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# Evaluation of sustainability of sewerage systems in metropolitan areas. The case of Greater Paris

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**Città di Milano**
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## Economic analysis of the Milan wastewater treatment system : sustainability issues

## Evaluation of sustainability of sewerage systems in other metropolitan areas

# The case of greater Paris

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## Glossary of terms

| | |
|---|---|
| M€ | Million Euros |
| CGCT | Code général des collectivités territoriales |
| C.S.T.B. | Centre scientifique et technique du bâtiment |
| FF | French Francs |
| FNDAE | Fonds national des adductions d'eau |
| INSEE | Institut national de la statistique et des études économiques (French national statistics institute) |
| M€ | Million Euros |
| M m3 | Million m3 |
| N | Nitrogen (total nitrogen) |
| OM | Oxidisable matters (COD + BOD) |
| P | Phosphorus (total phosphorus) |
| P.E. | population equivalent |
| Petite couronne | (little belt) close suburb of Paris : départements 92, 93, 94. |
| SATESE | Service d'assistance technique aux exploitants de stations d'épuration |
| SIAAP | Syndicat interdépartemental pour l'assainissement de la région parisienne (inter départements syndicate for sewerage of Greater Paris) |
| SPDE | Syndicat professionnel des distributeurs d'eau : professional union of private water operators |
| SPIC | Service public industriel et commercial |
| SS | Suspended solids |
| WFD | Water framework directive (EC ) |
| WTW | Wastewater treatment work |
| UWWTD | Urban waste water treatment directive (EC 91/271, 1991) |
| VNF | Voies Navigables de France |

## BACKGROUND of the situation of sewerage in the country

### General situation : approaches to the implementation of the WFD

The 1964 French water law adopted integrated water resources management and protection at river basin level. France was then split into six groups of river basins, each with an executive body (the *agence de l'eau*), and a water parliament: the *comité de bassin* is made up of local elected officials, industrial and other users, NGOs

and government representatives. On a 5-year program basis, the *Comités* both decide an investment program, and vote levies to be paid by users on water abstractions and pollution discharges to the *Agences de l'eau*, which can in turn provide partial funding to investments improving the quality or the quantity of water resources. Under the 1964 law, *Agences* also had the mission of setting up quality targets for surface waters. The quality targets were set up for a river body in relation to the local uses of the water. The protection and quality control of water bodies had been organised so that the quality would be satisfactory for the uses planned locally. E.g. immediately upstream from Paris city, at Ivry-sur-Seine, the quality of river Seine has to be adapted to the production of drinking water. Efforts concentrated on limiting pollution of Seine and Marne rivers.

Water management has not been as efficient as expected and river quality targets had not been met in many instances. This water planning was found to be a very difficult task; conversely, the levy system allowed France to build a large number of sewage works for industrial premises and for cities (today, more than 16,000, including more than 4,000 lagoons). After 12 years, the *Agence*s were involved also in the funding of sewerage extension.

## Quality of surface and ground water resources

IFEN[1] publishes every 4 years a report on environmental quality in France. The 2002 issue gives the most recent data on the state of surface water resources. Assessment of surface water quality is based on biological, physical and chemical parameters. The most commonly used biological parameters are a "fish indicator" (RHP monitoring network), based on the extreme sensitivity of fish to any form of pollution, a Diatomea biological index (IBD) and a global biological normalised index (IBGN). The Fish indicator was based on data from 636 stations in 1999. IBD and IBGN were respectively monitored through 887 and 605 stations in 1998.

Overall, biological quality of French water courses is fair. Best biological diversity is found in mountain and some coastal rivers. Worst quality is linked to densely populated areas with intensive economic activities (agriculture, industries, cities).

RNDE (national network on water resource data) uses 1346 monitoring stations to monitor the physical and chemical conditions of rivers. The parameters measured are compatible with the European Water Framework Directive (2000/60/CE): total oxygen demand, total nitrogen (nitrates excluded), nitrates, total phosphorus, consequence of vegetal proliferation, suspended solids, Temperature, Ph measures. A general quality mark is given to each river monitored depending upon the value of the parameters, size, river class, surfaces drained (described in 2000 EC directive). The mark varies from 0 (worst possible quality) and 10 (best). The average mark for French rivers is 5.3. It is rather independent from river class but very dependent upon geography. Best quality is found where activities are least developed (Massif Central, Alpine rivers) and worst where the pressure of human activities is high. Worst river qualities are found in Northern France, Brittany and Seine downstream Paris.

RNDE started collecting data recently (from 1997 on) and the evolution of river quality at national level cannot be described. Recent data shows that for rivers monitored, more than two third belong to the fair, bad or very bad quality classes (70% for organic micro pollutants and 75% for mineral micro pollutants). As of pesticides, in 1999 and 2000 95% of the 400 monitoring stations of RNB were highly contaminated. The levels observed are non compatible with normal aquatic life and when they are, water abstracted for drinking water supply implies pesticides removal.

Overall the quality of large and medium size rivers is not good, even if regular improvements can be observed for phosphorus, organic matter and reduced nitrogen. Serious contamination by nitrates, mineral and organic micro pollutants is a clear problem for the production of drinking water. For instance, in the 23 "*département*s" of Seine Normandie Basin, 191 surface water intakes were abandoned between 1989 and 2000 due to a level a nitrates exceeding 50 mg/l (in 2000 in France 1529 surface water intakes were used for the production of drinking water)

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[1] French Environmental Statistics Institute, focal point of EEA.

Quality of ground water resources

The quality of groundwater resources was monitored in 1992-93 and 1997-98 for Nitrates (implementation of EC Nitrates Directive) and showed a progression of the average level of nitrates of 1mg/l per year, with a much faster progression in areas where nitrates concentration is already above 40 mg/l.

More recent data of RNES (692 stations measured) show a contamination by pesticides with, in 41 % of cases a level that would imply a special treatment if used for the production of drinking water.

The content of arsenic (more than 50 µg/l is a problem in a few areas like Greater Paris, eastern France, Bordeaux region and *département* of Allier. High nickel levels (more than 20 µg/l) is a problem in some areas of region Nord Pas-de-Calais and north and west of Paris.

The national monitoring network (RNDS) for groundwater resources has started collecting data in 1999 but does not cover yet every French region. The extension of the network will be essential to the future policy of ground water protection imposed by the WFD.

Implementation of the WFD and other Directives

The WFD requires member States to reach a good ecological and chemical status of river bodies by 2015. The French river and groundwater system cannot wholly reach this ambitious target at that deadline and needs to characterise some of them as strongly modified, to extend the deadlines. However, the 6 *agences de l'eau* have a long experience in setting up 5-year programs, so that implementing the first part of the WFD (characterisation) could be done on time. A large public consultation took place in 2004-05, and a large number of stakeholders have been associated to the drafting of the plans.

What is more worrying is that there are serious delays in implementing the previous Directives, in particular the Urban Waste Water Directive (271/91 EC): France has been condemned by the European court of Justice for under-designing sensitive areas and for not upgrading several hundred sewage treatment plants on time.

A Senate committee chaired by Senator Miquel (2003) draws a severe picture of resource protection legal framework in France. It considers that water resources protection have never been a priority on the political agenda, as a few example tend to illustrate :

- Only 10% of water volumes abstracted are regularly declared or controlled
- one third of wells (*captages*) used for drinking water production are protected through protection perimeters (for some of them protection has been mandatory for 40 years)
- water police is inefficient and scattered between 500 local State Services. When a user is violating the law, penalties are very small. There is, in fact, very little incentive to change polluters behaviour.
- French water law is so complex that implementation is quasi impossible.

Senator Miquel's report also points that water management in France is not efficient because it implies too many actors : 36500 municipalities have the responsibility of the provision of water, sewerage services and storm water control but most of them lack the appropriate size and means (staff, technology and financing) to do a good job in providing sustainable water services; including many joint boards of municipalities which remain too small. The report suggests that responsibility for small rural utilities management should be transferred to *départements.*

## Main data concerning coverage of sewage collection and treatment

Until recently, France was missing an efficient monitoring system.

The difficulty of collecting data is due to the local responsability of sewerage. Responsibility lies in the (small) French communes, most of which are very small and lack administrative or technical staff to collect data and answer official surveys (95% of communes count less than 5000 inhabitants – INSEE, 1999 census). 27% of French population lives in communes of less than 2000 inhabitants.

Data collection is improving. With 1994 arrêté on self monitoring of sewage utilities, operators have to provide annual data on the operation of wastewater and storm water services. Since 1998, through a national survey by IFEN, data is collected every 3 years through a survey on a random sample of 5000 communes. The survey is progressively becoming very good.

In 1998, estimate number of WTW was 15400 with a capacity of 81,3 million P.E. In 2001 there were approximately 16750 sewerage utilities and 16100 WTW in France (including French islands) with a treatment capacity of 86,4 million P.E. (Source : 2001 IFEN's survey : sample of 5000 communes surveyed).

In 2002, estimates by the 6 *agences de l'eau* were bringing the figures closer to 17000 WTW. The difference is due to taking into account or not preliminary treatment processes in very small rural municipalities.

One conclusion can be drawn from these figures : a significant number of communes, most of them very small are developing systems for the collection and treatment of sewage. But an increasing number is also creating a *SPANC,* i.e. a public service for the control of septic tanks and decentralised sewerage. There is a clear recognition that in many rural areas septic tanks are there to stay and should be improved, because sewers would not be feasible or efficient.

2001 IFEN's survey states that 95 % of French housing units had their waste waters treated by centralised or decentralised treatment units.

- 23 millions housing units representing a population of 47,1 millions inhabitants were connected to a WTW;
- 5,1 millions housing units representing a population of 10,3 millions inhabitants were connected to decentralised treatment, mostly in very low density areas;

In addition :

- 0,66 million housing units were connected to a waste water collection network but not to a WTW ;
- 0,72 million housing units did not have any treatment, mostly in very low density areas in mountain regions.

For the same reasons, abatement of pollution is not easy to assess. For 2001 IFEN states that treatment is adapted to the zone of discharge (sensitive, normal) for 3 out of 4 housing units.

In metropolitan France, for communes located outside the sensitive zones defined by the UWWD (EU Urban Waste Water Directive) :

- 93% of housing units connected to a WTW had their effluents treated with a secondary treatment ;
- Less than 4% were discharging their wastewater without any treatment ;
- 15% had decentralised sewage treatment

This data does not give information about the actual abatment of pollution. A rough estimate states that for WTW of more than 2000 P.E. total entering oxidisable matters were approximately 1090 thousands tons and total abatement was 92% (final discharge of oxidisable matters was 91 thousands tons).

More recently, the 2004 E.C. report on compliance of member States to the UWWD as of december 31st 2000 (with data sent by the member States in 2003) was assessing French situation as follows :
- France is late in defining some of the sensitive zones
- data given by French authorities is either late or inexistant (for instance no data on monitoring of waste water discharged by industries in sensitive zones : no data on treatment efficiency)

- 348 cities discharging waster water in sensitive zones designed in 1994 and 50 more in sensitive zones added in 1999 : the commission considers France is or was late to upgrade to tertiary treatment.

The assessment of the treatment level of WTW in cities with a population of 10 000 to 150 000 P.E. is described in the paragraphs below.

Cities of more than 10000 P.E. discharging waste water in sensitive zones

The table below describe the situation of the 348 such cities that discharge waste water in sensitive zones defined by French authorities in 1994. Among these, 63.6% were non complying to required levels of treatment either because of insufficient nominal capacity or because of insufficient treatment level (needing tertiary treatment level for nitrate and phosphorus removal).

**Cities with more than 10000 P.E. in sensitive zones defined in 1994.**

| Number | Number | % | Nominal capacity P.E | % |
|---|---|---|---|---|
| Total | 348 | 100 | 16 727 000 | |
| Non compliance | 205 | 59 | 10 640 000 | 63,6 |
| Compliance | 143 | 41 | 6 087 000 | 36,4 |

Data, january 1st 2002 – 2004 E.C. compliance report

Cities with more than 15000 P.E in normal zones.

At the end of 2000 there were 468 such cities. Of these, 307 cities, representing 68% of pollution charge were complying with UWWD. 179 cities had yet to install a secondary treatment.

Cities of more than 150 000 P.E.

There are 60 cities in that case.

- 29 located in sensitive zones of which 11 complying and 17 with only secondary treatment or incomplete tertiary treatment, and one, on the sea shore with a primary treatment only.
- 8 cities were in potentially sensitive zones and should have adopted tertiary treatment since 1998. Among these, greater Paris (with 10 million P.E.) was only eliminating nitrogen and phosphorus for part of the population served.
- 23 in normal zones, of which 4 with a better treatment level than required, 9 complying to the secondary treatment requirement and 8 with a single primary treatment (compliance for all 8 before 2006) and 2 with preliminary treament (compliance by 2004).

France is on its way to comply with the UWWD for major cities and is quickly improving abatment for smallest cities.

Connections and treatments in rural areas

Rural population versus sewerage types —1995 data [FNDAE - 1997]

| Sewerage type | Permanent population | | Seasonal population | | **Total rural pop.** | |
|---|---|---|---|---|---|---|
| Centralised | 18402 | 73% | 11284 | 75% | **29686** | 74% |
| Decentralised | 5743 | 23% | 3180 | 21% | **8927** | 22% |
| Decentralised with public management | 915 | 4% | 546 | 4% | **1461** | 4% |
| All sewerage types | 25060 | 100% | 15010 | 100% | **40074** | 100% |

In 1995, 29,7 million rural inhabitants (seasonal and permanent population added) were “connectable” to public sewerage, 21,8 million being already connected. 91,4% of the waste water produced by the population connected were treated (8,6% were discharged without any treatment).

One has to recall that France is a highly tourist country, with in particular a large number of summer houses. 10,4 million rural inhabitants (seasonal and permanent), i.e. a little more of a quarter of rural population, are on decentralised treatment; a small fraction of it is managed by *communes* through a group-contract procedure. Population served by decentralised treatment is often ignored by statistics, in particular at European level, as if waste water in that case were not treated: even though they are treated, treatment performances have not been assessed at the national level, and reporting to the Commission has been poor. This also why sewage collection and treatment in France is always underscored by comparative European surveys.

Sewage treatment in the industrial sector.
French authorities assert a good compliance of sewage discharged by industry, but do not provide global data on the topic. True enough *agences* have been very active in the 1970s and in the 1980s setting up contracts with industrial sectors. This cooperation proved very successful with an important decrease of pollution discharges. Best management practices have been maintained since then.

## Prevailing management systems and organization of water services provision

In France, characteristics of water services provision are as follow :

- water services provision in the hands of the smallest level of government : the "communes" (36500 communes in France). *French "communes"* where mortality was above average became officially responsible for the organization of water supply and sewerage in 1902 (Law on Public Health). At that time it was considered a duty to connect to the sewer ; so it was not a service and had to be funded within the local taxes. On the other hand water supply is considered a commodity, and has usually been charged as a service through meters at the property level (i.e. one meter per building). Because of the small size of municipalities, communes started to set up joint boards as soon as they were allowed to do so (beginning 20th century) and increasingly after the 2nd World War. Most of the difficulties of French State services to gather management data required at European level come from the large number of water supply and sewerage undertakings (about 29000, source SPDE-BIPE conseil, june 2005), many of them of very small size. Waste water utilities are even more numerous than water supply ones (joint boards are fewer and smaller).

- There is an important involvement of private companies in service provision : private companies started operating water supply systems in the middle of the 19th century and supply about 80% of the volumes of water at present. Their involvement in sewerage started for most part after the fiscal law of 1959 which made cost recovery of sewage collection and treatment possible on the water bill. Before then, sewerage was usually operated under direct labour, as part of the public works or road services (sewers developed under the streets). Central State helped developing sewers massively in two phases : after first World War (until the economic crisis of 1929, which stopped further development for 20 years), and after second world war and until the beginning of the 1960s. Involvement of private companies is more frequent in operation and maintenance of sewage works: they run more than 4500 of them, among the largest.

  Communes can choose to delegate the services on their own or through a joint board which is common in service provision. Since the Sapin law of 1993, a tendering must be open at the end of each contract. The duration of contracts has slowly decreased over the years: today they are usually below 15 years; (see explanation below).

- *Agences de l'eau* play a major part in water management since 1968 : created by a 1968 decree (in application of 1964 law), they are one of the major tools for the implementation of the 1964 law. The number of 6 groups of basins was chosen for political and administrative reasons[2], but the basin level has clearly given an arena for the planning of water resources management between water users and state and local government representatives. Using financial incentives, *agences* influence water planning and management at local level. *Agences de l'eau* are the n°1 provider of subsidies for diagnostic and investment in water supply and sewage collection and treatment. The funds are collected on the water bills of water supply utilities and given back to all users (water and sewerage undertakings, industrial users and farmers), creating a solidarity between users at basin level.

