WHEN THE WELL RUNS DRY

An architectural approach to the water scarsity in southern Spain

Sigurd Røsok - Diploma 2022

Binder 1

Content:

Pleas note: For complete documentation, see Binder 2

RESEARCH QUESTION

The main objective of the diploma will be to figure out and understand the following research question:

How can architecture through holistic design be part of the solution to the pressing water scarcity in the Segura river basin?

The diploma will further investigate the different aspects of the water cycle: how it is obtained, how it is used and what happens to it afterwards, in order to address where and how an intervention can most purposefully be introduced.

WHEN THE WELL RUNS DRY

An architectural approach to the water scarcity in southern Spain

By Sigurd Røsok

The problem!

Overconsumption, flooding and water scarcity. When temperature rises, air expands. This increases the air's capacity to hold moisture which in turn tends to further humidify wet areas and dry up dry areas. This is one of the reasons for the correlation between increased global temperature and extreme weather, such as drought and floods[1].

Water shortage due to shorter or infrequent wet seasons, combined with higher evaporation due to increased temperatures, can lead to shortage of fresh water. This phenomenon is not restricted to one specific place but is a worldwide ongoing and looming crisis that affects hundreds of millions of people[2].

One of these places is the Segura basin in the region of Murcia, an autonomous community in southern Spain. The Segura river is the driest river on mainland Europe with only an average of 380mm per year[3]. Yet, it is the primary water source to one of the most productive agricultural areas in the country. There is a long history of handling water shortage in this arid region, but with growing consumption demands of fruit and vegetables, in addition to some of the worst droughts in recent history, local farms and agriculture infrastructure have been put under immense pressure[4].

The lower regions of the river, called Huerta Murcia, has always been an important agricultural area, producing a wide range of products such as oats, tomatoes, citrus fruits, peaches, almonds and olives. The farmland is supplied with water through a sophisticated network of dams and irrigation ditches transporting the water from the river to the fields. The irrigation systems were first introduced by the Romans but later perfected by the Moors during the 700s onwards[5]. The remains of these canals are still used today. In recent years large infrastructure projects have been added to deal with the increased demand of water, such as dams, desalination plants, wastewater treatment facilities and the Tajo-Segura transfer; an aqueduct importing water from the Tagus river basin to the upper parts of the Segura basin.

In the higher parts of the river the terrain is more mountainous and the farming methods less developed. Due to the sloping terrain the orchards are divided into smaller terraces. The smaller sized orchards makes conventional water reducing measures less suitable compared to bigger farms located in flatter areas further downstream. One area that is famous for its traditional agricultural landscape is the Ricote valley. The narrow valley is known for its steep cliffs and lemon orchards and is a popular tourist attraction.

The town of Ricote is situated on a small plateau above the Sigura river, and lends its name to the Ricote valley. Unlike other towns in the valley, Ricote does not depend solely on the Segura river for there water supply[6]. Traditionally it has received most of its water from a local natural spring at the foot of the nearby mountains; *Sierra de Ricote*. However, it faces many of the same challenges as the rest of the region; what happens when the stream runs dry?

[1] EPA, “Climate Change Indicators: U.S. and Global Precipitation”
[2] UN-Water, “Water Scarcity”
[3] Hernandez-Mora
[4] Buitrago, “El campo toma hoy Murcia con una marcha masiva, a la que se suman los partidos excepto Podemos”
[5] Asamblea regional de Murcia, “Murcia y el agua, Historia de un Pasión”
[6] Puy, “Land selection for irrigation in Al-Andalus, Spain (8th century AD)”

The solution?

There are two ways to avoid water shortage:

1. Use less
2. Get more

Usually, most people prefer the second option before having to settle for the first one.

However, the most reliable way to prevent water shortage, like with most other climate related challenges, is undoubtedly by implementing clear and strict long-term policies for water preservation.

At the same time, the continued pursuit to find new sustainable water sources and to invent better and more efficient ways of using and reusing the water we already have, will be decisive in our attempt to solve the immense challenge we are already facing.

When it comes to where we get our water, it is normal to divide the water sources into four categories[7].

1. Ground water
2. Surface water
3. Sea water
4. Municipal (reused water)

In the region of Murcia all of these four are utilized to the limits: The groundwater is being pumped up beyond the sustainable threshold and depletion of the aquifers has been an issue for decades[8]. The use of the surface water is strictly regulated by a central authority to make sure that all the available water is designated a purpose before reaching the sea[9]. The small amount of rain the region gets is channeled through a web of ditches leading out to the nearest river and further downstream to the next reservoir. The southern parts of Spain is one of the regions in the world with the highest expertise in transforming seawater into freshwater together with Israel, Saudi Arabia and the United States[10]. And at last Murcia has built up an impressive wastewater treatment system that manages to reuse almost 100% of all the wastewater from the cities[11].

Even though Murcia has reached the limit of the potential exploitation of their water supply, they still have a yearly water deficit of 63 million m³, two thirds of the amount of water Oslo uses in a year (89 million m³, 2020)[12]. It is easy to think that Murcia has run out of options, but recent research might shine some hope on the dire situation. There is actually a 5th water source that has not been fully utilized: the water trapped in the air around us.

[7] Wikipedia, “Water resources”
[8] Rodríguez-Estrella, “The problems of overexploitation of aquifers in semi-arid areas: the Murcia Region and the Segura Basin (South-east Spain) case”
[9] Confederación Hidrográfica del Segura, “Planificación”
[10] Bernabé-Crespo, Meseguer, Espín, “Desalination and water security in Southeastern Spain”
[11] Murcia today, “New Mazarron waste water treatment plant in Majada proceeding well”
[12] Oslo kommune, “Vann og vassdrag”

The proposal

The fact that the air holds a lot of moisture has been known and exploited for millennia, but it has not been expanded into large scale infrastructure projects in the same way as with other water sources.

The process of turning air into water is called atmospheric water generation and works by either cooling the air down so it creates condensation or by soaking up water using a hydrophilic material. This technology is widely used in household dehumidifiers but has never been scaled up and used in larger production facilities.

This technology will be the base for my proposal and, in addition to the newest water efficient farming techniques and flood prevention strategies, will serve as the foundation for my diploma. My proposal aims to illustrate three options of how smaller rural communities can face the present water crisis while at the same time enhance their unique identity. Through my work I will try to demonstrate the architectural potential of new technological solutions to cope with water shortage in an urban and social context. The diploma will use the town of Ricote as a case study, where three sites will be developed to address three phases of the water supply chain: how to harvest water, how to use it more efficiently and what to do when you have too much of it.

The three sites will also be combined with different social programs in order to include and involve the inhabitants of Ricote and the visiting tourists.

