Section 3
Assessment of Current Conditions

3.1 Water Resources

The cities of Tijuana and Playas de Rosarito currently obtain water from two primary water resources: surface water from the Colorado River and ground water coming from several aquifers, such as Tijuana, La Misión and Rosarito (see Figure 2-1).

Table 3-1 shows the water production from the main supply sources for the year 2001.

Table 3-1
Average Annual Water Production for 2001

Source	l/s
El Carrizo Reservoir	3,133
Abelardo L. Rodríguez Reservoir	38
Río Tijuana Wells	73
La Misión Wells	51
Rosarito Wells	22
Total	**3,317**

Source: Subdirección de operación y mantenimiento, Potable Water Department, CESPT 2001.

Occasionally, rainwater is stored in both reservoirs to supply Tijuana. However, this is not a reliable source of water due to the unpredictability of rain in the area. This will be discussed later in subsection 3.1.1.

3.1.1 Condition and Capacity

To resolve the problem of a lack of surface water from rain and the limited amount that can be extracted from the existing aquifers in the region through deep wells, the State Government, assisted by the Federal Government, has taken the following important actions:

- The construction of the Abelardo L. Rodríguez Reservoir in 1937.
- The construction of wells and a conveyance line in 1963 in La Misión, located approximately 37 miles (60 km) south of the City of Tijuana.
- The construction of the Colorado River-Tijuana Aqueduct in the 1980s.

The Colorado River: Main Supply Source

The International Water Treaty with the United States of Feb. 4, 1944 established an allotment of 1,850 million m^3 of water annually from the Colorado River for Mexico. Slightly more than 4 percent of this water is for urban-industrial use. The National Water Commission (Comisión Nacional del Agua, CNA) is in charge of the allocation and control of this water.

The City of Tijuana has an official annual allotment of 80.1 million m^3 (2.54 m^3/s) of national surface water for its exploitation and use, with a national, annual ground water volume allotment of 93.213 million m^3 (2.956 m^3/s), as stipulated in Title No. 1BCA100301/07HMSG94, signed October 13, 1994. Currently, according to CNA, CESPT is assigned 80 millions of m^3 in the discharge of wells in la Mesa Arenosa of San Luis, Sonora, not accounting for the conveyance losses in the main network of Irrigation District 014 resulting in the point of control of the Central Canal Feeder or reform to the Colorado River-Tijuana aqueduct canal feeder of 72 millions of m^3. If the 9.0 millions m^3 and the 3.3 millions m^3 assigned to Ensenada and Tecate (92.3 millions m^3 totals), respectively, are added with the same losses in the control point the result is 83.07 millions m^3, and in the year 2002 approximately 125 millions of m^3 were delivered, there fore more than 30 millions de m^3 need to be regulated.

If the mentioned title has a the Colorado River as a specific supply source, CESPT has an agreement with the agricultural community from Irrigation District No. 014, to exchange water from the Mesa Arenosa Aquifer for water from the Colorado River (groundwater for superficial water, CNA, 1996).

The Colorado River-Tijuana aqueduct is operated by the State Water Services Commission (Comisión de Servicios de Agua del Estado, COSAE), since it also transports water to Tecate. The aqueduct was built in 1975, with a capacity of 45.4 mgd (2 m^3/s), but due to the growing demand for water, the aqueduct was enlarged in 1991 to a capacity of 90.7 mgd/s (4 m^3/s). The enlargement of El Florido Water Treatment Plant followed this from 45.5 to 90.7 mgd (2 to 4 m^3/s). A study conducted by the COSAE in 1999 showed that the actual capacity of the aqueduct is 90.7 mgd (3.9 m^3/s) (COSAE, 1999).

The length of the aqueduct is a little less than 70 miles (112 km) when it reaches the El Carrizo Reservoir (Figure 3-1). The principal components of the aqueduct are:

- The Morelos Reservoir (a diversion Reservoir) on the Colorado River
- A 16.3 miles (26.3 km) concrete lined channel
- Six pump stations with 90.7 mgd (4 m^3/s) capacity, equipped with three pumps, and one spare pump, to elevate the water to 3,477 feet (1,060 m)
- 78 miles (126 km) of conveyance lines
- Two concrete tunnels, 4.3 and 2.45 miles (6.95 and 3.95 km) near the La Rumorosa area
- Six electrical substations
- Three sedimentation, concrete lined tanks 8.7 million gallons (32,750 m^3) and seven surge tanks 23 feet (7 m) in diameter and 15 feet (35 m) in height)

- Five suction tanks with a capacity of 8,100 m^3, one in each plant from PB-1 to PB-5.

