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Water sanitation and treatment in Aragon

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1 Introduction

Protecting the environment is essential to the quality of life of both today generations and those of the future, and water is one of the main components of the environment. Deterioration in water quality is a serious environmental, social and economic problem. Technological and social development have led to a gradual increase in pollution, as industry, cities and agricultural areas pour tons of waste into our rivers. The challenge is to combine protection of the environment with continuous, sustainable, long-term economic growth.

To meet the targets set in the European Waste Water Treatment Directive, the Government of Aragon approved the Aragon Sanitation & Treatment Plant (ASTP). This plan establishes the water treatment procedure for towns with population equivalents of over 1000 for 2005.

In 2004, to meet the targets outlined in the ASTP, the Government of Aragon launched the Special Sanitation & Treatment Plan, a tool including 171 works (131 water treatment plants and 40 collectors) all over Aragon. The aim of the plan is to treat the water of towns with population equivalents of over 1000 (more ambitious in this phase than the European Directive), and will allow 90% of Aragon's waste water to be treated by the end of 2008. The cost of the plan, including construction and operation of all the works for a period of 20 years, is over 1016 billion euros. This is the largest investment ever made in Aragon, and one of the most ambitious environmental plans anywhere in Europe.

2 Defining the challenge

2.1 Main aim

The main aim of the Aragon Sanitation & Treatment Plan is to improve the quality of Aragon's aquatic ecosystems.

2.2 Legal framework

2.2.1 TRANSPOSITION OF DIRECTIVE 91/271

Royal Decree-Law 11/1995 of 28 December 1995 establishes the regulations which apply to the treatment of urban waste water, adapting Directive 91/271. Royal Decree 509/1996 of 15 March 1996 developed the previous Royal Decree-Law. The content of both these decrees largely coincides with the legal provision they develop.

One innovation of Royal Decree-Law 11/1995 (art. 3) is that, following hearings with councils, it delegates the definition of the urban centres (areas for which water treatment can be carried out at a single facility) which form the structural basis for planning to Spain's Autonomous Regions. It also assigns the declaration of sensitive areas in supraregional basins (art. 7.3) to the Central State Authorities, following hearings with the Autonomous Regions and local bodies concerned.

It also allows for Autonomous Regions (art. 5.2) to argue for and apply for deadline extensions, up to the end of 2005, for their obligation to provide urban centres with population equivalents of over 15000 with secondary treatment facilities. Lastly (art. 9), it assigns to Autonomous Regions the responsibility for drawing up a Plan to apply these regulations.

2.2.2 DIRECTIVE 2000/60/EC

Directive 2000/60/EC, the EU framework for water policy, is particularly relevant for this sector. It aims to establish a framework for protecting continental surface waters, transitional waters, coastal waters and groundwaters which:

a) prevents any further deterioration and protects and improves the condition of aquatic ecosystems and, regarding their water needs, of terrestrial ecosystems and wetlands which are directly dependent on aquatic ecosystems;

b) promotes sustainable water use on the basis of long-term protection of available water resources;

c) aims to provide greater protection and improvement of aquatic environments, including via specific measures to bring about a gradual reduction in waste dumping, emissions and losses of priority substances, and by halting or gradually ceasing waste dumping, emissions and losses of priority hazardous substances;

d) guarantees a gradual reduction in groundwater pollution and avoids new pollution;

e) helps mitigate the effects of floods and droughts;

f) thus contributes to the following and other targets: a) guaranteeing an adequate supply of quality surface water or groundwater, as needed for sustainable, balanced, fair use of water, b) significantly reducing groundwater pollution, and c) protecting inland and sea waters.

The Directive aims to achieve the following and other targets within 15 years:

- To protect, improve and regenerate all surface water bodies, so that they are in good condition.

- To protect and improve all artificial and heavily modified water bodies, so that surface waters have good environmental potential and are in good chemical condition.

An artificial water body is defined as a surface water body created by human activity. A heavily modified water body is defined as a surface water body which has undergone substantial change due to physical alterations caused by human activity, and which has been designated a heavily modified water body by the State.

2.2.3 Specific Legislation: Law 6/2001 of 17 May 2001

The *Cortes de Aragón*, Aragon's regional parliament, approved Law 6/2001 of 17 May 2001 on Planning & Participating in Water Management in Aragon. This law was published in issue 64 of the Official Gazette of Aragon on 1 June 2001.

