: Valladolid city Council. Google My Maps link here.

Figure 2.6: New green cycle lane and re-naturing existing bike lane (Source: Google/Valladolid City Council elaboration).
Legend: Green line = urban green corridor

The URBAN GreenUP project will help to connect current existing cycle lanes with new cycle lanes, in order to increase connectivity, sustainable transport but also for biodiversity. Current cycle lane is not completely connected, so it is not a continuous layout. There are some existing stretches (Blue line) and other new stretches that will be constructed (Red line).

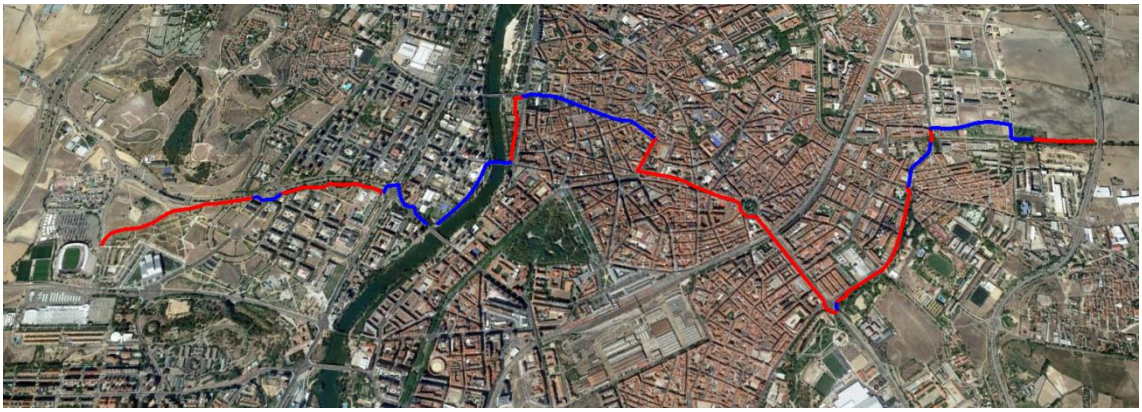


Figure 2.7: New green cycle lane and re-naturing existing bike lane sections (Source: Google/Valladolid City Council elaboration).
Legend: Blue line = existing cycle lane. Red line = new cycle lane

2.1.3 Technical Specifications

Cycle track types

The General Urban Planning Plan of Valladolid (PGOU, 2017) establishes the following different types of cycle tracks, based on the PIMUSSVA. It is important to understand those different types, as the technical-economical specifications are particular.

Spanish name	Segregation type	Location	Direction	Width (m)	Speed (km/h)
Cycle-lane	non-segregated	Urban area	U / B	1.5-2 (U) 3 (B)	20 - 30
Protected cycle-lane	segregated	Urban area	U / B	1.5-1.75(U) 2.5(B)	20 - 30
Cycle-sidewalk	segregated	Urban area	U	1.5-1.75 (U)	10 - 20
Cycle-path	segregated	Urban area (open space)	U / B	2.2-2.5 (U) 3 (B)	30 - 50
Shared road	non-segregated	Urban area	U / B	2.25 (U) 2.25 (B)	30 - 50
Cycle-shoulder	non-segregated	Peri-urban area	U (only)	1.5-2 (U)	30 - 50
Cycle-road	segregated		U / B	1.5-2 (U) 2.5 (B)	30 - 50

Table 2.2: Types of cycle tracks (Source: PGOU Valladolid 2017, revision)
Legend: Direction (U) Unidirectional (B) Bidirectional.

- Cycle-lane (*Sp. Carril-bici*): this cycle track runs next to the vehicle traffic road (non-segregated track). There are possible one or two directions. Width: 1.5-2 m (unidirectional), 3m (bidirectional). Speed: 20-30km/h.

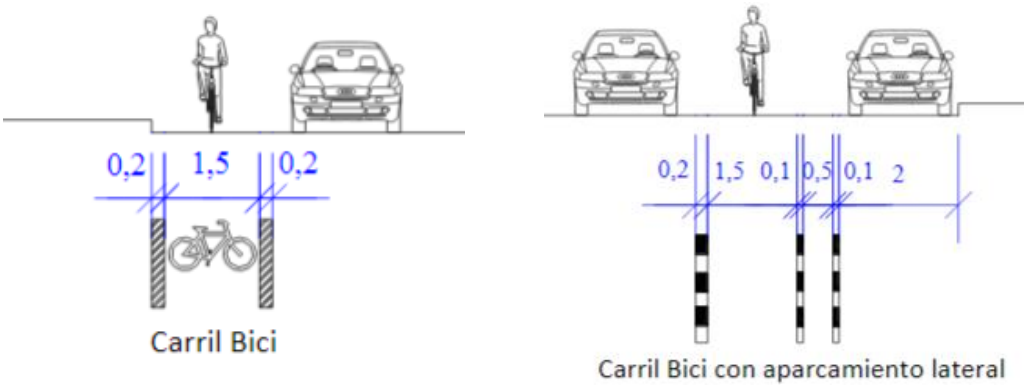


Figure 2.8: Cycle-lane section (Source: revision PGOU 2017).

- Protected cycle-lane (*Sp. Carril-bici protegido*): this cycle track runs next to the vehicle traffic road but they are separated from each other using specific elements such as a bollard, guide rail or similar (segregated road). Width: 1.5-1.75 m (unidirectional) or 2.5m (bidirectional). Speed: 20-30 km/h.
- Cycle-sidewalk (*Sp. Acera-bici*): this cycle track is located in the sidewalk. The cycle track is marked (painted) on the sidewalk or the pedestrian space (segregated road). The sidewalk must have a minimum width of 4 m. Width: 1.5-1.75 m (unidirectional), as bidirectional is not recommended. Speed: 10-20 km/h.

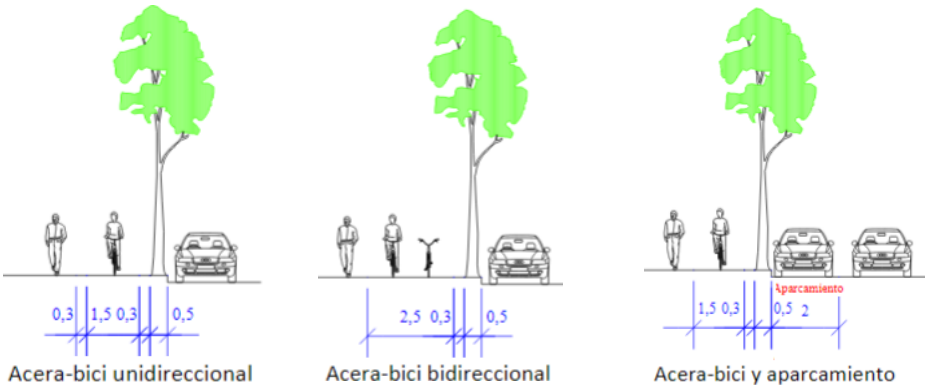


Figure 2.9: Segregated cycle-sidewalk section (Source: revision PGOU 2017).

- Cycle-path (*Sp. Senda-bici*): this cycle track is separated from the vehicle traffic (segregated road). This track can be used by pedestrian and/or by bicycles. It is located in open spaces such as parks, gardens and forests. If possible, it is recommended to segregate pedestrian and cyclist movement. Width: 2.2-2.5 m (unidirectional) and 3 m (bidirectional). Speed: 30-50 km/h.

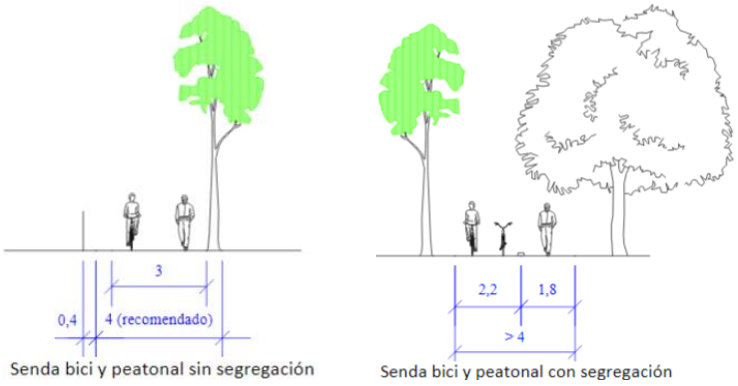


Figure 2.10: Cycle-path section (Source: revision PGOU 2017).

- Shared road (*Sp. Vías compartidas, Ciclo-vía)*: in this cycle track the cyclist and vehicles share the road, without any access restriction (non-segregated road). It exists in urban areas. The shared road is painted along the driveway (see figure 2.2). Width: 2.25 m. Speed: 30-50 km/h.

There are two more cycle track types designed for peri-urban areas:

- Cycle-shoulder (*Sp. Arcén-bici*): this cycle track is not separated from the vehicle road (non-segregated track). Cyclist track is part of the driveway roads, which are out of city in the peri-urban area. Width: 1.5-2 m (unidirectional only). Speed: 30-50 km/h.

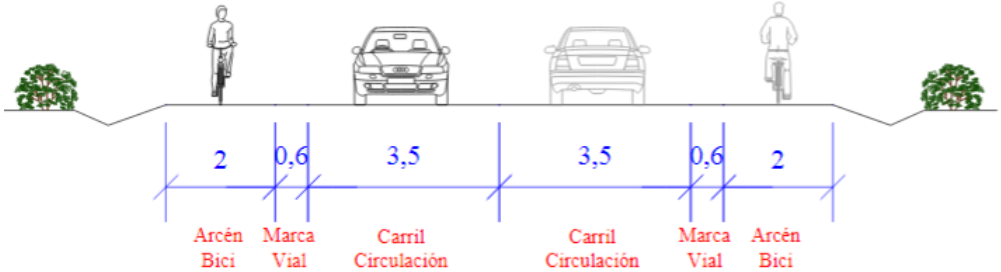


Figure 2.11: Cycle-shoulder section (Source: revision PGOU 2017).

- Cycle-road (*Sp. Pista-bici):* this cycle track is separated from the vehicle traffic (segregated track). Cycle-road has an independent layout to the main road. It is also located out of urban agglomeration in the peri-urban area. Width: 1.5-2 m (unidirectional) and 2.5 m (bidirectional). Speed: 30-50 km/h.

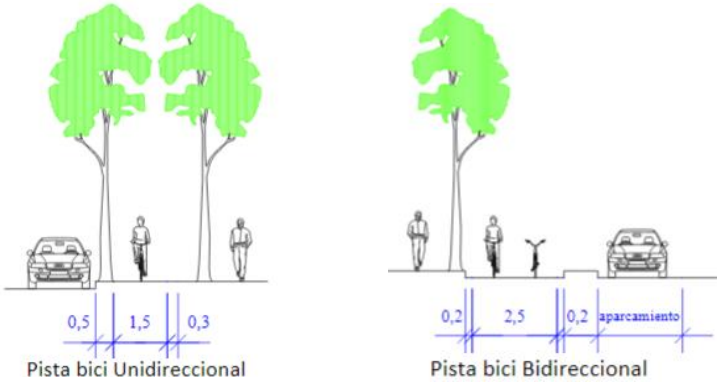


Figure 2.12: Cycle-road section (Source: revision PGOU 2017).

According to this classification, the *VAc1-New cycle lane and existing bike lanes*, is composed by the following five different sections. Legend:

Dark-blue	Existing cycle track: *cycle-lane* and *cycle-sidewalk* types.
Violet	Existing cycle track: *shared road*.
Light-blue	New cycle tracks: *cycle-lane* and *cycle-sidewalk* types.
Pink	New cycle tracks: *shared road*.
Green	New cycle tracks: *cycle-path* (segregated or non-segregated).

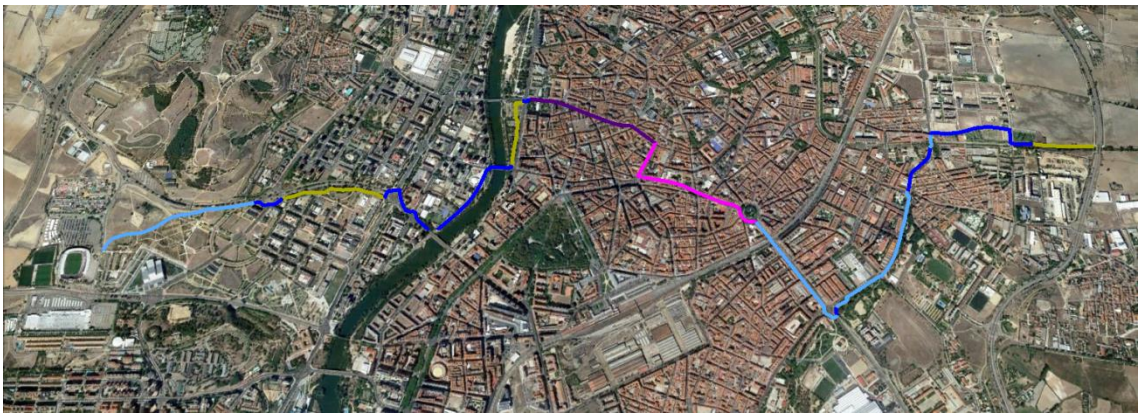


Figure 2.13: New green cycle lane and re-naturing existing bike lane sections (Source: Google/Valladolid City Council elaboration).
Legend: Blue & violet lines = existing. Light blue & pink lines = new cycle lane

Cycle tracks in urban space will be *cycle-lane* and *cycle-sidewalk* types (light blue lines). The first one is the typical of Valladolid city, the standard cycle lane that runs in parallel to the drive walk. The second one looks for co-existence in the sidewalks. The cycle track will be either painted over the sidewalk, of there will be constructed a new platform with porous or semi-glossy pavements.

The cycle paths are current earth tracks in parks and gardens (green lines) in 'Parque Grande de Magisterio' (Padre José Acosta road) and Las Moreras park. The URBAN GreenUP project will look for consolidate the cycle-track in those areas, easing the coexistence between pedestrian and cyclist.

The distances of the new cycle lane stretches and the current cycle lane stretches, which are part of the Urban Green Corridor, have been calculated. The following values have been measured through Geographic Information Systems (GIS) technology, so that real measurement could be slightly different.

Type of cycle tracks	Existing cycle lane stretches (km)	New stretches (km)
Cycle-lane	0	0
Protected cycle-lane	0	0,68
Cycle-sidewalk	2,26	1,85
Cycle-paths	0	1,41
Shared road	0,80	0,97
Total VAc1	3,06 km	4,91 km
	7,97 km	

Table 2.3: Length planned for *Vac1-Cycle lane* (Source: Valladolid City Council)

Cycle lane technical solutions

Cyclist track design

Cycle track type selection depends on many criteria: vehicle traffic intensity, potential cycle-users, planned cycle traffic, available space, parking, intersections frequency or other surrounding characteristics.

There are reference dimensions for cyclist space: width 1 m, length 1.9 m and high 2.5 m. Those references must be considered for every cycle-track.

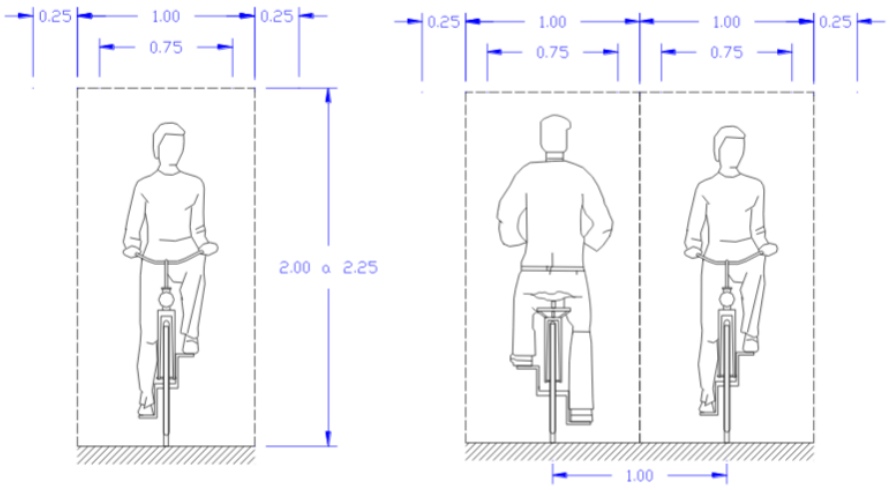


Figure 2.14: Reference dimensions for cycle-tracks (Source: revision PGOU 2017).

Constructive solutions

There are available different technical solutions and the use of different materials depending on the cycle track type, location and other characteristics. For the selection of the suitable constructive solution, there were analysed some considerations:

- Floor load capacity: the bicycle circulation loads are not critical, but those due to construction works, maintenance or emergency access vehicles must be considered.
- Surface regularity and adherence.
- Water drainage.
- Durability.
- Integration into the landscape, aesthetical considerations and related existing regulations.
- Economic considerations: execution works and maintenance.

Generally, the technical solutions for cycle tracks (VAc1) are composed by two layers: road surface basis and a wearing course. Depending on the location and specific needs, different materials can be used in these two layers, having each solution different advantages and disadvantages.

According to the existing scenarios in the *VAc1- New cycle lane and Renaturing existing cycle lane* of Valladolid, the following technical solutions [TS] will be implemented.

[TS1] Superficial painting: This horizontal signalling is ideal for those tracks that co-exist with current roads or sidewalks, where it is not necessary to build a new road surface basis and wearing course. Cycle tracks would be *cycle-lane*, *cycle sidewalk* or *shared road* types.

[TS2] Layer of concrete with semi-polishing coloured treatment on a graded aggregate basis: This second solutions will be constructed for the creation of new cycle-lanes or cycle-sidewalks, when an impermeable solution is needed due to existing infrastructure under the cycle tracks.

[TS3] Layer of porous concrete on a graded aggregate basis: This third solution will be constructed for the creation of new cycle-lanes or cycle-sidewalks, when it is possible to install a permeable solution that filters the water runoff into the soil (because there are not underground networks).

[TS4] Graded aggregated and gravel layout on it: This solution will be implemented in cycle paths in parks and gardens, when a natural appearance is foreseen. In the areas where there is co-existence of cyclist and pedestrians there will be need vertical signalling too.

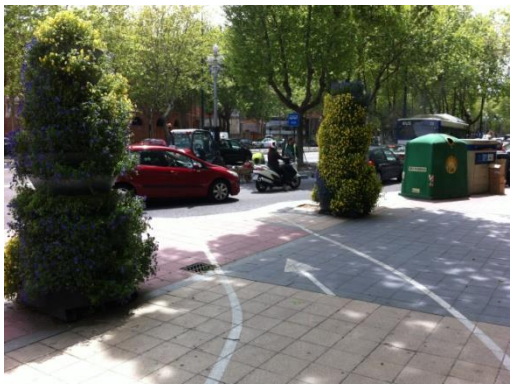


Figure 2.15: Cycle sidewalk painting signal (Source: www.oigaestudio.com).

Figure 2.16: Concrete cycle sidewalk (Source: Google Maps).

Figure 2.17: Pervious concrete cycle track (Source: www.perviousproducts.com).

Figure 2.18: Graded aggregated cycle path (Source: www.mapio.net).

Signalling

There are different signalling solutions depending on the cycle track type.

Horizontal signing: Superficial painting is ideal for those tracks that co-exist with current roads or sidewalks. Cycle tracks would be *cycle-lane*, *cycle sidewalk* or *Shared road* types. It is not necessary to build new pavements or new roads. There is necessary only a superficial road treatment.

Vertical signing: For concrete pavements there is necessary to install vertical signs. There is not currently uniformity in vertical signing for cycle tracks in Valladolid, but there have been working on that. There are some cycle lane sections in current open spaces whose cycle-paths should be properly signalled.

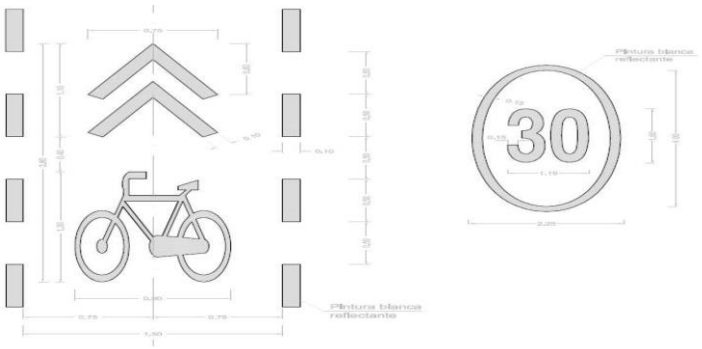


Figure 2.19: Horizontal signalling for cycle tracks (Source: Junta de Andalucía).

Figure 2.20: Vertical signalling for cycle tracks (Source: revision PGOU 2017).

2.1.4 Operational and Maintenance Considerations

Maintenance and cleaning are essential factors for the correct use of cycle tracks, avoiding insecurity for the cyclist. Cycle track conservation covers a wide spectrum of activities: esplanade ground, drainage systems, bridges, structures, signalling and beaconing, lighting and, in general, all elements that constitute the cycle tracks.

Pavement maintenance: sweeping and watering. Eliminate obstacles like potholes, screams, and breaks. Review horizontal signalling (painting).

Drainage maintenance: sink cleaning, ditch repairing, grid replacement.

Signalling maintenance: It includes replacement, graffiti removal, and lightning maintenance.

2.1.5 Economic Specifications

The following table shows preliminary estimated costs for *VAc1- New green cycle lane*. URBAN GreenUP project will finance a total amount of 203.000 €, where 101.500 € will be financed by the European Commission and Valladolid City Council will co-finance another 101.500 €. Different areas of the City Council are involved in the decision making of this intervention, so that the technical definition is still in process. The possibilities of increasing co-financing with other City Council Departments are being analysed.

Green cycle lane	unit	quantity	Price (€)	Amount (€)
Demolition works and excavation works	m^2	1.840	10 €	33.400 €
Preparation of the terrain	m^2	3.340	0,8 €	2.672 €
Superficial painting in existing roads or sidewalks	ml	970	9 €	8.730 €

Road surface basis made of graded aggregated road (15-20cm)	m^2	3.340	17	56.780 €
Wearing concrete with semi-polishing coloured treatment (12-15cm)	m^2	3.360	16	53.760 €
Wearing course made of porous concrete (12-15cm)	m^2	2.060	18	37.080 €
Gravel layer (10-15cm)	m^2	700	13	9.100 €
Horizontal and vertical signs	ml	2.710	5	13.550 €
Kerbs, limits, other	ml	2.710	14	35.230 €
Demolition works and excavation works	m^2	1.840	10 €	33.400 €
Total budget of material execution (€)				**250.302 €**
Tender budget with VAT (€)				**350.422 €**

Table 2.4: New cycle lane budget (Source: Valladolid City Council).

2.2 Installation of Green Resting Areas (VAc6)

2.2.1 General Description

The *VAc6- Green Resting Area*s will install 3 resting areas in three areas of the Urban Green Corridor: next to Campo Grande Park (B), in the Football Stadium-Auditorium zone (C1-C2) and in the Floodable park area (C3).

Each resting area will have an approximately surface of 100 m^2 with the following elements: a tree shade area, a small pollinator module, a bike parking, resting structures (benches/green slopes) and a fountain.

Expected impact: The main expected impact of VAc6 in the Green Corridor is the promotion for leisure, sports purpose and increasing the citizen well-being.

2.2.2 Location

The *VAc6- Green Resting Area*s will install resting areas in the SubDemo A -Urban Green Corridor, but close to SubDemo B -City centre (close to Campo Grande park) and Sub-Demo C (close to the Football Stadium-Auditorium zone and a third are close to the Floodable park).

Figure 2.21: Pre-selected zones for Vac6- Green resting areas in the Green Corridor (Source: Google/Valladolid City Council elaboration).

- Green corridor in the Football Stadium - Auditorium zone (SubDemo C1-C2).

In the East of Valladolid city there is an extensive green area, between Las Contiendas Park, Villa del Prado archaeological area and Miguel Delibes Auditorium gardens. The Green corridor crosses between Villa del Prado and Auditorium gardens. The green resting area could be installed in any point of this area. Furthermore, there could be also possible to include the green resting area in La Olma Park, close to the Green Corridor and Salamanca Avenue.

Location C1.1. Auditorium gardens.
Location C1.2. La Olma park.

Figure 2.22: Available locations for a green resting area in the football St – Auditorium (Source: Google/Valladolid City Council elaboration).

- Green corridor in the City Centre connected to Campo Grande Park (SubDemo B).

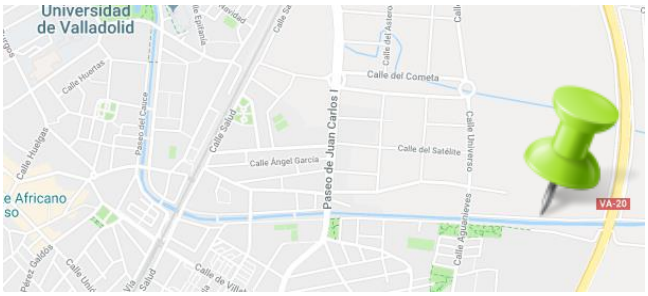
In the downtown is very difficult to find suitable areas to place new green resting areas, as the Parks and Gardens Department of Valladolid City Council already plant new trees in every street that has available space. Nevertheless, there has been identified a possible location close to Plaza del Milenio Square. There has been identified a second possible location in the crossroad between José Mª Lacort street and Simón Aranda street. Both areas will connect green areas with the big Campo Grande Park.

Location B1. Plaza del Milenio.
Location B2. José Mª Lacort St / Simón Aranda St.
Location B3. Plaza Caño Argales.

Figure 2.23: Available locations for a green resting area in the city centre area (Source: Google/Valladolid City Council elaboration).

- Green corridor in the Floodable park area (SubDemo C3).

The floodable park is located in a very open zone surrounded by current green areas. It will be easier to locate the green resting area there.



Location C3.1. Floodable park (green areas close to La Esgueva river, in the right riverbank)

Figure 2.24: Available location for the green resting area in the floodable park (Source: Google/Valladolid City Council elaboration).

2.2.3 Technical Specifications

The technical characteristics of the green resting area elements are defined. In the street furniture selection there are considered the quality and cost but also the management and cleaning operations.

1. Tree shade area.

Trees or plants will shade the resting area. The selected species follow the same criteria than *Vac3-Tree shady areas* and *VAc4- Shade and cooling trees*. The tree will be leafy type (dense) medium sized. It has been initially calculated 4 trees / green resting area (to be defined in detail).

Common name	Characteristics	Scientific name
Almez (Hackberry)	Deciduous tree that can reach 20 to 25 m in height.	*Celtis australis*
Acer (Maple)	Some interesting species for gardens are the common maple, red maple or different Japanese maple types.	*Sapindaceae (Acer)*
Árbol del amor (Redbud)	Small deciduous tree. Usually reaches 4 to 6 m in height. Pink flowers. Resists cold, up to -10 ° C but not prolonged frost. It is resistant to drought. Des not tolerate soil water logging.	*Cercis siliquastrum (Fabaceae)*
Cerezo (Cherry tree)	Large volume tree that can reach 30 m in height.	*Prunus avium (Rosaceae)*

Table 2.5: Some trees species suitable for green resting areas (Source: www.arbolesdevalladolid.es)

2. Pollinator compacted module.

The green resting area has a small pollinator's module. This bugs' hotel is mainly suitable for bees and solitary wasps, but also lacewings, coccinellids and arachnids. There are some commercial models available in the market with a cost of 25 € - 45 €. The post, anchors and installation workforce are not included.

Figure 2.25: Small pollinator's modules for the resting areas (Source: La Granja de Bitxos).

3. Bike parking.

In urban spaces metallic tube bicycles parking are ideal. This model adapts to both urban and rustic environments. Estimated average cost is 300 €/unit.

Description: Park model Copenhagen galvanized tube bicycles for 6 units. Material: Galvanized steel. Anchoring: Screw M10 x 100 mm (Not supplied). Source: www.grupfabregas.com

Figure 2.26: Bike parking for the resting areas (Source: Grup Fabregas).

There are available other models made of wood, but they are less resistant to vandalism.

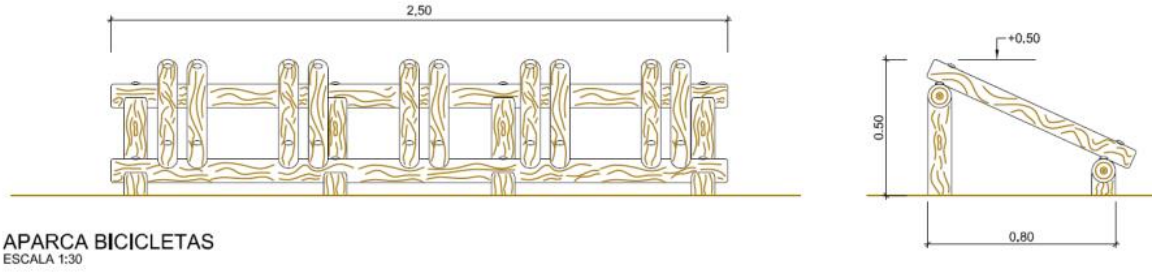


Figure 2.27. Suggested design for rustic bicycles parking areas (Source: Duero River Basin Authority).

4. Resting structures.

Public benches in urban space have a high back and suitable height for elderly people (45 cm height). In the city of Valladolid is usually installed the neo-romantic bench model. The following model of sheet metal bench that simulates vegetable figures could be ideal for both an urban and rustic (park) environments. Average cost is 400 €/unit. The installation cost is included in the price.

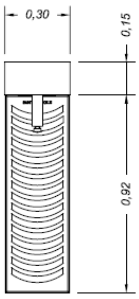
Description: Maverik model bench with ductile cast iron legs painted in martele. Seat and back in sheet steel painted in martele. With primer and oven painted. Measures: 1,810 x 638 x 774 mm. Source: www.grupfabregas.com

Figure 2.28: Benches for the resting areas (Source: Grup Fabregas).

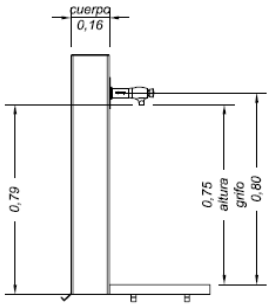
There might be constructed other resting structures such as green grass slopes, as natural resting areas.

5. Fountain.

Public fountains management belongs to Aquavall, the municipal water management entity. There are currently installed 73 public drinking water fountains in Valladolid. During this 2018 there are being installed another 20 new fountains in parks, open spaces and promenades.



Description: Atlantida model. Iron casting monolith with antioxidant protection and painted black. One-inch brass casting spout. Source: www.architonic.com



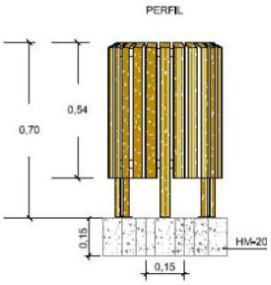
Description: Galdana model. Chromed tap and galvanized religated drain grate height 1000 mm tube 160 × 160 mm. finished with ox iron black forge paint. Source: www.groupfabregas.com

Figures 2.29: Fountain for the resting areas (Source: Architonic / Group Fabregas).

6. Other elements.

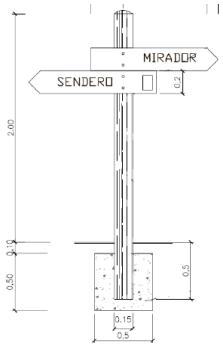
Depending on the final locations, there might be suitable to include other street furniture elements, such as a waste bin or indicating signals for the citizens.

- Street waste bin: The model should be overturned type and not bucket type, for the convenience of maintenance operations (cleaning) and to avoid vandalism, because the bucket cannot be extracted. Average cost is 240 €/unit. The installation cost is included in the price.



Description: Paper basket with metallic inner structure (galvanized steel tray) and outside with wooden slats treated with fungicide, insecticide and water-repellent protector. The paper basket will have approx. a capacity of 60 l, a total height of 0.70 m and ideally with anchor base for fixing it on the ground. The price includes parts and assembly.

Figure 2.30: Waste bin for the resting areas (Source: Duero River Basin Authority)



- Indicating signal: There could be installed a signal that indicate Resting area with the URBAN GreenUP logo.

Description: Indicator signal arrow type of dimensions 1,1 x 0,2 m single or multiple. Made in pine wood with special treatment for weathering; construction, materials supply and fully finished placement.

Figure 2.31: Indicating signal for the resting areas (Source: Duero River Basin Authority).

2.2.4 Operational and Maintenance Considerations

As it is mentioned before, in the street furniture selection there are considered the municipal management and cleaning operations: maintenance of public street furniture such as benches, signals, bike parking or children's games, is carried out by the Parks and Gardens Department of Valladolid City Council; waste collection is delivered by the Cleaning Service of Valladolid City Council; maintenance of public fountains is carried out by Aquavall of Valladolid City Council.

2.2.5 Economic Specifications

In the following table it is shown the green resting areas estimated costs. There is not included the civil workforce needed for planting, either soil movement, water inlet, waste management, or other items related with the installation.

Green resting areas	unit	quantity	Price (€)	Amount (€)
Shade trees				
Soil preparation	m2	10	0,85 €	8,5 €
Medium leafy tree	tree	4	58,21 €	240 €
Plantation	unit	4	26,83 €	100 €
Pollinator's module				
Small	unit	1	25 €	50 €
Medium	unit	1	45 €	
Bike parking	unit	1	300 €	300 €
Bench				
Metal bench (cheap-medium)	unit	2	331 – 656 €	800 €
Fountain				
Atlantida model	unit	1	1.386,86 €	950 €
Galdana model	unit	1	506,14 €	
Other				
Waste bin	unit	1	240 €	240 €
Simple sign	unit	1	98 €	98 €
Total per resting area (€)				**2.500 - 2.800 €**
Total budget of material execution (3 resting areas) (€)				**7.350 - 8.400 €**
Tender budget with VAT (€)				**30.000,00 €**

Table 2.6: Green resting area budget (Source: www.basepaisajismo.es)

2.3 Cycle-Pedestrian Green Paths (VAc15)

2.3.1 General Description

In Spanish cities there is not very common to use bicycles as urban transport, so that neither cyclist nor pedestrians are used to live together in the same urban space. There are some basic rules for cyclist and pedestrians in the city that there must be considered:

- Every pedestrian is a cyclist when he gets on the bicycle: therefore, no cyclist can cross a zebra crossing, neither to make a change nor to cross to the opposite sidewalk, except if there is a bike lane on the road.
- A cyclist is considered a pedestrian when getting off the bicycle: If a cyclist moves his bicycle without being mounted on it, it is considered a pedestrian. Then he could go for a zebra crossing or a sidewalk like a pedestrian.
- Sidewalks without bike lanes are exclusively for pedestrians.

So that, in the city of Valladolid there are specific places where pedestrian's waypoints cross with cyclist lanes. Those conflictive places must ease the coexistence between cyclist and pedestrians. Furthermore, among the PIMUSSVA objectives is the improvement and standardization of cycle lanes signalling.

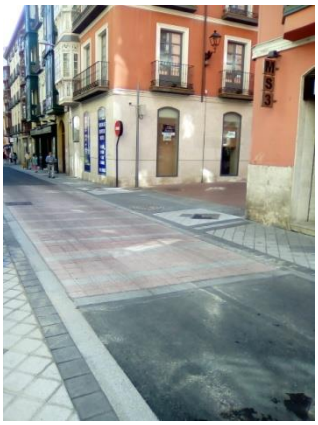



Figure 2.32: Existing pavement treatments in conflictive areas of Valladolid (Source: Valladolid City Council)

The URBAN GreenUP Green Corridor will cross the city from West to East, through a cycle lane (VAc1-New green cycle lane). Along the green corridor three cycle-pedestrian green paths areas will be installed, which are crossing points for coexistence, located in conflictive places.

This intervention includes green pavements in a special structure with filter properties. Those green pavements leave small gaps filled with smart soil and with specific creeping grass species with a short growing and minimum maintenance.

These features will allow manage the water runoff and it could serve in the cycle-pedestrian areas to reduce cycle speed in specific urban sections with many pedestrians. These sections of pavements will indicate slow velocity zones in street crosses, pedestrian stops, etc.

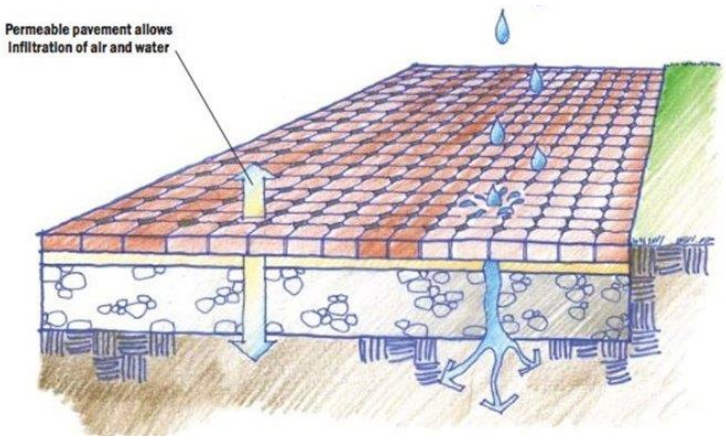


Figure 2.33: Permeable pavements (Source: www.organicsolutions.com).

2.3.2 Location

The *VAc15- Cycle-pedestrian green paths* are innovative paths wherever cyclists could interact with pedestrians without conflicts. It is integrated in the Urban Green Corridor (SubDemo A).

A deep analysis has been made in order to select the most appropriate sites for this intervention. There have been identified 10 suitable points where to install the cycle-pedestrian green paths. Those points are conflictive crosses between cycle lane and pedestrians' crossings. After a deeper analysis there will be selected three locations.

Figure 2.34: Possible locations for cycle-pedestrian green pavements (Source: Google/Valladolid City Council elaboration).

Different types of conflicts between pedestrian and cyclist could happen. The following images show some examples of the locations previously pre-selected: the blue line represents the cycle lane, and the red line shows the critical area for coexistence. Then, explanations about those potential locations (study cases) are included.

A. Milenium square.

B. Arzobispo José Delicado Street.

C. Juan Carlos I Avenue.

D. Las Moreras green area.

Figure 2.35: Areas with possible conflicts between cyclist and pedestrians (Source: Google/Valladolid City Council elaboration).

On the top left (A) it is shown an existing bike lane between a children play park and an urban open space quite crowded sometimes. The cyclist speed reduction here is critical in order to avoid accidents of children who could cross the street to the park through the zebra crossing.

The second figure (B) shows the typical study case where the cycle lane crosses the sidewalk, so that the citizens and cyclist necessarily coexist. These emerging points are complicated to solve, so a different pavement could help to alert cyclist of the caution.

On the lower left (C) the case is similar to (B), with the aggravating that this is the access place to the zebra crossing and it is at the end of the stairs, so that the coexistence is maximum.

The last study case (D) is in a very crowded zebra crossing, and the connection between cycle lanes in the green area with the existing cycle lane requires a long area or coexistence.

2.3.3 Technical Specifications

The *VAc15- Cycle-pedestrian green paths* consists on a green pavement made of prefabricated concrete blocks that are placed on a different soil layers' superposition. The runoff water can percolate directly to the ground, when the substratum and water table are adequate.

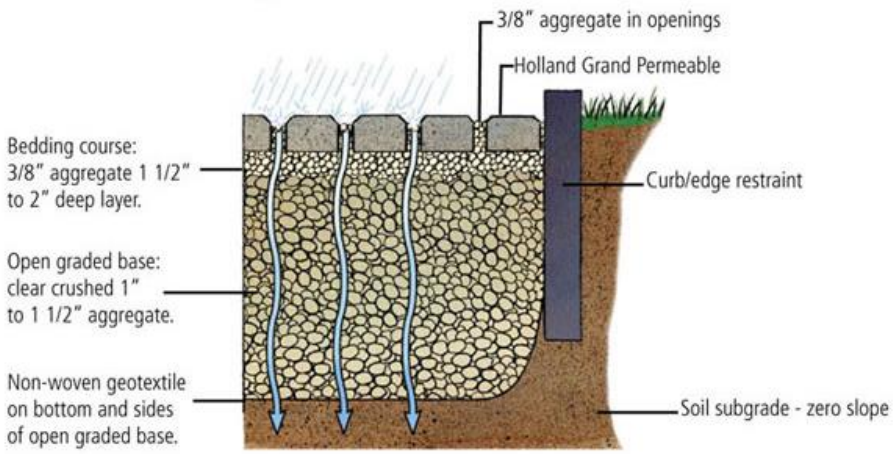


Figure 2.36: Typical green permeable pavement scheme (Source: www.ercisconcretepavers.com).

Nevertheless, in many urban places direct water infiltration to the ground is not possible due to the existence of underground systems, like water pipes, electrical wires, ducts, etc. For these cases, a drainage system that derives the water to the city rainwater collectors or to the sewage system will be necessary.

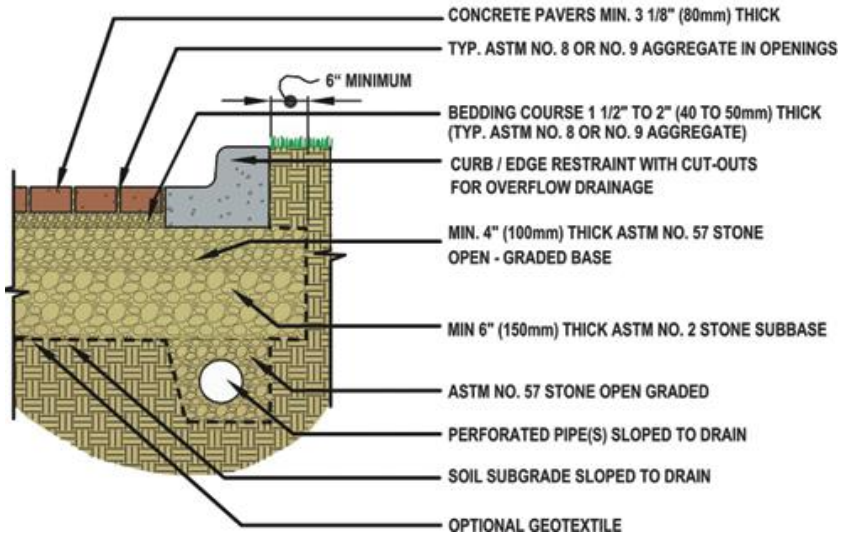


Figure 2.37: Installation of permeable pavement with water treatment and detention (Source: www.rainwaterpillow.com).

In both systems, the aggregate and sand layers act as a water filters and water storage before the infiltration to the ground or the water derivation, depending on the solution.

There are different prefabricated concrete blocks available in the market that would be suitable for this solution. Depending on the product, the geometry and colours may vary. The following figures show an available option that consists on squared concrete blocks, with a geometry that ensures a correct separation between them, allowing grass growing. Different colours are available, which is very interesting in order to increase the path differences between the sidewalk for pedestrians and the cycle lane for cyclist.

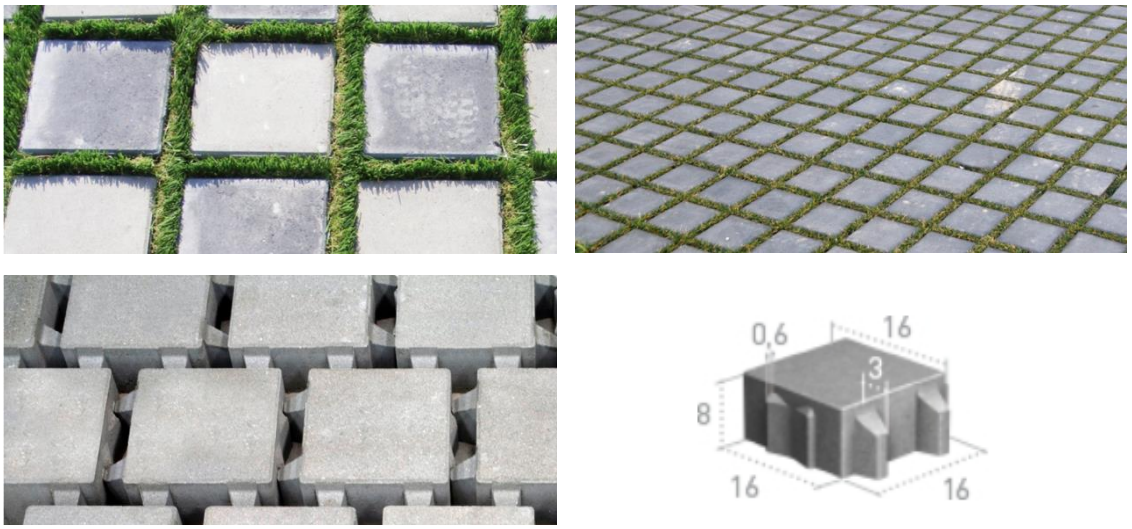


Figure 2.38: Cycle-pedestrian green pavements detail (Source: www.glsprefabricados.com).

The building process is similar to the *VAc14- Green parking pavements* (see section 4.1.3)

2.3.4 Operational and Maintenance Considerations

The maintenance of green permeable pavements is very simple, but there are some details to take into consideration. In the upper part of the join material between blocks and in the holes of the pieces, a surface crust is formed over time, and the infiltration rate will decrease. Nevertheless, the infiltration capacity of permeable pavements normally exceeds hydrological requirements, so this should not be a problem. Furthermore, any problems will be revealed on the surface by puddles and a simple non aggressive brushing will be enough.

Structural problems as damaged or displaced blocks could occur, and the reposition of these pieces should not be very complicated.

A current routine maintenance can be established as follows:

- Visual inspections, important in rain days in order to check the permeability of the systems.
- Control of the excessive weed, which grow typically where vehicles do not circulate.
- Winter maintenance: this type of pavements requires less de-icing than conventional pavements, even so, standard de-icing techniques could be applied.

2.3.5 Economic Specifications

Final costs depend on the location selection and will be affected for multiple factors. For that reason, an estimation of the price analysing market costs of similar projects in the city has been carried out.

Cycle pedestrian green paths area	unit	quantity	Price (€)	Amount (€)
Excavation works and preparation of the terrain	m^2	300	15	4.500
Graded aggregate compacted layer of a section of 250mm: material and execution works	m^2	300	25	7.500
Prefabricated concrete block of dimensions 160x160x80mm placed on a sand bed and filled of the holes with sand: material and execution works	m^2	300	12	3.600
Installation of other elements (kerbs, limits…)	ml	100-300	15	1.500-4.500
Total per green path (€)*				**17.100 – 20.100 €**
Total budget of material execution (3 green path areas) (€)*				**51.300 - 60.300 €**
Tender budget with VAT (€)				**71.820 - 84.420 €**

Table 2.7: Cycle-pedestrian green paths budget
(Source: Valladolid City Council http://www.basepaisajismo.es/).

2.4 Planting 1,000 Trees (VAc2)

2.4.1 General Description

The Green Corridor will communicate the West and East of the city of Valladolid, so it will improve landscape connectivity between green areas and provide very important ecosystem services for the promotion and mobility of urban biodiversity.

The green corridor will have a bike lane, but it will also be renatured with the highest arboreal and plant density possible in the urban space. This green corridor will include tree series, which provide shady places and improve the citizens' well-being. Trees series will hold the connectivity among spaces and will contribute to preserve biodiversity. All actions related to vegetation will contribute to carbon sequestration.

The Environment Department of the Valladolid City Council is in charge of parks and gardens maintenance in the city. The Park and Garden Service has maintained for years a policy of maintaining a very wide variety of tree species in order to avoid monospecific plantations that lead to pest problems and can cause allergenic problems. Thus, the city of Valladolid has 120 different species of ornamental and road trees, with an estimated total of 64,000 units in the green areas of the city such as parks, gardens and squares (P) and 30,000 units located on streets (S) (data from 2018). There will be considered also avoiding female trees (dioecius).

In the last years, in the city the problematic species there have been progressive replaced, such as gramineous grasses, female poplar and London plane ('shade banana', in Spanish).

Xeriscaping practices ensure efficient water consumption with plantation of aromatic species, low consumption grass, shrubs and hedges.

The municipal Parks and Gardens Service are progressive substituting allergenic species, such as the London plane. Also female poplar species are not planted anymore to avoid the discomfort and irritations of their lint.

When the streets are renovated, the Urban Planning Department always introduce some new trees on the sidewalks and green areas as much as possible.

2.4.2 Location

Valladolid is one of the greener cities of Spain, the second in Castilla y León Region, after Segovia city. Valladolid has 126 green areas (533 Ha, 2018). Current average is 17.81 m^2 green areas per capita, which is higher than the OMS recommendation (10-15 m^2/capita).

The following map view shows the distribution of green areas available in the city of Valladolid according to the General Urban Plan (PGOU), among the URBAN GreenUP Green Corridor.

The URBAN GreenUP project trees will reinforce the current green areas, the number of trees will increase and damaged individuals will be substituted. Those trees will be used for replenish, complete flower beds or planting trees in renovated streets.

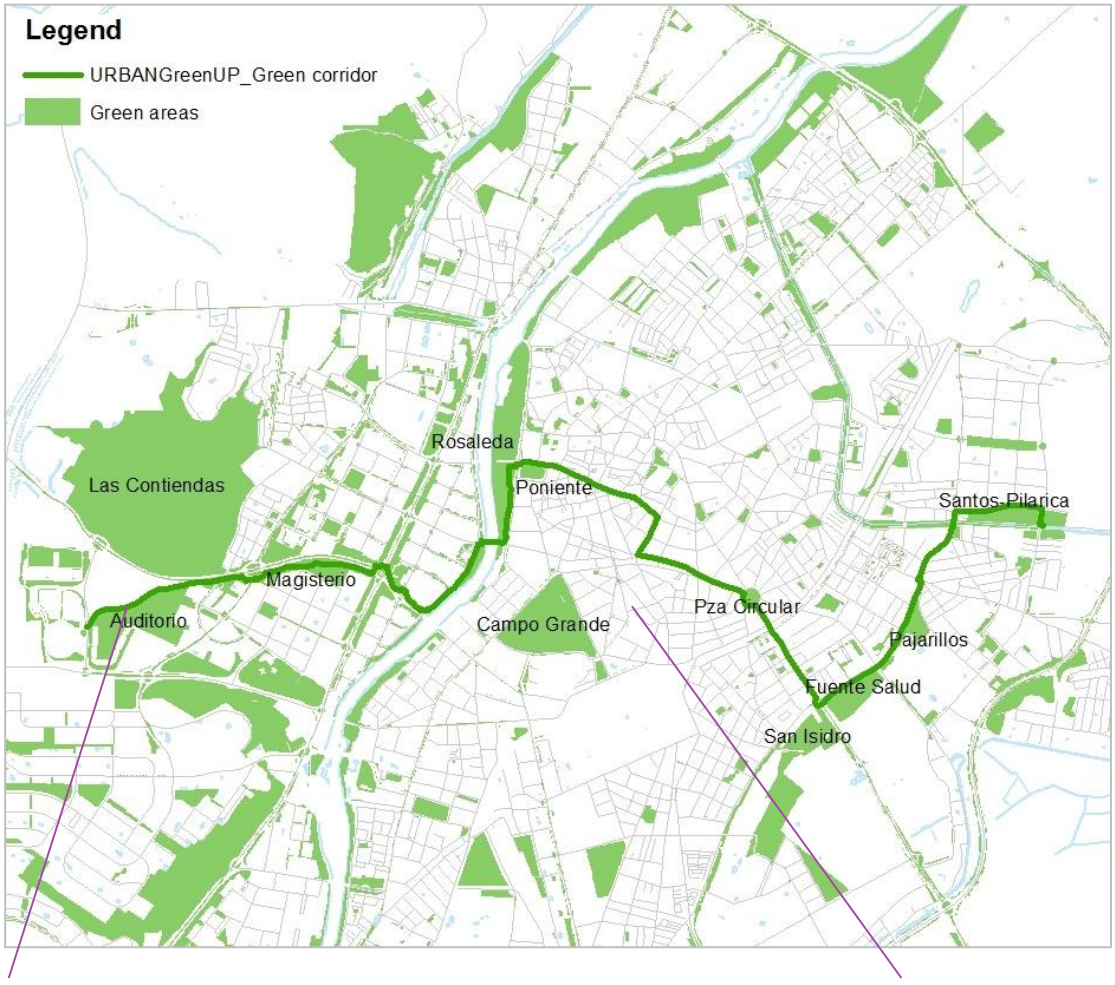


Figure 2.39: Valladolid Green Areas along the Urban Green Corridor (Source: Valladolid City council).

The following are possible locations for the Green Corridor trees:

- Side of the Padre José Acosta Street.
- Junction of N-601 and Salamanca Avenue.
- Along Pisuerga riverbank.
- Estación Street, along the railway, close to Circular Square.

In the strict city centre will be very difficult to include new trees (such as Cebadería Street and Correos Street). There is a lack of available space and there are underground networks systems (water, sewage, electricity). Apart from technical issues, the trees plantation approval in the Valladolid Historic Centre requires a Heritage Department permit.

2.4.3 Technical Specifications

Valladolid City Council encourages the design and execution of green spaces with low allergenic impact and low water consumption species. The Environment Department prioritizes biodiversity in parks and gardens in order to avoid monospecific plantations that lead to pest problems and can cause allergenic problems.

In Valladolid there is a public arboreal database: http://www.arbolesdevalladolid.com/ whose objective is to provide information to citizens and to guide neighbours on what species are low allergic impact and low water consumption, so that, if they wish, the can adopt these criteria in private gardens and single-family housing spaces.

There will be avoided allergic species such as gramineous plants, olive tree and ash tree.

The lawn is the big consumer of water in the garden. Usually, more than two thirds of the total water consumption in Valladolid is dedicated to irrigation. Valladolid is reducing the lawn areas for trees and shrubs, whose irrigation needs are much lower. The city is also creating attractive vegetable rugs without resorting to grass.

The trees, shrubs and bushes typical of the Mediterranean region are appreciated in gardening for their beauty and their aromas. They also require little irrigation and endure periods of drought. The following table shows different species which are going to be planted in Valladolid's gardens because of lower irrigation requirements and pollen with less allergic impact. There is a municipal nursery where there are produced 871 trees and 839 bushes (May 2018).

Common name (Spanish)	Common name (English)	Scientific name
Almendro	Almond	*Prunus dulcis*
Almez	Elm	*Ulmaceae*
Árbol del amor	Redbud	*Cercis siliquastrum*
Arce	Maple	*Acer*
Boj	Box	*Buxus sempervirens*
Cedro	Cedar	*Cedrus*
Cerezo	Wild cherrie	*Prunus avium*
Ciruelo de jardín	Cherry plum, myrobalan plum	*Prunus cerasifera*
Laurel	Laurus	*Laurus nobilis*
Magnolia	Magnolia	*Magnolia grandiflora*
Manzano	Apple	*Malus domestica*
Peral	Pear	*Pyrus communis*
Pino	Pinus	*Pinus*
Tejo	Yew	*Taxus baccata*
Adelfas	Nerium, oleander	*Nerium oleander*
Aromáticas (lavandas, romeros, salvias, etc.)	Aromatic plants (lavender, rosemary, sage, etc.)	*Lavandula, Rosmarinus officinalis, Salvia, etc.*

Table 2.8: List of arboreal species suitable for Valladolid.
Source: Árboles de Valladolid (www.arbolesdevalladolid.com)

Plantation works

The plantation works includes the opening of holes, the placement of the plant and the subsequent filling of the excavated hole.

The opening of holes will be made as far in advance as possible on the plantation, to improve the land weathering. The interval between excavation and planting should not be less than one week. The rocks and other obstructions that appear at the time of making the holes should be removed as necessary. Once the plant is installed in the excavation hole, it must be filled with successive layers, compacting slightly by layering. It will be advisable to mix the extracted materials when making the hole with slow release fertilizers and organic matter, before filling the hole.

The opening of the planting holes can be done by manual means (pick and shovel) or by mechanical means (backhoe, transplant, compressor, drill, etc.). On average the dimensions of the holes should be the following:

- Palm trees and very large trees 150 x 150 x 150 cm.
- Big trees 100 x 100 x 100 cm.
- Young trees and large bushes 60 x 60 x 60 cm.
- Ditch for hedges 40 x 40 cm.
- Shrubs and similar plants 40 x 40 x 40 cm.

The plants will be supplied in containers in most cases. However, some of them may be supplied in forest canopies.

The plantation must take into account the best season of the year, depending on the species. The best period is October-November, also February. If the plant is provided with container roots the planting period can be longer (September-April).

In the planting holes filling there is considered the filling materials quality. If the material is more or less homogeneous and suitable, it will be used directly. However, if the material is not adequate, it can be mixed with topsoil and fertilizers.

After the plantation, a copious irrigation must be given until reaching the field capacity.

- Trees 50-200 litres.
- Large bushes 20-50 litres.
- Shrubbery 5-15 litres.

Plantation frames

In the urban space there will be need to install tree pits, whose design will include water runoff harvesting systems to minimize the irrigation.

The tree pits minimum measurements are 1 m^2 for the trees and 36 cm^2 for the shrubs. The plantation frames may vary according to the species and the plantation intentionality (alignment, group, forest). In the urban environment, the subsequent tree development should be taken into account: maximum tree height when mature, root development, land thickness, others. On average and in trees in alignment the minimum separations are:

- Trees of small and columnar size 4-6 m.
- Medium sized trees 6-8 m.
- Large trees 8-12 m.

2.4.4 Operational and Maintenance Considerations

The plant species that are being planted in Valladolid have low water needs and low allergenic potential. There are several motivations to reduce water consumption: economic savings, supply guarantee, environmental health, etc. To reduce water consumption there can be used plants that have low-medium irrigation requirements or that not require any watering, once they have established well.

The basic maintenance considerations for planting trees are the following.

- Irrigation. During the first year after planting.
- Pruning. This includes the organic waste collection.
- Fertilizing, only other non-arboreal vegetation such as hedges.
- Mulching. A mulch ring 5 to 8 centimetres deep until the tree irrigation line (the reach of the branches).

Watering needs

If we group plants with similar water requirements, we can make more efficient irrigation. Sprinkler irrigation and manual irrigation mean greater water losses than localized irrigation, in which the water is applied by droppers that water, drop by drop, at low pressure.

- Schedules: it is advisable to water at the hours of less heat.
- Trees and shrubs: require frequent watering when they are newly planted; but when they have already well-developed roots require less watering.
- We must adapt the irrigation to meteorology.
- In automatic irrigation systems, rain and humidity sensors avoid unnecessary watering.
- The excess of irrigation causes a bad development of the roots and a greater weakness before the diseases.

2.4.5 Economic Specifications

In the following table it is shown the planting trees estimated cost. The budget depends on the tree species but also on the root growth system: bare rooted (10-15 €), with root ball or container-grown plants (90 €). The following prices are root ball or root in container. There might be budget for the plantation of a maximum of 400-500 trees.

Planting trees	unit	quantity	Price (€)	Amount (€)
Construction works				
Soil excavation/movements	m^3	1	50 €	
Tree pit	unit	1	60-80-90 €	
Installation works				
Water supply and drainage	m	n/a	45-55 €	
Irrigation system - Irrigation canalization - Drop irrigation system - Sprinkler irrigat. system	 m m^2 m^2	n/a	 35-40 € 2,5 € 15 €	
Electric system		n/a		
Plantation works				
Ground preparation	m^2	n/a	0,85	
Tree planting*	unit	n/a	13-30-45 €	
Tree/plant supply - Costs depending on the size (small, medium, tall) (transport not included)				
Conifer tree	unit	n/a	30-60-90 €	
Leafy tree	unit	n/a	25-60-105 €	
Palm tree	unit	n/a	250-500 €	
Bush	unit	n/a	2-4,512 €	
Total budget of material execution (€)				**41.322 €**
Tender budget with VAT according to Valladolid Investment plan (€)				**50.000 €**

Table 2.9: Tree planting budget
(Source: Base Paisajismo www.basepaisajismo.com)

*Tree planting: Small, medium or large-sized tree plantation, considering replanting, plant presentation; making, filling and tamping the hole; lateral filler and tamping, mixed with clean topsoil in a 50% proportion; tree pit formation and first irrigation, measured the unit completely executed. It does not include the price of the plant.

2.5 Tree Shady Places (VAc3)

2.5.1 General Description

In the West of Valladolid there is an open public space, where the municipal flea market is set every Sunday. This market is called “El Rastro”. It is the most multitudinous and traditional municipal market. The market has more than 280 stalls about clothing, costume, jewellery, handbags or shoes; another 150 stalls are dedicated to second-hand items; and 30 more stalls for antiques. In the same place, yearly during the local holidays (September), there is settled the funfair area.

This open area is completely paved, with low density of trees and bushes. The funfair area surface is approximately 6 Ha. This intervention Vac3 is intending to plant 250 trees in this leisure area next to the Football Stadium, which will generate an arboreal shady place. Maximum green area will be 4 Ha.

For the species selection, there is considered the tree shadow type, as each tree species projects a characteristic shadow: high or low, dense or sifted, seasonal or permanent.

The creation of shaded areas serves to reduce the losses of water from the plants located in these places. Planted trees (new units and/or substitution of current individuals) will provide humidity, and preserve the local biodiversity in the funfair area.

2.5.2 Location

There will be planted trees in the funfair area called ‘Real de la Feria’, close to the football stadium area. Total surface available in the funfair area is almost 4 Ha of green plots. The following map views show the total green plots available. The map view on the right shows that this surface is covered by temporal infrastructures, such as the flea market stalls and the funfair games.

Figure 2.40: Funfair green area (Source: Google/Valladolid City Council elaboration)

The funfair area is near to the José Zorrilla football stadium and its car parking, where there will be implemented *VAc5-Renaturing parking* and other URBAN GreenUP water interventions.

2.5.3 Technical Specifications

The funfair area has limiting characteristics for the shade tree species selection and for the trees final location.

In this area, it is not possible to plant trees close together or with high density crowns, as there is compulsory to leave enough space for the funfair games, which some have a lot of space requirements, like the Ferris wheel or the bumper cars. In the past, the fair workers have destroyed the vegetation because of their needs to install the games.

Local guidelines allow planting more trees in the funfair area in the available green plots (see previous Figure), but it is not possible to lift the current asphalt, because of the commercial and leisure land uses.

Water supply is not an issue in the funfair area, because there is a dense water network around. However, water supply is used for irrigation but also for the funfair and flea market workers. So that, leaks are frequent in the area and competence management is divided, among Parks and Gardens Service and the municipal Water Management Service (Aquavall).

