# “Sewerage Board of Limassol Amathus Wastewater treatment, Effluent, Sludge and Energy Reuse”

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**Improving Efficiency in Water Management**

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# PRESENTATION CONTENTS

- Introduction
- Sewerage and Drainage Scheme of Limassol Amathus
- Wastewater Treatment and Reuse
- Sludge Treatment and Reuse
- Biogas Production and Reuse
- Sustainable Urban Drainage Systems

# INTRODUCTION

# HISTORIC DATA

## Historic Milestones

- Sewerage and Drainage Mater Plan - 1974
- SBLA Establishment - 1980
- Sewerage Master Plan - 1989
- Commencement of Construction Works Phase A - 1992
- Storm Water Drainage Master Plan - 1992
- Area Expansion - Sewerage Master Plan Update - 1995
- Area Expansion - Storm Water Drainage Master Plan Update - 2002
- Area Expansion - Sewerage Master Plan Update - 2005
- Area Expansion - Sewerage Master Plan Update - 2009

# MISSION

**Construction, Operation and Maintenance of The Central Sewerage and Drainage System of Greater Limassol Area, with the objective**

- of improving the quality of life,
- environmental preservation and
- upgrading of hygienic conditions in the area.

# SEWERAGE AND DRAINAGE PROJECT

## Construction in stages

- **Phase A:** Construction started in 1992 Completed in 1995

  **Cost: 70 million euro**

- **Phase B1:** Construction started in 2000 Completed in 2004

  **Cost: 50 million euro**

- **Phase B2:** Construction started in 2006