Its general provisions establish the following:

The actions of the Authorities of the Autonomous Region and of local bodies within the field of sanitation and treatment of waste water shall aim for waters and their associated ecosystems to be in good ecological condition, via pollution-preventing measures and fulfilment of the targets established for sanitation and water treatment in state law.

Reuse of waste waters shall also be encouraged when this is viable, depending on their intended uses and sanitation conditions, and according to the necessary technical and financial studies.

Art. 6 defines sanitation and water treatment as consisting of the following:

- Sewer systems, including the urban waste water and rainwater collection network and urban collectors.

- Treatment of waste waters and disposal of them in rivers or other recipient systems.

- Collectors or outlets between sewer systems and treatment may be included in one or the other of the items stated in points a) and b) of this section, according to the optimum conditions for management of the service.

Art. 10 defines the ASTP as the planning instrument for the sector, and assigns it the status of Partial Sector Directive. The Aragon Sanitation & Treatment Plan must therefore also comply with the Law on Land Use Planning.

The whole of Aragon (Art. 11) will be divided into Planning Zones, defined according to water-based criteria and on the basis of infrastructures and efficiency of service management. Each zone will have its own Zone Plan, which must be suited as fully as possible to the requirements of *comarcas*, or administrative regions. Supply and treatment zones may differ from each other, but must always be coordinated.

Zone Plans (Art. 12) must normally be drawn up after the Plan for the Autonomous Region has been approved, although exceptions may be made.

The ASTP and acts which develop it (Art. 13) will be subject to regulations on environmental impact evaluation, according to their own terms.

The ASTP (Art. 14) will comply with the Law on Nature Reserves in Aragon, and may not alter or modify the stipulations of Plans for Natural Resource Usage. However, town planning documents must comply with this Plan.

2.3 Analysis of the Region

2.3.1 CLIMATE

Aragon's location within the Iberian Peninsula, between the Cantabrian and Mediterranean Seas and delimited by mountain systems, gives rise to a wide range of different climates.

The map attached shows average annual precipitation figures, which generally fall into strips parallel to the Pyrenees.

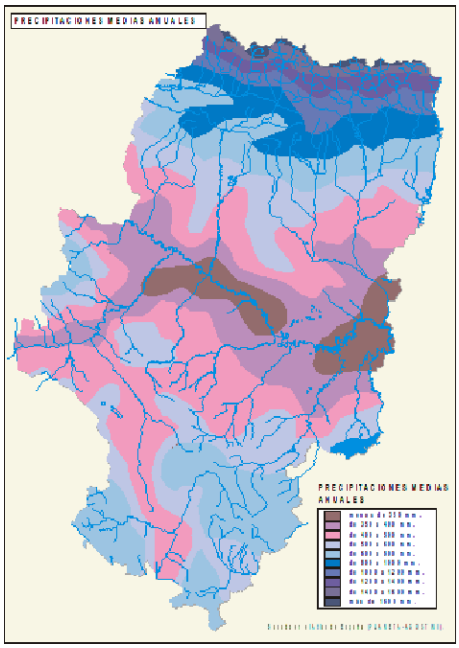
The highest values (1400–1600 mm) occur in the *Pirineo axial* (the highest land, in the centre of the Pyrenees), feeding the upper waters of the river systems on the left bank: Aragón, Gállego, Cinca and Noguera. These therefore have substantial flows, at least at certain times of the year. Values remain high (800–1200 mm) in the *Depresión Intrapirenaica* (lower land further south) and the *Sierras Exteriores* (sierras lying further south still).

Precipitation figures are lower in the foothills of the Pyrenees, in a rapid transition to the centre of the Ebro Basin, with annual averages of around 400 mm, and even under 350 mm in substantial areas. The area with low precipitation figures includes the foothills of the Iberian System, and extends towards the south along the Jiloca basin.

The rest of Teruel Province has relatively low precipitation figures (around 600 mm), even though a large part of it is at altitudes of over 1000 metres. This is reflected in the low flow of

the rivers on the right bank, which substantially restricts the possibilities of using these rivers as supply sources.

Combining the precipitation and temperature maps gives us the overall climate map[1].



This shows that almost all of the Ebro Basin is included in the semi-arid area, which extends towards the south along the Jiloca basin. Semi-dry to very dry areas cover the whole of the rest of Teruel and Huesca Provinces as far as the *Sierras Exteriores*, and part of the *Depresión Intrapirenaica*. Only the northernmost part of Aragon has a wet climate.