El Carrizo Reservoir

El Carrizo Reservoir has a total storage capacity of 11,471 million gallons (43.5 million m^3), and a usable volume of 9,088 million gallons (34.5 million m^3). This represents a supply of approximately four months from the Colorado River, based on the volume distributed in the year 2001. In case of emergency, the CNA requires a minimum three-month supply of storage. The water from the El Carrizo Reservoir is conducted to the El Florido potable water treatment plant, through two pipelines; one is a 72-inch diameter of reinforced concrete (183 cm diameter) and the other is a 48-inch diameter of ductile iron, with an 8.4 mile (13.6 km) longitude.

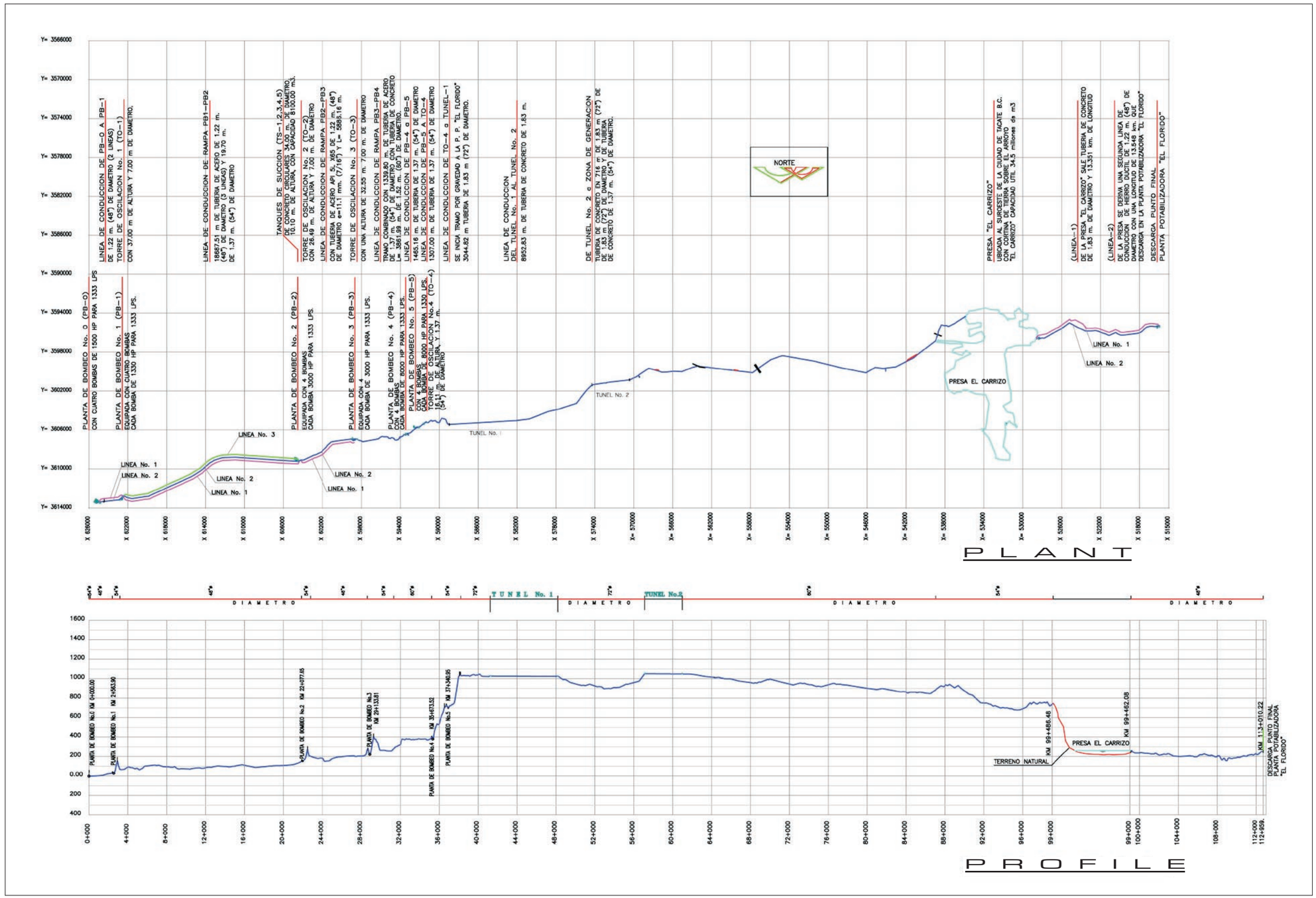
Some sections of the conveyance pipeline between El Carrizo Reservoir and the El Florido plant need maintenance. There have been some small leaks through cracks, due to the age of the pipeline and to other factors such as their irregular connections (unauthorized) before the water arrives at the El Florido Treatment Plant.