  Expected to be Completed in 2013

  **Expected Cost: 350 million euro**

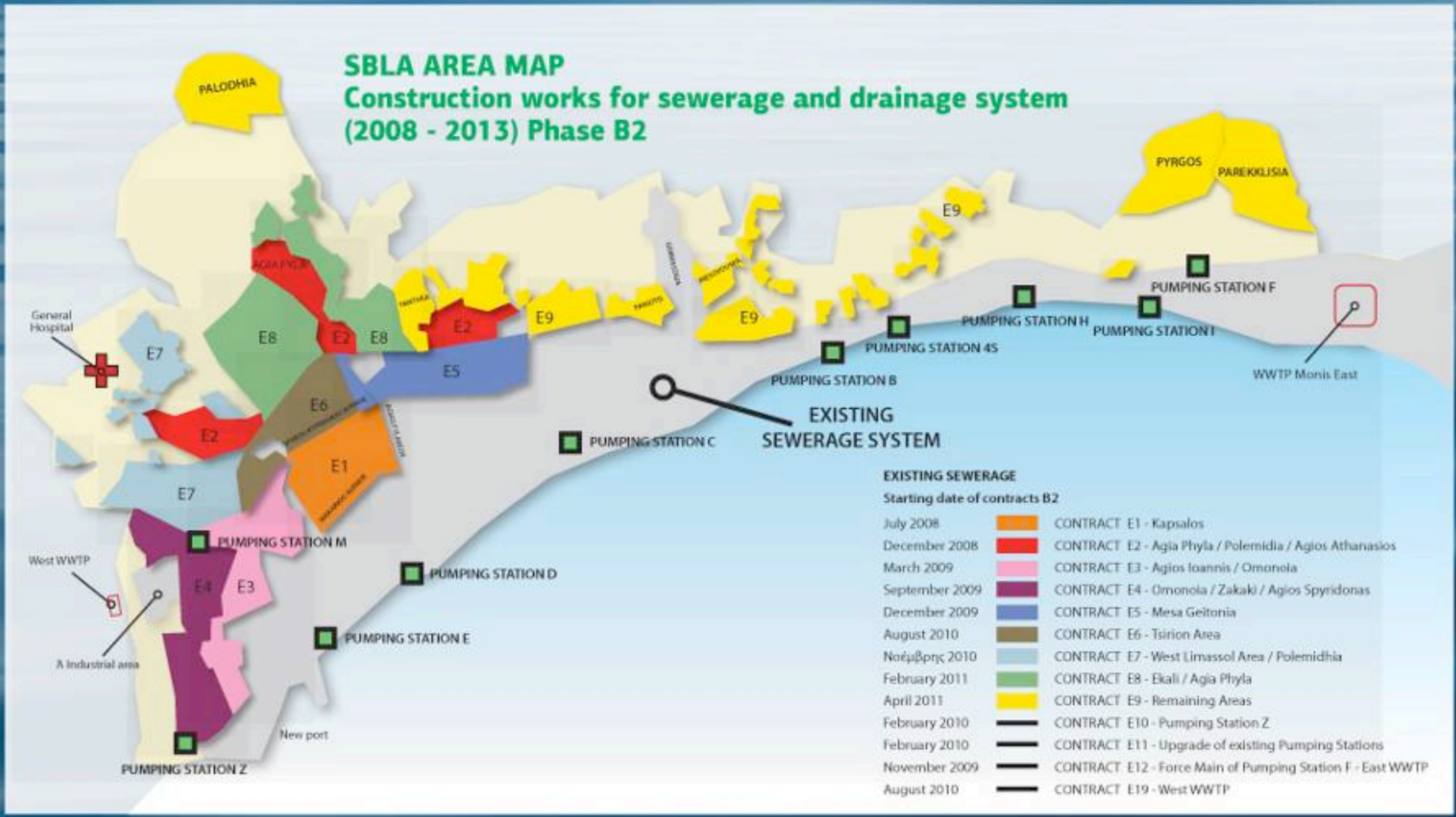
# Phase B2 - MAJOR OBJECTIVES

- Extension of Sewerage Network to cover the entire SBLA area
- Extension & Upgrading of existing sewage treatment and pumping Infrastructure
- Construction of priority Storm Water Drainage & Flood Control Infrastructure

# SEWERAGE WORKS - Phase B2

- Extension of the existing WWTP at Moni area to 40.000 m³ per day as compared to 22.000 m³
- Extension of the existing sewerage network by about 470 km increasing the network to about 800 km
- Extension of the existing Force Main and Gravity Mains by at least 15 km
- Upgrading of six large Pumping Stations
- Construction of one additional large Pumping Station
- Construction of a new WWTP in western Limassol
- Construction of Flood Control and Storm Water Drainage System

# PROJECT IMPLEMENTATION CONTRACTS (14)



# Waste Water Treatment Plant1995 prior to 2008 expansion

(Capacity 22.000 m³ per day)

# Waste Water Treatment Plantfollowing 2008 expansion

(Capacity 40.000 $m^3$ per day)

# STAGES IN SEWAGE TREATMENT PROCESS

- **Pre-treatment process**
- **Primary Settlement**
- **Biological Treatment**
- **Secondary Settlement**
- **Tertiary Treatment**
- **Disinfection with sodium hypochlorite**
- **Sludge Treatment**
  (Thickening, Digestion, Dewatering & Drying)
- **Biogas Production**
- **Electricity Power Generation**