In conclusion, then, most of the territory covered by the Plan falls within semi-dry to semi-arid areas, which restricts the water resources available. Water is scarce in the greater part of Aragon, despite the widespread idea that Aragon is a wet part of Spain, which does not stand up to analysis. This is only true for approximately 20% of Aragon; the remaining 80%, as we have seen, falls within semi-dry to semi-arid areas, i.e. areas in which water is a precious item which restricts activities.

2.3.2 Large Natural Units

Territorial studies[2] traditionally divide Aragon into three large units, which partly coincide with three relief and bioclimate units in the north-east of the Iberian Peninsula: the Pyrenees, the Iberian System and the Central Ebro Basin; the latter is usually subdivided into three parts: the foothills of the Pyrenees, the Central Section and the foothills of the Iberian Mountains.

This gives us five sections, each with its own environmental and spatial problems[3].

Aragon's natural resources are extraordinary, both in themselves (uniformity, high productivity, species and biocoenoses of great ecological interest, etc.) and due to the role they play. These resources as a whole are extremely valuable, although they are very unevenly distributed.

[1] Source: Atlas de España, Planeta-Agostini.

[2] See Land Use Planning Directives for Aragon.

[3] See J. M. García Ruiz, The Advance of Land Use Planning Directives for Aragon, EID. This point was developed by the author on the basis of the work cited. The plan we present has adapted these large units to the map of comarcas, in some cases with obvious problems.

2.3.3 POPULATION

According to the 2006 municipal census, Aragon's population is as follows:

Population density	Population 2006 Population 2006	Surface Area (km^2)	Density (inhab/km^2)
Huesca Province	220.107	15.636	14
Zaragoza Province	932.502	17274	54
Teruel Province	144.046	14.809	10
Aragon	1.296.655	47.719	27
Zaragoza Province, excluding Zaragoza City	278.112	16.300	17
Aragon, excluding Zaragoza City	642.265	46.745	14

The huge effect of Aragon's capital city, Zaragoza, on the demographics of the region as a whole is very clear. Zaragoza City is home to half of Aragon's total population. If we discount Zaragoza City, all three provinces have a similar population density, which is very low compared to both Spain as a whole (89 inhab/km2) and Europe as a whole (116 inhab/km^2).

Aragon has 731 towns. Only its capital city, Zaragoza, has over 50000 inhabitants; seven towns (Huesca, Teruel, Calatayud, Ejea de los Caballeros, Monzón, Barbastro, Utebo and Alcañiz) have over 15.000 inhabitants; another three (Jaca, Tarazona and Fraga) have between 10000 and 15000. Only twenty-three of Aragon's 731 towns have a population density higher than the Spanish average.

The most densely-populated area is the central part of the Ebro Valley, particularly Zaragoza City and its surrounding villages. There are other areas with a certain level of population density and activity (and therefore with significant demand for water): Huesca City, Teruel City, the Jaca-Sabiñánigo axis, middle and Bajo Cinca, Cinco Villas, the valleys of the Jalón and Aranda rivers, the Borja-Tarazona axis, Bajo Aragon and Andorra. The remaining areas have no urban centres which provide structure, and their demographic situation is very vulnerable.

The future viability of many of the smallest population centres is problematic, unless they manage to convert their traditional agricultural economy into other types of activity.

3 Methods: planning & implementation. Planning:The Aragon sanitation & treatment plan

3.1 Problem 1: Estimating pollutant loads and construction & operating costs of water treatment plants

3.1.1 INTRODUCTION

The first Aragon Sanitation & Treatment Plan analysed the 74 projects carried out by the Water Authority of the Government of Aragon. This Sanitation Plan includes newer data from these water treatment plants. Some projects have been altered, while in other cases the water treatment plants have already been built, and actual construction and operating data are available.

Meanwhile, the Aragon Special Waste Water Treatment Plan has incorporated a large amount of information, as the preliminary projects of its actions have now been drawn up.

The ratios between a set of primary data have been obtained. These data include de facto inhabitants, first and second homes and industrial activity, and another set of data needed to determine the sizes of water treatment plants: the design flow and the design population equivalent. Another aim is to deduce laws which define the unit costs of the various water treatment plants.

The ultimate goal is to apply these ratios and laws, by extrapolation, to all population centres within Aragon. This statistical procedure should yield the main values of the Plan.