[2] Large basins were needed at the beginning because despite the small rates of the pollution and abstraction levies, there was money to fund pilot projects and make the system visible

- Before 1992 there was no national or basin planning framing the development of sewerage. Sewerage is the result of local decisions, more of less influenced by the incentives from *agences de l'eau* but with a clear deficit or global strategies and upstream – downstream solidarity. Implementation of EC UWWD (1991) through 1992 water law created a guideline for the first time in the history of French sewerage.

  The 1992 water law created the condition of a national recognition of the interest of decentralised sewage treatment. Communes have to make a precise mapping of zones covered by centralised or decentralised treatment. Communes are encouraged to provide a special service for control and maintenance of septic tanks in private properties.

- No money for stormwater control. The discussions preceding the 1992 law clearly showed that storm water control in urban areas is the bottleneck of any further improvement of sewerage performance. During heavy rains, combined sewers suddenly discharge raw pollution at overflows. But there is no direct source of revenue for investment in storm water control, which is considered as part of the general duties, and then of the general budget of communes. After 15 years of discussions, the 2006 water law in project does not seem to bring any financial solution. *Agences* are not supposed to dedicate money to storm water control because this would mean water users are subsidizing the general budget of communes. However, under a pollution control argument, Seine-Normandie *agence de l'eau* has taken some of the funds raised by the pollution tax to finance the construction of separate networks and rainwater storage reservoirs in greater Paris. End of pipe technologies and civil engineering works have been privileged. Today, experts in hydrology encourage new policies with a retention and collection of rain water before entering the sewer. The 3 inner suburbs *départements* are encouraging many new practices as will be described in the chapter "filling the gap to the requirements of WTW". Seine Saint Denis *département* is a pioneer in that field.

- There has been a strong involvement of Corps of Engineers in water management : they form powerful networks and are present in the State services, *agences de l'eau*, local authorities, private companies, industries, at all the decision levels of water management. They influenced most of technological choices over the last 150 years. They have privileged end of pipe solutions that they perfectly master and for which the procedures to get subsidies from *agences de l'eau* are well known.

  A few characterictics of French sewage management derive from that strong influence of Engineers (Berland, doctoral thesis, 1994) :

- **France has one of the largest proportion of separate systems in Europe** : at the time of rapid growth of sewage collection, after the Second World War, the French Corps of engineers advocated for separate systems.

- **Activated sludge (AS) is the most common purification technique in France**, even in small utilities : activated sludge techniques were well mastered by Engineers in the 1970s when massive investment were realised in WTW in France. In the case of small utilities, AS is a bad choice if maintenance means are limited. It then offers bad treatment efficiency.

  New trends in sewerage development include smaller treatment units spread out along rivers to use self cleaning capacities of rivers and development of rustic treatment with very little maintenance in very small municipalities (typically, lagoons, also called waste water treatment pond, plant filters with reeds in particular).

## Prevailing patterns of private sector involvement

### Water supply

Private involvement in water supply started in the 18th century with brothers Périer who pumped river Seine up into reservoirs and delivered pressurised water in a couple of networks to deliver wealthy areas of Paris. They went bankrupt in less than 10 years, but English mechanics succeeded in solving the leaks problem; following

the British example, cities increasingly invited private engineering companies to create water supplies and operate them under a concession regime.

Private investors did initiate water supply in France as in other European and North American countries. But they wanted a good return on their investment and were not ready to invest in poor neighbourhoods. They were not ready either to maintain a network in the long run. Private supply rapidly proved inefficient. From the end of 19th century onward, the general movement was to municipalise water supplies. It was also the case in France. However, public provision was particularly constrained by public accounting rules: French Treasury constantly imposed tight controls on local authorities' budgets and opposed depreciation or provisions for renewal; government also opposed cities to loan themselves money from the savings banks.

As a result, private companies have been a good partner in the development of public water supply. The investors would have a concession. Once terminated the infrastructure would be handed to municipalities. Little by little, all forms of public private partnership have developed in France, from direct labour (*régie directe* and in Italian *ad economia*) : 0% private involvement in investment, operation and maintenance, to pure "concession" contracts (100% private involvement in investment, operation and maintenance for the duration of the contract, with the property of the assets sold to the commune or joint board for a symbolic euro at the end of the contract). The most common contract arrangement, *affermage* or lease contract is between these two extreme formulae : very often, investment is borne by the public authority and operation and maintenance is private, the company being liable only for the replacement of the short-life infrastructure. The duration of contracts has been accordingly and progressively reduced to around 15 years. Lastly there are quite a few management contracts, where the private operator is only responsible for operation and maintenance, and bills water services on account of the public authority (no risk, little profits).

In 2001, the estimate number of water supply undertakings was 16200 (IFEN, 2001). In 1990, the number was 15500, of which 15200 rural (Ministry of the Interior, and FNDAE 1990 inventory)

One undertaking consists of an isolated commune or a joint board operated by a given public or private operator.

The professional syndicate of private operators, SPDE edited precise statistics until 1994 on the following items : customers served, m3 sold, communes served, and estimate of population served. After 1994, data is not available. For the year 2003, SPDE has given customers and volumes sold.

**Evolution of water supply delegation between 1938 and 1994.**

| | | Water utilities served by private operators | | | |
|---|---|---|---|---|---|
| Year | French population | Population | Communes | Customers | m3 sold |
| 1938 | 41 500 000 | 7 100 000 | 995 | 835 900 | |
| 1956 | 43 600 000 | 13 500 000 | 2 636 | 1 645 800 | |
| 1970 | 50 800 000 | 22 200 000 | 10 821 | 4 690 000 | |
| 1994 | 57 800 000 | 43 400 000 | 21 195 | 12 962 600 | |
| 2003 | 60 500 000 | NA | NA | 14 198 291 | 3 793 378 806 |

Source of figures from 1938 to 1970 : Baguenier, Faisandier, chapitre VI, in *40 ans de politique de l'eau en France*, sous la direction de M. Loriferne, DAEI, Economica, 1987. Source of 1994 data : SPDE, 1995.
Approximate number of *communes* from 1938 to 2003 : 36 500 (exact number of communes : 36565, 1999 national census).
Source of 2003 data : SPDE, 2004. NA=not available.

Between 1938 and 1994, *communes* adopting contracting out formulas increased from 3 % to 58 % of the total number of French *communes* representing respectively 17 % and 75 % of total population.

Among the 16200 water undertakings (IFEN survey 2001), 40% are run direct labour. But direct labour is mostly dominant in low density rural zones. Only a few large cities and joint boards keep a direct labour operation.
About 4000 undertakings are joint boards.

Three private companies are serving more than 75% of population and delivering 80% of water volumes billed (Véolia water, Suez-Lyonnaise des eaux, and SAUR, a Bouygues company).

Two sources of data show a stability of the volumes used in water undertakings (from which one can expect a

stability in the volumes of sewage collected and treated) :

- *agences de l'eau* collect the water withdrawal data to levy the withdrawal tax (on of the components of the water bill as we will see later) : the withdrawals were at a maximum in 1989 with 6 193 million m3, but since 1994 they are being stable. The volumes abstracted for water supply in 2001 were 5 966 million m3. In the meantime, French population increases. The per capita consumption is clearly going down.
- SPDE is serving about 75% of French population in all French region and figures on the volumes sold between 2000 and 2002 show a stability of water sold.

| Year | Customers | Volumes sold | Vol / customer (m3) |
|---|---|---|---|
| 2000 (dec 31) | 13 749 443 | 3 660 591 748 | 266,2 |
| 2001 (dec 31) | 14 075 923 | 3 982 063 208 | 282,9 |
| 2002 (dec 31) | 14 198 291 | 3 793 378 806 | 267,2 |

Source : interview with SPDE, 2004.

**Sewerage**

The construction of sewers started at the end of XIXth century. For most of cities with more than 10000 inhabitants, downtown areas were served before the 1st world war. The economic crisis or the 1930s quasi stopped the developed of sewerage for 20 years. On the contrary Second World War compelled a massive and rapid development of sewer infrastructure supported by Central State.

Law on Public Health of 1902 has made *cities* responsible for the organization of sewerage. Sewage treatment was not really developed before the 2nd WW. Sewerage used to be operated direct labour.

Private involvement started when the 1959 law transformed water supply and sewerage services into utilities (service public industriel et commercial, SPIC) with separate budgets from the main budget, with obligation to balance expenses with recipes, and also a possible inclusion of the sewerage tax or charge in the drinking water bill. The creation of an annex budget for sewerage was made mandatory for smaller and smaller cities. This change was supplemented by the creation of the *agences de l'eau* in 1964 that included an abstractor and a polluter charge, also on the drinking water bill. Both changes have boosted the development of sewerage and more specifically of wastewater treatment works, and given way to contract out building and operation of WTW, well mastered by private companies. The same type of contracts apply as for water supply – direct labour, management, affermage, concession (see appendix 1 for the description of the contracts).

There are approximately 16750 sewerage utilities in France (2001 IFEN's survey - sample of 5000 communes).

1988 was the last year of national information on service delegation. Results are given in the following table.

Population served by public sewerage versus management option in 1988
(Source, INSEE, inventory of *communes*, 1988).

| Management option | Waste water collection | Waste water treatment |
|---|---|---|
| **Direct labour** | **63%** | **52%** |
| Affermage (+other partial delegation) | 32% | 40% |
| Concession (total delegation) | 5% | 8% |
| TOTAL all options | 100% | 100% |

FNDAE 1995 survey gave more recent data but for rural areas only. In 1995, 24% of the 15484 authorities managing waste water collection had contracted the service out. Out of the 6.154.000 customers connected to public sewers, 45% belonged to a delegated service, which confirms that large sewerage authorities (joint boards in particular) delegate much more than small ones.

In rural areas also, waste water treatment was run by 12589 authorities managing 5.843.000 customers and 13444 WTW. 29% of the authorities, representing 52% of customers had contracted out the management of WTW.
Delegation to private companies is therefore much more common for waste water treatment than for waste water collection in rural areas. But more and more private companies who are managing WTW are now taking over investment and operation of communal sewers.

In 1994, SPDE (syndicat professionnel des distributeurs d'eau – professional union of water suppliers, representing private water companies) was managing 7 million customers and 4446 WTW of a total nominal capacity of 33,4 million pe, on behalf of 5860 urban and rural *communes*. When comparing FNDAE and SPDE data (distant from one year only), one can conclude that about 40% of SPDE customers are rural (with FNDAE definition) and 60% urban.

In an interview, SPDE gave us some figure on year 2002 : on december 31st 2002, 8,25 million customers had their collective sewerage managed by the private companies member of SPDE, and sewage volumes were 1 698 million m3.

## Integration vs. separation between water supply and sewerage

Water supply and sewerage services are run separately. The development of the two services has not been made at the same pace. Actors and territories involved are not the same. Private involvement has been much more intensive for water supply. The two services are run with separate budgets. It remains quite rare for local authorities to create a single authority to run water and wastewater services, but it has been considered in the above mentioned Senate report to centralise water services at the level of the *département*, like was done in Italy with the Galli law.

## Financial aspects

**Price setting.**

In France, water consumption is generally metered. In every commune or joint board a price per $m^3$ is set up. Customer connected to centralised sewerage pay for water supply and sewerage in the same bill.

- The water supply part of the water bill includes a flat fee for fixed charges and meter rental and a proportional part, based on the actual volume consumed. The exceptions are found in small rural communes.
- The sewerage part is only based on the volume metered.

As we said earlier, water supply and sewerage are run with separate budgets.

For each of the utility, the tariff per $m^3$ is calculated at local level to cover the costs generated by operation and maintenance and to anticipate capital investment (renewal of existing assets, depreciation and new assets).

Pricing in France is based on the cost recovery principle. However, as will be seen in the next paragraphs, there still are cross subsidies from annex budgets to the general budgets of local authorities operating the utilities.

Prices greatly vary from one municipality to another (even in the same geographic area). <u>The commune or joint board takes the key decision</u> : since 1986 (i.e. 3 years after French law on decentralization), municipalities are responsible for the regulation of prices and private involvement in both water supply and waster water collection and treatment. Price setting must however follow obligation to balance costs and revenues (at least for operation and maintenance).

In case of public private partnership, the revenue of the private operator is decided by the local authority before the delegation contract signature. The price then evolves with the price index of the main production factors (energy, manpower, provisions…). As was said earlier, important investments are usually carried out by local authorities. Investment pay back is separated in the bills from O&M and is usually named "surtaxe" or "redevance". There can be as many "surtaxe" ("redevance") as levels of government supporting the investments. In Greater Paris, sewage collection and treatment is operated by 3 actors. Hence, customers pay three "redevances" : one for the commune, one for the *département* in inner suburbs, and one for an inter*départemental* joint board (SIAAP).

**Components of the water bill**

Appendix 2 gives an example of water bill in a commune of 81000 inhabitants (36th biggest city in France), Vitry-sur-Seine, located in our case study, Greater Paris.
The water bill design depends upon the operator of water supply. Vitry-sur-Seine, as most "communes" of Greater Paris is supplied with water by a joint board, gathering 144 communes, which has contracted out water supply to Compagnie Générale des Eaux under "régie intéressée" contracting out formula (see appendix 1 for the definition of that type of contract).

The operator of water supply collects all the money from the bills and gives their share back to the other operators of water supply and sewerage. For customers with decentralised sewage treatment, there is no charge for sewerage except for communes organising control and maintenance of decentralised units.

There are two main charges in the water bill :

- a charge for water supply with a fixed part (meter rental, flat fee for connection costs) and a volumetric charge proportional to the volumes of water metered.
- a charge or several charges for sewerage, proportional to the volumes metered.

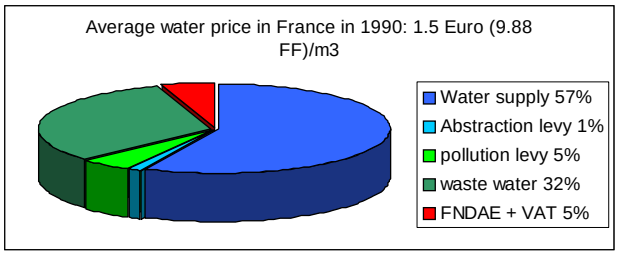
<u>The other parts of the water bill are fixed at river basin or sub basin level and national level.</u>
VAT, the national value added tax (VAT=5,5% on basic food products, including water) FNDAE tax (recently replaced by "fonds de solidarité pour l'eau" – solidarity fund for water – paid back to the State by *Agences de l'Eau* on revenues from the abstraction and pollution levies) and VNF tax[3] are fixed at national level, by the Parliament.

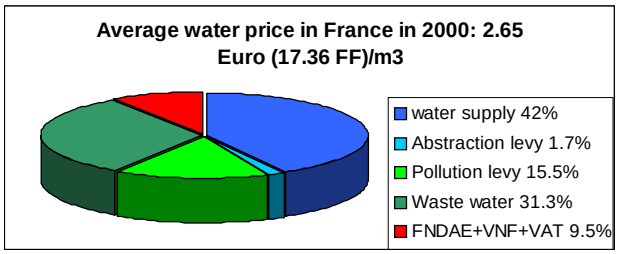
The water bill includes two levies from the *agence de l'eau* : one for water abstraction and the other for pollution discharges. The levies are voted separately by each of the six river basin councils, where the different users, the local authorities and the state services are represented. The level of the pollution levy depends upon ecologic pressure on a sub river basin. The levy is greater in sensitive zones where important investments have to be made in storm and sewage treatment to improve the quality of water resources.

**Current pricing levels**

The French Ministry of Economy instituted a national price observatory. It is biased because the sample includes a majority of big towns: only 90 of the 730 towns surveyed had less than 5 000 inhabitants, whereas they represent 97% of the 36200 municipalities.
But the observatory is interesting to follow the relative evolution of the price.

The observatory also shows the evolution of the sewerage share in the water bills.