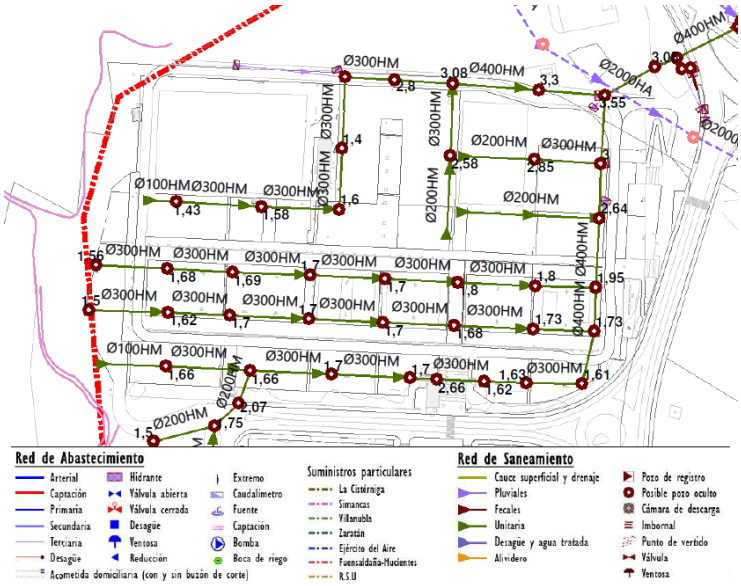


Figure 2.41: Sewage network in the funfair green area (Source: Aquavall)

In the trees species selection, there will be selected those which can support sun and high temperatures, but also low growth root, as the ones in the following table. There will not be suitable the next tree species: maple tree or chestnut.

Common name (Spanish)	Common name (English)	Scientific name
Arce común, arce rojo, arce japonés	Maple	*Acer (negundo, campestre, platanoides, pseudoplatanus)*
Almez americano	Hackberry	*Celtis occidentalis*
Árbol del amor, Árbol de Judas/Judea, Ciclamor o Algarrobo loco	Redbud	*Cercis siliquastrum*

Acacia	Acacia, locust	*Fabaceae*
Aligustre	Privet	*Ligustrum lucidum*
Plátano de sombra	London plane	*Platanus hispanica*
Cerezo japonés		*Prunus serrulata*
Sófora, falsa acacia	Pagoda tree	*Styphnolobium japonicum*

Table 2.10: List of shady arboreal species selection for Valladolid.

For years in Valladolid there have been planted London planes, as they provide a nice shadow. There are currently planted about 16.000 units in the whole city, which are being progressively substituted by other species, due to their allergenic effect.

Acer negundo is commonly used in Valladolid for parks & gardens, but also as a road tree. In the city there are increasing the *Acer campestre* units. Acer species provide good shade such as *Acer palmatum, Acer rubrum* or *Acer pseudoplatanus*. For places with less space *Acer campestre* (10 meters), the *Acer pensylvanicum* (5-10 meters) or the *Acer negundo* (12-15 meters) are smaller species.

Recently there is increasing the number of *Ligustrum lucidum* in Valladolid, native to China and Japan that reach a height of 12-15 meters. It has a rapid growth, it adapts to all types of soils, and it resists pruning and frost of up to -12 °C. The disadvantage is that the fruits when they fall dirty the ground.

Prunus serrulata individuals *(*var. *Amanogama, Kanzan* and *Royal Burgundi)* are being increased in Valladolid in the last years too.

Plantation works

In the places where needed, there will be installed defences to avoid the cars collisions.

2.5.4 Operational and Maintenance Considerations

The maintenance considerations of shade trees are detailed in section 2.4 (VAc2).

2.5.5 Economic Specifications

In the following table it is shown the planting trees estimated cost. The budget depends on the tree species but also on the root growth system. There might be budget and space for the plantation of a maximum of 200-250 trees.

Tree shady places	unit	quantity	Price (€)	Amount (€)
Installation works				
Water supply and drainage	m	n/a	45-55 €	
Irrigation system - Irrigation canalization - Drop irrigation system - Sprinkler irrigat. system	 m m^2 m^2	n/a	 35-40 € 2,5 € 15 €	
Electric system		n/a		
Plantation works				
Ground preparation	m^2	n/a	0,85	
Tree planting	unit	n/a	13-30-45 €	

Tree/plant supply - Costs depending on the size (small, medium, tall) (transport not included)				
Conifer tree	unit	n/a	30-60-90 €	
Leafy tree	unit	n/a	25-60-105 €	
Total budget of material execution (€)				**20.661,00 €**
Tender budget with VAT (€)				**25.000,00 €**

Table 2.11: Shady tree planting budget
(Source: Base Paisajismo www.basepaisajismo.com)

2.6 SUDs for Green Bike Lane (VAc8)

2.6.1 General Description

SUDS are drainage systems that are considered to be environmentally beneficial, causing minimal or no long-term detrimental damage. They are often regarded as a sequence of management practices, control structures and strategies designed to efficiently and sustainably drain surface water, while minimising pollution and managing the impact on water quality of local water bodies.

SuDS take inspiration from natural features and processes like uptake of water by plants, soil infiltration, pools, ponds, marshes, wetlands, springs, streams and rivers. SuDS can take many forms, both above and below ground. Some types of SuDS include planting, others include proprietary/manufactured products. In general terms, SuDS are designed to manage and use rainwater close to where it falls, on the surface and incorporating vegetation, tend to provide the greatest benefits. Most SuDS schemes use a combination of SuDS components to achieve the overall design objectives for the site.

Concretely, for the *Vac8- SUDs* corresponding with the *VAc1- Green cycle Line* (VAc8), green swales, permeable pedestrian/parking pavements and rain gardens have been selected. Swales are shallow, flat bottomed, vegetated open channels designed to convey, treat and often attenuate surface water runoff. When incorporated into site design, they can enhance the natural landscape and provide aesthetic and biodiversity benefits. They are often used to drain roads, paths or car parks, where it is convenient to collect distributed inflows of runoff, or as a means of conveying runoff on the surface while enhancing access corridors or other open space.

Green pavement concept refers to permeable and porous pavers which allow water to percolate through them. Therefore, this kind of pavements allows natural drainage through the spaces between the pavers and migration of water into the earth. Rain gardens are planted depressions or holes that allows rainwater runoff from impervious urban areas, like roofs, driveways, walkways, parking lots, and compacted lawn areas, the opportunity to be absorbed.

Figure 2.42: Examples of SUDS for rain water retention & infiltration: green swales and rains gardens (Source: Soil Science Society of America and SuD Sostenible)

Figure 2.43: Examples of SUDS for rain water retention and infiltration: green pavements (Source: E3CN – Estrategias de Edificios de Energía Casi Nula).

2.6.2 Location

Different SUDs will be constructed along the new green corridor. Concretely, SUDs will be located in the areas closer to these two streets: San Isidro Street, and N-601 Road. It has been corroborated, through several municipal sources, that those streets are flooded during storm episodes. The two streets have a small slope, so that the rainwater accumulates in certain places. San Isidro Street SUDs' area is closer to the Plaza Circular underpass, which crosses rail lines underneath. N-601 Road location is in the section between the Auditorium Garden and Salamanca Avenue.

The pictures below show an aerial view of the proposed locations identifying the SUDs interventions type.

Figure 2.44: Proposed SUDS location in San Isidro Street area (Source: Google/CENTA elaboration)

Figure 2.45: Proposed SUDS location in N601 Road /José Acosta Av (Source: Google/CENTA elaboration).

2.6.3 Technical Specifications

The technical specifications of the two locations are differentiated.

SUDs in San Isidro Street

Current situation	Planned intervention
	
Cross between San Isidro St and Cadiz St.	*Permeable pedestrian pavements*

Figure 2.46: Proposed SUDS in San Isidro Street area (I) (Source: Google/E3CN – Estrategias de Edificios de Energía Casi Nula).

Description:

First of all, the current concrete pedestrian pavement needs to be removed (partially or totally). Then, the area has to be excavated and later filled with the different material layers as indicated in the following picture.

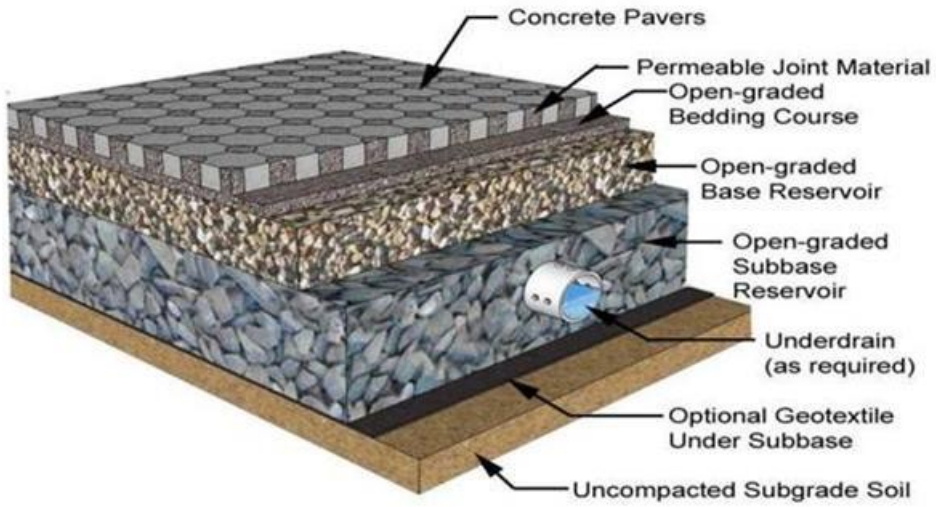


Figure 2.47: Filtering pavement layers (SUD) (Source: Smith, D., 2006.)

The pavers to be employed will be similar to the ones described in VAc14- Green parking pavements (see section 4.1.3). The underdrain will be connected to the municipal sewer system. The total permeable surface will be 97 m^2.

Current situation	Planned intervention

Impermeable Median strip

Green swale median strip

Figure 2.48: Proposed SUDS in San Isidro Street area (II) (Source: Google/ Northumbrian Water)

Description:

A green swale is foreseen in San Isidro St. in the stretch between Cadiz- de las Cigüeñas Streets and the Paseo Juan Carlos I. The first stage will be the removal of the concrete median strip and the excavation of the swale as graphically depicted in the following illustration.

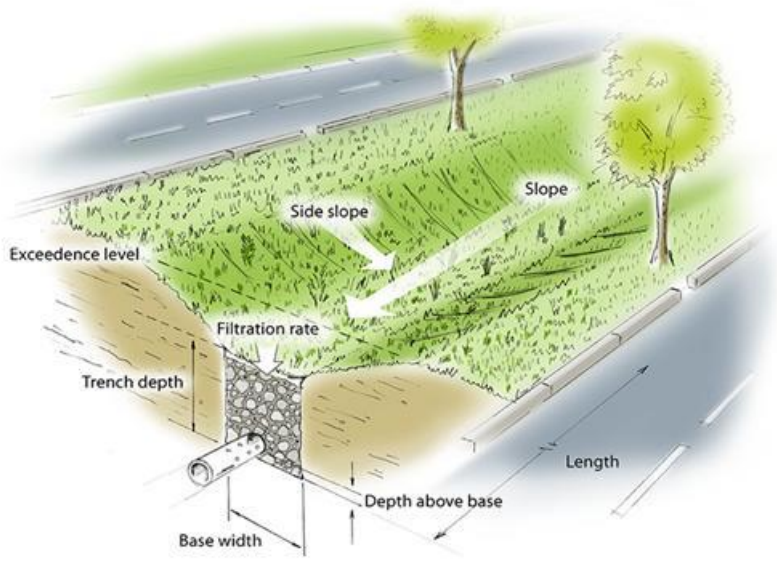


Figure 2.49: Green swale scheme (SUD) (Source: City of Lafayette)

A central filtration trench (filled with gravel) will be placed in the bottom of the swale along the road. The drainage pipe will be then connected to the municipal sewer system in the closet point (to reduce the investment). The slopes will be planted with grass as the strip is quite narrow.

Note: due to budget limitation, the green swale will have a length of approx. 50 m.

Current situation	Planned intervention
	
Roundabout in the cross between San Isidro St. and Paseo Juan Carlos I	*Rain garden*

Figure 2.50: Proposed SUDS in San Isidro Street area (III) (Source: Google/Susdrain)

Description:

The current roundabout will be adapted to host a rain garden. For that purpose, the soil of the actual green areas will be excavated. A smoothly depression will be created that will be covered with a thin (200–500 mm) layer of compost/sand-amended native soils (recommended option). The rain gardens will have simple inlet points where rainwater enters the garden. The maximum depth of standing water will be 150 mm. They can have an aboveground overflow where excess water exits, although in some instances a simple underdrain may be more effective than providing a small control structure. This second option will be chosen if the connection to the municipal sewer system is feasible.

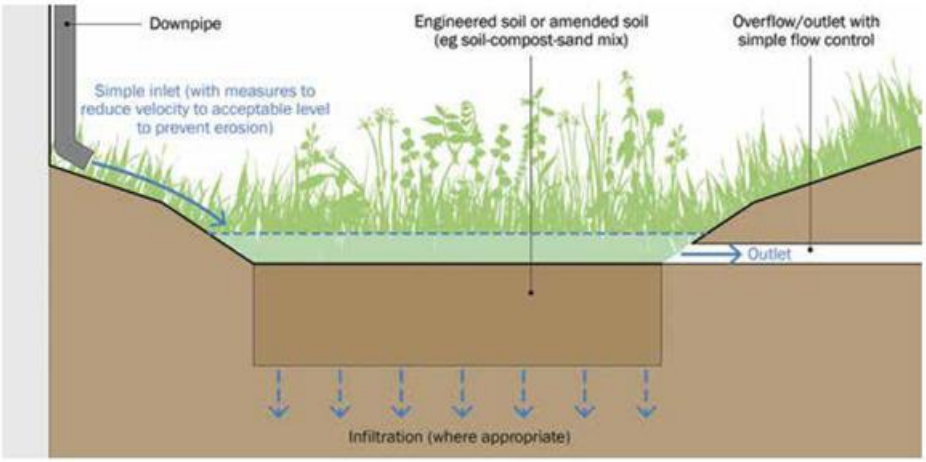


Figure 2.51: Rain garden scheme (SUD) (Source: CIRIA Manual).

Note: Due to budget limitations, the roundabout will be partially transformed in a rain garden (310 m^2)

SUDs in N-601 road

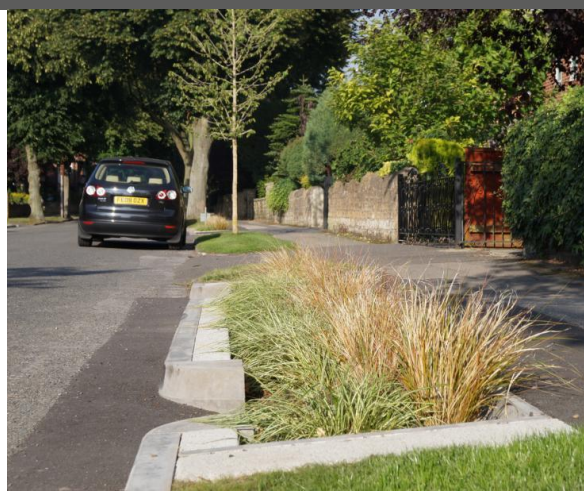
Current situation	Planned intervention
	
Roundabout in Road 601	*Rain garden*

Figure 2.52: Proposed SUDS in N-601 road (Source: Google/Susdrain)

Description:

The current roundabout presents an impermeable pavement and some scattered trees. The idea is to transform this roundabout in a rain garden. Therefore, the first works will focus on the removal of the current pavement and the excavation of the soil to create different depressions. The rain gardens will be constructed following the specifications described above. The current layout of the Road 601 will not be modified.

Note: Due to budget limitations, the roundabout will be partially transformed in a rain garden (240 m^2).

2.6.4 Operational and Maintenance Considerations

For the operation and maintenance of the permeable pavements, please, check section 4.1.4 (Vac14).

The following table summarizes the operation and maintenance requirements for the rain gardens (and other bio-retention systems).

Maintenance schedule	Required action	Typical frequency
Regular inspections	Inspect infiltration surfaces for silting and ponding, record de-watering time of the facility and assess standing water levels in underdrain (if appropriate) to determine if maintenance is necessary	Quarterly
	Check operation of underdrains by inspection of flows after rain	Annually
	Assess plants for disease infection, poor growth,	Quarterly

	invasive species etc. and replace as necessary	
	Inspect inlets and outlets for blockage	Quarterly
Regular maintenance	Remove litter and surface debris and weeds	Quarterly*
	Replace any plants, to maintain planting density	As required
	Remove sediment, litter and debris build-up from around inlets or from fore bays	Quarterly to biannually
Occasional maintenance	Infill any holes or scour in the filter medium, improve erosion protection if required.	As required
	Repair minor accumulations of silt by raking away surface mulch, scarifying surface of medium and replacing mulch	As required
Remedial actions	Remove and replace filter medium and vegetation above	As required but likely to be > 20 years

Table 2.12: Maintenance operations for the rain garden
(Source: The SuDS Manual) [*] or more frequently for tidiness or aesthetic reasons.

The following table summarizes the operation and maintenance requirements for the green swales.

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter and debris	Monthly, or as required
	Cut grass – to retain grass height within specified design range	Monthly (during growing season) or as required
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for > 48 hours.	Monthly, or when required
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
	Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies.	Half yearly
Occasional maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required or if bare soil is exposed over 10% or more of the swale treatment area
Remedial actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required
	Remove build-up of sediment on upstream gravel	As required

	trench, flow spreader or at top of filter strip	
	Remove and dispose of oils or petrol residues using safe standard practices	As required

Table 2.13: Maintenance operations for the green swales
(Source: The SuDS Manual)

2.6.5 Economic Specifications

Interventions at San Isidro St Area

Permeable pedestrian pavement	unit	quantity	Price (€)	Amount (€)
Land movements and preparation of the terrain	m^2	97	15	1,455.00
Subbase: graded aggregate compacted layer (250 mm). Material and execution works	m^2	97	25	2,425.00
Geo-textile sheet	m^2	97	15.09	1,463.73
Pavement: concrete blocks installed over a sand bed and filled of the holes with sand	m^2	97	16	1,552.00
Installation of other elements (kerbs, limit,…)	m^2	40	15	600.00
Total budget of material execution (€)				**7,495.73**
Tender budget with VAT (€)				**9,069.83**

Table 2.14: Permeable pedestrian pavement budget (San Isidro St) (Source: CENTA)

Green swale (linear)	unit	quantity	Price (€)	Amount (€)
Land movements	m^3	375	4,15	1,556.25
Filtering trench	m	50	58,98	2949.00
Gardening	m^2	250	3,88	970.00
Total budget of material execution (€)				**5,475.25**
Tender budget with VAT (€)				**6,625,05**

Table 2.15: Green swale budget (San Isidro St) (Source: CENTA)

Rain garden	unit	quantity	Price (€)	Amount (€)
Land movements	m^3	457	4.15	1,896.55
Refill with filtering substrate	m^3	110	47.15	5,186.50
Geo-textile sheet	m^2	310	15.09	4,677.90
Refill with topsoil	m^3	102	12.55	1,280.10
Gardening	m^2	310	5.67	1,757.70
Total budget of material execution (€)				**14,798.75**
Tender budget with VAT (€)				**17,906.49**

Table 2.16: rain garden budget (San Isidro St) (Source: CENTA)

Interventions at N- 601 road area

Rain garden	unit	quantity	Price (€)	Amount (€)
Land movements	m^3	425	4.15	1,763.75
Refill with filtering substrate	m^3	92.7	47.15	4,370.81

Geo-textile sheet	m^2	240	15.09	3,621.60
Refill with topsoil	m^3	90,6	12.55	1,137.03
Gardening	m^2	240	5.67	1,360.80
Total budget of material execution (€)				**12,253.99**
Tender budget with VAT (€)				**14,827.33**

Table 2.17: rain garden budget (N-301 Road) (Source: CENTA)

2.7 Smart Soils as Substrate (VAc16)

2.7.1 General Description

Smart soils are soils that have been developed to keep the level of oxygen, water, pH and nutritional ingredients at an optimal level. A technosol, according to the World Reference Base for Soil Resources, is a soil group that combines soils whose properties are dominated by their technical origin; they contain a significant amount of artefacts (something in the soil recognizably made or extracted from the soil by humans), including soils from waste.

In this document, these terms are used as synonyms because the origin and final characteristics of the soils meet both denominations.

Smart soils will be used along SubDemo A for cycle-pedestrian green paths, pollinator's modules & trees. For all these surfaces a total of 378 m^3 of technosols have been calculated, adding a maximum of 20 cm at the top of each infrastructure that carries smart soils.

Smart soils designed for the URBAN GreenUP project will be technosols made of by-products from agrifood industries allowed for this purpose (in the Spanish law for technosols[3]), biomass residues coming from different types of pruning (urban and non-urban), biochar and other waste included in the Spanish Regulation AAA/1072/2013[4].

The elaboration of these smart soils has a twofold purpose, on the one hand, the used waste is valued, minimizing the potential environmental impacts derived from poor management of them and, on the other hand, soils are made without excessive costs.

Components of the mixtures have different and individual characteristics, according to the final destination of the smart soil elaborated: depending on their composition, structuring and water properties.

Smart soils derived from by-products must comply with the main functions of the soils, be susceptible to evolve by soil formation processes and realize an efficient stabilization of the carbon in the soil and in the biomass.

[3] "Resolución de 8 de enero de 2008, de la Dirección General de Calidad y Evaluación Ambiental, por lo que se da publicidad a la instrucción técnica de residuos ITR/01/08, de 8 de enero de 2008, de la Dirección General de Calidad y Evaluación Ambiental, referente a la elaboración de suelos (tecnosoles) derivados de residuos. Consellería de Medioambiente y Desarrollo Sostenible de la Comunidad de Galicia".

[4] "Order AAA/1072/2013, de 7 de junio, sobre utilización de lodos de depuración en el sector agrario".

This kind of smart soils are used in recovery processes of degraded and/or contaminated soils and water, areas with rocky outcrops, covering of tailings, areas affected by urban works and urban/peri-urban infrastructures (such as roundabouts, roadsides and non-recreational garden areas), industrialized areas, mines and quarries or silvicultural soils degraded by erosion, fire or loss of productive capacity, intensive forestry soils and non-food biomass crops.

Specific bacteria of the genus *Azotobacter*, *Rhizobium* and *Azospirillum* marketed as biofertilizers, can be added to the technosols. These bacteria manage to actively capture NO_x, perform the N cycle correctly and improve the availability of plants, developing their capacity for self-fertilization.

The technosoils contain a large amount of organic matter that improves the availability of nutrients and better holding water capacity.

Expected impacts: The use of smart soil in other NBS involves creating natural sinks of NO_X (nitrogen oxides, an extremely important contaminant of urban air) inside the city. It is estimated that smart soils (VAc16, VAc17 & VAc18) will capture 1.665 kg/year of NO_2 from urban air[5] and avoid its fertilization. In the case of VAc16, it will capture 640 kg/year of NO_2.

Around 350 $m^3$of products will be reused, otherwise, most of them would be managed as waste reducing the impact of this on sensitive systems (air, water, biota), and recycling micro and macronutrients as N, P, K.

2.7.2 Location

VAc16-Smart soils will be use in trees (VAc2), cycle-pedestrian green paths (VAc15) and pollinator's modules (VAc19). The exact location is described in these interventions.

2.7.3 Technical Specifications

All smart soil must contain between 5-10% of biochar and 90-95% of by-products.

Smart soils should be free of heavy metals and eco-toxicity and have structural and nutritional characteristics that guarantee their quality as a culture medium and minimize the environmental and hygienic-health risks derived from their application. It should be avoided that, when making smart soil, it may contain some type of toxic compound.

The texture that has been provided to the soil will be that which resembles as closely as possible that of the natural fertile soils, and will be the most suitable textures (in the fraction smaller than 2 mm) of sandy loam to silty loam, with a percentage of gravel not exceeding 10% and with a maximum size particle size 50 mm.

The values of the C / N ratio of soil must be greater than 12. The minimum content of organic matter will be 4%. The pH of the mixture once matured will be neutral, around 6.5 - 7.5. In case any of the implementations need a basic or acid pH, it will be corrected in situ with pH

[5] "CARTIF results "Technological development Substrates with self-fertilizer and air pollutant uptake capacity. Sustra-TEC" RTC -2016-5043-2. MINECO".

correctors. The smart soils prepared must also prove that they do not exceed the following levels of microorganisms:

- *Salmonella*: absent in 25 g of processed product.
- *Escherichia coli*: <1,000 CFU (forming units of colony) per gram of processed product.

The use of byproducts from nearby industries such as coffee growers, horticulture, agri-food industries, carbonates from waste of sugar industries, straw and other biomass from pruning is recommended. All smart soil must contain between 5-10% of biochar.

Smart soil composition		Smart soil characteristics	
By-products	90-95%	Texture	sandy loam - silty loam
		C/N ratio	+ 12
Biochar	5-10%	Organic matter	+ 4%
		pH	6,5-7,5

Table 2.18: Composition and characteristics of Smart soils (VAc16, Vac17 and Vac18).

2.7.4 Operational and Maintenance Considerations

This intervention does not need any type of maintenance. It is recommended to make annual analyses of soil quality and if necessary add some fertilizer.

2.7.5 Economic Specifications

The smart soil price will be maximum 70 €/m^3. The budget will include transportation, mixing with the original soil (for actions that require it) and an analysis of the soils where it reflects the conformity with the hygienic-sanitary, physical-chemical and microbiological parameters.

The total budget for this action is 27,000 €.

2.8 Natural Pollinator´s Modules (VAc19)

2.8.1 General Description

These spaces will be designed to attract pollinators and biodiversity in general by weather conditions as a refugee (colder areas in hot periods and refugee for wintertime) and feeding (water and food providing areas for pollinators).

It is important to incorporate this NBS housing for pollinators, both insects and other species as birds, bats and small reptiles, etc. They will have the housing function but also they will be awareness elements for citizens.

Urban areas are the refuge of numerous pollinators, for instance 83% of butterflies live in an urban area, and they are disappearing faster from towns and cities than the countryside, 2/3 of butterfly species are declining. However, one garden could attract more than 18 species of butterfly. To this end it is necessary: to choose a sunny sheltered spot with flowers throughout pollinators' season with a source of water and avoid peat, using peat-free compost, which is friendly with the butterflies (Source: Butterfly Conservation).

There will be installed 6 units of *VAc19-Natural pollinator's modules* and 15 units of *VAc21-Natural pollinator's modules* in several locations in Valladolid. Each natural pollinator's module will be installed in the ground with Smart Soil (Vac16), with anti–allergy species and will have an estimated surface between 10-20 m^2.

Additionally, this NBS could include some street furnishing as street seats, a drinking water fountain or some elements to create shadow areas as trees or shadow pergolas with plants.

The expected impact is help to create connexions or/and connexions networks among green and blue spaces or areas in urban environments, increase the level of biodiversity, improve air quality, run-off mitigation, energy savings, increase in property values, well-being and social cohesion.

Connectivity. The distance between modules will be affected by the characteristics of the urban space and the presence of other green elements (like street trees or bush lines), space availability, etc. These structures allocated in periurban areas will help to connect countryside with green urban areas.

2.8.2 Location

These NBS will be installed in several locations. The selection of final locations for the Natural pollinator's modules is still ongoing. VAc19 will install 6 units along the Green Corridor.

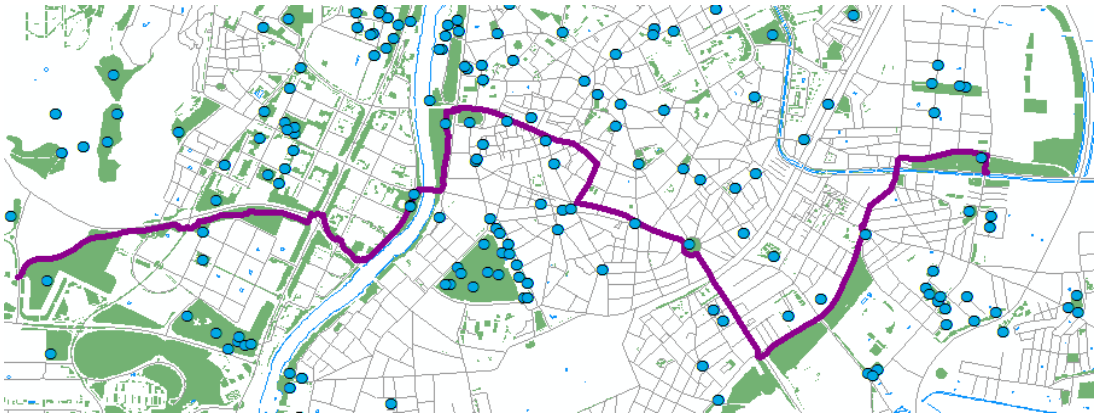


Figure 2.53: Water fountains along the green corridor (Source: Aquavall)

Locations will be selected depending on sunshine irradiation times and according with characteristics of surrounding area (vegetation, green areas, urban furniture, roads, etc.). Locations will be also selected in order to create connexions or/and connexions networks among green and blue spaces or areas in the urban environment, included the Compacted Pollinator's Modules (VAc20), which will be located in the periurban area. The locations might have additionally a source of irrigation or possibility of being irrigated in a simple way.

2.8.3 Technical Specifications

This green space attracts pollinators and biodiversity through flowers and plants. To achieve that, a favourable sequence of flowering permits the production of pollen, nectar and essential oils. For that reason, is compulsory to select an optimal combination of different native plants

(to avoid the risk of introducing non-native invasive species and pathogens) of trees, shrubs and/or wildflowers, with different flowering, to cover the period between March to November, overall in spring, when hunger gaps are most likely to occur.

It is also necessary to provide the modules with plenty of safe nesting habitats, like long grass, bare earth, crevices in dry stonewalls or wood - insect hotel, pollinator walls or bee towers for bumblebee, bees, pollinators, etc. All these elements will be done with free-pesticides and non-toxic materials. Only then, we will achieve that pollinators arrive and establish permanently.

Natural pollinator's Modules – Marina Model

Marina Model is selected for the technical specifications of the natural pollinator's modules. The following are the key elements description:

Constructive elements: Natural/organic building materials. The soil/ground will be complemented with *VAc16-Smart soils as substrate*. In case of using substrate this must be peat-free (Peat bogs are important habitat for many species, overall butterflies).

Plants, like trees, bushes and flowers. This NBS will put special attention to install native and anti-allergy species (*Lavandula latifolia, Rosmarinus officinalis,*. etc..) with different flowering periods. A selection of more convenient plants and combination of them will be done according different parameters like location, surrounding vegetation, pollen and nectar accessibility for pollinators among other. For this reason, a specific list of plants has been made for the city of Valladolid, which must be respected, because there are varieties of the same species that do not attract pollinators. As it is a specific list for the city of Valladolid, its replication in other cities should be revised, in order not to introduce invasive species and promote native plants.

Species	Native name (Spanish)	Family	Natural poll's mod	Compacted poll's mod	Trees	Bush	Herba-ceous
Rosmarinus officinalis	Romero	Lamiaceae	x (control)	x		x	
Primula veris	Primavera	Primulaceae	x	x			x
Primula vulgaris	Prímula	Primulaceae	x	x			x
Viola odorata	Violeta de olor	Violaceae	x	x			x
Prunus domestica	Ciruelo (Claudia)	Rosaceae	x	x	x		
Viburnum tinus	Durillo	Adoxaceae	x	x		x	
Bellis perennis	Bellorita	Compositae	x	x			x
Taraxacum spp.	Diente de león	Compositae	x	x			x
Pisum sativum	Guisante	Leguminoseae	x	x			x
Syringa vulgaris	Lilos	Oleaceae	x	x		x	
Pyrus communis	Peral	Rosaceae	x	x	x		
Malus domestica	Manzano	Rosaceae	x	x	x		
Sambuscus nigra	Saúco	Caprifoliaceae	x	x		x	
Paeonia officinalis	Peonia	Paeoniáceas	x	x		x	
Aquilegia vulgaris	Aguilera	Ranúnculacea	x	x			x
Lonicera etrusca	Madreselva	Caprifoliaceae	x (control)	x		x	
Allium roseum	Ajo rosado	Liliaceae	x	x			x

Cydonia oblonga	Membrillo	Rosaceae	x	x	x		
Rubus sp.	Frambuesa	Rosaceae	x	x		x	
Fragaria vesca	Fresa	Rosaceae	x (control)	x			x
Lavandula officinalis	Lavanda	Lamiaceae	x (control)	x		x	
Lathyrus sp	Guisante de olor	Leguminoseae	x	x			x
Budleia davidii	Budleia	Buddlejáceas	-	x		x	
Budleia madagascariensis	Budleia	Buddlejáceas	-	x		x	
Tanacetum vulgare	Tanaceto	Astaraceae	x (control)	x			x
Saponaria officinalis	Saponaria	Caryophyllaceae	x	x			x
Mentha suaveolens	Menta	Lamiaceae	-	x			x
Mentha sativa	Hierbabuena	Lamiaceae	-	x			x

Table 2.19: List of selected species suitable for pollinator's modules in Valladolid – part 1.
Sources: Regional public health website (https://www.saludcastillayleon.es/ciudadanos/es/polen) and www.pollenlibrary.com, http://www.lepidopteros.com/
Species for Valladolid, a similar list had to be prepared for each region avoiding invasive species and prioritizing native species.
Key: [x (control)] It is possible planting it into the soil with controlled growth. [-] Avoid to plant in soil. [·] Invasive species in some regions of Spain.

Species	Flowering	Pollen Allergy (High/Medium/Low)	Rich in	Insects visitors	Watering	Height
Rosmarinus officinalis	Jan-Feb & Mar-Jun	L	nectar	Bf, B, F	Scarce	1 m
Primula veris	Feb-May	L	nectar	Bf, B	Regular	10 cm
Primula vulgaris	Feb-May	L	nectar	B	Regular	10 cm
Viola odorata	Feb-Apr	L	nectar	B	Regular	10-15 cm
Prunus domestica	Mar	M/L	pollen	B, FF	Regular	5-6 m
Viburnum tinus	Mar-Apr	M/L	pollen	B, FF	Moderated	2-4 m
Bellis perennis	Apr*	M	pollen	Bf, B	Abundant	10-0 cm
Taraxacum spp.	Apr	No allergy	pollen	Bf, Bt, FF	Regular	11-20 cm
Pisum sativum	Apr-May	L	pollen	B, FF, Bt		
Syringa vulgaris	Apr-May	H	nectar	B	Regular	3-7 m
Pyrus communis	Apr-May	M/L	pollen	B, Bf, FF, Bt	Moderated	2 m
Malus domestica	Apr-May	M/L	pollen	B, Bf, FF, Bt	Moderated	2 m
Sambuscus nigra	Apr-Jun	No allergy	pollen	Bf, B, F	Moderated	2-5 m
Paeonia officinalis	Apr-Jun	n.d.	pollen	B, FF , Bt	Regular	70 cm
Aquilegia vulgaris	May	n.d.	nectar	Bf, B	Scarce	30-70 cm
Lonicera etrusca	May-Jun	n.d.	nectar	Bf, B	Regular	7 m
Allium roseum	May-Jun	n.d.	pollen	Bf, B	Scarce	30-80 cm
Cydonia oblonga	Jun	M/L	pollen/nectar	B	Scarce	4-6 m
Rubus sp.	Jun	M/L	pollen	B, Bf, FF, Bt	Moderated	40-60 cm
Fragaria vesca	Jun	M/L	pollen	B, Bf, FF, Bt	Regular	10 cm
Lavandula off.	Jun-Aug	L	nectar	Bf, B	Scarce	60-80 cm
Lathyrus sp	Jun-Sp	L	pollen	Bf, B	Scarce	50-200 cm
Budleia davidii	Jul-Aug	n.d.	nectar	Bf, B	Abundant	2- 3 m

Budleia madag.	Jul-Nov	n.d.	nectar	Bf, B	Abundant	2-3 m
Tanacetum vulgare	Aug	L	pollen	B	Regular	1 m
Saponaria officinalis	Sep	n.d.	pollen	Bf	Regular	10-60 cm
Mentha suaveolens	Oct	n.d.	pollen	B, Bf, FF, Bt	Abundant	40-100cm
Mentha sativa	Nov	n.d.	pollen	B, Bf, FF, Bt	Abundant	41-100cm

Table 2.20: List of selected species suitable for pollinator's modules in Valladolid – part 2.
Sources: See above Table.
Key: [*] throughout the year [n.d.] No data. Insect visitors [Bf- Butterflies, B- Bees, F-Flies, FF- Flowering flies, Bet-Beetles]

Design criterion:

- Modules should be multiflora in order to attract a high number of different pollinators at different times of the year, above all for monitoring purposes. A list of plants is provided for this purpose, an optimal combination of this herbaceous, shrubs and trees list is compulsory taking into account flowering time, soil, size, irrigation needs, needs for sunshine and shade.
- The distance between modules will be taken into account. Although some pollinators such as bees can travel up to 3 km in countryside, in urban areas this distance is much less, it is necessary to create a green connexion to allow easy access to pollinators, so modules should be located as close together as possible as well as of green areas.

Water source: It is necessary provide a water source for pollinators with a spot land, to not drown into the water. This is why the pollinators often fly around clothesline or near to a fountain, is their way of drinking water safely.

An irrigation system could be installed to supply needs if necessary.

This NBS could include a rain garden (see VAc10) that contributes to the management of water, because it is a bioretention shallow basin designed to collect, store, filter and treat water runoff. It will have a drainage system to fill the rain garden or collect the water for other uses such as the urban orchards or the floodable park.

Housing for biodiversity (pollinators, birds, other insects). These pollinator-nesting blocks (also called pollinator houses, bee houses or bee hotels) will support biodiversity by creating wildlife friendly spots or areas and contribute to preserve and enhance the local biodiversity in urban areas. Bees to keep their young need nectar and pollen, as well as areas of clear ground and full sun, old logs or woods, and even areas with pieces of bark or stones.

Protection elements. Anti-vandalism elements like thorn bush fences could be included in the NBS.

Street furnishing. Street seats, water sources for humans, shadow structures or elements (shadow tree), etc. These elements look for create a point of interaction between nature and citizens in the city centre.

Additional functionality. Rainwater collection can be integrated throughout a SUD and addressed to an indoor storage area that will provide additional moisture to the plant substrate.

Urban Landscape architecture criteria in the city must be taken into consideration.

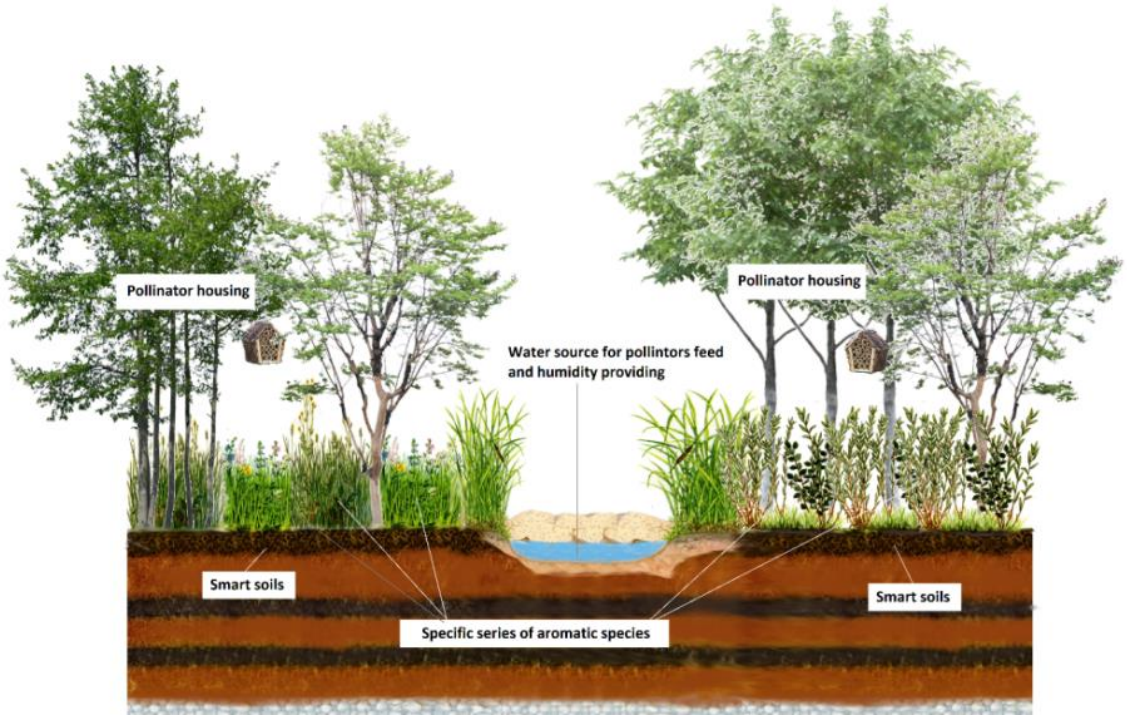


Figure 2.54: Natural pollinator's modules – Marina Model (Source: CARTIF).

2.8.4 Operational and Maintenance Considerations

General visual inspection of the elements.

Reparation or substitution of damaged elements or plants:

- Constructive elements: Maintenance of seats, fences, etc.
- Vegetation: General visual inspection of the vegetation. Pruning, maintenance and growth control. Control of pest' presence, if necessary an ecological treatment should be planned in order not to damage pollinators.

Waste management: Biomass production or composting actions are suggested as the proper form of managing these wastes. It could also be reincorporated as mulch after adequate treatment.

Weed control: Weed should be controlled frequently in order to avoid interferes the correct plants growing. The selected methods for their management should be environmentally friendly, and preferably mechanical. It can be planned frequently.

Irrigation: Periodic irrigation or control of irrigation system.

2.8.5 Economic Specifications

The economic specification of *VAc19-Natural pollinator's modules* is not already detailed. The total budget for this action is 50.000 € for VAc19 (another 50.000 € for Va21). *VAc17-Smart soil* cost is not included. This action should include the following cost elements:

- Plantation works.
- Plants purchase.
- Pollinators house purchase and installation.
- Watering planting irrigation.
- Elements for humans, such as seats, water fountain.

3 Definition of the Interventions in Sub-Demo B (City Centre)

In Sub-Demo B there will be implemented NBS to reduce heat island effect and improve air quality. Sub-Demo B will be deployed in Valladolid City Centre. This Sub-Demo includes different types of green infrastructure (GI) that will reduce maximum/averages temperatures, will increase relative humidity and will reduce air pollutants. In this zone, it will be used NBS adapted to high-urbanized areas.

Re-naturing urbanization	Water interv.	Singular green Infrastructures	Non-technical interventions
VAc4- Shade and cooling trees		VAc22- VAc23 - Green noise barriers	Common non-technical interventions: VAc37, VAc38, VAc39, VAc40, VAc41 & VAc42
		VAc24- Vertical mobile garden	
		VAc25- Green façade	
		VAc27- Green covering shelter	
		VAc28- Green roof	
		VAc29- Green shady structures	
		VAc26- Electro wetland	
		VAc30- Urban garden bio-filter	
		VAc17- Smarts soils as substrate	
		VAc20- Compacted pollinator's modules	

Table 3.1: List of interventions in Sub-Demo B 'City Centre'

The Nature Based Solutions (NBS) of Sub-Demo B are:

- Plantation of shade and cooling trees in City Centre, over Smart soils as substrate.
- Vertical green infrastructures such as a Green façade and Vertical mobile gardens.
- Horizontal green infrastructures such as a Green roof and Green covering shelters.
- Green-shady structures in City Centre streets.
- Urban garden biofilter in Zorrilla underground car parking.
- Electro wetland surface which can provide electricity (not in the map view)
- Green noise barriers in a main road with high noise levels.
- Compacted pollinator's modules installed in mobile window boxes.

Figure 3.1: Location map of Sub-Demo B interventions "City Centre" (Source: Google/Valladolid City Council elaboration).

The interventions to be installed in sub-demo B, the city centre, will have a high impact in the citizens, and also in the commercial and economic activities of the area. For that reason, it is very important to keep citizens informed and know their opinion. It will also involve the private sector, which is very positive, through co-financing and sponsoring activities. Thanks to the development of a specific application for mobile phones, citizens will learn about the implementations develop.

3.1 Shade and Cooling Trees (VAc4)

3.1.1 General Description

Climate in Valladolid is Mediterranean cold type because of the height of the city (over 680 m above sea level), which can provide temperatures 5 °C less than the rest of the Mediterranean region. Temperatures and precipitation are irregular, with dry summers. Winter period is long, as there are five months of winter, from November to March. An extended criterion considers a winter month when the average temperature does not exceed 10 °C and this is because, below this threshold, cold is a very restrictive factor of the vegetative development of most plants. On the other hand, average temperatures of the warmer months (July and August) barely exceed 21 °C, which is why summers cannot be considered warm, but rather mild, especially when compared to those suffering from the depression of the Ebro river (from 23 to 25 °C) or even more those of the South of Spain (where they reach 26-27 °C) (Source: General Urban Plan, PGOU).

Despite of the mild summers, the city suffers Heat Island Effect (HIE). The vegetation is essential to counteract this HIE effect typical of urban areas. It is calculated that there is a difference in the temperature among 1.5 - 1.9 °C between the cities and surrounding areas.

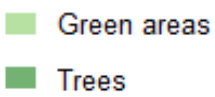
Valladolid urban area has lost trees and plants in last decades. This intervention looks for increase the urban tree population with shade and cooling purposes, which will be planted in Valladolid city centre.

3.1.2 Location

The URBAN GreenUP project trees will reinforce the current green areas, the number of trees will increase and damaged individuals will be substituted. Those trees will be used for replenish, complete flower beds or planting trees in renovated streets.

The general conditions of *VAc4-Shade and cooling trees* are similar to *VAc2-Planting 1,000 trees* in the Green Corridor (see section 2.4)

The following map view shows the distribution of green areas available in the City Centre of Valladolid according to the General Urban Plan (PGOU), among the URBAN GreenUP Green Corridor.



Legend: The dark green polygons are current arboreal zones. The light green polygons are available green areas.

The *VAc4-Shade and cooling trees* could be planted in the light green areas. On the other hand, there are planned improvement works in some streets of the city centre, such as the Mayor Square. These new areas will be conditioned with new trees.

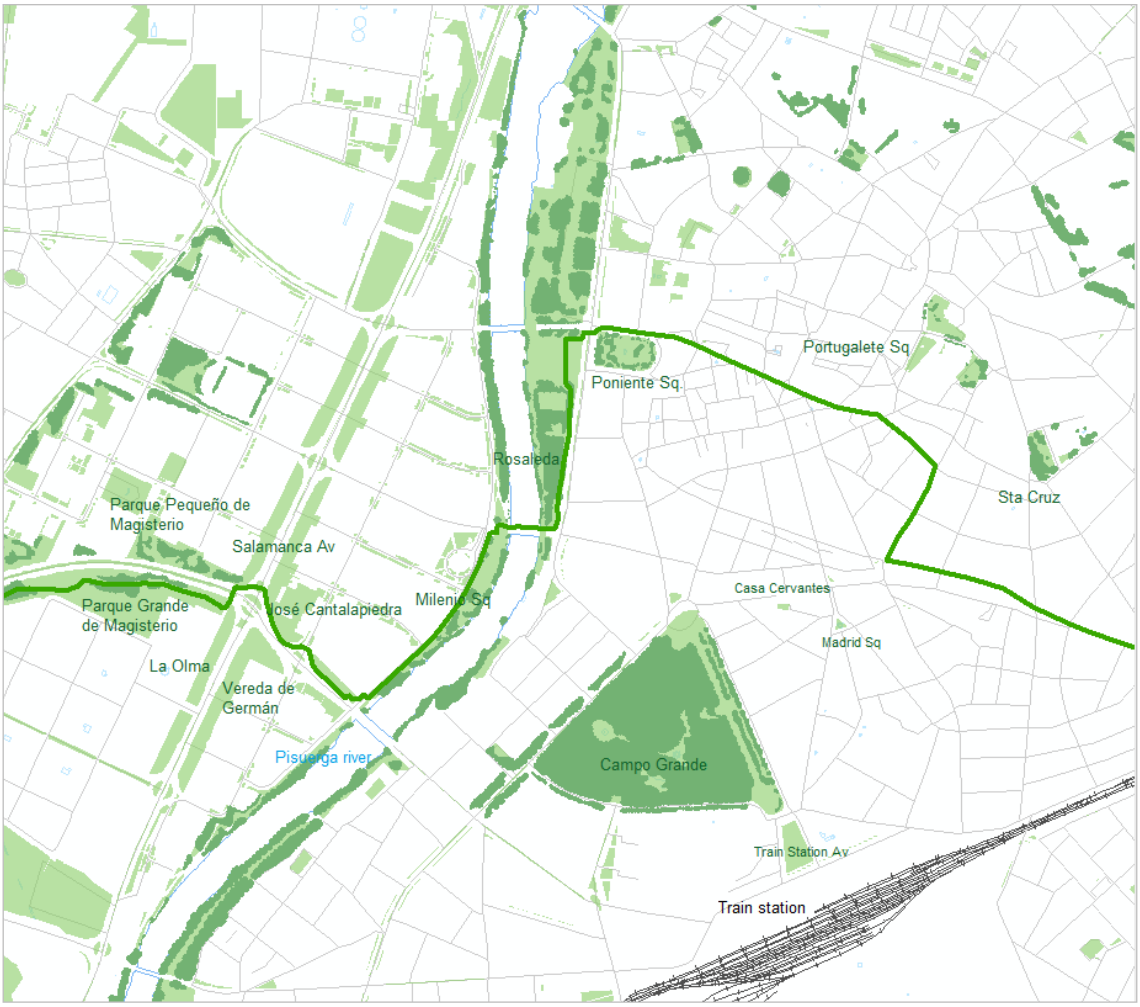


Figure 3.2: Green areas in Valladolid City Centre (Source: Valladolid City Council)

3.1.3 Technical Specifications

The trees species selection depends on the soil quality, root growth and soil depth, height and also the tree crown size. The following table shows the most typical trees species planted in Valladolid. The 'Use' column indicates if the tree is used for gardens and squares (P) or in the streets (C). The black dot (●) is a species introduced in the last 10 years. The last number is the % abundance: 1 singular element, 2 frequent and 3 very frequent.

Genus	Species	Use
Acer platanoides	Crimson King	C - - 2
Acer campestre	Anny Globe	C - ● -1

Catalpa bignonioides		C y P - - 3
Celtis australis		C y P - - 2
Chitalpa tashkentensis		C - ● - 1
Crataegus lavallei	Carrierei	C - ● - 1
Fraxinus ornus	Globosum	C - ● - 1
Fraxinus angustifolia	Raywood	C - ● - 2
Koeleuteria paniculata	Fastigiata	C - ● - 1
Laurus nobilis	copado	C - ● - 1
Ligustrum lucidum	A.varegatum	C - ● - 1
Ligustrum japonica		C y P - - 3
Ligustrum lucidum		C y P - - 3
Liquidambar styraciflua		C - ● - 2
Liriodendron tulipifera		C y P - ● -1
Malus floribunda		C - ● - 1
Morus platanifolia		C - ● - 2
Platanus acerifolia	Alphons Globe	C - ● - 1
Platanus hispanica		C y P - - 3
Prunus padus		C - ● - 1
Prunus serrulata	Amanogama	C - ● - 1
Prunus serrulata	Kanzan	C - ● - 1
Prunus serrulata	Royal Burgundi	C - ● - 1
Prunus eminens	Umbraculifera	C - ● - 2
Prunus serrulata	Pyramidalis	C - ● - 2
Pyrus calleriana	Aristocrat	C - ● - 1
Pyrus calleriana	President	C - ● - 1
Pyrus calleriana	Chanticleir	C - ● - 2
Quercus ilex		C y P - - 2
Robinia pseudoacacia	Umbraculifera	C - - 3
Robinia hispida		C - ● - 1
Robinia pseudoacacia	Casque Roge	C - ● - 1
Sorbus aucuparia	Fastigiata	C - - 1
Tilia cordata		C - ● - 1
Tilia europaea		C - ● - 1
Ulmus resista		C - ● - 1
Ulmus pumila	Lobel Pagoda	C - ● – 1
Acer platanoides	Crimson King	C - - 2
Acer campestre	Anny Globe	C - ● -1
Catalpa bignonioides		C y P - - 3
Celtis australis		C y P - - 2

Table 3.2: Common road trees species for Valladolid (Source: Valladolid City Council).

3.1.4 Operational and Maintenance Considerations

The maintenance considerations of shade trees are detailed in section 2.4 (VAc2, VAc3).

3.1.5 Economic Specifications

In the following table it is shown the *VAc4- Shade and cooling trees* estimated cost. The budget depends on the tree species but also on the root growth system. There might be budget and space for the plantation of a maximum of 250-300 trees.

Shade and cooling trees	unit	quantity	Price (€)	Amount (€)
Installation works				
Water supply and drainage	m	n/a	45-55 €	
Irrigation system - Irrigation canalization - Drop irrigation system - Sprinkler irrigat. system	 m m^2 m^2	n/a	 35-40 € 2,5 € 15 €	
Plantation works				
Ground preparation	m^2	n/a	0,85	
Tree planting	unit	n/a	13-30-45 €	
Tree/plant supply - Costs depending on the size (small, medium, tall) (transport not included)				
Conifer tree	unit	n/a	30-60-90 €	
Leafy tree	unit	n/a	25-60-105 €	
Total budget of material execution (€)				**24.793,00 €**
Tender budget with VAT (€)				**30.000,00 €**

Table 3.3: Shade and cooling trees budget (Source: Base Paisajismo www.basepaisajismo.com)

3.2 Green Noise Barriers (VAc22 - VAc23)

3.2.1 General Description

This NBS is designed to reduce the traffic noise that affects to the residential areas. On one hand, the green noise barriers have a specific geometry favouring sound reflection and on the other hand, they are composed by vertical garden modules with a specific substrate favouring sound absorption.

The dimensions of this NBS depend on the geometry of the structure (straight, curved or both), the height of residential buildings and the street width.

In Valladolid it is planned installing the NBS only in the road median of the street Paseo Hospital Militar (Military Hospital Street), with a barrier height of 3 meters. With these dimensions, there will be protected the pedestrians on the left sidewalk from the noise produced by the right lanes (East-West direction). In order to fully protect pedestrians, there has been proposed combining this NBS with other non-technical interventions about citizen awareness: divert traffic from the left lanes some days, maybe Sundays, every month.

This NBS together with the non-technical intervention is a prototype performance that will study the effectiveness of the Noise Green Barriers. If the results are satisfactory, this NBS may be extended further on the initial location and may be installed in other streets of the city.

Green noise barriers VAc22 and VAc23 are being developed together in SubDemo B 'City Centre', close to the SubDemo A 'Green Corridor'.

The following image is a noise scheme diagram for the Paseo Hospital Militar, in Valladolid.

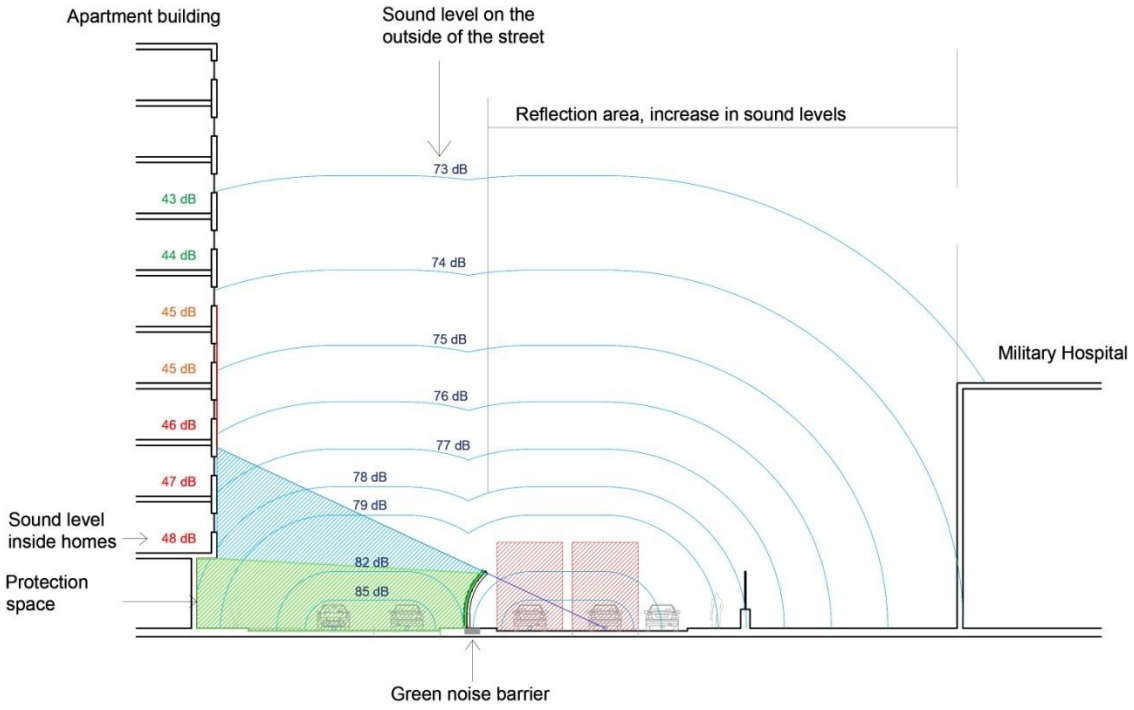


Figure 3.3: Noise scheme for the Paseo Hospital Militar street section, Green noise barriers (Source: SingularGreen).

3.2.2 Location

The Green Noise Barriers are planned to be located in Paseo Hospital Militar (Military Hospital Street). This street has four lanes and a road median. It is one of the main access roads to the city, so the traffic level is high.

Figure 3.4: Location of the Green Noise Barriers (Source: Google/SingularGreen elaboration).

As we can see in the next figure, in this street there is a noise level higher than 75 dB.

Figure 3.5: Noise study (Source: Valladolid Noise Map, 2013).

Selected location must comply with the following requirements:

1. Facilities near the location: There must be a water faucet, a drain or in the case of pouring off the water directly to the ground, there should be no basement underneath.
2. Occupation of the public space. The location of vertical mobile gardens must comply with the following regulations:
    - Order VIV/561/2010, 1st of February, basic conditions of accessibility and non-discrimination for the access and use of urbanized public spaces.
    - DB-SI of the CTE (Basic Document-Fire Security, of the Building Technical Code), section 5.
    - Article 364 of the POGU of Valladolid, about Accessibility in emergencies.
    - List and Spanish catalogue of invasive alien species.
    - City regulation service of water supply and sanitation
3. It is a noisy street, with a central space where we can place the NBS.

The NBS location and barrier effect depends on the geometry, the height of residential buildings and the street width. There are other conditioning characteristics such as the existence of car parking entrances, the sidewalks and the driveway widths.

3.2.3 Technical Specifications

In the next image you can see the constructive section of the *VAc22-23 Green noise barriers*.

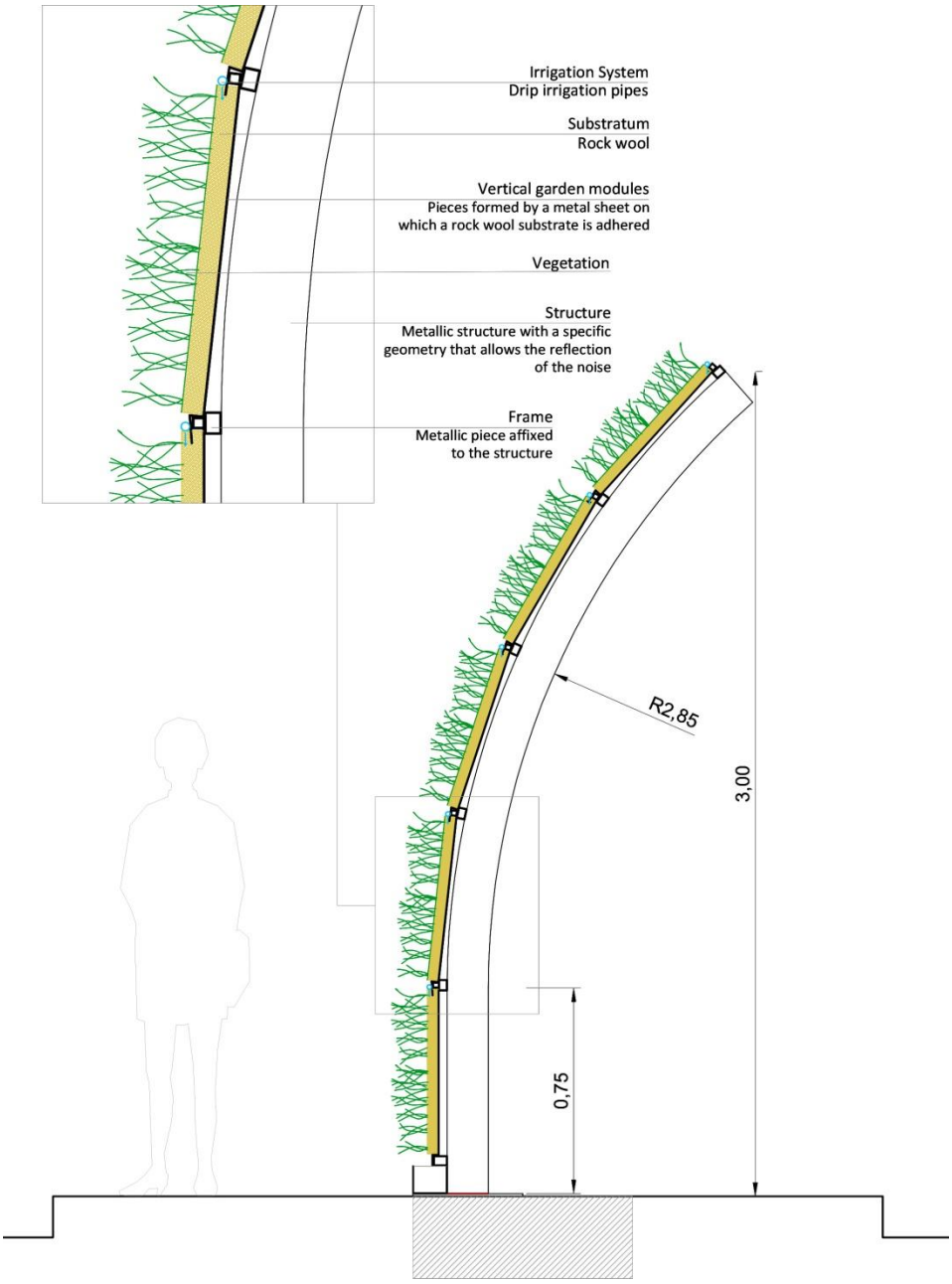


Figure 3.6: Constructive section of the Green Noise Barriers (Source: SingularGreen)

In the election of the noise barrier system, the small available space of the location has been considered: a combined solution with metallic support and stone wool. Other massive options would never fit into the available dimensions. This NBS is composed by a main curved structure and a vertical garden on it. The structure will be fixed to a continuous foundation footing. The structure is formed by curved steel pillars each 2 meters. In horizontal position there are going to be installed metal frames of 80 x 40 x 2 mm every 60 cm, to be able to fix the garden.

The vertical garden consists of steel sheet modules of 1.5 mm thickness, galvanized and lacquered in furnace, and substrate formed by panels of special rock wool for vertical gardening 100 mm thickness and 170kg / m^3 density, adhered to the steel sheet.

The metallic parts have an acoustic reflective function, while the high density mineral wool has an absorbent function; this combination allows to reduce the weight and the space that the system needs. This prototype is going to be analysed in order to know its behaviour and to correct deficiencies or improve its effectiveness.

The vegetation requires special plants adapted to the climate of Valladolid. The amount planted is 40 units / m^2.

Next figure shows the irrigation scheme that is hidden in two basins next to the *VAc22-23 Green Noise Barriers*.