Figure 3-1 shows the outline and floor plan of the Mexicali-Tijuana Aqueduct, including the location of the most important facilities.

Deep Wells

The wells are located in the City of Tijuana in the Río Tijuana area, in Playas de Rosarito and in the town of La Misión. The results of a study from August 2000 on the gauging of the wells (AFOROS, 2000) to determine the volume of water that the wells can extract from the aquifers showed that it is feasible to extract around 12 mgd (528 l/s). Currently, however, they are only extracting 3.3 mgd (146 l/s), or 28 percent of the total available water.

Some wells are out of service, due to the poor quality of the water; others are used for irrigation of green areas. There are 98 registered wells, of which, 45 are operated by CESPT and 49 by CNA; another four are for private use and for water trucks. (CESPT, 2001). Of the 45 wells that are operated by CESPT, only 15 are in operation and in most of them the electromechanical components are in need of general maintenance (see Table 3-2).



Legend

- Aqueduct line No.1
- Aqueduct line No.2
- Aqueduct line No.3
- Body of water

CDM

Figure 3-1
Mexicali-Tijuana Aqueduct

Playas de Rosarito

The municipality of Playas de Rosarito is supplied by treated water from the Colorado River, through the La Misión-Tijuana Aqueduct, (a pipeline made of AC and PVC with a 20 inch (508 mm), diameter and a maximum capacity of 6 mgd (250 l/s). The amount of water supplied from this line varies throughout the year, depending upon the demand in the supply area. Normally in summer there is a flow of 4 mgd (180 l/s) and during winter the flow is approximately 2 mgd (100 l/s). Playas de Rosarito receives its supply of water form the La Misión wells.

The La Misión-Tijuana Aqueduct starts at the pumping plant located in the town of La Misión (with an elevation of 3 m.s.n.m.) and flows to the Herrera Tank in the City of Tijuana. The Herrera Tank, with a regulation capacity of 1.3 million gallons (5,000 m^3), is located at an elevation of 473 ft (144.20 meters) above sea level. The Herrera Tank is supplied by water coming from the Aguaje de la Tuna Tank.

Water from La Misión aquifer is also used to supply Playas de Rosarito. Currently there are four wells with a capacity of between 48 and 55 gal/s (180 and 210 l/s). However, only one well supplies 1.4 mgd (60 l/s) to Rosarito, from which 457,000 gpd (20 l/s) are conveyed to the Bajamar area.

The volume extracted from each one of the wells is shown in Table 3-2, along with the location, physical condition and year of construction of the well (please note that of the four La Misión Wells we only have information for three).

Abelardo L. Rodríguez Reservoir

The Abelardo L. Rodríguez Reservoir is used as an auxiliary source of water, with a storage capacity of 137 million m^3. This Reservoir was constructed in 1937 to control and impound the run-off from the Las Palmas River and the Arroyo Seco. However, due to low rainfall amounts, the water level has been historically low. CNA requests that CESPT maintain a storage volume equivalent to three months of water demand for Tijuana and Playas de Rosarito. Another reason for requiring this minimum storage volume is to prevent a significant deterioration in the water quality. During the summer of 1996, elevated levels of manganese were detected 0.25 a 0.5 mg/l in water of Abelardo L. Rodríguez Reservoir, requiring the use of permanganate of potassium 2.75 mg/l in the reservoir's pump station. Much of this substance was retained in the filters of the Abelardo L. Rodríguez Treatment Plant, resulting in less than optimum filter runs and a decrease in production rate.