The average national price per m³ quasi doubled in 10 years (from 1,50 € in 1990 to 2,65€ in 2000) but most

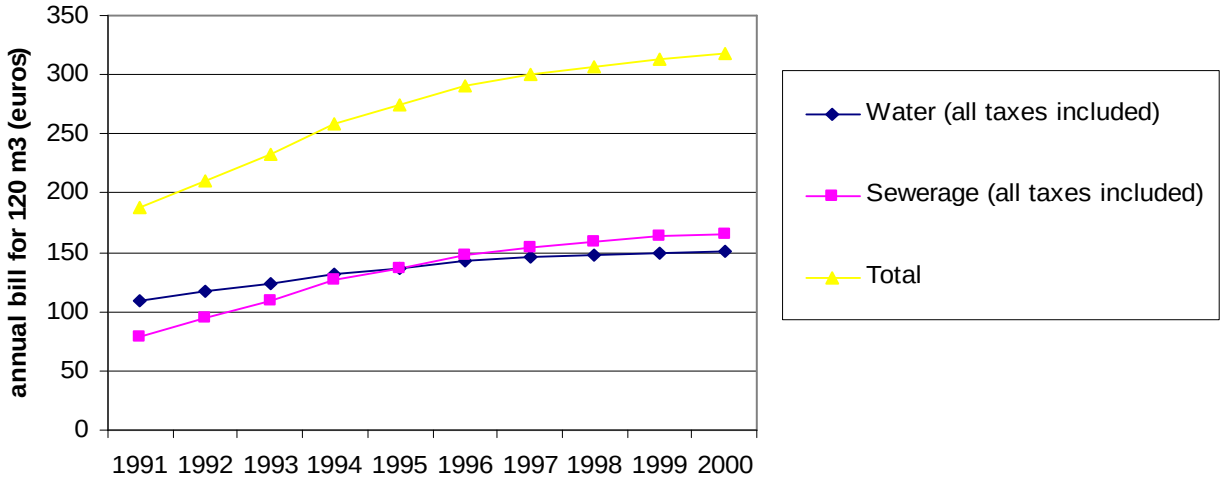
[3] Fonds National pour l'Adduction d'Eau (national fund for the water conveyance) and Voies Navigables de France (French waterways)

interesting is that the breakdown changed. In 1990, water supply together with the abstraction levy of *Agence de l'eau* accounted for 58% of the unit price against 37% for waste water and pollution levy. The share for water and waste water were 44% and 47% respectively 10 years later.

The following table and figure give the annual evolution of the water bill from 1995 to 2000 (for a standard consumption of 120 $m^3$) (in €)

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|
| **water** | **136.8** | **142.7** | **146.4** | **147.7** | **149.1** | **151.5** |
| evolution rate | | 4.3% | 2.6% | 0.8% | 1% | 1.6% |
| **sewerage** | **137.2** | **148.5** | **154.5** | **159.5** | **163.3** | **166.0** |
| evolution rate | | 8.2% | 4.1% | 3.2% | 2.4% | 1.7% |
| **TOTAL** | **274.1** | **291.2** | **301** | **307.1** | **312.4** | **317.6** |
| Unit cost : €/ $m^3$ | 2,28 | 2,43 | 2,51 | 2,56 | 2,60 | 2,65 |
| total evolution rate | | 6.3% | 3.3% | 2% | 1.7% | 1.66% |

**Source: Ministry of Economy - DGCCRF -November 27, 2001**




Evolution over 10 years of the annual water and sewerage bill
all taxes included (urban sample). **Source: Ministry of Economy - DGCCRF -November 27, 2001**

In the early nineties, increase in price was largely due to European Directives (in particular 91/271/EEC : UWWD) and to the corresponding increase in the levies collected by the *agences de l'eau*. Yearly increase reached 7% a year, but then it smoothed down.
According to the Ministry of Economy, from 1995 to 2000, the total amount of the bill increased by 16% whereas the retail price index (excluding tobacco) on the same period did not exceed 6%. However, the annual rate of increase slowed down during all the period (+6.5 % from 1994 to 1995, +6.2 % from 1995 to 1996, +3.4 % from 1996 to 1997, + 2.1 % from 1997 to 1998, +1.7 % from 1998 to 1999, +1.66 % from 1999 to 2000).

Lyonnaise des eaux (2004) mentions an average price around 2,68 €/ $m^3$ in july 2003 and mentions INSEE as a reference, but it is unclear whether the methodology for calculation of the price is compatible with DGCCRF methodology and figures. For the same year IFEN-SCEES study (on 5 000 towns, representative of all the sizes and all the types of management -direct labour and delegations-) gives a average national price of 2.61 Euros/ $m^3$ in 2003, (a 314 Euros / year water bill), including 1.30 Euros/ $m^3$ for drinking water and 1.32 Euros/ $m^3$ for sewerage.

In any case, it is expected that the waster water collection and treatment part becomes even more important in the total.

**Cost recovery levels**

Cost recovery is a principle generally accepted in France for the water and sewerage services. However, two mechanisms must be distinguished:
- cost recovery at the local level,
- cost recovery via regional or national cross subsidies.

- **cost recovery at local level, by the direct users of the utility**

As mentioned earlier, costs borne by local authorities for the provision of water and sewerage utilities have to be split in two annex budgets, balanced by the revenue from the water sales and sewer charges.

Since 1996, the cost of capital depreciation has to be included in the annex budget.

The so-called entry fees ("droits d'entrée", a retribution to the local authority that was very often required from any private operator contracting to operate the public assets) has been forbidden by the 1992 water law, and, as a consequence, has limited cross-subsidies toward other public utilities or the general budget. In the past, part ot the profit generated by water sales and entry fees were used to subsidize other public utilities in deficit such as public transportation. Conversely, some costs generated by fire protection or by storm water collection and treatment (which are administrative public services and not industrial and commercial public services like water and sewerage) should be financed by a transfer from the general budget to the water and sewerage budgets, by the taxpayer and not by the bill-payer.

There are two exceptions to the balanced budget principle:
- On the one hand local authorities can subsidise the heaviest investments (treatment plant and network) from their general budget, if the investment would cause a major increase in water bills resulting in social difficulties (article L.2224-2 of local authorities' code). This derogation is possible whichever the population of communes.
- On the other hand, law n°96-314 leaves the option for municipalities of communes under 3000 inhabitants to keep the costs of their water and sewerage services within the general budget, and to cover them freely from taxes or bills. In our case study area, the population of all communes is greater than 3000.

In many cases, the transfers for fire and storm water costs are not always done so that the users of water and sewerage services probably pay a little more than should be the case. Conversely, it is not always easy to impute to the annex budget a fair share of the general expenses of the local authority.

The costs of the private operator should also be covered locally by the water sales. It's the basis of all negotiations to fix the price with the local authority. However, a private operator may have contracts with several neighbouring municipalities, e.g. a large one and small rural ones. There are cross-subsidies between different contracts.

The most important limit to the cost recovery principle at local level comes from subsidies granted to local authorities by upper level institutions, usually for investment. Exceptionally, they can represent up to 80% of the investment, and usually between 30 and 40%. However, Most of these subsidies are granted by the *Agences de l'eau* which mobilise money coming from the water bills by redistribution inside the water sector. There is what we could call a "mutualisation" of the cost of investments, or a particular form of averaging out as exists in other Member States. Thus it is highly questionable to consider them as breaching the cost recovery principle.

- **Cost recovery at regional or national level, via redistribution mechanisms**

Indeed, the two main sources of subsidies are the *agences de l'eau* and *départements*. Until recently, there used to be special solidarity fund (FNDAE) to help rural communes developing water supply. Half of FNDAE fund came from a waterpenny collected on all water bills for a total amount of 75 million euros in 2003. A tax outside the water sector (horse-race gambling) was complementing the amount to 140 that was transiting through *département* elected council for decision of subsidies to rural communes upon justified request. The system

resulted in solidarity between urban and rural municipalities and between *départements* (all *départements* did not receive as much as they paid.

FNDAE has been replaced in 2005 by a water solidarity fund. Financial mechanisms differ. A percentage of the money levied by *agences de l'eau* is given back a special fund managed by central government. Again, this system is based on cost recovery at national level for water management and not at local level as requested by WFD.

The subsidies of the *agences de l'eau* are funded by levies. This system entails cross-subsidies between different categories of users. Table below indicates the rate of return on charges levied by *agences de l'eau*, by categories of users. Clearly, farmers are benefiting the most of the solidarity system between users of the same basin and industries the least.

| | VIth (1992-95) | | | VIIth Programme (1996-1999) |
|---|---|---|---|---|
| | levy | subsidy | rate of return | rate of return |
| | million euros | | | |
| Local authorities | 4519 | 5371 | 119% | 103% |
| Industry | 1019 | 1115 | 109% | 97% |
| Farmers | 37 | 164 | 439% | 279% |

source : Commissariat Général du Plan 1997, referring to data from *agences de l'eau*

If the rate of return of water users is above 100%, it is because part of the aids from the *Agences de l'eau* are zero interest loans, which can be reused once reimbursed.

To some extent, redistribution also comes from the organisation of French private companies. Because they have a national scale, they have a large proportion of personnel that are shared (head office, but also research centre, customer centre, financial services, technical assistance service and so on).

In the past, when the companies where in a logic of territorial expansion in France, it was not rare to see some tariffs, especially in the small towns, that were marginal cost tariffs. The shared means were already supported by the other big contracts. Once again, it was a kind of redistribution from the big cities to the rural towns. But compared with FNDAE system, it was less transparent. At present, the tendency is to have a tariff covering all the costs (Cf. implementation of 1995 Seguin law, see appendix 1), including the shared costs. This leads private companies to limit the redistribution, but not totally, because the economies of scale still benefit to all the services, small and big.

**Financial flows in water supply and sewage : national level.**

A report on 2003 national water accounts based on IFEN data and Ernst and Young 2004 survey gives the following figures:

Operation and maintenance costs : 11 150 million euros (M €). 68% is for operation and 32% for self financing and payment of the debt.

- 5 300 M € for water supply utilities
- 5 850 M€ for sewerage utilities

This is balanced by the revenue from water bills (95%, 10 593 M€) and revenues from *agences de l'eau* subsidies (mostly 240 M€ of bonuses for good pollution abatement in WTW and other minor subsidies. Since *agences de l'eau* money is levied on water bills, it is estimated that 98% of O&M costs is paid by the water bill and cost recovery is observed at local level.

Investment costs :
As for investments, estimate is 5120 M€, 31% for water supply (1610 M€) and 45% for sewerage (3510 M€), of which 2320 M€ for the sewers and 1190M€ for WTW.
Only 30% of the investments is covered by :

- 870 M€ subsidies from *agences de l'eau* + 30 to 40 M€ bonus for correct operation of WTW

- 400 M€ from decentralised State services (320 M€ from *Départements* and 80 M€ from *Régions*).
9% of investment costs are not covered by the revenues from water bills.

With all this in mind, it is clear that in France cost recovery has to be viewed at a national level.

At national level, taking into account the national redistributions of taxes levied on water bill, cost recovery can be estimated around 95% (including operation, capital and interests costs). But this does not necessarily means that water services are sustainable: one can suspect that renewal of ageing infrastructure is insufficient.

## Trends and issues regarding the above variables

### Evolution in the organization of water services provision

The 1992 framework water law, replacing the 1964 framework water law, provided new guidelines for water management in France. Main aspects of the new law are :

- the incorporation of all categories of waters under the Nation's common heritage (patrimoine commun de la Nation). This implies a new planning and new ways of coordinating various water uses on two territorial levels : at the six river basin levels through SDAGE (Schémas directeurs d'aménagement et de gestion des eaux), and at small or sub-basin level through SAGE (Schémas d'aménagement et de gestion des eaux). The two planning tools are supposed to materialize the allocation of water resources between various categories of users ;

- communes receive new responsibilities in water management (in particular river maintenance) and are given new obligations for sewerage (Cf. EC directive on urban wastewater—UWWD) ;

- the water police reorganization ;

- a general attempt to clarify water costs, to advertise future increases in water bills (due to the UWWD in particular) and make the public sensitive to the true economic value of drinking water and water resources. Following the 1992 law, decrees and new laws have clarified both contracting out procedures and price setting criteria.

### Evolution in the regulation of private involvement

The freedom granted to *communes* after decentralization in terms of free definition of water prices and choice of contracting out procedures coincided with high investment needs due to the integration of EC Directives in the French legislation (in particular, 1980 Directive on the quality of water supply and 1991 Directive on urban waste water treatment, respectively integrated in the French legislation in 1989 and in 1991).

Until recently, there was little transparency on water service budgets, and consumers were not too curious. But the simultaneous occurrence of rapid water prices increases at the beginning of the 1990s and some "corruption affairs" in 1992 and 1993, involving elected officials of big cities (Grenoble, Saint-Etienne) changed the situation. It was very unclear what part of the price increases were justified by new investments sewerage and water supply and what part was due to private operators' excessive profits or abusive use of money from the water bills to finance other *communal* works.

In 1993, the Sapin law imposed systematic calls for tender when contracting out water services. In 1995, the Barnier Law compelled local authorities to publish a yearly assessment giving the financial elements on top of compliance to various standards. (In Barraqué, Berlin international conference, 1999)

More details on the laws are given in appendix 1.

L. Guérin of GEA lab 2004 gives the results of a survey on call for tenders in water supply and sewerage services for the year 2002. 573 calls for tenders took place, of which more than 200 could and have been analysed. The survey indicates several changes between 1998 and 2002 in application of 1993 Sapin law :

- average contract duration is going down (from 14,4 to 11 years) ;
- on the 200 procedures, the average price paid to the private operator (with a volume weighting) is decreasing by 21% due to 5 changes in cities of more than 100 000 persons. It is going down by 9% without the 5 big cities ;
- all the local authorities doing a call for tenders ask for technical assistance : 23% of consulting revenues go to private operators, 77% go to State services ;
- the share of contracts between the 3 major water companies is not significantly modified by the procedures but new small operators have won some contracts since 1998.

All the regulation procedures around criteria for pricing and private involvements in water supply and sewerage is going to limit in the long run unreasonable prices paid by some customers.

**Trends in pricing levels.**

The implementation of the UWWD caused a 50% increase of average water bills in France between 1990 and 1994, due to massive investment in wastewater collection and treatment.
After 1997 the increase has slowed down to be close to inflation (1,8% per year).
Average prices are less than inflation in 2002 and 2003.

Average water bill in France for a family connected to centralised sewerage is 322 € for 120 $m^3$ (july 2003), representing 1% of family income and a unit price of 2,68 €/ $m^3$.
(Source : in Lyonnaise des Eaux, Septembre 2004, réf. 20)

The levies of the *agences de l'eau*, regularly criticized and judged unconstitutional, are still the main source to help financing new investments. With new obligations rising from implementation of the WFD, legitimacy of the actions of *agences de l'eau* should be reinforced.

The investments in sewerage have not been as efficient as they should have. To face new obligations of WFD, the increase of pollution levies and sewerage charges is not a fatality. The development of concerted actions through basin contracts can encourage best management practices with an evolution of charges following inflation rates.

However, the share of sewerage charges in the water bill keeps rising at the expense of water supply charges.

## GREATER PARIS WATER SYSTEM DEVELOPMENT ACROSS THE LAST CENTURY

### Definition of "greater Paris" (perimeter of the case study)

We define "greater Paris" as Paris City and the 3 *départements* of inner suburbs around Paris. Each *département* is known by a 2-digit number. Paris City is also *département* of Seine (n° 75). The 3 *départements* are called "petite couronne" of Paris : Hauts-de-Seine (n°92), Seine-Saint-Denis (n°93) and Val-de-Marne ( n°94). Before the administrative reform of 1964, the old *département* of Seine was roughly covering the territory of new *départements* 75 (Paris) and 92, 93 and 94.

Greater Paris is a very special zone in Seine Normandie river basin :

- all the communes have a high density of population
- the population of Greater Paris is above a third of the population in Seine Normandie river basin
- all the communes are connected to centralised sewerage (no decentralised treatment)
- two thirds of communes are member of the biggest joint board in France, SEDIF, for water supply
- SEDIF and "Eau de Paris" (company supplying Paris) serve more than 85% of Greater Paris population
- All communes in Greater Paris belong to SIAAP, joint board for sewage collection and treatment.
- Average water prices in Greater Paris are very close to average water prices in Seine Normandie basin (for groups of communes with collective sewerage). This is not surprising considering the weight of Greater Paris population.

(Source : Agence de l'eau Seine Normandie : water price 2002 report, réf. 3 ).

## Main milestones of the development of greater Paris water networks

1807 : imperial decree creating a unique water and sewerage service. The administration of Paris Water is under the jurisdiction of the ministry of interior and managed by the Prefect of Seine with technical supervision of the general director of Ponts et Chaussées Corps of Engineers.

1830 : French Ponts et Chaussées Engineers are sent to London to study the modern water supply and sewage sewerage of the city. They report that about 30% of housing units are supplied with water (even upper floors), their waste water being collected by hidden networks.

1831 : there are 35km of sewers in Paris for a population of 861000 persons. Cesspools are common under buildings and they are regularly emptied and brought by carts to drying zones to produce a fertilizer.

1840s : the sanitarian movement estimates 100 litres per capita per day is a good figure to ensure cleanliness needs and a good hydraulic operation of sewers.

1852 : decree of Prefect of Police in Paris imposes sewage collection (tout à l'égout) for all new building in Paris. A sewer has to be created in every street of Paris.

1860 : creation of greater Paris by inclusion of villages located outside old defensive walls. Population rises to 1700000 and surface to be drained is 80 km2.