3.1.2 DESIGN PARAMETERS

The Aragonese Water Institute has a collection of 187 projects for urban waste water treatment plants (74 projects of the former General Water Authority, and the rest within the Special Treatment Plan). While these projects were being drawn up, an intense campaign was carried out to obtain primary data; flows were measured at various times of the day and at various points during the week and the year, and samples were taken of actual waste dumped, which were fully analysed.

The design parameters of these projects were thus deduced. This document updates these values.

An initial idea would be to obtain the ratios in question by considering all projects as part of a single whole. Ratios obtained in this way would be valid for any population centre in Aragon. However, this idea has been rejected, as Aragon is very large, and contains very different local dynamics. Some areas see a great deal of tourism, others are more agricultural, and still others are dominated by industrial or service-related activities. Some areas contain high numbers of second homes, while others are dominated by their resident populations. All this gives rise to specific problems, which are generally reflected in the sizing parameters for water treatment plants. This has been witnessed empirically, as the statistical fits obtained on the basis of a

single sample have proved unsatisfactory.

It therefore seems logical to divide Aragon into spaces or territories which behave more homogeneously. Previous chapters have explained the division of Aragon into five large sections (the Pyrenees, the foothills of the Pyrenees, the Ebro Basin, the foothills of the Iberian Mountains and the Iberian System).

Each of these five sections has its own dynamics, which respond to more uniform uses, and which therefore generate more comparable pollution guidelines. It has also been argued that these five large areas should be adapted to the administrative division into comarcas, as this divides the problem into a manageable number of units.

The number of water treatment plants per group varies: 26 in the Pyrenees, 22 in the foothills of the Pyrenees, 65 in the Ebro Basin, 35 in the foothills of the Iberian Mountains, and 39 in the Iberian System.

The numbers of de facto inhabitants, first homes, second homes and industrial jobs have been taken as independent variables, while flow and BOD_5 have been taken as dependent variables.

Three of the independent variables (de facto inhabitants, first homes and second homes) appear individually by population centre in the statistical sources of the Governing Council of Aragon.

To calculate the fourth variable, the number of industrial jobs, information published only by town, the industrial jobs/de facto inhabitants ratio has been calculated for each of the five large areas, and applied to all population centres. This seems a reasonable simplification. The coefficients obtained were as follows: Pyrenees 4%; foothills of the Pyrenees 10%; Ebro Valley 12%; foothills of the Iberian Mountains 24%; Iberian System 9%.

A computer program was used to plot straight lines of regression between the dependent and independent variables. An iterative process disregarded independent variables which appeared insignificant.

The BOD_5 fit considered most reliable is as follows:

SECTION	BOD_5 (kg/day)
Pyrenees	0.348 FH + 0.412 SH
Foothills of the Pyrenees	0.367 FH + 0.411 SH
Ebro Valley	0.199 FH + 1.311 IJ
Foothills of the Iberian Mountains	0.524 FH
Iberian System	0.100 JI + 0.487 SH

where

FH = first homes,
SH = second homes,
JI = *de jure* inhabitants,
IJ = industrial jobs.

- In the Pyrenees, the fit is very good, and gives high results. In terms of BOD_5, the population equivalent is almost 6 per first home and almost 7 per second home. The number of *de jure* inhabitants, a variable related to the number of first homes, is insignificant, as is the number of the industrial jobs, which is very limited in this area.

- In the foothills of the Pyrenees, the results are similar: a population equivalent of 6 per first home, and almost 7 per second home. The numbers of *de jure* inhabitants and industrial jobs are insignificant here too, for the same reasons as above.

- In the Ebro Valley, which is functionally more heterogeneous, the fit is somewhat weaker. This seems reasonable, bearing in mind that everything from agricultural centres such as Sariñena to industrial centres such as Utebo or Cuarte, with a wide range of cases in between, was included in the sample. In terms of BOD_5, each first home has a population equivalent of 3, and each industrial job a population equivalent of 22.

- In the foothills of the Iberian Mountains, the BOD_5 fit is adequate. Each first home has a population equivalent of almost 9.

- In the Iberian System, the fit is very good. In terms of BOD_5, the population equivalent is 1 per *de jure* inhabitant, and 8 per second home. The number of first homes is insignificant, due to the dependency of the variables cited. The number of industrial jobs is also insignificant, as it is very limited here too.