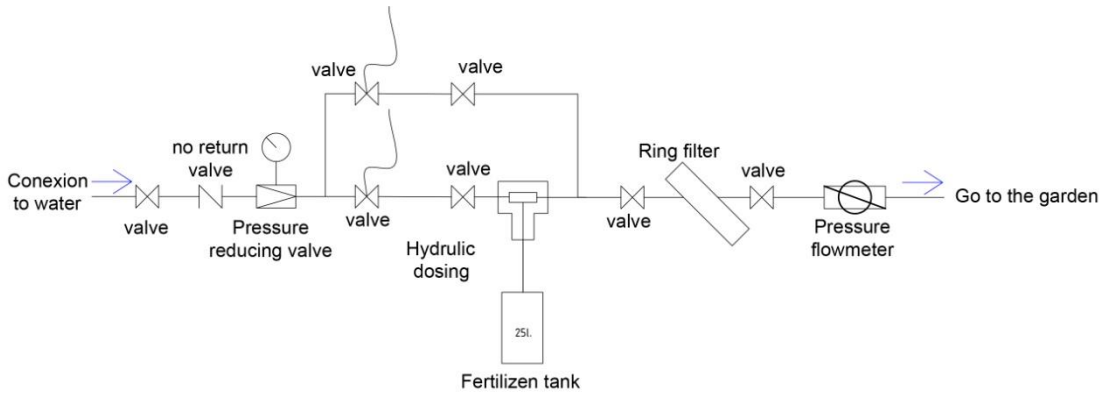


Figure 3.7: Irrigation scheme of Green Noise Barriers (Source: SingularGreen).

In the irrigation system there is no water recirculation. This solution has been chosen because of if the irrigation is properly adjusted, the excess water is very small, and the electricity cost involved in recirculating the water is very high. In other words, the pollution that is generated in the production of the required electricity is more harmful than pouring a small amount of water into the sanitation network.

3.2.4 Operational and Maintenance Considerations

Regular maintenance of the Green Noise Barriers is required, consisting on a monthly visit to the NBS, in which the following tasks are performed:

- Visual inspection of the vegetation status.
- Visual control of irrigation operation.
- Maintenance and start-up of the irrigation system: Filter cleaning, pH and conductivity control.
- Visual control of pests.
- Supply of hydroponics consumables (fertilization, acid, spare parts, etc.)

In addition to that monthly visit, there will be:

- Preventive phytosanitary treatments twice a year (1 in spring and 1 in summer).
- Pruning and growth control twice a year.

- System of telematic control of the irrigation in a maximum term of 3 natural days.

3.2.5 Economic Specifications

The following table shows the approximate costs of the Green Noise Barriers. The technical specifications have to be detailed in order to adapt the interventions to the available budget.

Green Noise Barriers	unit	quantity	Price (€)	Amount (€)
Clearing and cleaning the ground with shrubs	m^2	100	2,04	204,00
Excavation trenches for foundations	m^3	32	26,93	861,76
Sanitation water connection	unit	1	3.090,00	3.090,00
Water supply connection	unit	1	3.090,00	3.090,00
Footing of foundation	m^3	24	176,41	4.233,84
Steel mooring plate	unit	170	15,84	2.692,80
Curved steel pillars	kg	6.179,84	3,37	20.826,06
Supply and installation of vertical garden composed of aluminium structure, rock wool substrate, plants selected for the Valladolid climate at a rate of 40 ud / m^2 and irrigation system.	m^2	315	401,89	126.595,35
Soil transport with truck to dumping site	m^3	32	5,4	172,8
Total budget of material execution (€)				**161.766,61**
Tender budget with VAT (€)				**232.927,74**

Table 3.4: Green noise barriers budget (Source: SingularGreen)

3.3 Vertical Mobile Garden (VAc24)

3.3.1 General Description

Vertical mobile gardens are a type of vertical garden that are self-supporting, that is, it does not need to be supported by any auxiliary element, and it can be installed or moved to different places in the city.

The vertical mobile gardens have a metal structure that supports the substrate and the irrigation system. The substrate serves to set the roots and provide the water and the necessary nutrients. The own irrigation system guarantees the water contribution and vegetation development. This irrigation system must be connected to the water supply network. The excess water can be discharged to the public road or to the sewerage network.

In the URBAN GreenUP Project there are two different types of vertical mobile garden:

Vegetable sculpture

A vegetable sculpture is a vertical mobile garden with volume. This type of vertical garden is designed to form the shape of anything, for example the Puppy in Bilbao. This type of gardens, besides contributing to improve the air quality, also revitalize the urban area where they are installed, since they become an attraction.

In Valladolid, the vegetal sculpture designed is formed by the letters of the name of the city, 'VALLADOLID'. This vertical garden is 12 m long, 1.95 m high and 1.14 m wide at the bottom, and 0.33 m at the vegetative part. At the bottom, this garden has a space for the citizen to sit down. It is divided into two parts; each part has five letters, so that transportation is easier and cheaper.

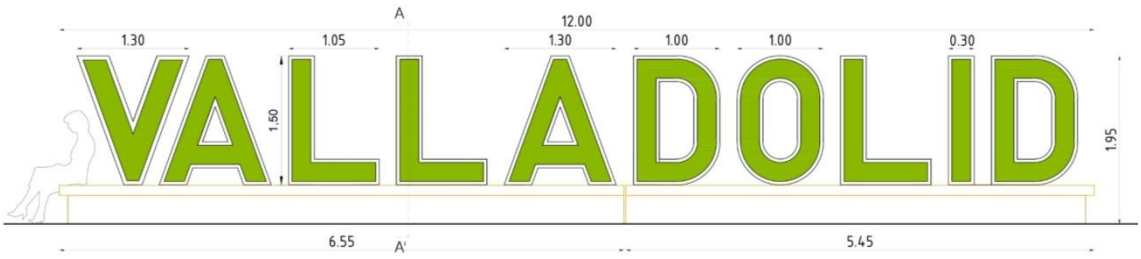


Figure 3.8: Vertical mobile garden - Elevation of vegetable sculpture (Source: SingularGreen)

Vegetable board

A vegetable board is a vertical mobile garden with square or rectangular shape. It can have vegetation on one or both sides, for example the vertical mobile gardens in Dresden (Germany) in the summer of 2016.

In Valladolid it is planned to install 2 large vegetable boards. Each vertical mobile garden is 5.25 meters long and 2.35 meters high. The plant part is 4 meters long and has an area of 6.95 square meters on each side. In one of the sides we have designed an area for citizens to sit down and also receive fresh air from the garden thanks to solar fans.

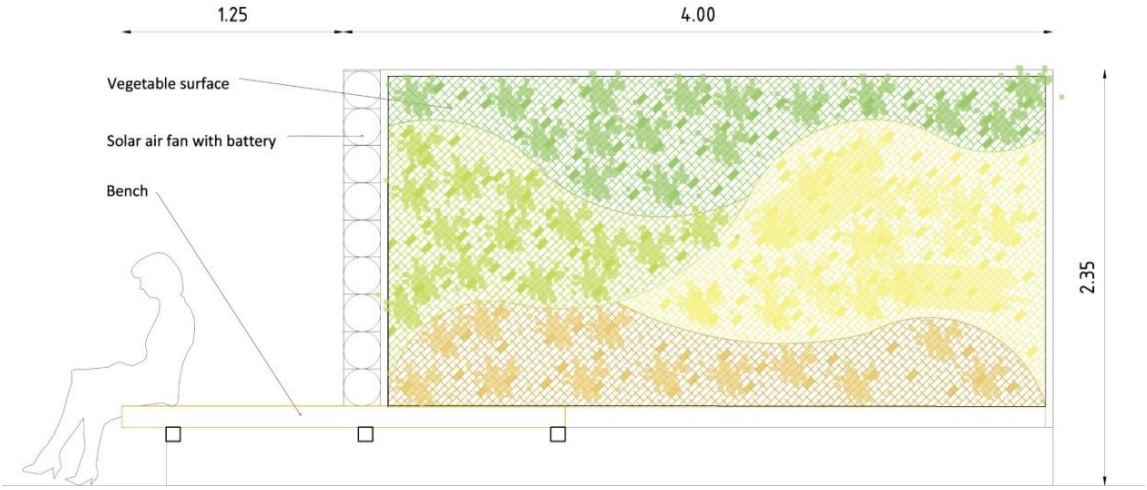


Figure 3.9: Vertical mobile garden - Elevation of board (Source: SingularGreen)

3.3.2 Location

All vertical mobile gardens proposed locations are in the downtown area. We have located these NBS in open urban spaces with a lack of shade elements and with accessible water and sanitation facilities. The locations should be also accessible to the citizens, located in places with lack of green areas and/or supporting citizens' demand, ensuring accessibility. Identifying adequate locations for the Vertical mobile gardens in an urban space might be challenging.

The vegetable sculpture is located parallel to the access wall to the Valladolid Cathedral, on the side of Portugalete Square.

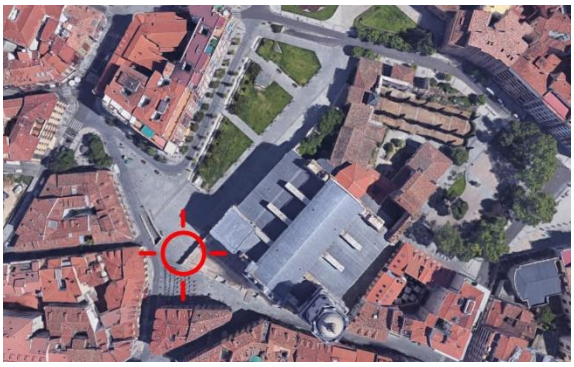


Figure 3.10: Aerial view of Portugalete square. Location of the vegetable sculpture (Source: Google/Valladolid City Councyl elaboration)

The vegetable boards are located, one of them in Zorrilla Square, and the other one in San Andrés Square. Those areas are free of singular green resources, in the City Centre and in very well connected areas.

Figure 3.11: Aerial view of Zorrilla Square. Vegetable board location (Source: Google/Valladolid City Council elaboration)

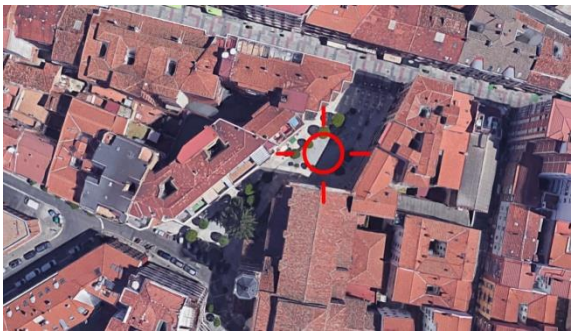


Figure 3.12: Aerial view of San Andrés Square. Vegetable board location (Source: Google/Valladolid City Council elaboration)

These places have met the following requirements:

1. Facilities near the location. There must be a water faucet, a drain or in the case of pouring off the water directly to the ground, there should be no basement underneath.
2. Occupation of the public space. The location of vertical mobile gardens must comply the following regulations:
   - Order VIV/561/2010, 1st of February, basic conditions of accessibility and non-discrimination for the access and use of urbanized public spaces.
   - DB-SI del CTE, section 5 (CTE, Technical Building Code).
   - Article 364 of the POGU of Valladolid, about Accessibility in emergencies.
   - List and Spanish catalogue of invasive alien species.
   - City regulation service of water supply and sanitation.

3.3.3 Technical Specifications

In both types of vertical gardens the system is the same. Both have a galvanized steel frames structure that allows the garden to stand alone. An impermeable layer of 1 cm thickness foamed PVC is installed on the structure. In the Vegetable Board, the PVC is perforated to allow capturing air through the garden through the garden. On the PVC there will be installed rock wool panels, with a density of 170 kg / m^2, especially designed for cultivation. The vegetal finish is different in each one of the gardens. In the vegetal sculpture there will be installed a type of turf and on vegetal board specific plants adapted to the climate of Valladolid, an amount of 40 plants / m^2.

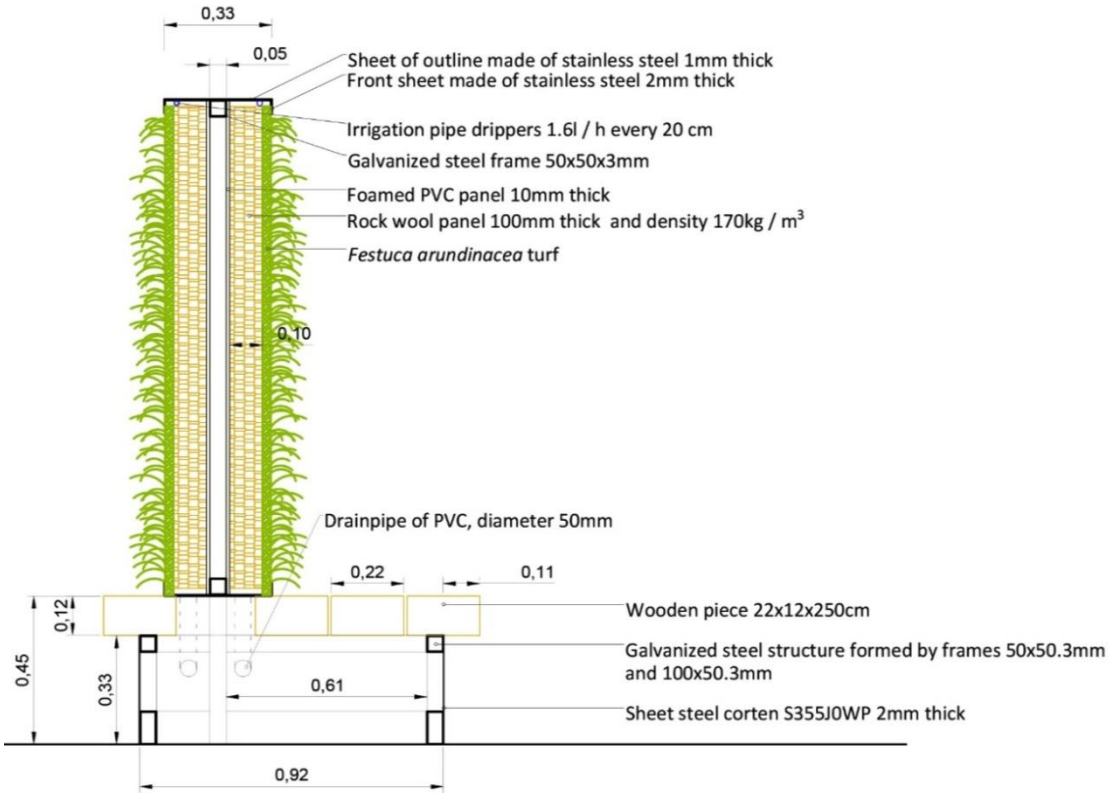


Figure 3.13: Vegetable sculpture constructive section (Source: SingularGreen).

Figure 3.14: Vegetable board constructive section (Source: SingularGreen).

Each vegetable board has 18 solar air fans with battery. These machines are configured to force the circulation of air from outside to inside the vertical garden; then they expel it at a lower temperature and with higher quality. Next figure shows the process of one of them.

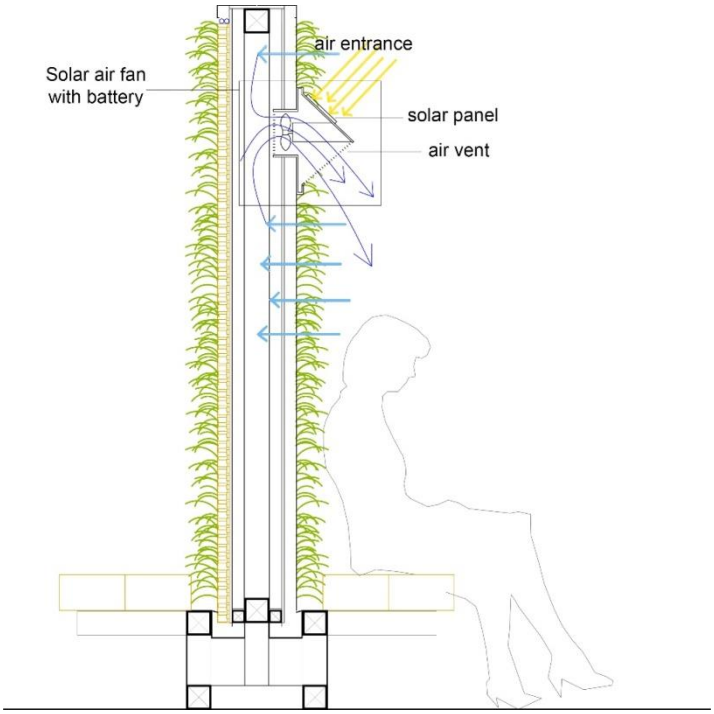


Figure 3.15: Process of air circulation through the vertical garden (Source: SingularGreen).

The irrigation system is the same in both types. In both cases there is no recirculation of water. This solution has been chosen because, if the irrigation is properly adjusted, the excess water amount is very small, and the electricity cost involved in recirculating the water could be very high. In other words, the pollution that is generated in the production of the required electricity is more harmful than pouring a small amount of water into the sanitation network.

Next figure shows the irrigation scheme that is hidden at the bottom of the garden, under the benches.

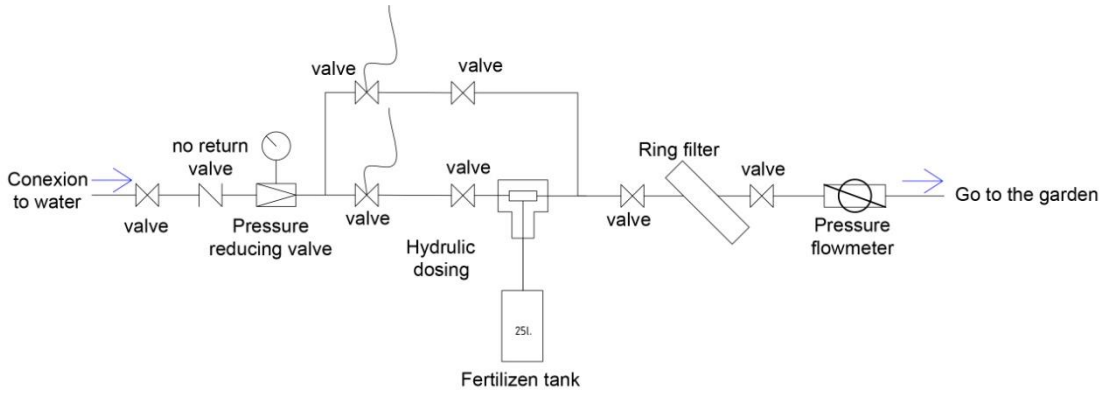


Figure 3.16: Irrigation scheme of Vertical mobile gardens (Source: SingularGreen).

3.3.4 Operational and Maintenance Considerations

Regular maintenance of the Vertical Mobile Garden is required, consisting of a monthly visit to the NBS in which the following tasks are performed:

- Visual inspection of the vegetation status.

- Visual control of irrigation operation.
- Maintenance and start-up of the irrigation system: Filter cleaning, pH and conductivity control.
- Visual control of pests.
- Supply of hydroponics consumables (fertilization, acid, spare parts, etc.).

In addition to that monthly visit, there will be:

- Preventive phytosanitary treatments twice a year (1 in spring and 1 in summer).
- Pruning and growth control twice a year.
- System of telematics control of the irrigation in a maximum term of 3 natural days.

3.3.5 Economic Specifications

In the following table it is shown the NBS estimated cost. The technical specifications have to be detailed in order to adapt the interventions to the available budget.

Vegetable sculpture, 1 unit	unit	quantity	Price (€)	Amount (€)
Installation of vertical garden defined in the technical specifications (impermeable layer of foamed PVC, rock wool panels, turf and irrigation system), forming the plant letters	m^2	18	695,14	12.512,52
Galvanized steel metallic structure formed by frames	unit	1	3.838,81	3.838,81
Letters with the word "VALLADOLID" of stainless steel	unit	1	13.995,68	13.995,68
Water supply pipe and sanitation pipe	m	23	64	1.472,00
Sanitation and potable water connections	unit	2	1.999,38	3.998,76
Transportation from studio	unit	1	2.665,84	2.665,84
Truck crane for loading and unloading	hour	8	50	400
Total budget of material execution (€)				**38.883,61**
Tender budget with VAT (€)				**55.988,51**

Vegetable board, 2 units	unit	quantity	Price (€)	Amount (€)
Installation of vertical garden defined in the technical specifications (impermeable layer of foamed PVC, rock wool panels, specific plants for the climate of Valladolid, an amount of 40 plants / m2 and irrigation system)	m2	32	744,76	23.832,32
Galvanized steel metallic structure formed by frames	unit	2	1780,00	3.560,00
Transportation from studio	unit	2	300,00	600,00
Truck crane for loading and unloading	hour	16	60,00	960,00
Water supply pipe	m	30	60,00	1.800,00
Potable water connection and draining	unit	2	3.000,00	6.000,00

pavement				
Bench	unit	2	666,87	1.333,74
Solar air fan with battery	unit	32	90,00	2.880,00
Total budget of material execution (€)				**40.966,06**
Tender budget with VAT (€)				**58.987,03**

Table 3.5: Vertical mobile gardens budget ((Source: SingularGreen).

3.4 Green Façade (VAc25)

3.4.1 General Description

A green façade is a constructive system that allows to plant vegetable species in the entire vertical surface of a façade. The structure that supports this system is affixed to the façade. On this structure there are placed different layers and a hydroponic substrate in which the plants grow. The green facade is built with the following elements:

- Irrigation system. Drip irrigation pipes that soak the substrate.
- Metallic structure. This structure is affixed to the façade. The structure is formed by metallic frames separated 45 – 60 cm.
- Waterproof layer. Foamed PVC panel**.**
- Hydroponic substrate. Special rock wool panels for vegetation growth.
- Vegetation. Plants resistant to the climatic conditions of the place.
- Water collection system. All the water from the irrigation system is collected on the bottom of the garden.

The vertical garden in the city of Valladolid is planned to be installed in the private building of the department store 'El Corte Inglés'. Initial design has a total dimension of 366.11 m^2 divided into two façades. The north façade is going to have an area of 296.89 m^2, and the east facade is going to have 69.22 m^2, planned in the initial designs.

Figure 3.17: Image of the green façade in El Corte Inglés department store (Source: El Corte Inglés)

The design of this vertical garden is conditioned by the existing façade. The current façade has a very marked geometry of hexagons, and it has been decided to integrate this NBS into the building with the same geometry.

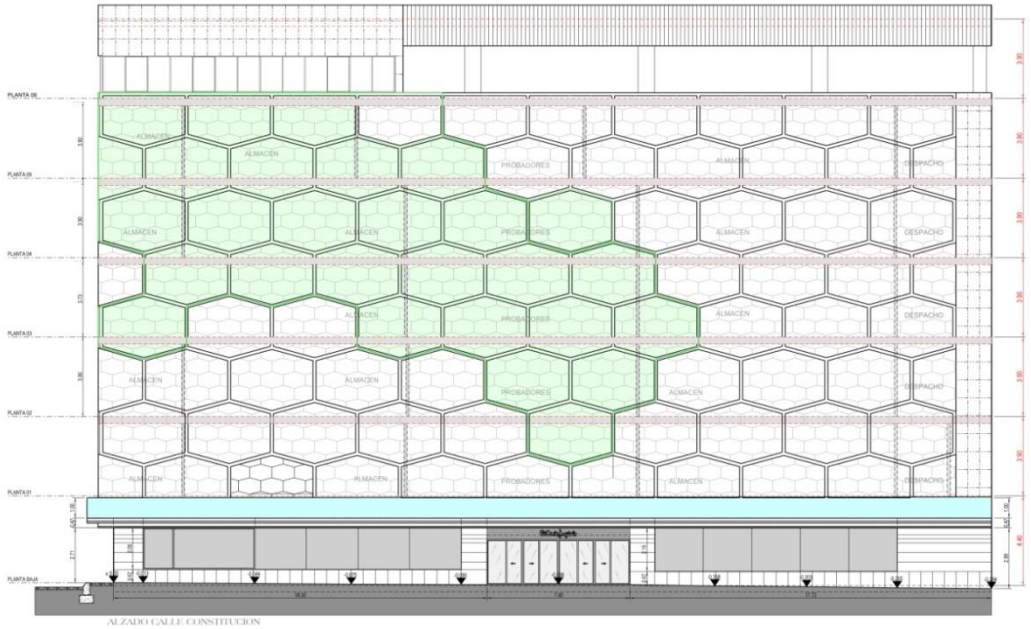


Figure 3.18: North green façade - El Corte Inglés (Source: SingularGreen).

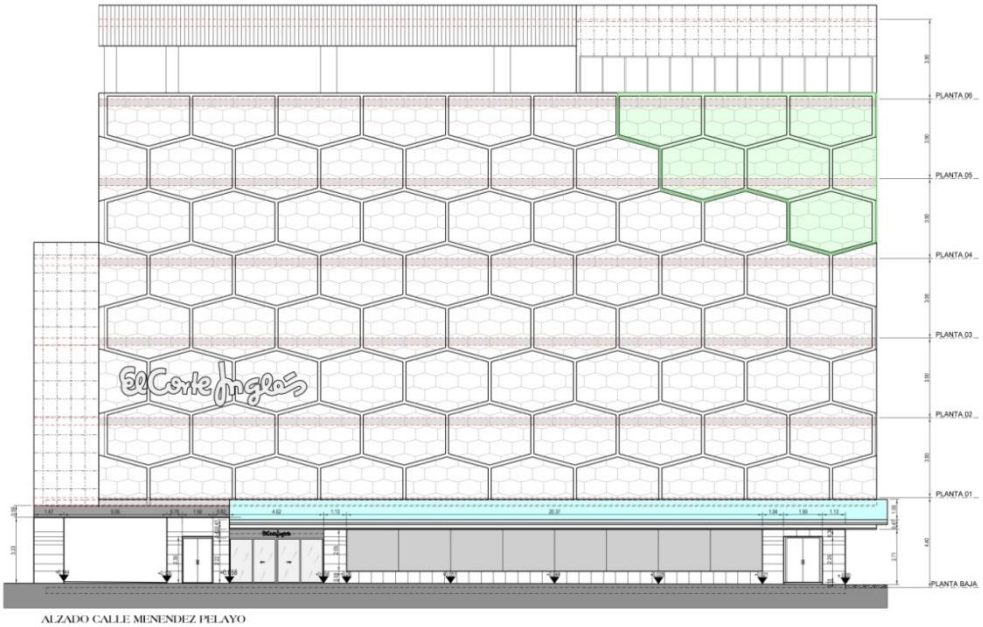


Figure 3.19: East green façade - El Corte Inglés (Source: SingularGreen).

3.4.2 Location

El Corte Inglés is a private commercial department store which has a building located in Constitución Street, in the heart of Valladolid, very well connected with other NBS. This

building was chosen, among other reasons, because it is a very busy department store and it will have a large impact in the citizens. It is also interesting to involve a private company in the green infrastructure development through the URBAN GreenUP project, as it will have a demonstrator and leading effect on other private companies and stakeholders.

On the technical side, this department store has a huge façade not provided with decorative elements, structurally ready and suitable to support a large vertical garden.

Figure 3.20: Green façade location in the Corte Inglés (Source: Google/SingularGreen elaboration).

The Green Façade must comply with the following Spanish regulations:

- Technical Building Code, DB-SE. Technical Building Code, DB-SI. Technical Building Code, DB-HS.
- List and Spanish catalogue of invasive alien species.
- Regulation of the municipal service of water supply and sanitation.

3.4.3 Technical Specifications

Durability and ease of maintenance: this is one of the main criteria to select a vertical garden system. There are several types of vertical garden solutions: made with textiles, stone wool, granular substrates, sphagnum… and they are divided into two groups: hydroponics (with the growing medium inert or organic) or with granular substrate. It's widely accepted that hydroponics and semi-hydroponics gardens with inert substrates have a greater durability, because the inert growing mediums don't change their chemical composition and its physical structure over time unlike the granular substrates, that change their properties, no matter how well formulated they are done.

The mineral wool election as a growing medium is related to the durability need and offers a better roots protection against cold weather. "El Corte Inglés" team, after studying several solutions arrived to the same conclusion about mineral wool substrate as the option that offers the best quality warranty and durability. Another reason why mineral wool has been chosen as substrate is the lightweight: each additional kg on the system supposed an extra cost in supporting structure that could made the project non-viable. Mineral wool is more pollutant than other ones, but with a longer lifecycle that mitigates the impact.

PVC panels have been chosen because is the most cost-effective material in order to maximize the green surface and to improve the impact on the environment before opting for other more sustainable materials but more expensive. Other materials with less ecological footprint, for example HDPE recycled panels or expanded polystyrene panels reinforced with GRP, have been analysed, but the garden has to be stable and green as soon as possible, in order to meet the monitoring requirements of the project.

The Green Façade is composed by three main elements:

1. Clamping structure.
2. Vertical garden.
3. Irrigation system.

Each component is technically detailed.

1. Clamping structure of the green façade

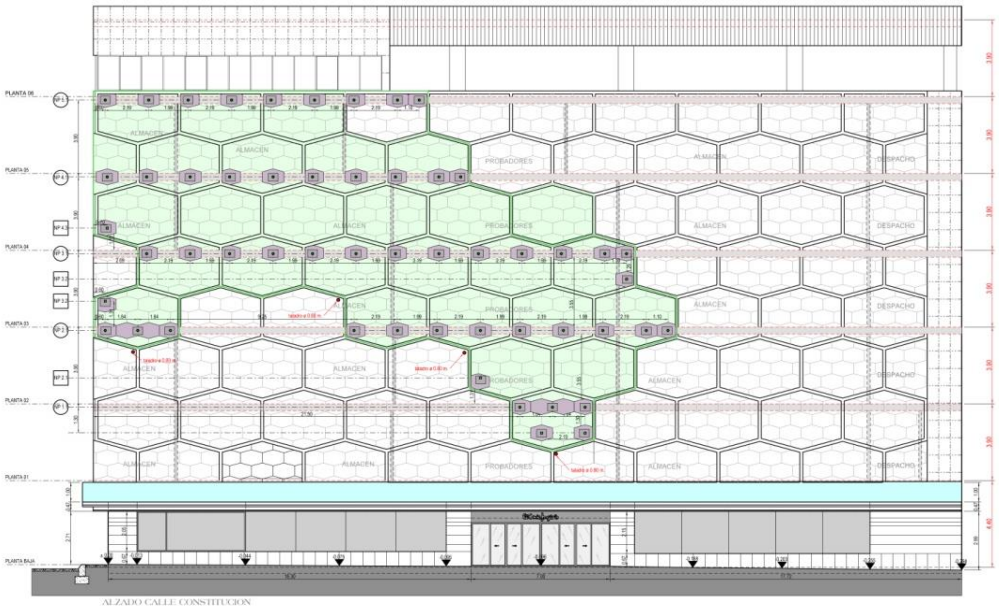


Figure 3.21: Camping structure on the north façade - Green facade in the Corte Inglés (Source: El Corte Inglés).

The current owners of El Corte Inglés bought the building years ago from another company, so there is little knowledge about what exactly load the façade can hold. There have been celebrated several meetings with the technical team responsible for the buildings of El Corte Inglés, to decide the structural system that will support the vertical garden.

The structure designed is fixed to the slabs, pierce the current façade.

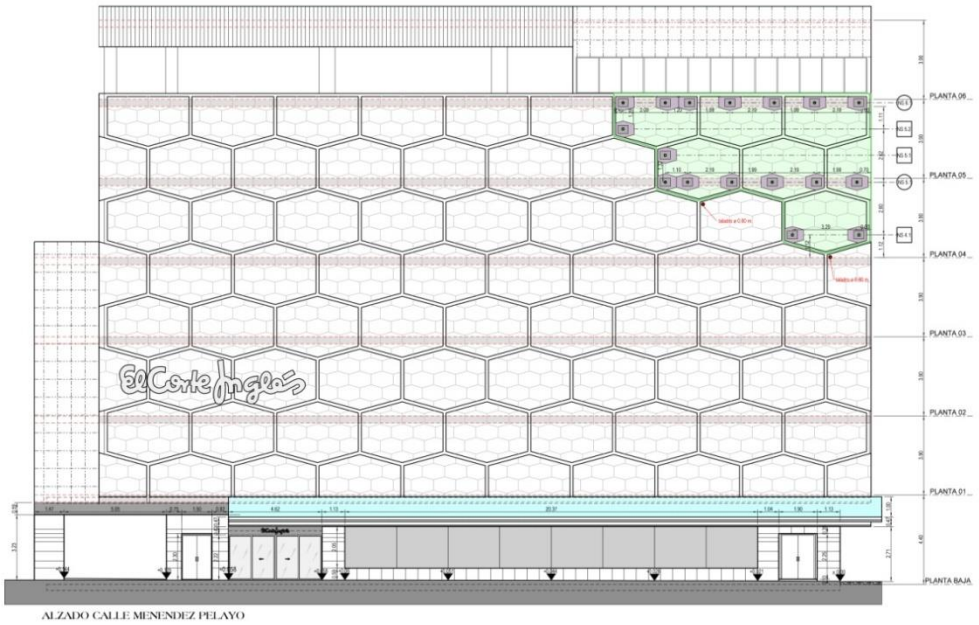


Figure 3.22: Camping structure on the east facade - Green facade in the Corte Inglés (Source: El Corte Inglés).

In the following image appears the detail of moorings to the slabs.

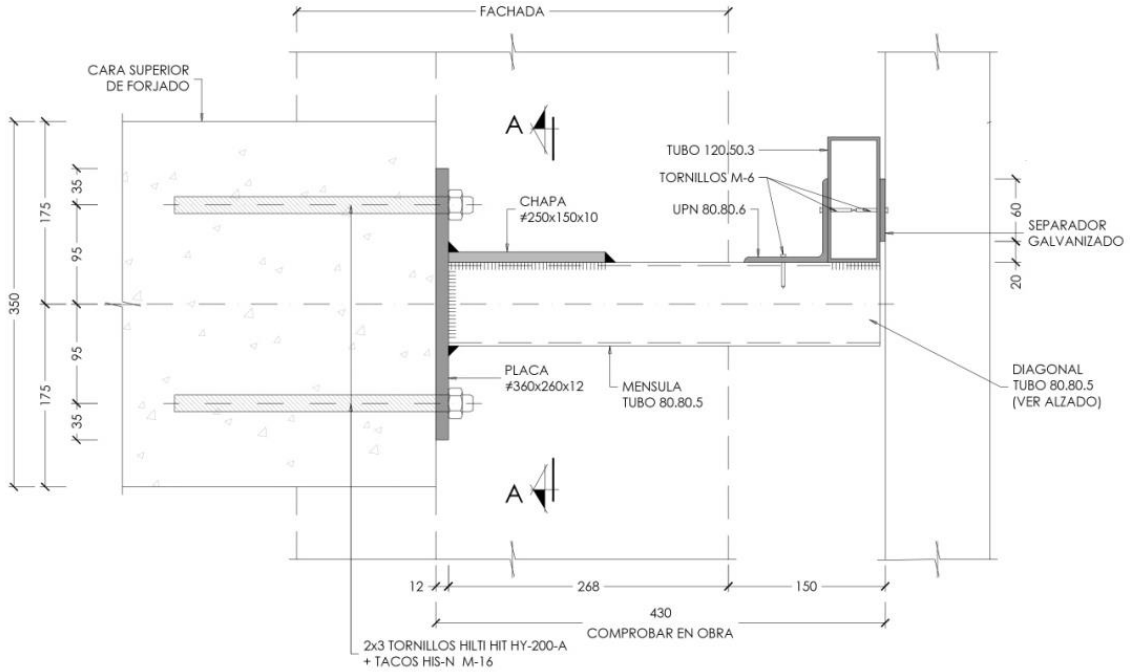


Figure 3.23: Moorings to the slabs - Green façade in the Corte Inglés (Source: El Corte Inglés).

In some points of the green façade it is not possible to fix the structure to the slab and it is needed to build secondary structures.

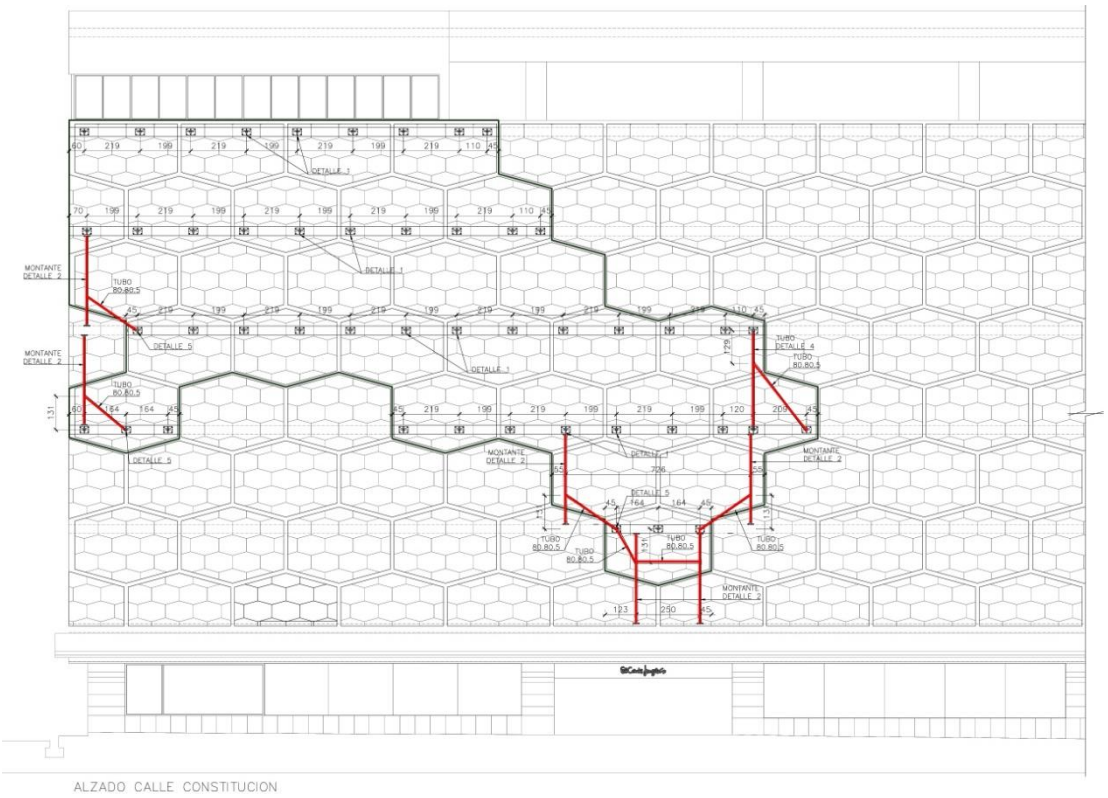


Figure 3.24: Secondary structure on the North façade - El Corte Inglés (Source: El Corte Inglés).

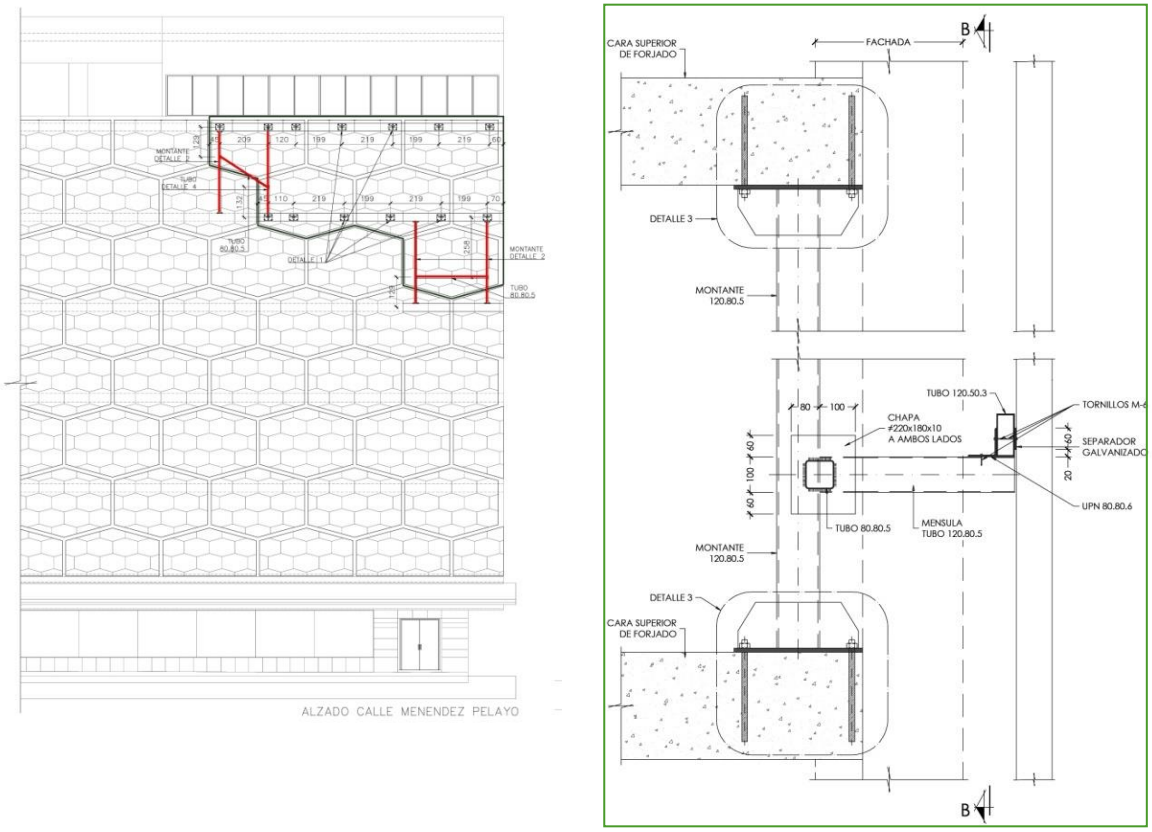


Figure 3.25: Secondary structure on the East façade and detail of a secondary pillar (Source: El Corte Inglés).

2. Vertical garden

The vertical garden is composed by aluminum frames fixed to the clamping structure. An impermeable layer of foamed PVC 1 cm thick is installed on the frames. On the PVC there will be installed rock wool panels, with a density of 170 kg / m^2, designed for cultivation. The vegetation is specific plants adapted to the Valladolid climate, an amount of 40 plants / m^2. The substrate is dampened by drip pipes.

Next figure shows the constructive section.

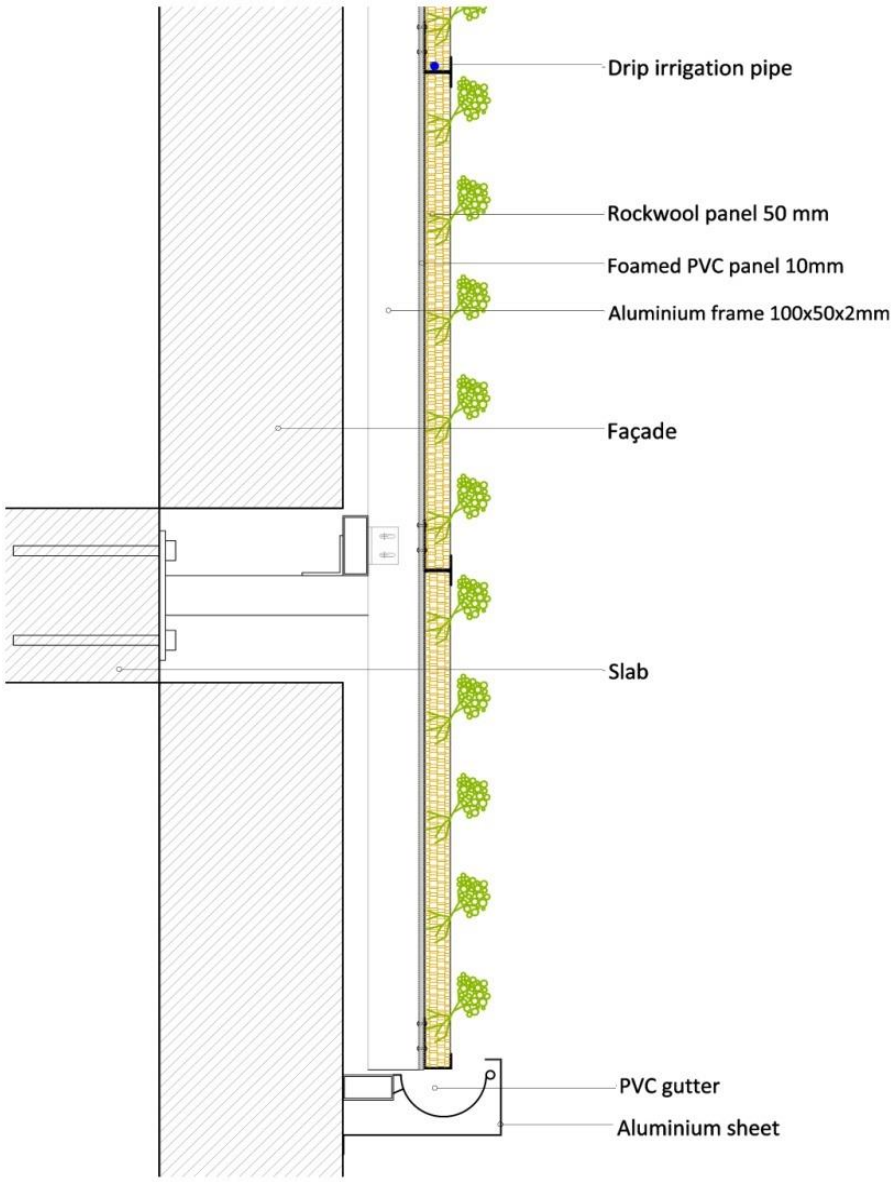


Figure 3.26: Constructive section of the vertical garden - Green façade in the Corte Inglés (Source: SingularGreen).

3. The irrigation system

In the irrigation system there is no recirculation of water. We have chosen this solution because if the irrigation is properly adjusted, the excess water amount is very small, and the

electricity cost involved in recirculating the water is very high. In other words, the pollution that is generated in the production of the required electricity is more harmful than pouring a small amount of water into the sanitation network.

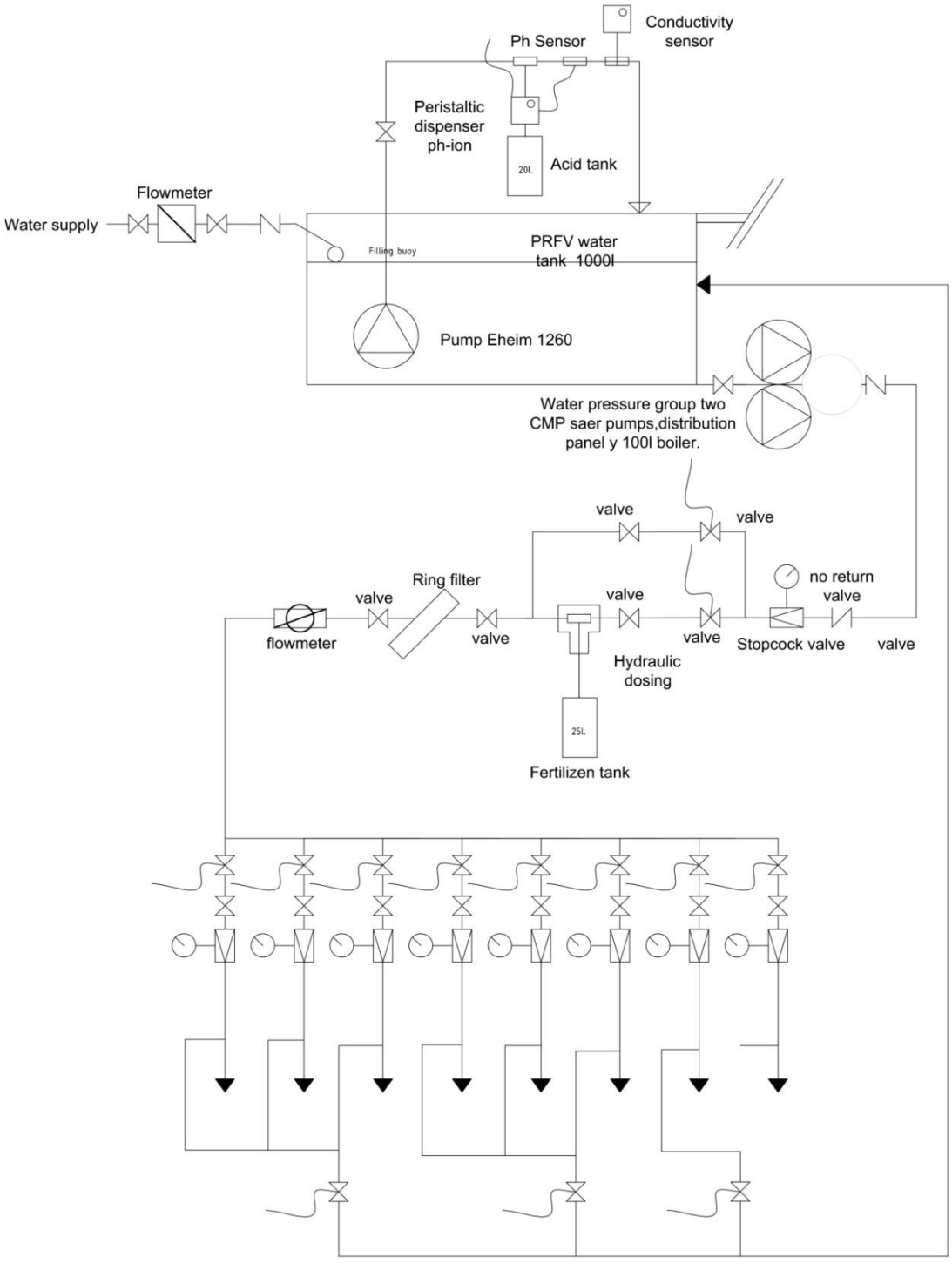


Figure 3.27: Irrigation scheme - Green facade in the Corte Inglés (Source: SingularGreen).

3.4.4 Operational and Maintenance Considerations

Mineral wool vertical gardens are ones with the less maintenance costs in the market.

Regular maintenance of the Vertical Mobile Garden is required, consisting of a monthly visit to the NBS in which the following tasks are performed:

- Visual inspection of the vegetation status.
- Visual control of irrigation operation.
- Maintenance and start-up of the irrigation system: Filter cleaning, pH and conductivity control.
- Visual control of pests.
- Supply of hydroponics consumables (fertilization, acid, spare parts, etc.)

In addition to that monthly visit, there will be:

- Preventive phytosanitary treatments twice a year (1 in spring and 1 in summer).
- Pruning and growth control twice a year.
- System of telematics control of the irrigation in a maximum term of 3 natural days.

The use of pesticides or fungicides in this kind of vertical gardens is not usually necessary.

3.4.5 Economic Specifications

The following is the current budget for the green façade in El Corte Inglés building of Constitución St in Valladolid city centre. Total eligible budget for intervention VAc25 is 145.000€ (130.500 € European Commission + 14.500 € co-financing Valladolid City Council).

Vegetable sculpture, 1 unit	unit	quantity	Price (€)	Amount (€)
Installation of vertical garden defined in the technical specifications • Aluminum metallic structure formed by frames • Impermeable layer of foamed PVC • rock wool panels • vegetation • irrigation system	m^2	366,11	403,34	147.666,81
Clamping structure and building adaptation	unit	1	60.470,32	60.470,32
Total budget of material execution (€)				**208.137,13**
Tender budget with VAT (€)				**299.696,65**

Table 3.6: Green façade budget (Source: Singulargreen and technical team of El Corte Inglés)

This intervention is economically oversized concerning current URBAN GreenUP budget. The technical-economic specifications are being adapted to that limit, but there are also being explored other co-financing options.

3.5 Green Covering Shelter (VAc27)

3.5.1 General Description

A Green Covering Shelter is a very light type of green roof. This type of green roof has a very light and thin substrate to avoid a big load on the roof of the shelters.

In Valladolid, this NBS has 488 m^2, divided into four parts, according to the following image.

Figure 3.28: Aerial view of the Green Covering Shelter (Source: Google/SingularGreen elaboration).

The intervention does not occupy the entire surface of the shelters since they have structural problems and are not able to support more weight. The chosen vegetation is small so there will not be added too much weight, and it needs little maintenance.

Excepted impacts: With this NBS it is expected fundamentally to reduce air pollution and the heat island effect (HIE).

3.5.2 Location

The Green Covering Shelter is located in Plaza España. In that square there are two shelters. Below these shelters there is a daily fruit market. Next to one of them there is a janitor cupboard with cleaning elements and a water tap. It is planned to install de irrigation system inside this cupboard.

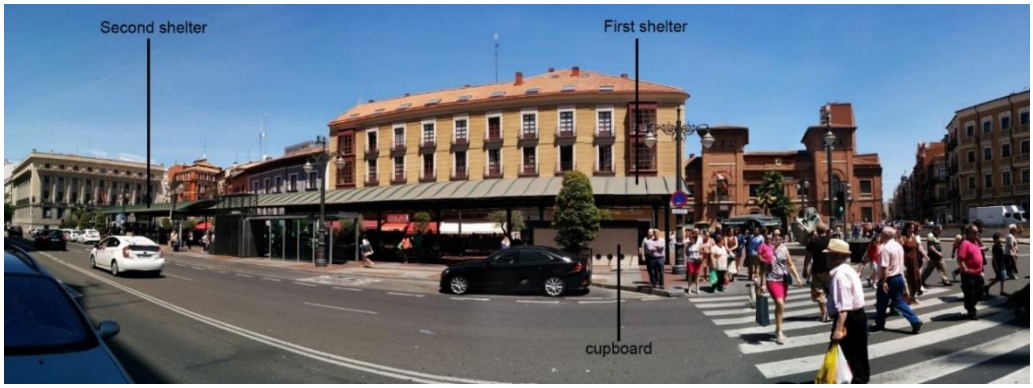


Figure 3.29: Current image of the market shelters in Plaza España (Source: Google/SingularGreen elaboration).

The green covering shelters must comply with the following Spanish regulations:

- Technical Building Code, DB-SE
- List and Spanish catalogue of invasive alien species.
- City regulation service of water supply and sanitation

3.5.3 Technical Specifications

The election of the green roof system for these shelters responds to the main problem of limited load in the roof. The existing structure is already working in the 92% of its capacity, so the maximum load we can apply was 26 kg/m2, and only in part of the surface:

- The quantity of substrate must be very small, so irrigation system and use of fertilizers are mandatory.
- The growing medium should be very stable to avoid the wind action.
- The solution must be so light that must be affixed to the roof in a way that the wind cannot rip it off.
- The installation should be as fast as possible.

With all those considerations, there were only three possible substrates: mineral wool, sheep wool, growing polyurethane foam. Granular substrates have been discarded because of the weight, the slope and the need to contain them. Polyurethane foam has been discarded because it's a very new material without installing experiences more than 10 years. Natural sheep wool is the more sustainable option but it has been discarded because it couldn't be adhered to the roof, in the tests done the material unravels and breaks away, and the mechanical fixations are not possible because they can endanger the waterproofing and the aesthetic of roof from below. Mineral wool 80 kg/m3 and 25 mm thickness remains the only option as substrate.

The quickness and cleanness of installation is another critical point: due to the interruption of the activity of the market during the installation works, the election of a light an easy system has been crucial. Because of that, a sedum turf and mineral wool is proposed.

The adopted solution allows us to cover the surface of the shelters that the structural limit allows, with the available budget, and being totally green from the beginning (sedum turf). Economically it's a solution a little bit under the range for that kind of systems in the market.

This type of green roof is built with the following layers (from bottom to top):

- Waterproofing with polyurethane membrane, polyurea or similar, minimum application of 3kg/m2, anti-slip system, anti-root and M2 flame retardant certificates, UV resistant, estimated life cycle minimum 25 years, applied by airless spray gun.
- Special inert substrate of rock wool 40mm thickness and 100kg/m3 density, 90x60cm size, slotted and glued by type T11 adhesive or similar.
- Mulch coverage of 1 cm and sedum cuttings of 200 g/m^2.
- Irrigation system composed by drip pipes to bury, drippers of 0.7 l /h placed each 20 cm, sprinkler irrigation system formed by MP rotator or similar and sprinkler (including special PVC parts for fixing the sprinklers to the ribs).

In the next images you can consult the general dimensions and details of this NBS.

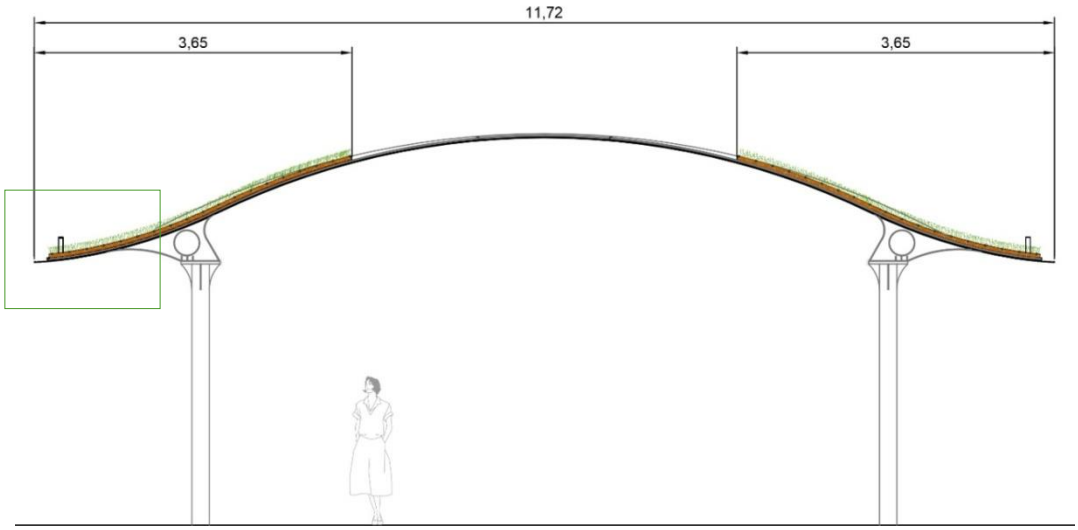


Figure 3.30: Elevation of the Plaza España green covering shelter (Source: SingularGreen).

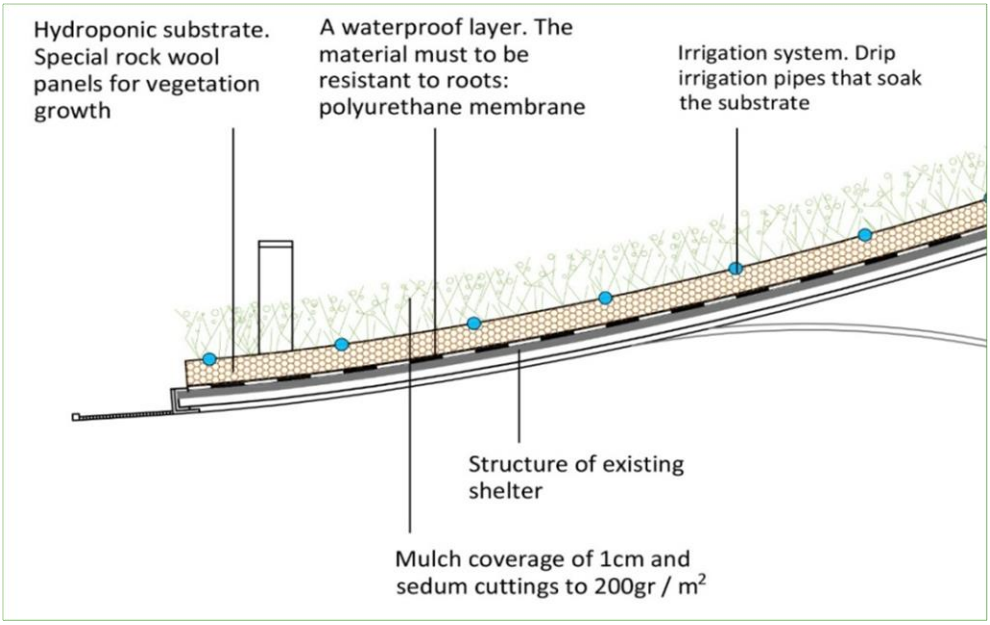


Figure 3.31: Detail of the Green Covering shelter design (Source: SingularGreen).

One of the main difficulties of this roof is to irrigate without wasting a big amount of water, due to the small substrate layer. Because of that, we provided an irrigation drip pipe 0,7 l7h, each 20 cm, while the conventional pipes are 2 l/h. The installation has a telematics system, to avoid excessive consumption. It does not include humidity sensors because, this kind of sensors could generate errors in the calibration and give wrong measures very easily, so they increase the maintenance costs and even the water consumption, due to the inaccuracy on their monitoring. A re-cycling system to save water consumption is not possible, because there is not space enough for the deposits.

Next figures show the irrigation scheme that is planned to be hidden in the cupboard.

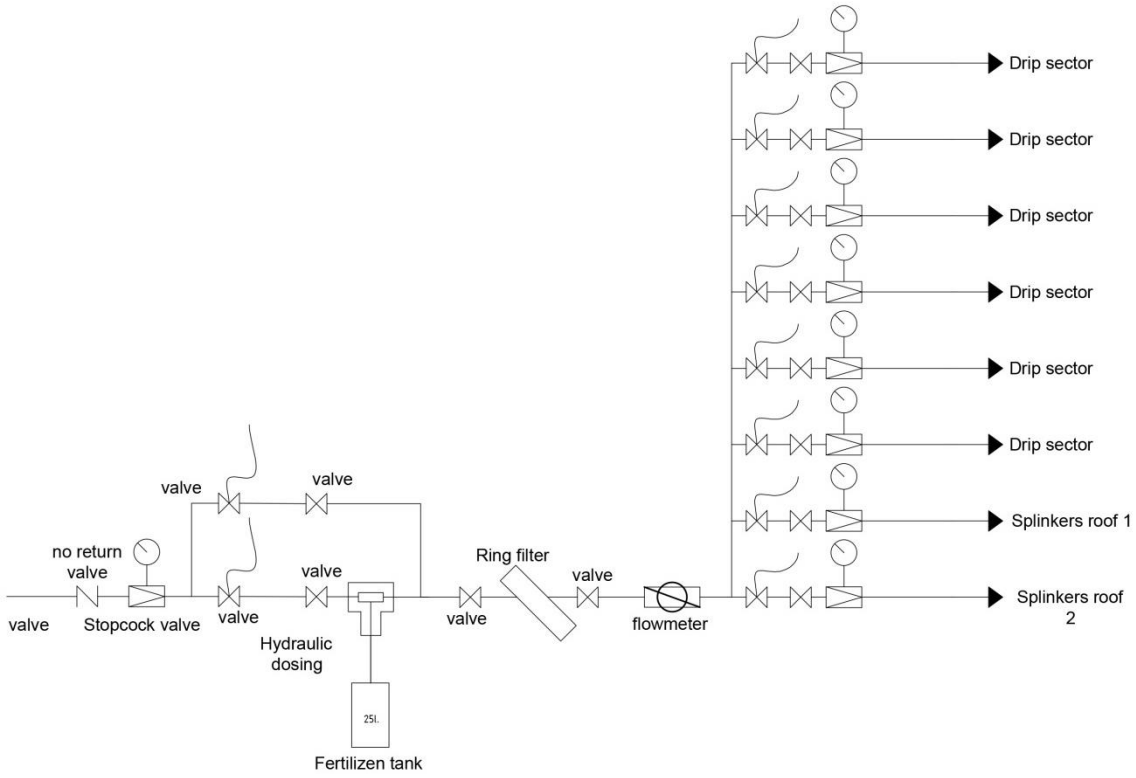


Figure 3.32: Green Covering Shelter irrigation scheme (Source: SingularGreen).