1870 : Belgrand Engineer of Ponts et Chaussées, appointed by Seine Prefect Haussmann finishes an ambitious programme of water supply : 5 aqueducts of 100 to 150 km will bring spring waters to Paris. 114 litres/c/day is made available to every Parisian.

The volume of waste water increases from 45 000 $m^3$/day in 1815 to 500 000 $m^3$/day in 1864.
Belgrand proposes in 1856 a scheme with 4 giant interceptor sewers (also used as technical galleries), to take Paris sewage drown stream to Clichy where is would be discharged.
The concentration of all the pollution at Clichy quickly causes major pollution of the Seine. In 1874, engineers Mille and Durand-Claye study the idea of spreading sewage on sewage farms. City of Paris buys land in Achères, Méry and Carrières. Sewage is first spread on these lands from 1895 to 1905.

1894 : all buildings and constructions of Paris have to be connected to existing or future sewers (Durand-Claye).

1902 : Public health law. Communes are given the responsibility of organizing water supply. Connecting properties to an existing sewer is considered a duty wherever mortality surpasses national average..

1910 : a giant interceptor (Sèvres-Achères) carries 180 million $m^3$/year (490 000 $m^3$/day) to 5000 ha spreading fields at Achères.

1935 : a sewerage programme for Paris and Seine *département* is adopted as "public interest" (declaration d'utilité publique). A convention with Seine et Oise *département* defines which communes of Seine et Oise are connected to Paris sewers. The construction of a WTW in Achères is part of the programme.

1940 : a first unit of Achères WTW is operational and supplied by Achères interceptor. Less waste waters are sent to spreading fields.

1966 : creation of the second unit of Achères WTW and construction of a second giant interceptor (Saint-Denis Achères).

1964 : administrative reform. The *3 départements* of Ile-de-France, Seine-et-Marne, Seine and Seine-et-Oise are transformed into 8 *départements*. Seine et Marne (n°77) remains untouched ; former Seine plus a few outer communes become Seine (n°75 - city of Paris) + Hauts de seine (n°92) +Seine Saint Denis (n°93) +Val de

Marne (n°94) ; the rest of Seine et Oise becomes : Es sonnes (91) + Val d'Oise (95) + Yvelines (78).
The administration of sewerage organisation of the old *département* of Seine is split up between the 4 new *départements* of Paris (75) and inner suburbs, also called "Petite couronne" (92, 93, 94). Communes are responsible for connexions and common or lateral street sewers, *départements* for main sewers and interceptors, i.e. for stormwater management. Greater Paris is the unique instance in France where sewerage responsibility is granted to *départements*.

1964 water law : creation of 6 *agences de l'eau*. River basin solidarity between users and funds levied at basin level to finance a policy of surface water quality improvement. Major problem is that in the summer Paris feeds river Seine with treated sewage but still full of ammonium (NH4).

1968 : a new sewerage programme is set up for Greater Paris. The construction of two WTW in Noisy le Grand (Seine-Saint-Denis) and Valenton (Val-de-Marne), upstream from Paris is planned.

1970 : Paris and "petite couronne" decide to form a sewerage joint board : the SIAAP. In fact they keep the old central organisation of sewerage at the level of the old *département* of Seine which was covering the same territory. SIAAP is responsible for the biggest interceptors and for the sewage works.

1972 to 2006 : third unit of Achères WTW and interceptor Clichy-Achères, Argenteuil branch (1972) ; WTW of Noisy le Grand (1976) ; fourth unit of Achères WTW and interceptor Clichy-Achères, Bezons branch (1978) ; first unit of Valenton WTW (unit 1A -1987) ; second unit of Valenton WTW (unit 1B) and interceptor Sèvres-Achères, Nanterre branch (1993) ; WTW of Colombes (1998) ; beginning of construction of Gresillons WTW (2004) ; doubling of Valenton's capacity (2006)

1992 : new French water law. It includes the implementation of the UWWD. Article L.35-111 compels communes to create a zoning for centralised or decentralised sewerage, standards to limit storm water runoff and soil imperviousness, zones to store rainwater. For densely populated areas, a programme to reduce pollution discharge has to be set up, complying with the SAGE, an analysis of ecosystem's sensitivity, assessment of initial pollution loads, etc. Prefect services at *département* level help design the various zones. The mapping is approved locally after public inquiries and financed by the communes. Global schemes have to be designed at basin level (SDAGE) and local schemes at *départements'* level (SAGE).

## DESCRIPTION OF THE CASE STUDY AREA: THE STATE OF THE ART

### Economic and social structure in greater Paris

**Population**

- Paris and "petite couronne" represent 143 communes (including 20 for the *arrondissements* of Paris) on a total of 1300 in Ile-de-France and 36565 in France.
- In Paris and petite couronne, 84% of the territory is urban and 60% of the surface is built (16% of the remaining territory is rural).
- Density in Paris was 24448 inhabitants/km$^2$ in 1999 (the surface of Paris woods excluded).
  Taking the communes of petite couronne served by SEDIF, at the end of 2004, densities are as follows (source : activity report, SEDIF, 2004):
    - Hauts-de-Seine : 9403 inhab/km$^2$
    - Seine-Saint-Denis : 6496 inhab/km$^2$
    - Val-de-Marne : 6947 inhab/km$^2$

  That same year, density is 912 inhabitants/km$^2$ in Ile-de-France and 110 inhabitants/km$^2$ in France.

Population of Paris has reached a maximum in 1921 with 2 906 500 persons and has dropped ever since with a minimum reached in 1999 (2 125 000). Paris population has been going up again recently with a positive evolution of 0,9% from 1999 to 2004.

Birth rate in *petite couronne* has been very high since the year 2000 and much higher than anywhere else in Ile-de-France.

Average size of households is 1,9 in Paris, 2,2 in Hauts-de-Seine, 2,6 in Seine-Saint-Denis, 2,4 in Val-de-Marne.

Most of housing units are in flats. Since the 1960s most of housing units built have been in apartment buildings. Individual homes account for less than 20% of newly built housing units.

**Jobs**

Paris was offering 1 676 100 jobs at the end of 2000 (1 815 300 in 1990). Paris has lost 220 000 jobs from 1990 to 1994 and has been creating 134 000 new jobs ever since. 86000 jobs have been lost between 1990 and 2000 but the recently there is a slow increase in the number of jobs.
Salaried jobs are split as follow (INSEE, SIREN, 2003)

| Repartition of salaried job in various activities : Paris city, 2003. | | | | | |
|---|---|---|---|---|---|
| Services | Administration | Shops | Industry | Construction | Total salaried |
| 55% | 26% | 10% | 7% | 2% | 100% |

There were 301000 firms in Paris in 2003. The average size of the firms is very low : 60% have just one worker in addition to which 34% have between 1 and 9 salaried workers.

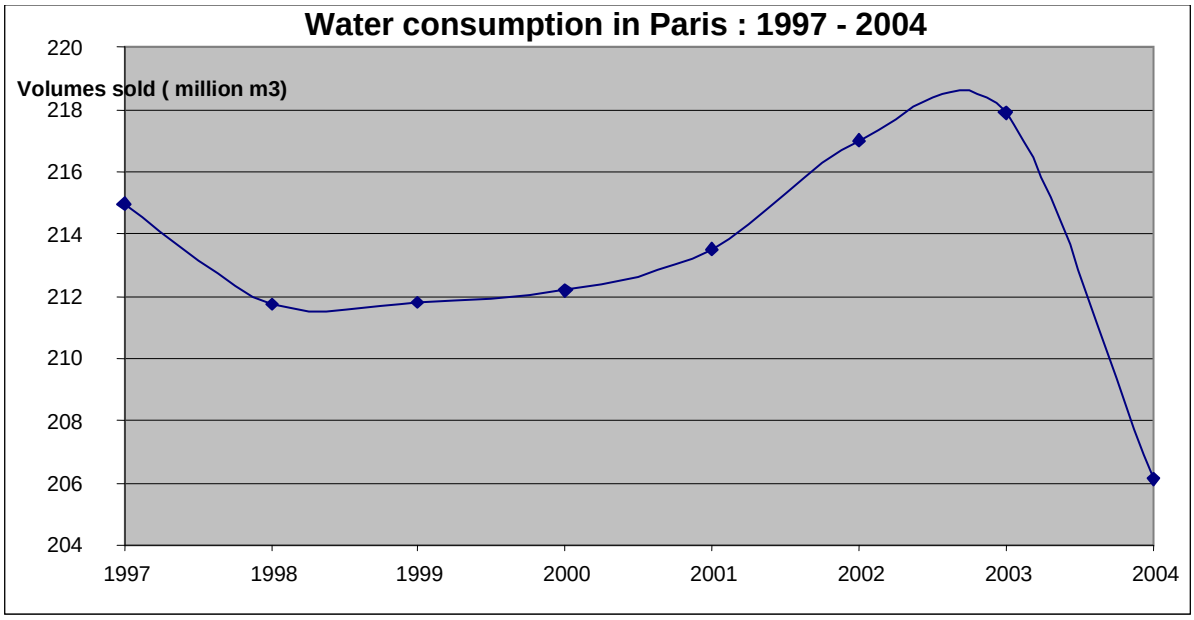
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Services to firms | Services to individuals | Commercial activities | Industry | Hotels,cafes restaurants | Construction | Transport | Other | total |
| 32% | 15% | 19% | 7% | 6% | 4% | 3% | 14% | 100% |

The region Ile-de-France is attracting an increasing number of young workers but at the same time, more population is moving away to the countryside, especially families with children and retired persons. Since birth rate is very good, it compensates the deaths and also the loss of population due to the migration outside Ile-de-France. As a result, the population growth of Ile de France is in the French average (0,62% per year).

Ile-de-France region is the third most dynamic pole in the world. It concentrates high value activities and superior education and research poles. Unemployment is 1 to 1.5 points less than French average (but in Paris it is 1 point more). 19% of French exportations and 30% of importation originate in Ile-de-France.

Ile de France offers 5 166 700 jobs at the end of 2000 (5 081 000 in 1990).
0.1% of the jobs are in agriculture, 11.6% in industry. The sewage from other jobs is very much like municipal sewage (office buildings, commercial activities, schools, hotels…).

## Patterns of water use in the area




Paris population (2,144,700 in july 1st 2004) is supplied with water by Eau de Paris (formerly SAGEP).
73% of the population of "petite couronne" is supplied by SEDIF : 72% in Val de Marne ; 57% in Hauts de Seine and 91% in Seine saint Denis.

SEDIF is supplying a total of 4,037,732 persons (end of December 2004), 3,005,290 in "Petite couronne" and 1,032,442 in "Grande couronne". Petite couronne represents 74% of SEDIF population, 64% of customers and 77% of consumption. The average customer of "petite couronne" is larger than in "grande couronne". This is due to collective housing, with usually one meter per apartment building, which is more common in "petite couronne" than in "grande couronne"..

Table below gives the evolution of water sold by the two operators.

| | population | 1988 vol. sold | 1997 vol. sold | 2004 vol sold | 1988 (m3/c) | 1997 (m3/c) | 2004 (m3/c) | 88-04 (%) | higher value | lower value |
|---|---|---|---|---|---|---|---|---|---|---|
| SEDIF | 4 000 000 | 292 | 277,1 | 269,7 | 73,0 | 69,3 | 67,4 | -7,6 | 76,8 (1991) | 69,31 (2004) |
| Paris | 2 150 000 | 243,1 | 213 | 206,1 | 113,1 | 99,1 | 95,9 | -15,2 | 117,5 (1990) | 99,07 (2004) |

Source, Cambon, SAGEP, 1999 ; SEDIF activity reports.

On average over the past 16 years, consumption has dropped almost 1% per year.
The level of consumption in 2004 was the same as year 1957 when Paris population was 2 830 000. Per capita consumption is 96 $m^3$ per year compared to a 73 value in 1957. This data includes all the activities of the City : services, administration, education, industries, shops and housing. In 2004, consumption in Paris was 42% higher than in SEDIF (95.9 versus 67.4 $m^3$ per capita per year)[4]. Paris consumption is unique in France, due to the importance of daytime population. A large number of persons come from the suburbs to Paris to work during the day. Paris consumption is roughly split into 68% residential (74% of connections), 8% office buildings (5% of connections), 5% commercial activities (11% of connections), 4% education (schools and universities with 2% of connections), 15% other activities (8% of connections). (Source Cambon, SAGEP, 1999).

In Greater Paris the general trend is a decline of per capita water consumption (progressive decline of

[4] Consumption in large French cities is in a range of 55-75 m3/c/y, lows being found in the North of France and highs in the south east.

consumption combined with a slow increase of total population). The 32% of non residential consumption have dropped the most over the last 15 years. Businesses and administration have targeted lower water budgets and reduced wasteful water practice. Cooling systems have been changed, water pipes have been changed and plumbing fixtures reduced with renovation of old buildings, especially in Paris. In the suburb, the use of alternate water source is becoming more common. It is probably still marginal but no survey has really been quantifying the phenomenon.

950 millions $m^3$ have been saved from 1988 to 2004 (592 million $m^3$ in Paris and 357 million $m^3$ SEDIF). If 800 $m^3$ of this has not been used and collected by sewers in 16 years, it means that a capacity of treatment of 8 500 $m^3$ per day has been saved on average (about 3% of total treatment capacity of SIAAP in 2004). This is marginal compared to the considerable volumes of clear water entering leaky sewers (about 35% of the volumes collected in sewers of Greater Paris).

Expert in Seine-Normandie *Agence de l'eau* says that the leaks of sewers in Paris have been reduced, preventing clear water intrusion. The *départements* of petite couronne are also working on limiting the volumes of clear water intruding leaky sewers. They are also willing to limit the discharges of pumped groundwater (exhaure).

As a consequence of all this, the volumes of sewage have already gone down and should continue to go down in the future. Compared to its nominal capacity of 2 million $m^3$ per day, average sewage volumes treated in Achères WTW is 1,7 million $m^3$ (including rainy days).

## Technical choices for sewerage in greater Paris

### Short description of the sewage collection and treatment system in greater Paris.

The sewage collection and treatment system in greater Paris is directly inherited from the past. Between 1870 and 1964, sewerage of old département of Seine that is now covering Paris, *départements* 92, 93, 94, have been organised around the following system :

- development of combined sewers ;
- connexion to interceptors to bring the pollution downstream to Achères (it was first concentrated in Clichy but was bringing too many problems to Paris itself). The sewage were first treated through land applications from the turn of the XXth century to 1940 when a first WTW unit was opened in Achères
- concentration of all sewage in Achères.

After creation of SIAAP in 1970, Achères WTW has been developed to a maximum treatment capacity of 2,05 M $m^3$ per day.

3 WTW have been added on Marne at Noisy-le-Grand and Seine at Valenton, also called "Seine amont" (Seine upstream) and Colombes "Seine Centre" (Seine downstream). The total daily capacity of the 3 WTW was 0.57 M $m^3$/day in 2005 (0.03 M $m^3$/day for Noisy-le-Grand WTW) and was just augmented to a 0,87M $m^3$/day with the doubling of treatment capacity at Valenton at the beginning of 2006.

We should note here that the territory covered by the joint board "SIAAP" is greater than the territory of our case study. SIAAP is serving Paris, the 3 *départements* 92, 93, 94 but also 177 communes of outer suburbs, belonging to "grande couronne" area. They belong to *départements* of Seine et Marne (77), Essonne (91) and Yvelines (78).
Part of Val d'Oise *département* (95), created by the administrative reform of 1964, is necessarily associated to SIAAP because major final interceptors and Achères are located in Val d'Oise.

Until recently, in dry weather conditions, WTW of greater Paris were being used at maximal capacity. With the new treatment capacity at Valenton, it is no longer the case. A major problem is the intrusion of clear water in porous or damaged sewers along with the discharges of pumped water from water tables (exhaure). As a result about 35% of sewage transported by SIAAP interceptors is clear water. Paris and *départements* of "petite couronne" are working on 3 actions to limit clear water intrusion : 1/ a better inventory of main sources of clear water intrusion ; 2/ repair leaky sewers ; 3/ forbid discharges of pumped water in the sewers.

Paris is maintaining combined sewers but communes and *départements* of “petite couronne” are developing separate sewers and sewerage planning for the next 15 years includes several measures to retain storm water at its source with the reduction of impermeable surfaces.

Storm water has been a clear limit to the improvement of river quality in greater Paris for the last 30 years.

During storm events, sewers are frequently flooded and WTW are bypassed causing major ecological impact on the Seine.

## Resume of main technical information on the sewerage system.

Greater Paris (with territorial additions described above in *départements* 77, 78, 91 and 95), sewerage assets are composed of :

- **4 WTW** managed by SIAAP with a total capacity of 2,82 million $m^3$ / day of which 1,95 at Achères.