The population equivalents of the water treatment plants in the sample range from 133000 (Utebo) down to 500 (Arándiga).

3.1.3 Calculating the design population equivalent

The population equivalent is calculated once the BOD_5 is known, by applying a rate of 60 g of BOD_5 per inhabitant per day. This method is more reliable than calculations based on a standard flow (e.g. 250 litres per inhabitant per day), as flow is more closely linked to other factors: the existence or otherwise of meters, tariff structure, etc.

Population Equivalent

The formula worked out to calculate BOD_5 was applied to each of the five areas, giving a list of population equivalents for all population centres in Aragon. There are some factors which must be borne in mind concerning the validity of the results obtained:

- The population equivalent of each town is obtained by applying the formula to the four primary variables. This is a statistical approximation to reality, and may differ from similar data obtained by empirical study (actual measuring of flow and BOD_5). In other words, there may be discrepancies, perhaps even significant discrepancies, for each individual value. On the other hand, the deviation for the data as a whole will be limited, and so this method is valid for the purposes of this planning work.

- The upper section, larger water treatment plants, is the best represented in the sample, and precisely for this reason there is generally no need to carry out statistical extrapolation, as the projects have been drawn up, and actual data are available.

- The incorporation of the projects of the Aragon Special Waste Water Treatment Plan provides information on water treatment in towns with population equivalents of over 1000. This gives data on 82 population centres with population equivalents of under 2000, 30 population centres with population equivalents of 2000–4000, and 20 population centres with population equivalents of 4000–15000. In short, it contributes enormously to improving the reliability of the model, as reliability depends on the number of values in the sample.

- The lower section, in which more extrapolation of results will be used, is less well represented, as there are no water treatment plant projects already drawn up for population equivalents of under 600.

Design Population Equivalent

Individual examination of the results obtained by applying the method described above reveals a significant number of population centres whose estimated population equivalent/*de jure* inhabitants ratio is very high. In general, this occurs in population centres which were once relatively large and have since suffered significant depopulation; they now have significant hamlets, with a large number of second homes. With the adjustments obtained, this leads to a high population equivalent but a low number of *de jure* inhabitants. It is likely that in these population centres there are in fact significant peaks during holiday seasons, when the population is several times greater than the usual number of inhabitants, with the pollutant load increasing accordingly.

From the point of view of determining the sizes of water treatment plants, it seems reasonable to place an upper limit on the population equivalent for which a plant is designed, and to link this upper limit to the number of *de jure* inhabitants.

In fact, although in theory it is possible for a water treatment plant to function correctly at peak times, with loads high above average, this requires a high technical level of operation, as well as a special, more expensive design. This is only possible with large water treatment

plants. For all these reasons, this effect will be taken into account as follows when calculating the design population equivalent:

- In population centres whose population equivalent is zero, the design population will be zero.

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If: EPE = 0 DPE = 0
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- For other cases, the following table is proposed:

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If: (EPE / JI) < 1 DPE = MAX(JI, 3 (FH + SH) ),
(EPE / JI) < 3 DPE = EPE
(EPE / JI) > 3 DPE = JI (3 + 0.4 (EPE / JI - 3) )
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where:

EPE = estimated population equivalent (calculated statistically),
JI = *de jure* inhabitants,
DPE = design population equivalent,
FH = first homes,
SH = second homes.

In the population centres for which real data are available, these empirical data will be applied, with no subsequent correction. The results obtained by applying the criteria stated above are summarised in the following table:

DESIGN POPULATION EQUIVALENT FOR THE SCOPE OF THE PLAN					
SECTION	RANGE OF POPULATION EQUIVALENT	NUMBER OF POPULATION CENTRES	PERCENTAGE OF POPULATION CENTRES	DESIGN POPULATION EQUIVALENT	PERCENTAGE OF POPULATION
7	Over 250.000	1	0.07%	1.000.000	34.11%
6	15.000–250.000	22	1.46%	846.825	28.88%
5	4.000–15.000	58	3.84%	385.030	13.13%
4	2.000–4.000	66	4.37%	190.286	6.49%
3	1.000–2.000	117	7.75%	156.598	5.34%
2	600–1.000	212	14.05%	167.920	5.73%
1	0–600	1033	68.46%	185.186	6.32%
	TOTAL	**1.509**	**100%**	**2.931.845**	**100%**

Several conclusions can be drawn from this table:

- Zaragoza City has approx. 34% of the design population equivalent of Aragon.
- Zaragoza City and the 21 population centres in Aragon with population equivalents of over 15.000 produce 63% of Aragon's pollutant load.
- The water treatment plants of the Aragon Special Waste Water Treatment Plan will treat 20% of Aragon's pollutant load.
- Building water treatment plants for the population centres with population equivalents of over 1.000 will provide for treatment of 88% of Aragon's urban waters.
- The 1.033 population centres with design population equivalents of under 600 represent a pollutant load of approx. 6% of the total, which provides an accurate picture of the complexity of the problem of water treatment in Aragon.

