METITO

Commitment to a Cleaner Environment

ASPROKREMMOS WATER TREATMENT WORKS FOR PAPHOS, CYPRUS

A Case Study

INTRODUCTION

Cyprus is an island with a rich history located in the sapphire blue waters of the Mediterrean Sea. The country is blessed with almost year round sunshine, and, together with golden beaches, high mountains, modern facilities and hospitable people it continues to attract millions of tourists every year.

This ever-increasing tourist industry combined with the island's own recent rapid development, has countinuously stretched nature's limited supply of water. The government has been wisely investing to manage this limited available natural water by building dams to collect the rainwater and by regulating river waters.

Paphos is a major tourist city located in the south western part of Cyprus that has been experiencing unprecedented growth and, as the demand for drinking water grew, there was a requirment to treat water from the nearby Ezousa river and Asprokremmos dam on the Xeros river. A sizeable investment was approved by the Government of the Republic of Cyprus to treat the water and convey it to the existing network. Following an international bidding process, the Department of Water Development of the Ministry of Agriculture, Natural Resources & Enviroment awarded Metito the design and construction contract of a new potable water treatment works.

Project execution involved complying with the strictest international standards and specifications set by the consulting engineers, Howard Humphreys & Partners Ltd. of Surrey, England. The specification requirements presented a number of challenging tasks for the designers. The most challenging task was to design the plant to run at its maximum capacity with limited available gravimetric hydraulic head of a mere 6 m between the bottom of raw water tank and top of the treated water reservoir. Furthermore, the project has been planned for completion in two stages, however all the common equipment and facilities have been designed taking into consideration the future capacity. The first stage has been designed and constructed so as to enable the future conversion of the aeration unit to a pre-ozonation facility, the installation of ozone generation plant associated equipment and the conversion of filters from sand media to GAC (Granular Activated Carbon).

The treatment plant is now supplying the water after successful completion of the project, working under challenging technical and contractual conditions.

GENERAL INFORMATION

The complete package comprises the following :

- Raw Water Tank
- Pre – chlorination
- Aeration
- Chemical coagulation by Aluminium Sulphate and Polyectrolyte
- Sludge recirculation
- Flocculation
- Clarification
- Sludge thickening
- Filtration
- pH adjustment
- Post-chlorination
- Treated water reservoir
- Chemical handling
- Chlorine building ventilation and neutralization system
- Sludge drying beds

PLANT TECHNICAL CHARACTERISTICS

Water supply source:

The treatment works receive water from two sources, namely Ezousa river, identified as the primary source, and Asprokremmos dam on the Xeros river. Water from the river Ezousa abstracted at a diversion weir travels about 25 km through a 600 mm diameter pipe before reaching the raw water storage tank. Since the Asprokremmos dam mainly serves irrigation needs, this source of water was to be used only when the water supply in the Ezousa river is inadequate. Water from Asprokremmos dam is pumped to the treatment works through a 2.7 km long 600 mm diameter pipe.

A VIEW OF THE SLUDGE THICKENER

Capacity:

The nominal output of the plant is 31800 m3 per day in the first stage, increasing to 47700 m3 per day after construction of the second and final stage. The plant is designed to produce treated water to the specified quality on a daily basis at any flow ranging from 15% to 125% of nominal output, with total losses not exceeding 2% of the raw water input.

Taking the above into consideration, the capacities of the individual treatment units were decided as follows.

Treatment Plant	stage I (m3/d)	stage I I (m3/d)
Nominal output	31,800	47,700
Minimum output	4,770	7,155
Design maximum output	39,750	59,625
Hydraulic capacity	41,340	62,010

The design influent water characteristics are as follows:

Constituent	Units	Range
pH		7.6 – 8.8
Conductivity	mhos/cm	370 – 1100
Chloride (as Cl)	mg/l	30 – 160
Carbonate (as CaCO3)	mg/l	0 – 12
Bicarbonate (as CaCO3)	mg/l	160 – 370
Sulphate (as SO4)	mg/l	20 – 130
Iron (as Fe)	mg/l	0.1– 0.7
Turbidity	NTU	0.2 – 50
Colour	Hz (mg/l Pt/Co scale)	5 – 50
COD	mg/l	0 – 7

Water temperature varies from 8 to 15 deg C.