In 2003, the flow of treated effluents discharges into Seine at Achères was on average 1,94 million $m^3$ / day.
This represents a flow of 22,5 $m^3$/s, i.e. more than a third of mean summer flow of river Seine.
In 2006 the treatment capacity at Valenton has been doubled and flows directed to Achères have been reduced. Achères is presently treating 1,7 million $m^3$ / day.

- **A sewage collection network** composed of sewers operated by three territorial levels.

At communal level : in greater Paris there are close to 7700 km of street sewers. The new sewers developed by communes and renovated sewers are often separate but it also can be combined depending on the precise location in the commune.
The elementary sewers are connected to 2067 km of main sewers at *département* level. 53% are combined sewers (1090 km) and 47% separate (526 km of storm water sewers and 451 km of sanitary sewers). In Paris city, the 155 km of main sewers are combined.
Sewers in *départements* are connected to 343 km SIAAP interceptors (*interdépartemental* level). Their diameter varies between 2,5 and 4 m and they are 10 to 100 meters deep.

- **A system of rainwater storage.** Combined sewers in Paris were designed with big capacity to store rainwater during storms. However, with climate change and increasing impermeable surfaces, during storm events, the storage capacity is insufficient.

SIAAP and *départements* are developing rain water detention basins. Total capacity was 1 086 000 million $m^3$ in 2004, 50% of the capacity managed by SIAAP and the other half by *départements*.
This capacity is still limited and the *départements* and SIAAP are developing alternative methods to limit rain water runoff.
Recently, Val-de-Marne hired international experts to assess the cost benefit analysis of a new project based on rain water storage units and a treatment plant. Experts as well as *Agence de l’eau* found that this project was very costly, despite its significance for storm water both quality and quantity control. Val-de-Marne could reduce the costs through preventive measures such as retaining storm water on site ; land planning and innovating urban design and construction is bound to be much more efficient economically than developing capital intensive storage basins. (Report Arrojo, Ru de la Lande, réf. 4). Appendix 5 gives the investment and O&M costs of a 15 000 $m^3$ storage basin.

The following table sums up main characteristics of assets in greater Paris for sewage and storm water management.

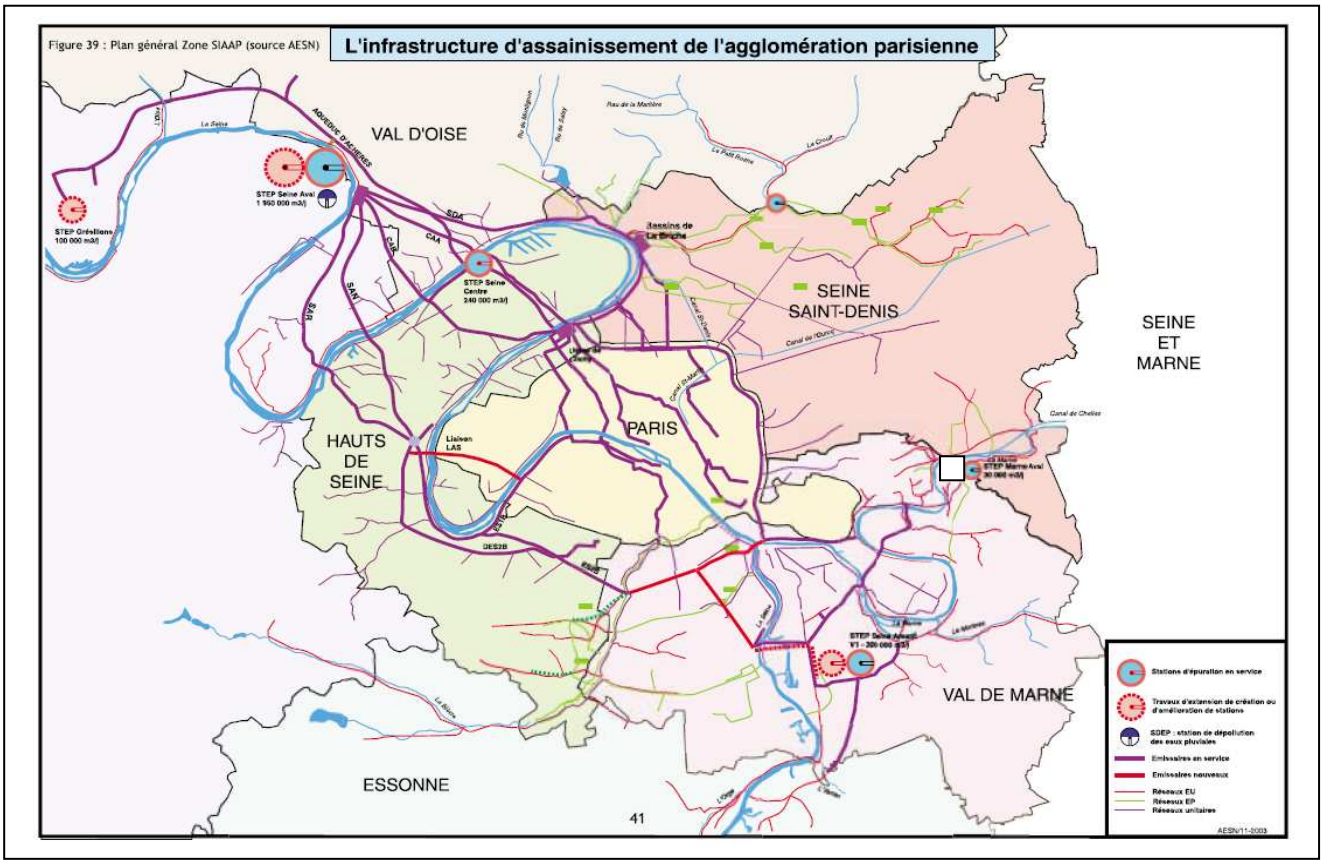
| | | *Département* | | | | |
|---|---|---|---|---|---|---|
| | SIAAP | 75 | 92 | 93 | 94 | TOTAL |
| **Waste water management** | | | | | | |
| Combined sewers (km) | | 155 | 384 | 356 | 195 | 1090 |
| Storm water sewers (km) | | 0 | 74 | 190 | 262 | 526 |
| Sanitary sewers (km) | | 0 | 72 | 124 | 255 | 451 |
| SIAAP interceptors (some managed by Départements) | 160 | 20 | 10 | 58 | 95 | 343 |
| Km of communal sewers in the *département* | | 1540 | 1253 | 2400 | 2500 | 7693 |
| Sewer cleaning (sludge in t) 2004 | | 419 | 0 | 321 | 1383 | |
| NA : not available | | | | | | |
| **Storm water management** | | | | | | |
| Rainwater storage capacity ($m^3$) | 542 000 (7 sites : 6 basins, 1 tunnel) | 17 000 (1 site) | 115 000 (1 site) | 253 000 (2 sites) | 159 000 (3 sites) | 1 086000 (14 sites) |
| Sand chambers (units) | | 10 | 1 | 14 | 39 | 64 |
| Sand chamber cleaning (t of sludge) 2004 | | 508 | 115 | 610 | 3250 | 4483 |

Source : for *département of Val-de-Marne (94), estimate km of street sewers from interview with researcher C. Carré. For Hauts de Seine (92), see réf 2 ; Seine-Saint-Denis (93), réf 12 ; other data, réf 1.*

The WTW managed by SIAAP use a biological treatment technology. The maximum treatment capacity was almost being used daily until 2006. With the new treatment capacity in Valenton, Achères is not used any more at maximum capacity.

| | Built in | Capacity Million $m^3$/d | Type of treatment | Nitrogen removal | Phosphorus removal | Sludge treatment unit |
|---|---|---|---|---|---|---|
| Achères | 1940-1966-1972-1978-2004 | 1,95 | Biological | No | Yes (dry weather) | No |
| Valenton | 1987 – 1993<br>2006 | 0.30<br>0.30 | Biological | Yes (no $NO_3$ treatment) | No | Yes, partial |
| Colombes | 1998 | 0.24 | Biological | Yes | Yes (high efficiency) | Yes incineration |
| Noisy le Gd | 1976 | 0.03 | Biological | Yes | No | Yes incineration |
| **Total** | | **2,82** | | | | |

Location of major interceptors and WTW is presented on the following map (source : *Agence de l'eau Seine Normandie*; 2004, réf. 1)




Experts of Agence de l'eau Seine Normandie indicated that volumes of wastewater treated for the first 5 months of year 2006 is representative of situation targeted in 2008 (reduction of flows directed to Achères, increase of flows directed to Valenton, new sewage discharges compensated by reduction of clear water intrusion). The following table gives the flows and treatment efficiency of the WTW for key parameters. Treatment efficiency is defined as the ratio between pollution load removed and pollution load entering WTWs.

| WTW | Nominal Capacity M $m^3$/d | Dry days | Wet days | Average flow treated M $m^3$/d | Efficiency | Phospho-rus | NTK Reduced N | Total Nitrogen |
|---|---|---|---|---|---|---|---|---|
| Achères | 1,95 | 99 | 28 | 1,715 | 81% | 71% | 8% | 1% |
| Valenton | 0,60 | 114 | 13 | 0,361 | 92% | 64% | 94% | 61% |
| Colombes | 0,24 | 108 | 19 | 0,252 | 96% | 93% | 95% | 74% |
| Noisy le Gd | 0,03 | 77 | 50 | 0,022 | 90% | 44% | 84% | 46% |
| **total** | **2,82** | | | **2,35** | | | | |

Recent years are relatively dry years explaining a decrease of average sewage flows treated by SIAAP.

| | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|
| Flow entering WTW in M $m^3$/d | 2,81 | 2,79 | 2,59 | 2,47 |

SIAAP activity reports gives key figures of wastewater collection in SIAAP interceptors and treatment in WTW (year 2004) :

Volumes treated by the WTW were on average : 2,44 M $m^3$/d throughout the year.

| | SS (t/d) | OM (t/d) | Total nitrogen (t/d) | Tot phosphorus (t/d) |
|---|---|---|---|---|
| | 621,1 | 383,8 | 119, 9 | 18,1 |
| Global efficiency | 87,8% | 78,8% | 30% | 64,5% |
| Pollution discharged | 75,8 t/d | 81,4 t/d | 84 t/d | 6,4 t/d |

Volumes bypassed at WTW : 266 000 $m^3$/d

Direct discharges (5 SIAAP interceptors) :
- cumulated days of discharges 179
- total volumes discharged in 2004 : 8 M $m^3$ (220 000 $m^3$/d)

As a result big pollution loads are discharged in Seine downstream Paris explaining the very bad quality of the river from Achères to Poses, near Rouen (see map in next section on quality).

Sludge production of SIAAP is 200 t/d (dry matters) and ash production from sludge incineration is 30 t/d. Achères has no sludge treatment units and accounts for 91% of sludge production. Colombes and Noisy le Grand treat all their sludge and Valenton only partially.

## Recent records of river water quality

The most important water supplier of greater Paris, SEDIF, has three major drinking water production plants on Seine (Choisy le Roi), Marne (Neuilly sur Marne) and Oise (Méry sur Oise) and constantly controls the quality of rivers at these locations.

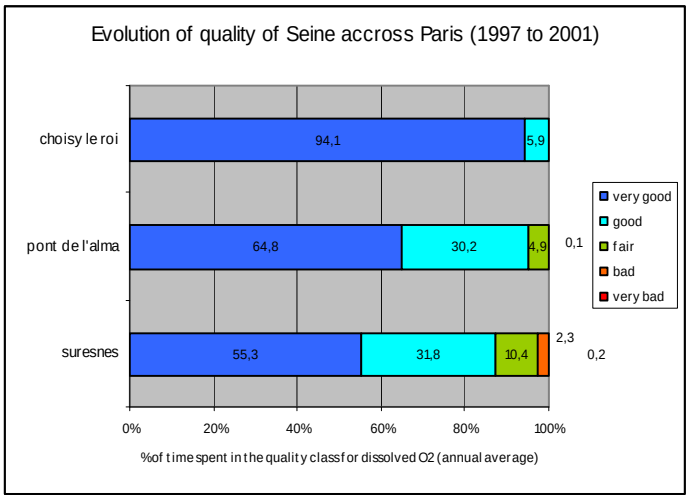
Seine and Marne rivers already have a high content of nitrates upstream from the SIAAP WTW with an average concentration of 25mg/l (guide value for drinking water supply). The concentration has constantly increased over the last 40 years. In 1960, nitrate concentration was 6mg/l. There is no sign of improvement. Nitrates originate in farming practices in Seine and Marne catchment basins, which have not been controlled over the last 40 years.

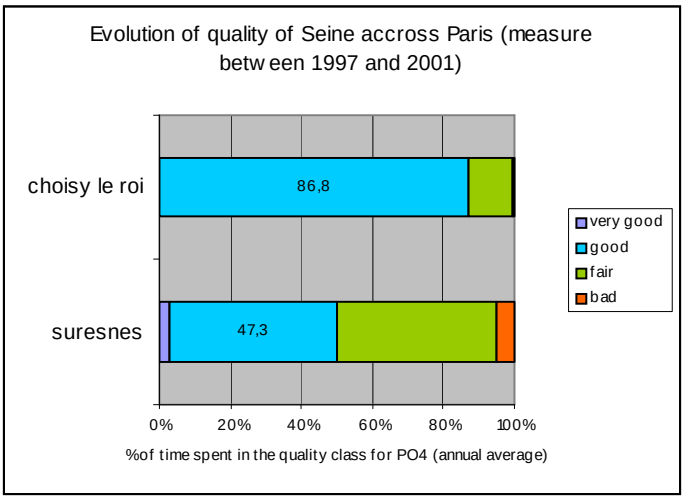
The quality measured at Choisy le Roi can be compared to the quality measured in Pont de l'Alma (central Paris) and in Suresnes, downstream from downtown Paris. The situation appears on the two following figures.

The following map is giving a simplified location of rivers, cities, *départements* and WTW of greater Paris.

The good results are not very surprising. There is no waste water discharged after treatment in that zone because most of the waste water, as we said earlier, is sent much further downstream at Achères. The other discharges of WTW are upstream at Valenton on the Seine and Noisy le grand on the Marne.

The report on drinking water and sewage of Ile de France is not giving any comparable information on dissolved $O_2$ or $PO_4$ after Achères. As explained at Agence de l'eau Seine Normandie, the quality is so bad that data will be advertised at the horizon of 2015 when Achères will receive limited flows of wastewater (maximum 1,5 M $m^3$/d compared to an average 1,7 M $m^3$/day in 2006) and when all flows will be treated for total nitrogen removal (see Scenario C of SIAAP in next paragraphs).



## MAIN MANAGEMENT AND ECONOMIC ASPECTS OF THE STATE-OF-THE-ART

### Managing system and its legal, economic and organizational aspects

We mentioned earlier the specificities of sewerage governance in greater Paris.

*Départements* of petite couronne are under a special authorization, derogatory to the 1992 water law and have been given the charge of sewerage on their territory. (According to the CGCT – *code general des collectivités territoriales* – that is applying the 1992 water law in art L2224-7 to L2224-10 communes and joint boards only have the duty to provide sewerage services, i.e. collection, transport, treatment and sludge disposal). This special authorization has caused serious difficulties, operators at commune level, refusing to pay the *départemental* charge for sewage collection (réf. 12).

*Départements* of "petite couronne", have a duty for sewage collection (and hence storm water) : a special Arrêté Départemental defines the planning scheme for sewage collection in the territory of Département. The planning document is discussed with actors of water supply and sewerage and with polluters for several months before adoption and vote. All polluters and water users have to comply with that scheme when their sewage transits through the *départements'* main sewers and interceptors.
Arrêté départemental was adopted by département council of june 2nd 1992 in Seine-Saint-Denis and was expected to be defined in 2004 in Val-de-Marne. It should be soon defined in Haut de Seine (ref. 9).

*Départements* holds an intermediate position between SIAAP and communes. The development of concerted actions between the 3 levels of government is a key to sustainable development of sewerage in greater Paris.

### Private sector involvement

Private sector is involved in greater Paris sewerage at two levels :

- Direct involvement : Hauts-de-Seine Département has contracted out operation of Département sewage system to SEVESC in 1994. SEVESC is also in charge of sewer renewal. 100 persons of SEVESC are devoted to that task.
- Indirect involvement is not specific to greater Paris. Private sector is involved in designing innovative waste water treatment techniques and in technical advice for management methods.

### Cost-recovery patterns

As we mentioned in the part "financial aspects", investment pay back is separated in the bills from operation and maintenance. This special line for investment is usually named "surtaxe" or "redevance communale".

Technical services of the municipalities (or joint boards) prepare the annex budget of the service by assessing usual operation and maintenance costs as well as needs for renewal and special investments. The budget is approved and voted by the municipal council of "conseil d'administration" of the joint board.

The local tax payer may be supporting a limited part of the investment in storm water assets, but investment is also covered by subsidies of the Département, Agence de l'eau Seine-Normandie and possibly Ile-de-France region.