Near the entrance to the valley of Ricote the first project is situated on the top of a hill with a view towards the town. Today the site contains the remains of an old abandoned hotel that recently has been proposed to be remodeled. Since this will be the first meeting with the town of RIcote, it will be a good location to introduce the first step of the water supply chain: How to get more water. In order to do this a water harvesting tower also known as an air well will be proposed on the site. In addition the tower will also serve as a viewing platform for visiting tourists. The tower will supply the new hotel with water as well as the new proposed nursery further down in the valley. The water is produced by cooling down the hot, moist air using cooling panels. This creates condensation on the panels that can be collected. The panels are tilted so that the water will run off and have a hydrophilic coating on one side and an insulating layer on the other. This process has traditionally been highly energy consuming and inefficient, but with recent advances in material technology and sustainable energy sources the option has become more reasonable.

The second project is a fruit tree nursery. The structure will also host the social programs already present on the site. This includes a funeral home, a community space and a kindergarten. The valley of Ricote is known for their lemon production and this facility will provide the entire valley with all the new trees that are planted each year. The agriculture sector in the Segura basin consumes around 86% of all available water resources. Even if an efficient irrigation method is used most of the water is lost to evaporation as a result of photosynthesis. In open air farming this water is almost impossible to recover. That is why a nursery with a sealed closed hydrological system is proposed to illustrate an alternative method of farming where the used water can be recaptured and reused. The water demand for growing lemon trees is greatest

during the plant's first years of growth and a nursery will take advantage of the water-saving potential during this period.

The last of the three projects tackles some of the many challenges related to flood. Even though the Segura basin receives a scarce amount of rain during a year, it is not uncommon that most of the annual rainfall comes as torrential rain during short periods of time. This has led to many disastrous floods and preventive measures are constantly being taken into action in order to prevent new ones. In addition to constructing flood barriers the main strategy has been to channel the flood water towards areas where it poses a lower threat, mainly towards the Mediterranean sea. This is being achieved by straightening parts of the river and introducing parallel flood channels. Even though this decreases the amount of incidents it also increases the potential harm should an extreme situation occur. The project on the 3rd site illustrates an alternative option to this strategy. By capturing and storing the water locally, in an underground cistern at the lower end of the valley, it is possible to limit the amount of water that could cause a potential overflow further downstream. The space above the cistern will be utilized as a RV-park for visiting tourists. During drier periods the water can either be used locally, transported to other areas through the Tajo-Segura aqueduct or released slowly into the Segura river.

Individually the three proposed projects address three specific steps of the water supply chain. Additionally the combination of the three projects shows the potential of introducing infrastructure as an urban feature and the possibility of combining different industrial and social programs. The capabilities of the structures are dependent on several technological solutions. Rather than proposing an optimized invention, the main goal of this diploma has been to showcase the architectural potential of these methods in a social, urban context.

1. EPA. “Climate Change Indicators: U.S. and Global Precipitation”. Last modified: 04.2022. https://www.epa.gov/climate-indicators/climate-change-indicators-us-and-global-precipitation
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7. Wikipedia. “Water resources”. Last modified: 18.05.2022. https://en.wikipedia.org/wiki/Water_resources
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11. Murcia today. “New Mazarron waste water treatment plant in Majada proceeding well” 03.05.2021. https://murciatoday.com/new_mazarron_waste_water_treatment_plant_in_majada_proceeding_well_1593499-a.html
12. Oslo kommune. “Vann og vassdrag” accessed 18.05.2022. https://www.oslo.kommune.no/statistikk/miljostatus/vann-og-vassdrag/#gref

View through the main door of the hotel towards the air well

”The Air Well”

Site 1

The first project is situated near the entrance to the valley of Ricote, on the top of a hill with a view towards the town. Today the site contains the remains of an old abandoned hotel that recently has been proposed to be remodeled.

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In addition the tower will also serve as a viewing platform for visiting tourists. The tower will supply the new hotel with water as well as the new proposed nursery further down in the valley.

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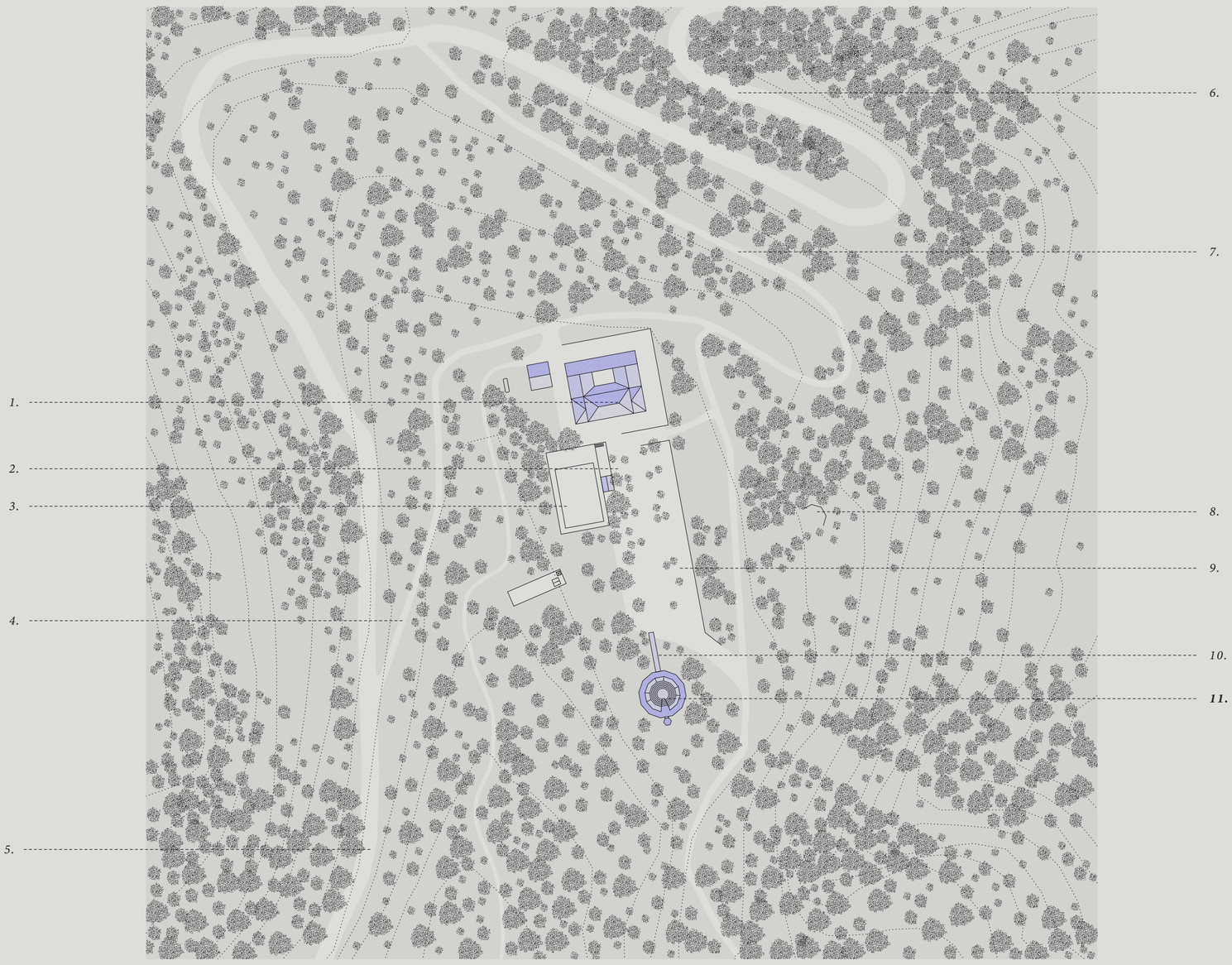