# SEWAGE TREATMENT PROCESS

**Treated Effluent**

**Reused for Agricultural and other Irrigation**

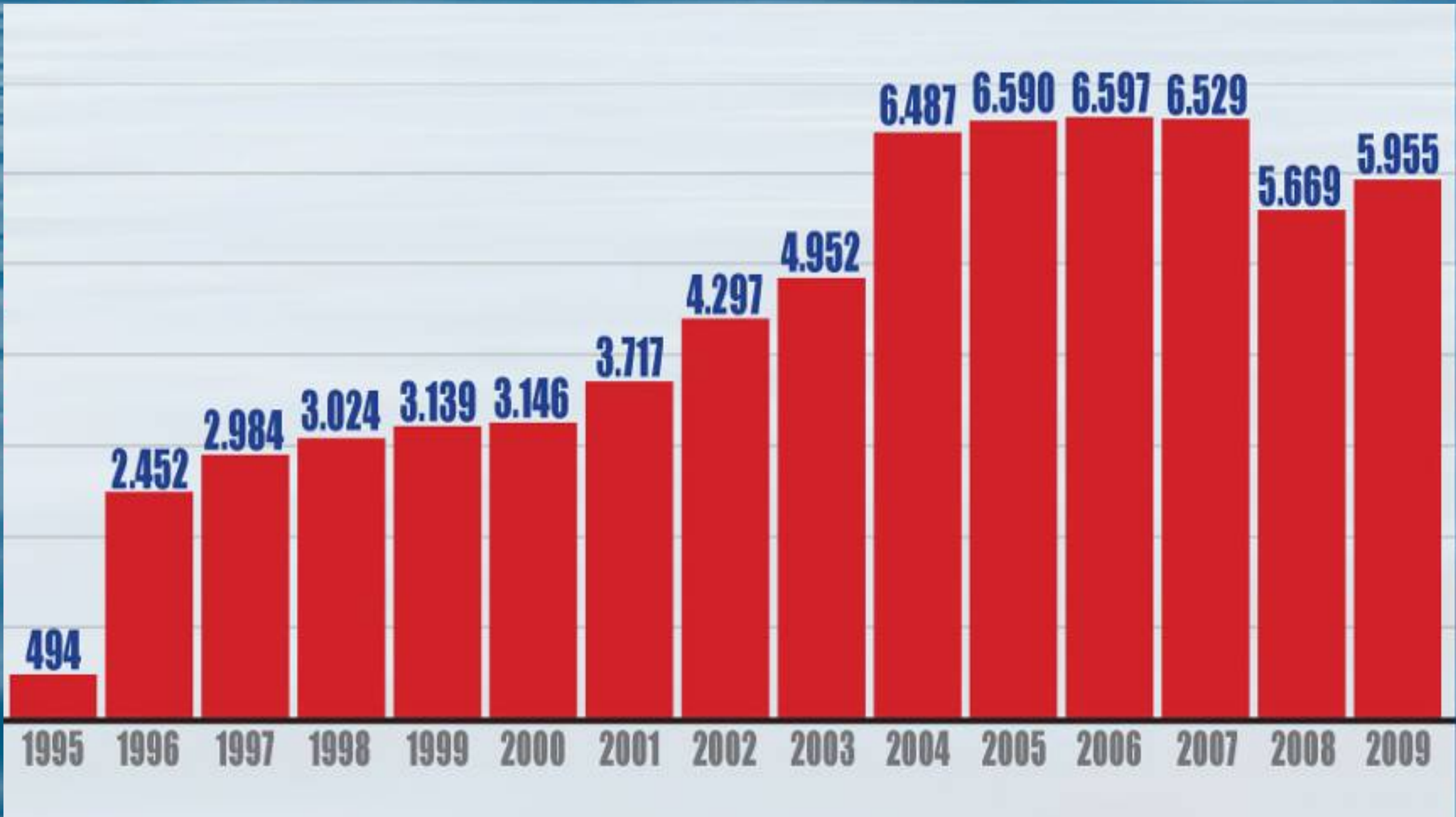
**Bio solids**

**Anaerobic Digesters**
(Digestion and stabilisation)

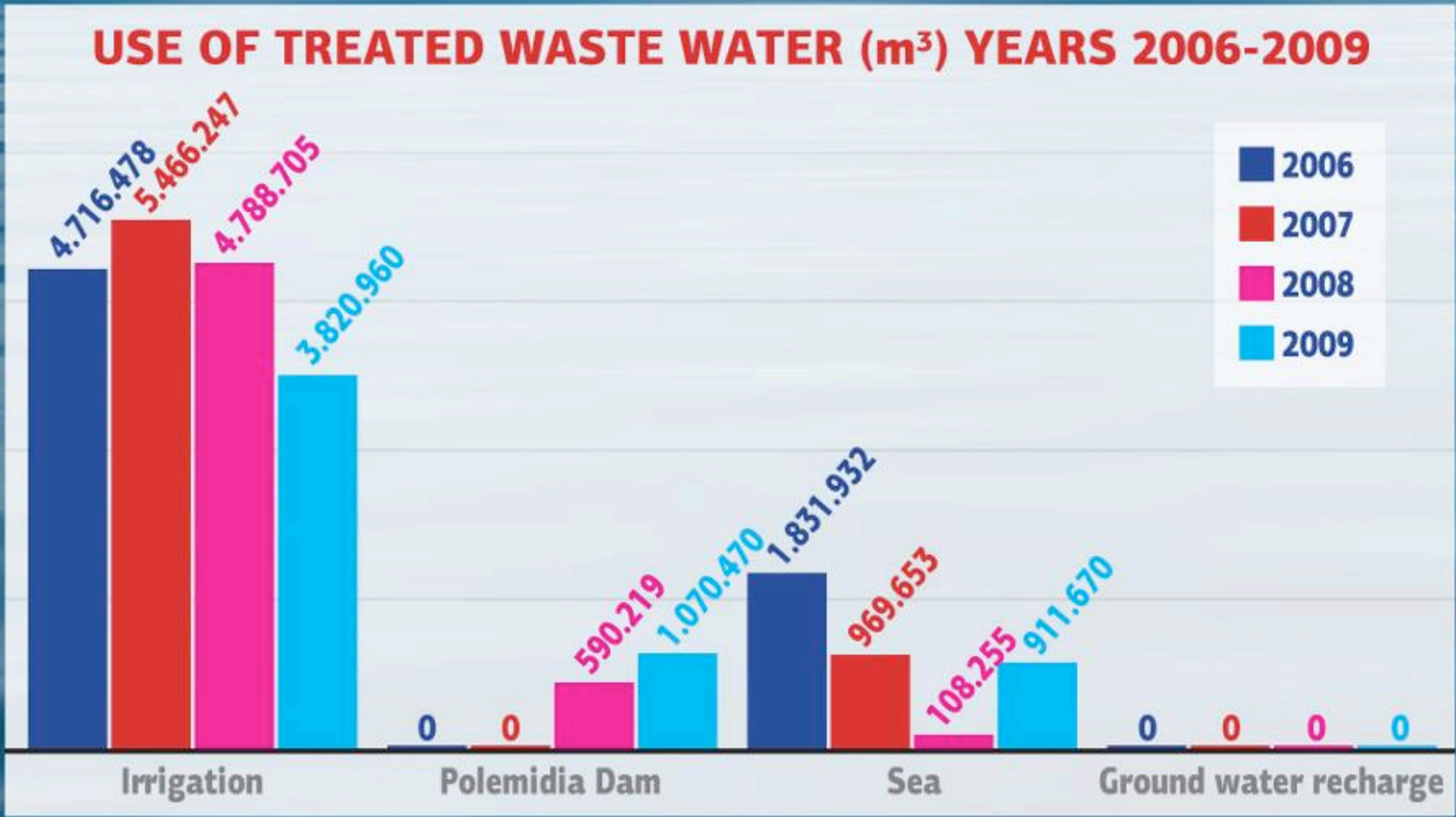
**Methane (>65%)**

**Biogas reused as renewable Energy Source "Green Energy". Environmentally Friendly Energy used as a fuel for the Operation of Gas Generators for Electricity Generation and Thermal Generation in the CHP Unit** (Combined Heat and Power Unit).