There is also a fee paid by the operators of the assets to *communes* for public domain occupation of sewers.

### Actual level of tariff revenues (per m³ and in total)

The average cost supported by customers in greater Paris in not the same in Paris and "petite couronne". Within petite couronne, the tariff also varies. Customers living in the suburb in Val-de-Marne pay 45% more per m³ than customers living in Paris.

- Eau de Paris : 2,50 euros per m³ (price January 1st, 2006 for a 120 m³ annual water bill, including meter rental, flat fee for service, water supply and sewage collection and treatment). The average 120 m³ water bill is 300 euros. Of this :

- Water supply : 43% of the cost : service + withdrawal tax (*agence de l'eau*)
- Sewerage : 52 % of the cost [32% for service, 20% for pollution tax (*agence de l'eau*)]
- VAT and VNF close to 5%.

o SEDIF : 3,63 euros per m³ (price January 1st, 2006 for a 120 m³ annual water bill, including meter rental, flat fee for service, water supply and sewage collection and treatment). The average 120 m³ water bill is 300 euros (see appendix 2 for more details). Of this :
- Water supply : 47% of the cost : service +withdrawal tax (*agence de l'eau*)
- Sewarage : 48% of the cost : service + pollution tax (*agence de l'eau*)
- VAT and VNF close to 5%.

Appendix 2 gives details about SEDIF price in a commune of Val-de-Marne with average tariff of 3,63 €/ m³.
The table below gives an estimate of the revenue generated by the *départemental* sewage collection charge in 2002:

| *Département* | Estimated volumes sold M m³ in 2002 | Redevance level (January 1st 2003) | Revenue in M€ in 2002 |
|---|---|---|---|
| 75 | 217 | 0,229 | 49,7 |
| 92 | 112 | 0,408 | 45,8 |
| 93 | 90 | 0,349 | 38,3 |
| 94 | 83 | 0,3419 | 28,5 |

Sources : Agence de l'eau Seine normandie, report on operators in Ile-de-France, 2004 and SEDIF activity reports 2002.

## Cross-linkages with other urban utilities and cost recovery

Cross linkages happen between sewerage utility and storm control duty. The later should be financed on general budgets only and the firmer on the annex budget only. In Val-de-Marne *département*, about 7% of investment in storm water assets seems to be supported by customers of sewerage utility. Conversely in Seine-Saint-Denis where flooding is a major issue, programs for investment have been important for a long time and the general budget is financing part of the annex budget dedicated to sewerage (5% of investment). (Source : Blanc, 2002).

It is difficult to actually separate the budgets dedicated to storm water control and sewerage. Clearly the operation of combined sewers is calling for a cross linkage between the two utilities.

A *circulaire* of December 1978 is giving instructions on the level of participation of the general budget for operation of combined sewers.
- for O&M costs only (no depreciation, no financial costs) : the transfer should be in the range [20 ; 35%]
- for depreciation and financial costs only, the transfer should be in the range [30 ; 50%]
- if all the costs are included, the transfer from the general budget should be in the range [20 ; 50%]. If the level is lower than 20%, it means that the burden on sewerage customers is too high.

In the Blanc report, it was found that in the period 1992-1999, the average participation of general budget to depreciation of assets was on average 24% for Val de Marne, 13% for Seine Saint Denis and 14% for Hauts de Seine.

For the analysis of sustainability of cost recovery level, the analysis of depreciation practices is important. What *départements* are not spending now (are not supported by tax payers) will have to be supported more massively later by future tax payers or customers.

### General estimate of cost recovery in greater Paris

In petite couronne there is a contribution of general budgets to the annex budgets of water and sewerage in of about 20% of the amount of investments and 5 to 7% of the total amount of revenues collected annually in water bills.

The budgets of sewage and storm control are difficult to identify in Greater Paris, especially because most of collection networks are unitary (100% in Paris). However, the separation of budgets between the two utilities seems respected.

From the various data collected, it can be stated that there is a good cost recovery level in greater Paris with a correct depreciation of assets.

Some detailed data are available in appendix 6. However they are too partial to make a general statement of the situation.

Now the real issue is whether Waste water operators invest enough to maintain the sewers and the sewage works on the long run. As concerns WTW, we have seen that the only operator, SIAAP, was in the process of doubling the treatment capacity in quantity and quality. We can consider that for this part the management is sustainable. Waste water treatment represents 330 M€ invested per year, i.e. slightly less than ¾ of the 480 M€ invested under'scenario C', as revised in 2003.

Concerning sewers, if we take an average life time of 60 years, we can calculate how much should be invested in average per year in greater Paris to maintain the system: if we take an average value of 400 K€ / km for street sewers, 800 K€/ km for *département* interceptors, and 10,000 K€ /km for the *interdépartemental* interceptors, we get the following financial needs

| Population density | Operator | Street sewers | *Département* sewers | Regional interceptors | Total network |
|---|---|---|---|---|---|
| 24,500/ km2 | Paris | (1540 km) 10,3 | (155 km) 2,1 | (20 km) 3,3 | 15,7 |
| 9,400 | 92 | (1250 km) 8,3 | (530 km) 7,1 | (10 km) 1,7 | 17,1 |
| 6,500 | 93 | (2400 km) 16 | (670 km) 8,9 | (58 km) 9,7 | 34,6 |
| 7,000 | 94 | (2500 km) 16,7 | (712 km) 9,5 | (95 km) 15,8 | 42 |
| | SIAAP | | | (160 km) 26,7 | 2 |
| Total greater Paris | | 51,3 M€/yr | 27,6 M€/yr | 57,2 M€/yr | 136,1 M€/yr |

It is presently difficult to check whether the present investment program is sustainable, since we have no access to the investment made by each commune. This would request a special investigation. However, analyses made at national level tend to indicate that the long term maintenance of sewers is the most under funded part of the infrastructure. Paris region should be no exception.

## Special questions:

### Who is the owner of the assets ?

House and business connections are a private property. Sewers are most commonly owned by communes that develop and operate them. In case of private operation and maintenance, ownership stays with the commune. In greater Paris, the situation is very specific. For historical reasons, Seine *département* (before 1964) had the responsibility of developing the network and was the owner as well. New *départements* have kept the ownership of sewers developed by the old Seine *département*. Communes remain the owners of the sewers they develop.
WTW are owned by the SIAAP.

### Who is responsible for replacement and development of the infrastructures ?

In Greater Paris, communes, *départements* and SIAAP are responsible for maintenance and development of the sewage infrastructures they own. When communes or *départements* choose to contract out that task, responsibility lies in the private operator for the duration of the contract.
SIAAP is responsible for replacement and development of the WTW.

## THE IMPACT OF THE WFD ON THE CASE STUDY AREA

### Assessment of the current situation face to the WFD and the "good ecological status"

In September 2004, the European court of justice condemned France for failures in the implementation of the UWWD. In particular it considered that the lower Seine Basin and Seine estuary were deeply affected by nitrogen and phosphorus pollutions, causing major eutrophication problems. It therefore considered that the lower Seine basin, including Paris region should have been listed in sensitive areas and should have equipped all WTW with tertiary treatments as early as 1998.

Until now for most of its treatment capacities, SIAAP has provided only secondary treatment. N & P removal are clearly insufficient causing major ecological damage downstream Paris on the Seine. SIAAP has to find solutions to limit N and P discharges to meet a good ecological status on these parameters by 2015.

The SIAAP is also worried because of the pending toxic substances blacklist (heavy metals, micro-organics) of WFD, and the Reach Directive. A recent study showed that in particular metals such as zinc, copper and cadmium are discharged in the rivers, due to roofs rain wash. (Buildings built during the Haussman period (mid 19$^{th}$ century) are covered with zinc. Cadmium is a natural impurity of zinc metal. As a result, surface and ground water resources around Paris happen to have high content of cadmium).

It is not exactly known at present what kind of treatments WTW of SIAAP will have to treat or what kind of solutions will have to be adopted to treat specific pollutions from rain water runoff.

### How are new obligations arising from the WFD transfered into management contracts ?

The management of sewerage in Ile-de-France is publicly operated for most part (except for management in Haut-de-Seine *département*, given out to a private company).

Transfer into management contract is not a key issue in Greater Paris.

## MAIN OPEN ISSUES, OPTIONS AND STRATEGIES

### What are the options for filling the gap between the present situation and the requirements of the WFD ?

To fill the gap between present situation and good ecological status SIAAP has to invest in four sectors :

- Immediate actions to bring the WTW to tertiary treatment (N and P removal)
- Storm water control along with *départements* and communes
- Sludge disposal
- preserve wildlife (mostly fish).

To meet the requirements of WFD, SIAAP is working on a scenario (called scenario C) that is being regularly updated to take into account new environmental regulations, technical innovations and the evolution of urbanisation in Ile-de-France region.
In particular, scenario C, first set up in 1997, has been modified by the regulation on sludge disposal, by the classification of lower Seine basin as a sensitive zone and by the continual increase of the impermeable surfaces. This implies to better treat existing pollution discharges in WTW with improved capacities.

- SIAAP created 3 new WTW in upstream and central zones of Paris. The new treatment capacities will be more spread out than before to encourage self cleaning capacities of rivers. In the meantime, the

capacity at Achères will progressively be reduced to 1,7 and 1,5 M $m^3$ per day in 2015. In October 2004, the construction of the WTW of Grésillons has started. It will take some of the pollution directed to Achères and will replace an older treatment works in Carrières sous Poissy.

- SIAAP will « tertiarise » Achères WTW for nitrogen removal and will create phosphorus removal units in Valenton and Noisy le Grand
- The 3 *départements* are working on storm water control strategies with money from general budget which is limited : along with SIAAP, the goal is to reduce the intrusion of clear water in the system
- Collect and store most polluted storm water flows and create specific storm water treatments
- SIAAP is creating « survival zones » to protect fish in summer storm episodes
- SIAAP has to face the black listed toxic substances issue

Appendix 5 is showing a map of greater Paris sewerage systems at the horizon 2015.

To tertiarise its treatment units, SIAAP has to close them at least partly one by one and find ways to better dispatch the flows among the remaining units during dry and/or wet weather. The real time management of flows is a key for improvement of existing facilities.

As shown in a *agence SN* report on *département* 92, an optimal management of existing systems (implying perfect knowledge of the networks as well as diagnostic of equipments) and a good maintenance program with self financing capacities can greatly limit the increase of the communal or départemental charge on the water bills.

Medium and long term actions :

All new planning documents discussed at *département*, SIAAP and *agence de l'eau* levels are pointing out the necessity to :

- develop data from self monitoring on all of the assets of sewage and storm water collection and treatment. The idea is to have a good inventory on the shape of assets and also to measure the main flows entering the network. Berland, Juéry OIEau report for MEDD, 2003 indicates that data collected by operators for self monitoring of facilities (imposed by arrêté of December 22nd, 1994) is a mine of information for future policies of maintenance and renewal. The national projet "rehabilitation des réseaux d'assainissement urbains" (REREAU, urban ) has created an expert group on the subject to develop performance indicators on sewage and storm water systems

- Improve coordination between the 3 public levels of governance with contracting out formula and concerted actions

- develop management conventions between actors of sewerage : communes, *départements*, SIAAP, private operators, Agence de l'eau Seine Normandie…. The idea is to share common goals, discuss most efficient ways of meeting the goals and to introduce a solidarity between communes discharging the pollution into collection sewers and communes supporting the pollution at discharge points on the river.

- Create a management tool, based on self monitoring, and share by actors of the same sub basin and based on GIS technologies to best use the existing assets. In particular, this implies :
    - improvement of the mapping system of existing facilities ;
    - development of dry weather sewage flow measures in some strategic points (major discharges)
    - development of dry weather quality of sewage in some points (were sewer are subject to unusual ageing and corrosion problems) ;
    - development of rain gauges.

- Integrate storm water management in local urban plans (PLU) and impose in site storm water retention solutions when delivering building permits

- Develop environmental education of technical staff and the general public. Find innovative ways to make

the general public responsible for the success of storm water control and better practices of discharges into public sewers

### What are the main constraints (technical, institutional, political, economic ...)

As we mentioned many times, for the last 15 years there has been public debate on creation of a new levy in Agence de l'eau on impermeable surfaces but such a measure was never voted. The very recent 2006 water law has not proposed any new financial mechanism to develop storm water control.

In greater Paris both *départements* and communes have a responsibility in sewage collection and sludge management. *Départements* often complains that communes are not following their recommendations, limiting the efficiency of actions. Communes can be inefficient in controlling industrial discharges, pumped water or clear water intrusion.

*Départements* are making contracting out procedures with communes a top priority to improve efficiency of actions. But the technical staff of communes is limited and concerted actions are not easy to implement.

Storm water control is another field where concerted actions between communes and *départements* are crucial. In Seine-Saint-Denis rain water runoff has caused frequent flooding. In the last 25 years the *département* has controlled urban development to avoid increasing flooding of public sewers. For the last 10 years, it has pioneered in proposing an urban development integrating rain water storage on site. For any new building project on a site never built before, Seine-Saint-Denis is asking for a maximum rain water discharge of 10l/s/ha. It also controls all new urban development and 80% of major building permits. When requested storage capacity is above than 20 $m^3$ or 1500 $m^2$, *départemental* services control the conformity to the building permit (20% of such permits in 10 years). The *département* is also controlling the maintenance of storage facilities. 50% of assets are not maintained after 5 years and become rapidly inefficient. The *département* is working on finding more sustainable rain water detention methods, better integrated in the landscape and better accepted by professionals (architects, urban planers) and the Public.

## ASSESSMENT OF LONG-RUN SUSTAINABILITY

### Will the management system allow to keep (or reach) good ecological status in the future?

In 2006 SIAAP is far from quality objectives of SDAGE which target reaching good ecological status in the future.

Let us recall that Seine and Marne rivers upstream from Paris have had an increasing content of nitrate which is reaching and sometimes going over the quality required for water supply production (25 mg/l of $NO_3$). The management of Seine and Marne river basins has been yet unable to to control nitrogen sources from agriculture. There is no measure in scenario C mentioning actions to contract out with farmers or industries of the Seine basin (9400 $km^2$) or Marne basin (8850 $km^2$). Yet on the total length of Seine (762km) and Marne (506 km) 290 km and 141km respectively are located in Ile-de-France region.
SIAAP would have to define a policy jointly with communes and *départements* of Ile-de-France crossed by Seine (i.e. 75, 92, 93, 94 + 77, 78, 91, 95) and Marne (93, 94 + 77).

The report on *major operators in Paris region, 2004,* clearly states that the new WTW facilities in 2015 may not suffice to reach a good ecological status of Seine downstream Achères. On top of this, there is unceretainty concerning new treatments needed for toxic substances removal.

### Will the cost remain affordable in the long run ?

For implementation of scenario C (which is very end of pipe, capital intensive), SIAAP announces the doubling of the inter*départemental* charge on the water bill (0,51 €/ $m^3$ to 1 €/ $m^3$). If the other partners do not increase their charges, SIAAP woul move from 20% to 40% of the total.

On the other hand, Seine-Saint-Denis considers that the increase of *départemental* charge above inflation is not a sustainable option. The idea is to limit the increase of charges. Access to water supply is considered a basic civic right and elected officials are reluctant to see further significant increases of the price per $m^3$. As Seine-

Saint-Denis points out, the increase of 1% of its charge (0,339€/ $m^3$ in 2002) would cost an additional 0,40 € per year for a family using 120 $m^3$ per year, i.e. the cost of a bottle of mineral water. But still, water is not a mere consumption good and every increase causes an intense political debate.
Seine Saint Denis wants to work on every possible concerted actions with other partners of sewage and storm water management to best use subsidies from the *agence de l'eau* and make the best possible use of every revenue.

Agence de l'eau Seine Normandie shares the same point of view. Most of subsidies will be granted to operators of sewage and storm water development within basin management contracts.

The most sustainable scenario is probably a clever combination immediate investment (clearly needed to bring WTW to tertiary treatment level) and new management options such as on site storm water control (ref 13, Seine-Saint-Denis files).

The increase of water bills can cause financial difficulties in the long run :

- there is a declining trend in water consumption in greater Paris. In the economic and public sectors (office buildings, restaurants, parks…) it has proven to be connected to the increase of water prices (Cambon, SAGEP, 1999). The link is not as obvious in the case of residential uses. Most of the population in greater Paris lives in collective housing which have shown rather stable consumption profiles. However, public housing managers are willing to develop actions to limit water wastage and unpaid bills. Also, here and there in petite couronne one can hear neighbours talking about installing a new pump in the old well of the garden or using a tank to store rainwater. As a result, the financial burden of new investments is divided by a decreasing volume causing the water price per $m^3$ to increase… causing in turns more savings…
- In the long run, a small minority of families could decide to abandon public water supply and use alternate sources with no quality control, which is a very serious public concern. This seems to develop also in many rural or suburban areas in France.

