

The Plan for integrated management of water resources in Vitoria-Gasteiz has provided an effective and reliable solution to local water supplies since 1996.

Vitoria-Gasteiz, May of 2011.

The water supply sources for Vitoria-Gasteiz and Bilbao are the Urrunaga-Ullibarri reservoirs, located in the Zadorra River basin, an affluent of the Ebro's River in the Cantabrian Mountains. The limited storage capacity of these reservoirs (206 hm³), the climatic conditions of the area and the high water consumption (200 hm³/year) of the three "customers" of the reservoirs (water supply for Vitoria-Gasteiz and Bilbao and the regulated stream flow from the reservoirs) make it possible for Vitoria-Gasteiz to suffer both a serious drought episode and an intense flood episode in one single year.

The area upstream of the reservoirs houses a population of around 10,000 people, whose water supply has a limited reliability, because they are not allowed to capture water from rivers and streams discharging into those reservoirs, as they do not have administrative concession for it. Their possibilities for obtaining a water concession have been so far conditioned to the previous solution of the limited reliability of water supply for Vitoria-Gasteiz and Bilbao.

The area downstream of the reservoirs covers 8,500 ha of fertile agricultural lands, but with an insufficient water concession for irrigation from the reservoirs, because drinking water supply is the top priority and the exclusive use for their water so far.

The option of raising the reservoirs dams' height, as a practical solution to satisfy drinking water supply reliability and irrigation water needs, has not been socially acceptable, because of the significant damage that would be inflicted to existing populations. It has neither been possible to consider a water diversion from other rivers of the Mediterranean Basin to the Urrunaga-Ullibarri reservoirs, as it would imply a water transfer between the Mediterranean and the Cantabrian water basins.

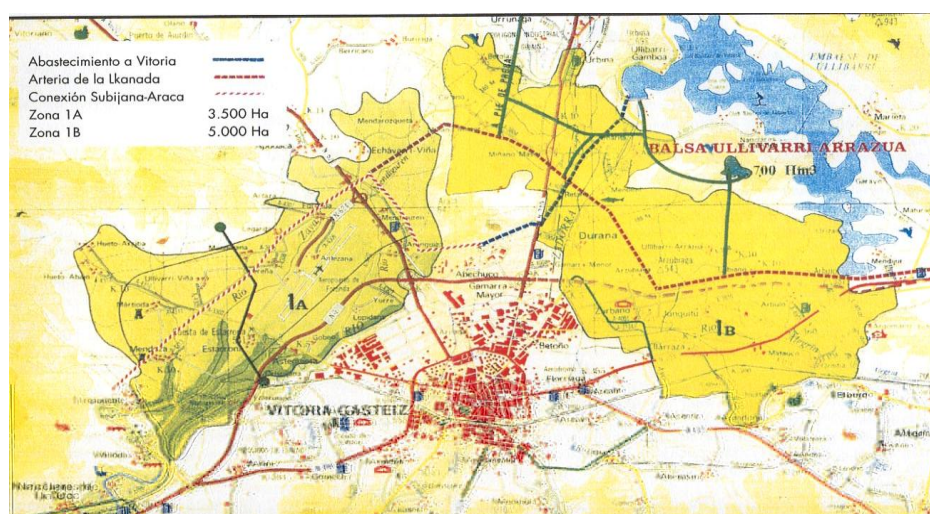


Figure 1. Water supply for Vitoria-Gasteiz and Bilbao.

In 1992 Alava's Provincial Council approved a Plan for Integrated Water Reclamation and Reuse, in order to satisfy water demands from urban, industrial and agricultural uses in Vitoria-Gasteiz's area. The main objectives of the Plan were:

1. To increase the reliability of water supply for urban uses in Vitoria-Gasteiz and Bilbao, as well as for industrial and agricultural uses.
2. To enable water supply from the Urrunaga-Ullibarri reservoirs for the 10,000 inhabitants located upstream of the aforementioned reservoirs,
3. To reduce water extraction from the reservoirs for water supply to Vitoria-Gasteiz, restoring water allocations for Bilbao, as well as the hydroelectric generation capacity associated to this supply.
4. To mitigate the flood risk for industrial areas in Vitoria-Gasteiz.
5. To assure environmental protection in the reservoirs watersheds.
6. To enable seasonal irrigation of the current 8,500 ha of agricultural lands.

The main component of this Plan was to build a water reclamation plant, with a production capacity of 34,000 m³/day (12.5 hm³/year), capable of producing a reclaimed water that satisfies the quality requirements of Title 22 of the Californian Water Code for unrestricted irrigation of raw eating crops. This water reclamation plant went into operation in 1996 and has subsequently been completed with a reclaimed water supply network covering 8,500 ha and an off-stream storage reservoir in the Azúa Valley, with a capacity of 7 hm³.

The excellent quality and the large capacity (350,000 equivalent inhabitants) of the wastewater treatment plant (WWTP) of Vitoria-Gasteiz, with biological nitrification and denitrification processes, have helped in reinforcing the Plan's objectives, allowing the production of reclaimed water that satisfies European regulations applicable to the protection of salmonid species. This high reclaimed water quality has allowed a partial replacement of the regulated stream flow from the reservoirs with reclaimed water. The water conserved in the reservoirs has been used to advance the first three objectives of the Plan. Reclaimed water quality fully satisfies the fifth objective of the Plan.