Guaranteed water quality:

Treated water from the plant at any output between 15% to 125% during any 24 hour period is guaranteed as follows:

Constituent	Units	Value
Iron (as Fe)	mg/l	< 0.1
Turbidity after filtration	NTU	< 0.2
Colour	(Pt/Co scale)	< 5
Manganese	mg/l	< 0.05
Aluminium	mg/l	< 0.1
Taste		unobjectionable
Dissolved oxygen (not less than)		60% of saturation
Residual chlorine (not less than)	mg/l	0.2
pH		7.5 – 7.8
Bacteriological standards:		Free from coliform organism

AN OVERVIEW OF THE WATER TREATMENT PLANT SITE

Furthermore, the treated water complies with the maximum permissible concentrations for other parameters given in the EU's Drinking Water Directive and the drinking water guidelines set by the World Health Organization (WHO). For pesticides and related contaminents, provision has been made in the plant design for future introduction of ozone dosing and the change of filtration media to granular activated carbon instead of sand.

TECHNICAL DATA

Raw Water Tank: Water is received from the source and stored in a two-compartment 8000 m3 elevated concrete tank, where it is injected with chlorine. Water from this tank flows to the treatment works through a 25 km pipeline, and is regulated by a special plug type modulating control valve.

Aeration & Future Ozonation: These are provided to remove possible H2S, increase the dissolved oxygen and oxidize iron. The process utilizes two 270 m3 aeration basins catering for Stage I of the project. A third aeration basin has been constructed for stage II, while the inlet has been designed to provide equal flow to all three basins.

All the installed equipment is suitable for conversion to the future planned change. Accordingly, the aeration basins are totally sealed and have gas tight stainless steel access manholes. Sealed observation port holes are provided on chamber walls for visual verification of the diffusion process.

The blower house is designed to accommodate blowers for stage I and stage II, as well as equipment required for the future ozone generating plant.

Chemical Coagulation and Flocculation: Coagulation is employed to destabilize particles by adding Aluminium Sulphate, whilst Polyectrolyte is used to agglomerate the particles. This is achieved by flash mixing the chemicals through a hydraulic jump that is further aided by mechanical agitation.

Flocculation is accomplished in successive slow mixing compartments that are provided with vertical variable speed paddle mixers.

Clarification: Lamella type clarifiers were chosen for the process. Lamella gives the advantage of optimized space utilization coupled with high removal efficiencies. Lamella is constructed by placing parallel stainless steel plates inclined at 55 degrees to the horizontal. The plates can be easily removed for cleaning. Sludge concentrators are provided within the clarifier basin to produce sludge with 2-3% consistency.

Filtration: Four fully automatic downflow, dual cell, rapid gravity type sand filters are provided. Equipment and pipework have been arranged and connected so that two more filters can be added under Stage II. An efficient underbed collection and distribution system is of extreme importance in the performance of any filter. With this in mind, an underbed collection and distribution system of special suspended concrete floor with polypropylene strainer nozzles has been chosen. The filter floor is constructed using pre-cast concrete panels. When the slabs are placed on the support pillars, the special construction of the slab provides a leak tight joint in a monolithic slab structure. The polypropylene strainer levels have been set using laser technique to maintain accuracy within 3 mm. This ensures uniform collection of filtrate in the downward direction and an even distribution of air and

THE MOTOR CONTROL CENTER

water in the upward direction. The filters internal arrangement is designed to

enable a media depth increase of 1m for future conversion of the sand filters to activated carbon filters.

Treated Water Reservoir: The total reservoir volume is 6000 m3. The reservoir is divided into two compartments having roof slabs. Chlorine contact tanks of 300 m3 constant volume are located at the inlet of each compartment.

Chemical Plant: This includes chemical handling, weighing equipment, chemical preparation tanks, chemical dosing pumps, chemical pipework and ancillaries. Chemicals handled are Alum, Lime and Polyelectrolyte. Alum and lime are used in powder form. Fully enclosed bag loading hoppers with dust tight lids and dust extraction system are provided to ensure that no dry particles of lime or alum spread during charging. Two months storage facilities are provided on a higher floor, from where the measured quantities are fed to the solution preparation tanks.

The Polyelectrolyte system is a continuous preparation and metering type dosing a 0.1 % strength solution.

All chemical dosages are automatically controlled by variable stroke dosing pumps through appropriate flow/analyzing signals.

THE CHLORINE NEUTRALIZATION TOWER

Chlorination System: The chlorination system is designed to provide a dose of up to 2.5 mg/l of chlorine for both raw water pre chlorination and disinfection of treated water.

The Chlorine gas supply system consists of vacuum regulators, vacuum operated automatic switchover module, chlorine gas manifolds complete with all accessories. Four 7 kg/h chlorinators are provided to deliver an adjustable chlorine quantity between 0.2 to 4 kg/h.