One side issue is that the total water bill in down town Paris is under the average mean (2.50 €), and therefore well under the price paid in inner suburbs. This might create a growing political issue

## CONCLUSION

As Barraqué stated at Berlin conference in 1999, from all the elements we have gathered, French water and sewerage services are almost reaching cost recovery criterion. This may appear surprising to foreign observers who compare water bills income to the whole turnover. But it is important to recall that the levies paid to the Agences de l'eau are money saved for future investments. This is why we add the pollution levy to the sewer charge, and the abstraction levy to the drinking water price. This gives the long term average price of each of the 2 services. Since 1996, note that the sewer plus pollution part is above the water plus abstraction part. On the long run, a sustainable sewer service should be more expensive than a drinking water service, at least under cost recovery policies.

Money paid to the *agencies* is pooled at river basin level, and it is only on the long run that each utility recovers more or less the money paid by domestic users. This solidarity mechanism must be considered not as subsidies but as a specific way the French have found to reach the needed level of investments. Without the Agences' money, French water prices would be even more variable and many small services would reach unacceptable price levels after heavy investments. Recent studies showed that subsidies to water services from general budgets of communes, *départements* and regions were quite limited. Actually these subsidies in sewerage policy represent only about 8% of the turnover and mainly concern rural areas and greater Paris sewerage.

## REFERENCES


1. Agence de l'eau Seine-Normandie, (*Water supply and sewerage : major operators in Paris region. Infrastructures, operation, results). Eau potable et assainissement : les grands maîtres d'ouvrage de l'agglomération parisienne. Infrastructures, exploitation, résultats. Etats des lieux et perspectives*, février 2004, 77 pages. http://www.eau-seine-normandie.fr/fileadmin/mediatheque/rivieres-ile_de_france/eau_potable_et_assainissement_agglo_parisienne.pdf

2. Agence de l'eau Seine-Normandie : *financement et renouvellement de la collecte des eaux usées. Analyse technico-économique. Etude de cas dans les Hauts-de-Seine*, 21 pages, août 2005. Financing and maintaining waste water collection. Case study in Hauts-de-Seine.

3. Agence de l'eau Seine-Normandie : *Prix de l'eau 2002 sur le bassin Seine-Normandie,* report. *(2002 levels of water prices in Seine Normandie basin).*

4. Arrojo-Agudo P., coordinator, rapport sur la durabilité du projet du "Ru de la Landes", expert report for Conseil Général du Val de Marne, 28 pages. *Report on sustainibility of rain water storage works "Ru de la landes in département of Val de Marne*.

5. Barraqué, B. : *sewerage charges in France*, paper presented at the international conference on "abwassergebühren in Europa", Berlin, october 26-27, 1999.

6. Berland J.M., Juery C. : *Inventaire et scénario de renouvellement du patrimoine d'infrastructures des services publics d'eau et d'assainissement,* OIEau pour le Ministère de l'environnement et du développement durable, 2003, 204 pages. (Inventory and scenario for the renewal of infrastructures in water and sewerage services).

7. Berland J.M. : *Norms, influence on technical choices of sewerage. France / germany comparison. - Normes : quelle influence sur les choix techniques dans les domaines de l'assainissement et de l'épuration. Comparaison France / Allemagne*. Doctoral thesis - Thèse de doctorat, LATTS, Ecole des Ponts, december 1994, 458 pages.

8. Bouleau G. (2001) : *acteurs et circuits financiers de l'eau en France*, ENGREF, 99 pages (Stakeholders and their financial responsibilities in French water management)

9. Conseil général des hauts de seine : schéma départemental d'assainissement 2005-2020, 17 février 2006.

10. Cambon-Grau S., "Decrease of water consumption in Paris – survey on a sample of 51 big water consumers" « Baisse des consommations d'eau à Paris. Enquête auprès de 51 gros consommateurs ». In *TSM l'eau, n°2, 95,* février 2000, pages 37-46.

11. Cambon-Grau S., *Decrease of water billed in Paris from 1991 to 1997 : analysis of the causes on a panel of big consumers in Paris. Baisse des facturations d'eau à Paris entre 1991 et 1997 : analyse des causes sur un panel de gros consommateurs de Paris rive droite.* Société Anonyme de Gestion des Eaux de Paris (SAGEP). Report, 71 pages, july 1999. Update : 1998-2004 in Shadi Sedghi et Paul Trousseau : *Evolution des consommations d'eau à Paris de 1997 à 2004, analyse des facteurs.* Eau de Paris et Ecole des Ponts. Juillet 2005. 120 pages dactylographiées.

12. Chambre régionale des comptes d'Ile-de-France, rapport d'observation définitives sur la gestion du département du Val-de-Marne, mai 2003, 18 pages. (http://www.ccomptes.fr/crc/rods/22/IFR200308.htm)

13. Département de la Seine-Saint-Denis, conseil général : *assainissement urbain départemental et actions concertées pour l'eau*, schéma 2003-2012, AUDACE consultant, rapport principal 32 pages + 22 fiches

thématiques. (*Départemental assembly of Seine-Saint-Denis, départemental urban sewerage and concerted actions for water, 2003-2012 framework*, main report 32 pages + 22 thematic files)

14. ECOLOGIC. Berland Jean-Marc et Cambon-Grau Sophie, *Comparing sewerage charges in Europe : France, country report*, 27 pages, 1998.

15. ECOLOGIC, Barraqué B., Cambon S., *Comparing water prices in Europe*, France country report, October 1996.

16. Ernst and Young, Etude relative à la récupération des coûts des services liés à l'utilisation de l'eau pour les districts hydrographiques français, for Ministère de l'écologie et du dévelppement durable, 2004, 108 pages. (Study on cost recovery of water related services for french hydrographic districts).

17. Guérin-Schneider L., *déroulement des procédures de délégation des services publics d'eau et d'assinissement en 2002*, laboratoire GEA, ENGREF, pour le Ministère de l'Ecologie et du Développement Durable, 2004. Procedures of call for tenders in the field of water supply and sewerage in 2002.

18. IFEN, *la gestion de l'eau potable en France en 2001*, collection Etudes et travaux, n°44. (Management of water services in 2001).

19. IFIP-TU Wien, *International Comparison of Water Sectors. Comparison of Systems against a Background of European and Economic Policy.* Informationen zur Umweltpolitik Nr 153/6 Vienna, October 2004. IFIP-TU Wien, W. Schönbäck, project coordinator, with contribution from ECOLOGIC Berlin, A. Kraemer, Director. Contributors for France : B. Barraqué (ENPC), J-M. Berland (OIEau), E. Brunet (ENGREF), S. Cambon-Grau (ENPC), L. Guérin-Schneider (ENGREF), R. Morvan (IFEN).
http://www.arbeiterkammer.at/pictures/d21/153_Band6.pdf

20. Lyonnaise des Eaux : *Enjeux des services de l'eau en France*, Septembre 2004, les cahiers de l'eau, 96 pages. Challenges of water services in France.

21. Ministère de l'écologie et du développement durable, *la gestion des services liés à l'utilisation de l'eau*, rapport réalisé par TNS SOFRES, juin 2005. Management of services in the water field –survey on 5300 local authorities
http://www.eaufrance.fr/docs/enquete-collectivites-SOFRES-2005/49EN62%20Rapport%20final_V3.pdf

22. Miquel G. Sénateur, *qualité de l'eau et de l'assainissement en France*, rapport pour l'Office parlementaire d'évaluation des choix scientifiques et techniques, 2003, 256 pages. Report for French Parliament on the quality of water supply and sewerage in France.

23. Blanc, S : *Flux financiers de l'eau en région Ile-de-France*, rapport pour l'Agence de l'eau Seine Normandie, Ecole des Ponts, 2002, 83 pages (financial flows of Ile de France region in the water sector)

24. B. Barraqué, J.-M. Berland, S. Cambon, Eurowater, vertical report on France, CEE-DG XII, janvier 1995, rapport dactylographié, 198 pages. Publié par F. Nunes Correia et R.A. Kraemer, Editeurs, Eurowater 1, *Institutionen der Wasserwirtschaft in Europa*, Spinger-Verlag, Berlin, 1997, 759 pages, pp 191-328.

Verifier 2004 E.C. statement, compliance or member state to UWWD

Statistical information on Ile-de-France region :
http://www.paris-iledefrance.cci.fr/pdf/eco_regionale/chiffres_cles/2005/cc_2005_population.pdf
http://www.insee.fr/fr/insee_regions/idf/rfc/docs/Numero112.pdf
http://www.paris.pref.gouv.fr/SDC/Sommaire/annexes/Annexe%201%20pdf/annexe%201.pdf

Figures on financial flows of water services at national level
http://www.economie.eaufrance.fr/IMG/doc/060105_CNE_comptes_eau.doc

## APPENDIX 1 : public-private partnership in water management : development, type of contracts, regulation

The success of private companies in France : history and recent development

It was after the middle of the XIXth century that private capital started investing in the water supply business at a large scale. Creation of *Générale des Eaux* (1853) and *Lyonnaise des Eaux* (1880) were supported by financial capitalism and by political circles. In 1853, the demand for stocks of *Générale des Eaux* was for instance greater than the offer (80 000 stock shares of 250 F each proposed, 390 000 asked for). *Lyonnaise des Eaux* was created by the bank *Crédit Lyonnais* with a stock emission as well. The two big companies developed their water business through purchase of small family water businesses that emerged during the first half of the XIXth century.
Engineers from *Grandes Ecoles* such as the prestigious *Ecole Nationale des Ponts et Chaussées* (created in 1747) provided an ideal expert working force for the newly created companies. French engineers were soon involved in the main businesses and political affairs of the country (including key fonctions in the central and local governments administration), providing to the water companies an interesting network of contacts for the development of the water supply market.

French private companies implied in water supply have been successful partly because of that incapacity of local authorities to manage depreciation of assets and also partly because industrialisation and urbanisation in France was much slower that in England or Germany. Private investors had time to invest and follow the pace of urbanism and infrastructure development in cities.

*Communal* water supply management through the contracting out formula started as early as *Générale des Eaux* was created (1853). The contracts were the result of a negociation between local governments and private operators.

Between 1938 and 1994, *communes* adopting contracting out formulas increased from 3 % to 58 % of the total number of French *communes* (contracted out services supplied respectively 17 % and 75 % of total population).

**Table 1 : four options for the management of PWS.**

| | Isolated commune | Joint board |
|---|---|---|
| direct labour | **1** | **2** |
| delegated | **3** | **4** |

N.B. : references **1, 2 ,3 ,4** defined above are used in table 3.1.

99,6 % of French *communes* were equipped with public water supply in 1988 (source : INSEE, 1988 communal inventory).
Table 2 gives repartition of *communes* between the 4 management options defined in table 1.

**Table 2 : water supply management options versus urban or rural nature of *communes* in 1988.**

| | rural (31 509 *communes*) | urban (4 898 *communes*) | >200 000 inhabitants. (755 *communes*) |
|---|---|---|---|
| 1 | 25,0 % | 21,7 % | 15,4 % |
| 2 | 24,3 % | 15,8 % | 16,6 % |
| 3 | 5,4 % | 18,6 % | 15,5 % |
| 4 | 45,4 % | 43,9 % | 52,6 % |

Source : INSEE, SCEES, *L'inventaire communal 1988*, collections de l'INSEE, 1989. Cited by Aliette Delamarre et alii, *Les services de réseaux en France. Intercommunalité, modes de gestion*. GIP Reclus, mai 1992, 23 pages.

There were 3892 joint boards in 1988 for water supply management, 3375 of them were SIVU (*syndicat*

*intercommunal à vocation unique*[5]—the oldest form of joint boards that multiplied particularly in rural areas to support the development of water supply), 455 of them were SIVOM (*syndicat intercommunal à vocation multiple*[6]) and 62 were *districts*[7].

Cooperation for water supply is more developed in rural areas than in urban areas. There is no correlation between any demographic characteristic of regions and adoption of joint boards even if joint board management seems to follow a negative gradient from the north west to the south east.

There are regional variations : all above mentioned forms of management are adopted in all regions with a preference for direct labour south of river Loire and for “affermage” in the north west and the south west.

Type of contracts for public private partnership

There are at least 6 forms of public private partnership. The most common type of contract is “Affermage”. There are in fact as many affermage contracts as utilities, each contract resulting from a particular negociation between one local authorities and one private operator (chosen after the call for tender). Concession is rare because most often investment risks remain in the hands of the local authorities.

- *Régie directe,* Direct Labour, Regiebetrieb: municipality does everything alone (investing, running, billing); no separate budget
- *Régie autonome*, Eigenbetrieb: same, but with separate budget
- *Société d’Economie Mixte*, Eigengesellschaft: municipality creates her own company which does everything
- *Gérance*, Management contract: investing & billing public, but private operator paid for its costs plus small profit (no risk)
- *Régie Intéressée*: same, but with incentives to perform in profits
- *Affermage*, Lease contract, Betriebermodell: Investing public ; O&M + limited reinvestment, and billing by private operator
- *Concession*, Konzession: private operator does everything, but hands infrastructure over to public authorities at end of contract

Regulation of public private partnership

**Law Sapin :** law n°93-122 of january 1993 on *prévention de la corruption et transparence de la vie économique et des procédures publiques* (corruption prevention and transparency of economic life and public procedures), called «law Sapin» started regulating service delegation. Such a regulation had been non existent until then and delegation was sometimes detrimental to tax payers or to customers. Main statements of law Sapin are as follows :
- delegation procedures must go through a call for tender,
- maximum length of delegation contracts must be limited to the average duration of infrastructure amortization (for infrastructures financed by the contractor). Contract prolongation is regulated,
- contracts cannot include clauses granting contractors works and payments that are not directly connected to service delegation,
- all contracts fees (*droits d'entrée*) asked by the local authority to the contractor must be justified.

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[5] Single purpose joint board.

[6] Multi purpose joint board.

[7] A "District Urbain" is a special association of neighbouring local authorities for planning and land-use control purposes. A District Urbain can be put in charge of some utilities.

Law "Sapin" was in turn made more flexible for small contracts by law n°94-679 of august 1994 and then reinforced by law "Seguin" n°95-127 of february 8th 1995 stating that contractors must give an annual report to the local authority, giving all necessary information about technical and financial service operation and about quality of service.

**Law "Barnier Mazeaud**" n°95-101 of february 2nd 1995 on environmental protection reinforced law "Sapin".
- Article 73 states that mayors (or presidents of joint boards) must edit an annual report not later than 6 months after the end of the fiscal year, on price and quality of public water supply service. For *communes* of more than 3500 persons, the annual report must be made available to the general public at any request. Decree n°95-635 of may 6th, 1995 gives a list of technical and financial indicators that must be integrated in the annual report.
- The law also limits the duration of *concessions* to a maximum of 20 years.
- Article 76 forbids the use of service fees (*droits d'entrée*) that local authorities were generally using for other purposes than for water service improvement.

## APPENDIX 2 : a water bill in greater Paris

**The following table presents a 120 m³ water bill for residential customer in the town of Vitry-sur-Seine.**
The annual consumption has been metered between april 2005 and april 2006.
The unit price calculated gives a good notion of pricing level at the beginning of 2006

**2006 price : 3,63 € / m³**

Vitry-sur-Seine is a township of a commune of 81000 inhabitants, located in Département of Val-de-Marne.

The aspect of the water bill depends upon the operator of water supply.

Vitry-sur-Seine, as most “communes” of Greater Paris, is supplied with water by a joint board, the “SEDIF” gathering 144 communes, which has contracted out water supply to Compagnie Générale des Eaux under “régie intéressée” formula. Vitry-sur-Seine is depending on three actors for the management of sewerage services : the technical service of the commune itself, SDEA service at Département of Val de Marne (départemental service responsible for water and sewerage) and a joint board at interdépartement level : SIAAP (syndicat intercommunal d’assainissement de l’agglomération parisienne).

**120 m³ water bill of a SEDIF customer connected to centralised sewerage**

| | Vol. m3 | € / m3 | Total € | vat 5,5% |
|---|---|---|---|---|
| **WATER SUPPLY** | | | | |
| *Consumption* | **120** | **1,39** | **166,8** | **yes** |
| *Service fee (independent of volume) : 4 three-monthly period* | **120** | **5,27** | **21,1** | **yes** |
| *Meter rental : 4 three-monthly period* | **120** | **2,74** | **10,94** | **yes** |
| Abstraction charge – préservation resource (*agence de l’eau* | **120** | **0,56** | **6,70** | **yes** |
| | **Total water supply** | | **205,54** | **11,10** |
| **SEWAGE COLLECTION and TREATMENT** | | | | |
| *Redevance communale* (charge paid to the commune) | **120** | **0,31** | **37,0** | **no** |
| *Redevance interdépartementale* (paid to SIAAP) | **120** | **0,56** | **67,57** | **yes** |
| *Redevance départementale* (paid to the département) | **120** | **0,37** | **44,07** | **yes** |
| Pollution charge (*agence de l’eau*) | **120** | **0,50** | **60,51** | **yes** |
| | **Total sewerage** | | **209,15** | **9,40** |
| **OTHER FEE or TAX** | | | | |
| *taxe "Voies navigables de France"* | **120** | **0,007** | **0,88** | **0,06** |
| | | | | |
| **TOTAL WATER BILL** | **120** | **3,63** | **436,1** | |

The water bill cumulates 4 three-monthly bills. The total volume billed is 120 m3 which is the reference for comparison of water price per m3 in France.