# Annual Treated Effluent Production
## m³ x 1000

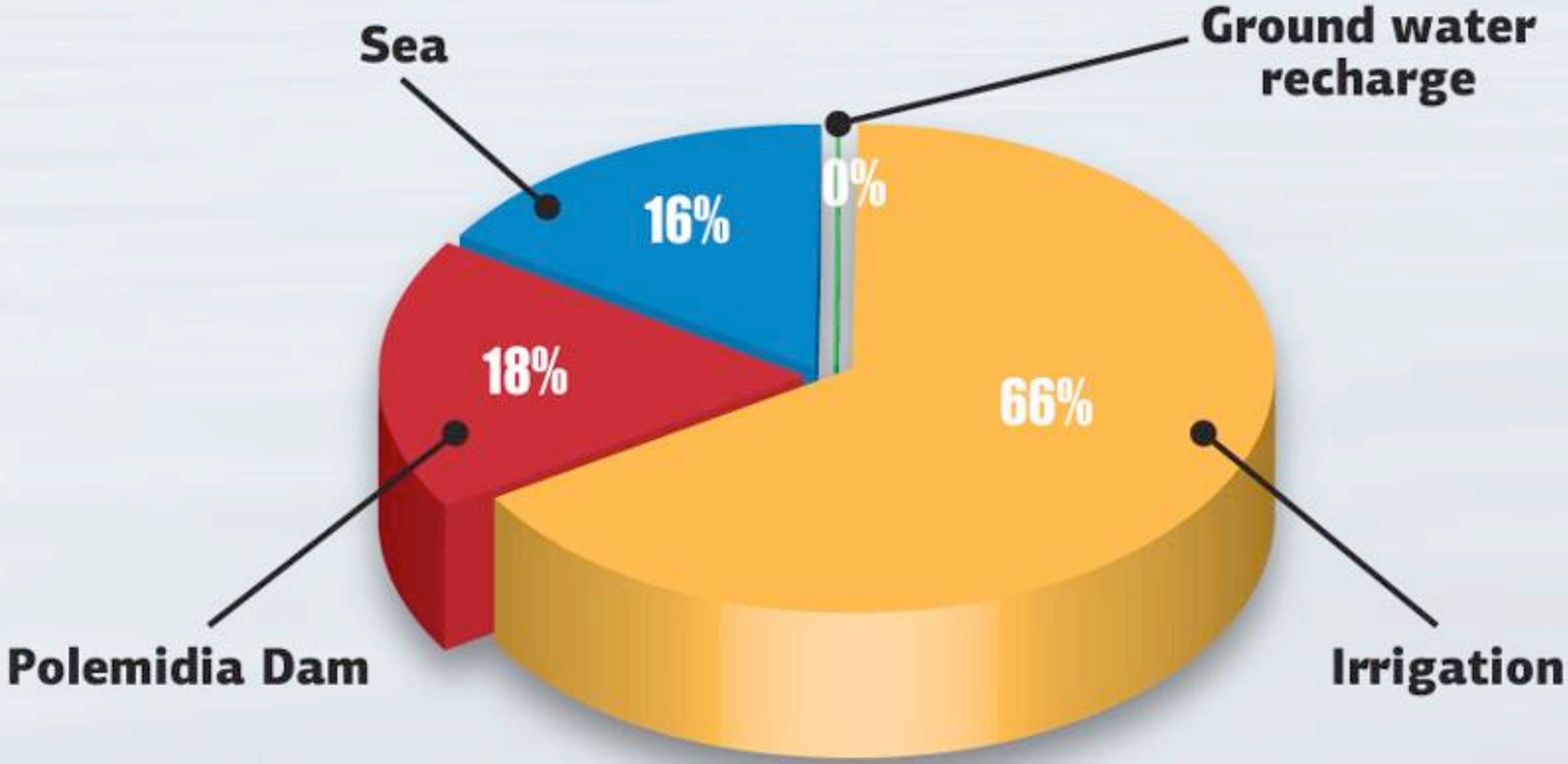


# Waste Water Reuse



# Waste Water Reuse 2009

## USE OF TREATED WASTE WATER ($m^3$) FOR YEAR 2009



# Waste Water Reuse 2009

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# Waste Water Reuse 2009

# Treated Effluent Quality

| | BOD 5 | COD | SS | Tot-n | Tot-p | Cl | Conductivity | Oil & Grease | Zn |
|---|---|---|---|---|---|---|---|---|---|
| **Aver. Value** | 7 | 42 | 4,21 | 5,95 | 4,81 | 265 | 1663 | 4 | 0,044 |
| **Conces-sion Limits** | 10 | 70 | 10,0 | 15 | 10 | 300 | 2200 | 5 | 1,000 |