3.5.4 Operational and Maintenance Considerations

Regular maintenance of the Green Covering Shelter is required, consisting on a monthly visit to the NBS, in which the following tasks are performed:

- Visual inspection of the vegetation status.
- Visual control of irrigation operation.
- Maintenance and start-up of the irrigation system: Filter cleaning, pH and conductivity control.
- Visual control of pests.
- Supply of hydroponics consumables (fertilization, acid, spare parts, etc.)

In addition to that monthly visit, there will be:

- Preventive phytosanitary treatments twice a year (1 in spring and 1 in summer)
- Pruning and growth control twice a year.
- System of telematics control of the irrigation in a maximum term of 3 natural days.

3.5.5 Economic Specifications

In the following table it is shown the NBS estimated cost:

Green Covering Shelter	unit	quantity	Price (€)	Amount (€)
Inert substrate, vegetation and drip irrigation pipes	m^2	488	77,91	38.022,11
Waterproofing	m^2	789,20	22,97	18.127,92

Lifeline	m	2	791,00	1.582,00
Connection to water and electricity	ud	1	3.000,00	3.000,00
Adaptation of the cupboard for irrigation station	unit	1	3.000,00	3.000,00
Total budget of material execution (€)				**63.732,03**
Tender budget with VAT (€)				**91.767,75**

Table 3.7: Green covering shelter budget (Source: SingularGreen)

3.6 Green Roof (VAc28)

3.6.1 General Description

There are different types of green roofs. The most common classification is extensive and intensive green roofs. There is another way to differentiate this type of NBS, by the type of substrate. There are green roofs with granular substrates that are usually heavier and green roofs with synthetic substrate that are lighter. The vegetation that can be planted in each of them is different. On roofs with granular substrate depending on the thickness of the substrate we can plant all kinds of vegetation. Only small plants with little nutrient requirements can be planted on roofs with synthetic substrate.

In Valladolid, it is planned to build a green roof with inert substrate because the surface that is going to be covered has a particular geometry. This type of vegetation roof has the advantage that it can be adhered to inclined surfaces.

This NBS in Valladolid is divided into 7 small vegetable roofs with a semi-cylindrical shape, adapted to the current surface of El Campillo Market. The market building has infiltration waters problems, and it is not possible to modify other parts of the roof.

Figure 3.33: Aerial view of the Green Roof in El Campillo Market (Source: Google/SingularGreen elaboration).

The total area of the NBS is 244 m^2; the small vaults are 28 m^2 and the large vaults 40 m^2. The weight of the green roof saturated with water is 26 kg/m^2.

Figure 3.34: Image of Campillo Market roof with the Green Roof render (Source: SingularGreen)..

3.6.2 Location

The Green Roof is located on the roof of the Campillo Market, in Panaderos Street. The roof of this building is a walking surface, which is currently closed to the public. With the construction of this NBS the roof will be revitalized and renewed. This area might be transformed into an open urban space again, available for the citizens' enjoyment and well-being.

Figure 3.35: Current image of the shelters of the Campillo Market (Source: SingularGreen).

The Green Roof must comply with the following Spanish regulations:

- Technical Building Code, DB-SE
- Technical Building Code, DB-SI
- Technical Building Code, DB-HS
- List and Spanish catalogue of invasive alien species.
- City regulation service of water supply and sanitation

3.6.3 Technical Specifications

This type of green roof is built with the following layers (from bottom to top):

1. Waterproofing with polyurethane membrane, polyurea or similar, minimum application of 3kg/m2, anti-slip system, anti-root and M2 flame retardant certificates, UV resistant, estimated life cycle minimum 25 years, applied by airless spray gun.

2. Special inert substrate of rock wool 40mm thickness and 100kg/m3 density, 90x60cm size, slotted and glued by type T11 adhesive or similar.
3. Mulch coverage of 1cm and sedum cuttings of 200gr/m^2

The limited load, structural and space requirements are very similar to the green cover shelters in Plaza España, so because of that the same solution is chosen.

Irrigation system composed by drip pipes to bury, drippers of 0.7 l /h placed each 20cm, sprinkler irrigation system formed by MP rotator or similar and sprinkler (including special PVC parts for fixing the sprinklers to the ribs).

Irrigation station is formed by a Galcon GSI or similar remote control system, a 2HT filter, hydraulic dispenser Mixrite 1000 or similar and the necessary stopcocks.

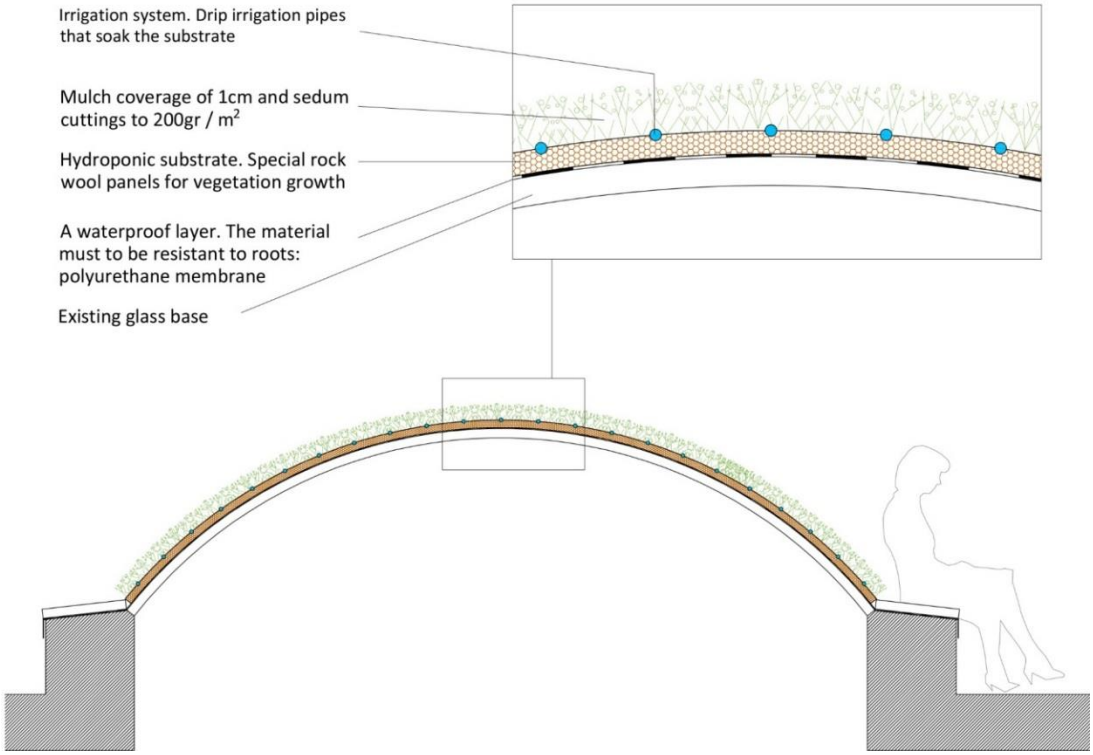


Figure 3.36: Technical detail of the Green Roof (Source: SingularGreen).

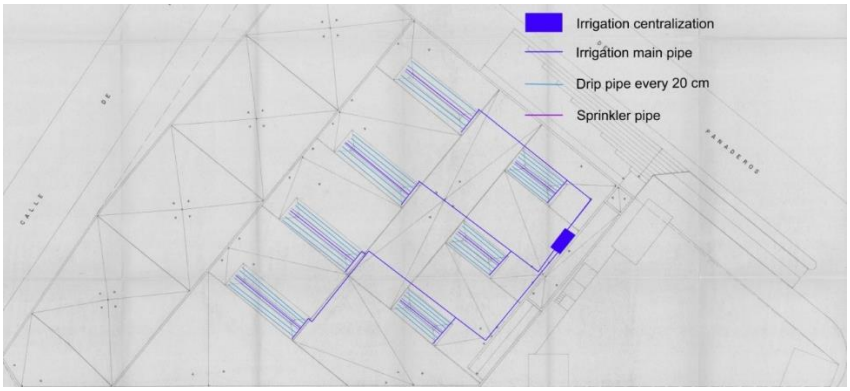


Figure 3.37: Pipe distribution of the Green Roof (Source: SingularGreen).

3.6.4 Operational and Maintenance Considerations

Regular maintenance of the Green Covering Shelter is required, consisting on a monthly visit to the NBS, in which the following tasks are performed:

- Visual inspection of the vegetation status.
- Visual control of irrigation operation.
- Maintenance and start-up of the irrigation system: Filter cleaning, pH and conductivity control.
- Visual control of pests.
- Supply of hydroponics consumables (fertilization, acid, spare parts, etc.)

In addition to that monthly visit, there will be:

- Preventive phytosanitary treatments twice a year (1 in spring and 1 in summer)
- Pruning and growth control twice a year.
- System of telematics control of the irrigation in a maximum term of 3 natural days.

3.6.5 Economic Specifications

In the tables of this section the approximate costs of the installation of the NBS appear.

Green Roof	unit	quantity	Price (€)	Amount (€)
Inert substrate, vegetation and drip irrigation pipes	m^2	244	119,76	29.221,44
Waterproofing	m^2	244	22,97	5.604,68
Total budget of material execution (€)				**34.826,12**
Tender budget with VAT (€)				**50.146,13**

Table 3.8: Green roof budget (Source: SingularGreen)

3.7 Green Shady Structures (VAc29)

3.7.1 General Description

There are different types of green shady structures depending on the design of the structure and the type of vegetation. In the city of Valladolid, we are going to develop green shade structures with stretched textile structures.

This type of NBS is made by pieces of stretched textile structure on which an inert substrate is installed. This inert substrate is covered with seeds that germinate and grow on the textile structure. This NBS can be fixed to the facades of the buildings on the street or by posts located on the sidewalk. In this case, the structures are fixed to the façades.

In the city of Valladolid, each one of the pieces is triangular with an approximate length of 4m on each side. This NBS also has a public lighting installation.

Figure 3.38: Image of Santa María Street with the Green Shady Structures (Source: SingularGreen).

Excepted impacts: With this NBS we expect fundamentally reduce air pollution and the heat island effect and increase the commercial activity of the zone.

3.7.2 Location

The Green Shady Structures are planned to be located in two streets, Zúñiga Street and Santa María Street. The total intervention length is 201 meters in Santa María Street, and 188 meters in Zúñiga Street. Both streets are finished in squares where there are not-used kiosks that there will be used as a room for irrigation facilities, grabbing the current misused public infrastructure.

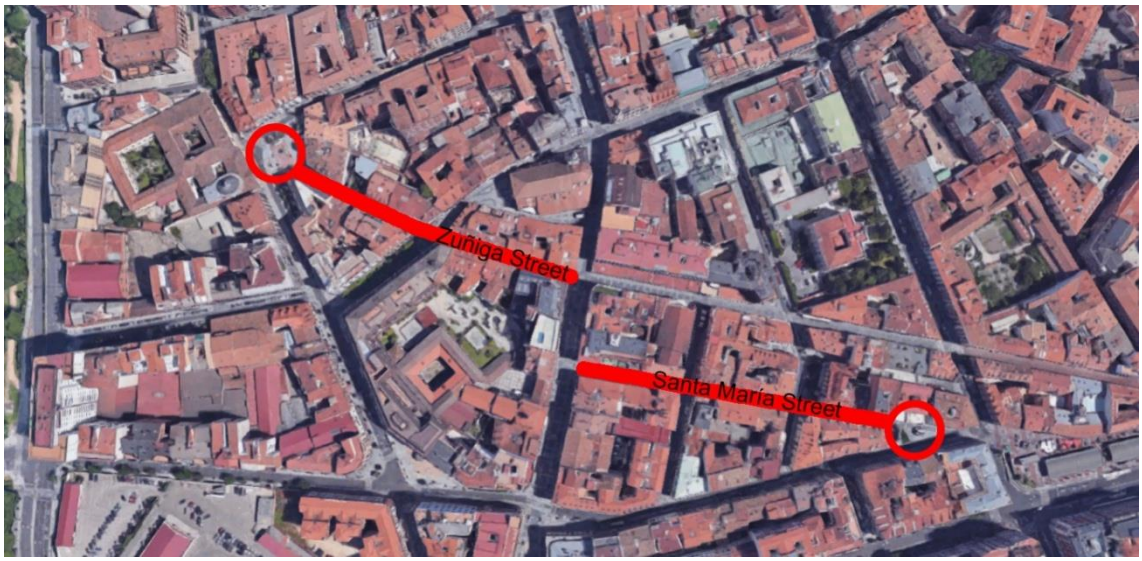


Figure 3.39: Location of Green Shady Structures (Source: Google/SingularGreen elaboration).

Figure 3.40: Santa María Street Floor plan - Green Shady Structures (Source: SingularGreen).

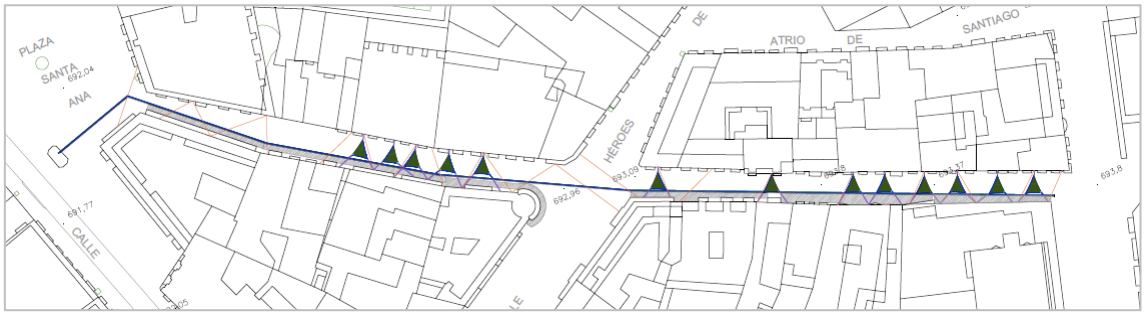


Figure 3.41: Zúñiga Street Floor plan - Green Shady Structures (Source: SingularGreen).

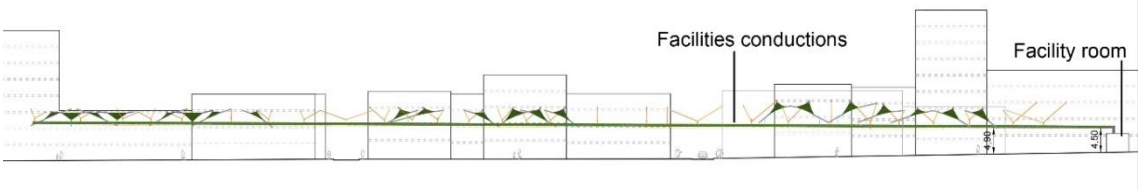


Figure 3.42: Santa María Street Elevation plan - Green Shady Structures (Source: SingularGreen).

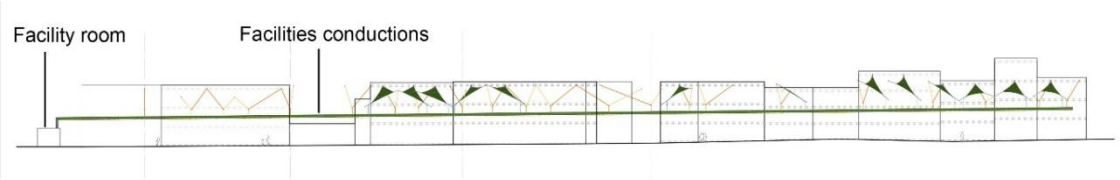


Figure 3.43: Zúñiga Street Elevation plan - Green Shady Structures (Source: SingularGreen).

3.7.3 Technical Specifications

Initially, in this project it was planned to install some pergolas with climbing plants in the city centre streets, but after checking with several departments of the city council, that was not possible because of different reasons:

- Firefighting regulations: The selected solution must allow the circulation of a fire fighting truck and unfold the ladder at any point of the street. The solution with climbing plants doesn't allow any of those conditions at the narrow streets of the city centre. The adopted solution allows the circulation of the fire truck and also has an emergency mechanism that hooks off the shade very fast so the ladder can be unfolded at any point of the street.

- Regulations for the pedestrian and vehicles traffic and minimum separation. In the beginning it was planned to construct the pergolas with supporting columns, but the regulations regarding the minimum separation to the facades and traffic circulation made impossible to allocate the columns in the narrow streets, because of that the adopted solution has been hooked on facades.
- Private property. One of the possibilities that was studied is to use the building facades for the climbing plants, but the owners exposed many doubts about it and to get the permission was very difficult, so we decided to implement a solution that doesn't need to ask permissions.4) Holy week processions and festivities. We should warrantee the circulation on holy week and festivities.
- Technical and social difficulties to allocate the supports on the floor. We were not sure about the location of pipes, cables, etc., and to shut down the service to the citizens would be a big disorder to the neighbours. Also the works to open and close the pavements would have a very negative impact on the shops and citizens. The final solution allows a fast installation.

The NBS is composed by three main elements:

- The facilities room. It is an unused newspaper kiosk, where there will be installed the irrigation system machines. An irrigation pipe is coming from this kiosk to the structures and a duct with the excess water returns back to it.
- Aluminium truss. Along this truss we will install the water pipes and an electric cable. Each green shady textile structure has two pipes that connect with the main one in the truss.
- Green shady structure. It is composed by a textile structure with triangular shape, 4 meters on each side. They are fixed to the facades with steel cables and moorings. Two vertices are fixed on the third floor, and one vertex on the second floor.

The green shady structures must comply with the following regulations:

- Order VIV/561/2010, 1st of February, basic conditions of accessibility and non-discrimination for the access and use of urbanized public spaces.
- Technical Building Code DB-SI, section 5
- Article 364 of the POGU of Valladolid, about Accessibility in emergencies
- List and Spanish catalogue of invasive alien species.
- City regulation service of water supply and sanitation.

Next figures show the main parts of the innovative system.

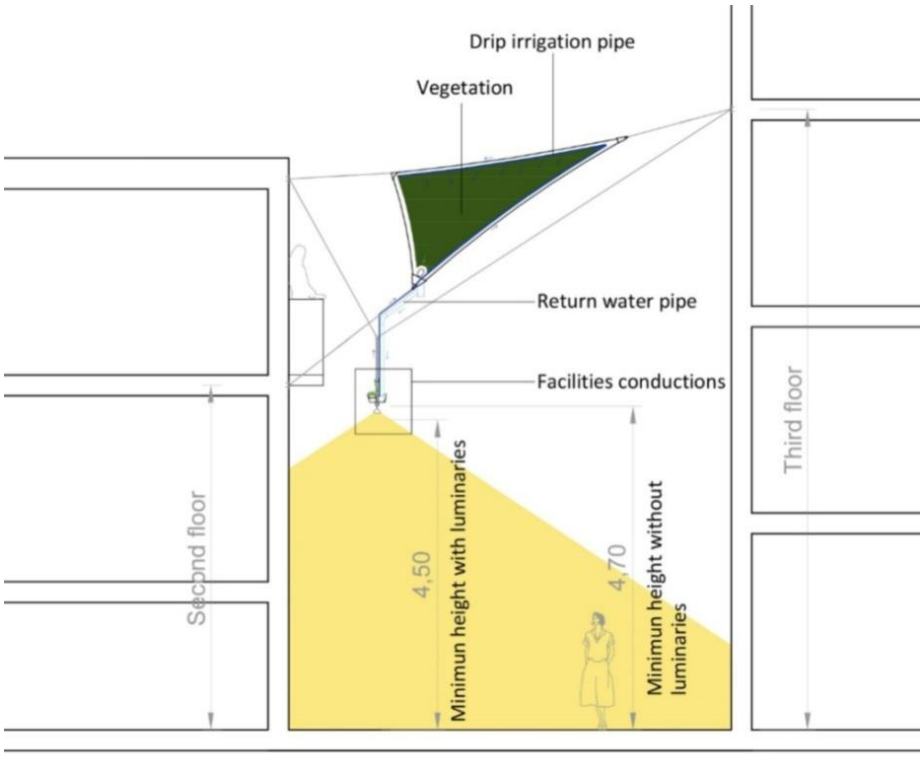


Figure 3.44: General section - Green Shady Structures (Source: SingularGreen).

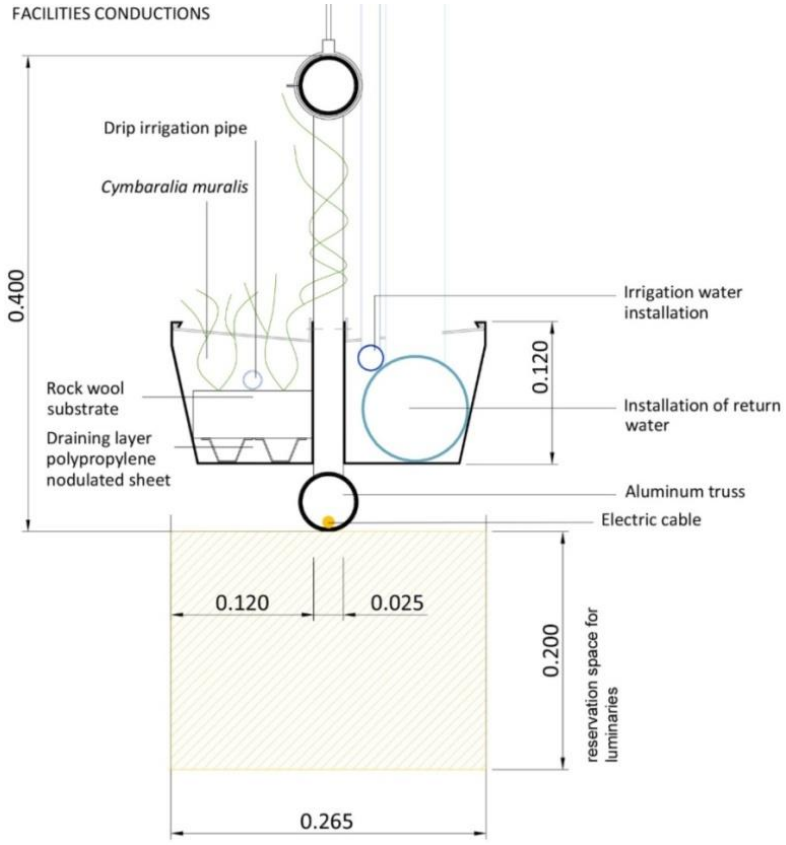


Figure 3.45: Detail of facilities ducts - Green Shady Structures (Source: SingularGreen).

Next figure shows the irrigation scheme that is hidden in the kiosk.

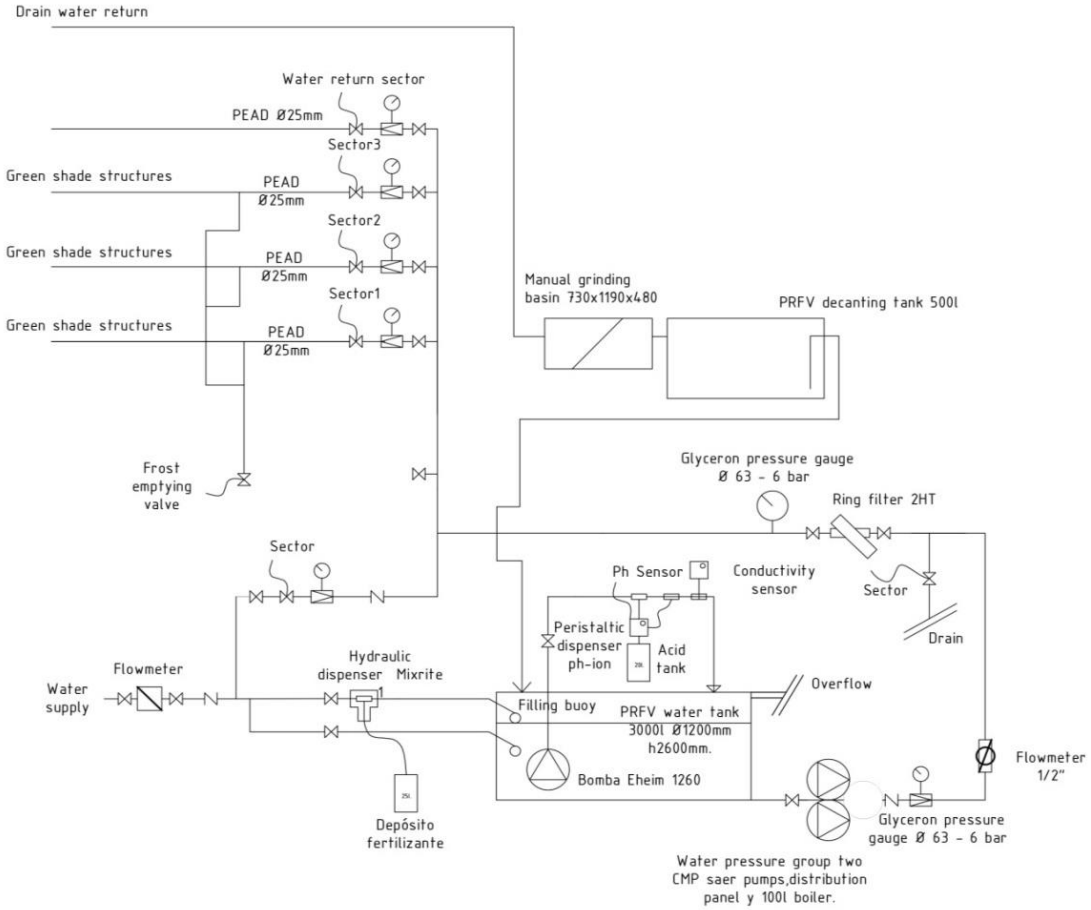


Figure 3.46: Irrigation scheme - Green Shady Structures (Source: SingularGreen).

3.7.4 Operational and Maintenance Considerations

Regular maintenance of the Green Covering Shelter is required, consisting on a monthly visit to the NBS, in which the following tasks are performed:

- Visual inspection of the vegetation status.
- Visual control of irrigation operation.
- Maintenance and start-up of the irrigation system: Filter cleaning, pH and conductivity control.
- Visual control of pests.
- Supply of hydroponics consumables (fertilization, acid, spare parts, etc.)

In addition to that monthly visit, there will be:

- Preventive phytosanitary treatments twice a year (1 in spring and 1 in summer)
- Pruning and growth control twice a year.
- System of telematics control of the irrigation in a maximum term of 3 natural days

3.7.5 Economic Specifications

In the tables of this section there is shown the approximate initial costs of the NBS installation.

Santa María Street

Santa María Street	unit	quantity	Price (€)	Amount (€)
Vegetable covering Leaf-skin	m^2	146	403,61	58.927,06
Stretched textile structures	unit	21	2587,00	54.327,00
Supply and installation of irrigation centralization inside the kiosk	unit	1	9601,96	9601,96
Aluminum truss	m	201	190,80	38.350,80
Water connexion	unit	1	3000	3.000
Sanitation water connection	unit	1	3000	3.000
Adequacy of the kiosk	unit	1	3000	3.000
Total budget of material execution (€)				**170.206,82**
Tender budget with VAT (€)				**245.080,8**

Zúñiga Street

Zúñiga Street	unit	quantity	Price (€)	Amount (€)
Vegetable covering Leaf-skin	m^2	91	403,61	36.728,51
Stretched textile structures	unit	13	2.587,00	33.631
Supply and installation of irrigation centralization inside the kiosk	unit	1	9.601,96	9.601,96
Aluminum truss	m	188	190,80	35.870,4
Water connection	unit	1	3.000	3.000
Sanitation water connection	unit	1	3.000	3.000
Set up of the kiosk	unit	1	3.000	3.000
Total budget of material execution (€)				**124.831,87**
Tender budget with VAT (€)				**179.745,41**

Table 3.9: Green shady structures budget (Source: SingularGreen)

3.8 Electro Wetland (VAc26)

3.8.1 General Description

An Electrowetland (EW) is an innovative and hybrid technology between a constructed wetland and a bioelectrochemical system. The proposed technology consists of a natural wastewater treatment system that, in addition, generates electrical energy from the organic matter degradation. This electricity generated by the system will be stored and later used to monitor some of the parameters that contribute to the HIE. Currently there are few experiences in the world that implement EWs on a real scale; this is why LEITAT optimized the technology before its implementation in Valladolid to guarantee a successful implementation.

More into detail, Horizontal Subsurface Constructed Wetlands (CW) are secondary wastewater treatment systems that are commonly used in medium and small-sized treatment plants. These systems remove organic matter and nutrients, such as phosphorus or nitrogen, through physical, chemical and microbiological processes occurring within the treatment bed. They consist on planted and permanently flooded gravel basins in which wastewater flows horizontally from one side to the other. Since they are permanently flooded systems, CW are mainly anaerobic environments. The surface layer, however, which is in direct contact with air,

has aerobic conditions. Therefore, a redox gradient is naturally generated between the deeper layers and the surface layer, which can be exploited to implement bioelectrochemical systems like Microbial Fuel Cells (MFC). On the other side, an MFC is a bioelectrochemical system that generates electricity from the oxidation of organic matter by means of electroactive bacteria. MFCs are divided in two different chambers: the anodic chamber has anaerobic conditions inside and is where electrons (electricity) are generated from the biological oxidation of the organic matter in the wastewater, while the cathodic ones are aerobic. This fact generates a redox gradient between both compartments, which is the driving force for electricity generation.

An EW, therefore, integrates a bioelectrochemical system within the treatment bed by locating the anode in the deeper part of the wetland, which is in anaerobic conditions and the cathode in the upper part where there are aerobic conditions. Both electrodes are externally connected to harvest the electricity generated. The generated electricity will power the specific sensors to monitor some ambient parameters.

The EW implemented in Valladolid will up to 50 m^2 of treatment surface and will treat a municipal wastewater volume up to 1.5 m^3/day. It will be planted with common reed and the electricity generated will be stored and used to power one temperature and one humidity sensors. Data recorded will be sent to the database by a wireless communication module.

As a wastewater treatment, the EW will participate in the abatement of most wastewater pollutants such as organic matter, N or P. Although not initially integrated in the Valladolid solution, when fulfilling legal requirements treated wastewater may be used for irrigation purposes. Also, the EW will generate electricity, contributing to the Savings in energy use due to improved Green Infrastructure and will promote the Decrease in mean or peak daytime local temperatures.

3.8.2 Location

Due to the nature of the technology, Electrowetland's location must fulfil the following requirements: (1) Surface load higher than 2200 kg/m^2. [6]; (2) Close access to a municipal sewage manhole from which wastewater will be taken; (3) Wastewater availability of at least 3 m^3/day; (4) Area with sunlight; (5) Close electricity source for pumping; (6) Be away from very crowded areas to avoid citizens contact with wastewater (although the sub-superficial flow minimizes possible contact risks).

[6] Environmental Protection Agency of United States (2000) Constructed Wetlands Treatment of Municipal Wastewaters. Office of Research and Developement. EPA/625/R-99/010. Cincinnati, Ohio, United States of America.

Figure 3.47: Electrowetland location (marked in red) (Source: (A) Google Maps, 2018; (B) Aquavall, 2018.)
(A) General Valladolid layout; (B) Municipal sewage layout around the selected area (marked in green).

The best option for the Electrowetland location would be the green area between Fernando Ferreiro St. and Juan Carlos I St (Figure 3.47 - Image B). This green area is placed close to a residential area from which the wastewater generated should have enough organic matter content for Electrowetland feeding. Also unforeseeable toxic discharges from industries, which may affect internal wetland biodiversity, will be avoided. Furthermore, as it can be seen in Figure 3.47 - Image A, it is pretty far from the city centre and therefore it does not constitute a crowded area. Both of the streets surrounding the green area have sewage pipes and several manholes from which wastewater can be taken (Figure 3.47 - Image B). Most common manhole design in Valladolid, provided by Aquavall, is shown in Figure 3.48 - Image A. Both streets surrounding the green area are found at different level thus generating pronounced slope (Figure 3.48 - Image – C). This fact will facilitate, if technically and economically viable, the operation of the Electrowetland by gravity, minimizing the number of pumps.

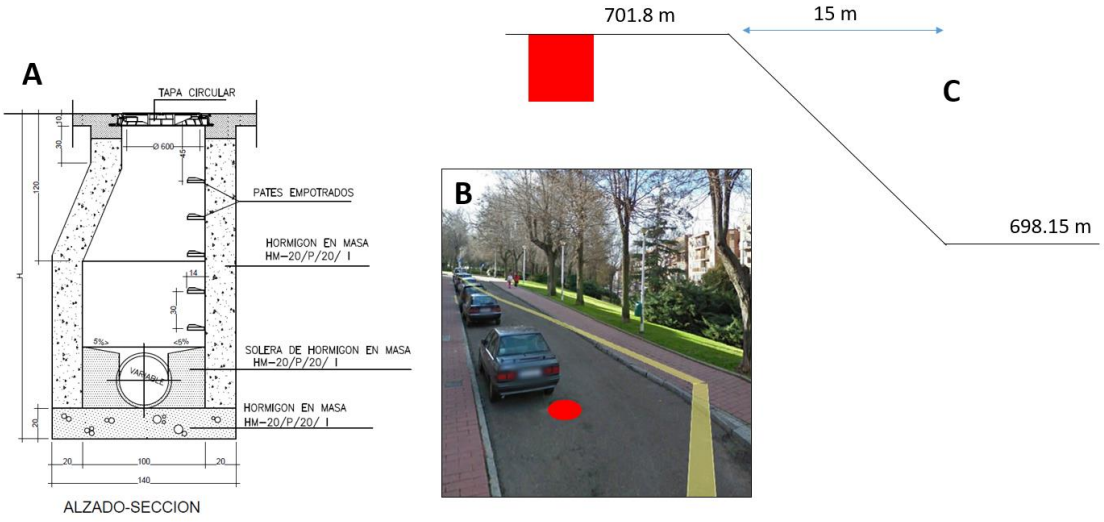


Figure 3.48: Caracterization of the location in Fernando Ferreiro Street (Source: Valladolid City Council/Google).
(A) Section of the common manhole in Valladolid city (Aquavall); (B) View of the Fernando Ferreiro St. The manhole from which wastewater will be taken is marked with a red circle.; (C) Section of the green area between Fernando Ferreiro St. and Paseo de Juan Carlos I where the Electrowetland will be located.

3.8.3 Technical Specifications

A conceptual drawing of an EW is shown in the following figure. As can be seen, both electrodes are introduced within the treatment bed and externally connected in order to generate electricity from the oxidation of the organic matter and taking profit of the naturally generated redox gradient between deeper and upper areas of the treatment bed. This electricity will be used to power temperature and humidity sensors. A more detailed description of the elements that constitute an EW is established in Figure 3.49.

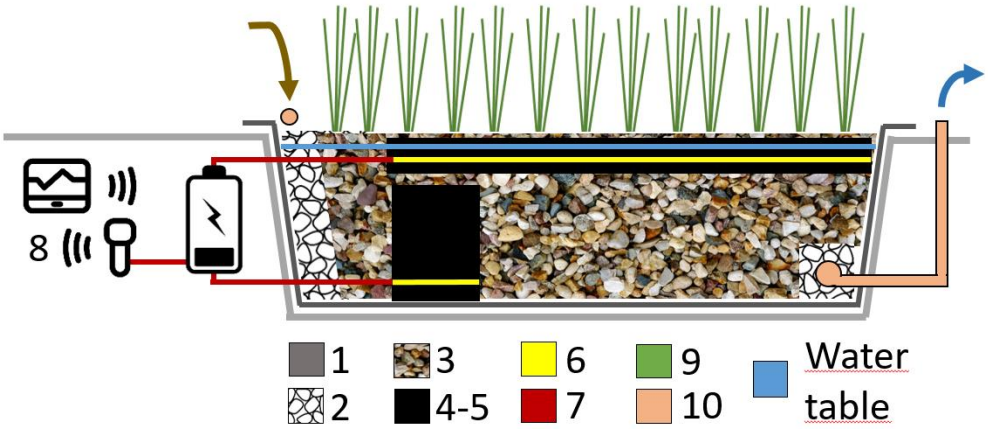


Figure 3.49: Conceptual drawing of an Electrowetland (Source: LEITAT).
(1) Waterproof liner; (2) Coarse gravel; (3) Treatment bed, fine gravel; (4-5) Conductive granular material for the anode and the cathode electrodes; (6) Current collectors; (7) External circuit; (8) Energy harvesting and sensoring systems; (9) Aquatic plants; (10) Inlet and outlet piping.

Element	Description
HSSF CW Elements	
Treatment bed (gravel) 	Constitutes a filter at the time that acts as the base for aquatic plants development and microbial community establishment. It will be permanently flooded with a constant water level at 5 cm below the gravel level. Gravel used will be granitic and of 5-12 mm of diameter.
Aquatic vegetation 	Plant roots provide extra surface for microbiological development, introduce oxygen into de system and participate in nutrient uptake. The treatment bed will be initially planted with *Phragmites australis* at a density of 8 plants/m^2.
Bioelectrochemical system Elements	
Anode (anthracite) 	Constitutes a carbon based conductive support for electroactive bacteria to grow transferring the electrons resulting from the oxidation of the organic matter to the external circuit. It will be made with anthracite 8-18 mm which is a material already used for water treatment. Electrode volume will be of 0.1 m^3/m^2 of Electrowetland.
Cathode (anthracite) 	Constitutes a carbon based conductive support through which electrons coming from the anode are emitted to reduce the final electron acceptor, the oxygen. It will be made with anthracite 8-18 mm. Electrode volume will be of 0.1 m^3/m^2 of Electrowetland.
Current collector 	Due to the granular nature of the anode and the cathode, a current collector is provided to facilitate the flow of electrons to and from the external circuit. It will be made with stainless steel mesh (grade 316L) and placed every 10 cm though all electrodes surface (both anode and cathode).
External circuit	Its function is to externally connect both electrodes by means of the external connection of the anodic and the cathodic current collectors. To this purpose conventional copper wires will be used.
Energy harvesting and sensoring systems	
Energy harvesting	The electricity generated in the Electrowetland will be harvested by means of batteries able to work with low voltages and low intensities.
Sensoring	Humidity and temperature sensors will be connected to the energy harvesting system and powered when enough energy is accumulated.
Data communications	Recorded data will be sent by means of GSM system and Wi-Fi transmission.

Table 3.10: Elements that constitute and EW and their technical description

The EW is a secondary treatment so it will be preceded by a septic tank acting as the primary treatment. The entire treatment line is specified in the following image (Figure 3.50), where the implementation of the EW in the proposed green area and pumping wastewater from the manhole indicated in the diagram. Also an external view of the EW is provided in the following image (Figure 3.51).

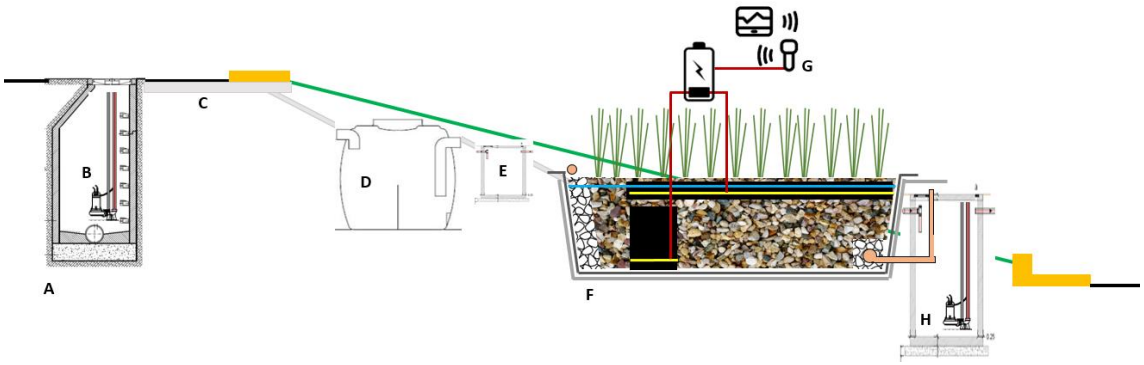


Figure 3.50: Scheme of the treatment line of the Electrowetland (Source: LEITAT).
A) Existing municipal sewage manhole; B) Pumping; C) Connection trench; D) Primary treatment – septic tank; E) Feeding pumping manhole; F) Electrowetland; G) Harvesting and sensoring systems; H) Outflow manhole

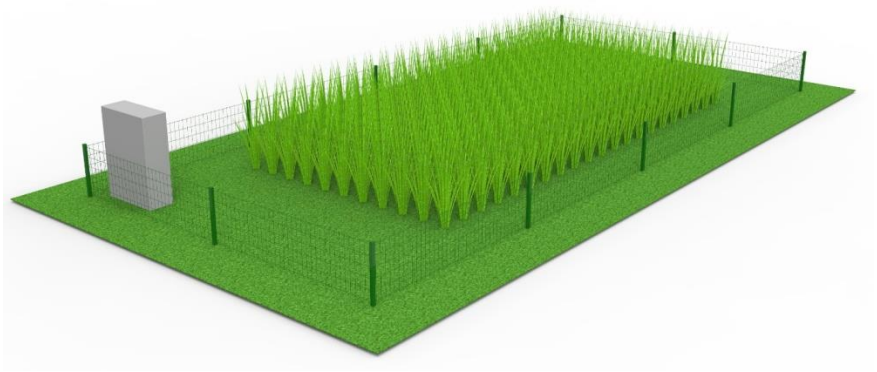


Figure 3.51: External view of the Electrowetland (Source: LEITAT).

The preliminary dimensions of the EW treatment line are detailed in the next table. The final size of each component, although being of the same magnitude, will be subjected to the wastewater characterization at the specific manhole selected.

Component	Preliminary dimension
Feeding pipes	20 – 100 mm
Feeding and outflow manholes	0.5 x 0.5 m x 0.8 m
Primary treatment – septic tank	Ø = 1.4 m; h = 1.6 m
Electrowetland area	25 - 50 m^2
Electrowetland depth	0.5 m
Harvesting and sensoring system box	0.5 x 0.5 m x 0.3 m
Operational parameters	**Preliminary dimension**
Water flow	0.5 – 3 m^3/day
Consumed electricity for pumping	< 3KW

Table 3.11: Most relevant parameters of the EW treatment line preliminary sizing

The EW final design will be calculated according to the characteristics of the real wastewater taken from the municipal sewer. A pre-analysis campaign (2 samplings) has been carried out during July 2018. The results detailed in the next table will constitute the base for the final sizing of the infrastructure.

	Units	Sampling 1	Sampling 2
Conductivity	uS/cm	760	991
Temperature	ºC	7.2	24.6
pH	pH units	24.1	7.5
COD	mg/L	548	666
BOD5	mg O_2/L	330	330
Suspended solids	mg/L	111	130
Total Nitrogen	mg/L	30	27
Total Phosphorus	mg/L	15.2	12

Table 3.12: Results of the pre-analysis campaign (Electro-wetland)

The preliminary architecture of energy harvesting and sensoring system will consist of:

- Energy Management unit: Manage the generated energy from the Electrowetland to the energy storage devices.
- Energy Storage devices: Storage the generated and managed energy in order to supply data acquisition and communications units.
- Sensors and data acquisition unit: This unit reads and processes the data from the environmental sensors and energy generation parameters from the energy management unit. Once the information has been collected and processed it is sent to the communications unit
- Communication platform: This platform reports the information acquired by the sensors and the data acquisition unit, and transmits it to the main platform, where the information could be stored and processed.

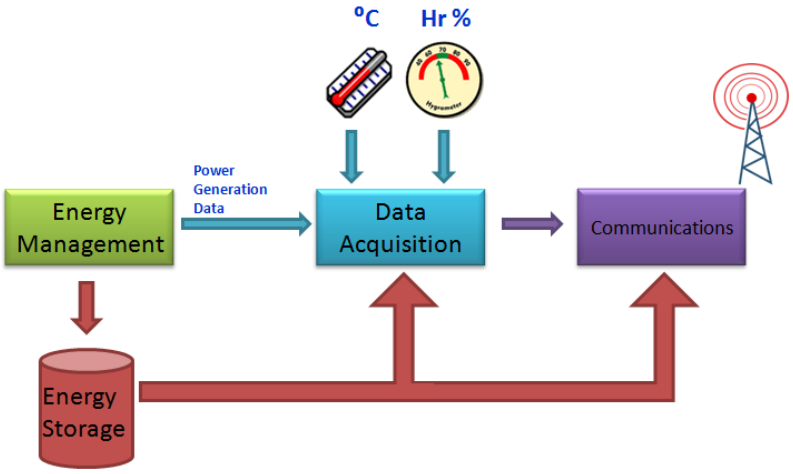


Figure 3.52: Energy harvesting and sensoring system block diagram (Source: LEITAT).

Some elements that will form the energy harvesting and sensoring system will be concretized or optimized once the EW is operational in Valladolid, and preliminary energy generation data are available.

Element	Preliminary Characteristics
Energy Management system	Designed and developed by LEITAT. Able to work from 0.3Vdc and manage up 2A
Energy storage device	Lithium battery 3.7V 4500mAh as a fist option. It could be replaced by supercapacitors depending on the operation in Valladolid
Data acquisitions unit	Data acquisition unit designed and developed by LEITAT based en MCU ARM STM32
Communications	Lora communications for reporting the data acquired. Lora/LoraWan enables low power consumption and long range communications, allowing creating private or public WAN networks
Environmental sensor	Temperature and Relative Humidity integrated sensor. Temperature: -20ºC to 70ºC Humidity: 0 to 100% RH IP protection: 67

Table 3.13: Elements that constitute the Energy Harvesting and sensoring system and their preliminary characteristics

3.8.4 Operational and Maintenance Considerations

The Electrowetland will be designed towards it automation in order to minimize the number of actuations needed for its operation and maintenance. However, its monitoring is subjected to the quantification of inflow and outflow water quality parameters which requires periodical sampling campaigns. In Table 3.14 there are the most relevant actions required for the treatment system regular operation, but also, the unforeseeable actions and the monitoring requirements are detailed.

Regular operation	Frequency	Responsible
Water level and pumping control	1 time/day	LEITAT
Electricity production and sensors control	1 time/day	LEITAT
Visual control of the Electrowetland	1 time / week	VAL City Council
pH and conductivity sensors calibration	1 time / 6 months	LEITAT
Aquatic vegetation pruning	1 time / year	VAL City Council
Unexpected events	**Frequency**	**Responsible**
Pumping errors	unforeseeable	LEITAT
Power cut	unforeseeable	LEITAT
Water quality and temp/humidity sensors brake	unforeseeable	LEITAT
Vandalism consequences repair	unforeseeable	VAL City Council
Monitoring	**Frequency**	**Responsible**
Water quality parameters (inflow and outflow)	2 times / month	Aquavall
Temperature and humidity measurement	subjected to elect.	LEITAT

Table 3.14: Regular operation actions, unexpected events and monitoring requirements

3.8.5 Economic Specifications

The following table shows a preliminary estimation of the material costs and total budget of the construction of Electrowetland.

Electrowetland	unit	quantity	Price (€)	Amount (€)
Civil works				56.000,00 €
Wastewater connection	unit	1		
Pumping systems	unit	1		
Primary treatment	unit	1		
Basin construction	unit	1		
Gravel and aquatic plants	unit	1		
Control System	unit	1		
Electrode materials				7.570,00 €
Conductive granular materials	m^3	10	190,00 €	1.900,00 €
Current Collector	m^2	100	56,70 €	5.670,00 €
Energy harvesting and sensoring systems				170,00 €
Total budget of material execution (PEM) (€)				**63.740,00 €**
Industrial benefit (6% PEM)				3.824,40 €
General expenses (13% PEM)				8.286,20 €
Tender budget without VAT (€)				**75.850,60 €**
VAT (21%)				15.928,63 €
Tender budget with VAT (€)				**91.779,23 €**

Table 3.15: Electro-wetland foreseen costs (Source: LEITAT)

3.9 Urban Garden Bio-Filter (VAc30)

3.9.1 General Description

Air quality is a major concern worldwide, particularly in urban areas, due to its direct consequences on human health, plants, animals, infrastructure and historical buildings (among others). Particulate matter, nitrogen dioxide and ground-level ozone, are now generally recognised as the three pollutants that most significantly affect human health. Long-term and peak exposures to these pollutants range in severity of impact, from impairing the respiratory system to premature death. Around 90% of city population in Europe are exposed to pollutants at concentrations higher than the air quality levels deemed harmful to health. For example, fine particulate matter ($PM_{2,5}$) in air has been estimated to reduce life expectancy in the EU by more than eight months. European Union legislation sets air quality standards for both the short-term (hourly/daily) and long-term (annual) (Directive 2008/50/EU)[7].

In general terms, green infrastructures are beneficial for many reasons but most of them do not represent a solution to remove significantly air pollution from cities in comparison with the global emissions once the pollutant agents are released. However, the impact can be higher

[7] http://ec.europa.eu/environment/air/quality/standards.htm

when the emissions from a stationary source are filtered. Urban Garden Bio-Filter is an air filter framed in an urban garden for the emissions of underground car parks or other stationary sources of pollutants agents in urban environments.

The system is going to be installed in the underground car park "Plaza Zorrilla" in Valladolid. The Bio-Filter will have 10 m^2 and will filter 2.500 m^3/h of the indoor air by direct extraction.

According the expected impacts for this NBS, air quality and climate change mitigation and adaptation related KPIs will be used to assess the beneficial effects of the Urban Garden Bio-Filter.

3.9.2 Location

The system is going to be installed next to one of the indoor air exit areas of the underground car park "Plaza Zorrilla" placed in this square (see Figure). There is a low maintenance small green area next to this exit tower. Urban Garden Bio-Filter will be installed on this green area. It can be done without big modifications.

Figure 3.X shows the current state of the selected area and one example of the future appearance of the Bio-Filter to keep the aesthetics of the tree pits and parterres of the area.

Figure 3.53. Location of Urban Garden Bio-Filter (Source: Google/CARTIF elaboration)

It is needed to create an access to extract the indoor area of the car park through the tower. Extractor and other facilities will be installed inside the tower in order to avoid aesthetics and noise impacts. Solar panels will be set on the rooftop of the tower as the main energy source for the fan extractor in order to create an autonomous air cleaning system.

Figure 3.54. Selected location (left) for Urban Garden Bio-filter in Zorrilla Sq. and future appearance (right) keeping aesthetics of the sourrondings (Source: CARTIF).

3.9.3 Technical Specifications

The NBS is composed by three main elements, the fan extractor to extract the polluted air from underground car park, the plenum section to distribute the air under the BioFilter and the BioFilter itself.

The BioFilter is composed by several layers for support, pollutants absorption and protection and finally is cover by vegetation. The absorption/capture of air pollutants (at least NO, NO_2, PM2.5 and PM10 – and greater PM too-) is made by the different layers and the metabolization of these pollutants is made by the soil microbiota and the vegetation. Additionally, vegetation provides an aesthetical aspect and the general appearance of the system have been designed to maintain coherence with the surroundings.

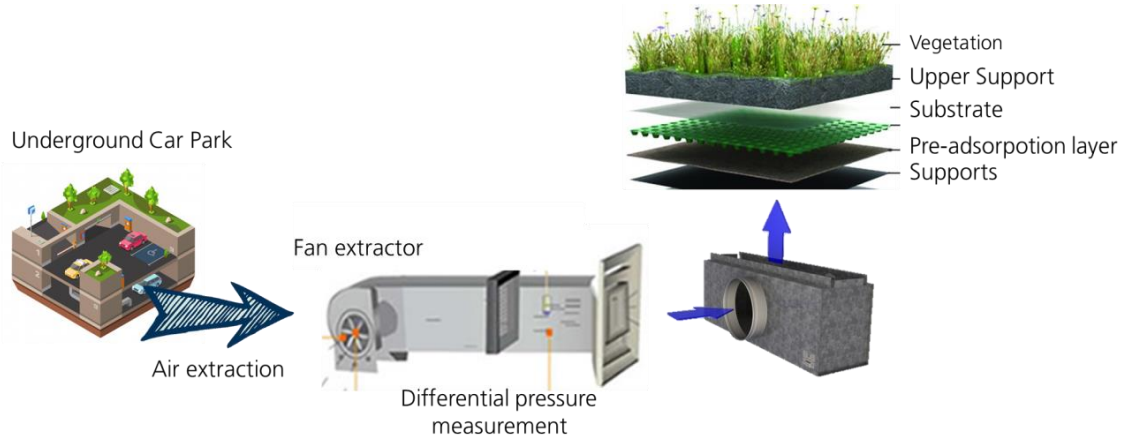


Figure 3.55. Urban Garden Bio-Filter schema (Source: CARTIF).

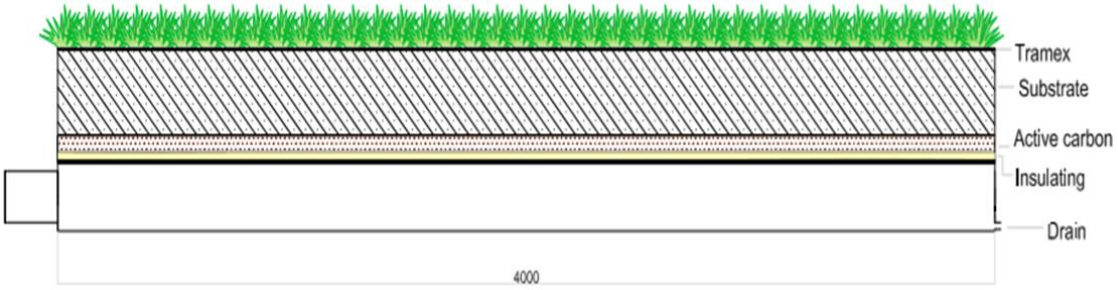


Figure 3.56. Urban Garden Bio-Filter front view (Source: CARTIF).

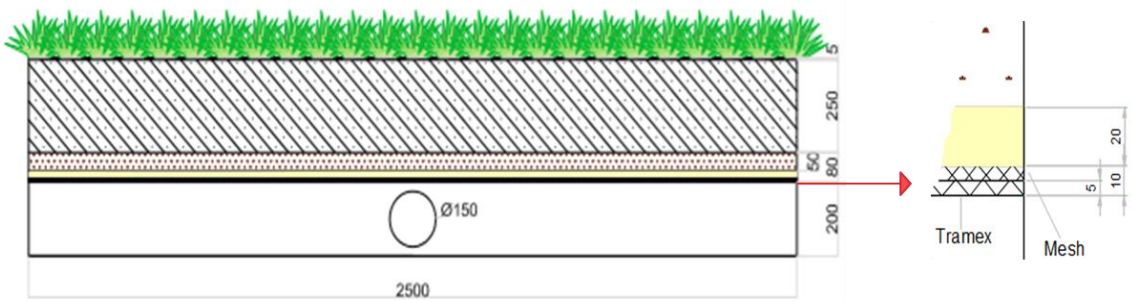


Figure 3.57. Urban Garden Bio-Filter side view (Source: CARTIF).

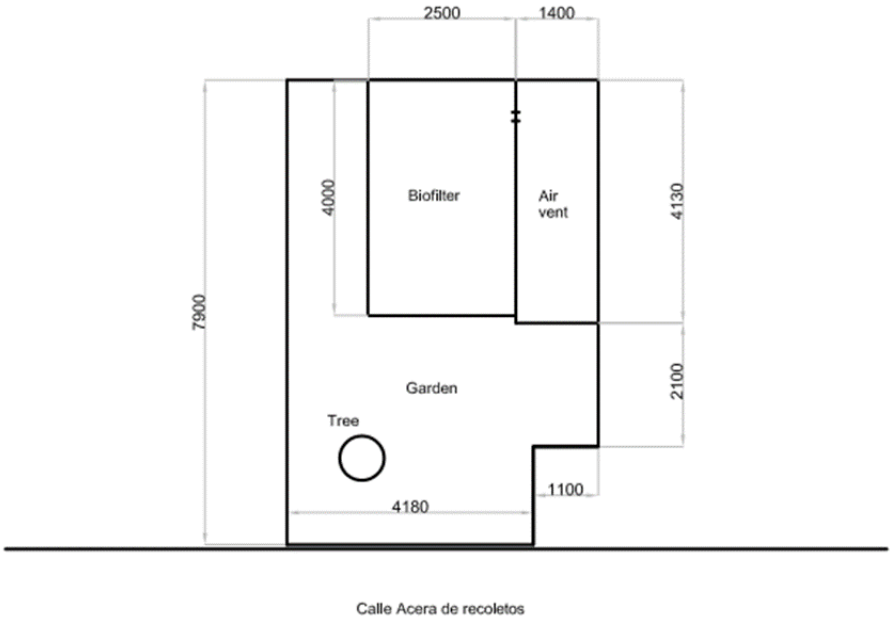


Figure 3.58. Urban Garden Bio-Filter top view. (Source: CARTIF).

Regarding vegetal species to be used, it is proposed to include both bushes for fence purposes and herb for the central area. Both kinds will provide aesthetical and pollutant metabolization services.

Species	Type	Maintenance	Pollinator friendly
Cotoneaster sp.	Bush	Cleaning pruning	Yes
Berberis sp.	Bush	Cleaning pruning	Yes
Bellis sp.	Herb	-	Yes
Viola Oradata	Herb	-	Yes

Table 3.16: Urban garden biofilter vegetal species

3.9.4 Operational and Maintenance Considerations

Maintenance operations will be carried out by CARTIF except those indicated.

- Vegetation and soil manage.
- Visual supervision monthly
- Soil aeration bi-annual.
- Weekly watering[8] in summer time (out of this period only in case of dry season).

Extraction installation

- Annual maintenance[9] (according to the installation manual).
- Differential pressure supervision constantly.

[8] Operation to be carried out by Valladolid municipality.
[9] Operation to be carried out by the extraction system installer during at least the two first years.

3.9.5 Economic Specifications

Urban garden biofilter	unit	quantity	Price (€)	Amount (€)
Extraction system				
Fan extractor: 0,25kW/3.500m3/h. Eg. THGT/4-450-6/22-0,25KW-F300-3-230/400V-50HZ-50HZ-IE2 Pipes, piping systems, fittings and other accessories including electrical panel with protections and elements according to current legislation. Labour Other	unit n/d n/d	n/d	5.000 €	5.000 €
Electrical power supply				
Solar panel Accessories Labour Other	unit n/d n/d	n/d	5.000 €	5.000 €
Filter holder				
Preparatory operations. Surrounding wall*. Plenum chamber Filter's support (2 x Tramex layer, stainless steel mesh 1mm and sheep wool blanket) Labour Other*			17.000 €	17.000 €
Engineering project				
Engineering project			3.000 €	3.000 €
Total budget of material execution (€)				**24.793,00 €**
Tender budget with VAT (€)				**30.000,00 €**

Table 3.17: Urban garden biofilter budget (Source: CARTIF)

*Similar appearance to other existing parterres in the area (Zorrilla Sq.)
** Filter materials to be set between tramex layers not included; there will be provided and implemented by CARTIF (see section 3.9.2)

3.10 Smart Soils for Green Singular Infrastructure (VAc17)

3.10.1 General Description

In the technical-economical aspects, this intervention *VAc17-Smart soils as substrate*, is similar to VAc16 (see *Section 2.7*).

This innovative smart soil will be used for development of Green Singular Infrastructures (40 m3) in actions *VAc6- Green resting areas*, and *VAc20-Compaced Pollinator's Modules*.

Expected impacts: The use of smart soil in other NBS involves creating natural sinks of NO_X (nitrogen oxides, an extremely important contaminant of urban air) inside the city. It is

estimated that smart soils (VAc16, VAc17 &VAc18) will captured 1.665kg/year of NO_2 from urban air[10] and avoid its fertilization. In the case of VAc 17, 68 kg/year of NO_2 will be captured.

Around 35 m^3 of products will be reused, otherwise, most of them would be managed as waste reducing the impact of this on sensitive systems (air, water, biota), and recycling micro and macronutrients as N, P, K.

3.10.2 Location

VAc17-Smart soils will be use in Green Resting areas (VAc6) and Compact pollinator modules (VAc20). The exact location is described in these implementations.

3.10.3 Technical Specifications

In the technical-economical aspects, this intervention *VAc17-Smart soils as substrate*, is similar to VAc16 (see *Section 2.7*).

3.10.4 Operational and Maintenance Considerations

In the operational and maintenance considerations, this intervention *VAc17-Smart soils as substrate*, is similar to VAc16 (see *Section 2.7*).

3.10.5 Economic Specifications

The smart soil price will be maximum 70 €/m3. The budget will include transportation, mixing with the original soil (for actions that require it) and an analysis of the soils where it reflects the conformity with the hygienic-sanitary, physical-chemical and microbiological parameters.

The total budget for this action is € 3,000.

3.11 Compacted Pollinator´s Modules (VAc20)

3.11.1 General Description

These small spaces will be designed to attract pollinators and biodiversity in general by weather conditions as a refugee (colder areas in hot periods and refugee for wintertime) and feeding (water and food providing areas for pollinators).

It is important to incorporate in this NBS, housing for pollinators, both insects and other species as birds, be, etc. They will have the housing function but also they will be awareness elements for citizens.

Urban areas are the refuge of numerous pollinators, for instance 83% of butterflies live in an urban area and they are disappearing faster from towns and cities than the countryside, 2/3 of butterfly species are declining. However, one garden could attract more than 18 species of

[10] CARTIF results “Technological development Substrates with self-fertilizer and air pollutant uptake capacity. Sustra-TEC” RTC -2016-5043-2. MINECO.

butterfly, to this end it is necessary: to choose a sunny sheltered spot with flowers throughout pollinators season with a source of water and avoid peat using peat-free compost. Source: Butterfly Conservation.

There will be installed 13 units of *VAc20- Compacted pollinator's modules* in several locations in Valladolid. Each pollinator will be installed in the ground with Smart Soil (Vac17), with anti – allergy species and have and estimates surface between 5-10 m^2.

Additionally, this NBS could include (depending on its location and characteristics) some site furnishing as street seats, drinking water fountain or some other elements to create a point of interaction between nature and citizens in the centre of the city.

The expected impact is help to create connexions or/and connexions networks among green and blue spaces or areas in urban environments, increase the level of biodiversity, improve air quality, run-off mitigation, energy savings, increase in property values, citizens well-being and social cohesion.

Connectivity. The distance between modules will be affected by the characteristics of the urban space, the presence of other green elements (like street trees or bush lines), space availability, etc. These structures allocated in urban areas will help to connect the peri-urban area where is located the Natural pollinator's modules (VAc19 and VAc21) which are connecting countryside with green urban areas.

3.11.2 Location

These will be installed in several locations. The initial proposal is that there will be installed 13 units of VAc20 in the following initially planned locations:

- 1 unit in El Corte Inglés area.
- 3 units in Santiago Street.
- 2 units in Zorrilla Square.
- 3 units in Miguel Íscar street.
- 3 units in España Square.
- 1 unit in Campillo Market area.