Water supply represents 47% of the water bill
Sewerage represents 48%, pollution charge included
VAT and national fund for navigable waters: close to 5%

The next document shows the water bill of an individual home located in southern suburb of Paris, in Val-de-Marne *département* (94) in the town of Vitry-sur-Seine (81000 inhabitants). That bill is one of the 4 three-monthly bills received by a customer during the year.

SYNDICAT DES EAUX D'ILE DE FRANCE

VEOLIA EAU

ISO 9001 - ISO 14001 OHSAS 18001 Certifié par BVQI

**Vous pouvez nous écrire à :** page 1
Véolia Eau-Compagnie Générale des Eaux
94417 SAINT-MAURICE Cedex

**Site d'accueil de Saint-Denis**
**10,rue Albert Walter (M° St Denis - Basilique)**
de 8h30 à 17h45 sans interruption du lundi au vendredi
de 9h00 à 11h45 le samedi

**Nous répondons à vos appels au :**
☎ **0811 900 900**
du lundi au vendredi de 7h30 à 19h30 sans interruption
le samedi de 9h00 à 12h00
☎ **0811 900 918** **Urgences fuites (24H/24)**

05174

# Facture

émise par Véolia Eau-Compagnie Générale des Eaux le : 05.04.2006

▶ **montant prélevé : 120,64 Euros**
**reprise sur facture(s) antérieure(s) :** 0,00 Euros
**à partir du : 18.04.2006**

**numéro client :** [redacted]
référence facture
1339546 05 06094141 | 323 - 000

**nom du client et adresse de la propriété desservie :**
[redacted]
94400 VITRY SUR SEINE

| | |
|---|---|
| **volume consommé en m3** | **32** |
| période de consommation facturée | du 05.01.2006 au 27.03.2006 |
| montant de votre facture TTC | 120,64 Euros |
| dont : Consommation | 111,26 Euros |
| Prime fixe et/ou loc. de compteur | 9,38 Euros |

**nom et adresse du destinataire de la facture :**
[redacted]RANCIS
[redacted]
94400 VITRY SUR SEINE

Le détail de votre facture figure au verso.

**Message** **Le montant de votre facture représente 0,4 cent(s) par litre dont 0,2 cent(s) pour le Service de l'Eau.**

page 2

▶ **index et volume**

| numéro de compteur | nouvel index | | | ancien index | | volume en m3 |
|---|---|---|---|---|---|---|
| 99022033 | relevé par vos soins | le 27.03.06 | 730 | du 05.01.06 | 698 | 32 |

**Volume total facturé en m3 : 32**

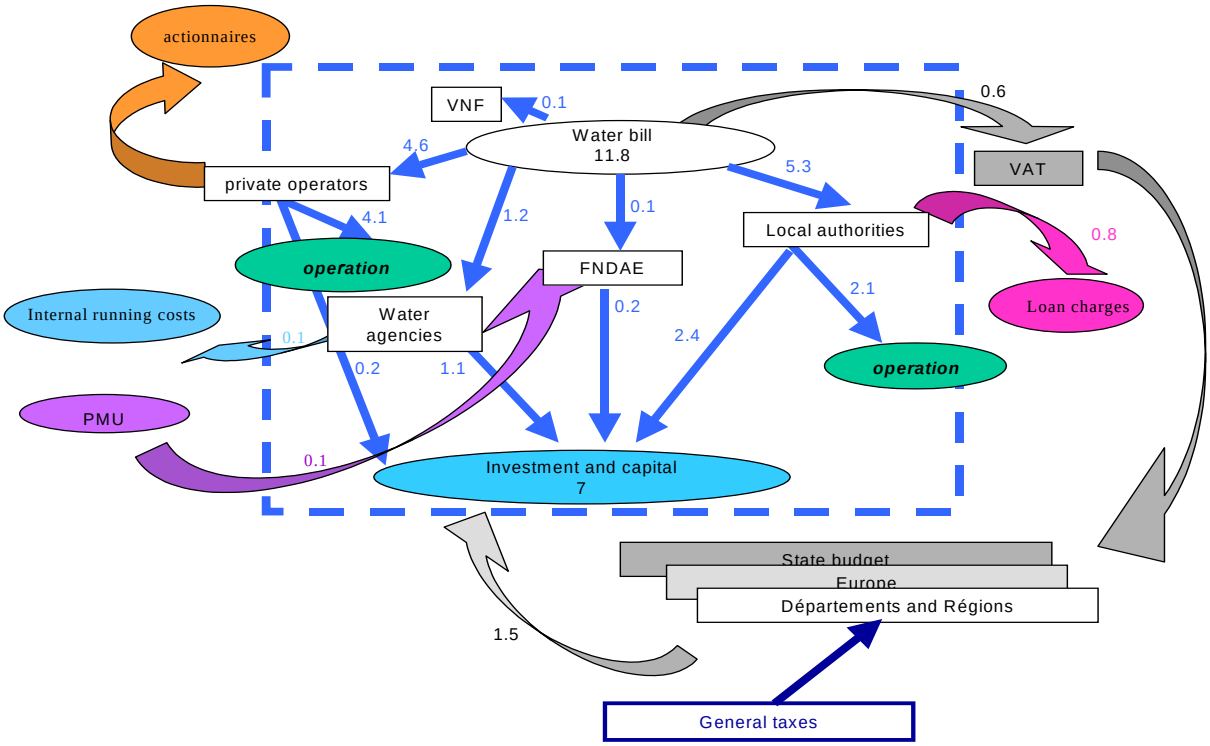
## Détail de votre facture

| | volume ou quantité facturé | prix unitaire en euros | montant HT en euros Service de l'eau | montant HT en euros Autres organismes | taux TVA | montant TVA en euros |
|---|---|---|---|---|---|---|
| **DISTRIBUTION DE L'EAU** | | | | | | |
| • Consommation | 32 | 1,4213 | 45,48 | | 5,50 % | 2,50 |
| • Prime fixe | 2 | 3,0558 (1) | 6,11 | | 5,50 % | 0,34 |
| (contribution aux frais fixes du Service de l'eau) | | | | | | |
| • Location de compteur trimestrielle 2 TRIM 06 | | | 2,78 | | 5,50 % | 0,15 |
| • Préservation des ressources en eau | 32 | 0,0561 | | 1,79 | 5,50 % | 0,10 |
| (Agence de l'Eau Seine-Normandie) | | | | | | |
| **COLLECTE ET TRAITEMENT DES EAUX USEES** | | | | | | |
| • Redevance communale | 32 | 0,3150 | | 10,08 | 0,00 % | 0,00 |
| • Redevance interdépartementale | 32 | 0,6017 | | 19,25 | 5,50 % | 1,06 |
| • Redevance départementale | 32 | 0,3788 | | 12,12 | 5,50 % | 0,67 |
| **ORGANISMES PUBLICS** | | | | | | |
| • Lutte contre la pollution | 32 | 0,5315 | | 17,00 | 5,50 % | 0,94 |
| (Agence de l'Eau Seine-Normandie) | | | | | | |
| • Développement des voies navigables | 32 | 0,0082 | | 0,26 | 5,50 % | 0,01 |
| (Voies Navigables de France) SEDIF 15/12/2005 | | | | | | |
| **Total :** | | | **54,37** | **60,50** | | **5,77** |

(1) Après rabais de 40,00 % appliqué au prix de 5,0930 €

OLIA EAU-COMPAGNIE GÉNÉRALE DES EAUX, régisseur, SCA au capital de 2 207 287 341 Euros - 52, rue d'Anjou 75008 Paris, 572 025 526 RCS Paris
individuel d'identification à la TVA : FR 17 25 7500 017

## APPENDIX 3 : water supply and sewerage services, national financial flows, 2001




*Rough estimate (more or less 20%) of the global financial transfers dealing with water and sewerage services (Guérin 2003, report for Austria, adapted from Bouleau G., ENGREF, 2001)*

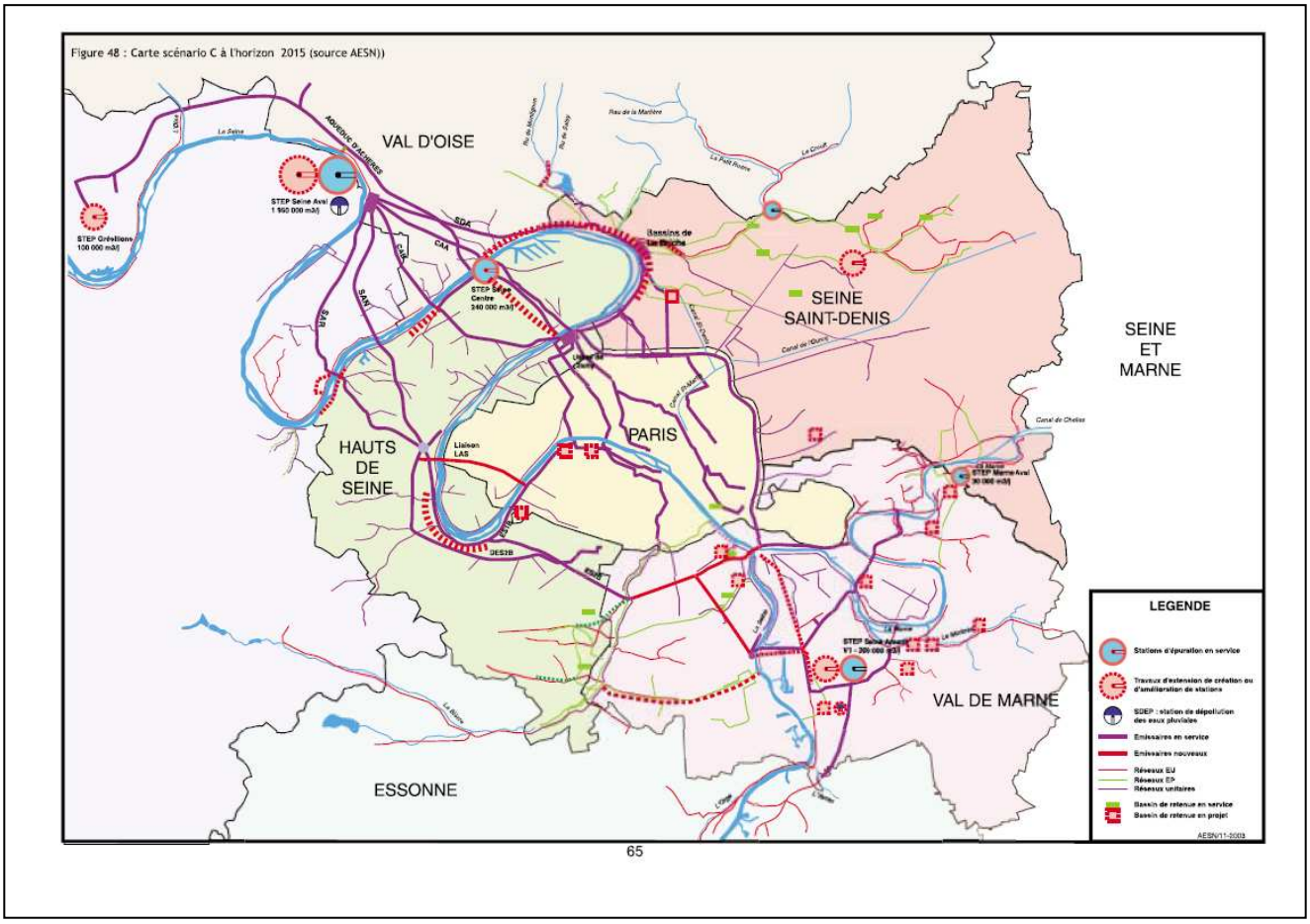
Actionnaires = stakeholders
PMU = horse bet gambling

## APPENDIX 4 : some investment costs

| | Investment | O&M (per year) |
|---|---|---|
| A WTW for a population of 150 000 | 50 000 000 € | |
| 1 km of interceptor, diameter 2m | 10 000 000 € | |
| 1 km small sewers | 400 000 € | |
| A machine for sewer clean out (cureuse) | 150 000 € | |
| 4 street drains (bouches d'égout) | 15 000 € | |
| 1 storm water basin storage, capacity 15 000 m3 | 6 000 000 € | 80 000 |
| 1 pump for sewer overflow control | 50 000 € | |

In file n°8 on cost control, Seine-Saint-Denis, 2003 (réf. 13).

## APPENDIX 5 : map of SIAAP treatment means in 2015.




## APPENDIX 6 : data for cost recovery analysis

### Sewage transportation costs

**Policy and cost recovery in *départements* in Petite couronne.**

- 93 and 94 manage sewage collection direct labour whereas 92 has given out operation and part of renewal to SEVESC private operator.
- The amount of départemental tax is equivalent in the 3 départements
- The 3 départements are more of less spending the same annual amount of works but 93, which is very sensitive to flooding invests a lot on storm water control equipment, which is not the case in the two other *départements*
- None of the départements is granting regular subsidies to communes of their territory (communal networks eventually connect to départements mains).

The accounting is not the same in the 3 départements. 93 and 94 are splitting the amounts between investments in sewage and storm water. It is not the case in 92.

In the period 92 to 99, the average investment spendings have been as follow (euros 2001) :

| Investment budget | Nature of investment | Average per year 1992 to 1999 M€ | Of which average subsidies *agence de l'eau* | Of which other subsidies (Ile-de-France region) | Depreciation total WW + SW |
|---|---|---|---|---|---|
| Département 94 (Val-de-Marne) | Waste water (WW) | 25,2 | | | |
| | Storm water (SW) | 11,3 | | | |
| | Total | 36,5 | 27% | 17% | 22% |
| | | | | | |
| Département 93 (Seine-St-Denis) | Waste water | 10,8 | | | |
| | Storm water | 9,7 | | | |
| | Total | 20,5 | 18% | 16% | 23% |
| | | | | | |
| Département 92 (Hauts de Seine) | Total WW+ SW | 19,6 | 24% | 17% | 22% |
| | | | | | |

Trend for investments : decrease in investments in 94 and 92 ; stable investments in 93 (mostly for storm water control) over the period 1992-1999
No general trend for subsidies
Trends for depreciation : depreciation has increased a lot from 1997 on, probably because of application of M49 instruction compelling utilities to make provisions for assets depreciation. Increase has been very important in Val-de-Marne from 1997 to 1999.

Recipes are coming from water bills and land occupation charge. For the 3 départements the annual level of recipes was 76,6 M€ in the period 1992-1999 (in 2001 euros) (Source : Blanc report, 2002)

**Policy and cost recovery in communes of Petite couronne.**

**Paris**
SAP service d'assainissement de Paris (sewerage service in Paris) :
Revenues 83 M€ of which 51,4 M€ from customers (Paris sewerage charge) and 31,6 M€ come from Paris general budget for storm control, charge on land use and other subsidies such as AQUEX –financial help given by *agence de l'eau* upon improvement of operation efficiency.

This is compatible with the national instruction on budgets rules in case of unitary systems. From 20 to 40% of the annex budget for sewerage can be transferred from the general budget to finance storm water collection and treatment.

**Other communes**
There is no centralised data on cost recovery of communes of Petite couronne (36 communes in "92", 47 communes in "94" and 40 communes in "93").

However the Agence de l'eau Seine Normandie report on Hauts-de-Seine indicate that cost recovery at national level is 140% (including depreciation and future investments, whereas it is 240% in communes of Hauts de Seine (ref. 2).

***Départements.***
In the *départements* of Greater Paris, financial data vary and make a global comparison very difficult.

In Val-de-Marne, the public accounting regulator indicates a very sound situation of sewerage operation

(reference 12). In Particular, Val-de-Marne has a good self financing capacity from users water bills.

From 1995 to 2000, financial data are as follows : both revenues and expenditures increased on average by 1,7%/year.

Expenditures

- average operation budget : 44 M €
- average investment budget : 32 M €
    - 15 M€ / year saved for self financing capacity (from water bill revenues) (34% of revenues)
    - 8 M€ / year subsidies, mostly from Agence de l'eau revenues (from water bills with solidarity as basin scale)
    - 9 M€ new debt and moderate use of provisions (fonds de roulement)