# Treated Effluent Quality

| | Cooper (mg/l) | Lead (mg/l) | Cd (mg/l) | Hg (mg/l) | Cr (mg/l) | Ni (mg/l) | Bo (mg/l) | pH (mg/l) | Residual Clorine (mg/l) |
|---|---|---|---|---|---|---|---|---|---|
| Aver. Value | 0,012 | 0,003 | 0 | 0,007 | 0,008 | 0,020 | 0,303 | 7,8 | 0,78 |
| Conces-sion Limits | 0,100 | 0,150 | 0,01 | 0,05 | 0,100 | 0,200 | 0,750 | 6,5-8,5 | 1,00 |

# Treated Effluent Quality

| Cost Category | 2008 Euro | 2009 Euro | 2010 Euro | 2011 Euro | 2012 Euro |
|---|---|---|---|---|---|
| Energy Cost | 0,20 | 0,22 | 0,23 | 0,24 | 0,24 |
| Total Operating Cost | 0,80 | 0,82 | 0,85 | 0,88 | 0,87 |
| Administrative Cost | 0,45 | 0,51 | 0,51 | 0,50 | 0,47 |
| Depreciation | 0,74 | 0,71 | 0,64 | 1,10 | 1,58 |
| Financing Cost | 0,27 | 0,56 | 0,86 | 1,10 | 1,16 |
| Total Cost | 2,26 | 2,82 | 3,09 | 3,82 | 4,32 |

# Bio solid Treatment Process

- **Accumulation of Sludge in the primary and secondary settling tanks, aeration tanks and the filter plant**

- **Thickening takes place in the thickeners** (a process that increase the concentration of solid materials in the sludge)

- **From the thickeners the sludge is pumped to the anaerobic digesters. The digestion process of the sludge is achieved in 35 $^{O}$C temperature and minimum 18 days retention time and a further reduction of the organic load is achieved**

# Bio solid Treatment Process

- During the process, biogas is produced which is used to heat the digesters and for the generation of electricity power
- Water is removed from the digested sludge in special centrifuges and the dewatered sludge is collected and transferred for reuse
- In winter the dewatered sludge, is sun dried and used as a fertilizer in agriculture
- In summer, is directly transferred for use as a fuel supplement at a nearby Cement Factory, or transferred for use as land reconditioning at a quarry

# General Benefits
# From the Operation of the System in Limassol

- **Upgrading quality of life & Health conditions**
- **Environmental Preservation and Upgrading**
- **Saving and increasing water resources**
- **Saving of money** (Increased Efficiency)
- **Economic development and tourism**
- **Flooding incidences**
- **Improvement of standard of living**

## Specific Environmental Benefits From the Operation of the System in Limassol

- **Treated Effluent Reuse in Agriculture, Gardening, Industrial and other purposes including Groundwater Recharge. Currently 6 million cubic meters of Effluent are reused per year, gradually increasing to 13 million by 2016**
- **Groundwater preservation**
- **Clean Beaches** (Blue Flag in all beaches)
- **Bio Solids reused in agriculture for soil improvement and or as a Fuel Supplement in the neighbouring Vasiliko Cement Factory**
- **Green Energy Generation - Biogas reused for Electricity Generation**

# INNOVATIVE TECHNOLOGY
# Combined Heat And Power (CHP) Unit

# COMBINED HEAT AND POWER (CHP) UNIT

## Main Functions

- **Electricity Power Generation through Gas Generators**
- **Exploitation** (Reuse) **of Hot Water and Air produced during the Operation of the Generators Cooling System**