Table 3-2
Record of Wells

No.	Facility Code	Name	Location	City Section	Physical State *	Year Built	Depth (m)	Static Level (m)	Dynamic Level (m)	Flow (l/s)
1	11101	Well 3	Boulevard Lázaro Cárdenas and Insurgentes	Álamos	1	1975	85.00	5.64	6.48	15.00
2	11109	Well 36	Vía Rápida Oriente and Calle Alfonso Reyes	Zona Río Tijuana	1	1965	28.00	5.20	6.70	55.00
3	11111	Well Xd	Francisco Goita between Doctor y Puente	Zona Río Tijuana	1	1992	51.51	4.88	28.00	6.00
4	11112	Well XA-4	Vía Rápida Oriente and Avenida de la Paz	Zona Río Tijuana	1	1993	55.00	4.84	35.00	9.00
5	11113	Well 73	Avenida Centenario and Avenida Padre Kino	Zona Río	1	1993	50.60	5.58	24.00	6.00
6	21102	Well 56	Callejón Piedrera and Cañón de la Piedrera	Cañón de la Piedrera	1	1995	85.36	45.82	67.78	10.00
7	21109	Well 17	Calle San Felipe and Calle Libertad	Los Santos	1	1995	39.93	5.48	29.40	20.00
8	21116	Well 14	Vía Rápida Poniente between Calle Ermita and Libertad	Los Santos	1	1993	36.58	16.05	23.00	25.00
9	21117	Well 70 (*4)	Avenida Sinaloa de Leyva and Calle Baburias	Los Angeles	1	1993	50.00	4.45	15.19	5.00
10	51101	Well 4 (La Misión)	Valle de la Misión	La Misión	1	1993	30.48	2.70	6.90	90.00
11	51102	Well 5 (La Misión)	Valle de la Misión	La Misión	1	1993	24.38	6.00	9.50	82.00
12	51104	Well 10 (La Misión)	Ejido la Misión	La Misión	1	1994	48.76	5.00	7.00	68.00
13	51105	Well 2 Rosarito	Calle Mexicali and Tijuana Rosarito	Machado Sur	1	1990	54.25	18.60	25.24	6.00
14	51106	Well 1 Rosarito	Calle del Árbol and Rosarito	Rancho los Olivos	1	1965	35.00	3.00	32.60	10.00
15	51108	Well 3 Rosarito	Tijuana Ensenada highway km 21 and Calle del Árbol Rancho los Olivos	Not available	1	2000	-----	-----	------	10.00

*1, wells in operation.
Source: Subdirección de operación y mantenimiento (Departamento de electromecánica y Oficina de hidrometría, 2001 CESPT).

The last time that a significant volume of rainwater was available from the Abelardo L. Rodríguez Reservoir was in 1993, during a rainy period. CESPT did not have to divert water from the Colorado River for an 18-month period. The usable volume of the Reservoir when full is 137 million m^3, though the CNA established 26.2 million m^3, as the minimum volume. Currently this amount represents approximately a 3-month supply from the Colorado River, based on the volume distributed in 2001. However, in 2001 the storage volume increase due to rainwater runoff was approximately 0.5 million m^3, or less than 1 percent of total supply originating from the Colorado River in 2001 (Source: Departamento de Agua Potable, Sub-dirección de Operación y Mantenimiento de la CESPT, 2002).

Due to the lack of rain (the average annual rainfall in the region is 9-inches (224 mm), in 2001, the CESPT started a program to divert excess water (not needed to meet demands) from El Carrizo Reservoir to the Abelardo L. Rodríguez Reservoir. The goal is to increase the storage volume in the Abelardo L. Rodriguez Reservoir to be able to use the water in excess of the minimum CNA storage level.