1. - Refurbished hotel w/ visiting center
2. - Tree-lined path leading to tower
3. - Swimming pool
4. - 1st entrance
5. - Road to Mula
6. - Road to Ricote
7. - 2nd entrance
8. - View point
9. - Parking lot
10. - Ramp
11. - Air well/ water generating tower

New situation
–
1 : 2 000
(A1)

A view from a kitchen window in Ricote, looking out towards the nursery

”The Nursery”

Site 2

The second project is a fruit tree nursery. The structure will also host the social programs already present on the site. This includes a funeral home, a community space and a kindergarten.

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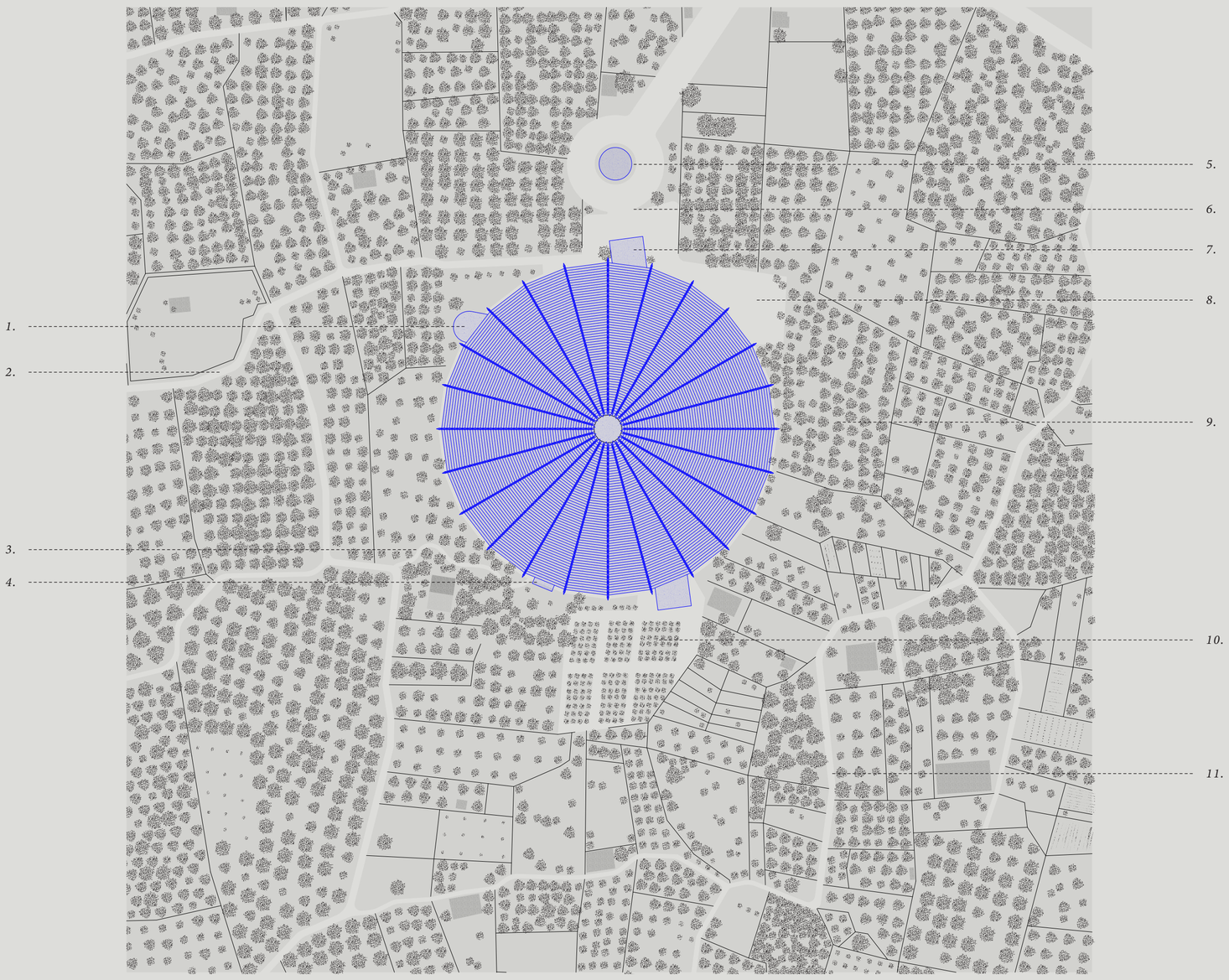
That is why a nursery with a sealed closed hydrological system is proposed to illustrate an alternative method of farming where the used water can be recaptured and reused. The water demand for growing lemon trees is greatest during the plant’s first years of growth and a nursery will take advantage of the water-saving potential during this period.



New situation

1 : 2 000

(A1)

1. - *Kindergarten*
2. - *Main road through the orchards*
3. - *Path to funural home*
4 - *Funural home*
5. - *Water tower*
6. - *Main access point*
7. - *Entrance*
8. - *Parking lot*
9, - *Lemon orchards*
10. - *Area for acclimatization*
11. - *Path*

View through the windshield of a RV parked under the sun cover

”The Cistern”

Site 3

The last of the three projects tackles some of the many challenges related to flood. Even though the Segura basin receives a scarce amount of rain during a year, it is not uncommon that most of the annual rainfall comes as torrential rain during short periods of time.