A separate building is provided to store 28 liquid chlorine ton containers. The drums are arranged in two parallel rows and served by a 2-ton electrically operated monorail hoist. The building is provided with continuous gas leakage monitoring and an automatic ventilation system connected to a chlorine gas neutralization system.

Sludge Treatment and Disposal: The facility comprises sludge transfer, thickening, recirculation, extraction and

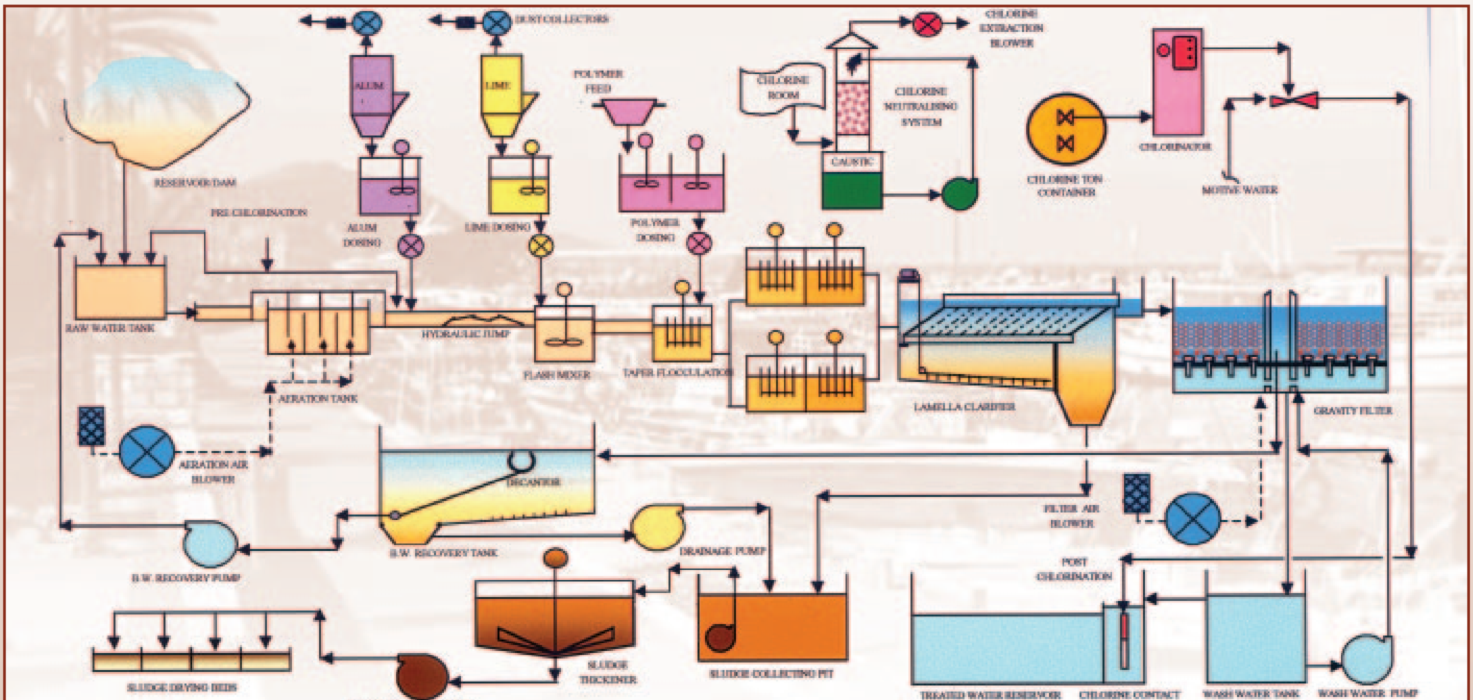
A VIEW OF THE FLOCCULATION CHAMBERS AND LAMELLA CLARIFICATION UNITS

drying. Two sludge thickeners are provided having 24 hours storage capacity. Underflow sludge with solids content of 4% is dried over the sludge drying beds to increase the solids content to 30%. The beds are sized to contain dried sludge volume equal of 2 years production at plant nominal output.

Water Quality Monitoring and Sampling:

A continuous water quality monitoring system is provided. Samples are extracted from a number of points, and these are lead to a central sampling stainless steel sink located in a laboratory that is fully laid out to enable carrying out of analytical tests of the various water samples.

Process Control and Measurement: Control and instrumentation are designed to provide fully automatic operation. Process control is performed through programmable logic controllers, and process equipment are supplied with instrumentation and devices for status indication and alarms, with signals transmitted to local control panels and to the supervisory computer equipment located in the central control room, where all measured values are displayed on the Supervisory Computer.



SCHEMATIC FLOW DIAGRAM