These spaces were selected because they receive sunshine for a few hours of the day and they are near to other green spaces in order to create connexions or/and connexions networks among green and blue spaces or areas in urban environments. They have a source of irrigation or the possibility of being irrigated in a simple way.

The involved departments of the city council are analysing the different location options in order not to disturb the pedestrian routes, the location of trees, the traffic, the necessary spaces for bus or taxi stops, etc... but maintaining the connectivity between the modules for a real and global vision, understanding and impact of the intervention.

Figure 3.59: Example of compacted pollinator's modules in the city centre of Ath (Belgium) (Source: Google).

3.11.3 Technical Specifications

This green space attracts pollinators and biodiversity through flowers and plants. To achieve that, a favourable sequence of flowering permits the production of pollen, nectar and essential oils. For that reason, is compulsory to select an optimal combination of different native plants (to avoid the risk of introducing non-native invasive species and pathogens), trees, shrubs, wildflowers, with different flowering to cover the period between March to November, overall in spring, when hunger gaps are most likely to occur.

Additionally, it is necessary to provide the modules with plenty of safe nesting habitats -- long grass, bare earth, crevices in dry stone-walls or wood - insect hotel, pollinator walls or bee towers for bumblebee, bees, pollinators, etc. All these elements will be done with free-pesticides and non-toxic materials. Only then, we will achieve that pollinators arrive and establish permanently.

Compacted pollinator's Modules – Julia Model

Julia Model is selected for the technical specifications of the compacted pollinator's modules. The following are the key elements description:

Constructive elements: Natural/organic building materials. The module is big container plant or group of plots (creating several layers of different plants) that will be placed in the city. They must be mobile to be moved or displaced if needed. Therefore, it must be resistant and with comfortable dimensions to be used (take into account the machinery of the municipality for its movement). Total surface of Compacted pollinator's modules between 5-10m^2 (standard but it depends on the available space). The shape of the module can be adapted to the available space.

Plants, like trees, bushes and flowers. This NBS will put special attention to install native and anti-allergy species (*Lavandula latifolia, Rosmarinus officinalis,* etc..) with different flowering

periods. In section 2.8.3 of *Vac19-Natural pollinator's modules,* there is a specific list of plants ideal for the city of Valladolid's pollinators' modules (see section 2.8.3.).

Design criterion:

- Modules should be multiflora in order to attract a high number of different pollinators at different times of the year, above all for monitoring purposes. A list of plants is provided for this purpose, an optimal combination of this herbaceous, shrubs and trees list is compulsory taking into account flowering time, soil, size, irrigation needs, needs for sunshine and shade (see section 2.8.3.).
- The distance between modules will be taken into account. Although some pollinators such as bees can travel up to 3 km in countryside, in urban areas this distance is much less, it is necessary to create a green connexion to allow easy access to pollinators, so modules should be located as close together as possible as well as of green areas.

Water source. It is necessary provide a water source for pollinator, with a spot land to not drown into the water. This is why they often fly around clothesline or near to a fountain. This is their way of drinking water safely. It includes a water reservoir or rainwater harvesting which storing part of drainage water (extra water should run off by a drainage system). It is possible to connect these modules to rain gutters in nearby buildings.

- An irrigation system could be installed to supply needs if necessary.
- It will have a drainage system to avoid the flooding of the roots.

Housing for biodiversity (pollinators, birds, other insects). These pollinator-nesting blocks (also called pollinator houses, bee houses or bee hotels) will support biodiversity by creating wildlife friendly spots or areas and contribute to preserve and enhance the local biodiversity in urban areas. Bees need nectar and pollen to keep their young, as well as areas of clear ground and full sun, old logs or woods, and even areas with pieces of bark or stones.

Street furnishing. Street seats, water sources for humans, shadow structures or elements (e.g. shadow tree), etc. These elements look for create a point of interaction between nature and citizens in the city centre.

Additional functionality. Rainwater collection can be integrated throughout a SUD and addressed to an indoor storage area that will provide additional moisture to the plant substrate.

Connectivity: Creation of a modules network (habitats for biodiversity) connecting green areas in the city.

Urban Landscape architecture criteria in the city must be taken into consideration.

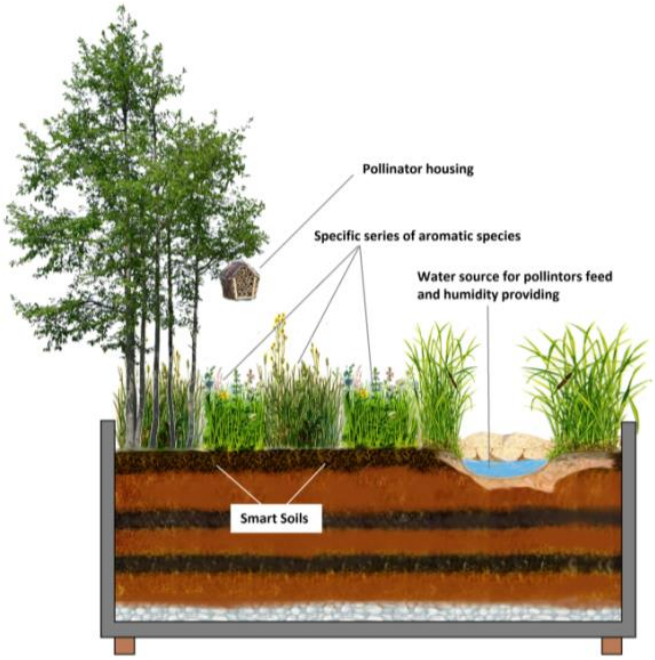


Figure 3.60: Compacted pollinator's modules – Julia Model (Source: CARTIF).

3.11.4 Operational and Maintenance Considerations

Operational and maintenance considerations are described in *VAc19- Natural pollinators' modules* (see section 2.8.4). This is an abstract of the main actions:

General visual inspection of elements.

Reparation or substitution of damaged elements or plants, such as constructive elements and the vegetation (pruning, maintenance, pest' control, weed control). Organic waste should be valorised as biomass or compost, and

Irrigation: Periodic irrigation or control of irrigation system.

3.11.5 Economic Specifications

The economic specification of *VAc20- Compacted Pollinator's modules* is not already detailed. This action should include the following aspects for the 13 units:

- Compact module purchases or construction with drainage and water storage elements
- Plantation works
- Plants purchase
- Pollinators house purchase and installation
- Watering planting irrigation
- Elements for humans

The total budget for this action is 30.945 €. *VAc17-Smart soil* cost is not included.

4 Definition of the Interventions in Sub-Demo C (Renaturing Urban Areas)

Sub-Demo C is named "Retrofit urban ecosystems to improve well-being and to avoid flood risk. New models of re-naturing urban areas". This Sub-Demo C includes a set of actions that will develop sustainable green infrastructure with a high ecological value and low maintenance costs. This Sub-Demo C will be deployed in different locations in Valladolid; for that reason, we divide Sub-Demo C into the following four sections:

- **C1.- Football Stadium area (Parking)**

  The Zorrilla football stadium parking surface is being re-naturalized with green pavements of high drainage capacity and creeping grass; and the plantation of trees. It will be completed with the installation of SUDs and a rain garden.

- **C2.- Sustainable park**

  A Natural Wastewater Treatment Plant will be installed in a sustainable urban park as water recovered source model for irrigation and other purposes. It is close to the football stadium area.

- **C3.- Floodable park**

  A floodable park at the entrance of La Esgueva River in the city will integrate several NBS to minimize flooding risks and provide co-benefits to Climate Change such as water storage, carbon sequestration, biodiversity, quality public spaces, health and wellbeing for citizens.

- **C4.- Urban farming**

  Urban farming facilities will be improved in Alameda Park and Santos-Pilarica municipal orchard areas.

<table>
<tr><th>Re-naturing urbanization</th><th>Water interventions</th><th>Singular green Infrastructures</th><th>Non-technical interventions</th></tr>
<tr><td rowspan="4">VAc5- Re-naturing parking trees</td><td>VAc14- Parking Green Pavement</td><td rowspan="2">VAc18- Smarts soils as substrate</td><td>VAc34- Educational path in VAc13</td></tr>
<tr><td>VAc9- SUDs (re-naturing parking)</td><td>VAc35- Educational path in VAc11</td></tr>
<tr><td>VAc10- Rain gardens</td><td rowspan="2">VAc21- Natural pollinator's modules</td><td>VAc36- Urban Farming Educational activities</td></tr>
<tr><td>VAc13- Natural Wastewater Treatment Plant</td><td rowspan="3">Common non-technical interventions: VAc37, VAc38, VAc39, VAc40, VAc41 & VAc42</td></tr>
<tr><td rowspan="2">VAc7- Urban Carbon Sink</td><td>VAc12- Green filter area</td><td>VAc31- Urban orchards</td></tr>
<tr><td>VAc11- Floodable Park</td><td>VAc32- Community composting</td></tr>
</table>

Table 4.1: List of interventions in Sub-Demo C "Renaturing urban areas"

Sub-Demo C interventions are located in the West and the East part of the city of Valladolid. The West is the football stadium, auditorium and Las Contiendas park area. The East is in Santos-Pilarica neighbourhood, close to the VA-20 road (Ronda Interior) and La Esgueva River.

Figure 4.1: Location map of the Sub-Demo C interventions “Renaturing urban areas” (Source: Google/Valladolid City Council elaboration).

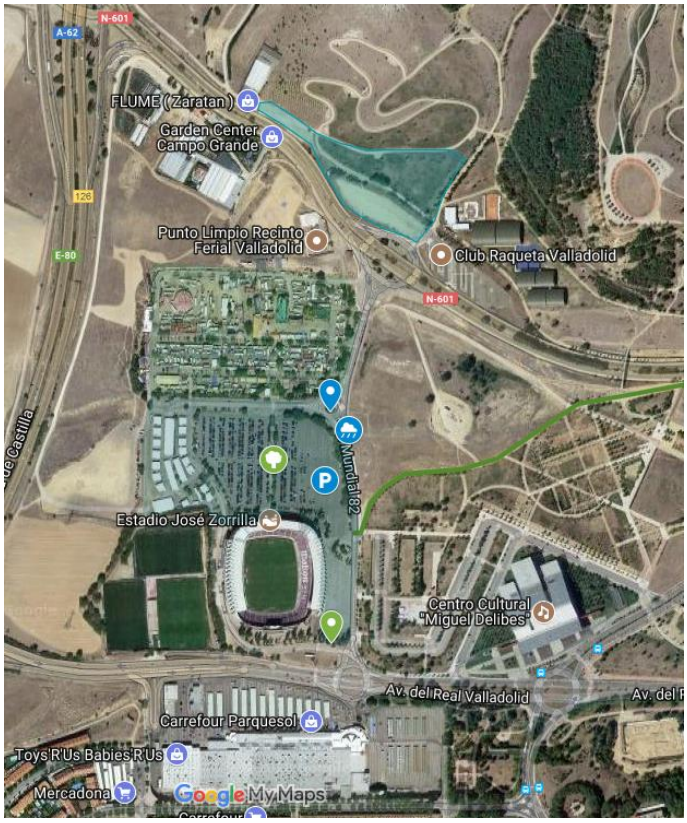
In the following chapters there is described every Sub-Demo C section (C1, C2, C3, C4).

This four sectors will be improved thanks to the URBAN GreenUP project, and will serve as new recreational areas for the citizens and visitors. The water implementations to be developed here are very innovative from a technical point of view so educational paths and educational activities will be carried out, to promote the ecological intelligent. The activities related with orchards and farming will serve to increase the participation of the neighbours and also of children or other particular sector of the population. These interventions require a strength collaboration between different areas of the Valladolid City Council, and the different stakeholders.

Sub-Demo C1.- Football Stadium Area

Re-naturing urbanization	Water interventions	Singular Green Infrastructures	Non-technical interventions
VAc5- Re-naturing parking trees	VAc9- SUDs (re-naturing parking)	VAc18- Smarts soils as substrate	
	VAc10- Rain gardens		
	VAc14- Parking Green Pavement		

Table 4.2: List of interventions in Sub-Demo C1 'Football stadium area (parking)'



C1.- Football Stadium area (parking)

- Green pavement in car parking.
- SUDs.
- Rain Garden.
- Plantation of trees to re-naturing Football Stadium parking, over Smart soils as substrate.

Figure 4.2: Location map of the Sub-Demo C1 Interventions 'Football Stadium area' (Source: Google/Valladolid City Council elaboration).

4.1 Parking Green Pavement (VAc14)

4.1.1 General Description

Parking green pavement concept refers to permeable and porous pavers which allow water to percolate through them. Therefore, this kind of pavements allows natural drainage through the spaces between the pavers and migration of water into the earth.

There are different types of green permeable pavements depending on the application: pedestrian paths, car parking areas, cycle lanes, landscaping, etc. The configuration, the material and the geometry of the solutions may vary according to the resistance capacity needs, degree of permeability to reach, addition of vegetation or aesthetical considerations.

For parking applications, permeable pavers must present a solid surface which ensures resistance by creating an interlock between pavers. So that, a green pavement composed of concrete pavers with holes over a permeable substrate, has been selected.

The holes in the surface can be filled with aggregate or vegetation depending on the need, in this case it is defined the implantation of green pavements with 50% vegetal soil and high drainage capacity.

Figure 4.3: Green parking pavement in open and private space (Source: Valladolid City Council)

Green pavements provide durability, low maintenance, resistance to heavy loads as traditional pavers, but also reduction of the heat island effect, reduction of storm water runoff that leaves parking lots and improvement of the air quality among other benefits.

4.1.2 Location

There are three possible locations identified for *VAc14- Green Parking Pavement*. At the moment an analysis in detail is being carried out to select the most appropriate. The three options are shown in Figure 4.4, and they are the following:

1) Parking area between the football-stadium and auditorium: The green parking would be integrated in the existing gardens of the auditorium Miguel Delibes, and would serve to meet the parking spaces need of both buildings.

2) Parking area in Las Contiendas Park: A new green parking would be built in the Football Stadium area, in a vehicle access of the Las Contiendas Park, one of the bigger green lungs of the city. The green pavement will be near to the Natural Waste Treatment Plant described in the 4.5 section (C2.- Sustainable park), increasing the number of visitors to the zone. In another hand, it will help also to increase the number of parking spaces of the zone because of the high demand during important football matches in the stadium, different events in the auditorium, the funfair area and other sportive and leisure activities.

3) Football stadium parking area: There is a wide parking area in the football stadium (see *VAc5- Re-Naturing parking* for further details). The idea is to substitute the existing asphalt pavement for a green permeable pavement, which implies the destruction of a system that is currently working.

Figure 4.4: Three possible locations for the green parking pavement (Source: Google/Valladolid City Council elaboration).

4.1.3 Technical Specifications

The solution consists on several layers of different permeable materials which offer resistant capacities and vegetation growing, as it is shown in Figure 4.5. Correct design, detailing and construction are essential to the long-term performance and minimising maintenance.

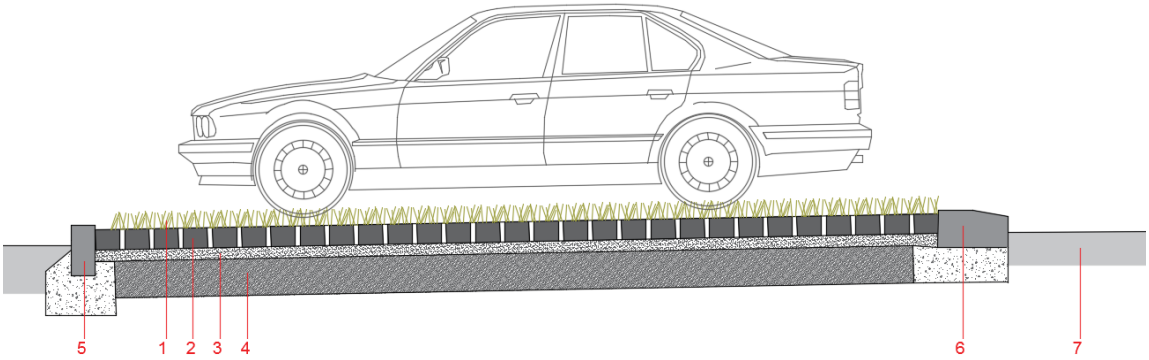


Figure 4.5: Technical section of the green parking pavement (Source: Valladolid City Council).

1. Grass
2. Prefabricated concrete block (600x400x100mm)
3. Sand bed (40mm)
4. Graded aggregate compacted (250mm)
5. Concrete kerb
6. Slanted concrete kerb for cars access
7. Road

First step of the construction is the excavation of the area to a determined depth depending on different considerations: permeability of the soil, rainfall frequency, costs, water table, etc. After, the area is filled with graded aggregate and covered by a sand bed, with two purposes: the layer acts as a pollutant trap and filter and also it becomes a rain water temporary storage before the water naturally percolate into the earth.

The prefabricated concrete blocks have to be placed upon the sand bed ensuring that joints between blocks are completely filled with the correct permeable jointing material. The following figure shows one product in the market, that allows a 50% of vegetation growing. Kerbs are also necessary to limit the parking spaces and to protect the pedestrian routes.

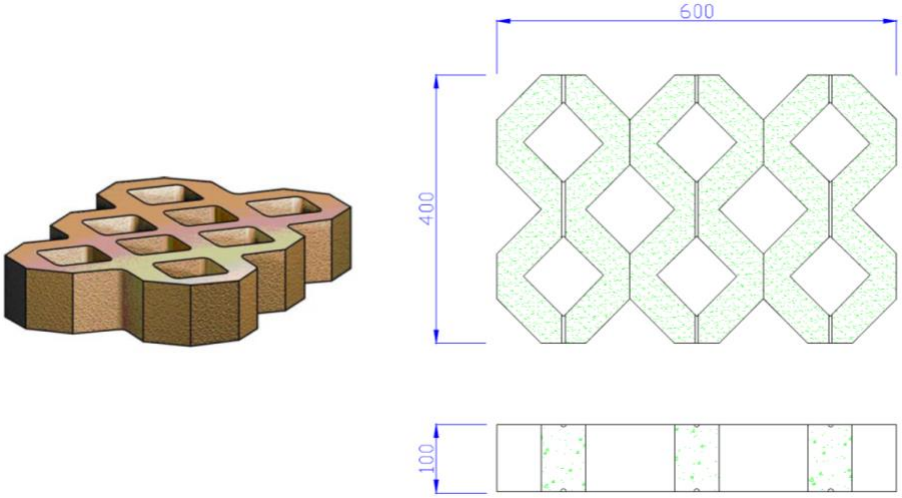


Figure 4.6: Prefabricated concrete permeable blocks (Source: Alberdi).

Figure 4.7: Example of a green parking area with prefabricated concrete blocks (Source: Alberdi[11]).

4.1.4 Operational and Maintenance Considerations

In the Operational and Maintenance Considerations, this intervention *VAc14- Parking green pavement*, is similar to *VAc15- Cycle pedestrian green paths* (see *Section 2.2.4*).

4.1.5 Economic Specifications

Final costs depend on the location selection and will be affected for multiple factors. For that reason, an estimation of the price analysing market costs of similar projects in the city has been carried out. The results show a range of 65-90 €/sqm. Taking into account the available budget for this intervention, it will be possible to build approximately 360 sqm, around 30 parking spaces. Next table shows the approximately costs per item of the intervention.

Green parking pavement	unit	quantity	Price (€)	Amount (€)
Excavation works and preparation of the terrain	m^2	360	15	5.400 €
Graded aggregate compacted layer of a section of 250 mm: material and execution works	m^2	360	25	9.000 €
Prefabricated concrete block of dimensions 600x400x100mm placed on a sand bed and filled of the holes with sand: material and execution works	m^2	360	16	5.760 €
Installation of other elements (kerbs, limits…)	m^2	160	25	4.000 €
Total budget of material execution (€)				**24.160 €**
Tender budget with VAT (€)				**33.824 €**

Table 4.3: Green parking pavement budget (Source: Valladolid City Council)

[11] Prefabricados Alberdi: www.prefabricadosalberdi.com

4.2 Re-Naturing Parking (VAc5)

4.2.1 General Description

The José Zorrilla football stadium in Valladolid has capacity for more than 26,000 viewers. It is located in the East of the city, in Mundial 82 Avenue. José Zorrilla is the official stadium of the local football team "Real Valladolid". The vehicle parking is located beside the stadium. It has more than 2,500 parking spaces divided into different areas, with a total surface of 6.5 Ha:

- For cars: North Car Park: 1,512 places.
- For coaches and urban buses: East Parking: 180 places (for car).

It is foreseen to plant trees in the facilities of Football Stadium area. This action involves the development of a new concept of car parking in combination with *VAc9- SUDs for re-naturing parking* and *VAc14- Green Parking Pavements* actions.

The car parking is near the funfair area, where there will be implemented *VAc3-Tree shady places*.

It is worth reminding that close to the Football Stadium area there will be included a *VAc6-Green resting area* (see section 2.2 for further details).

4.2.2 Location

There will be replaced current trees and planted new individuals in the José Zorrilla football stadium vehicle parking, in Mundial 82 Avenue. Total surface available in the parking area is 2.05 Ha of green plots. The following map views show the total green plots available.

Figure 4.8: Zorrilla football stadium green areas (Source: Google/Valladolid City Council elaboration).

4.2.3 Technical Specifications

The José Zorrilla Stadium vehicle parking has limiting characteristics for the tree species selection and for the trees final location.

Local guidelines allow planting more trees in the vehicle parking area in the available green plots (see previous Figure), but it is not recommended to lift the current asphalt, as it happens in *VAc3-Tree shady places*, in the funfair area that is close by.

Water supply is not an issue in the football stadium area, because there is a dense water network around.

Species selection should consider some dry degree, high temperatures during summer and low temperatures during winter, below 0 °C. The trees should provide shadow and they must allow the vehicles movements (circulate and parking). It is ideal that the trees do not produce dirty and waste, so the cars will not be affected. The following table shows suitable trees species for Renaturing the José Zorrilla car parking.

Common name (Spanish)	Common name (English)	Scientific name
Almez americano	Hackberry	*Celtis occidentalis*
Aligustre, ligustro o alheña	Privet	*Ligustrum lucidum*
Morera de hojas de plátano	Parasol mulberry	*Morus platanifolia*
Plátano de sombra	London plane	*Platanus hispanica*
Sófora, falsa acacia	Pagoda tree	*Styphnolobium japonicum*

Table 4.4: List of arboreal species selection for Renaturing car parking in Valladolid.

Ligustrum lucidum is common for the car parings. It is important that the variety do not provide fruit (*Morus platanifolia* var. fruitless).

Plantation works

In the places where needed, there will be installed defences to avoid the cars collisions.

4.2.4 Operational and Maintenance Considerations

The maintenance considerations of Renaturing parking trees are detailed in section 2.4.4 (*VAc2- Planting trees*).

4.2.5 Economic Specifications

In the following table it is shown the planting trees estimated cost. The budget depends on the tree species but also on the root growth system. There might be budget and space for the plantation of a maximum of 100-130 trees.

Planting trees	unit	quantity	Price (€)	Amount (€)
Installation works				
Water supply and drainage	m	n/a	45-55 €	
Irrigation system - Irrigation canalization - Drop irrigation system - Sprinkler irrigat. system	 m m^2 m^2	n/a	 35-40 € 2,5 € 15 €	
Electric system		n/a		
Plantation works				
Ground preparation	m^2	n/a	0,85	
Tree planting	unit	n/a	13-30-45 €	
Tree/plant supply - Costs depending on the size (small, medium, tall) (transport not included)				
Conifer tree	unit	n/a	30-60-90 €	
Leafy tree	unit	n/a	25-60-105 €	
Total budget of material execution (€)				**10.331,00 €**
Tender budget with VAT (€)				**12.500,00 €**

Table 4.5: Renaturing parking trees budget
(Source: Base Paisajismo www.basepaisajismo.com)

4.3 SUDs for Re-Naturing Parking (VAc9)

4.3.1 General Description

SUDS are drainage systems that are considered to be environmentally beneficial, causing minimal or no long-term detrimental damage. They are often regarded as a sequence of management practices, control structures and strategies designed to efficiently and sustainably drain surface water, while minimising pollution and managing the impact on water quality of local water bodies.

SuDS take inspiration from natural features and processes like uptake of water by plants, soil infiltration, pools, ponds, marshes, wetlands, springs, streams and rivers. SuDS can take many forms, both above and below ground. Some types of SuDS include planting; others include proprietary/manufactured products. In general terms, SuDS are designed to manage and use rainwater close to where it falls, on the surface and incorporating vegetation, tend to provide the greatest benefits. Most SuDS schemes use a combination of SuDS components to achieve the overall design objectives for the site.

Concretely, for the parking area located in the surroundings of the Stadium Nueva Zorrilla, the following SUDs are planned (VAc9): detention basin and infiltration well (connected to the rain garden in VAc10). The main purpose is the retention of the surface runoff and the infiltration.

Figure 4.9: Picture of a detention basin in a roundabout (Source: Susdrain).

4.3.2 Location

SUDs in VAc9 will be located in the surroundings of the parking lot of the Football Stadium Nueva Zorrilla. This area is not connected to the municipal sewer network so it suffers from surface runoff during storm episodes.

Figure 4.10: Water runoff produced during a storm in the surroundings of the Football Stadium, June 2018 (Source: Valladolid City Council).

The detention basin will be placed in an existing roundabout in the Avenida Mundial 82. The infiltration well will be located close to the rain garden (Vac10) in order to collect and infiltrated the water storage and retained by that NBS.

Figure 4.11: Location of the detention basin (green point) and the infiltration well (red point) (Source: Google/Valladolid City Council elaboration).

4.3.3 Technical Specifications

The detention basin will have a total surface of 440 m^2 and will occupy the existing the roundabout. For that purpose, the plot will be excavated (around 1.5 m depth in the middle/ most depressed point). The length/width ratio for the detention basin will be 3:1.

The bottom of the vegetated basin will be fairly flat with a gentle slope (no more than 1 in 100) towards the outlet, to maximise contact of runoff with the vegetation and to prevent standing water conditions from developing. Areas above the normal high water elevations of the basin will also be sloped towards the basin to allow effective drainage.

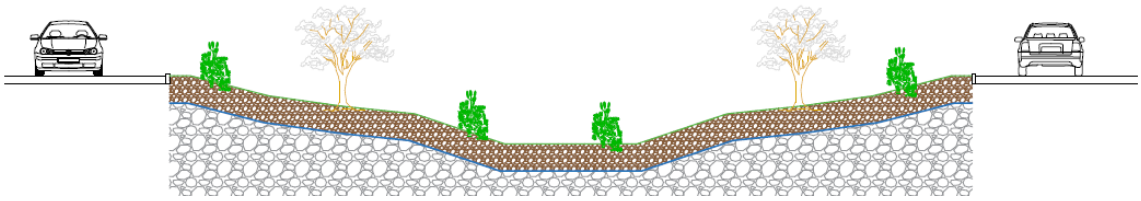


Figure 4.12: Section of the detention basin (Source: CENTA).

A first gravel layer will be placed at the bottom of the detention basin in order to promote the infiltration of the water accumulated. Then a permeable geo-textile sheet will cover this first layer and hold the topsoil layer (20-40 cm). Initially, this detention basin will be planted with grass.

The infiltration well will be placed close to the Rain Garden (VAc10) as it will be received the water drained by this NBS. The following picture shows the technical specifications of this infiltration well.

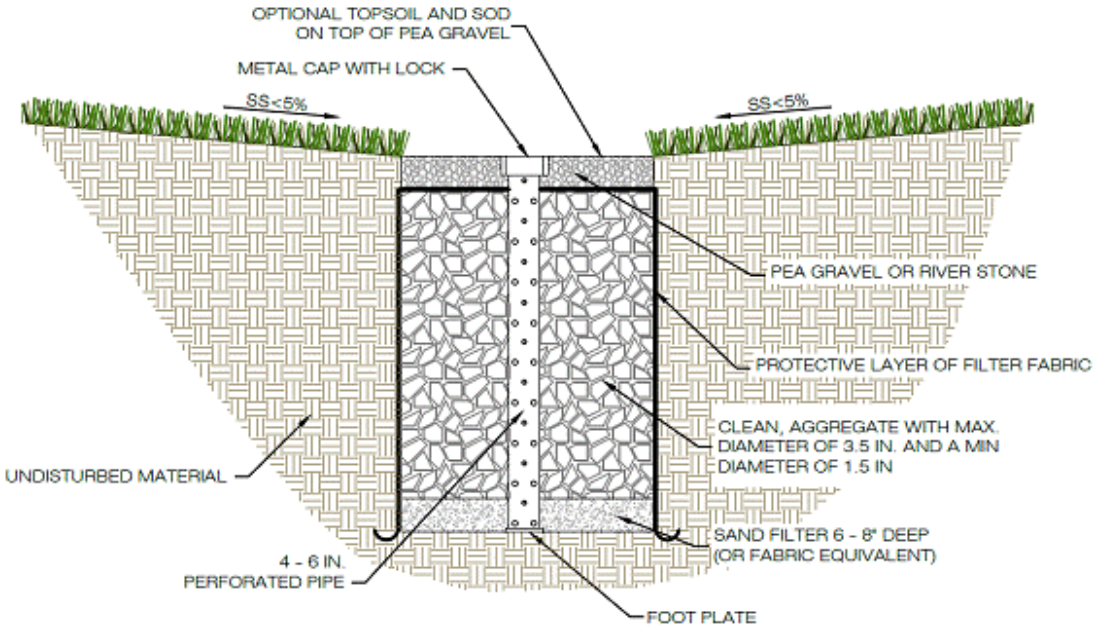


Figure 4.13: Section of the infiltration well (Source: Virginia Deq Stormwater Design Specification no. 8. Infiltration practices).

The infiltration well will have a depth of 1.5 m. It will be filled with grave 40-100 mm diameter in order to promote the water infiltration. A metal cap will be installed to check the level of clogging of the infiltration well.

4.3.4 Operational and Maintenance Considerations

The following table summarizes the operation and maintenance requirements for the detention basin (Woods, 2015).

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter and debris	Monthly
	Cut grass – for spillways and access routes	Monthly (during growing season), or as required
	Cut grass – meadow grass in and around basin	Half yearly (spring – before nesting season, and autumn)
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Inspect inlets, outlets and overflows for blockages, and clear if required.	Monthly
	Inspect banksides, structures, pipework etc. for evidence of physical damage	Monthly
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies.	Monthly (for first year), then annually or as required
	Check any penstocks and other mechanical devices	Annually
	Tidy all dead growth before start of growing season	Annually
	Remove sediment from inlets, outlet and forebay	Annually (or as required)
	Manage wetland plants in outlet pool – where provided	Annually
Occasional maintenance	Reseed areas of poor vegetation growth	As required
	Prune and trim any trees and remove cuttings	Every 2 years, or as required
	Remove sediment from inlets, outlets, forebay and main basin when required	Every 5 years, or as required (likely to be minimal requirements where effective upstream source control is provided)
Remedial actions	Repair erosion or other damage by reseeding or re-turfing	As required
	Realignment of rip-rap	As required
	Repair/rehabilitation of inlets, outlets and overflows	As required
	Relevel uneven surfaces and reinstate design levels	As required

Table 4.6: Maintenance operations for the detention basin
(Source: The SuDS Manual)

4.3.5 Economic Specifications

The following table shows estimated cost for *VAc9-SuDs for re-naturing parking*.

SUDs in the parking area	unit	quantity	Price (€)	Amount (€)
Land movements	m^3	850	4.15	3,530.14
Refill with filtering substrate	m^3	170	47.15	8,015.13
Geo-textile sheet	m^2	440	15.09	6,639.25
Refill with topsoil	m^3	190	12.55	2,385.36
Infiltration well	Ud	1	883,85	883,85
Gardening	m^2	440	5.87	2,584.03
Total budget of material execution (€)				**24,037.76**
Tender budget with VAT (€)				**29,085.69**

Table 4.7: SUDs for re-naturing parking budget (Source: CENTA)

4.4 Rain Garden (VAc10)

4.4.1 General Description

A rain garden is a planted depression or a hole that allows rainwater runoff from impervious urban areas, like roofs, driveways, walkways, parking lots, and compacted lawn areas, the opportunity to be absorbed. This reduces rain runoff by allowing storm water to soak into the ground (as opposed to flowing into storm drains and surface waters which cause erosion, water pollution, flooding and diminished groundwater).

Figure 4.14: Examples of rain gardens (Sources: City of Indianapolis; Greater greater Washington and RandShardscaping: : http://indygov.org; https://ggwash.org; https://www.randshardscaping.com).

4.4.2 Location

The rain garden Vac10 will be located in the surroundings of the parking lot of the Football Stadium Nueva Zorrilla. This area is not connected to the municipal sewer network so it suffers from surface runoff during storm episodes (see section 4.3.2)

The rain garden will be placed in an existing green area which surrounds the main parking lot of the Nuevo José Zorrilla Football Stadium. This area is also included in Vac5 (plantation of trees). Vac 5 and Vac 10 are compatible.

Figure 4.15: Rain garden in the parking lot -striped red area- (Source: Google/CENTA elaboration)

4.4.3 Technical Specifications

The rain garden will have a total surface of 1.000 m^2. Its shape will respect the existing green area, so that means that it will be mostly linear.

There are many different approaches to the design of bioretention systems and rain gardens. However, the main components that are usually provided in a bioretention system are shown in the following figure.

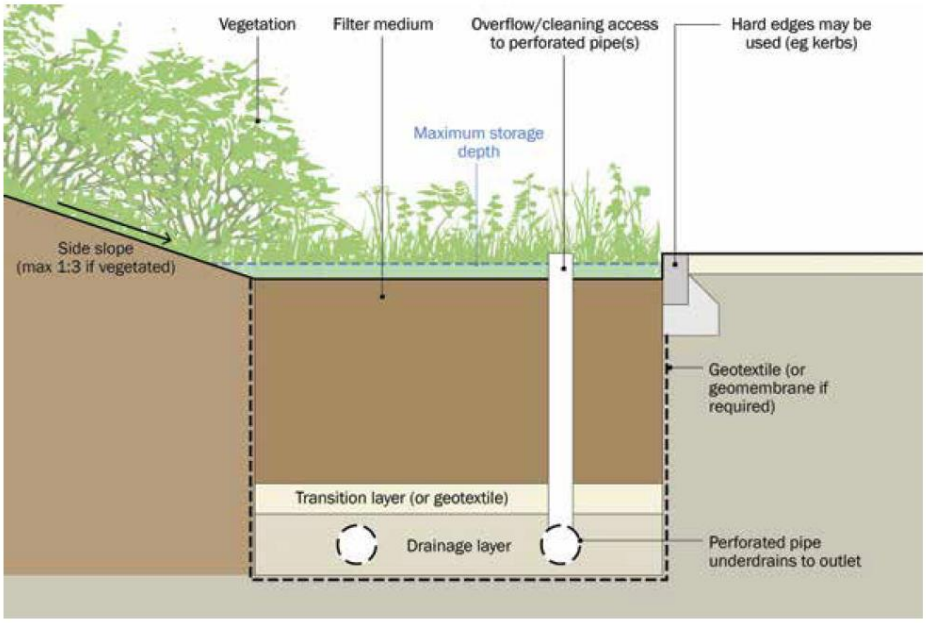


Figure 4.16: Section of the rain garden (Source: CIRIA Manual)

In order to simply the design, the filter medium layer and the drainage layer will be filled with the same material (gravel size 20-32 mm). The superficial layer will consist of ornamental gravel as it will be visible (similar to the illustration on the right in Figure 4.14.

Normally, in rain gardens the retained runoff is infiltrated into the surrounding ground. However, in this case, and in order to increase the retention capacity of the rain garden, an

underdrain has been included. A 200- mm- diameter perforated pipe will be will be placed about 60 cm from the most depressed part of the rain garden. The drainage pipe will be then connected to the infiltration well (Vac9).

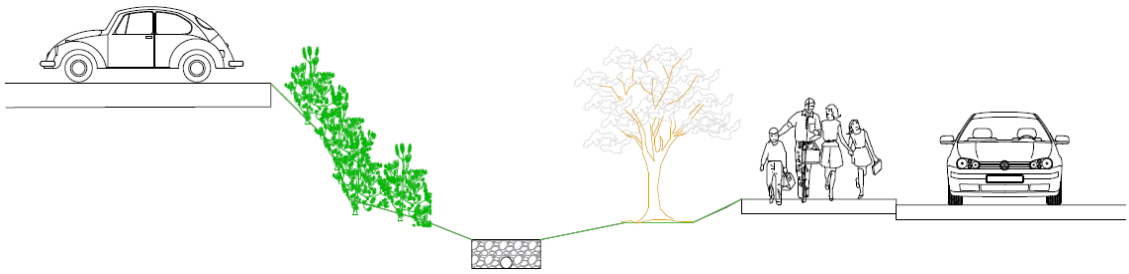


Figure 4.17: Section of the rain garden (Source: CENTA).

Concerning the plantation, rain gardens should be planted up with native vegetation that is able to bear with occasional inundation.

4.4.4 Operational and Maintenance Considerations

Rain gardens require little additional maintenance to normal gardens, but their effectiveness in delivering runoff attenuation and treatment will decline if they are not properly maintained.

The following table summarizes the operation and maintenance requirements for the rain gardens (and other bioretentation systems)

Maintenance schedule	Required action	Typical frequency
Regular inspections	Inspect infiltration surfaces for silting and ponding, record de-watering time of the facility and assess standing water levels in underdrain (if appropriate) to determine if maintenance is necessary	Quarterly
	Check operation of underdrains by inspection of flows after rain	Annually
	Assess plants for disease infection, poor growth, invasive species etc and replace as necessary	Quarterly
	Inspect inlets and outlets for blockage	Quarterly
Regular maintenance	Remove litter and surface debris and weeds	Quarterly*
	Replace any plants, to maintain planting density	As required
	Remove sediment, litter and debris build-up from around inlets or from forebays	Quarterly to biannually
Occasional maintenance	Infill any holes or scour in the filter medium, improve erosion protection if required.	As required
	Repair minor accumulations of silt by raking away surface mulch, scarifying surface of medium and replacing mulch	As required
Remedial actions	Remove and replace filter medium and vegetation above	As required but likely to be > 20 years

Table 4.8: Maintenance operations for the rain garden
(Source: The SuDS Manual)
[*] or more frequently for tidiness or aesthetic reasons.

4.4.5 Economic Specifications

The following table shows estimated cost for *VAc10-Rain garden*.

Rain garden	unit	quantity	Price (€)	Amount (€)
Land movements	m^3	1,500	4,15	6,229.65
Filtering trench	m	140	58,98	8,256,93
Gardening	m^2	1000	3,88	3,879.99
Total budget of material execution (€)				**18,366.57**
Tender budget with VAT (€)				**22,223,55**

Table 4.9: Rain garden budget (Source: CENTA)

Sub-Demo C2.- Sustainable Park

Re-naturing urbanization	Water interventions	Singular Green Infrastructures	Non-technical interventions
	VAc13- Natural Wastewater Treatment Plant	VAc21-Natural pollinator's modules.	VAc34- Educational path in VAc13
	VAc12- Green filter area		

Table 4.10: List of interventions in Sub-Demo C2 'Sustainable park'

C2.- (Sustainable park)

- Natural wastewater treatment plant (NWTP).
- Green filter area, irrigated with treated water.
- Plantation of trees in the Sustainable Park.
- Educational path for the Sustainable Park.
- Natural pollinator's modules.

Figure 4.18: Location map of the Sub-Demo C2 Interventions 'Sustainable park' (Source: Google/Valladolid City Council elaboration).

4.5 Natural Wastewater Treatment Plant (VAc13)

4.5.1 General Description

The Natural Wastewater treatment plant (NWTP) is based on the combination of natural treatment systems, such as constructed wetlands and ponds, following the concept of waterharmonica. Constructed wetlands are water purification systems that reproduce the processes of contaminant elimination which occur in natural wetlands.

Concretely, the NTWP in Valladolid consists on a combination of vertical flow constructed wetlands (designed for the removal of organic matter, mainly) and a surface flow constructed wetland (polishing unit: nutrients and pathogens removal). For the later reuse of the reclaimed water, a tertiary treatment (sand filtration + chlorination) is included.

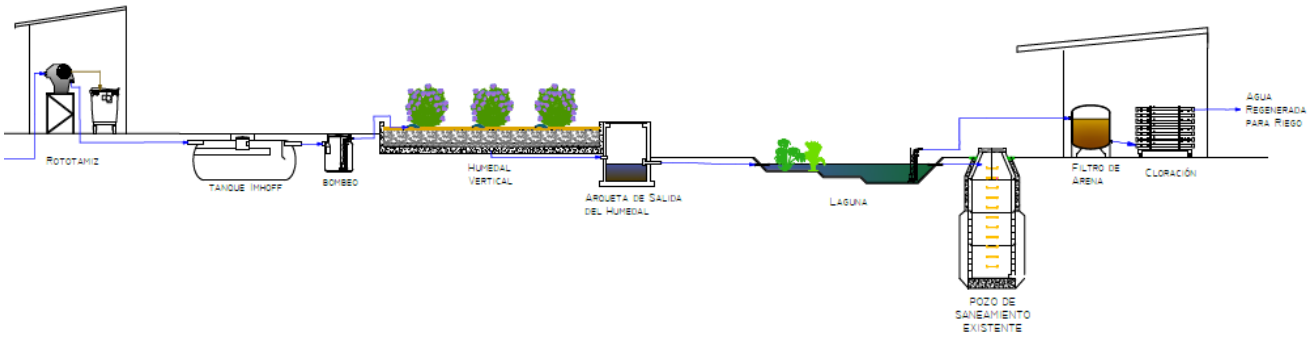


Figure 4.19: NTWP flow-sheet (Source: CENTA)

The sewage water is pumped from the sewage collector coming from Zaratán and submitted to a preliminary treatment (rotary screen and Imhoff tank) prior to the wetlands. Those units are designed to reduce the visual impact, respecting the green character of the NTWP and maximizing its integration in the park. The design of the wetlands is inspired in the H2020 URBAN GreenUP Project's corporative image.

On the other hand, and with the objective of fulfilling the function of providing a public park for the use and enjoyment of citizens, paths for people and bicycles will be provided (VAc13), as well as recreational urban furniture. Landscape integration in the entire implementation area is pursued by means of the plantation of typical species normally employed in Valladolid gardens.

Related actions

This action is located within the zone known as "Sustainable park". Thus, Vac13 is related to the following other actions (See the corresponding sections for more details):

- VAc13- *Natural Wastewater plant*.
- Vac12- *Green filter area*.
- VAc18- *Smarts soils* as substrate.
- VAc21– *Natural Pollinator's modules*.
- VAc34- *Educational path* in the C2- Sustainable Park.

Figure 4.20: General design of the NTWP in Valladolid (Source: CENTA)

4.5.2 Location

The next table shows the maximum and minimum coordinates of its location.

	X Coordinate	Y Coordinate
Maximum	353 584.87	4 612 541.09
Minimum	353 434.89	4 612 439.91

Table 4.11. Maximum and minimum coordinates of the studied plot for the NWTP
Proj = utm; zone = 30; ellps = grs80; towgs84 = 0,0,0,0,0,0,0; units = m

The picture beside shows an aerial view of the plot. The Natural wastewater treatment plant will be located in the South of Las Contiendas Park. The plot is municipal called “SG1 Sector 18 Villa del Prado – GIRÓN”.

Figure 4.21: Location of the NTWP in Valladolid (Source: Google/Valladolid City Council elaboration)

4.5.3 Technical Specifications

In this section, the technical specifications of the different units to be implemented in the NTWP are described, following the proposed flow-sheet.

Pumping well

The pumping well will be located in parallel to the main sewer system that comes from Zaratán and that conducts the sewage water to the Valladolid WWTP. An overflow channel will be constructed to deviate partially the flowing wastewater.

The water will be then pumped to the NTWP by three grinder submersible pumps (2+ 1R). The functioning of the pumping system will be controlled by float levers (maximum, minimum and security level).

Once the well is constructed, the affected services in the main sewer system will be corrected.

The following table shows the specifications of the submersible pumps:

Flange DN	Motor Power (kW)		Rated current (A)	Rated voltage (V)	Speed (rpm)	Flow max (l/s)	Hmax (m)
	P1	P2					
50 DIN	6.08	5.50	10.30	400 3~	2900	6	35

Table 4.12: Technical specifications of the submersible pumps to be installed in the pumping well

Pre-treatment

A rotary screen will be installed to remove those wastes larger than 1 mm (debris, branches, rocks) swept along by the wastewater.

The rotary screen will be installed over a metallic structure that will elevate the screen up to 1.5 m height above the surface. The wastes removed will be then accumulated in a container (similar to the ones for the domestic solid wastes).

Both the rotary screen and the container will be placed inside a building that will be constructed for that purpose (and that will be integrated in the landscape). The following pictures show an example of the rotary screen and the location of the building.

Figure 4.22: Example of a rotary screen (Source: Biosistemas, tratamientos de aguas residuales S.L.).

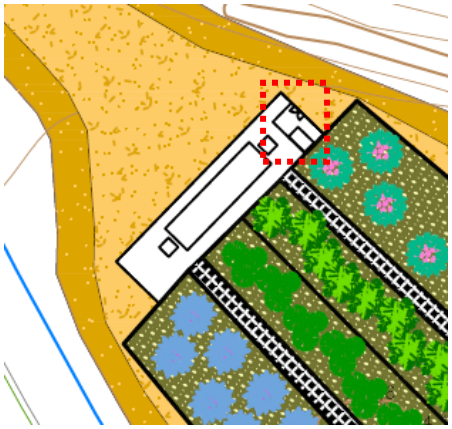


Figure 4.23: Proposed location of the auxiliary building (Source: CENTA)

Primary treatment

The pre-treated wastewater will flow by gravity to a pre-fabricated Imhoff tanks in fiberglass reinforced plastic (FRP). The Imhoff tank will be designed for 300 PE (population equivalent; 1 PE means 60 g BOD_5/day) and 45 m^3 capacity.

The Imhoff tanks will be partially buried in order to minimize the volume of the excavation and will be covered with the excavated material. Around the Imhoff tanks a partition bricks wall will be erected to confine the Imhoff tanks and the filling material. The upper part will be also confined and an iron cover will keep the access to the Imhoff tanks.

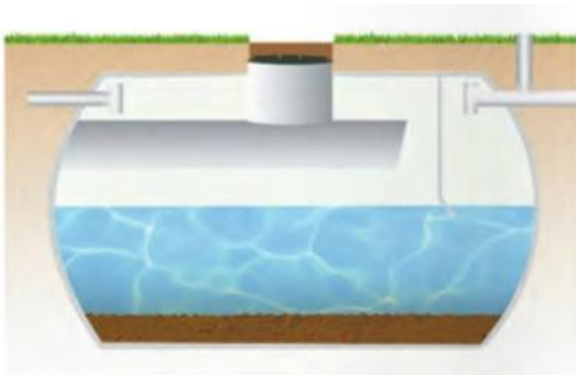


Figure 4.24: Schema of an Imhoff tank (Source: Remosa)

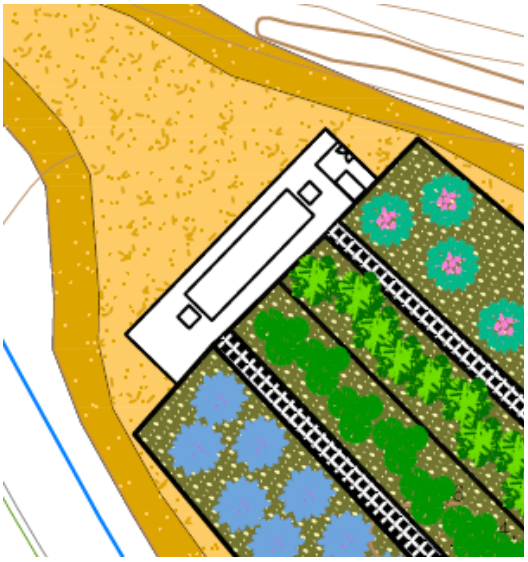


Figure 4.25: Location of the primary treatment (Source: CENTA)

Pumping well

A second pumping well is included in the flow sheet to feed the constructed wetlands (at least once per hour). The capacity of the well will be around 1.5 m^3, considering that the flow rate on wetlands will be 60 m^3/day and there will be 4 units working in parallel. The discharge of the wastewater on each wetland will take maximum 10 minutes. The technical specifications of the pumps in this second pumping well will be similar to the ones described in the table from “Pumping well” section.

Constructed wetlands

Constructed wetlands are water purification systems that reproduce the processes of contaminant elimination which occur in natural wetlands. Therefore, constructed wetland technology operates as a complex ecosystem made of the following elements (Vymazal, 2008; Kadlec et al., 2009):

- The water to be treated, which flows through the filtrating substrate and/or vegetation.

- The substrate, which is the support of the plants and has to retain the microbial population (in the form of a biofilm), and is essential in most processes aimed at removing the wastewater contaminants.
- The emerging aquatic plants (macrophytes), which supply surface area for the formation of bacterial films; they facilitate the filtration and adsorption of the wastewater constituents, they help to oxygenate the substrate and remove the nutrients as well as controlling the growth of algae by limiting the penetration of sunlight. Furthermore, the vegetation helps to integrate these treatment devices in the landscape.

The vertical flow constructed wetlands in the NTWP for Valladolid are designed for a superficial organic load of 14 g/m^2·d, which means around 3 m^2/PE. The following table shows the main technical characteristic of the wetland in the NTWP in Valladolid.

Vertical flow constructed wetlands	
Total area (m^2)	820.00
Numb, units (uds)	4
Population equivalent (PE)	300
Flow rate (m^3/d)	60
Filling material (from the bottom to the top)	
Thickness of gravel ϕ =20-32 mm (cm)	20
Thickness of fine gravel ϕ =3-8 mm (cm)	70
Thickness of sand (cm) ϕ =0,6-1 mm	10
Clearance (cm)	30
Drainage	Granting at the bottom
Slope of the outlet channel (%)	1

Table 4.13: Technical specifications of the constructed wetlands in Valladolid NTWP

The expected organic matter removal rate in the wetlands is 95%. The construction of the wetlands will be done in reinforced concrete with a ceramic cover. The height of the perimeter walls above the surface will be 60 cm approx. (that height must be corroborated with the level of the phreatic). The effluent of the vertical flow wetlands will be discharge to the superficial flow wetland through an overflow spillway, reducing the deposition of solids.

The following picture shows the configuration of the 4 vertical wetlands, following the logo of URBAN GreenUP Project.

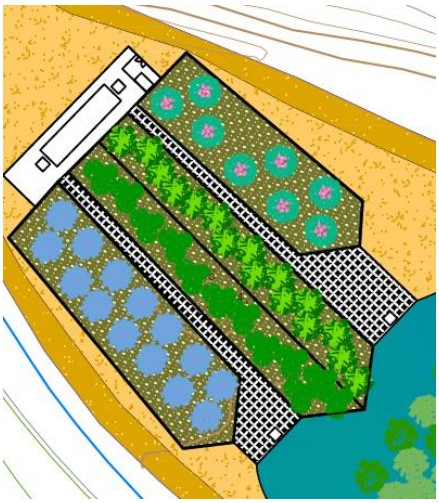


Figure 4.26: Design of the constructed wetlands following the logo of URBAN GreenUP project (Source: CENTA)

Superficial wetland

The construction of this wetland will suppose the excavation of a stepped vessel with three different depths. The vessel will be coated with a polyetilene sheet 1.5 mm thickness. The total area of the wetland will reach 2730 m^2 approx. A clearance of 30 cm will be kept, and the water level will be 0.3, 0.7 and 1.2 m. These three water levels allow the implementation of three different ecosystems.

The inlet will be located in the shallow part of the wetland, meanwhile the outlet, in the deepest part. The discharge of the treated water to the main collector will be done through a spillover.

The wetland will be equipped with a pumping station to conduct the treated water to the regeneration system for its later reuse in the irrigation of green areas in the sustainable park. The pumping system, with three centrifuge submersible pumps, will be operated in manual mode or with a timer.

The following picture shows the configuration of the superficial wetland.

Figure 4.27: Design of the water ponds in the NTWP in Valladolid (Source: CENTA)

Regeneration system (tertiary treatment for water reuse)

The regeneration system consists on a pressured-sand filter and chlorination channel with hypochlorite supply. The sand filter will have a treatment capacity of 10 m^3/h and a diameter of 1 m. The capacity of the hypochlorite dosage will be in accordance to the flow filtered through the sand filter.

The regeneration system will be placed inside a wooden building (to minimize the visual impact) close to the deepest part of the wetland.

4.5.4 Operational and Maintenance Considerations

The O&M labours in the NTWP will consist of:

Pre-treatment (Rotary screen): Minimal maintenance is to keep this unit in peek running condition. Periodically perform the following:

- Grease all bearings.
- Check the oil level in the drive system and fill as required.
- See enclosed periodic procedures for maintenance.

Primary treatment / Imhoff tanks: The following tasks should be carried out regularly:

- Once a year, it is needed the inspection and of the inside of the tank checking in particular its water-tightness to ensure that there are no leaks or parasitic water intrusion, and checking the water inlet and outlet areas.
- Twice a year, of the thickness of the floating layer and the sludge settled at the bottom of the tank.
- Twice a year, the tank will be cleaned by removing the sludge and floating solids. Tankers equipped with aspiration devices are used for this purpose. When Imhoff tanks are used as primary treatment prior to another treatment process, it is recommended that the accumulated sludge is removed when the digestion area is two-thirds full.

Wetlands

- The operator should visit the plant once or twice a week.
- In the case of vertical flow wetlands, during each visit the proper functioning of the outlet U-bends and pumps should be checked.
- It is essential to inspect the supply/distribution systems and the water tightness of the tank.
- During the first months of operation, the weeds that could hinder the growth of the planted vegetation should be removed.
- Once a year, at the end of the growing cycle of the plants (when the plant withers), the plant biomass should be cut down and removed by hand, using a sickle or a scythe, if the wetland has a small surface area, or using mechanical means (strimmer) in larger wetlands.
- After the harvesting, the condition of the input devices of the vertical flow wetlands should be checked.
- Every year, when the dry vegetation is cut (to facilitate the operation), the permeability of the substrate should be measured to check whether it is clogged or not.
- The possible appearance of pests which could jeopardise the plants should be prevented.
- Animals likely to feed on the wetland plants should be kept away.

4.5.5 Economic Specifications

In the following table it's shown the NWTP estimated cost.

New wastewater treatment plant	unit	quantity	Price (€)	Amount (€)
Preliminary land movements	Unit	1	3,109.34	3,109.34
Civil works	Unit	1	276,604.40	276,604.40
Mechanical equipments	Unit	1	59,976.00	59,976.00
Piping construction	Unit	1	3,683,32	3,683,32
Total budget of material execution (€)				**343,373.06**
Tender budget with VAT (€)				**415,481.40**

Table 4.14: SUDs for re-naturing parking budget (Source: CENTA)

4.6 Green Filter Area (VAc12)

4.6.1 General Description

Green filter is a land application system for treating water (wastewater). It consists of a plot area, sized according to the influent to be treated, which has forests installed and is irrigated with wastewater. The residual water partially evaporates and the rest is taken up by the roots of trees and filtered through the soil.

Before application to the soil, it is desirable to introduce a primary treatment system, to remove coarse solids, sand, grease and solids. In VAc12, the water to be used for the irrigation of the green area will be the treated water from the NTWP (Vac13) (not submitted to the tertiary/disinfection treatment).

The green filter provides more than just simple purification of water, because while treating the water, we are also producing biomass that may have a high economic value. Additionally, the added value generated by the capture of CO_2 in the biomass growth processes may constitute an input to be considered in the case of larger installations. Recharging of aquifers with the treated surplus is another big advantage, which can enable reuse in periods of great demand.

On the other hand, and with the objective of fulfilling the function of providing a public park for the use and enjoyment of citizens (C2.- Sustainable park), paths for people and bicycles will be provided (*VAc34- Educational path*), as well as recreational urban furniture. Landscape integration in the entire implementation area is pursued by means of the plantation of typical species normally used in Valladolid gardens.

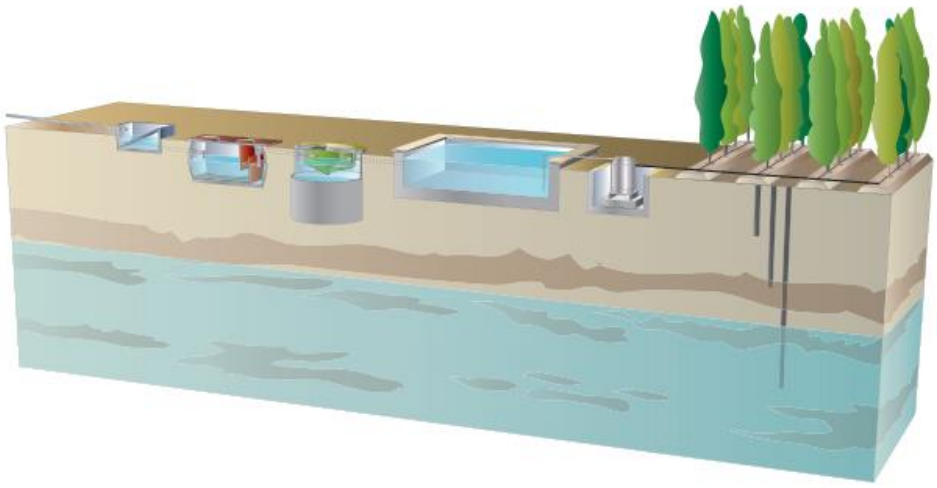


Figure 4.28: Typical flow-sheet of a Green Filter or Land application system (Source: Instituto IMDEA).

4.6.2 Location

VAc12- Green Filter area has been moved from C3.- Floodable Park to C2.- Sustainable park, because of improving the treated water obtained from the Natural Wastewater Treatment Plant (VAc13).

The next table shows the maximum and minimum coordinates of the *Vac12-Green filter area* location.

	X Coordinate	Y Coordinate
Maximum	353 584.87	4 612 541.09
Minimum	353 434.89	4 612 439.91

Table 4.15. Maximum and minimum coordinates of the studied plot for the Green filter
Proj = utm; zone = 30; ellps = grs80; towgs84 = 0,0,0,0,0,0,0; units = m

The picture below shows an aerial view of the pre-selected plot where the green filter will be implemented. In the picture it is also marked the *Vac13- Natural Wastewater Treatment Plant* location.

Figure 4.29: Location of the Green filter in the Sustainable park (Source: Google/CENTA elaboration).

4.6.3 Technical Specifications

Water provision

Water from the last pond of the NTWP (VAc13) will be pumped to the green filter area. The following table shows the specifications of the submersible pump.

Flange DN	Motor Power (kW)		Rated current (A)	Rated voltage (V)	Speed (rpm)	Flow max (l/s)	Hmax (m)
	P1	P2					
50 DIN	6.08	5.50	10.30	400 3~	2900	6	35

Table 4.16: Technical specifications of the submersible pump

The pumping pattern (and volume of water deviated to the green filter) will depend on the water demand of the vegetation/trees planted in the area. The water demand will depend on the type of trees/vegetation planted, the total planted surface and the water balance in the soil (depends on the rainfall, the evapo-transpiration rate and the infiltration rate, it varies seasonally).

Selection of the trees

Normally, green filters are planted with *Populus* or *Eucaliptus*, but in this case, other species can be considered (autochthonous species). For the design of the green filter area (selection of the trees and shrub, the frame of plantation, etc.) the same criteria employed in other NBS based on the plantation of trees (such as Vac2 or Vac5) will be followed, as well as the

indications of the Municipal Service for Parks and Gardens from Valladolid City Council. Plantation works: Please, check section 2.4.4 (VAc2- Planting trees)

Irrigation system

Drip irrigation will be implemented in the green filter area to avoid the production of aerosol, and, consequently, the reduction of the risk of contact with the citizens. The *VAc12- Green filter area* will be irrigated with treated water obtained from *Vac13- NWTP*.

4.6.4 Operational and Maintenance Considerations

The maintenance considerations of Green Filter trees are similar to the ones detailed in section 2.4.4 (*VAc2- Planting trees*).

4.6.5 Economic Specifications

In the following table it is shown the planting trees estimated cost. The budget depends on the tree species but also on the root growth system. There might be budget and space for the plantation of around 100 trees, but final economic specifications need to be detailed.

Green Filter/ planting trees	unit	quantity	Price (€)	Amount (€)
Installation works				
Water supply and drainage	m	n/a	45-55 €	
Irrigation system - Irrigation canalization - Drop irrigation system - Sprinkler irrigat. system	 m m2 m2	 n/a	 35-40 € 2,5 € 15 €	
Plantation works				
Ground preparation	m2	n/a	0,85	
Tree planting	unit	n/a	13-30-45 €	
Tree/plant supply - Costs depending on the size (small, medium, tall) (transport not included)				
Conifer tree	unit	n/a	30-60-90 €	
Leafy tree	unit	n/a	25-60-105 €	
Total budget of material execution (€)				**13,223.14**
Tender budget with VAT (€)				**16,000.00**

Table 4.17: Green filter area budget
(Source: Base Paisajismo www.basepaisajismo.com)

4.7 Educational Path in C2.-Sustainable park (VAc34)

4.7.1 General Description

The Educational Path (EP) is conceived as a natural path to promote educational activities related to NBS and, most concretely, to the ones related to Challenge 2: Water Management (NTWP, Green filter, etc.).

This educational path will be designed following the same criteria to the ones defined for other educational interventions (see *VAc35- Educational path in floodable park area*).

Expected impacts: The EP will create an attractive place for citizens to enjoy nature in the urban area, without leaving the city. This educational path will be close to the *Vac13- Natural Wastewater Treatment Plant*, which has a superficial wetland with a permanent body of water that will create a special biotope for urban spaces. In addition, this action will enhance the value of the different elements included in this area (Natural Wastewater treatment plant, green filter, SUDs, etc.) in an educational and entertaining way.

Informative panels will explain the role of NBSs solving environmental challenges, in this concrete case, those related to water.

Related actions

This action is located within the zone known as "Sustainable Park". Thus, Vac34 is related to the following other actions (See the corresponding sections for more details):

- VAc13- Natural Wastewater Treatment Plant.
- VAc12- Green filter area.

4.7.2 Location

The Educational Path is located within the C2.- Sustainable Park, among other interventions such as the Natural Wastewater Treatment Plant (VAc13) and the Green Filter area (Vac12). This *VAc34-Educational path* will be located in the South of Las Contiendas Park. The table below shows the maximum and minimum coordinates of its location.

	X Coordinate	Y Coordinate
Maximum	353 584.87	4 612 541.09
Minimum	353 434.89	4 612 439.91

Table 4.18. Maximum and minimum coordinates for the Educational path
Proj = utm; zone = 30; ellps = grs80; towgs84 = 0,0,0,0,0,0,0; units = m

Characteristics

The EP is proposed as a sinuous path through the different points of interest considered within the C2.- Sustainable park and the Green filter area.