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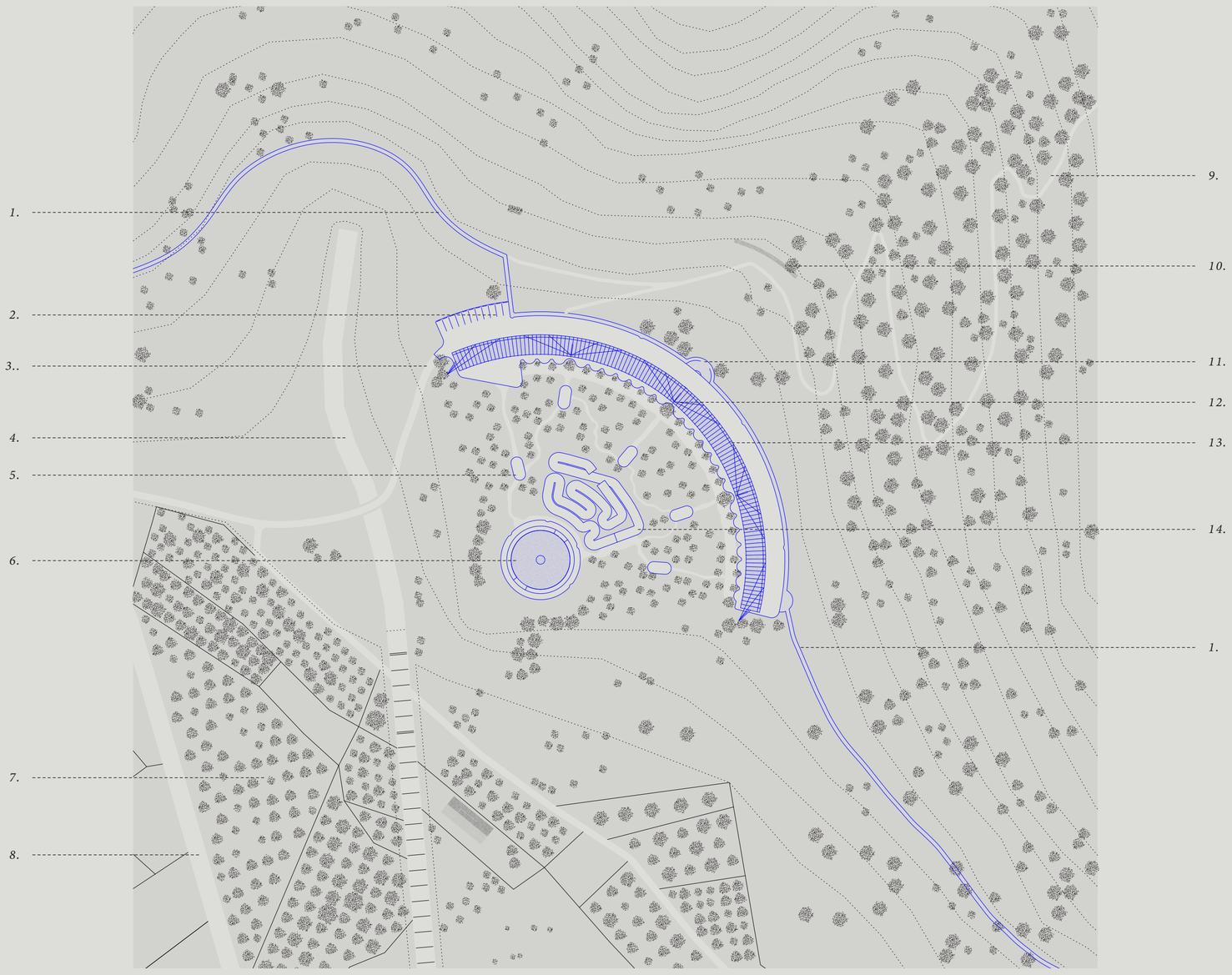

New situation

1 : 2 000

(A1)

1. - New irrigatioin ditch
2. - Parking lot
3. - Entrance
4. - Tajo-Segura Aqueduct
5. - Park with patios
6. - Platform/ opening down to cistern
7. - Lemon orchard
8. - Road to Ricote
9. - Trail to the Ricote castle
10. - Flood barrier
11. - Drain down to cistern
12. - Mast and cables
13. - Sun cover
14. - RC car track