3.2 Problem 2: Plan funding by users: The sanitation tax

3.2.1 INTRODUCTION

Using water generally causes its quality to deteriorate. The agent of this deterioration is therefore the water user. The direct aim of the water treatment process is to reduce the deterioration caused by water use to within certain limits, while its end goal is to mitigate the adverse effects of dumping the resulting waste water in the recipient system; in short, to protect the quality of water and its associated ecosystems and natural resources.

All citizens benefit from this end goal, particularly those who live downstream from dumping sites in each specific case.

The characteristics, limits and timeframes of the process are essentially determined by the following factors:

- Achieving the water quality targets established for recipient systems. These are established in the basin Water Plans, on the basis of the intended uses of the water and the characteristics of the ecosystems to be maintained. They therefore cover an area different from and greater than towns, or even the Autonomous Region.
- In compliance with the dumping restrictions defined in the relevant emission regulations. These are generally state regulations, and are sometimes EU or suprastate regulations, as there is more and more regulation in this area by the European Union.
- In compliance with the European Directive concerning waste water treatment.

- The criteria of the Framework Directive which requires application of the cost recovery principle for water-related services, including environmental costs and resource-related costs, and in particular in compliance with the polluter pays principle.

3.2.2 SANITATION TAX CALCULATION FOR THE ARAGON SANITATION & TREATMENT PLAN

Once the necessary investment and the Plan's management and operating costs had been defined, both overall and per year from 2007 to 2035, which is the Plan horizon for the purposes of paying for infrastructures, the tax needed to cover these costs were estimated.

The precise quantities of all the volumes used and the whole of the pollutant load, including all consumption and dumping not connected to public networks, have not yet been empirically defined. The tax must therefore be calculated on the basis of theoretical estimates, which will subsequently need to be corrected as data from actual application of the tax become available.

The first Sanitation Plan proposed a theoretical model, the parameters of which needed to be empirically corrected at a later date. This did not make the model, which in any case was essentially dynamic in nature, any less valid, as the aim, particularly in applying the tax to industrial dumping, was to reduce dumping gradually to within reasonable limits.

Applying the Sanitation Tax has provided a set of data which recommend that the original model be corrected, mainly to reduce significantly the pollutant load of industrial dumping not connected with public networks, as this has been revealed to be very limited, according to available empirical data.

The sum calculated for the tax was collected by the Aragonese Water Institute, on the basis of the rates stated in current law.

3.2.3 SANITATION TAX RATES

Current rates are as follows:

SANITATION TAX RATES		
DOMESTIC RATE		
FIXED-TERM	3.75	euros per person per month
VARIABLE-TERM	0.45	euros per cubic metre
ADDITIONAL INDUSTRIAL RATE		
FIXED-TERM	15.00	euros per person per month
VARIABLE-TERM		According to pollution

IMPLEMENTATION: SPECIAL TREATMENT PLAN

3.3 Problem 3: Funding works: Public tender system

3.3.1 SHOCK PLAN, FACTORS TO TAKE INTO ACCOUNT FOR THE ARAGON STP: TIME & GEOGRAPHICAL CHALLENGE

Implementing the Aragon STP represents a challenge for the Authorities of the Autonomous Region, not because of the volume of construction to be carried out, but because of the 172 population centres involved and the 142 actions to be carried out, with 132 Waste Water Treatment Centres (WWTCs) and an average construction timeframe of 18 months.

Record times are being achieved in administrative processing of the actions; agreements have been signed with councils, environmental procedures have been carried out, all the relevant authorities have been informed, the technical bidding documents have been drawn up, land has been obtained, works have been awarded and construction plans have been drawn up.

Each and every one of the Basic Projects, the basis for bidding for administrative tenders, has been drawn up according to environmental criteria; 21 of them have been submitted to Environmental Impact Declarations, and the rest have undergone environmental impact reports. These have been reported on and approved by the Aragonese Environmental Management Institute (INAGA).