The *VAc34- Educational path* will go around the NTWP (Vac13), not crossing it in order to avoid the potential contact of the citizens with the wastewater (biological risks) or the accidental falls in the water ponds. Then, it will be connected to the existing path in the plot were the green filter area will be constructed. The educational path will have a total length of between 1.5 - 2 km and a width of about 2 m.

Figure 4.30: Plot view that will host NTWP (Vac 10), Green filter (Vac 12) and educational path (Vac 34) (Source: Google/CENTA elaboration).
Legend: Educational path

Informative panels will be located in those sites of noteworthy interest. Other kind of furniture should also be installed in order to achieve a more comfortable experience: wastebaskets, fountains, benches, etc.

4.7.3 Technical Specifications

Pathway designing

The design of the pathway will follow the same technical as the one described in *Vac35- Educational path in C3.- Floodable park area* (please, check section 4.10.3).

As shown in Figure 4.30, the path will go around the NTWP and then it will be connected to the existing path. Resting areas with informative panels will be placed in different points along the path, preferably in higher points for having a global sight of the NBS implemented.

Panels and furniture

Furniture selection must match aesthetical, economic and durability criteria. It is recommended using natural materials, such as wood, stone, etc. whenever possible.

Panels and signalling

The purpose of the informative panels is guiding the visitants throughout the most important points along the educational path. These points will be selected in order to enhance the value of the NBSs within the sustainable park, the environmental problems which they are suppose to solve and how they work.

The list below contains the panels that should be included, at least, as part of the route.

Location	NBS	Description
Path around the NTWP	NTWP	· Wastewater origin / main pollutants / potential risks for the environment and human health. · Wastewater treatment through nature based solutions: constructed wetlands and ponds. · Water reuse to fight against water scarcity problems. · Benefits of the NTWP.
Existing path	Green Filter	· What is a green filter and how it works. · Benefits of the green filter. · The importance of water infiltration.
Entrances	All	· General map of the park, including relevant points location and services, normative, exits, etc.

Table 4.19: Informative panels suggested for the Educational path in the Sustainable park
Note: See VAc13 and VAc12 for detailed information about location

In addition to the panels, vertical information signalling should be included. Signals provide information of the services (bicycles parking, fonts, etc.) and guide (exits, locations, etc.).

Facilities and comfort

Waste bins should be conveniently installed at strategic points along the route. These devices should be placed at detention points. These points are, for instance, resting areas, information panels, bicycle parking, etc.). Other intermediate points can be considered in the case the previous ones were too separated.

Other objects can be suggested to contribute for wellness and commodity for the users. Their installation is recommendable but it depends on the total budget available and the final technical design of the Sustainable Park area.

The technical specifications of the informative panels, signalling and other furniture elements are detailed in *Vac35- Educational path in C3.- Floodable park area* (section 4.10.3).

4.7.4 Operational and Maintenance Considerations

Periodic maintenance and cleaning of the EP and elements included will be carried out. Damaged furniture should be repaired or replaced if necessary. Pay special attention to barriers and other safety elements.

Pathway surface should be checked periodically, especially after a long period of rains. Weeds and plants' roots should be removed as they may entail a fall risk for users. Likewise, bumps that might appear on the surface should be repaired.

4.7.5 Economic Specifications

The technical specifications shown above are an approximate calculation of the characteristics of the project, in price and units number that will be installed. Therefore, the economic specifications are equally approximate.

This action should include the following extra aspects, which are not included in the budget:

- Surface works: Excavation and removing of soil, installation of the different layers (geotextile, etc.) and other related works.
- Park furniture purchase and installation.
- Other requirements: technical reporting, projects, analysis, etc.

The total budget expected in the Investment Plan for the Educational Path in the Sustainable park is 30.000 €.

Educational path	unit	quantity	Price (€)	Amount (€)
Signs and informative panels				
Informative panel (1)	unit		1.849,00 €	
Informative panel (2)	unit		1.646,93 €	
Informat. panel (3) Simple sign	unit		98,34 €	
Facilities and comfort furniture				
Metal bench (cheap-medium)	unit		331 – 656 € (400 € ave)	
Rustic bench (cheap-medium)	unit		350 – 537 € (500 € ave)	
Table and benches pic-nic	unit		300 – 670 € (400 € ave)	
Other				
Waste bin	unit		240 €	
Bike parking	unit		300 €	
Barrier (m)	unit			
Total street furniture (€)*				**to be defined (€)**
Tender budget with VAT according to the Valladolid Investment plan (€)				**30.000,00 €**

Table 4.20: Educational path in Sustainable park budget

* Civil works, soil movement, workforce, installation costs and other costs are not included.

4.8 Smart Soils as Substrate (VAc18)

4.8.1 General Description

In the technical-economical aspects, this intervention *VAc17-Smart soils as substrate*, is similar to VAc16 (see *Section 2.7*).

VAc18- Smart soils in Sub- Demo C will be use in C1, C2, C3 and C4. For these surfaces a total of 565 m^3 of technosols have been calculated.

- C1- *Parking green pavement* (VAc14): 200 m^3
- C1- *Renaturing parking* (VAc5): 40 m^3
- C1- *Green Resting areas* (VAc6): 20 m^3
- C2-C3-C4: *Natural pollinator modules* (VAc21): 15 modules with 3m^3 each. Total of 45m^3 of smart soil.
- C3- *Urban Carbon Sink* (VAc7): 240m^3
- C3- *Green resting areas* (VAc6): 20 m^3

Expected impacts: The use of smart soil in other NBS involves creating natural sinks of NO_X (nitrogen oxides, an extremely important contaminant of urban air) inside the city. It is estimated that smart soils (VAc16, VAc17 & VAc18) will captured 1.665 kg/year of NO_2 from urban air[12] and avoid its fertilization. In the case of VAc18, it will capture 957 kg/year of NO_2.

Around 500 m^3 of products will be reused, otherwise, most of them would be managed as waste reducing the impact of this on sensitive systems (air, water, biota), and recycling micro and macronutrients as N, P, K.

4.8.2 Location

The exact location of the *VAc18-Smart soils* will be described in the corresponding implementations.

- C1 - Renaturing parking (VAc5), Green Resting areas (VAc6) and Parking green pavement (VAc14).
- C2 - Natural pollinator modules (VAc21).
- C3 - Green resting areas (VAc6), Urban Carbon Sink (VAc7), Natural pollinator modules (VAc21).
- C4 - Natural pollinator modules (VAc21).

4.8.3 Technical Specifications

In the technical-economical aspects, this intervention *VAc18-Smart soils as substrate*, is similar to VAc16 (see *Section 2.7.3*).

4.8.4 Operational and Maintenance Considerations

In the Operational and Maintenance Considerations, this intervention *VAc18-Smart soils as substrate*, is similar to VAc16 (see *Section 2.7.4*).

4.8.5 Economic Specifications

The smart soil price will be maximum 70 €/m3. The budget will include transportation, mixing with the original soil (for actions that require it) and an analysis of the soils where it reflects the conformity with the hygienic-sanitary, physical-chemical and microbiological parameters.

The total budget for this action is € 40,000.

4.9 Natural Pollinator´s Modules in SubDemo C (VAc21)

4.9.1 General Description

In the technical-economical aspects, this intervention *VAc21-Natural Pollinator's Modules* is similar to VAc19 (see *Section 2.8*).

[12] CARTIF results "Technological development Substrates with self-fertilizer and air pollutant uptake capacity. Sustra-TEC" RTC -2016-5043-2. MINECO.

4.9.2 Location

A total of 15 units of *VAc21-Natural Pollinator's modules* will be designed and they are planned to be installed in Sub-Demo C in the following areas:

- 6 units in SubDemo C2- Sustainable Park (Wastewater Plant zone).
- 6 units in SubDemo C3- Floodable Park (La Esgueva River zone).
- 3 units in Subdemo C4- Alameda Park zone (Urban Farming activities).

Final locations are still ongoing (see *Section 2.8*).

4.9.3 Technical Specifications

In the technical-economical aspects, this intervention *VAc21-Natural Pollinator's Modules* is similar to VAc19 (see *Section 2.8.3*).

4.9.4 Operational and Maintenance Considerations

In the operational and maintenance considerations, this intervention *VAc21-Natural Pollinator's Modules* is similar to VAc19 (see *Section 2.8.4*).

4.9.5 Economic Specifications

The total budget for this action is 50.000 € for VAc21 (another 50.000 € for Va19). *VAc17-Smart soil* cost is not included.

Sub-Demo C3.- Floodable Park

Re-naturing urbanization	Water interventions	Singular Green Infrastructures	Non-technical interventions
VAc7- Urban Carbon Sink	VAc11- Floodable Park	VAc31- Urban orchards VAc18- Smarts soils as substrate VAc21-Natural pollinator's modules	VAc35- Educational path in VAc11

Table 4.21: List of interventions in Sub-Demo C3 'Floodable Park'

C3.- Floodable park area (La Esgueva River)

This area is close to the VA20 road ('Ronda Interior') along with La Esgueva River at the entrance of the Valladolid municipality, in the East of the city.

- Floodable park of near 40,000 m^2.
- Urban Carbon Sink, with new trees with high capacity of Carbon sequestration.
- Educational path in the Floodable Park.
- Natural pollinator's modules in the Floodable Park
- Urban orchard area in Santos-Pilarica area (close to Floodable Park area)

Figure 4.31: Location map of the Sub-Demo C3 Interventions 'Floodable Park' (Source: Google/Valladolid City Council elaboration).

4.10 Floodable Park (VAc11)

4.10.1 General Description

The floodable park project is designed to create a green space, close to the Esgueva River, which has the capacity to store water in case of intense rainfall in the study area and under extraordinary flood conditions of the Esgueva River. Subsequently, once the flood episode is over, the volume of rainwater stored will be gradually returned to the riverbed and in safety conditions.

The operation of the park will be as follows:

- Under normal flow conditions of the Esgueva River, which will occur during a large part of the facility's operative life, the space will be used as a park for public use and enjoyment analogous to any other existing park. In case of heavy rainfall, the water from precipitations stored within the pond will drain to the riverbed through the water flow outlet control structure. In this scenario, the river will be able to absorb the impact of fallen precipitation without causing flooding and thus, generating damages downstream.
- Under ordinary flood conditions of the Esgueva River where the water level of the river would be above the level of the water flow outlet control structure of the pond, the floodable park will retain the water volume precipitated over the area. In this way, the introduction of new water contributions to the river that could aggravate the safety conditions downstream of the park is prevented.
- Finally, under extraordinary flood conditions in which the closer areas to the river course become flooded, the floodable park will allow to temporarily store a small part of the volume of the overflowed water, allowing its re-entry into the river once the flood episode had concluded.

Related actions

This action is located within the zone known as “Floodable Park Area”. Thus, Vac11 is related to the following other actions (See the corresponding sections for more details):

- VAc11- *Floodable Park*.
- Vac7- *Urban Carbon Sink*.
- VAc18- *Smarts soils* as substrate.
- VAc21– *Natural Pollinator’s modules*.
- VAc35- *Educational path* in the C3- floodable park area.
- Vac31- *Urban orchards*: Santos-Pilarica municipal orchards are close to the Floodable park.

Close to the Floodable park area there will be also included a *VAc6- Green resting area* (see section 2.2 for further details).

4.10.2 Location

The area is located in the municipality of Valladolid, at the east part of the city. The plot is located south of Barrio Los Santos II (previously known as Sector No. 50), bounded to the north with other plots of the sector to be developed, to the west with the urbanization "Los Santos (Pilarica)" which is fully executed, to the east with the VA-20 highway and to the south with the Esgueva river.

The municipal plot where the floodable park would be implemented is the SG-1. The surface of it is 70,230.06 m^2 and its uses are distributed as follows:

- Parks and gardens: 56.552,92 m^2
- Road surface: 7.715,83 m^2.
- Area for other uses (Equipment): 5.961,31 m^2

Figure 4.32: Location of the Floodable park plot (Source: Google/Duero River Basin Authority elaboration).

The municipal plot is free of buildings and has a noticeably flat relief, without large variations in elevation, although with a slight downward slope in an east-west direction.

Figure 4.33: Municipal plot for the Floodable park (Source: Duero River Basin Authority).

The Esgueva river flows east-west at an average distance of between 10 and 15 meters south of the boundary of plot SG1. Between the riverbed of the fluvial course and the plot there is an unpaved path, about 3 meters wide, which is usually frequented by cyclists and people walking.

4.10.3 Technical Specifications

Hydrological and hydraulic aspects regarding the building site

On December 2017, the document "Preliminary studies of the detention pond at the Esgueva River" was drafted by Duero River Basin Authority (Confederación Hidrográfica del Duero, CHD), and presented to the attending members in the meeting held at the Valladolid Innovation and Economic Development Agency on December 14th, 2017.

The aforementioned study presented a hydrological and hydraulic study of the final section of the Esgueva River, more specifically; from its mouth in the Pisuerga River until the viaduct of the VA-20 Internal Round. The objective of the study is to get to know the different parameters which are necessary in order to pre-dimension the retention pond.

The following paragraphs consist on a summary of the methodology used and the work that has been developed in the study: First of all, a Hydraulic study was developed in order to obtain the flows pattern of Esgueva River and the points where overflows start occurring for different return period floods. The return periods considered were 10, 15 and 25 years.

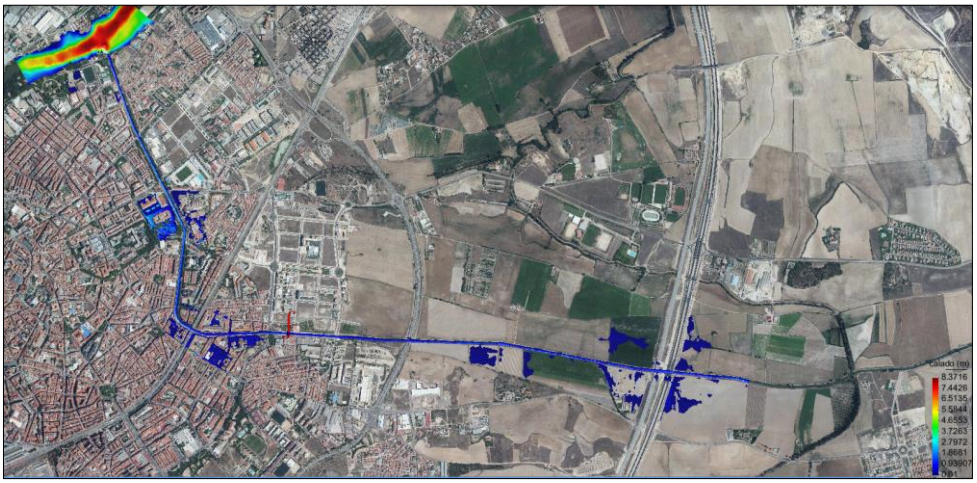


Figure 4.34: Flood map for a 10 year return period flood (Source: Google/Duero River Basin Authority elaboration).

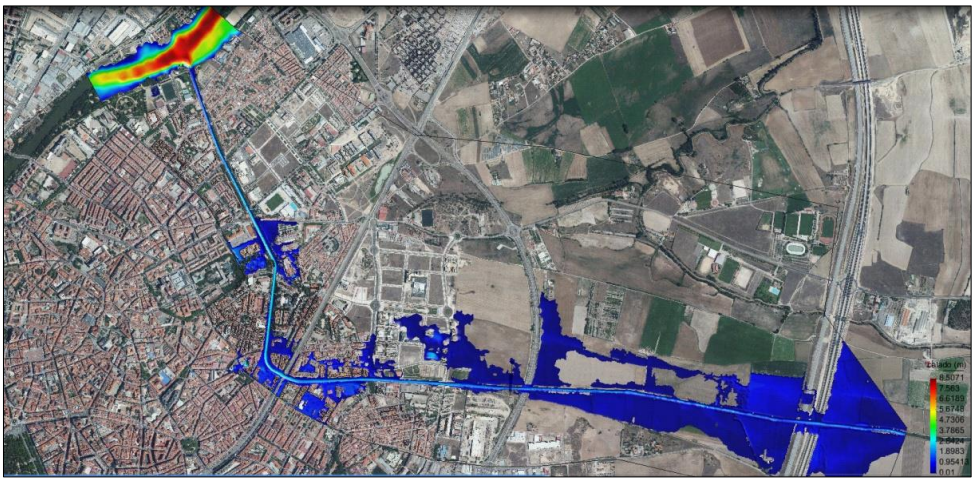


Figure 4.35: Flood map for a 15 year return period flood (Source: Google/Duero River Basin Authority elaboration).

Figure 4.36: Flood map for a 25 year return period flood (Source: Google/Duero River Basin Authority elaboration).

In second place, a Hydrological study was carried out as a very useful tool in order to define the flood hydrographs for different return periods, and thus be able to determine the real need of temporal floodwater storage.

For this purpose, it was necessary to follow the following steps:

1. Defining the Basin Model (Study Area) of the Esgueva River: The river basin or study area of the Esgueva River covers almost 1.000 km^2. For this reason, and due to its big watershed area, it was considered to divide it in 3 river subasins. Data involving meteorology, stormwater run-off and recharge time series were required at subbasin level for each return period considered.

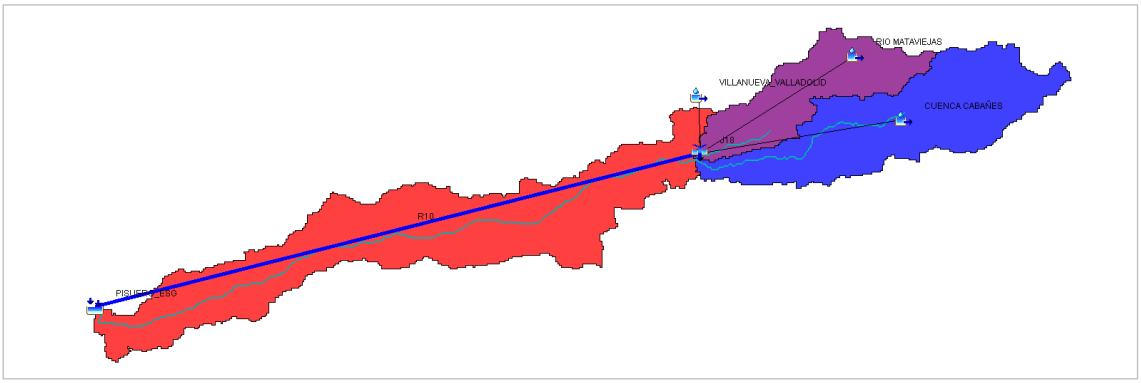


Figure 4.37: Hydrological model in Geographic(al) Information System (GIS) (Source: Duero River Basin Authority).

2. Determine Precipitation Gage Weights: Precipitation gage weights for computing basin average precipitation in the region and their location with respect to the watershed were estimated.

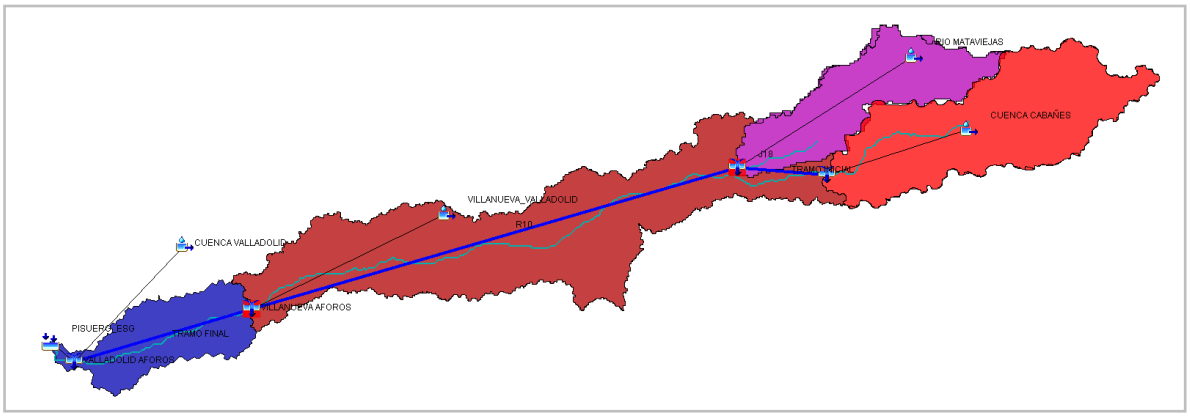


Figure 4.38: Hydrological model for gauging stations along the Esgueva River in (GIS) (Source: Duero River Basin Authority).

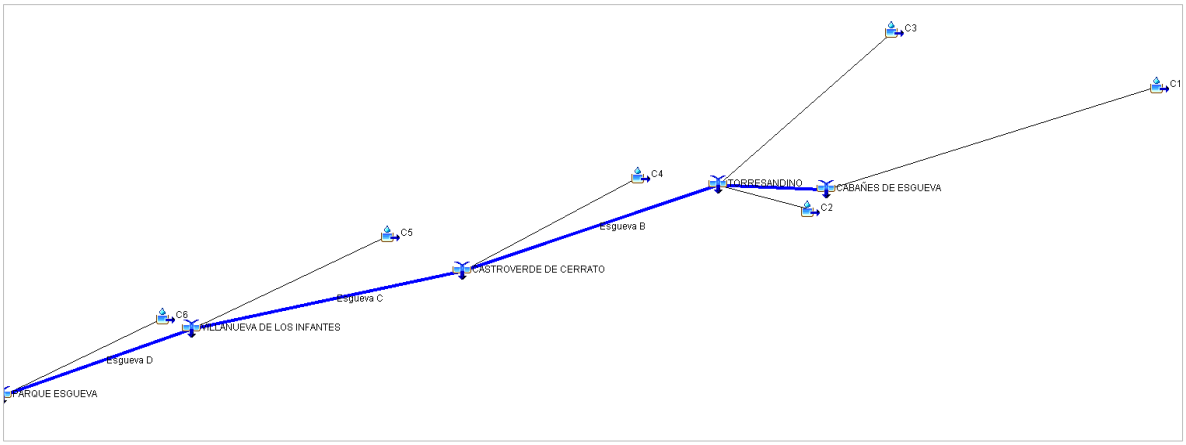


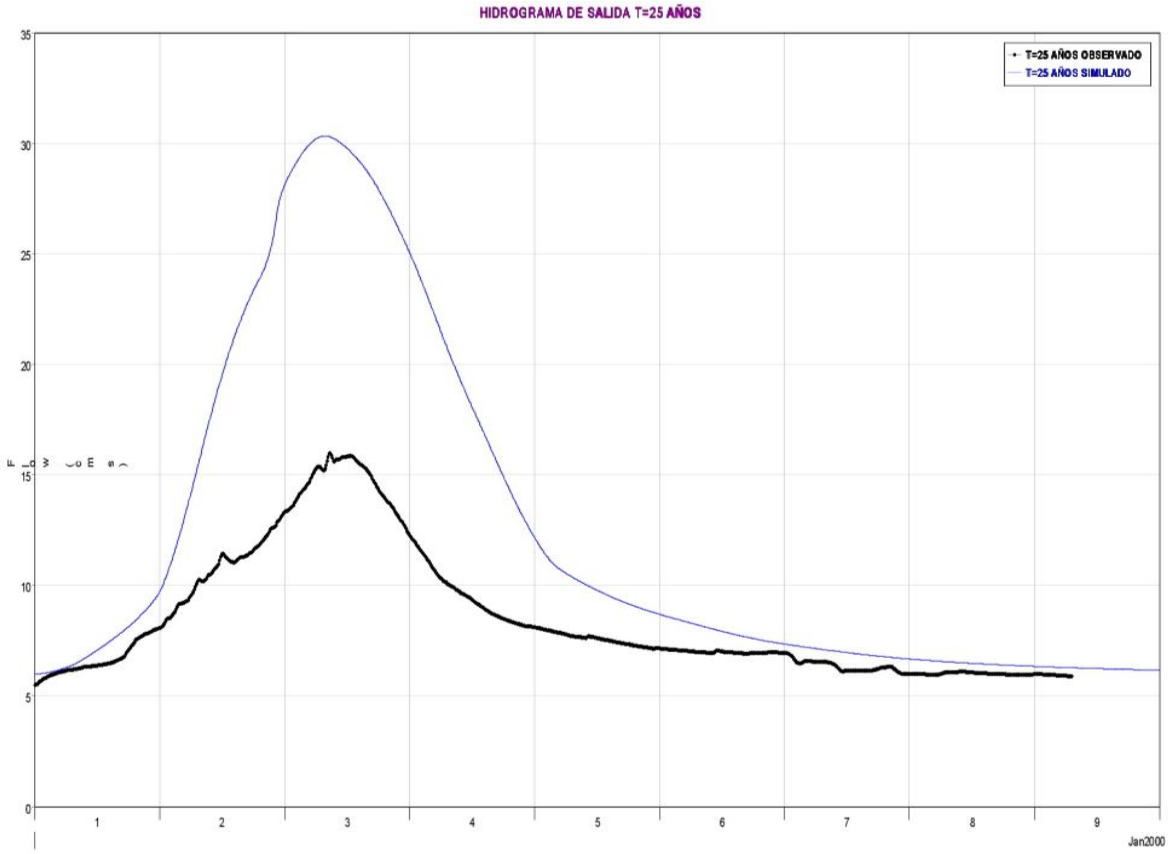
Figure 4.39: Hydrological model for gauging stations along the Esgueva River in HMS (Source: Duero River Basin Authority).

3. Parameterize the Basin Model: According to the digital land cover maps, the hydrologic soil group and land use was established. Moreover, hydrologic methods of computation were required as well as the basin and subbasins physical parameters that would be involved in the method of calculation chosen according to the physical features of the Esgueva River.

4. Create a Meteorological Model: In this step, the boundary conditions for every subbasin were defined.

5. Create and run a simulation: Three different simulations were run and then computed, one for each return period considered (10, 15 and 25 years). In order to create these simulations, the meteorological model and control specifications from previous steps were incorporated to the project.

Hydrographs results for the return periods considered of 25, 15 y 10 years at the point closest to the Esgueva River where the floodable park will be located are shown below in the following figures.



Project: ESG25 Simulation Run: BALSA_1_0

Diversion: Diversion-1

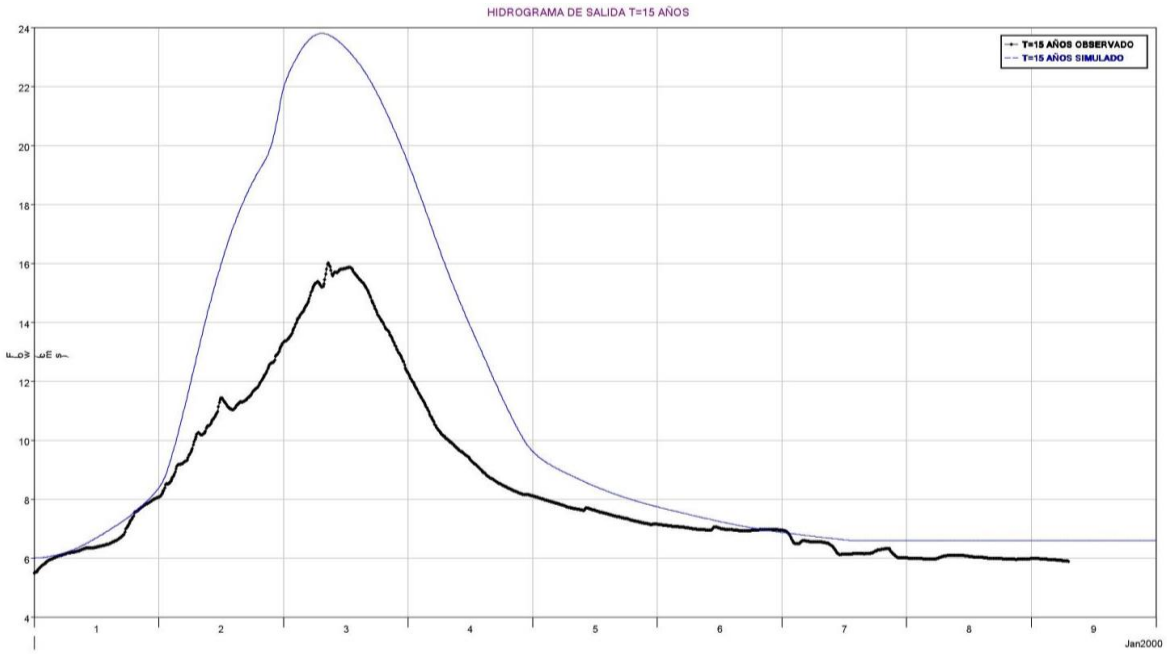
Start of Run:	01ene2000, 00:00	Basin Model:	ESG_AF_BALSA
End of Run:	10ene2000, 00:00	Meteorologic Model:	ESGUEVA3
Compute Time:	30nov2017, 08:47:16	Control Specifications:	AVENIDA DE 25 AÑOS

Volume Units: MM 1000 M3

Computed Results

Peak Inflow:	31,05 (M3/S)	Date/Time of Peak Inflow:	03ene2000, 09:10
Peak Discharge:	20,00 (M3/S)	Date/Time of Peak Discharge:	03ene2000, 02:40
Peak Diversion:	11,05 (M3/S)	Date/Time of Peak Diversion:	03ene2000, 09:10
Inflow Volume:	10796,24 (1000 M3)		
Discharge Volume:	9118,12 (1000 M3)	Diversion Volume:	1678,12 (1000 M3)

Figure 4.40: Hydrological model results (return period = 25 years) (Source: Duero River Basin Authority).



Project: ESG15 Simulation Run: BALSA

Diversion: DERIVABALSA

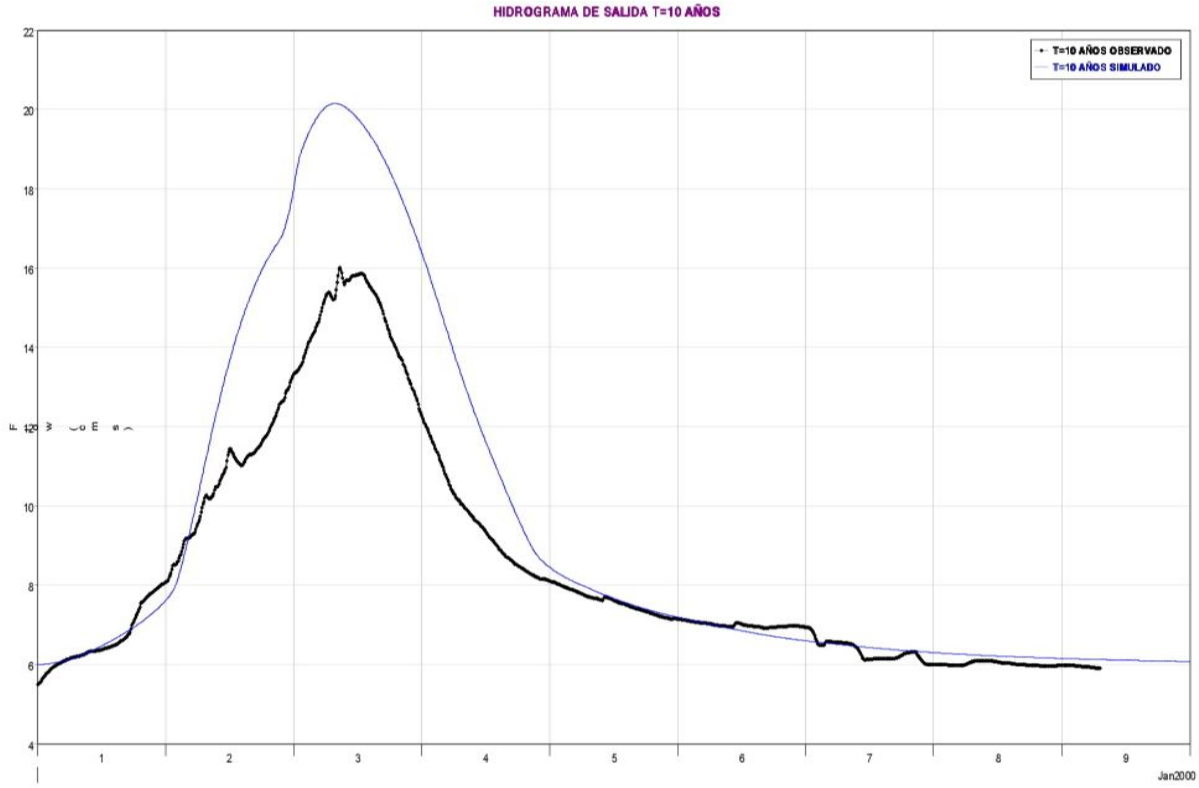
Start of Run:	01ene2000, 00:00	Basin Model:	ESG_AF_15_BALSA
End of Run:	10ene2000, 00:00	Meteorologic Model:	ESGUEVA3
Compute Time:	05dic2017, 17:35:44	Control Specifications:	AVENIDA DE 10 AÑOS

Volume Units: MM 1000 M3

Computed Results

Peak Inflow:	23,49 (M3/S)	Date/Time of Peak Inflow:	03ene2000, 07:20
Peak Discharge:	20,00 (M3/S)	Date/Time of Peak Discharge:	02ene2000, 22:10
Peak Diversion:	3,49 (M3/S)	Date/Time of Peak Diversion:	03ene2000, 07:20
Inflow Volume:	8038,95 (1000 M3)		
Discharge Volume:	7841,07 (1000 M3)	Diversion Volume:	197,89 (1000 M3)

Figure 4.41: Hydrological model results (return period = 15 years) (Source: Duero River Basin Authority).



Project: ESG10 Simulation Run: BALSA

Diversion: DERIVABALSA

Start of Run:	01ene2000, 00:00	Basin Model:	ESG_AF_10_BALSA
End of Run:	10ene2000, 00:00	Meteorologic Model:	ESGUEVA3
Compute Time:	07dic2017, 08:09:57	Control Specifications:	AVENIDA DE 10 AÑOS

Volume Units: ○ MM ◉ 1000 M3

Computed Results

Peak Inflow:	19,91 (M3/S)	Date/Time of Peak Inflow:	03ene2000, 07:40
Peak Discharge:	18,00 (M3/S)	Date/Time of Peak Discharge:	03ene2000, 00:20
Peak Diversion:	1,91 (M3/S)	Date/Time of Peak Diversion:	03ene2000, 07:40
Inflow Volume:	7177,62 (1000 M3)		
Discharge Volume:	7094,29 (1000 M3)	Diversion Volume:	83,33 (1000 M3)

Figure 4.42: Hydrological model results (return period = 10 years) (Source: Duero River Basin Authority).

Finally, the main conclusions obtained from the "Preliminary studies of the detention pond at the Esgueva River" were the following:

- The storage capacity in terms of volume of water required for a detention pond in order to control floods with a return period of 25 years return should be at least 1.7 hm^3 (1,700,000 m^3).
- The storage capacity in terms of volume of water required for a detention pond in order to control floods with a return period of 15 years return should be at least 0.2 hm^3 (200,000 m^3).
- The storage capacity in terms of volume of water required for a detention pond in order to control floods with a return period of 10 years return should be at least 0.08 hm^3 (80,000 m^3).

Return period considered	Required storage volume of water
25 years	1.7 hm^3 (1,700,000 m^3)
15 years	0.2 hm^3 (200,000 m^3)
10 years	0.08 hm^3 (80,000 m^3)

Table 4.22: Required storage volume of water for floods with different return period.

In this sense, CHD considers that the proposed type of NBS to be used in the floodable park intervention could be more suitable for mitigating floods from stormwater runoff in areas with a high percentage of impervious land such as in urbanized areas, where, the typology of adverse meteorological events can cause peaks of very high flow rates, but in very short periods of time (normally a couple of hours), and consequently, the volume of water generated and needed to be temporally stored is not commonly very high.

Conversely, the case studied for the Esgueva River is different. Firstly, because of the geomorphological characteristics of its river basin, the concentration and recession flow curves present a very smooth leaning. These geomorphological features tend to generate hydrographs very broad at their base with little pronounced flow peaks and whose depletion occurs over several days, 3-4 days, until reaching the base flow rate, which is when an asymptotization of the curve occurs. Therefore, to achieve hydrograph attenuation in large or medium-sized rivers, it is necessary to have the possibility of storing large volume of water.

Topographical aspects of the building site

With the aim of achieving a deeper knowledge of the topography and geotechnical features of the building site plot and their surroundings, on July 27th, 2018, and during a week, surveying tasks and a hydrogeological study of the subsoil were carried out.

Results from the surveying campaign show that the building site has a noticeably flat relief around level 697 m. Maximum height reaches a level of 7712.53 m. The Esgueva River flows parallel to the southern boundary of the plot in an approximate length of 330 m. The average slope of the riverbed is about 3 ‰. The elevation of the bottom of the riverbed is approximately 695 m. This difference of heights is one of the conditions to be considered in the design of the detention pond, although as we will see in lines below, there exist more restrictive geotechnical and hydrogeological aspects of the ground that are also needed to be carefully taken into account.

Figure 4.43: Topographical specifications for the floodable park (Source: Duero River Basin Authority).

For the surveying campaign, four stakeout bases were used. The image below shows the points in where they were located.

Figure 4.44: Stakeout bases used for the topography study (Source: Duero River Basin Authority).

The following image represents the contour of a preliminary design of the detention pond. Two cross-sections have been defined in order to study the terrain relief along them.

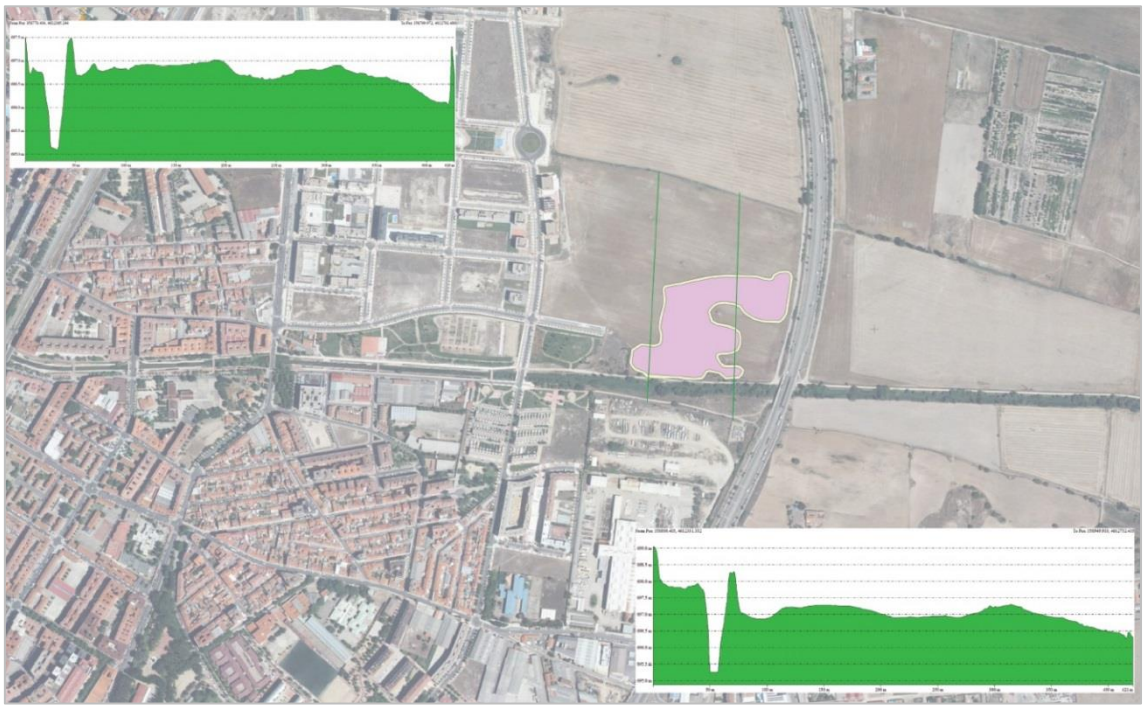


Figure 4.45: Cross-sections along a preliminary desing of the detention pond (Source: Google/Duero River Basin Authority elaboration).

Geological, hydrogeological and geotechnical aspects of the building site

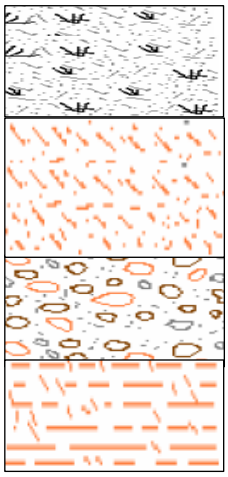
On the other hand, the geotechnical campaign has consisted of the execution of 4 pits, a geophysical study of the plot using the resistivity method in the Electrical Tomography modality and the laboratory test of the materials extracted in the pits. The next map shows the points in where pits were made.

Figure 4.46: Location of the pits of the geophysical study (Source: Google/Duero River Basin Authority elaboration).

To develop the pits, the use of an excavator machine was necessary. The depth of the holes reached depths between 2.7 and 3.5 m.

Figure 4.47: Excavator machine used to dig the pits and take out the terrain for its study (Source: Duero River Basin Authority).

The lithological column found at the building site plot was the following:



Depth		Material
From	To	
0,0 m.	0,2 - 1,0 m.	Topsoil
0,2-1,0 m.	0,7 - 1,5 m.	Silty sands and silty clays (low permeability)
0,7 - 1,5 m.	3,5 - 4,0 m.	Gravel and sands (high permeability)
> 3,5 - 4,0 m.		Argillaceous sands and sandy clays

Table 4.23: Lithological column of the Floodable park ground

The Electrical Tomography developed in the building site plot aimed to provide a deeper knowledge of the hydrogeological conditions of subsoil materials. The next figure shows the shape of the wire lines used to undertake the geophysical study of the subsoil.

Figure 4.48: Location of the wire lines used to carry out the Electrical Tomography (Source: Google/Duero River Basin Authority elaboration).

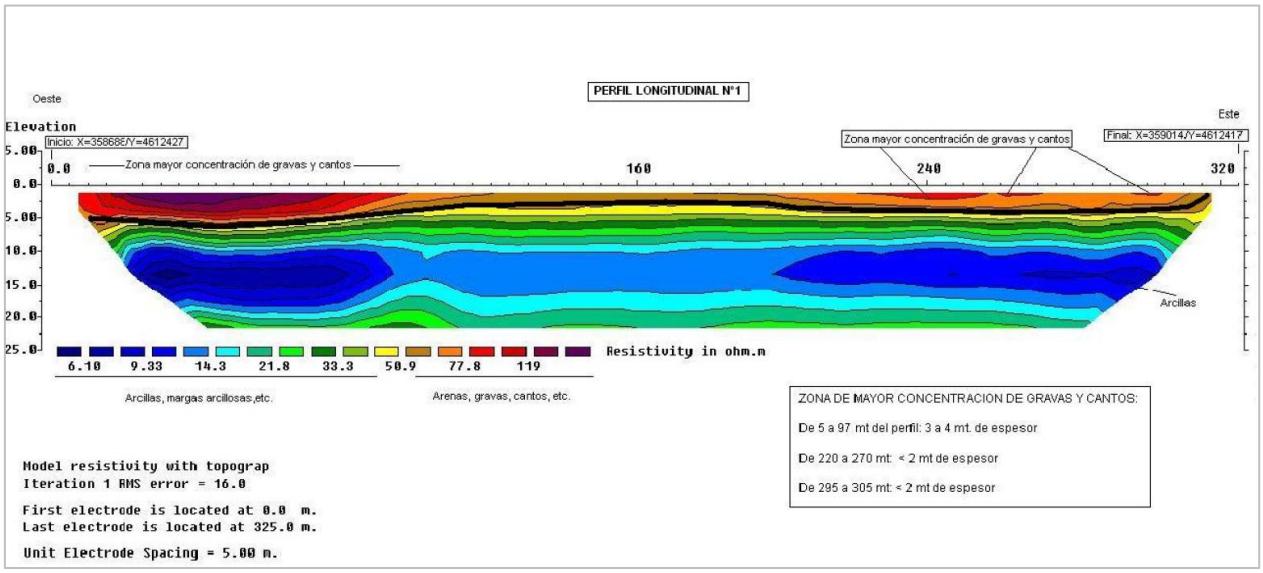


Figure 4.49: Example of the results obtained from the longitudinal profile nº1 of the Electrical Tomography (Source: Duero River Basin Authority).

According to the geotechnical and geophysical campaign that has been carried out, the main limiting aspects when attempting to design the detention pond are the following:

- The water table is at a depth between 1.9 m. and 2.2 m.
- The entry of water into the aquifer from the pond by means of infiltration must be carefully controlled since an over-elevation of the water table or uncontrolled flow from underground water might cause structural problems and underground floors flooding at nearby buildings, both existing ones and future ones that are expected to be built within the sector. In addition, they could cause problems to the sewerage network of the adjoining roads since the drainage pipes are below the level of wet surface planned for the pond.
- The previous conclusions explained lines above would imply not going deeper than the layer of silty sands and existing sandy clays, although in some points (specifically in the place where the waterflow outlet control structure will be located, the deepest point)

the depth to which the impervious layer is surpassed is only 70 cm. This would entail designing a pond with a very small storage capacity since the level in the bottom of the pond at the inlet area would be practically the current one of the land.

In consequence of these aspects, it is necessary to consider the waterproofing of the bottom and sides of the detention pond.

Detention basin design

Earthworks: The earthwork works are distributed basically in two different actions:

- Excavation of the pond with an estimated depth of 1.80 m.
- The edges of the excavation will be left with a gentle slope (5H:1V) in order to improve the stability of the hillslopes.

In order to collect and release water from the pond, both rainwater and water retained after a flood episode, the bottom of the excavation should have a slight double slope. On the one hand, towards the perimeter of the excavation where there will be a perimeter ditch, and on the other hand, towards the west, which is the direction in which the sewer of the pond will be located so the water can return to the riverbed.

Below, a preliminary outline of the excavation plan to be made is presented:

Figure 4.50: Preliminary design of the detention pond. (Source: Google/Duero River Basin Authority elaboration).

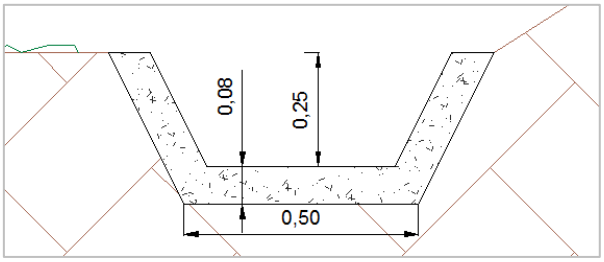


Figure 4.51: Preliminary design of the perimeter ditch section. (Source: Duero River Basin Authority).

In order to minimize, and even eliminate, the transport of excavated land to landfill, it has been considered necessary to create a small artificial hill with the earth coming from the excavation. However, the feasibility of this action is subject to the need to identify the composition of the terrain in order to know the suitability of its use as a filling material on the hill.

Next, a preliminary outline of the area where the artificial hill will be located is presented. The level curves are represented with a height difference between them of 2 meters.

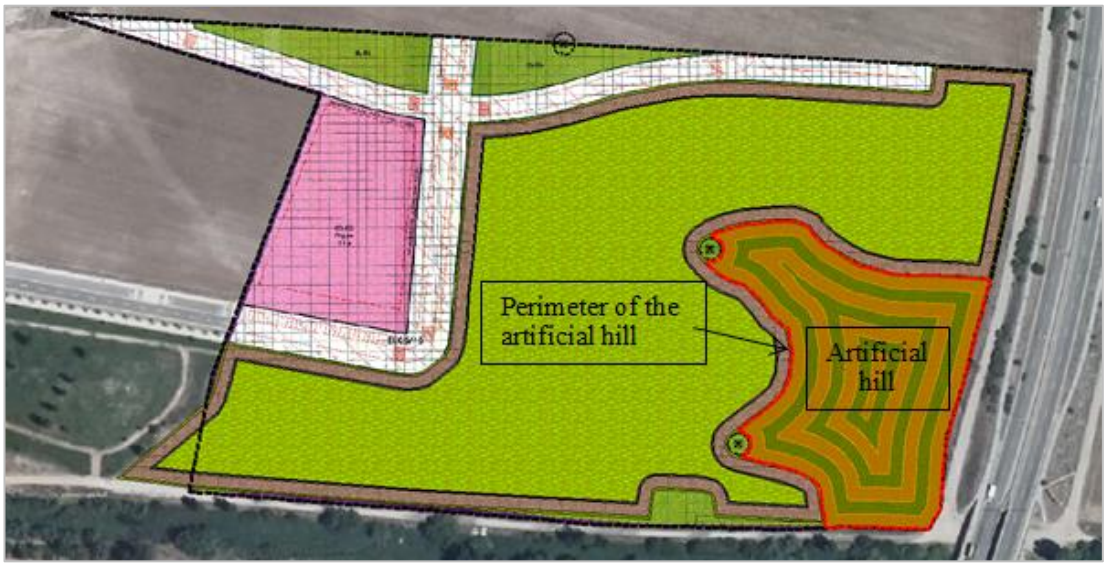


Figure 4.52: Preliminary design of the artificial hill (Source: Google/Duero River Basin Authority elaboration).

Finally, the main characteristics of the designed pond are the following:

Pond characteristics	Value
Maximum depth	1,8 m. at the deepest point
Slope at the bottom of the pond in order to allow runoff drainage	3 ‰
Maximum lean of the slopes of the pond	5H:1V
Waterproofing of the pond	Geotextile + PEAD sheet + Geotextile

Table 4.24: Pond technical specifications Floodable park

Waterflow intlet control structure design

As waterflow inlet control structure, the construction of a lateral spillway arranged on the river bank is proposed. The level of water entering the pond will be the same as the maximum level expected for the detention pond, which is the height of 696.8 m.

The length of the spillway will be 5 m. and will lead the waters through a channel that will run under the existing unpaved pathway which must be respected. Both the spillway and the channel beneath the pathway will be executed with reinforced concrete.

A schematic preliminary design for the waterflow inlet control structure is shown in the image below.

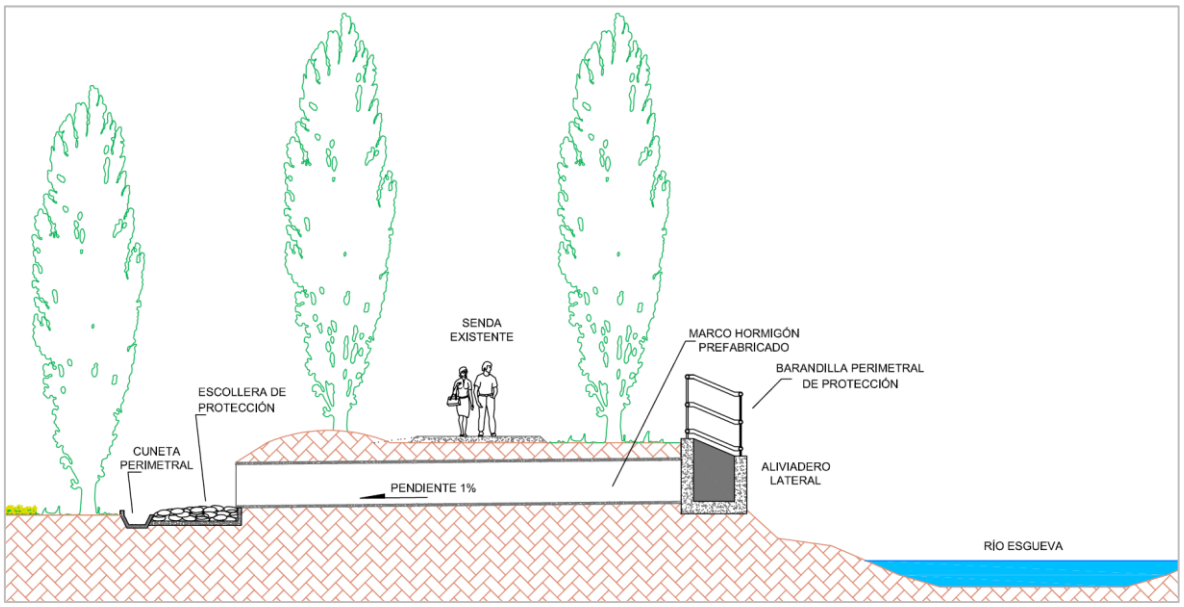


Figure 4.53: Schematic preliminary design for the waterflow inlet control structure (Source: Duero River Basin Authority).

Outlet waterflow control structure design

The mechanism in order to empty the pond will consist on the installation of a pipe (or maybe several of them in parallel) at the deepest point of the pond that will allow its drainage once the heavy rainfalls or extraordinary flooding episode had finished.

To prevent water from Esgueva river entering the pond through the waterflow outlet control mechanism, a non-return valve at the end o each pipe will be installed.

Figure 4.54: Detail of a non-return valve (Source: Duero River Basin Authority).

The elevation of the unpaved pathway around the waterflow outlet structure will be modified so that in case the capacity of the pond is overcome, this part of the pathway would work as an emergency spillway allowing the water to return back to the Esgueva River.

A schematic preliminary design for the waterflow outlet control structure is shown in image below.

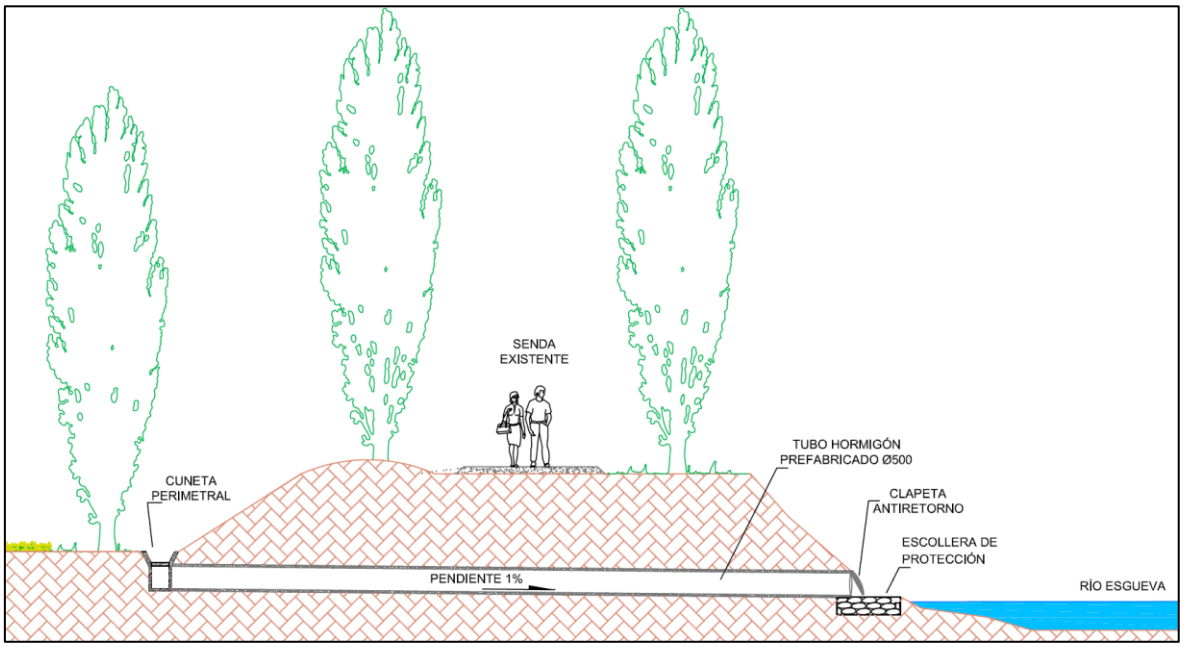


Figure 4.55: Schematic preliminary design for the waterflow outlet control structure (Source: Duero River Basin Authority).

Amenity and planting design

Over the floodable surface of the pond, and since it has been necessary to implant a sheet of waterproofing, the provision of grass with a low level of maintenance has been foreseen, thus avoiding the provision of arboreal elements that could break the waterproofing sheet.

% ESPECIE	CARACTERÍSTICAS	
40% *Festuca arundinacea* FIRACES	Cespitosa de clima templado, muy rústica, de crecimiento formando macollas y adaptada a una amplia gama de suelos y usos. Sistema radicular fibroso y profundo.	- Mínimas necesidades de mantenimiento en escarificados y pinchados. - Altamente tolerante al pisoteo y de elevada capacidad de recuperación. - De pocas necesidades fertilizantes. - Frecuencia de corte baja.
40% *Festuca arundinacea* MÉRIDA		- Destaca especialmente por ser una variedad fina y de crecimiento lento. - Excelente comportamiento en verano. - Máxima resistencia a la sequía. - Muy tolerante a pisoteo y arrancamiento.

10% *Poa pratensis* BLUECHIP	Cespitosa de clima templado, de textura de hoja media-fina y crecimiento formando rizomas. Muy tolerante al pisoteo y sensible a enfermedades de hoja en condiciones de clima suave. Recomendable en mezclas por su crecimiento lateral. No sembrar como especie única.	- Resistente a roya. - Destaca por tener un tamaño de semilla muy grande lo cual aumenta su rapidez y vigor de establecimiento. - Mantenimiento medio-bajo. - Textura de hoja media. Ideal para mezclar con *festuca arundinacea*. - Mantiene muy bien el color en invierno.
10% *Lolium perenne* RINGLES	Cespitosa de clima templado, de crecimiento formando macollas y que destaca por su rapidez de instalación, resistencia al pisoteo y aspecto ornamental. Sistema radicular profundo.	- Máxima resistencia a sequía. - Variedad enanizante, de porte erecto y textura de hoja fina. - Excelente vigor de instalación con mínimo mantenimiento. - Máxima resistencia calor y salinidad (hasta 15000 ppm). - Color verde medio.

Table 4.25: Suggested composition for the area covered by grass

This composition of lawn achieves a wide-spectrum, strong and aesthetic lawn. It has the following characteristics:

- Medium maintenance low scarification, pricking, mowing and fungicides.
- Very tolerant to heat, drought and salinity.
- Save 30% of water compared to traditional lawns.

Also, and depending on the budget availability, the design of pathways and the installation of various elements of urban furniture such as benches, litter bins, tables and bicycle parking slots could be considered (see technical specifications of the *VAc35- Educational path in floodable park area* intervention, section 4.13).

Security design and considerations

In order to prevent possible problems of vandalism and also for security reasons in case of a sudden entry of water into the detention pond, the installation of a perimeter fence has been considered. The fence should be opened and closed daily by the owner of the park.

On the other hand, due to its high cost, the installation of a lighting network must be carefully studied.

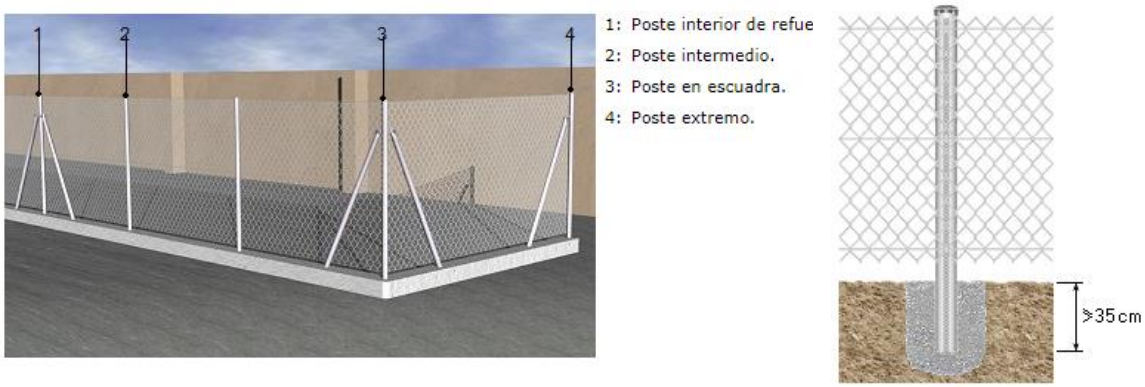


Figure 4.56: Suggested design of the perimeter fence (Source: CYPE Ingenieros S.A.).

Technical specifications' conclusions

Finally, CHD considers important to remark that due to results obtained from the geotechnical and geophysical campaign (waterproofing of the bottom and sides of the detention pond is completely necessary to avoid causing structural problems and underground floors flooding at nearby buildings) as well as for the limited budget availability (200.000 €, VAT included, for the floodable park action) this intervention have had to be rescaled now covering a much smaller area, and consequently, the volume of water that could be stored will not be high. In this respect, the floodable park action should not be understood as a measure that eliminates or even mitigates the risk of flooding of the Esgueva River as it passes through the city of Valladolid. Both Technical conditions and also economic considerations regarding this intervention makes no possible to fulfil the objective of absorbing the flow peaks from floods of Esgueva River.

Further exhaustive examinations such as risk assessment considering all the information provided to date (geotechnical and geophysical considerations and hydrological and hydraulic aspects, among others) are being developed nowadays in order to know the intervention viability.

4.10.4 Operational and Maintenance Considerations

No control or automation of the system elements has been planned. The operating situations considered during the life of the floodable park are those already mentioned in the first section *"general description"*.

The maintenance tasks involve regular visual inspections that identify possible clogging or deterioration in the construction. Regarding the non-return valve, maintenance and conservation program indicated by the manufacturer must be strictly followed, which mainly consist on tasks status review (external damage, anchorages checking, corrosion, painting problems). Also, the opening and closure of the non-return valve must be checked as well as controlling the need for lubrication.

With regard to the waterproof sheet, the owner of the park should perform regularly visual inspections to check that the sheet is not discovered under any circumstances and to monitor that has not been damaged by human action.

4.10.5 Economic Specifications

The approximate unit costs of the principal units for the floodable park construction would be the following. The table shows the total costs expected of the floodable park intervention.

Floodable park	unit	quantity	Price (€)	Amount (€)
Excavation	m^3		1,60	
Ground compaction	m^2		0,59	
Embankment formation with excavation material	m^3		1,56	
Ditch formation	m		1,91	
Geotextile 500 g/m2	m^2		3,33	
Placement of 2 mm. PEAD sheet	m^2		10,20	
Filling, spreading and compaction of selected soil	m^3		4,14	
Waterflow outlet control structure design	unit		20.000,00	
Artificial gravel for the execution of paths	m^3		19,90	
Seedbed grass	m^2		2,53	
Connection to supply network - irrigation	unit		1.000,00	
Fence	m		18,72	
Waste management	Ud		2.000,00	
Health and safety	Ud		3.500,00	
Total budget of material execution (PEM) (€)				**135.521,88 €**
Industrial benefit (6% PEM)				8.131,31 €
General expenses (13% PEM)				17.617,84 €
Tender budget without VAT (€)				**161.271,04 €**
VAT (21%)				33.866,92 €
Tender budget with VAT (€)				**195.137,96€**
Quality control (2,5% PEM) VAT included				4.099,54 €
Health & safety coordin. (0,465% PEM) VAT included				762,51 €
Total budget for the public administration (€)				**200.000,00 €**

Table 4.26: Floodable park budget (Source: Duero River Basin Authority)

4.11 Urban Carbon Sink (VAc7)

4.11.1 General Description

The Urban Carbon Sink (UCS) is conceived as an urban forest in which species have been selected mainly for their ability to fix carbon. Therefore, it is a nature-based solution for the over-accumulation of carbon dioxide in cities' atmosphere.