Although there is a limited amount of water resource attributed to rainfall in the region, occasionally there are very wet periods, as in 1993, when the Rodríguez Reservoir filled, and even discharged a significant amount of water to the ocean. This typically occurs during the years with the climatological phenomenon called El Niño. During these periods, CESPT avoids pumping water from the Colorado River, using the rainwater caught in the Abelardo L. Rodríguez Reservoir to satisfy the system demands, the equivalent of a 1 to 1.5-year supply. The rainy season in the area lasts from November to April. The overall operation of the Reservoir (draw and fill with Colorado River water) could be coordinated to optimize the capture of rainwater during those months. A detailed hydrological and watershed protection study should be conducted to help define how the reservoir should be operated to optimize the collection of rainwater and to protect the source water quality. A watershed protection study should establish strategies to protect the reservoir from unplanned development, which could significantly contribute to a decline in water quality and therefore an increase in the cost of water treatment.

Desalinization

In the 1960s, the Federal Electricity Commission (Comisiíon Federal de Electricidad, CFE), built a desalinization plant in Rosarito; however in the 1970s, it ceased operating.

Although desalinization is a promising option for water deficient coastal areas, such as the study area, no detailed studies have been completed for either Tijuana or Rosarito on the use of this technology. The desalinization option will be discussed later in Section 6.

3.1.2 Planned Improvements

There are two proposals whose primary objective is improving the provision of water in the period 2000-2010 in the study area.

The first proposal is an upgrade of the Colorado River-Tijuana Aqueduct and improvement of pump stations to increase conveyance capacity from 89 mgd (3.9 m^3/s), its real capacity, to 119 mgd (5.2m^3/s). The estimated cost to plan and finish the project is approximately 428 million pesos, with a project deadline of five years from planning to construction (CESPT, May, 2000).

The second proposal is the Integral Tapping of the Water Table, using the Rio Tijuana Wells, which need to be restored and reconditioned in order to extract a flow of 12 mgd (528 l/s). The cost of this project is 298 million pesos, at 2000 prices, according to the study "Programa Financiero para la Optimización de la Capacidad Existente y el Desarrollo de Nuevas Fuentes de Abastecimiento de Agua Potable en la Zona Costa de Baja California".

Lastly, there is a proposal to set up an emergency waterworks to deliver water from the United States to Tijuana, which would have a flow of 14 mgd (600 l/s).

The proposed projects are shown in Table 3-3.

Table 3-3
Proposed Project and Total Usable Flow

Action	Benefit Flow (l/s)
Upgrades to the ARCT to increase capacity.	1,300
Equip wells in the Río Tijuana Zona Poniente aquifer.	140
Equip wells in the Río Tijuana Zona Oriente aquifer.	130
Restore and equip wells in the Zona Norte.	40
Drill and equip wells in the Alamar arroyo.	120
Otay Interconnection (connection with United States).	600
Total	**2,330**

Source: Proposal for the supply of potable water to the municipalities of Tijuana and Playas de Rosarito, short term 2000-2010 (CESPT, May 2000).

All of these projects will be considered in Task 6 (F), which evaluates future supply alternatives.

3.1.3 Current Deficiencies in the Supply Sources

Colorado River water makes up approximately 94.5 percent of the water used in the study area. Currently the supply exceeds the CESPT allotment, but the allotment can be increased by purchasing water rights from the users of the Irrigation District of the Colorado River. CESPT currently uses only 5.3 percent of the total volume of the Colorado River water allotted to Mexico, since most of it is used for agriculture. Nevertheless, the study area could benefit from developing alternative supplies, especially from local sources that could offer greater reliability than the more distant sources, like the Colorado River.

The Colorado River-Tijuana Aqueduct has a limited capacity of 91 mgd (4.1 m^3/s). Although CESPT should research developing alternative supplies, the Colorado River will remain a key resource for the near future. Some studies are being conducted on

improving the supply of the existing aquifers and incorporating new aquifers. We recommend a continuation of these studies so that the improvements can bring long-term benefits to the region.

The Abelardo L. Rodríguez Reservoir is a key component for the storage of rainwater run-off during significant rain events and for the optimization of the use of Colorado River water. The dam needs to store excess water during periods of low demand, so the stored water is used during periods of high demand. A study should be undertaken to develop a plan that optimizes the operation of the reservoir relative to the use of the available storage volume, while protecting or even improving the water quality. This study should include a hydrological evaluation as well as a watershed protection study.

The potential groundwater sources in the region seem to be under-exploited and have not been adequately defined or studied. Additional studies are required for a better definition of the potential of these groundwater sources and their water quality. Opportunities exist to augment the supply by using groundwater injection of highly treated wastewater on both sides of the border.