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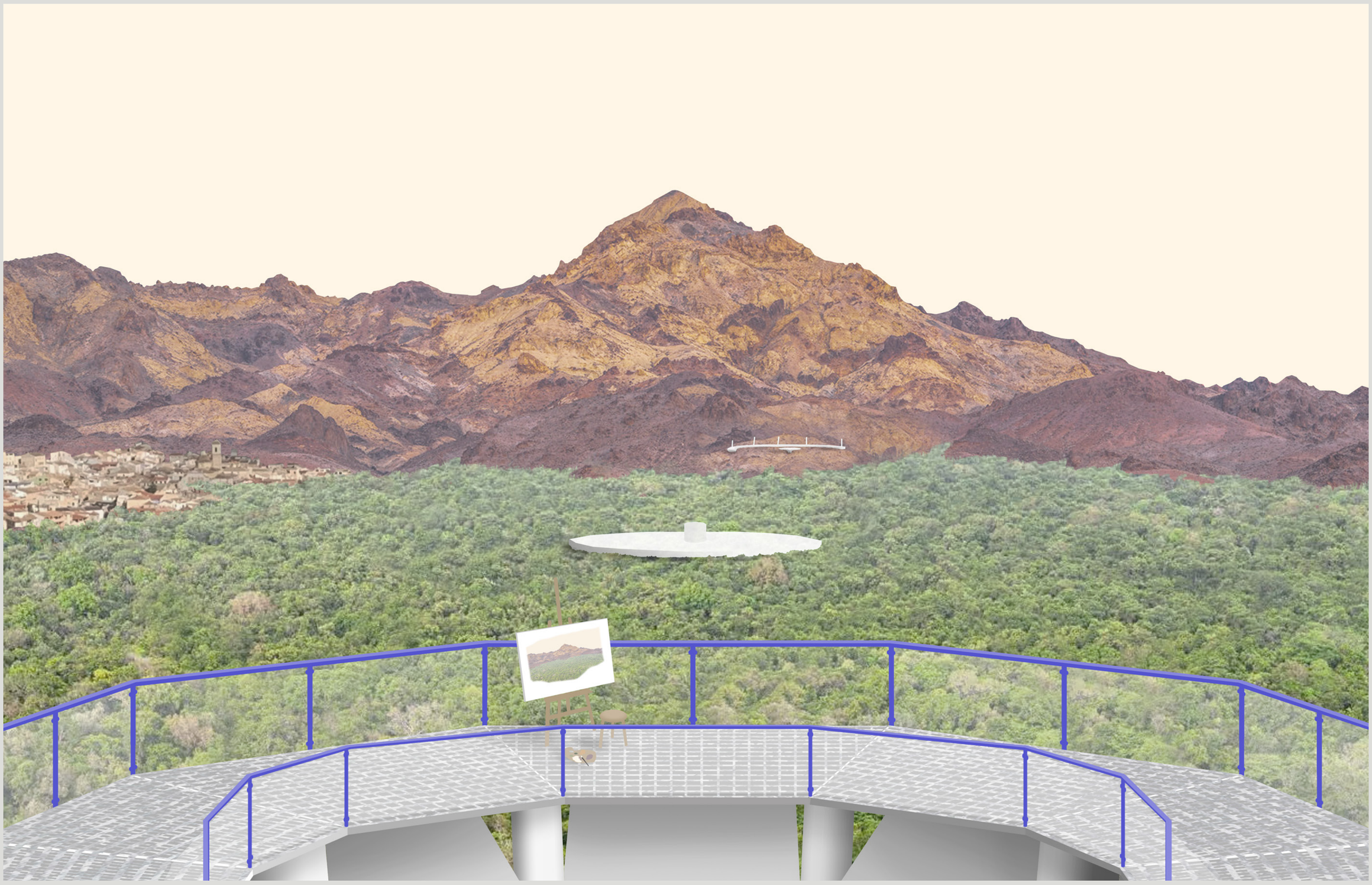
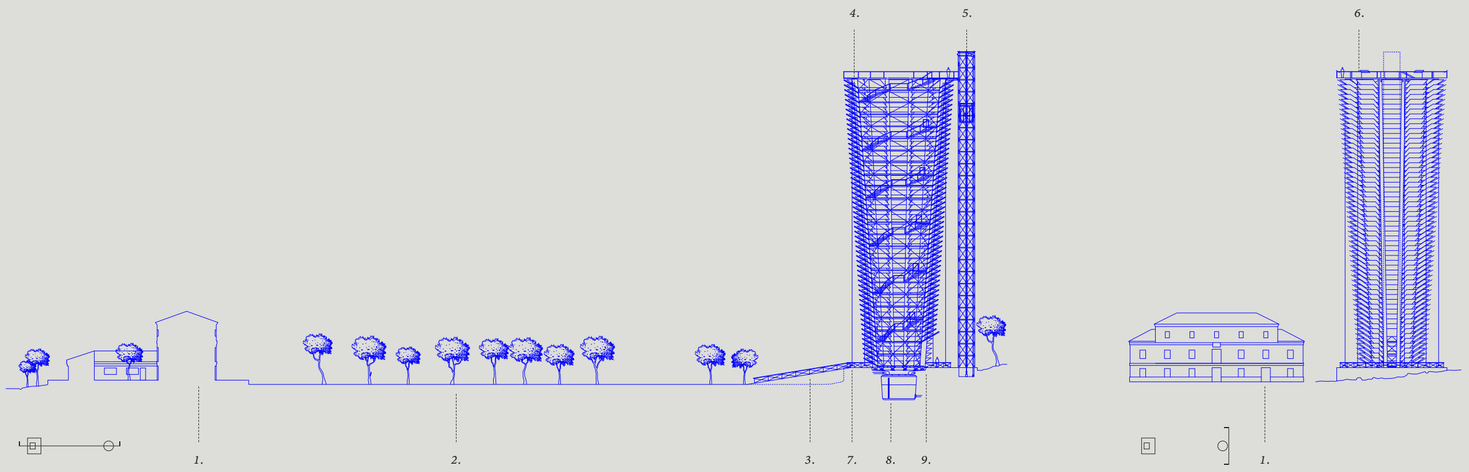
An architectural approach to the water scarsity in southern Spain



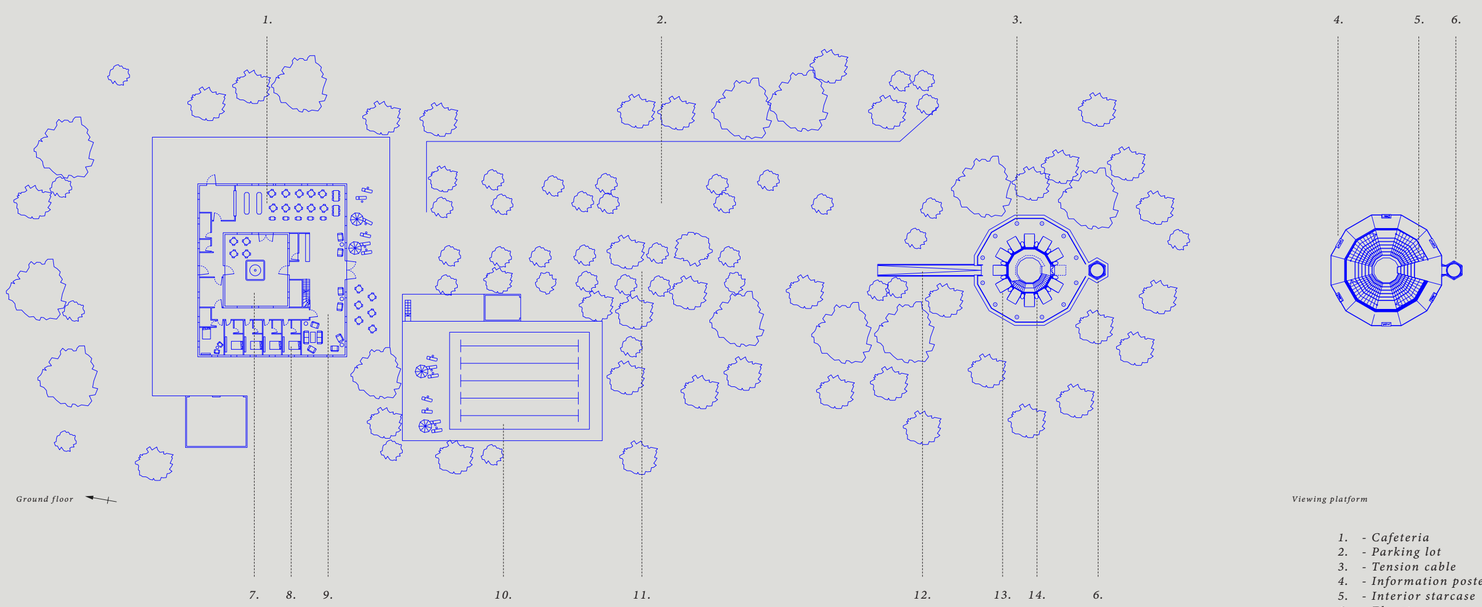
View from the top of the air well overlooking the lemon orchards of Ricote.