VAc7- Urban Carbon Sink is integrated into *VAc11- Floodable Park*. It will consist in the installation of urban woodland (initially planned planting 1,500 trees in a 40,000 m^2 surface) with appropriate species adapted to temporary flood condition and with high capacity of carbon sequestration (*Fraxinus* spp., *Betula* spp., *Salix* spp., *Populus* spp. etc.). The trees of this forest will be allocated in specific arboreal series.

This area will be a new urban carbon sink and will form a new urban ecosystem to preserve the biodiversity. Likewise, this woodland will provide biomass to energy use with social and economic purposes.

Expected impacts: The UCS will be located close to industrial and traffic areas, which act as a source of carbon dioxide emissions due to combustion processes. This NBS is proposed to compensate the emissions of this greenhouse gas, capturing it in the form of biomass.

In order to achieve this effect, it is necessary to include specific criteria for taxon selection composition and typology of them during designing stage of UF. Likewise, it will be essential to take into account to establish a management plan (pruning, spacing, etc.).

Multicriteria species assessment is required, focused on C fixation capacity, in addition with other aspects, such as native vegetation, easy management, aesthetics, health, ecological coherence and integrity criteria. Impacts derived from UF implementation must be evaluated on medium-long term, since to C fixation capacity of the species is highly related to the maturity grade of the taxa.

Related actions

This action is located within the zone known as “Floodable Park Area”. Thus, VAc7 is related to the following other actions (See the corresponding sections for more details):

- VAc11- Floodable Park.
- VAc18- Smarts soils as substrate.
- VAc35- Educational path: Educational path in Floodable Park area.
- VAc21– Natural Pollinator’s modules.

4.11.2 Location

Location plan

The Urban Carbon Sink is located in the eastern part of the municipality of Valladolid, in the neighbourhood known as Los Santos-Pilarica. Specifically, the plot is located in Sector 50 of the land for building development known as "Los Santos 2" with a plan definitively approved for its development (BOCyL, 27th June 2006). It limits to the south with the bed of the river Esgueva and to the east with the Outer Round VA-20 (‘Ronda Interior’). North and West are adjacent to other plots of similar characteristics.

Figure 4.57: Sector 50 plot named "Los Santos 2" (Source: Google/Duero River Basin Authority elaboration).

The next table shows the maximum and minimum coordinates of its location.

	X Coordinate	Y Coordinate
Maximum	359 055.90	4 612 633.77
Minimum	358 617.03	4 612 403.13

Table 4.27. Maximum and minimum coordinates of the studied plot
Proj = utm; zone = 30; ellps = grs80; towgs84 = 0,0,0,0,0,0,0; units = m

Characteristics

The plot has a total area of 70,315 m^2, of which 56,552.92 m^2 are intended for parks and gardens, 7,715.83 m^2 for roads and pavements and 5,961.31 m^2 for facilities. Both the road surfaces and the paths and road locations (drawn in white in the image above) and the plot for planned facilities (pink area in the image above) must be free of building, which means that the floodable park cannot be located in those places. The inner roads must be developed and paid by the approved plan's owners.

It is estimated that the floodable park has an area of approximately 50,700 m^2, of which 35,700 m^2 will be dug and used as a retention pond with a temporary water storage capacity of about 90,000 m^3. Likewise, it is possible that the floodable park has a permanent small lake.

Site conditions

Currently, the study plot has no *infrastructures* except a high voltage power line that cross the plot from North to South. The construction project should include and follow the regulations applicable in this sense.

Figure 4.58: Powerline along the "Los Santos 2" plot (Source: Google/Duero River Basin Authority elaboration).

Although there are no more infrastructures within the plot, a reserve of urban road is included in the regulations. This area should be considered within the project.

There is no evidence of any other subterranean infrastructures (electricity, gas, etc.), but further studies have to be done for the construction project. The plot is free of any kind of *construction* and its previous use was agricultural.

The southern limit of the plot is adjacent to a pedestrian way, which links the city with the pedestrian route known as "GR-27 Valle del Esgueva". It has 3 m width and it is frequented by walking and cycling users.

Site environment

Hydrography and Soil

The ITACyL institute carried out a sampling analysis of edaphic conditions in some points near to the plot. This data could be useful for an overall preview.

Distance	Organic Matter	Soil Structure	pH	Texture	Distance
1,5 - 2,0 km	2,23	High	Strong	8.5	Very basic
	2,34	High	Strong	8.4	Basic
	2,60	High	Strong	8.3	Basic
2,0 - 2,5 km	1,70	Moderate	Strong	8.1	Basic
	0,16	Low	Moderate		
	1,70	Moderate	Strong	8.5	Very basic
2,5 - 3,0 km	1,16	Low	Weak	8.3	Basic
	2,54	High	Strong		
> 3,0 km	0,64	Low	Strong		

Table 4.28. Edaphic conditions around the studied plot (Source: ITACyL Institute)

According to the data above, soils in the studied area are basics and mostly clayey-loam. However, a complete study of the edaphic conditions should be carried on in order to determinate the suitability of the taxa.

The plot is located in a potential floodable area of the Esgueva River. At present, the Esgueva River, which flows through the city of Valladolid, causes important damages even with floods of small return period (T = 10 years). For this reason, it is expected that the plot would have an influence from the groundwater surface. Further on-site studies are needed in order to determinate the real influence of the freatism in the considered area.

Climate

The climate is characterized by cold winters with frequent frosts and hot-mild and dry summers. The picture below shows an average climodiagram from a station located 4 km north from the plot.

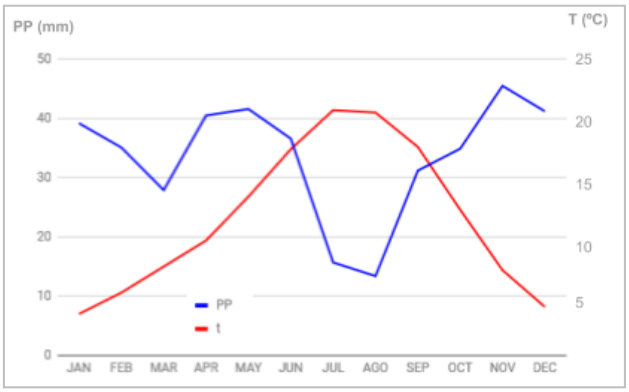


Figure 4.59: Climodriagram, Valladolid (Source: CARTIF based on data from SIGA: Sistema de Información de Datos Agrarios. Ministerio de Agricultura, Pesca, Alimentación y Medio Ambiente)

However, the location of the plot near the bed of the Esgueva River, can give the soil a certain freatism. Further studies should be carried out in order to determinate how groundwater level can provide water for taxa.

Native vegetation

The plot has a poor *spontaneous vegetation* cover. This vegetation does not match to the riparian vegetation that corresponds to its location near the river Esgueva. It is therefore a typical anthropogenic and degraded periurban area. At 1 km distance from the study plot and on the banks of the Esgueva River, there is a Natura 2000 network habitat, catalogued as Sites of Community Importance, whose characteristics are shown below.

Code	EU Code	HABITAT Code
16150004	92A0 *Salix alba* and *Populus alba* galleries	82A033 (80%) *Populo nigrae – Salicetum neotrichae* (Rivas-Matínez & Cantó ined.) 82A054 (20%) *Salicetum angustifolio- salvifoliae* (T.E. Díaz & Penas, 1987)

Table 4.29. Habitats (Habitat Directive 92/43/CEE) in Esgueva River 8 (Source: CARTIFT, based on data from Atlas y Manual de los Hábitats de España)

This habitat is a Mediterranean riparian forest composed mainly of woody vegetation (arboreal or shrubby) of the Salicaceae family (genera Salix and Populus). Specifically, we can find poplars (Populus alba, P. nigra), willows (Salix alba, S. purpurea, S. triandra), as well as elms (Ulmus minor) and other shrub species such as hops (Humulus lupulus).

Due to the proximity and environment of this habitat, it can be assumed that this would be the natural vegetation that the study plot would originally have.

4.11.3 Technical Specifications

Vac7- Urban carbon sink is part of the Floodable Park area, where the *Vac11- Floodable park* is being developed. Therefore, the following technical specifications should be adapted to the final floodable park layout.

Surfaces

Considering the electric powerline as a reference, the plot is divided into 2 different sections, according to its functionality: Section A on the left and Section B on the right.

Section A on the left will be the Floodable Area. In this area, the necessary works will be carried out to act as a temporary flood basin. In order to achieve this object, a gradual depression of the ground would be created. As results, two zones will be generated. One of them (A1) would be the deeper level of the floodable area, and it is expected that would be flooded more frequently. The rest of the area has been considered as a park area (A2). This area will be close to the groundwater level, but less likely to flood.

Section B on the right, will be the Urban Carbon Sink area. This area is higher than Section A, therefore, above the groundwater level. This area is also divided in two different zones: B1 and B2. B1 zone will be an artificial hill built from soil material removed from Section A. B2 zone will be the rest of the park.

An image of these 2 sections and 4 subzones is shown below. In grey colour a reserved area is represented. This area includes safety strip for the electric powerline, paths and other works.

Figure 4.60: Studied plot zonification for the Urban carbon sink (Source: Google/CARTIF elaboration)

The table below shows a preliminary estimation of each section and zone described above. It should be noted that these surfaces are a mere reference, since more detailed studies of the topography of the plot will be necessary. It will be also required reserve areas for construction works, safety distances, etc.

Section	Area	Description	Surface (m^2)	%
A Floodable Area	A1	Highly Depressed Area	4 510	10.95 %
	A2	Rest of the depressed area (park)	16 595	40.32 %
B Urban Carbon Sink	B1	Artificial hill	7 928	19.26 %
	B2	Rest of the Urban Carbon Sink (park)	12 129	29.47 %
Total			**41 162**	**100.00 %**

Table 4.30. Sections planned for the Urban carbon sink

Earthworks

Although further topographic studies are needed, the earthworks will consist in two different actions. On the one hand, the flood vessel will be excavated in Section A. On the other hand, an artificial hill will be constructed in Section B.

The gap between the excavated zone and the rest of the area will be saved with a gentle slope and safe for the users. Further information about this Section is detailed on VAc11-Floodable Park.

The materials removed from Section A will constitute the filling material of the artificial hill on Section B (zone B1) as long as they are suitable for that purpose. Otherwise, they must be taken to an authorized landfill. The height and extension of the hill will depend on the extracted material, although it is estimated at about 10 meters high.

Pavement and furniture

The construction of an educational path is proposed. The path will be 2 m wide and have a total length of about 1500 m. In addition, park furniture is also planned such as bins, banks, panels, etc. For more specific details, see VAc35- Educational route: Educational route in the Floodable Park area.

Plantation works

A regular terraced plantation is proposed for the artificial hill (B2), following the contour lines. For Section A and B2 of Section B an irregular forest cover is suggested in small groups. However, a linear planting framework can also propose for easier management if it is necessary. In any case, species must alternate in the plantation series in order to achieve a wilder (natural) aspect.

Spaces between plants should be at least 3 m (including bushes). Considering this and the total available surface, the amount of trees planted is estimated in 1300. The planting densities, however, will depend on the species finally selected and their surface requirements.

Section	Area	Description	Number of trees	Density tree/ha
A Floodable Area	A1	Highly Depressed Area	241	534
	A2	Rest of the depressed area	356	215
B Urban Carbon Sink	B1	Artificial hill	300	378
	B2	Rest of the UCS (park)	403	332
Total			**1.300**	**316**

Table 4.31. Plants density in each zone for the Urban carbon sink

Separation between plants has been estimated with a minimum of 3 m, although this is a generic figure. Thus, space between two taxa of species 1 (those of greater size at maturity) should be greater than between species of smaller size (species 2 and 3). Other option would be to intersperse small species with larger species to obtain a higher density of mass without compromising the correct development of the cups. In any case, the shadow tolerance of each species should be considered.

Before the planting work, a preparation of the land must be done, to be determined according to the initial conditions. This preliminary phase is closely related to the excavation works of the floodable park area and the creation of the artificial hill. During the excavation works, soil must be removed by layers avoiding compaction. Then the soil must be "re-constructed" by recovering its structure and characteristics, especially the previous vegetation cover.

Topsoil layer should have a 30 cm thickness minimum, while an under layer thickness should be 40 cm. Spreading soil works should be done by mechanics processes. As an option, slight wavy surfaces can be created in order to achieve a more “natural” looking.

External soil contributions should be minimized as much as possible. If necessary, it must come from local excavations, as close as possible to the action. The external soil provided must be adapted to the correct development of the proposed plantation, and be similar to the characteristics of the environment. The next table should be considered as an approximated reference.

Coarse material	< 15 % (< 5 cm Ø)	pH	> 6
Clay	< 25 %	C/N	4/12
Sand	< 70 %	N	> 0.2 %
Organic matter	> 3.5 %	P	> 25 ppm

Table 4.32. Model example for external soils contribution for the Urban carbon sink

Once the edaphic support is done, then plantation holes will be opened. These holes should have appropriate dimensions for the plant that will contain. They will also stay free of rocks and other elements that could avoid the correct plant growing.

Within one week from the opening, plants will be placed at the holes. Plants will be supplied in container or forest socket. In case of larger trees, they will be supplied in the form of root ball or large container. These will be placed straight and careful, and if necessary, placed next to a

guardian and properly protected. It is strongly recommended to select bigger plants for area A1, due to this zone would be flooded.

Then the holes will be filled again with the material previously extracted, if it is possible. Fertilizers and organic material can be also added, if necessary.

Watering

Once the planting is finished, an initial watering will be done. Thus, plantation irrigation should be done in order to ensure the correct growing of the plants at the first steps. Further irrigations should be done in moments of extreme drought for some of the species planted (those plants more related with freatism).

Species selection

Multicriteria species assessment is required, focused on C fixation capacity, in addition with other aspects, such as native vegetation, easy management, aesthetics, health, ecological coherence and integrity criteria.

Plants capture CO_2 in form of biomass, therefore, the more growing rate they have, the more potential capacity to fix Carbon. Thus, species such as poplars or eucalyptus will sequester more carbon than those with slower growth such as yews or junipers, considering Mediterranean environments. According to the CO_2 Calculator of Spanish tree forest species, the top 5 of forest species that have the greatest capacity for carbon fixation are *Eucalyptus globulus*, *Eucalyptus camaldulensis*, *Pseudotsuga menziesii*, *Picea abies* and *Cedrus atlantica*. However, none of them are native species of the Iberian Peninsula but all of them are currently wide spread for production or ornamental purposes. Cumulative absorption of CO_2 estimated over 30 years of this top 5 is shown below.

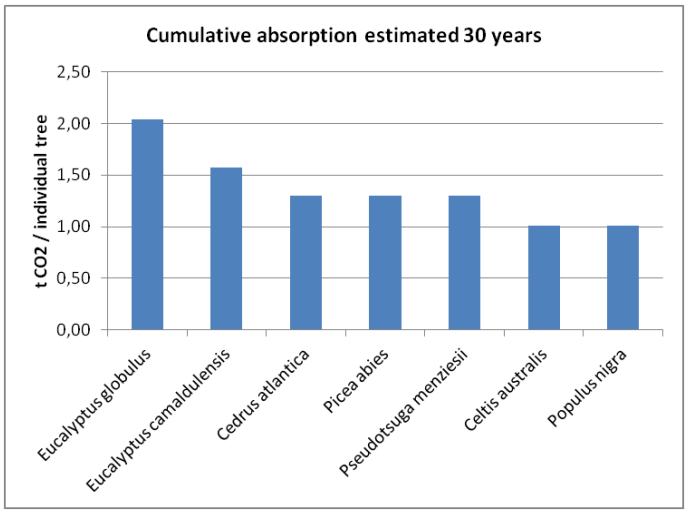


Figure 4.61: Cumulative CO2 absorption for individual trees for the most relevant species (Source: CARTIF, based on data from CO2 Absorption Tool)

Eucalyptus and C fixation

The different between the first one (*Eucaliptus globulus*) and the following one (*Ecupaliptus camaldulensis*) is quite notable. Therefore it could be an evident choice for the C capture criteria. Nevertheless, few other conditioners must be considered.

Firstly, eucalyptus is native species from Australia; therefore they are not native species in the study area. However, due to the consider area is located within an urban area; some trees can be planted in the Urban Carbon Sink. In any case, this action should require a certain monitoring in order to avoid secondary colonisations outside the park boundaries.

The eucalyptus has a draining effect, due to its powerful root system that draws water from the water table. That could be a desirable effect on the floodable area, but it can also have an adverse effect on the rest of species within the park. This effect will become stronger as the plants grow up.

Red eucalyptus would be a better choice rather than blue eucalyptus. In fact, the first one has higher ecological plasticity. However, this taxon is sensible to freezing and calcareous soils, both of them are conditioning factors from the study area. Additionally, potential risk of falling branches discourages ornamental purposes.

Poplar (*Populus nigra*) and hackberry (*Celtis australis*), are the native species with the greatest capacity to fix carbon from the list, but they are in the eighth and ninth position respectively. In general, species from *Salicaceae* family are good carbon collectors.

Taking into account the particular zone conditions, the lists of indicative planting species is shown in the following lines for each delimited area.

The taxa are classified by size. Thus, species 1 (SP1) groups taxa which exceed 15-20 m at maturity. Species 2 (SP2) are small trees that do not exceed 15-20 m in adulthood. Finally, species 3 (SP3) collects mainly bush-type taxa. These three typologies should be combined and intermingled in each area conveniently within small mixed forests along the park.

Floodable area. Zone A1

This zone is characterized by freatism and semi-permanent flooding. Therefore, species must resist this kind of conditions. Species should also resist the general site-conditions, such as pollution, basic soil and clayey loam soils (this should be confirmed lately).

Figure 4.62: Small forests planning in Zone A-1 Urban carbon sink (Source: CARTIF).

Floodable area	A1	[SP1]	[SP2]	[SP3]
▪ Freatism ▪ More frequently flooding ▪ Pollution ▪ Basic soils ▪ Clayey loam		*Fraxinus angustifolia* *Betula sp.* *Populus nigra* *Ulmus laevis* *Alnus glutinosa*	*Salix atrocinerea* *Salix triandra* *Salix purpurea* *Salix fragilis*	[Not suitable for semi-permanent flood conditions]

Table 4.33. Species sets proposed for Zone A-1 (Urban carbon sink)

Trees are proposed in little groups. In this zone, groups would be composed by a mixture of riparian species, accompanied by a set of willows. In this particular case, there are no bush species due to the foreseeable flooding of the area. However, some of the proposed species may have a lower bearing than in other areas of the park.

The graph below shows the levels of CO_2 absorption of some of these species.

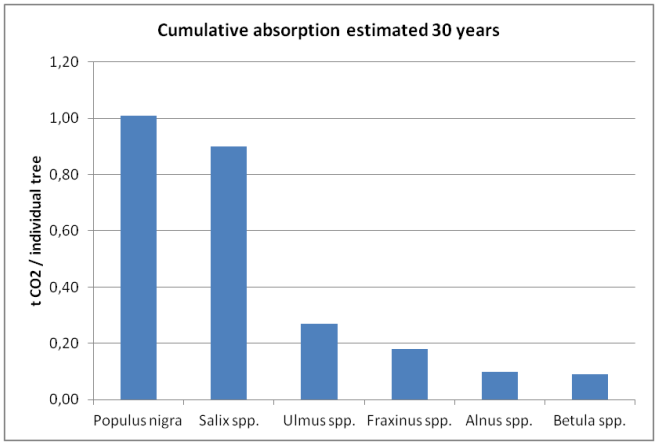


Figure 4.63: Cumulative CO2 absorption for individual trees for Zone A-1 Urban carbon sink (Source: CARTIF, based on data from CO2 Absorption Tool)

Carbon absorption in this area will be carried on by willows and poplars, so the selection of these plants is highly recommended. The rest of species will help in other functions, such as educational, ecological or ornamental purposes.

Figure 4.64: Riparian forest in Duero River, Quintanilla de Onésimo, Valladolid (Source: Source: www.lasendadelduero.com).

Floodable area. Zone A2

This zone is characterized by freatism but flooding would be occasional. This area has been considered as a second-line in a typical riparian forest in this environment. Some of the species are similar to Zone A1, such as poplars and willows. In addition, a set of thorny plants are also proposed due to its ecological value (red fruits, pollen, etc.).

Figure 4.65: Small forests planning in Zone A-2 Urban carbon sink (Source: CARTIF).

Floodable area	A2	[SP1]	[SP2]	[SP3]
▪ Freatism ▪ Occasionally flooded ▪ Pollution ▪ Basic soils ▪ Clayey loam		*Populus alba* *Ulmus laevis* *Populus tremula* *Betula sp.*	*Salix alba* *Salix atrocinerea* *Crataegus monogyna* *Corylus avellana* *Euonymus europaeus* *Rhamnus cathartica* *Salix purpurea* *Salix fragili*	*Sambucus nigra* *Rubus ulmifolius* *Rosa canina* *Prunus spinosa* *Berberis vulgaris* *Cornus sanguinea* *Rhamnus cathartica* *Salix triandra*

Table 4.34. Species sets proposed for Zone A-2 (Urban carbon sink)

The graph below shows the levels of CO_2 absorption of some of these species. The presence of willows and poplars increases C absorption.

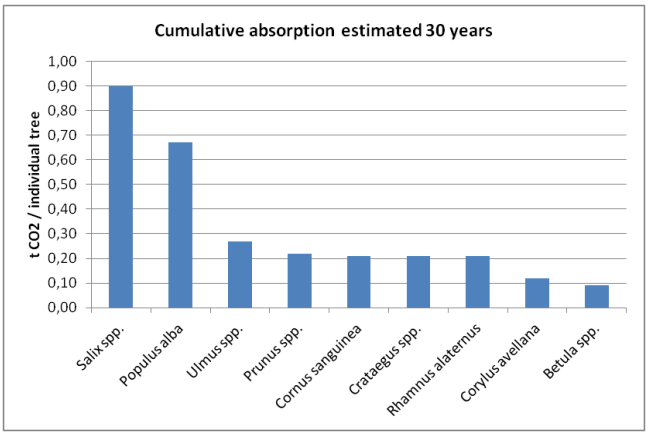


Figure 4.66: Cumulative CO2 absorption for individual trees for Zone A-2 Urban carbon sink (Source: CARTIF, based on data from CO2 Absorption Tool)

Urban Carbon Sink. Zone B1

As a consequence of the elevated area, freatism effect will be lower. Plants in this area should be more adapted to drought, in addition with slope conditions. The proposed vegetation in this area consists in species with a higher level of Carbon fixation, in addition with other species.

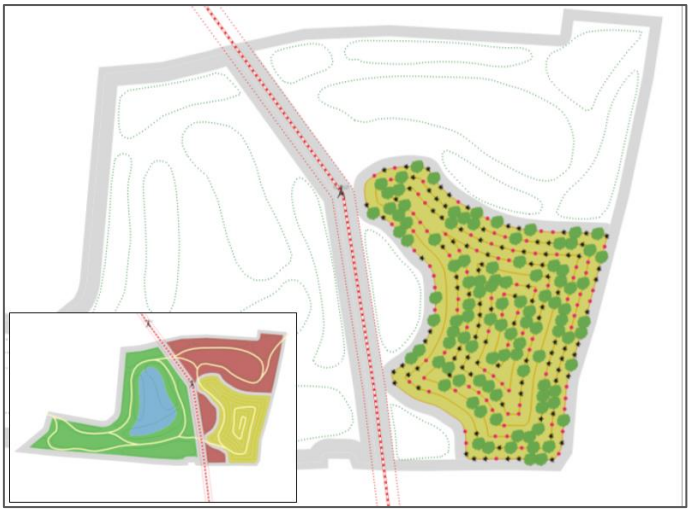


Figure 4.67: Small forests planning in Zone B-1 Urban carbon sink (Source: CARTIF).

Urban carbon sink	B1	[SP1]	[SP2]	[SP3]
▪ Elevated area ▪ Sloped ▪ No freatism ▪ Pollution ▪ Basic soils ▪ Clayey loam		*Celtis australis* *Tilia sp.* *Cupressus arizonica* *Ulmus minor* *Pinus halepensis*	*Ulmus pumila* *Colutea brevialata* *Ficus carica* *Quercus ilex subsp. ballota*	*Juniperus communis* *Quercus coccifera* *Osyris alba* *Retama sphaerocarpa*

Table 4.35. Species sets proposed for Zone B-1 (Urban carbon sink)

The graph below shows the levels of CO_2 absorption of some of these species. The European hackberry has a remarkable capacity to absorb CO_2, although it is Mediterranean native species. The rest of the species in this case, a part from the aesthetic and ecological function, can help to fix the slopes of the artificial hill. Additionally, some evergreen species are proposed, such as pines, oaks and junipers. These species will contribute to remind some "green" during the winter in the most visible part of the park.

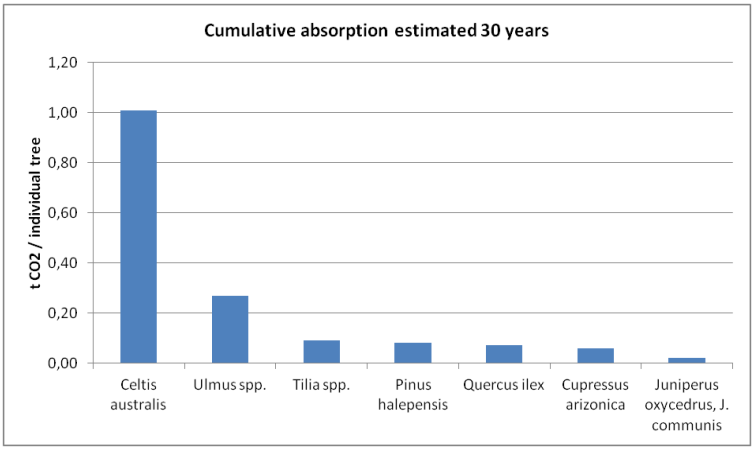


Figure 4.68: Cumulative CO2 absorption for individual trees for Zone B-1 Urban carbon sink (Source: CARTIF, based on data from CO2 Absorption Tool)

Urban Carbon Sink. Zone B2

The rest of the non-flooding area can have a certain phreatic influence due to the proximity of the riverbed, but in any case it will be predictably less than in the case of the floodplain.

Species proposed for this area are a mixture of Mediterranean native species, together with other less watering demanding riverine species. In this area, carbon capture effect is achieved by hackberry (*Celtis australis*), planes (*Platanus hispanica*) and maples (*Acer* sp).

Figure 4.69: Small forests planning in Zone B-2 Urban carbon sink (Source: CARTIF).

Urban carbon sink	B2	[SP1]	[SP2]	[SP3]
▪ Flat area ▪ Pollution ▪ Basic soils ▪ Clayey loam ▪ Low freatism		*Tilia sp.* *Morus alba* *Cedrus atlantica* *Celtis australis* *Platanus hispanica* *Acer campestre* *Ulmus minor*	*Acer monspessulanum* *Ulmus pumila* *Colutea brevialata* *Ficus carica* *Prunus mahaleb* *Quercus ilex subsp. ballota*	*Juniperus communis* *Quercus coccifera* *Retama sphaerocarpa* *Spartium junceum* *Genista scorpius*

Table 4.36. Species sets proposed for Zone B-1 (Urban carbon sink)

The graph below shows the levels of CO_2 absorption of some of these species. The C capture effect of the European hackberry is enhanced by the presence of *Cedrus atlantica*, a foreign species but with a remarkable C fixation power and evergreen leaf. Other species are suggested with aesthetical (evergreen trees) and ecological (*Prunus, Ficus*) purposes.

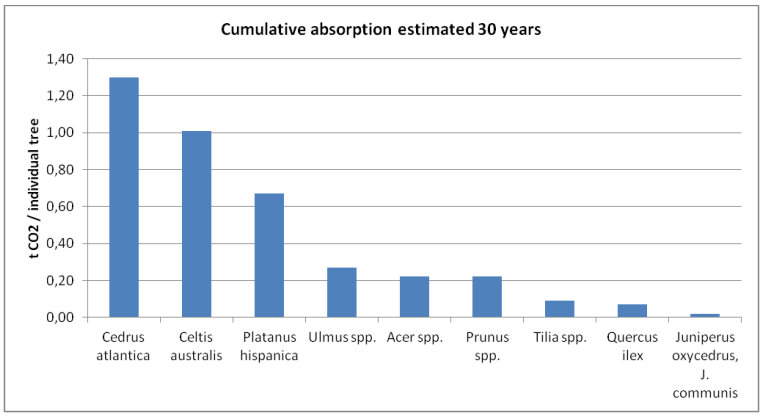


Figure 4.70: Cumulative CO2 absorption for individual trees for Zone B-2 Urban carbon sink (Source: CARTIF, based on data from CO2 Absorption Tool)

4.11.4 Operational and Maintenance Considerations

Pruning

A formative pruning will be carried out in order to enhance height growing and arboreal shaping. For the bushes species pruning will enhance its natural form.

Plants will also require an appropriate maintenance pruning for each taxon as frequent as needed. This maintenance pruning includes removing dead branches, epicormic shoots, and any branches or forms that could affect the correct formation of trees.

Selective actions should also be done for some concrete situations. For instance, if plant density is excessive the growth of the mass could be affected. In this case, those taxons with poorer size or worse characteristics will be selected for their elimination. Exceptional pruning could also be required in situations of potential risk for pedestrians or presence of feet that are highly affected by pests or diseases.

Waste management

Urban Forests are proposed as a nature-based solution in urban areas due to its role as carbon sink, balancing part of this gas emissions. Plants can act removing atmospheric CO_2 throughout

autotrophic processes and adding organic matter which is stored as their own biomass. As a result of many maintenance works like pruning, this biomass is taken off from the forest. In order to avoid new C emissions from this forest wastes, it will be essential to take into account to establish a management plan. Biomass production or composting actions are suggested as the proper form of managing these wastes. It could also be reincorporated as mulch after adequate treatment.

Weed control

Weed should be controlled frequently in order to avoid interferes the correct plants growing. The selected methods for their management should be environmentally friendly, and preferably mechanical. Especially in the pathways strimmer works can be planned frequently.

4.11.5 Economic Specifications

The technical specifications shown above are an approximate calculation of the characteristics of the project. Therefore, the economic specifications are equally approximate.

Earthworks and soil readiness are not included; see *VAc11-Floodable Park* and *VAc18-Smarts soils as substrate* for further information. In addition, pavement and furniture are not included too, see *VAc35-Educational path* for further information.

This action should include the following aspects:

- Plantation works (land and soil preparation, holes, tree-planting)
- Plants purchase (min. 1300)
- Watering: planting irrigation
- Other requirements: Organic amendment, fertilizations, etc.

First tentative budget is showed below. The total costs of these actions should be within 25.000 €.

Urban carbon sink	unit	quantity	Price (€)	Amount (€)
Hole Works (1300)	unit	1,00	1.900,00	**1.900,00**
Plantation works (1300)	unit	1,00	800,00	**800,00**
Plants purchase (1300)	unit	1,00	10.000,00	**10.000,00**
Watering and other requirements	unit	1,00	4.200,00	**4.200,00**
Total budget 2018 (€)				**16.900,00 €**
Maximum total budget with VAT (€)				**24.334,31 €**

Table 4.37: Urban carbon sink budget (Source: CARTIF)

4.12 Smart Soils as Substrate (VAc18)

4.12.1 General Description

VAc18- Smart soils in Sub- Demo C will be use in C1, C2, C3 and C4. For these surfaces a total of 565 m^3 of technosols have been calculated.

- C1 - *Parking green pavement* (VAc14): 200 m^3
- C1- *Renaturing parking* (VAc5): 40 m^3
- C1- *Green Resting areas* (VAc6): 20 m^3
- C2-C3-C4: *Natural pollinators' modules* (VAc21): 15 modules with 3m^3 each. Total of 45m^3 of smart soil
- C3- *Urban Carbon Sink* (VAc7): 240m^3
- C3- *Green resting areas* (VAc6): 20 m^3

VAc18- Smart soils in Wastewater Plant zone (Sub- Demo C). This smart soil will be used in actions VAc7 and VAc14 (301 m3).

In the technical-economical aspects, this intervention *VAc18-Smart soils as substrate*, is similar to VAc16 (see *Section 2.7*).

Expected impacts: The use of smart soil in other NBS involves creating natural sinks of NO_X (nitrogen oxides, an extremely important contaminant of urban air) inside the city. It is estimated that smart soils (VAc16, VAc17 & VAc18) will captured 1.665 kg/year of NO_2 from urban air[13] and avoid its fertilization. In the case of VAc 18, it will captured 957 kg/year of NO_2.

Around 500 m^3 of products will be reused, otherwise, most of them would be managed as waste reducing the impact of this on sensitive systems (air, water, biota), and recycling micro and macronutrients as N, P, K.

4.12.2 Location

The exact location of the *VAc18-Smart soils* will be described in the corresponding implementations.

- C1- *Renaturing parking* (VAc5), *Green Resting areas* (VAc6), *Parking green pavement* (VAc 14).
- C2- *Natural pollinators' modules* (VAc21).
- C3- *Green resting areas* (VAc6), *Urban Carbon Sink* (VAc7), *Natural pollinator modules* (VAc21).
- C4- *Natural pollinator modules* (VAc21).

4.12.3 Technical Specifications

In the technical-economical aspects, this intervention *VAc18-Smart soils as substrate*, is similar to VAc16 (see *Section 2.7*).

4.12.4 Operational and Maintenance Considerations

In the 4.13.4 Operational and Maintenance Considerations, this intervention *VAc18-Smart soils as substrate*, is similar to VAc16 (see *Section 2.7*).

[13] CARTIF results "Technological development Substrates with self-fertilizer and air pollutant uptake capacity. Sustra-TEC" RTC -2016-5043-2. MINECO.

4.12.5 Economic Specifications

The smart soil price will be maximum 70 €/m3. The budget will include transportation, mixing with the original soil (for actions that require it) and an analysis of the soils where it reflects the conformity with the hygienic-sanitary, physical-chemical and microbiological parameters.

The total budget for this action is € 40,000.

4.13 Educational Path in C3.– Floodable park (VAc35)

4.13.1 General Description

The Educational Path (EP) is conceived as a natural path to promote educational activities related to innovations on flood risk decrease, CO_2 sequestration/urban carbon sink and others.

Expected impacts: The EP will create an attractive place for citizens to enjoy nature almost without leaving the city. In addition, this action will enhance the value of the different elements included in this area (Urban Carbon Sink, Floodable Park, Pollinator Modules, etc) in an educational and entertaining way.

The presence of this pedestrian path is expected to increase the number of visitors to the park and contribute to environmental awareness. Informative panels will explain the role of NBSs solving environmental problems.

In addition, the location of this action within a peri-urban area will improve the life quality of the residents within the area.

Related actions

This action is located within the zone known as “Floodable Park Area”. Thus, Vac35 is related to the following other actions (See the corresponding sections for more details):

- VAc11- Floodable Park.
- Vac7- Urban Carbon Sink.
- VAc18- Smarts soils as substrate.
- VAc21- Natural Pollinator’s modules.
- VAc35- Educational path.

4.13.2 Location

Location plan

The Educational Path is located within the *VAc11- Floodable Park* area (see VAc11) and the *VAc7- Urban Carbon Sink* (see VAc7). All of them are located in the eastern part of the municipality of Valladolid, in the neighbourhood known as Los Santos-Pilarica. Specifically, the plot is located in Sector 50 of the developable land known as "Los Santos 2", which has a plan definitively approved for its development (BOCyL, 27th June 2006). The plot limits to the south

with the Esgueva River and to the east with the VA-20 (named Outer Round[14]). North and West are adjacent to other plots of similar characteristics.

Figure 4.71: Sector 50 plot named "Los Santos 2" (Source: Google/Duero River Basin Authority elaboration).

The table below shows the maximum and minimum coordinates of its location.

	X Coordinate	Y Coordinate
Maximum	359 055.90	4 612 633.77
Minimum	358 617.03	4 612 403.13

Table 4.38. Maximum and minimum coordinates of the studied plot
Proj = utm; zone = 30; ellps = grs80; towgs84 = 0,0,0,0,0,0,0; units = m

Characteristics

The EP is proposed as a sinuous path through the different points of interest considered within the Floodable Park and Urban Carbon Sink. It will have an approximate length of between 1.5 - 2 km and a width of about 2 m. Therefore, this action will involve an approximately 7.6% occupation of the plot.

Informative panels will be located in those sites of noteworthy interest. Other kind of furniture should also be installed in order to achieve a more comfortable experience: wastebaskets, fountains, banks, etc.

Site conditions

Currently, the study plot has no *infrastructures* except a high voltage power line that cross the plot from North to South. The construction project should include and follow the regulations applicable in this sense (see Figure “Powerline along the “Los Santos 2” plot” in *VAc7- Urban carbon sink*)

It is expected the presence of a semi-permanent flooded area (A1 Zone, see VAc7 section). This should be considered while designing the EP, in order to avoid this zone.

[14] Ronda Exterior.

There are 2 public pathways outside the plot. One of them is at the south of the plot; the other is at the East. At least 2 different entries should be planned in order to connect the EP with these pathways surrounding the plot.

The southern limit of the plot is adjacent to a pedestrian way, which links the city with the pedestrian route known as “GR-27 Valle del Esgueva”. It has 3 m width and it is frequented by walking and cycling users.

4.13.3 Technical Specifications

Pathway designing

The designing works must pursue the main purpose of this action. Thus, the EP must pass by the most important points within the area in order to explain the innovative characters of its NBSs. In addition, design and maintenance should be as simple as possible making the action sustainable in terms of time.

Building materials must adapt to the "naturalized" environment that the park will have, avoiding asphalted pavements. Land movement will consist in the removal of 20 cm of soil throughout the designing way. This removed soil can be used in the construction of the artificial hill (zone B1, see VAc7 for more details). A geotextile layer should be installed to protect the path avoiding proliferation of invasive species. Above this first layer, a 20 cm thick of artificial compacted gravel will be extended. At the top of them, a 5 cm layer of limestone dust will be extended.

Figure 4.72. Rural path in Castilla-León (Source: Agronews Castilla y León)

The layout of the path should have a minimum dimension so visitors can enjoy it with comfort. It is proposed a minimum of 2 m width and 1.5-2 km length. With this length, it is considered visitors can spend 30-60 min exploring the route.

The EP should have at least 2 different entries, in separated points of the park. The objective is to avoid circular routs. Location of these points should be carefully studied, avoiding “desire paths” that could damage the rest of the park. Desire paths are created as a consequence of erosion caused by human or animal foot-fall. An example is showed in the figure below.

Figure 4.73. A desire educational path example (Source: Wikipedia)

The image below shows a proposed route for the EP, with 1.6 km approximated length, and 4 different entries.

Figure 4.74. Suggested design for the Educational Path in the Floodable park area (Source: Duero River Basin Authority)

EP should be at most 6% sloped in its length and transversal slope should be at most 2%. In any case, the EP must comply with the accessibility regulation for disabled people and emergency vehicles.

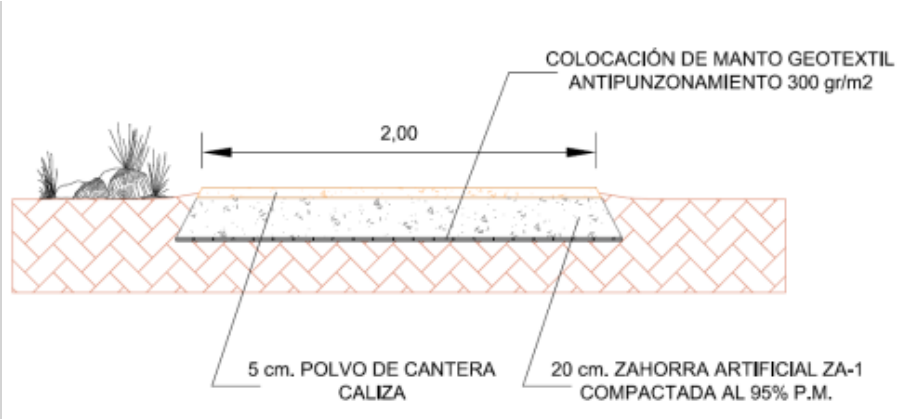


Figure 4.75. Transversal section for the Educational Path (Source: Duero River Basin Authority)

Panels and furniture

Furniture selection must match aesthetical, economic and durability criteria. It is recommended using natural materials, such as wood, stone, etc., whenever possible.

Panels and signalling

The purpose of the informative panels is guiding the visitants throughout the most important points along the educational path. These points will be selected in order to enhance the value of the NBSs within the park, the environmental problems which they are supposed to solve and how they work.

The list below contains the panels that should be included, at least, as part of the route.

Location	NBS	Description
A1, A2	Floodable Area	· The Esgueva River and its flow natural trends and problems caused. · The floodable area: how it works. Foreseeable effects. · Optional: Native animals and plants species. Importance of the river woods on flooding controlling.
B1, B2	Urban Carbon Sink	· The carbon cycle: fonts and sinks. The effect of Carbon Dioxide in the atmosphere. · The Urban Carbon Sink: how it works. Foreseeable effects. · Species selected due to their power in capturing CO^2. A brief description of them.
All	Natural pollinators' modules	· The pollinator species and their relevance for ecosystems and human beings. · Natural pollinators modules: how they work. Plants selected. Expected pollinator species.
Entrances, B1	All	· General map of the park, including relevant points location and services, normative, exits, etc.
All	All	· Optionally: typical river ecosystems, species description, Esgueva River and Valladolid, etc.

Table 4.39: Informative panels suggested for the Educational path in the Floodable park
Note: See *VAc11* and *VAc7* for detailed information about location (A1, A2, B1, B2).

The figures below show two examples of different types of panels. Structures are made of wood, with an upper protective covering, or have table form.

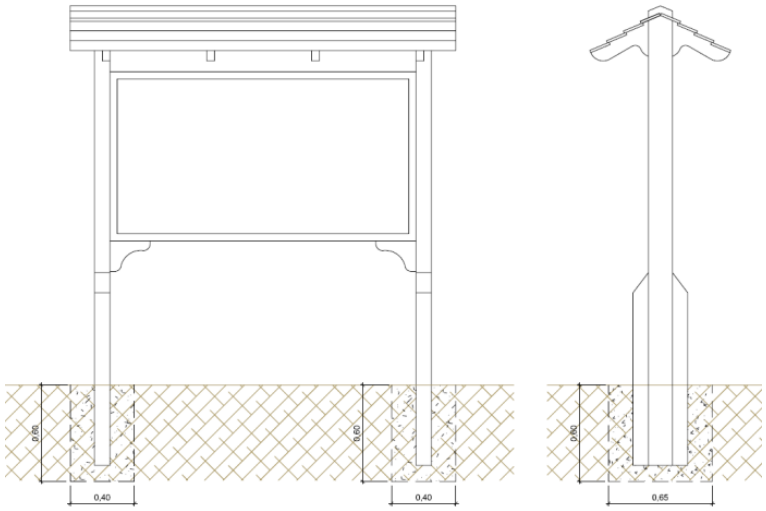


Figure 4.76. Suggested type for informative panel (1) (Source: Duero River Basin Authority)

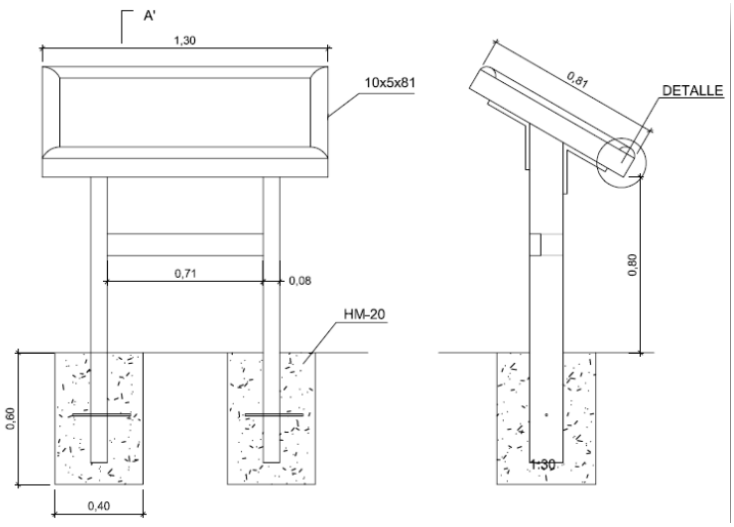


Figure 4.77. Suggested type for informative panel (2) (Source: Duero River Basin Authority)

Figure 4.78. Informative panel in Pinar de Antequera (Valladolid) (Source: Google Street View)

In addition to the panels, vertical information signage should be included. Signals provide information of the services (bicycles parking, fonts, etc.) and guide (exits, locations, etc.). It is highly recommended include warning panel for the floodable area.

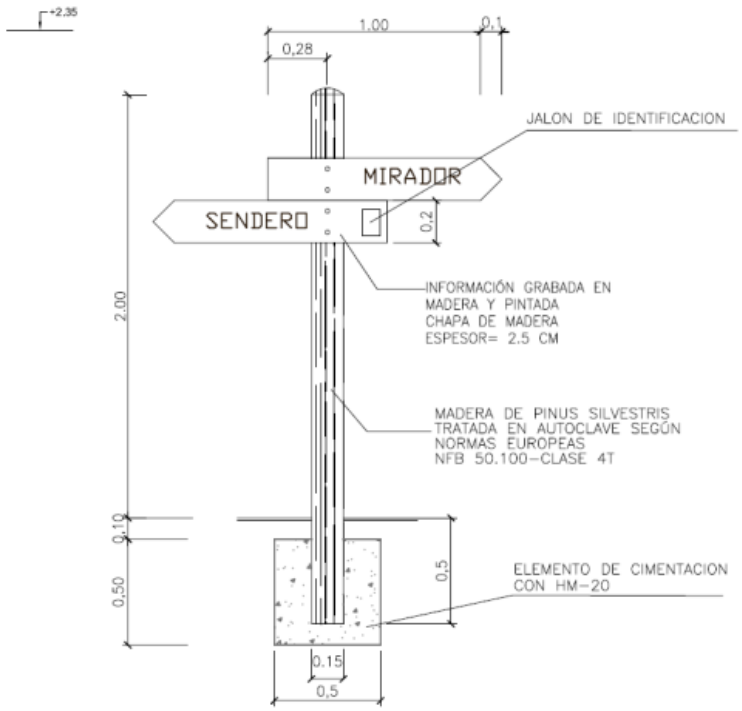


Figure 4.79. Suggested type for informative panel (3) (Source: Duero River Basin Authority)

Waste bins

Waste bins should be conveniently installed at strategic points along the route. These devices should be placed at detention points. These points are, for instance, resting areas, information panels, bicycle parking, etc.). Other intermediate points can be considered in the case the previous ones were too separated.

The image below shows an example of design for these devices. The bins should be overturned models and not bucket model, for the convenience of maintenance operators and to avoid vandalism.

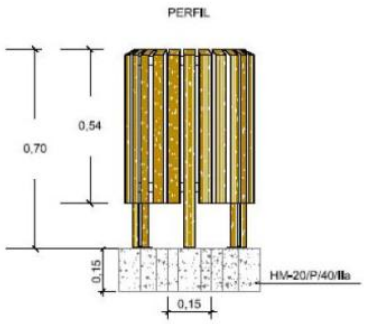


Figure 4.80. Suggested design for waste bin, overturned mode (Source: Duero River Basin Authority)

Facilities and comfort

Apart from the already detailed furniture above, other objects can be suggested to contribute for wellness and commodity for the users. This installation is recommendable but it depends on the total budget available and the final technical design of the Floodable Park area.

Benches

The installation of rest benches in strategic points of the park is recommended. These banks should be resistant such as iron, or maybe made of natural elements such as wood. The benches will preferably be located in shady areas, close to the trees and with ample and pleasant views, as possible.

The following model of sheet metal bench that simulates vegetable figures could be ideal for both urban and rustic (park) environment. Average cost is 400,0 €/unit. The installation cost is included in the price.

Description: Maverik model bench with ductile cast iron legs painted in martele. Seat and back in sheet steel painted in martele. With primer and oven painted. Measures: 1,810 x 638 x 774 mm.

Source: www.grupfabregas.com

Figure 4.81: Metallic benches for the educational path (Source: Grup Fabregas)

The figure below shows a suggested rustic design for rest benches.

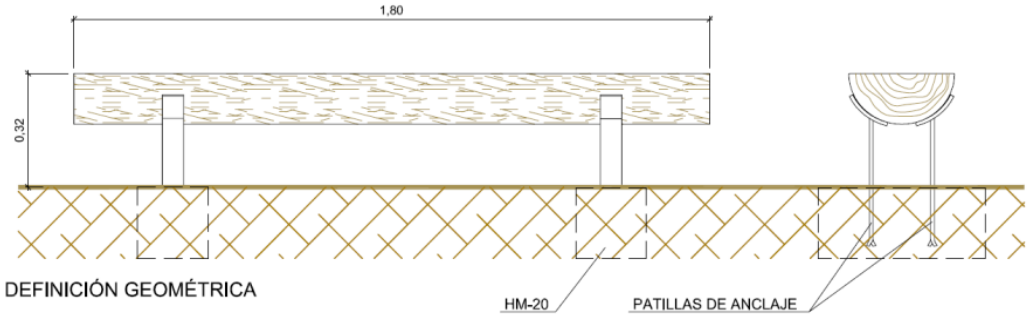


Figure 4.82. Alternative design for rustic rest benches (Source: Duero River Basin Authority)

Tables

Other furniture recommended for the park would be picnic tables, as well as drinking fountains. The image below shows a designing example of picnic tables made of wood.

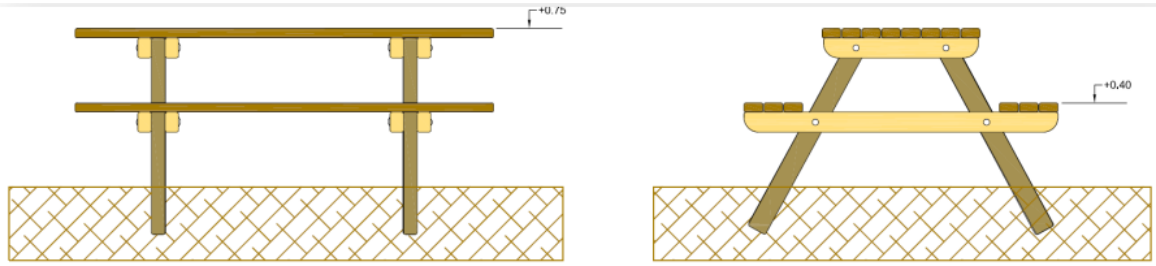


Figure 4.83. Suggested design for picnic tables (Source: Duero River Basin Authority)

Bike parking

It is well know that the area is frequented by bikers. Since the EP it is not designed for cycling, it will be recommendable to install an adequate parking area for bicycles. The image below shows a designing example of parking area for bicycles made of steel, as metallic tube bicycles parking are ideal for urban spaces. This model might adapt to both urban and rustic environments. Estimated average cost is 300,0 €/unit.

Description: Park model Copenhagen galvanized tube bicycles for 6 units. Material: Galvanized steel. Anchoring: Screw M10 x 100 mm (Not supplied).

Source: www.grupfabregas.com

Figure 4.84: Bike parking for the resting areas (Source: Grup Fabregas)

There are other wood models.

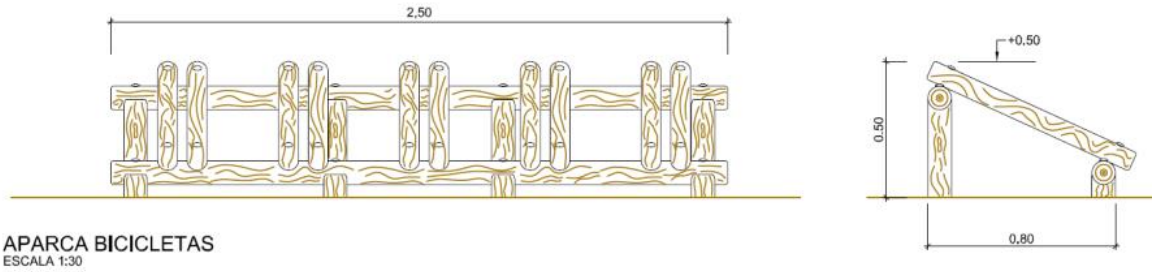


Figure 4.85. Suggested design for rustic parking area for bicycles (Source: Duero River Basin Authority)

Health and safety

Elevated areas such artificial hill or floodable area could involve a certain risk of falls. In these zones it is highly recommended install security barriers. In this case, wooden fences anchored to the surface are proposed, similar to the image below.

Figure 4.86. Security barriers in Contiendas Park (Valladolid) (Source: www.mappio.es)

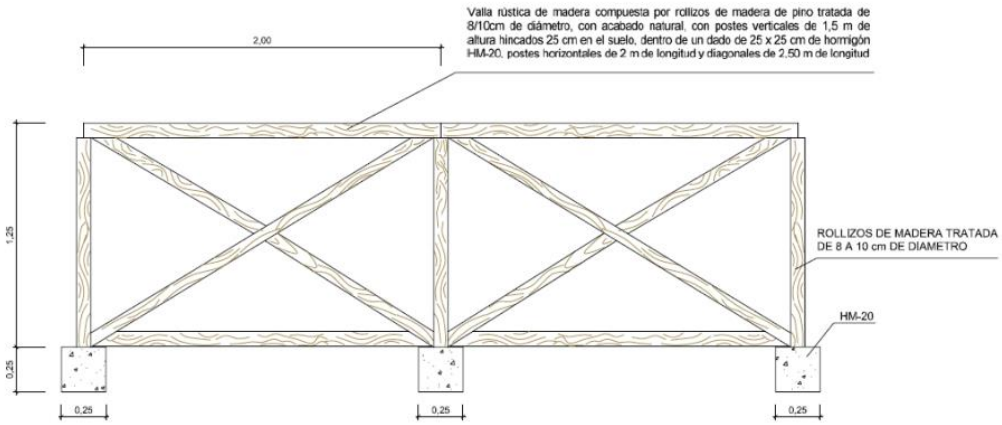


Figure 4.87. Suggested design for security barriers (Source: Duero River Basin Authority)

4.13.4 Operational and Maintenance Considerations

Periodic maintenance and cleaning of the EP and elements included will be carried out. Damaged furniture should be repaired or replaced if necessary. Pay special attention to barriers and other safety elements.

Pathway surface should be checked periodically. Weeds and plants' roots should be removed as they may entail a fall risk for users. Likewise, bumps that might appear on the surface should be repaired.

Punctual evaluation of the path surface should be carried out after a long period of rains. In this case, the pathway could be flooded, especially on the floodable park.

4.13.5 Economic Specifications

The technical specifications shown above are an approximate calculation of the characteristics of the project, in price and units number that will be installed. Therefore, the economic specifications are equally approximate.

This action should include the following extra aspects, which are not included in the budget:

- Surface works: Excavation and removing of soil, installation of the different layers (geotextile, etc.) and other related works.

- Park furniture purchase and installation.
- Other requirements: technical reporting, projects, analysis, etc.

The total budget expected in the Investment Plan for the Educational Path in the Floodable park is 20.000 €.

Educational path	unit	quantity	Price (€)	Amount (€)
Signs and informative panels				
Informative panel (1)	unit		1.849,00 €	
Informative panel (2)	unit		1.646,93 €	
Informat panel (3) Simple sign	unit		98,34 €	
Facilities and comfort furniture				
Metal bench (cheap-medium)	unit		331 – 656 € (400 € ave)	
Rustic bench (cheap-medium)	unit		350 – 537 € (500 € ave)	
Table and benches pic-nic	unit		300 – 670 € (400 € ave)	
Other				
Waste bin	unit		240 €	
Bike parking	unit		300 €	
Barrier (m)	unit			
Total street furniture (€)*				**to be defined (€)**
Tender budget with VAT according to the Valladolid Investment plan (€)				**20.000,00 €**

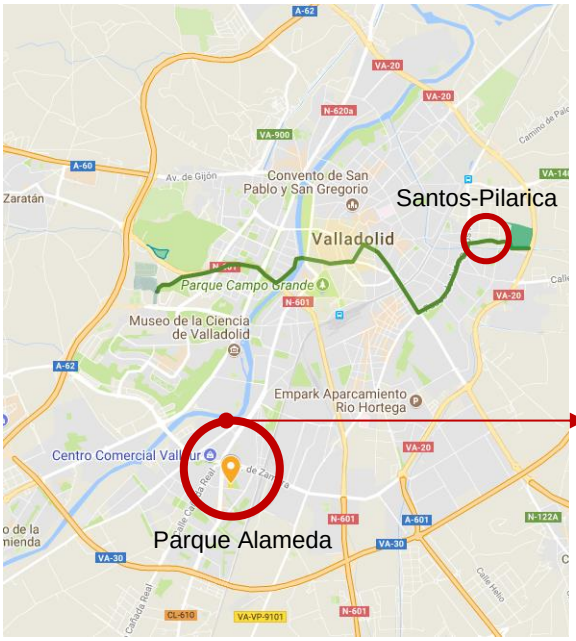
Table 4.40: Educational path budget

* Civil works, soil movement, workforce, installation costs and other costs are not included.

Sub-Demo C4.- Urban Farming

Re-naturing urbanization	Water interventions	Singular Green Infrastructures	Non-technical interventions
		VAc31- Urban orchards	VAc36- Urban Farming Educational activities.
		VAc32- Community composting	
		VAc21-Natural pollinator's modules.	

Table 4.41: List of interventions in Sub-Demo C4



Parque Alameda is located in the South of Valladolid.

Santos-Pilarica orchards are located in the East side, close to the floodable park.

C4.- Urban farming

- Urban orchard area.
- Community composting facility.
- Small-scale urban livestock facility (henhouse).
- Natural pollinator's modules.
- Environmental education and awareness activities.

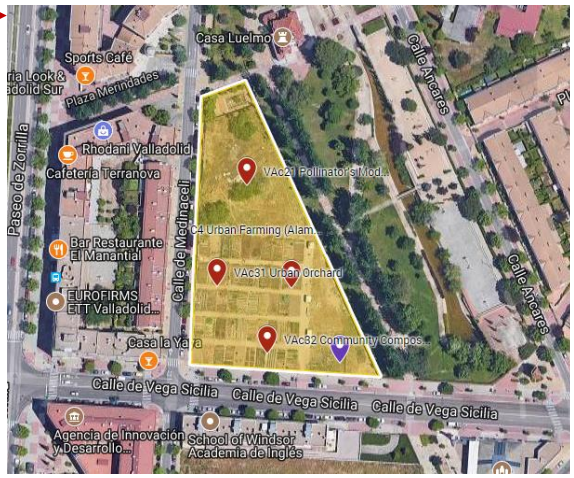


Figure 4.88: Location map of the Sub-Demo C4 Interventions. (Source: Google/Valladolid City Council elaboration).

4.14 Urban orchards (VAc31)

4.14.1 General Description

This action is focused to expand the organic farming concept and it has an important educational component. In the city of Valladolid there are currently a urban orchards network distributed in four areas of the city:

- Valle de Arán (Barrio España) o North zone.
- Parque Alameda (Covaresa) o South zone.
- Santos-Pilarica o East zone.
- Jardín Botánico (La Victoria) o West zone.

The installation of *VAc31-Urban orchard* areas has been defined as the identification of current needs in the orchards, and the implementation of improvements in Alameda Park zone (2ha) and in Santos-Pilarica zone (2ha), close to the floodable park area.

The orchard areas are devoted to cultivation of vegetables, fruits and flowers in an organic way. The Valladolid City Council manages those municipal orchards, concretely the Environment Department.

Unemployed, retired people, families with limited resources, neighbours' associations, disabled people, special needs groups can exploit them. To qualify for a vegetable garden, have to meet a few simple requirements and rules of coexistence and respect. It is a social space where people and families profit of nature and healthy vegetables from orchards.

In total there are 183 plots for the use of a single beneficiary (individual orchard) and there are three areas prepared for community orchard (managed by associations or another groups). The North, South and East zones have 50 individual plots and one communal one. The West Zone is composed of only 33 individual plots. Each individual plot has a surface of 50m^2. At October 2017 there were occupied 177 individual orchards and 2 community orchard (Parque Alameda has not been occupied). There are some available individual orchards.

There have been identified the following needs to improve the current municipal orchards of Valladolid:

- Efficient trickle irrigation system for a responsible water use.
- Shady areas for resting and working.
- Horticultural seedbed.
- Rainwater storage.
- Public bathroom.
- Natural pollinator's modules (see VAc21).
- Insect hotel (see VAc20).
- Community composting (see VAc32).
- Small-scale urban livestock (see VAc33).
- Urban farming educational activities (see VAc36).

The *VAc31-Urban orchard* activities have the following benefits for the gardeners and the communities:

- Improve the user's psychological level.
- Improve on a physical level.
- Economic assistance: The income from the production of food in unemployed people for growing fresh food increases.
- Coexistence and multiculturalism: The ranges of age, studies, experiences, personalities, nationalities, are very broad.
- Social works: It is sought that the gardens not only serve as help for the beneficiaries but also for other groups. The food produced in the community gardens is used for social purposes, such as the Santa María elderly people residence, Entrevecinos project (social community), Red Íncola (immigrants).
- Promotion of ecological practices:
    - The beneficial associations of crops limit the use of inputs such as fertilizers, herbicides or pesticides which is an effective means of combating pollution and depletion of resources as important as water.
    - The absence of herbicides.
    - The reduction of pesticides.

Expected impacts. VAc31 improves social cohesion, builds a stronger appreciation for life (Biophilia concept) and has an educational impact in citizens. The expected impacts are very similar to *VAc32- Community composting* and *VAc33- Small-scale urban livestock*.

- Increase facilities in contact with nature in the city. Creating a perception of connectivity and cultural mobility of trades related to the agricultural and farming. Reducing the distance to green spaces with animals.
- Involve the citizens in urban orchards, as a support measure to help unemployed people, green intelligence awareness and respect animals and environment.
- Create a new source of healthy and ecological food for people with fewer resources.
- Increase the welfare of the beneficiaries of the gardens, this action increase self-esteem by having a responsibility, an occupation and being able to eat vegetables grown by oneself.
- Increase the professional skills of the unemployed beneficiaries of the gardens and creating new market niches, new businesses, knowing other professions.
- It is highly valued to have a vegetable garden at home or near, so the property value of nearby houses is increasing.

4.14.2 Location

VAc31-Urban orchards improvements are located in the urban orchards of Parque Alameda and Santos-Pilarica zones.

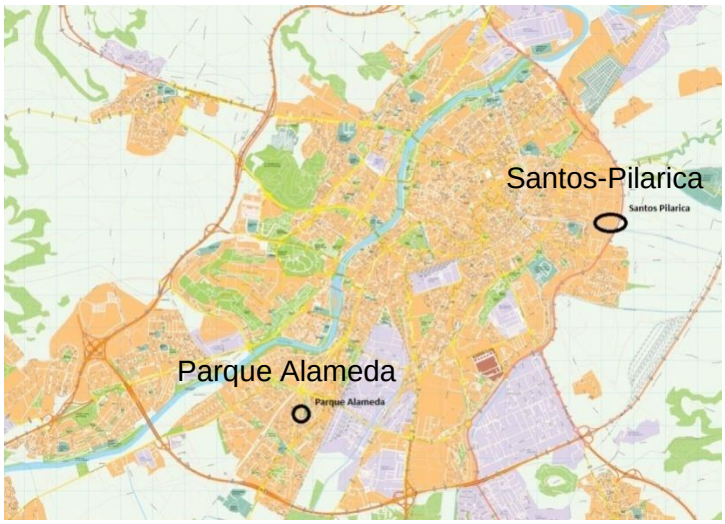


Figure 4.89: Parque Alameda and Santos-Pilarica urban orchards (Source: Valladolid City Council)

Parque Alameda orchard area (South zone)

North-South orientation.