In addition, desalinization is a potential option, especially for the Rosarito region due to its coastal location. Currently, there are no in-depth studies of desalinization in the region. Several studies have been done on desalinization in coastal Southern California. CESPT may want to take advantage of this interest in developing desalinization in the region and may wish to consider soliciting planning proposals from private entities for the private development of desalination facilities along the coast. These studies will serve to better define the optimal location of facilities and they will help CESPT to plan now for potential future facilities.

3.2 Water Production

Potable water supply data was obtained from meetings with the staff of CESPT, site visits to the water treatment plants, interviewing the staff in charge of operation and maintenance of the systems, analyzing information provided by the staff from CESPT's Department of Potable Water (Departamento de Agua Potable), and from other institutions.

3.2.1 Condition and Capacity

CESPT utilizes two surface water treatment plants and three groundwater basins (wells) for potable water production. The surface water treatment plants are the El Florido Water Treatment Plant, supplied via the El Carrizo Reservoir, and the Abelardo Rodriquez Water Treatment Plant, supplied via the Rodriquez Reservoir. Groundwater production is from a series of wells withdrawing from the Rio Tijuana, Rosarito, and Mission aquifers.

The water extracted from the Colorado River goes first to the El Carrizo Reservoir, and later it is piped to Tijuana and Rosarito. This reservoir has an elevation of 830 feet (253 m) above sea level and a total capacity of 11,492 million gallons (43.5 million

m^3), of which 9,090 million gallons (34.5 million m^3) are usable. The reservoir feeds the El Florido Water Treatment Plant. In the year 2001 there was an average rate of 72 mgd (3,164 l/s), through two pipelines; one is a 72 inch diameter of reinforced concrete (183 cm diameter) and the other is a 48 inch diameter of ductile iron, both pipes with an 8.4 mile (13.6 km) longitude.

There is an aqueduct between the Rodríguez Reservoir and the El Florido Water Treatment Plant that was built in 1993, made up of a pumping station (PB 6) and a 48 inch, ductile iron, diameter transmission main with a length of 5.3 miles (8.5 km). Surplus water not treated in the El Florido Water Treatment Plant can be transferred to the Abelardo L. Rodríguez Reservoir through this same pipe. The pipe was constructed to be utilized to the maximum and to extract, in the least time possible, the water stored in the reservoir to reduce the losses by evaporation, to utilize the capacity of existing treatment, significant save in electrical energy when the Colorado River-Tijuana aqueduct does not operate and the ability to give maintenance to the pipelines. The pipeline material used is ductile iron. Prior to 1996 (during rainy periods), the El Florido Water Treatment Plant was also fed by the A. Rodríguez Reservoir through this aqueduct. However, in 1997 the water level in the Rodríguez Reservoir dropped significantly due to the drought, and Tijuana has had to import close to 95 percent of their required water from the Colorado River.

The production history of all these water sources is shown in Figure 3-2, which contains data from the years 1998-2001. Figure 3-2 shows the months of July and August as having the maximum monthly production of all the sources in operation (the maximum for the year 2001 was 2,626 million gallons / month (9.9 million m^3 / month) in August. The month of February shows the lowest production 1,959 million gallons (7.4 million m^3). The monthly average for the year 2001 was 2,302 milion gallons (8.7 million m^3).

El Florido Water Treatment Plant

Production History

The El Florido Water Treatment Plant is the largest producer of potable water in the system. The highest production rate is during the summer months and the lowest production is during the winter months, with a monthly average of 2,166 million gallons (8.2 million m^3) during 2001. Figure 3-3 shows the average production of this plant.

The water from the El Florido Water Treatment Plant is conveyed to regulation tanks for later distribution. Currently, there is enough storage in the tanks to satisfy demand during the hours of maximum usage, which should contribute to minimizing flow variations in the plant. Nonetheless, there are significant variations in the water production rate during the day, which adversely impacts the treatment processes, because of the lack of storage for treated water within the plant, and the lack of system operation optimization, among other things.