1. - *Refurbished hotel w/ visiting center*
2. - *Tree-lined path leading to tower*
3. - *Ramp*
4. - *Condencation panels*
5. - *Elevator*
6. - *Viewing platform*
7. - *Tension cable*
8. - *Tank for collected water*
9. - *Entrance*

Section and facade

1 : 1 000
(A1)



1. - *Cafeteria*
2. - *Parking lot*
3. - *Tension cable*
4. - *Information posters*
5. - *Interior starcase*
6. - *Elevator*
7. - *Courtyard*
8. - *Hotel room*
9. - *Visitor center*
10, - *Pool*
11. - *Tree-lined path*
12. - *Ramp*
13. - *Condensation panels*
14. - *Collumns*

Plans

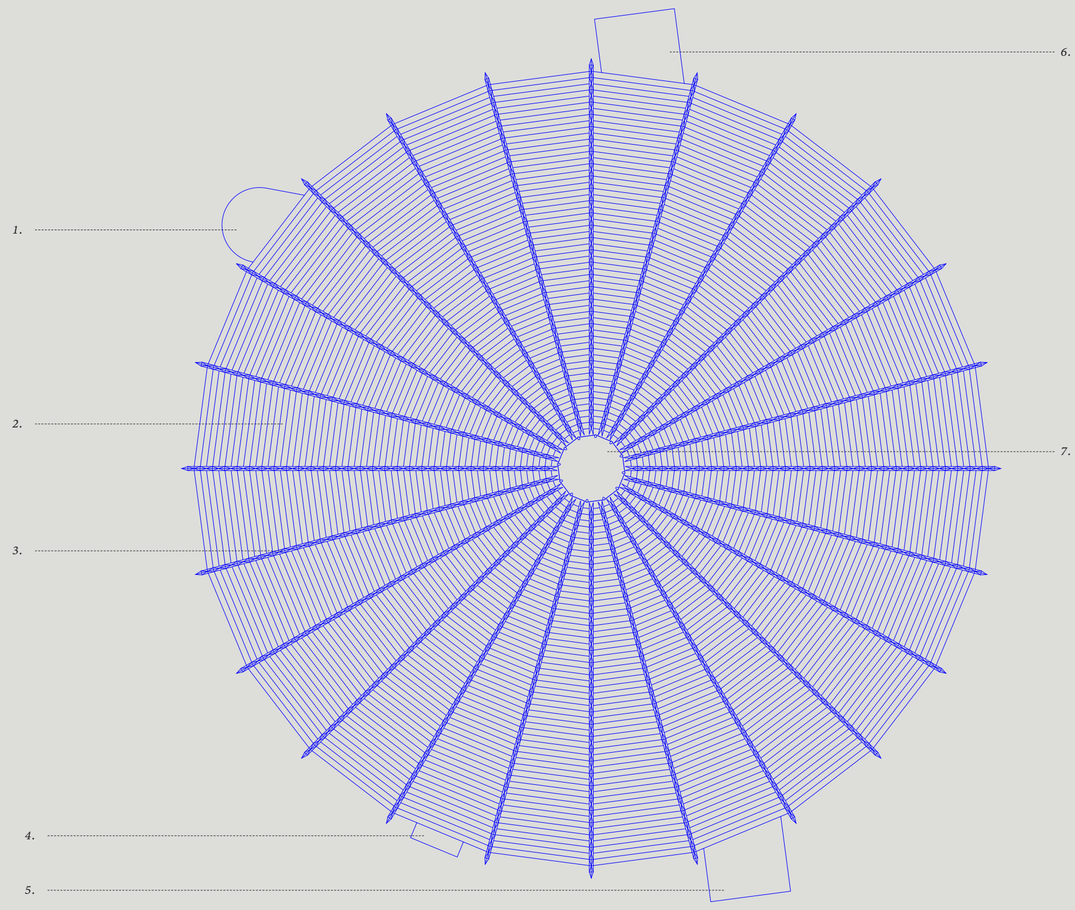
1 : 1 000
(A1)

Interior view showing the production area to the left and the community space to the right

Plan

1 : 1 500
(A4)

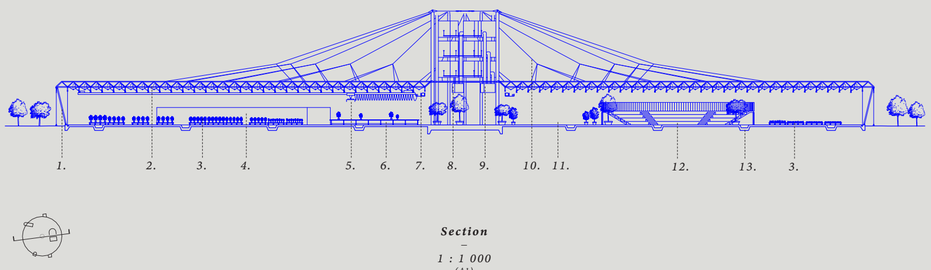
1. - Kindergarten
2. - Repotting area
3. - Path to funeral home
4 - Funeral home
5. - Funeral home garden
6. - Acclimatization area
7. - Main entrance
8. - Parking lot
9. - Central avenue
10. - Production area (inside dashed line)
11. - Community space
12. - Tower with technical installations
13. - Toilets and wardrobe
14. - Storage and soil production
15. - Germiantion room
16. - Pickup area for gantry crane
17. - Planting beds



Roof plan

1 : 1 500
(A4)

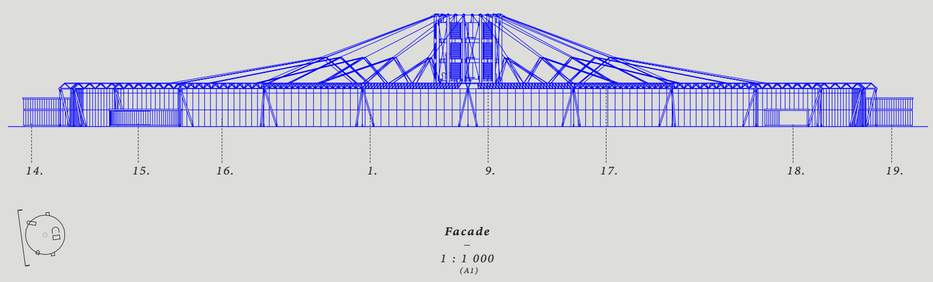
1. - Kindergarten
2. - Transparrent roof (multiwall polycarbonate)
3. - Suspended truss beam
4 - Funural home
5. - Secondary entrance facing acclimatization area
6. - Main entrance
7. - Tower with technical installations



Section

1 : 1 000
(A1)