URBAN GreenUP interventions:

- VAc31- Urban orchard improvements.
- VAc32- Community composting.
- VAc33- Small-scale urban livestock.
- VAc21- Natural Pollinator's modules.

Santos-Pilarica orchard area (East zone)

North-South orientation.

URBAN GreenUP interventions:

- VAc31- Urban orchard improvements.
- VAc32- Community composting.

Figure 4.90: Parque Alameda's urban orchards (Source: Valladolid City Council).

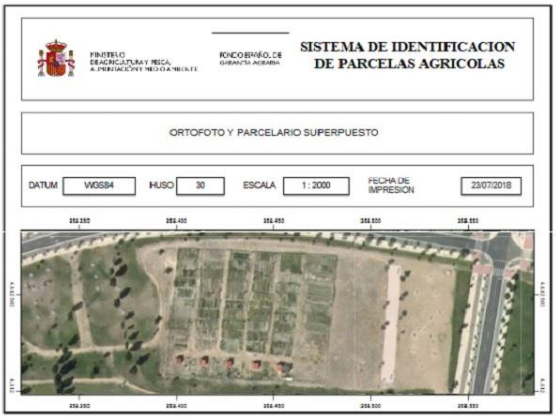


Figure 4.91: Santos-Pilarica's urban orchards (Source: Valladolid City Council).

These areas have an area currently occupied by the Valladolid City Council urban gardens. There is free space available that will be dedicated to different urban farming interventions.

Each vegetable garden has 50 m^2 (5x10m) and the orientation is North-South. The orientation of the plot will be taken into account for the design of the irrigation, which will consist of a main branch N-S and perpendicular branches separated 0.50 cm, which is the usual distance between rows. North-South is the ideal orientation.

Available resources: The facilities have a 20 mm pipe overhang with two forked valves with a "t" that provide irrigation water to two contiguous plots. Every plot has their own single tap; some beneficiaries have a double tap in order to connect a garden hose and drip irrigation hose at the same time. The taps are ½ inch.

The main pipes have 32 mm and they are buried about 30 cm. There are 5 branches going put from this general supply pipe, one for each row of orchards (each row has 10 orchards). In addition, there is a water supply for the three community gardens available for associations that exploit it for social purposes. All have stopcocks for several connections.

The water comes from the irrigation network of the city. For this, it is dependent on the supply by means of the pumping systems of Parks and Gardens Department for the landscaped areas next to the enclosures. It will be taken into account that the pressure is higher in Santos-Pilarica orchards.

4.14.3 Technical Specifications

URBAN GreenUP will create better conditions in vegetable gardens in order to improve the access and crop management. Under *Vac31-Urban orchard*, there will be implemented the following improvements in the current orchards: Efficient irrigation system and shady areas.

1) Efficient trickle irrigation system for a responsible water use

The most important improvement is the equipment with a basic system of drip irrigation that guarantees a much more efficient, economical and responsible consumption of the water in the facilities. This will promote the fulfilment of point 4 of the 8th Ecological Urban Gardens fundamentals:

"Make responsible use of irrigation water, avoiding abuse in water consumption"

Currently only 17 plots of the 154 that are cultivated (summer 2018) have a drip irrigation system, which represents 11% of the total. They were installed by themselves or with the help of the municipal technician; the orchard beneficiary pays only for the materials.

Most of the orchards are cultivated in furrows and irrigated by flood, which produces waste water and fungal diseases. It is necessary to move towards a more sustainable model, generate awareness and minimize the impact of the facilities on water consumption.

Technical design: Components required for the trickle irrigation for each plot (50 m^2):

- Ring filter ½ inches.
- Pressure reducer ½ inches (1 bar).
- Battery-operated programmer.
- Pipe elbow.
- 20 mm pipe (10 meters)
- Collars (20)

- Stopcocks (20)
- Tubes with dropper incorporated to 30 cm (20 x 5 m, separated 50 cm)
- End taps / plugs (for the main pipe and lines).

For the installation, there can be adapted some of the current materials installed. It is necessary to raise the current pipes to 50 cm high. The collars are replaceable by perforations at 50 cm in the 20 mm main tube. Installing a programmer is useful, but optional. Its purchase may be asked for the users.

2) Green shady areas for resting and working

The shady areas will be used as resting, comforting and refreshing areas for the gardeners. They will be spaces for socialization and exchange of experiences. In addition, they can be used to carry out complementary activities such as thematic workshops or on scheduled visits for local schools or civil associations.

Currently it is sometimes hard to find a shade area, which help preventing health risks caused by high temperatures and isolation.

In Parque Alameda the ideal areas might be the spaces between the huts where the gardeners store the tools and other equipment. There are other suitable free areas.

Figure 4.92: Space between work cabins in Parque Alameda's urban orchards (Source: Valladolid City Council).

Figure 4.93: Current shady area in Santos-Pilarica's urban orchards (Source: Valladolid City Council).

Technical design: The ideal size for these rest areas would be 5x4m. Prefabricated structures available on the stores have been preselected, which are made of treated pine wood. There might be installed 2 shady structures per urban orchard.

The wood pergolas could be covered with bare hurdle roll. And over that, there might be installed a green natural coverage by planting climbing plants.

The green shady areas will be completed with benches and tables. These might be reused and refurbished furniture from the municipal warehouse. The refurbishment might be done by the gardeners as a collective activity.

For soil conditioning, anti-weed and gravel mesh could be used. The pergolas installation needs other materials not-included such as anchors or foundation.

3) Other urban orchards improvements

The URBAN GreenUP project is considering two improvements for Parque Alameda and Santos-Pilarica urban orchard areas: Efficient irrigation systems, and Shady areas. But there have been identified other improvements that might be considered in the future.

- Horticultural seedbed.

Small plots may be constructed as cultivation area for horticultural seedbed, providing fresh vegetables that make the orchards' management easier. This action would provide also educational activities and will increase the community sense. Some educational activities could be teaching and showing how the orchard works.

Different plants grow in these plots: Vegetables for food, companion planting, fruit trees, etc. Companion planting in gardening and agriculture is the planting of different crops in proximity for pest control, pollination, providing habitat for beneficial creatures, maximizing use of space, and to otherwise increase crop productivity.

Technical design: The seedbeds orientation will be North-South, in a flat cultivated surface or with a gentle slope in order to help the water evacuation. They will have trickle irrigation systems.

The plots can be delimited with bricks, wood or another kind of small and natural fences. The plots are filled with compost, peat, topsoil. The seedbeds require the management of an agronomical specialist, who can be in charge of the urban orchard's educational activities.

One of the plots could have a greenhouse structure which seedbeds provide plants to the entire urban orchard.

- Rainwater harvesting storage.

Although the irrigation campaign extends from May to October, covering the needs of the time of most water consumption, it is necessary to have an additional source of water supply for the seedbeds that are made before the campaign begins, winter crops and for water cuts that occur due to temporary or drought damage

To this end, gutters and water tanks can be installed to store rainwater, which must have the necessary filtering systems to avoid water contamination or stagnation, avoiding the proliferation of insects and odors. These deposits will have the possibility of being filled with a hose and will have enough capacity to cover the needs of all the orchards during a day.

Rainwater harvesting mechanisms could be placed in the huts in the orchards, such as "gutters" to collect rainwater. INEA have placed a deposit of 1100L under a gutter and have collected in 1 week 1100L.

The help of the Impluvium project supported by the Agency of Innovation and Economic Development can be assessed through the Call for Grants for the Promotion of the Circular Economy in Valladolid 2017. This project seeks the design of a rainwater collection facility in school environments.

- Bathroom.

No orchard has a public bath nearby. This improvement would be so much for the technicians who work, improving their working conditions; as for the gardeners, having the possibility to clean themselves before returning home. Its construction is not contemplated in the URBAN GreenUP project.

4.14.4 Operational and Maintenance Considerations

- Efficient irrigation system to responsible use of water

The requirements to be able to choose one of the orchards are: to be registered in the City of Valladolid and to be unemployed or with a precarious job. Once it no longer meets the requirements, the garden must renounce allowing another beneficiary to take its place.

For that reason, the new facility should remain on the plot, not being an exclusive benefit of the beneficiary gardener during its implementation; if not a resource linked to the plot. The awardees of the plot will be urged to make a careful use of it and to notify the technician of the repairs that it would be necessary to execute.

The maintenance of the irrigation installation should fall on one of the three most feasible options:

- INEA (which is the company that is currently responsible for technical assistance)
- Valladolid City Council, specifically the Parks and Gardens area.
- External company.

The deterioration caused by misuse or other acts outside the good practices intended in the project will be evaluated by the INEA technician and its repair should be assumed by the offender or sanctioned following the bases that regulate the Urban Gardens.

In case the beneficiaries wanted to make some modification of the installed systems, it would always be necessary to make a prior consultation to the technician to see its feasibility and benefits of its execution. The economic costs would fall on the beneficiaries.

If after the implementation of the modifications the user leaves to be a beneficiary of the plot, for whatever reason; and wish to recover the materials that make up the modifications, the irrigation system must be restored in its original form. Always, ensuring optimal conditions.

In the case of plots that already have a drip irrigation system, the most practical option may also be to suggest the installation of a new one. If anyone decided to maintain their own system, a new one could be installed at the end of the adjudication of the owner of the materials. Being thus available, in equal conditions with the rest of the winners, for the future user of the plot.

It is recommended, if possible, to carry out the installation of the irrigation systems completed during the summer season. Perhaps the second half of October is the best date since it is the bridge between the end of the spring-summer season and the beginning of the autumn-winter season. Otherwise, in the months following the one indicated. In this way the installation will be much simpler and the gardeners will have time to adapt the plan of crops and design of the

garden to the irrigation system. When the approximate date of installation is known, it would be good to notify the users at least one month in advance so that they can make the necessary preparations.

- Shady areas for resting and working

· General visual inspection of elements is usually required.
· Maintenance, reparation or substitution of damaged elements.
· Periodic clean.

Weed should be controlled frequently in order to avoid interferes the correct plants growing. The selected methods for their management should be environmentally friendly, and preferably mechanical. It can be planned frequently.

4.14.5 Economic Specifications

Valladolid City Council is spending 30.000 € in improving the four municipal urban orchards areas in 2018. In the following table it is shown the improvements estimated cost per urban orchard. The budget depends on the number of vegetable gardens that will be implemented (estimated in 100 plots for 2 orchards, Parque Alameda and Santos-Pilarica). These are the budgets for the materials only; workforce and other concepts are not included; in case that the installation is subcontracted.

Urban orchards	unit	quantity	Price (€)	Amount (€)
Trickle irrigation system				
Ring filter ½ inches	unit	1	6,2	6,2
Pressure reducer ½ inches (1 bar).	unit	1	3,4	3,4
Battery-operated programmer*	unit	1	17,9	17,9
Pipe elbow ½ inch to 20mm	unit	1	1,15	1,15
20 mm pipe	m	10	0,27	2,7
Collars/tubing adaptor ½ inch 20mm*	unit	20	0,9	18,0
Stopcocks / taps for dropper tubes ½ inch 16 mm	unit	20	2,55	51,0
Tubes 16 mm with dropper incorporated to 30 cm	m	100	0,34	34,0
End tap 20 mm	unit	1	0,75	0,75
End tap 16 mm	unit	20	0,85	17,0
Total budget per orchard (€)**				**152,1 € * 100 = 15.210,00 €**
Total BME per orchard without collars and programmer (€)**				**116,0 € * 100 = 11.600,00 €**

Table 4.42: Trickle irrigation system – Urban orchard budget (Source: Bricomart).

*Optional. ** There are 100 vegetable gardens in Parque Alameda and Santos-Pilarica.

Urban orchards		unit	quantity	Price (€)	Amount (€)
Shady areas					
wooden post 2400x70x70mm	pergola	unit	1	278,78	278,78
wooden beams 28x95mm		unit			
joists		unit			
screws		unit			

Installation materials	n/d	n/d	n/d	n/d
Bare hurdle roll (coverage) 2x5 m	unit	2	14,87	29,74
Climbing plant				
Benches	unit	2	-	-
Table	unit	1	-	-
Subotal cost per shady area (€)				**308,52 €**
Total budget per urban orchard (2 pergolas/orchard) (€)				Pergolas (4) = 1.115,12 € Coverage roll (2*2*2) = 118,96 € **Total: 4 pergolas + 8 rolls = 1.234,08 €**

Table 4.43: Shady areas – Urban orchard budget (Source: www.gardinitis.com)

4.15 Community Composting (VAc32)

4.15.1 General Description

Composting is a natural method for treating solid waste in which organic material is broken down by microorganisms in the presence of oxygen to a point where it can be safely stored, handled and applied to the environment as a fertilizer and soil amendment.

Organic material has a twofold origin:

- Community: urban allotments, small-scale urban livestock, nearby restaurants, markets, fruit stores, etc.
- Industry processes: crop or agroindustry residues.

The objective is to close the loop on organics recovery. Likewise, this NBS has educational and engagement purposes.

Composting with chickens is a usual practice because chickens add chicken manure, clean the compost of weeds, rodents and insects; while the compost helps to warm the animals and feed the birds. It is possible to combine *VAc32 Community composting* with *VAc33 Small-scale urban livestock* (More info in *VAc33-Small scale urban livestock*).

VAc32 will provide to the users of the orchards a source of fertilizer for their allotments; this action requires that beneficiaries make their own compost. Other source of fertilizer is a sack of organic fertilizer that they can buy.

Composting is an activity that has been demanded for a long time by the users of Valladolid city council's orchards, in fact, some of them have already installed homemade composters.

In this case, several options are available:

- Install a composter for each user;
- Install two composters for each user, so they can let mature for longer, getting better quality compost and fill one with the remains of a campaign without having to alter the one that is composting.

- Install a composter by user and a community composter, to be able to cover the needs of all, of those who want to have their composter and of those who do not want to have their own composter but need to deposit the crop residues.

4.15.2 Location

Community composting will be installed in the urban orchards of Santos-Pilarica and Parque Alameda. Composters, especially the community composter, will be located in an area of easy access for quick cleaning, replacement or emptying.

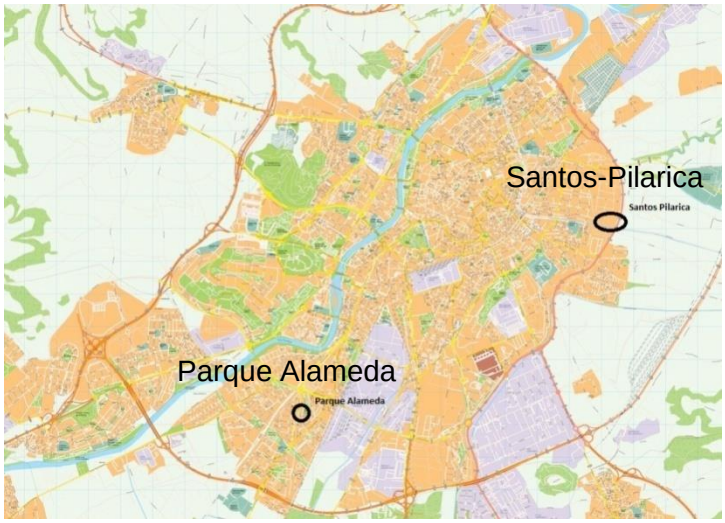


Figure 4.94: Parque Alameda and Santos-Pilarica urban orchards (Source: Valladolid City Council)

4.15.3 Technical Specifications

In order to develop an optimal composting process, it is very important that the raw materials are suitable for composting and there should have a correct proportion in the mixture of different structures and type of fibres, size of particles, adequate percentage of water, natural ferments, etc. In addition, the volume and aeration are decisive elements for the correct formation of the compost. For that reason, it is recommended a Chipper shredder in order to have a size of particles appropriate.

The minimum volume is $1m^3$. the dimensions of the composter will be of minimum 50 cm and maximum 150 cm of side, and a maximum height of 160 cm. The pH must be maintained between 6 and 7; and the temperature between 35 and 65 ºC. The composting time depends on many factors; it can take from 1 to 6 months. A compost thermometer will be useful because it will help to control the temperature of composting.

The composting process need a good oxygenation, to achieve this it is necessary to move the compost and to mix it properly with a Compost mixer and aerator.

The individual composter should be made of resistant materials that withstand the continued use of non-expert hands, as well as the weather conditions. It must be easily manipulated and accessible by its upper part to deposit the organic remains, and by the lower part or the entire side for the extraction of the final product, the compost. To optimize the composting process,

you must guarantee a thermal insulation system with hard and resistant walls and sufficient ventilation. It will be hygienic and easy to clean. Overall, easy to use by people, especially by people with disabilities.

Figure 4.95: Individual composter (Source: https://www.planfor.es).

There are few differences between the individual composter and the collective, among them are the size, and the compost extraction system that will be done by dismantling the front.

The final product, the compost, must be screened with a metallic sieve to obtain a suitable particle size and thus eliminate remains that may be too large or not properly composted.

4.15.4 Operational and Maintenance Considerations

General visual inspection of elements.

Reparation or substitution of damaged elements or plants.

- Constructive elements:

Maintenance of doors, composters, etc.

Periodic clean.

- Tools:

Maintenance of Chipper shredder, aerator, thermometer, etc.

- Misuse:

It is probable that some users make bad use of the composters throwing materials unsuitable for their composting like plastics, ropes, etc. To avoid this, bins will be placed (maintenance and emptying will be carried out by the cleaning services) and these composters will discard their content as compost.

- Weed control:

Weed should be controlled frequently in order to avoid interferes the correct plants growing. The selected methods for their management should be environmentally friendly, and preferably mechanical. It can be planned frequently.

4.15.5 Economic Specifications

In the following table it is shown the Community composting estimated cost. It also includes the cost value of the URBAN GreenUP investment plan.

Community composting	unit	quantity	Price (€)	Amount (€)
Composting systems				
Composters (individual)	unit	100	150	15.000
Composter community	unit	2	TBD	
Compost mixer and aerator	unit	2	13	26
Compost Thermometer	unit	2	13	26
Chipper shredder	unit	2	96	192
Metalic sieve	unit	2	40	80
Maximum budget with VAT (€)				**30.000,00 €**

Table 4.44: Community composting budget and investing plan
(Sources: www.ecompostaje.com ; www.planetahuerto.es; www.agrieuro.es) Key: TBD- To be defined.

4.16 Small-Scale Urban Livestock (VAc33)

4.16.1 General Description

Small –Scale Urban Livestock is a form of small livestock keeping that is concentrated in and around cities. Small farm animals like poultry, pigs, fish, and rabbits are the most commonly used because require minimum space and maintenance. On the one hand, animals provide meat, milk and eggs for families use and manure for urban orchards. They can be a source of income; they provide food or services, help to reduce the volume of organic waste and can be part of social networks for those who are involved in them (Source: FAO).

On the other hand, animals can generate problems such as smell, risk of disease, pollution of waterways, noise, or quarrels between neighbours when they invade and damage gardens.

This NBS is perfect to be implemented with other urban farming interventions such as *VAc31-Urban orchards*, and *VAc32-Community composters* and *VAc36-Urban farming educational activities*.

This action has mainly a didactic and recreational purpose. This NBS aims to promote the urban farming activities among special groups of population (children, disability people, elderly population, drugs rehabilitation, etc.).

Hens are the farm animal that will be used as livestock in the henhouse; it is considered that an adult and well fed hen will lay 1 egg a day. The hens usually will live in a chicken coop near Valladolid, and they will be carried to the urban henhouse punctually.

The henhouse must be built according to the ordinance/regulations for animal welfare. The livestock housing should be made of wood to ensure the insulation, ventilation, lighting,

positioning, nesting, perches, waste collection and protection from the elements and other predators.

For this action, three available technical solutions are proposed: Avi-compo, Chicken tractor and Aviary models. All these solutions will be designed in such a way that, in the case of not continuing with the hens farming education activities in the urban space of Valladolid, the henhouse final structure could be used for another purpose, such as the installation of horticultural seedbeds, tool store, shadow places or others.

The final decision of which henhouse will be build in Valladolid is not taken yet. For that reason, the three technical available solutions are included in this section.

The following is a general description for the three technical henhouse options available:

- "Avi-compo".

In this first option, it is possible to combine *VAc32- Community composting* with *VAc33-Small-scale urban livestock*. This technical solution combines composting ('compo') with chickens ('avi') as a usual practice. Chickens add chicken manure, clean the compost of weeds, snails, rodents and insects; while the compost helps to warm the animals and feed the birds. It is beneficial due to the improvement of compost quality, of hens' conditions, eggs and meat production, and reduction of organic waste.

- Chicken tractor.

A chicken tractor is a chicken coop on wheels on vegetables garden, which lets poultry forage freely and safely. The tractor can be often relocated, in order to allow the chickens´ clean another area of the garden. The chicken tractor has the chicken coop and an additional recreational area. It is possible to combine *VAc31- Urban Orchard* with *VAc33- Small-scale urban livestock*.

- Aviary.

An aviary is a large cage; a house or enclosure for keeping birds in. It is a fixed structure.

4.16.2 Location

The henhouse of *VAc33-Small-scale urban livestock* will be installed in the urban orchards at Parque Alameda, in an easy access area for quick cleaning and for educational activities.

Figure 4.96: Parque Alameda's urban orchards for the small-scale urban livestock (henhouse) (Source: Valladolid City Council)

Parque Alameda has an area intended for Valladolid City Council urban orchards. The current free space zone will be dedicated to the interventions *VAc31-Urban orchards*, *VAc32-Community composting* and *VAc21-Natural Pollinator's modules*.

Parque Alameda orchards area is bordered by two residential areas and a public park, so the intervention *VAc33-Urban livestock* must be executed avoiding bothering surrounding neighbours, so the henhouse will be located in such a way that the smells and noises that reach the neighbours are minimal.

4.16.3 Technical Specifications

Intervention VAc33 Small-scale urban livestock will be deployed in Valladolid as a henhouse where host hens that will be usually living in a chicken coop near Valladolid, and they will be carried to the urban henhouse punctually, for educational activities (children, disability people, elderly population, drugs rehabilitation, etc.). The educational activities will be covered by *VAc26-Urban farming educational activities*.

So that, this intervention has an important educational component, for that reason the henhouse design must consider this nature.

For this intervention, three technical solutions are proposed. In all of them, it is compulsory to comply with the current animal health and welfare rules. In this intervention, the Ecological Poultry Regulation is proposed as the most restrictive regulation.

In the technical design it is important to respect the following rules:

- Leave a free space perimeter of at least 2 meters around each chicken coop that will be kept clean of weeds, debris, litter, containers and other waste that may serve as a source of contamination, or as a shelter for wildlife, which can transport pathogenic microorganisms. This free space allows a free visual inspection in order to control construction deficiencies that could lead the access of wild fauna to the henhouse.
- The surfaces of the ships should be smooth, hard and easy to clean and disinfect.
- The table below contains chickens' needs, according to the ecological agriculture regulation.

Henhouse unit	Description	Characteristic
Principal area:	Usable area	6 hens/m2
Nest:	Nest individual boxes	7 hens/nest box
	Nest collective boxes	83,3 hens/m2 nest
Slopes:	Maximum slope of useful surface	<14%
Feeders:	Feeders linear	10 cm/ hen
	Feeders circular	4 cm/ hen
Waterer:	Waterer nipple	10 hens/nipple

	Waterer bell	1 cm/hen
	Waterer linear	2,5 cm/hen
Resting area:	Perches	18 cm/hen
Recreational area:	Recreation area	4 m2/hen

Table 4.45: Ecological chickens' needs for the urban livestock henhouse (Sources: MAPAMA - Spanish Ministry of Agriculture, Fisheries and Food; Junta de Andalucía)

At the beginning of the experience we will start with two hens and one cock, which is recommended because larger groups can become complex and the pecking order is obvious. A cock is not strictly necessary for egg production, unless you intend to bring on more birds.

The hens must never be fed with any animal by-products. They need at least 12 daylight hours per day. It is very important the water, hens should always have clean and fresh water, they drink a lot.

In the technical designs, a fence surrounds the recreation area in order to comply with current animal health and welfare rules. The Chicken coop and recreational area will provide to each hen enough space to move freely, exercise; with a shady area and another area to protect them from cold.

Nest or laying boxes will be closed, that allows chicken enter and turn on itself. The floor of the box should be covered with some material, such as straw, that makes the bed comfortable. It will be used to clean and renovate usually the straw bed.

Hereunder there are described the technical specifications for the three available solutions proposed, which are under study. There will be considered the use of recycled materials (environmentally friendly).

- Model 1. Composter & chicken coop ("Avi-compo").

AVI - COMPO

This is a henhouse construction with a compost area where nest and perches are installed for hens' resting. It is advisable to have a nearby water intake for compost irrigation and water for chickens. Depending on the state of the compost, it will be necessary to supplement the diet of the chickens with additional feed.

It is possible to see an example of these options in Noáin (Navarra), in collaboration between the Public University of Navarra and Noáin City Council, where an Avi-compo was installed. In this study, families participate in the management by community composting of the organic waste generated in homes in order to create a contact with animals, performance maintenance, cleaning the chicken coop, obtain the eggs produced that day and reducing the food waste of their house[15].

The basic module of the Avi-Compo contains one composter of $1m^3$ capacity, and sized for the coexistence of 3-4 chickens.

[15] Source. Public University of Navarra. Avicompo was installed in 2013 in Parque de los Sentidos, Noáin (Navarra, Spain) (link)

Figure 4.97: Henhouse model 1. Single module of Avi-compo (Source: Vermican http://ecompostaje.com/)

Figure 4.98: Henhouse model 1. Perches and eggs-nest details (Source: Vermican http://ecompostaje.com/)

- Model 2. Chicken tractor.

A chicken tractor is a chicken coop on wheels on vegetable gardens; it can be relocated often in order to allow the chickens clean another area of the garden. For that reason, the structure must be resistant to allow relocation. It has to comply with the current animal health and welfare rules.

The ideal would be to move and rotate the henhouse in the urban orchards, that is, each year or every winter, it will take a different allotment and the hens clean and fertilize the new location.

Those changes mean benefits such as soil aeration and lump break, soil improvement through the direct incorporation of poultry manure, pest control, and remains of cultivation, seeds and adventitious plants elimination.

Figure 4.99: Henhouse model 2. Chicken tractor in a terrace (Source: La huertina de Toni)

- Model 3. Aviary.

An aviary is a large cage, large house or enclosure for keeping birds in. It is a fixed structure. As it should comply with the current animal health and welfare rules, the aviary should meet the appropriate conditions for animals, including nests, feeders, drinking troughs, perches, recreational area, enough free inner space, etc.

Figure 4.100: Henhouse model 3. Aviary 5x2m (Source: cibermascotas.es)

4.16.4 Operational and Maintenance Considerations

This action will be located in an urban area and it will take into account the neighbourhood inhabitants, and it will be necessary to locate this action as far as possible from the houses. Likewise, the orientation of poultry houses will be towards the park to prevent noise and smells reaching the neighbours. The use of roosters will be avoided as much as possible.

The henhouse that will be installed should comply with the current animal health and welfare regulatory framework. This is an intervention with living beings, so operational and maintenance considerations must be taken into account strictly.

- Animal care:

The activities of educational, maintenance, animal care and handling must be appropriate in order to reduce stress to the animal. Those hens should feel comfortable and should develop

their lives normally. For that, a routine is required from Monday to Sunday with time at which they are fed, they are cleaned, etc. Due to the low number of animals, it is not necessary give vaccines so there is not veterinary cost. For that reason, it is very important to keep clean the area, to prevent problems. The animal food should have the adequate quality and necessary minerals.

- Constructive elements:

A periodic visual inspection of the constructive elements will be required. Small animals such rodents will try to damage the construction, in order to enter to eat. There are needed the following activities:

  - Maintenance, reparation or substitution of damaged elements.
  - Periodic clean.

- Poultry manure:

Fresh manure cannot be used in urban orchards directly; it needs to mature or the mature can be added to the composters.

- Misuse:

As this is a demonstrative action and completely new to the city, the City Council has to deploy a new management procedure, related with the urban orchard activities. There might be possible that the henhouse will not be used for holding livestock, because of problems with the implementation (neighbours' complaints, lack or management responsibility, bad practises, etc.). For that reason, in the technical design should be considered a reconversion of the structure for other uses (seedbed, tools store, other). This reconversion must ensure that the installation will not be damaged. In this case, it is recommended the installation of horticultural seedbeds.

- Local management:

It is recommended that the operational and building actions be carried out by entities for the social-labour integration of risk of exclusion people.

4.16.5 Economic Specifications

In the following table it's shown the *VAc33- Small-scale urban livestock* estimated cost, for every technical model pre-selected. It is important that animal welfare rules are complied. It is worth saying that the prices shown correspond to prefabricated and assembled structures, so it is possible to find structures simpler and cheaper.

The table also includes the cost value of the URBAN GreenUP investment plan.

VAc33 Small-scale urban livestock	unit	quantity	Price (€)	Amount (€)
1. Avi-compost *	unit	1	1.025	1.025,00
2. Henhouse *	unit	1	1.275	1.275,00
3. Aviary *	unit	1	1.190	1.190,00
Chicken coop **	unit	1	170	170
Nest / laying houses **	unit	2	46,72	93,44

Hens	unit	3	13	39
Feeders	unit	2	4	8
Drinkers	unit	1	10	10
Perches	unit	6	3	18
Educational poster (for Vac36)	unit	1		
Feed***	kg	1	1,00	1,00
Total budget of material execution (€)				**1.400,00 – 1.700,00 €**
Maximum budget with VAT (€)				**30.000,00 €**

Table 4.46: Small-scale urban livestock budget

* The selection of the more suitable technical option is in the making decision process (Valladolid City Council). There can be chosen either options or just one. The transport to Valladolid is not included (approx. 150 €+VAT)

** If it is necessary (e.g.: Avi-compost has it integrate)
***Feed: around €1/kg of feed. The consumption of feed depends on several factors including animal type, age, reproductive status, etc. On average, a hen can eat among 100-120 g/hen/day.

4.17 Urban Farming Educational Activities (VAc36)

4.17.1 General Description

It is foreseen the realization of educational activities in the urban farming frame, for the development of an “Urban Farming and Bio-culture School”. This intervention will raise awareness of environmental issues with young people.

Local schools will be engaged to visit *VAc31- Urban orchards*, *VAc32- Community composting* and *VAc33- Small-scale urban livestock*. Scholars will be leaded to visit also the *VAc34- Educational path* in the Sustainable Park and the *VAc35- Educational path* in the Floodable Park.

Urban farming activities are a current social project of Valladolid City Council. Since the 2016 scholar course there is accomplished the municipal program "Cultivating Environmental Education: School Orchards of Valladolid"[16]. The program Second Edition was in the school period of year 2017/2018. This educational intervention in the II edition had a scope of 13 public primary schools of Valladolid, reached approximately 3.500 students and their respective families.

I Edition 2016/2017: 8 public primary schools -> II Edition2017/2018: 13 p. p. schools.

The Innovation Agency of Valladolid City Council under the URBAN GreenUP project will support the continuity of the “Cultivating Environmental Education” for the coming years (at least 2022).

[16] Cultivando Educación Ambiental: Red de Huertos Escolares en Valladolid: https://redhuertosescolaresvalladolid.blogspot.com/

Yearly, there is organized a "School orchards annual meeting". The first meeting was celebrated in 2016. The event is attended by Valladolid City Council, a representation of students and teachers, and staff of the Parent Association of all schools in the network of gardens.

4.17.2 Location

The VAc36- Urban farming educational activities will be developed in the Parque Alameda and Santos-Pilarica urban orchards. On the other hand, Valladolid school orchards network is currently composed by 13 primary schools.

Figure 4.101: Valladolid school orchards network (2017/2018) (Source: Google/Valladolid City Council elaboration)

4.17.3 Technical Specifications

Valladolid school orchards network

The program "Cultivating Environmental Education: Network of School Gardens in Valladolid" is an initiative of Valladolid City Council[17]. In this program there are worked environmental education concepts such as food autonomy, basic foods cultivation and the awareness on healthier and more sustainable eating habits, with a call to a proximity and ecological consumption (www.redhuertosescolaresvalladolid.blogspot.com)

The program consists of mentoring and advising teachers for the design, planning and development of a didactic activities program during school hours, during specific subjects from

[17] Implementation by ERDE Gestión y Educación Ambiental www.erde.es

4th to 6th Primary Education grades (Biology, Geology or Geography). The activities are alternated with other practical activities for the school orchards maintenance. Additionally, there is generated a curricular space for the whole school; and the school orchards are a meeting place for the entire educational community.

Figure 4.102: Urban farming activities and Miguel de Cervantes school orchard (Source: Red de Huertos Escolares).

The program includes the following activities: agroecology education for the teachers, design and installation of an orchard garden, irrigation and crop planning, seed bank, individual composting facility, mushrooms cropping (*Pleorotus ostreatus*), environmental education activities about responsible and proximity consumption. The school is committed to manage and maintain the orchard.

Technical design: Most schools develop a ground orchard, which requires soil turning and tilling. Other schools, chose the design in terraces, which required topsoil contributions. The initial activities are: Plot delimitation, eliminate weeds, tillage, soil smoothing, fertilizer, sowing (garlic, peas).

Urban orchards activities

Complimentary Urban farming activities might be developed in the *VAc31-Urban orchards*, close to *VAc32- Composting* facilities and *VAc33- Small-scale urban livestock* (henhouse). The urban orchards' green shady areas could be used to carry out these complementary activities such as thematic workshops or on scheduled visits for local schools or civil associations. These actions will increase the community sense.

Some educational activities could be teaching and showing how the orchard works. Valladolid City Council, CARTIF Foundation and INEA (management entity responsible of the current municipal orchards network) will organise awareness actions in Santos-Pilarica and Parque Alameda urban orchards. The additional awareness activities might be:

- Urban orchards educative workshops for schools: 1 per year in Santos-Pilarica and Parque Alameda. The two hours' workshop will develop agricultural learning activities, about composting (VAc32) and urban farm management with chickens (VAc33)
- Urban farming activities Open Day: 1 per year in Santos-Pilarica and Parque Alameda. The urban orchards will be opened to all citizens, such as families with children. They will learn about how the municipal orchards work, included composting (VAc32) and urban farm management with chickens (VAc33).

Figure 4.103: Children visiting a farm school (Source: Idra School)

4.17.4 Economic Specifications

In the following table it is shown the URBAN GreenUP investment plant conditions. The maximum amount will be 30.000 € during the 5 years (until 2022). Final municipal inversion will be detailed after the activities execution.

Urban farming educational activities	unit	quantity	Price (€)	Amount (€)
Valladolid school orchards network (yearly)	1	1	11.500 €	11.500 €
Urban orchards activities (yearly)	1	1	30.000 / 5 = 4.000 €	4.000 €
Total budget 2018 (€)				**15.500,00 €**
Maximum total budget with VAT (€)				**30.000,00 €**

Table 4.47: Urban farming educational activities investment plan

5 Non-Technical Interventions

A large scale demonstration is being carried out in Valladolid, as URBAN GreenUP front-runner city. Valladolid will demonstrate the economic, social and environmental impacts of fully functional green infrastructure (GI), acting as living laboratory. In the URBAN GreenUP methodology the NBS planning and implementation process is considerate as a complex problem, in which social aspects must be considered one of the main keys. To achieve good impacts, a co-creation approach is being adopted from the very beginning of the project in the definition of the methodologies, from the definition and design of the technical solutions to the final assessment.

Among the initial objectives of Valladolid front-runner city in the URBAN GreenUP project there is also the (ii) "Promotion of the citizen awareness and participation, and fostering of ecological reasoning and ecological intelligent"[18]. With this objective, specific tasks have been included in the project work plan, following the current strategies of the city of Valladolid to engage citizens in the transformation of the city, and planning other innovative strategies to achieve the involvement of relevant stakeholders, as local companies, academia, representative of the industrial and commercial sectors and citizens, among others.

Leaded by Valladolid City Council an ambitious strategy of stakeholder engagement is being planned and developed, ensuring the maximum level of acceptability and adequacy of the final results. The co-creation process is being established in the whole project, as social acceptance is a key to the policies of the city of Valladolid.

Therefore, in the NBS implementation strategy of the city of Valladolid there have been planned complementary non-technical actions, such as educational activities (educational paths, urban farming), engagement activities (engagement portal, sponsoring activities, community-supported urban farming), city coaching (promotion of ecological reasoning and ecological intelligence, single desk) and support activities (to citizens about NBS projects, and a mentoring strategy).

Re-naturing urbanization	Water interventions	Singular Green Infrastructures	Non-technical interventions
			Common non-technical interventions: VAc37, VAc38, VAc39, VAc40, VAc41 & VAc42

Table 5.1: List of Non-technical interventions.

[18] GA nº 730426 URBAN GreenUP-Part B, page 9.

5.1 Engagement Portal for Citizens (VAc37)

5.1.1 General Description

Through the *Vac37- Engagement portal* Valladolid's citizenship may know, comment, attend and take part in the project activities. This portal will be desirable to be connected to the current platforms, the URBAN GreenUP website but also the Valladolid City Council and/or Innovation Agency websites.

Through the *Engagement portal* the citizen will develop their awareness on Renaturing issues. In this portal, there could be opened topics like green infrastructure, cooler streets, nearby green areas, cycle lane connections, etc.

5.1.2 Technical Specifications

The intervention *VAc37- Engagement portal for citizens* will be deployed in the Innovation Agency website, through which citizenship may learn, know, comment, attend and take part in the project activities. This portal will be connected to the URBAN GreenUP official website www.urbangreenup.eu as well as other stakeholders' websites.

The Innovation Agency of Valladolid City Council exploits an independent website about their activities such as innovation, employment, entrepreneurship, smart city and electric vehicle:

www.valladolidadelante.es

Valladolid City Council manages a webpage with the whole information of the city, intended to the citizens (information about the City Council and the city of Valladolid, citizen' interests, culture and tourism, electronic procedures, transparency, public participation):

www.valladolid.es

This intervention will be developed by members of the URBAN GreenUP Consortium related with the URBAN GreenUP website and the platform.

5.1.3 Economic Specifications

The following table includes the cost value of the URBAN GreenUP investment plan.

Engagement portal for citizens	unit	quantity	Price (€)	Amount (€)
Engagement portal for citizens in www.urbangreenup.eu or www.valladolidadelante.es	unit	1		
Maximum budget with VAT (€)				**100.000,00 €**

Table 5.2: Engagement portal for citizens' investment plan

This is an indicative figure, which is not necessarily the final real cost for the Consortium. This consideration may apply to VAc37, VAc38, VAc39, VAc40 and VAc41.

5.2 Sponsoring Activities (VAc38)

5.2.1 General Description

It is foreseen the development of sponsoring activities under a promotion program through which citizens may adopt/sponsor singular green infrastructure. It is foreseen 100 maximum sponsor activities in the whole project URBAN GreenUP, and it is expected the participation of 50,000 people/year in all URBAN GreenUP activities.

5.2.2 Technical Specifications

The sponsor's task is to provide resources and support for the URBAN GreenUP project, being responsible for facilitating its success. In this project, there are two different sponsors:

- Members of the URBAN GreenUP Consortium directly related with Valladolid front-runner: Valladolid City Council, CARTIF Foundation, Singular Green, Duero River Basin Authority, CENTA Foundation, LEITAT Technology Centre, GMV and Acciona Engineering.
- Other private or public stakeholders, such as private companies, the University of Valladolid or local schools.

The following *VAc38- Sponsoring activities* are planned and ongoing. However, throughout the URBAN GreenUP project life, more sponsorship actions will arise.

- URBAN GreenUP sponsorship in events.

There can be included and URBAN GreenUP stand or promotion area (poster, roll-on) in related events that take place in the city. The project can support events in different ways:

- Financial support.
- With the Participation of the URBAN GreenUP Consortium members in a lecture, panel discussion or in the project results dissemination (poster, publication, article, news).

Figure 5.1: Sponsoring an event (Source: www.byforcitizens.com/es/#colaboradores)

- URBAN GreenUP sponsorship in other related projects.

Valladolid City Council and other members of the Consortium related with Valladolid front-runner can sponsor other projects or activities related with the URBAN GreenUP project.

On the one hand, the city of Valladolid has a 'Sustainable and Integrated Urban Development Strategy' - EDUSI www.edusi.es named INNOLID 2020[19], which relates the challenges that the city has to address. Among those targets, there are climate challenges, environmental challenges and territorial challenges. On the other hand, Valladolid is walking towards the Circular Economy through a local Roadmap with specific actions, a schedule and financial support.

Environment, Circular Economy and Innovation

In this context there can be made connections among different projects in which Valladolid City Council and the city of Valladolid is engaged. Some examples of those projects are the following:

▪ Erasmus + project with the title: *Greenset your city!* It was proposed by Jesús y María local school in Valladolid. There will be participants from Finland, Italy, Check Republic and Germany. It is a 2 years' project for the exchange of knowledge and good practices of European students by the theme of Renaturing the cities, under the URBAN GreenUP project.

Spanish meeting will be in April 2019. The scholars will receive a workshop about the URBAN GreenUP project in Valladolid. A physical visit to the interventions will be delivered if possible. The students also will make the design of urban architecture and nature based-solutions in the participant cities, as it will be desirable that the students could participate in any URBAN GreenUP intervention.

▪ Impluvium[20] by iCatalist is a project where a rain collection system will be designed in 4 buildings belonging to Valladolid City Council, for reuse in schools' garden or the municipal orchards. This project is related with the urban farming activities in Parque Alameda and Santos-Pilarica in Valladolid.

Figure 5.2: Sponsoring related projects (Source: European Comission. iCatalist)

- "Sponsor a Nature-Based Solution" initiative.

Under agreement with private companies, Valladolid City Council could encourage to private entities in the NBS deployed in the city of Valladolid. Private companies could install a NBS in the public space and/or take charge of the maintenance. In return, there could be places a plaque with the name and logo of the company, "sponsoring a tree". For instance, a small shop plants a tree in a public garden and takes care of watering and cleaning the area.

[19] Estrategy DUSI 'INNOLID 2020' http://www.valladolidadelante.es/node/12063

[20] Impluvium: https://www.icatalist.eu/blog/impluvium-sistema-de-recogida-de-lluvias

Figure 5.3: Sponsoring a Nature Based Solution (Source: Google Maps in Mexico)

5.2.3 Economic Specifications

Under the following URBAN GreenUP project investment plan, the detailed budget is not already defined.

Sponsoring activities	unit	quantity	Price (€)	Amount (€)
Sponsoring activities: Events (personnel cost, trips, materials)				
Sponsoring activities: Related projects (personnel cost, trips, materials)				
Investment in materials (paper printed, stand, posters, roll-up)				
"Sponsor a Nature-Based Solution" initiatives				
Maximum budget with VAT (€)				**90.000,00 €**

Table 5.3: Sponsoring activities investment plan.

5.3 Promotion of Ecological Reasoning and Ecological Intelligent (VAc39)

5.3.1 General Description

In the Valladolid City Council local policies under the URBAN GreenUP project there is reflected the promotion of the citizen awareness and participation, and fostering of ecological reasoning and ecological intelligent.

Following the current strategies of Valladolid to engage citizens in the transformation of the city, there have been planned innovative strategies to achieve the involvement of relevant stakeholders, as local companies, academia, representative of the industrial and commercial sectors and citizens, among others.

The VAc39 intervention there will be promoted the concepts of ecological reasoning and ecological intelligence by the development of awareness activities, which include thematic meetings, the development of diffusion material and citizens' ecological workshops, among others. It is expected that these interventions will reach 250,000 recipients.

5.3.2 Technical Specifications

With the aim to promote ecological reasoning and ecological intelligent in the city of Valladolid, there have been planned different non-technical activities to be deployed during the URBAN GreenUP project.

- ***Thematic meetings.***

▪ Assistance and participation in events, forum, congresses, communities, etc. locally, nationally and internationally.

Valladolid City Council staff and other members of the Consortium are attending different events related with Nature Based Solutions where they participate with the URBAN GreenUP project. The actions are talks, conferences, round tables, exhibitions, posters or others. A few examples:

- International (Europe and the world). -
  - Eurocities Environmental Forum meetings, biannually, in European main cities.
  - 'Cities4Europe – Europe for citizens' campaign[21], to involve European citizens, inspire governments and impact the way decisions are made in Europe.
  - Michelin international network of cities meetings, biannually, around the world
  - Green Week partner events, yearly in May.

Figure 5.4: Thematic events in which the URBAN GreenUP project participates (Source: Eurocities, Michelin cities network, green week)

- National (Spain).-
  - Environmental Ministry of Spain meetings (about urban forest, air quality, sustainable mobility).
  - CONAMA[22], the Spanish environment congress, are biennially.
- Local (Valladolid).-
  - Day of the Earth, yearly 23rd April.
  - Neighbours' Day, yearly, around September in Valladolid. It is organized by the Valladolid's Federation of neighbours.

[21] Cities4Europe http://cities4europe.eurocities.eu/eu-campaign/index.html#/map

[22] CONAMA http://www.conama2018.org/web/es/presentacion/asi-es-conama-2018.html

Figure 5.5: URBAN GreenUP stand for the Day of Earth 2018 (Source: Valladolid City Council)

▪ The organization of workshops, talks, conferences, congresses or exhibitions.

Valladolid City Council organize different events in the city to easy the communication, dissemination and engagement activities. The City Council could provide logistic, space and materials; other members of the Consortium will be invited to participate.

The following themes may be organized for the URBAN GreenUP project, whose program, schedule, teachers and budget are not defined yet. The maximum frequency would be yearly, especially from when the interventions are implemented in Valladolid (from 2019 onwards):

- Green infrastructure workshop.
- Talk about Nature Based Solutions, Ecological reasoning and well-being.
- Urban pollinators' workshop.

- ***The URBAN GreenUP in Valladolid's tourist route.***

Once that all NBS interventions in Valladolid are implemented, there could be organized a touristic tour visiting the locations, with a technical guide who could explain the interventions and the process of Renaturing the city.

The tour will be opened to the citizenship, but also to the specialized sector (architects, landscape specialist, gardeners, builders, others) and students (University of Valladolid, local schools).

The route could be completed with a practical workshop about NBS. There may be used the touristic bus of the city.

- ***Diffusion materials and communication activities.***

Valladolid City Council contributes to the local news in different communication media. There are local newspapers, like El Norte de Castilla, el Día de Valladolid, and Diario de Valladolid. The regional television channel is Canal 8 TV Castilla y León, where the Innovation Agency participates weekly in a special program about innovation. There are also contributions in local and national radio.

Valladolid City Council writes also articles for specialized magazines about urban renaturing, Nature Based Solutions, urban climate change challenges.

On the other hand, the Innovation Agency of Valladolid City Council @INNOLID participates actively in social media like Twitter, Facebook, YouTube and LinkedIn.

#RenaturalizaValladolid

Diffusion materials are written in Spanish and English language. Local communication activities are launched in Spanish language.

Figure 5.6: URBAN GreenUP in some Valladolid local newspapers (Source: Valladolid City Council)

Communication and dissemination activities in newspaper, television, radio, articles in magazines, social media...

- ***Citizen participation in ecological and urban renaturing workshops***

The URBAN GreenUP project in Valladolid looks for increasing the participation of the citizens and their engagement in climate change, renaturing and Nature based solutions. With this aim, there are yearly organized different activities with different targets (schools, Valladolid university, professional colleges, architects, environmental, forestry and civil engineers, others). The following are examples or citizen participation in ecological and urban renaturing workshops.

▪ Contest for urban renaturing ideas “Renaturing your city”. #EUGreenWeek

First edition was launched in the Green Week 2018, but it will be launched yearly. This is a participation contest in which citizens propose ideas for improvement the city on aspects of urban restoration and resilience to climate change, as well as related to sustainability and the use of public spaces improvement. The ideas must be represented by graphic or media of any kind, such as models, posters, collages, pictures, photomontages, reports or others. The contest is open to the general public, not necessarily to specialized business: neighbourhood communities, educational centres, cultural associations. The topics were be related to URBAN GreenUP project, on green and blue infrastructures such as green façade, green roof, mobile garden, urban orchard, green noise barrier or a water park. At the end of the participation process there was a final event to present the citizen's ideas, with an awards ceremony.

Figure 5.7: Green Week contest 2018 "Renaturing your city" (Source: Valladolid City Council)

▪ Contest for urban Renaturing projects "Making your renaturing ideas a reality"

This advanced contest is for students and recently qualified experts of the University of Valladolid, of Architecture, Environmental, Forestry and Civil engineers or similar degrees. All participants develop a execution project about some of the ideas taken from the previous contest ("Renaturing your city") about green façades, vertical gardens, green roofs or other. The winners will be awarded, and their projects will be subjected to real execution. This contest will be launched as early as 2019.

▪ Other contests for the citizenship.

In August-September 2018 was launched a contest of photos and videos about Valladolid smart city that the Innovation Agency of Valladolid City Council launched on the occasion of the Congress By & For Citizens (19-20 September 2018).

▪ Photography exhibition "Greener present and past of Valladolid city"

It is a photos exhibition about the evolution of the Valladolid des-naturalization, which shoes the loss in green areas during last decades. It will be installed also a mailbox for citizen participation. This exhibition might be launched with the University of Valladolid support. This contest will be launched as early as 2019.

5.3.3 Economic Specifications

Promotion of ecological reasoning and ecological intelligence	unit	quantity	Price (€)*	Amount (€)
Thematic meetings (personnel costs, trips, materials)			5.411,12 €	
The URBAN GreenUP in Valladolid's tourist route				
Diffusion materials and communication activities				
Citizen participation ecological and urban renaturing workshops (contests, awards, grants...)			4.205,96 €	
Maximum budget with VAT (€)				**100.000,00 €**

Table 5.4: Promotion of ecological reasoning and ecological intelligence investment plan.
*Note: Those prices are the Valladolid City Council expenses 2018 directly related with those concepts.

5.4 Single Window/Desk for RUP Deployment (VAc40)

5.4.1 General Description

Valladolid Local Desk is a new system that comprises a major simplification of the re-naturing process concerning technical, administrative and funding aspects in the city of Valladolid, which has been implemented to reach a high potential for local individual initiatives. This Local Desk is a single window opened to communicate with the citizens, receive their comments, requests and information exchange about the URBAN GreenUP project. This non-technical action promotes the collaboration among Valladolid City Council and project stakeholders, such as other city councils

Valladolid Local Desk is managed by the Innovation Agency of Valladolid City Council. It was launched in the beginning of the URBAN GreenUP project.

valladoli+D adelante

Agencia de Innovación y Desarrollo Económico de Valladolid

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Figure 5.8: Valladolid local desk in the Innovation Agency (Source: Valladolid City Council)

5.4.2 Technical Specifications

Valladolid Local Desk is located physically in the Innovation Agency of Valladolid City Council, Vega Sicilia St, Valladolid. There has been provided also a email ugu@ava.es

What are the main activities deployed by Valladolid Local Desk? On the one hand, at EU level the main activities of Valladolid Local Desk are the following:

- Provision of contents for the C&D activities of the global URBAN GreenUP project, supporting WP8. It includes writing news or articles for the e-newsletter, URBAN GreenUP website www.urbangreenup.eu .
- Maximise outreach and impact towards other cities and cities networks.
- Contribute to the annual updates of the C&D plan
- Track and monitor D&C activities at local level.
- Participate in periodical audio-meetings.

On the other hand, at local level the main activities of Valladolid Local Desk are the following:

- Secretariat for local dissemination activities. The dissemination activities will focus on knowledge and the transfer of information to different professionals, industry, SMEs, researchers, decision makers and end users.

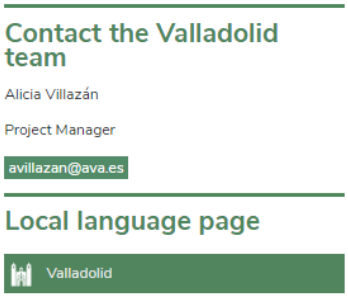

Figure 5.9: Contact details for the URBAN GreenUP project local correspondent in Valladolid (Sources: URBAN GreenUP website)

Main characteristics from Valladolid in the URBAN GreenUP website are available in Spanish language.

- Key point of the knowledge-sharing network about Valladolid local actions, among the URBAN GreenUP Cluster of cities (front-runner and follower cities) but also among other city councils (national and international).
- Increase the visibility of Valladolid interventions across Europe. Maximise outreach and impact within the city of Valladolid.
- Local communication agency that guarantee contents' localisation (press, news, articles, television, radio, events, social media, videos, flyers, etc.), according to the local communication and dissemination plan.
- Provision of dissemination material (press releases, flyers, posters, etc.).
- Answer all queries and attend every citizen who asks for an interview, information or support of any kind. This includes easing the connection among stakeholders or providing a database of (local) enterprises with expertise in NBS.
- Organize training activities for professionals, workshops and on line seminars.
- Coordinate the renaturing principles among other departments of the City Council, such as Innovation, Urban planning, Urbanism, Environment, Parks and Gardens, Mobility or Security. That means that the URBAN GreenUP methodology is promoted within the Valladolid City Council itself in other government areas so that re-naturalization actions are considered within any action in the city.
- Coordinate the URBAN GreenUP activities with other related activities and related projects that are being deployed in the city (nature based solutions, Renaturing the city, increase biodiversity, etc.). Related projects:

· The renovation of Juan de Austria Park, in Valladolid (April 2018, 600.000€).

· NAIAD H2020 project (www.naiad2020.eu) "Nature Insurance value: Assessment and Demonstration" with the urban water buffer Spangen in the Sparta Stadium (Rotterdam)23.

[23] https://fieldfactors.com/work/urban-waterbuffer-spangen

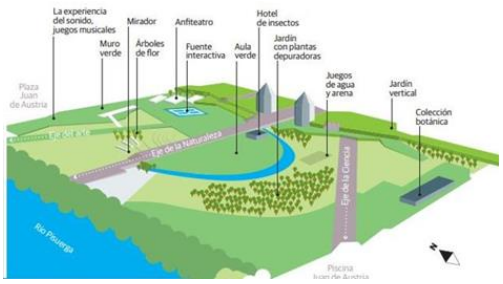

Figure 5.10: Coordination with related projects by the Local desk (Sources: Parque Juan de Austria, El Norte de Castilla 23 April 2018[24]. NAIAD project wwww.naiad.eu).

5.4.3 Economic Specifications

Single window / single desk for RUP deployment	unit	quantity	Price (€)	Amount (€)
Valladolid Local Desk activities				
Maximum budget with VAT (€)				**120.000,00 €**

Table 5.5: Single window / single desk for RUP deployment investment plan.

5.5 Support to Citizen Project of NBS (VAc41)

5.5.1 General Description

This complementary action *VAc41- Support to Citizen Project of NBS* will provide the stakeholders with the specifications of a group of Nature Based Solutions developed in Valladolid front-runner, that might be included in the Valladolid City Council websites (www.valladolidadelante.es for the Innovation Agency and/or www.valladolid.es for the City Council), starting from the URBAN GreenUP project website (www.urbangreenup.eu).

The objective of VAc41 is that Valladolid City Council promotes and facilitates the development of green projects about the implementation of NBS from citizens and private companies. It is expected that Vac41 will reach 250 recipients (stakeholders).

5.5.2 Technical Specifications

The main activities to *Support to Citizen Project of NBS* will be developed by the *VAc42- Single window/Local Desk*. There is enabled a place for citizen information, both physical and electronic. There will be answered all queries; Local Desk will attend every citizen who asks for an interview, information or support of any kind. Physically the *VAc41- Support to Citizen Project of NBS* is in the same location than Valladolid Local Desk (*VAc40- Single window/Desk for RUP Deployment*), in the Innovation Agency of Valladolid City Council, Vega Sicilia St, Valladolid. There is available an email ugu@ava.es

[24] Parque Juan de Austria: https://www.elnortedecastilla.es/valladolid/parque-juan-austria-20180423205259-nt.html

With the aim to support to citizen projects of NBS, there have been planned different non-technical activities to be deployed during the URBAN GreenUP project.

- ***Create a Nature Based Solutions database to Valladolid.***

There will be provided the help that the citizens need to deploy NBS in the city of Valladolid, for instance, sharing knowledge about the URBAN GreenUP project. The experience of implementing NBS in the city of Valladolid will be open to the stakeholders:

- Technical specifications.
- Economic specifications.
- Barriers and boundaries.

This database will be launched in the URBAN GreenUP website www.urbangreenup.eu starting from the Nature Based Solutions Catalogue (WP1). In the future, this database might be included in the Valladolid website (www.valladolidadelante.es and/or www.valladolid.es). It would be desirable to be translated into Spanish language.

- ***Promote the implementation of NBS in the city.***

Local Desk (VAc40) will try to encourage the implementation of NBS projects by citizens and businesses in the city. Local Desk support to citizen projects of NBS through the following two possible ways. There might be included other possibilities identified during the URBAN GreenUP project.

▪ Valladolid Participatory budgeting in favour of the NBS.

Participatory budgeting is an important step in participatory municipal management and local democratic system. The neighbours can decide the destiny of a part of the municipal budget (investments), according to the citizen's priorities. Participatory budgeting is open to the application of NBS, if the citizens apply for them.

▪ Fiscal incentives for private companies.

Valladolid City Council may propose the existence of benefits in the municipal canon and fiscal incentives, for the promotion of the NBS among the private companies. There may be considered also financing grants for private communities, like neighbours' communities, social entities or civil society.

This would be a new local governance model. However, this possibility is under study, whose deployment will be analysed during the URBAN GreenUP project.

5.5.3 Economic Specifications

Support to citizen project of NBS	unit	quantity	Price (€)	Amount (€)
Create a Nature Based Solutions database to Valladolid				
Activities to promote the implementation of NBS in the city				
Maximum budget with VAT (€)				**120.000,00 €**

Table 5.6: Support to citizen project of NBS investment plan.

5.6 City Mentoring Strategy (VAc42)

5.6.1 General Description

During the implementation of the URBAN GreenUP project in the city of Valladolid front-runner city, there have been collecting a huge number of experiences that could be shared with stakeholders. In the course of *WP1-Renaturing City Methodology*, and *WP6-Replication and City Clustering*, a number of good practices from Valladolid will be selected for mentoring purposes.

Members of Valladolid Consortium will be selected as mentors, so that they can explain in detail their experience and how they think that could be used by other cities. There might be organized specialised events to implement the Valladolid Mentoring Strategy. It is expected that Vac42 will reach 50 recipients.

This non-technical intervention is directly related with VAc40 and VAc41.

5.6.2 Technical Specifications

Among those stakeholders identified to received mentoring are: Other members of the URBAN GreenUP Consortium, especially other front-runner and follower cities; other cities with interest on urban Renaturing and NBS (such as Vitoria, Madrid or Barcelona, in Spain); the academia (University of Valladolid); private companies' experts in NBS implementation; civil society and social entities; among others.

There has been planned a "Mentoring Strategy for Valladolid city", which includes different non-technical activities to be deployed during the URBAN GreenUP project.

- *Valladolid Consortium mentors group.*

Members of the URBAN GreenUP Consortium related with Valladolid Demonstration are part of a Mentors Group, whose support will be asked for the Mentoring Strategy. Those members are: Valladolid City Council, CARTIF Foundation, SingularGreen SL, Duero River Basin Authority, CENTA Foundation, LEITAT Research Centre, Acciona Ingeniería and GMV.

- *Mentoring strategy activities.*

The Consortium Mentors Group will explain their experiences in the NBS field, specially related with Valladolid demonstration in the URBAN GreenUP project. They will be participating in the different activities that Valladolid City Council will organize.

With that objective, the following activities may be organized in the following years, at least once a year:

- Mentoring lectures opened to different types of stakeholders. For instance:
    - Lecture: "Green infrastructure: Case study Valladolid". Recipient: Gardeners. Impart: Singular Green.
- Visit to CARTIF Foundation facilities in Boecillo (Valladolid, Spain).

- Organize and participate in the Replication Webinars from Work Package 6. Valladolid was the front-runner city in charge of the first replication webinar that was launches on the 7th June 2018.
- Exchange of experiences and good practices with other members of the URBAN GreenUP Consortium, especially front-runner and follower cities, or the Cluster of Cities. Those actions are being developed during the UGU periodic meetings but also using online communication media (such as email, audio conference and video conference).
- Exchange of experiences and good practices with other cities on NBS. There may be organized an event-congress of green cities of Spain (Vitoria, Barcelona, Madrid, Zaragoza, Valladolid).
- Local mentoring: Exchange of experiences and good practices with other local stakeholders. The information reference is the Vac40- Local Desk (physically and online).

5.6.3 Economic Specifications

City mentoring strategy (Staff Exchange activities)	unit	quantity	Price (€)	Amount (€)
Mentoring Strategy activities (lectures, visits, meetings...)	unit	1/year		
Maximum budget with VAT (€)				**80.000,00 €**

Table 5.7: City mentoring strategy (Staff Exchange activities) investment plan.

6 Conclusions

This report describes the technical and economic definition of the 42 interventions of Nature Based Solutions, NBS, and non-technical interventions that are going to be deployed in Valladolid, which is front-runner city of the URBAN GreenUP project.

During the preparation process for the proposal there were defined the technical and non-technical interventions that were identified as adequate for the city of Valladolid, considering its environmental and climate challenges. In that initial zero phase, there were identified their main characteristics, potential locations and general budget.

During the first year of the URBAN GreenUP project, from June 2017 to August 2018, the URBAN GreenUP Consortium Members working for Valladolid front-runner city have been working on detailing the technical and economical definitions of the interventions, specifically designed for the characteristics of the city of Valladolid.

There have not been substantial changes in the NBS defined to Valladolid, as every intervention initially planned is still ahead. However, in the technical definition of the interventions there have been produced small changes in their location, which is considered one of the main challenges addresses in the current design phase. Those small changes have to be considered as technical adjustments to adapt the interventions to the reality of the city.

At the present time, there have been pre-defined the whole 42 technical and non-technical interventions of the URBAN GreenUP project in Valladolid. This includes the technical definition, selection of the actual detailed location if possible and initial economic budget designed. But there have been also defined the operational and maintenance issues, which are necessary to consider with the aim of ensuring the level of quality of the interventions in the future.

The technical and economic definition phase is not completely finished and it has to go on during the following months. It is needed to work for the more detailed definitions for every intervention in Valladolid. It is difficult to establish a progress percentage for all interventions in group, since each one has followed an independent design process. This is due to the differences in magnitude, impact, technical specifications, requirements and adaptation to the city (technical, environmental and politically) among other criteria. If possible, there have been working with grouped interventions, such as the Floodable Park, Sustainable Park or Renaturing football stadium parking interventions.

In the next months it will be necessary to work in the following three action lines: overcome the outstanding technical challenges, adapt the technical definition to the available total budget, and finalize the delivery of technical projects in Spanish, ready to launch the tendering processes for the construction of the interventions.

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