The Treatment Process

The El Florido Water Treatment Plant has two treatment modules with a capacity of 43 mgd (1.9 m^3/s) each, for a total of 89 mgd (3.9 m^3/s). Figures 3-4 and 3-5 illustrate the treatment process. The first treatment module consists of 4 pulsator sludge-blanket type clarifiers (super-pulsator), followed by 12 filters. The second module was built in 1993 and consists of a direct filtration process (without flocculation or clarification) with 12 filters.

Both modules share the same coagulation step with cationic polymer, the reagents injected into a common pipeline upstream of both modules. Other than mixing due to turbulence at bends and at the discharge into tanks, no other mixing is provided. Table 3-4 presents a summary of the treatment plant processes.

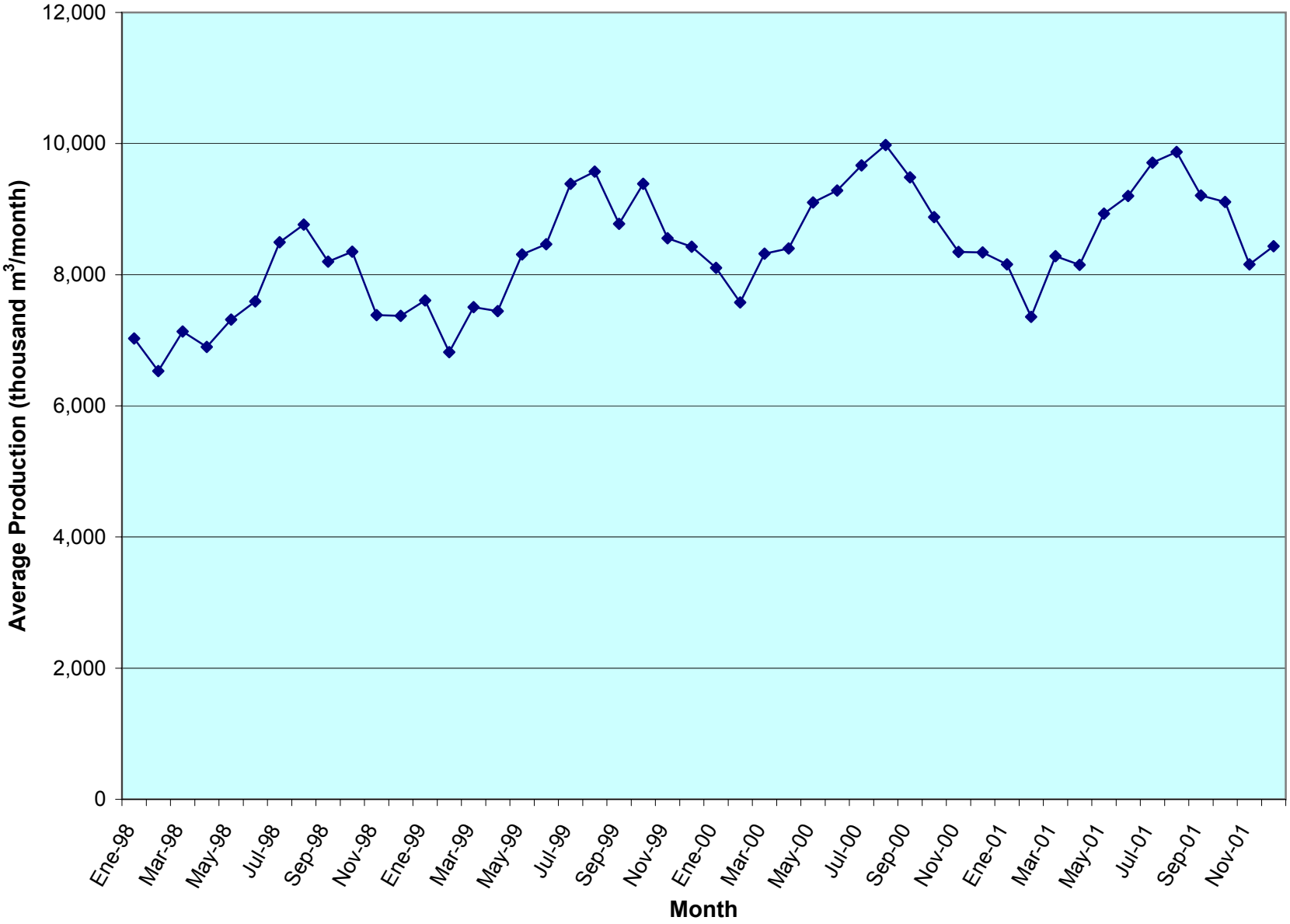


Figure 3-2
Historical production of all water sources

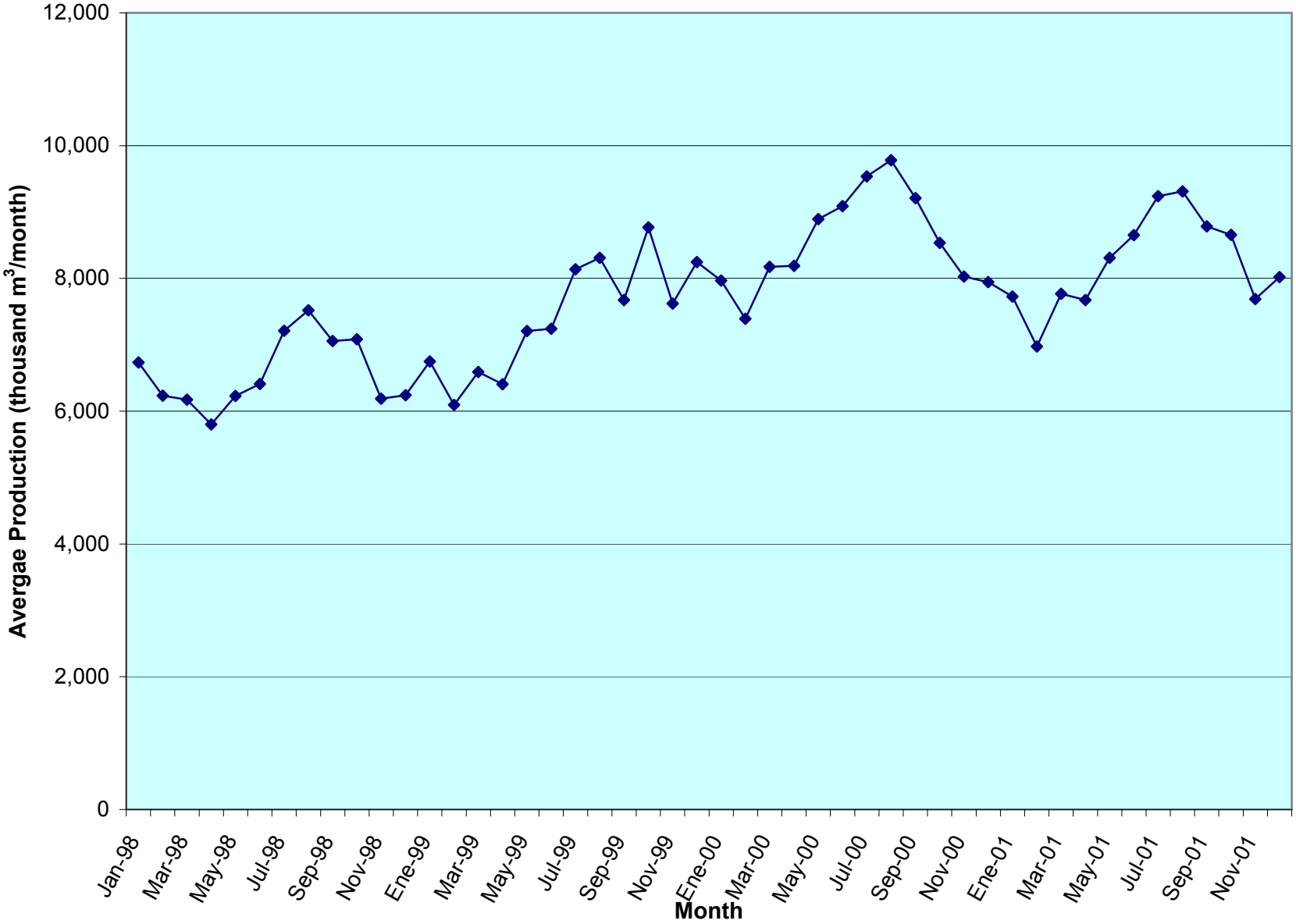


Figure 3-3
Historical production of El Florido water treatment plant