1. - Doble collumn w/ tension cable
2. - Roof hatches
3. - Production area
4 - Kindergarten
5. - Gantry crane
6. - Repotting area
7. - Technical Instalations
8. - Tanks for fertilizer
9. - Ventilation aggrigates and dehumidifiers
10. - Suspention cables
11. - Central avenue
12. - Community space
13. - Drain
14. - Main entrance
15. - Kindergarten
16. - Glass facade
17. - Suspended truss beam
18. - Funeral home
19. - Secondary entrance



Facade

1 : 1 000
(A1)

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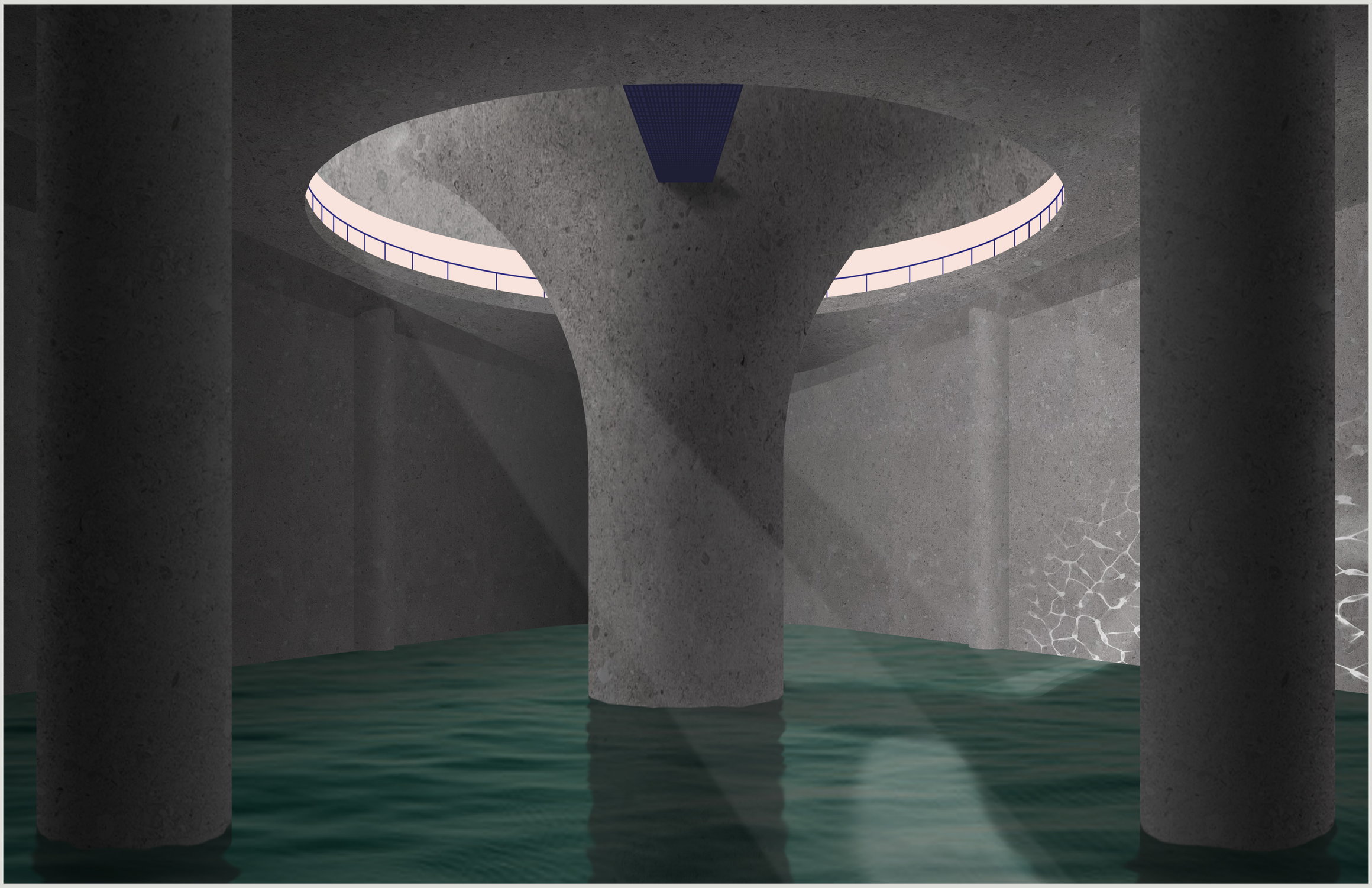
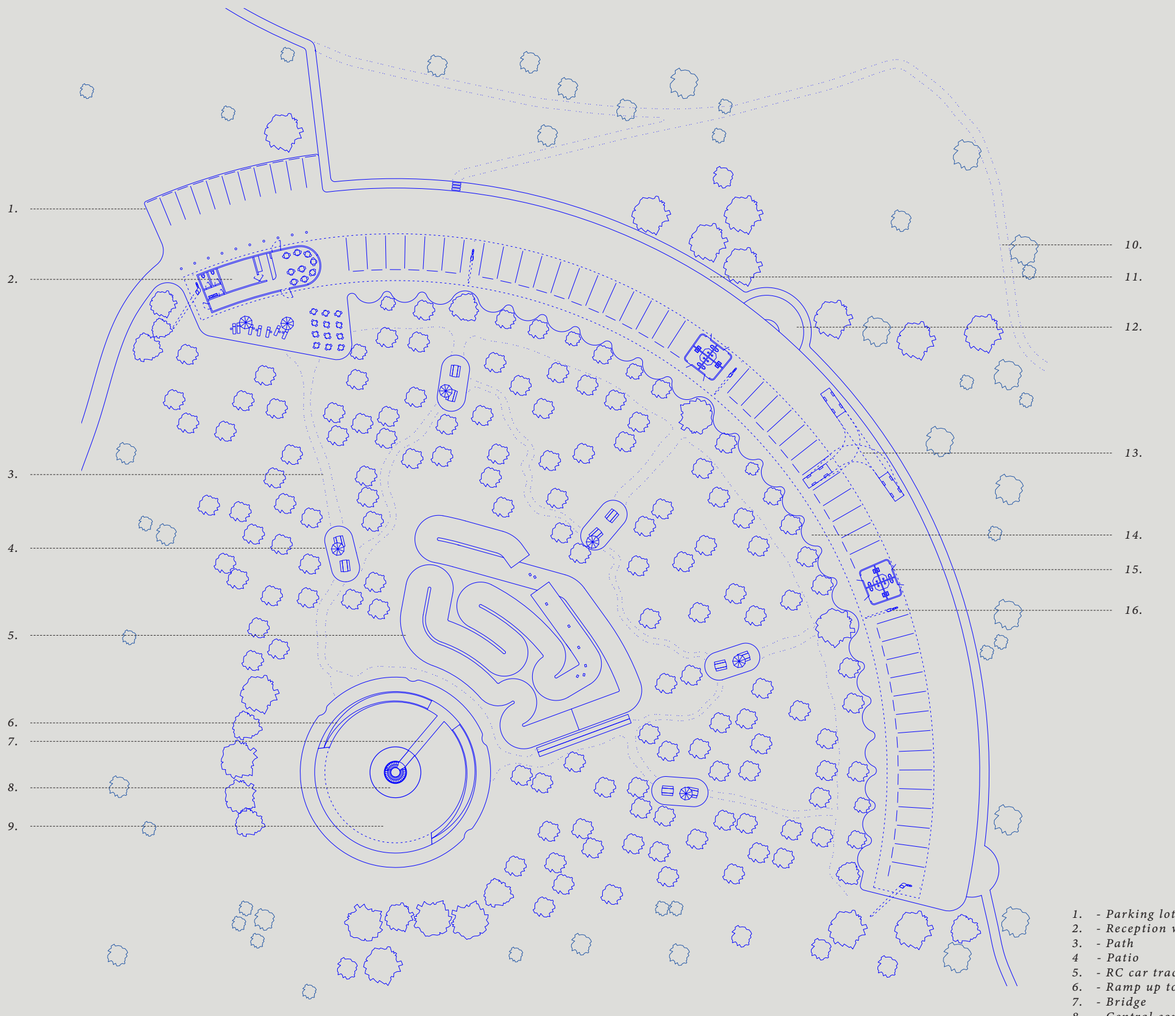