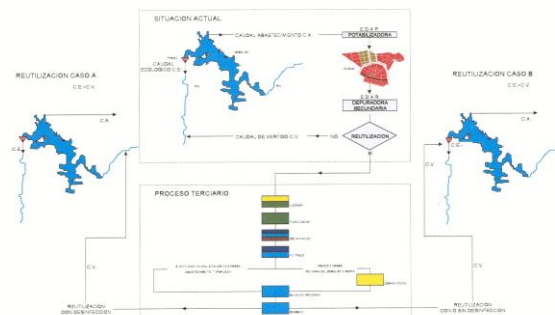


Figure 2. Water reuse alternatives of the Plan for integrated management of water resources in Vitoria-Gasteiz.

The water reclamation plant (WRP) of Vitoria-Gasteiz became operational in 1996. It has a water concession of 394 L/s throughout the whole year, equivalent to a flow of 34,000 m³/day. The influent to the WRP is a portion of the effluent from the secondary settling tank of the WWTP of Vitoria-Gasteiz.

The water reclamation process was initially designed in accordance to the provisions of Title 22 of the Californian Water Code for unrestricted irrigation (including sprinkler irrigation) of raw eaten crops. Essentially, it is a conventional drinking water process, provided with the reliability features and the reagent control systems required for the treatment of an influent raw water with a more variable and lower quality than conventional surface water sources in the area. The low electric conductivity of the secondary effluent flowing into the WRP (close to 800 $\mu\text{S}/\text{cm}$) renders unnecessary the application of an advanced reclamation process for reducing water salinity, such as reverse osmosis (RO) membranes or electro dialysis reversal (EDR).

The essential characteristics of the water reclamation process are the following:

1. Two coagulation-flocculation reactors of 97.5 m^3 each.
2. Two lamellar settling tanks, of 84 m^2 each. Lamellas are 2.5 m long.
3. Four open rapid sand filters of 22.1 m^2 each, with full recovery of backwash water, which is pumped to the head end of the plant.
4. A disinfection process using sodium hypochlorite.

Water abstraction from the WWTP of Vitoria-Gasteiz has an official administrative permit for its subsequent reclamation and reuse. The water abstraction permit was granted by the Ebro River Basin Authority through a resolution of 13 April of 1994. The permit amounts to a flow of 394 L/s during 75 years.

The Emergency and Security Plan of the Azúa Valley Dam was approved in March 2010.

The water reuse process for agricultural irrigation received the favorable assessment report prepared by the Health Department of the Basque Government, on 20 of March of 1996. In addition, the City Council of Vitoria-Gasteiz established different water quality requirements as specified by a series of parameters and its associated analytical frequencies: heavy metals and boron, weekly; trihalomethanes, monthly; chlorophenols, bi-monthly; faecal coliforms, daily; nematode eggs, bi-monthly. The quality of reclaimed water satisfies the limits for Urban Uses, Quality 1.1: Residential, established by Royal Decree 1620/2007 which sets the legal framework for reuse of reclaimed water.

The use of reclaimed water has allowed the replacement of 215 L/s of the regulated stream flow from the reservoirs, resulting in a water conservation rate of 6.75 hm^3/year .

The application rate for agricultural irrigation with reclaimed water has been 2,000 $\text{m}^3/\text{ha-year}$, exclusively used during the summer season. The irrigation schedule allows irrigation, once every three years (summer season), of the different land portions of the 8,500 ha included in the Plan. The irrigation network for reclaimed water distribution has 103 km of water supply pipelines and an installed power capacity of 1,200 kW.

The off-stream reservoir of the Azúa Valley has a capacity of 7 hm^3 , with a maximum depth of 34 meters and a flooding surface of 500,000 m^2 . The reservoir is pending (May 2011) completion of the waterproofing tasks in the area close to the dam. The reservoir can be filled with reclaimed water during the 88 hours of low electricity cost of every week of the year.

From the time the WRP went into operation until May 2011, the operational plan of the water reclamation and reuse system has systematically guaranteed the irrigation (summer season) of 3,400 ha of agricultural crops, including raw eaten crops. No replacement of the regulated stream flow from the reservoir is conducted at this time.

The water reclamation and reuse Project of Vitoria-Gasteiz has required an investment of 30.5 million Euros, of which 80% were provided by Alava's Provincial Council, and the remaining 20% were provided by the Arrato Irrigation District.

Considering a 40-year redemption period and a 3% interest rate, the production of 12.5 hm³/year represents a capital cost of 0.989 €/m³.

Table 1 shows the operation and maintenance costs of the project, as well as its energy efficiency, during 2010.

Table 1. Operation and maintenance costs of the water reclamation process of Vitoria-Gasteiz and its energy efficiency, during 2010.

Component	Cost, €/m ³	Component	Cost
Energy	0.035	Efficiency	0.51 kWh/m ³
Reagents	0.010	CO ₂ emissions	0.20 kg/m ³
Replacement	0.020		
Operation	0.020		
Total	0.085		

Planning, construction and operation of the water reclamation and reuse project have been possible thanks to a close political and technical collaboration, as well as to the budgetary contribution of the three competent institutions in the area:

- 1) Alava's Provincial Council, as the responsible organization for integrated management of water resources in the Basque Autonomous Community.
- 2) The Ebro River Basin Authority, as the basin authority responsible for the management of the hydraulic public domain in the Ebro multiregional river basin.
- 3) The Arrato Irrigation District, as water user and responsible for the use of water for agricultural irrigation, together with the company TYTSA, responsible for the operation and maintenance of the water reclamation and reuse facilities.

Technical References

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