The payment system established will guarantee compliance with construction deadlines and the quality of the treatment process, as the successful bidders will recoup their investment in construction and the operating costs according to the number of cubic metres correctly purified.

Also, the actions have been spread over 13 zones, on the basis of river sub-basins, land organisation and efficiency and flexibility of construction, which will guarantee correct operation of small WWTCs, which often get forgotten over time.

All water treatment technologies for which tenders are awarded correspond to secondary treatments. The most common type of treatment is prolonged biological air treatment, but there are also biodisc and bacteria bed plants.

3.3.2 MANAGEMENT & FUNDING MODEL: COST RECOVERY PRINCIPLE & TERRITORIAL EQUALITY

The Aragonese Water Institute, the public body within the Department for the Environment, is the institution which sets water policy, as it promotes construction of water treatment infrastructures throughout Aragon, and transfers the overall cost to the end user via the Sanitation Tax. This is an environmental tax which complies with the three basic principles stated above: cost recovery, polluter pays, and territorial equilibrium. Any inhabitant of Aragon, wherever he/she lives, will therefore pay the same amount for the volume of water which he/she uses.

The Sanitation Tax is a an environmentally-motivated tax. It is a tax of the Autonomous Region, and is linked to funding pollution prevention, sanitation and water treatment. It is

payable according to the production of waste water generated by consumption by the water supply user. Users may be either domestic or industrial.

The tax base for domestic uses is the volume consumed (in m^3), while for industrial uses it is determined by calculating the pollutant load. The rate has a fixed component in both cases (although this is greater for industrial uses), and another component which varies according to the volume consumed or the number of units of pollution.

In order to respond as effectively and efficiently as possible to the need to meet the goals stated in the STP, the Government of Aragon has decided to tackle all the works needed, and their subsequent operation, by public tenders. The legal framework for these is stated in Section V of Royal Legislative Decree 2/2000 of 16 June 2000, which approves the Revised Text of the Law on Public Authority Contracts introduced by Law 13/2003 of 23 May 2003, which regulates public tender contracts. With public-private partnerships, the public sector builds the water treatment infrastructures and operates them for a certain period of time —20 years, in this case— which means that the Public Authorities need not support initial efforts to build the infrastructures with their own resources or by borrowing.

In addition, so that these infrastructures are not classed an asset of the Public Authorities according to the European System of Accounts (ESA 95), with the resulting debt as counterpart, contractual relations between the Aragonese Water Institute and the concession holders have been structured so that the risks inherent in the aim of the contract have been transferred to the concession holders, following Eurostat directives.

According to Eurostat, in order for investment in infrastructures not to be classed as an asset of the Public Authorities, with its debt counterpart for the concession holder, the construction risk and either the demand risk or the availability risk must be transferred to the concession holder. In the case of the Individual Administrative Clauses (IACs) which governed bidding for the works within the STP, the aim is to transfer all three risks to the concession holder. The Clauses were therefore set out as follows:

- To transfer the **demand risk** to the concession holder, any minimum guaranteed payment is removed, and payment is established according to the volume of water treated. This would be zero for a zero volume of water (e.g. if the service were halted). Two sections of flow have been established, with different rates, so that the first section is equal to the expected flow minus a reduction coefficient of 25%. Thus a rate is fixed for the first section so that the flow yields sufficient remuneration to cover the fixed costs and the repayment costs. The rate for the second section is such that with the expected flow, sufficient remuneration is obtained to yield the profitability predicted in the viability studies.

- To transfer the **availability risk**, the penalty system has avoided any discretion in penalties, and sums and percentages to be imposed on the concession holder have been fixed

which substantially reduce its income in case of any infringement of or non-compliance with the minimum performance standards.

- To transfer the **construction risk**, the IACs establish as essential that the concession holder assumes the risk of higher or lower cost in investment than the investment budgeted for, and that the concession holder is not to be effectively remunerated before correct completion of works and start-up.

Thus the system is set up via a body, the Aragonese Water Institute, which assumes the scheduled payments to the concession holders of each of the areas into which Aragon has been divided. These payments, which depend on the volume of water treated, will be different for each plant. However, as this system is set up as an overall management system, the Aragonese Water Institute passes on its costs to all users equally. This means that the environmental water management model favours territorial equilibrium.