View from inside the cistern, looking back towards the opening



Plan - RV park
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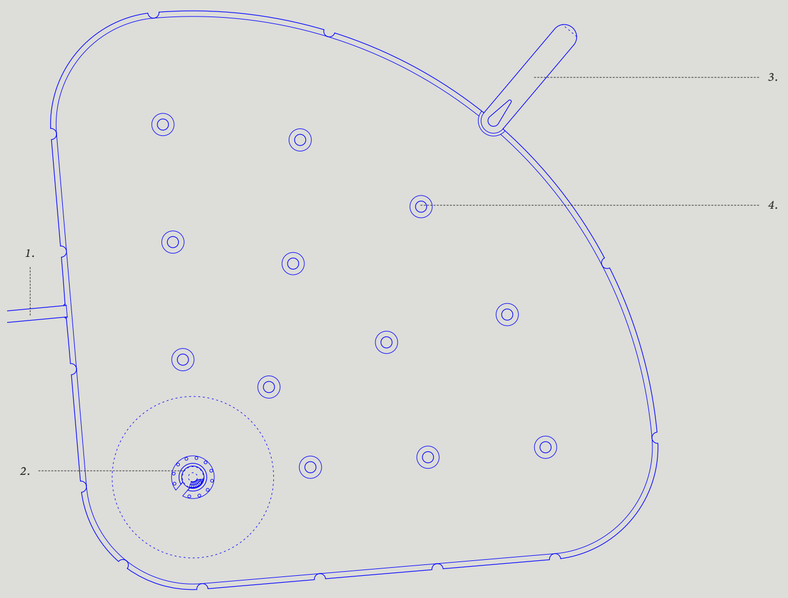
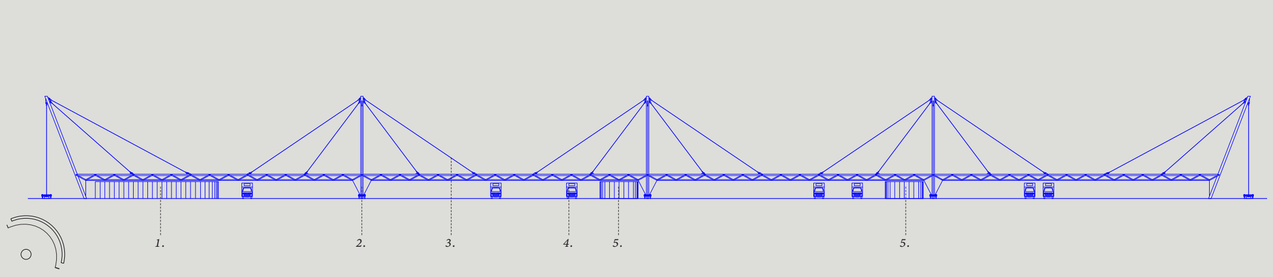
1 : 1 000
(A1)

1. - *Parking lot*
2. - *Reception with cafeteria*
3. - *Path*
4 - *Patio*
5. - *RC car track*
6. - *Ramp up to platform*
7. - *Bridge*
8. - *Central core with service staircase and drainage pumps*
9. - *Opening down to cistern*
10. - *Trail to the Ricote castle*
11. - *Flood ditch*
12. - *Drain*
13. - *Turning radius, RV*
14. - *Porch betweeen evry other RV spot*
15. - *Hygenic facilities*
16. - *Mast*



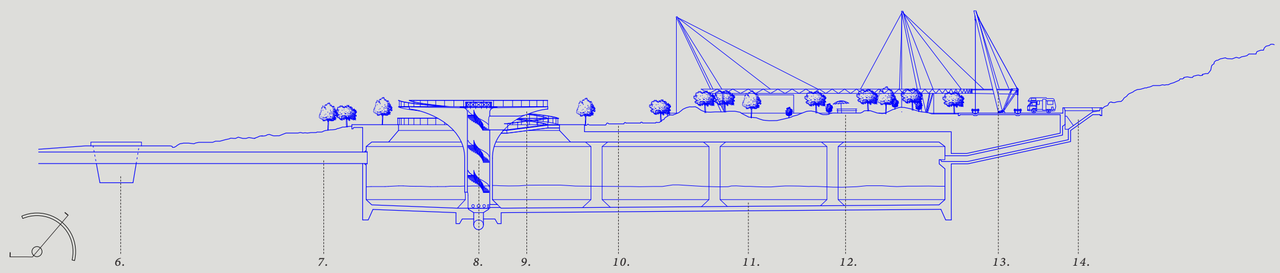
Plan - Cistern
–
1 : 1 000
(A1)

1. - *Piped Flood channel*
2. - *Central core with service staircase and drainage pumps*
3. - *Drain*
4. - *Collumn*



Facade
–
1 : 1 000
(A1)

1. - *Reception and cafeteria*
2. - *Mast*
3. - *Suspention cable*
4 - *RV*
5. - *Sanitary facilities*
6. - *Tajo-Segura aqueduct*
7. - *Piped flood channel*
8. - *Central core with service staircase and drainage pumps*
9. - *Viewing platform*
10. - *RC car track*
11. - *Flood cistern*
12. - *Park with patios*
13. - *Suspended sun cover*
14. - *Flood ditch drain*



Section
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1 : 1 000
(A1)

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