**Savings in Electricity Power needed for the operation of the Waste Water Treatment Plant and Thermal Power needed for the Anaerobic Digestion of Bio sludge**

# COMBINED HEAT AND POWER (CHP) SYSTEM

CONTROL PANELS SLUDGE DIGESTERS

# BIOGAS GENERATOR
# DEUTZ TCG 2016 V8K

# CHP - Financial Performance & Benefits

| | | |
|---|---|---|
| Initial Capital Investment | | €2.380.000 |
| Less Grants (Renewable Energy Scheme) | | €320.000 |
| Net Capital Cost | | **€2.060.000** |
| **Power Consumption (2008-2015) 7,5 Years:** | | |
| WWTP Electricity Power | €6.715.000 | |
| Sludge Digestion Thermal Power | €194.000 | |
| Total Energy Cost 2008-2015 | | **€6.909.000** |
| **Less Savings from CHP operation in 2008-2015:** | | |
| -Electricity Power | €2.094.000 | |
| -Thermal Power | €194.000 | |
| Total Net Energy Cost | €2.288.000 | |
| CHP Operation Cost | €109.000 | **€2.179.000** |
| AVERAGE ANUALIZED RETURN ON INVESTMENT | | 18% |
| AVERAGE ANUALIZED ENERGY SAVINGS | | 32% |
| PAY-BACK PERIOD | | 6 Years |

# Energy Costs Analysis and Savings

| Category | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|
| Annual Flow 000 $m^3$ | 5.669 | 6.000 | 6.333 | 6.680 | 7.500 |
| Annual Energy Cost - | | | | | |
| Pumping Stations 000 Euro | 550 | 725 | 829 | 928 | 1.028 |
| WWTP 000 Euro | 568 | 606 | 645 | 688 | 780 |
| Total Cost 000 Euro | 1.118 | 1.331 | 1.474 | 1.616 | 1.808 |
| Energy per $m^3$ in cents | 20 | 22 | 23 | 24 | 24 |
| Energy Saving: | | | | | |
| Total saving in 000 Euro | 72 | 220 | 230 | 250 | 270 |
| Saving per $m^3$ in cents | 3,8 | 3,7 | 3,6 | 3,7 | 3,6 |

## Specific Environmental Benefits

- Biogas generation used as a Renewable Energy "**Green Energy**", for the Operation of Electricity Generators

- Initial Annual Production of over 750.000 $m^3$ of Biogas. Average Electricity Generation of about 4.500 Kwh per day, re used for the operation of the Waste Water Treatment Plant covering about 30% - 40% of the power needs of the Plant, currently provided by The Electricity Authority of Cyprus

- Thermal Power Production from Generators of about 300 KW(=1.080.000 KJ) per day re used as an alternative source of Heat for Bio sludge Heating and Digestion

# Specific Environmental Benefits

- Properly Controlled Biogas Production results in Reduction of Pollutants Emissions
- Gas Emissions from the Generators not exceeding allowable Limits of:
  - carbon monoxide (CO): 1.000 mg/$Nm^3$
  - nitrogen oxides (NOx): 500 mg/ $Nm^3$
- In 2008 and 2009, $CO_2$ average emissions for electricity generation from the neighbouring "Vasiliko Electricity Power Plant" was 0,794 kg/Kwh whereas $CO_2$ average emissions for electricity generation from Vasiliko Cement Factory was 0,770 kg/Kwh. $CO_2$ average emissions from CHP Unit of SBLA at the WWTP was just 0,354 kg $CO_2$/Kwh

## Sustainable Urban Drainage Systems (SUDS)

# An Environmental Approach

# Sustainable Urban Drainage Systems (SUDS)

A sequence of management practices and control structures designed to drain surface water in a more sustainable fashion than some conventional techniques.

# Sustainable Urban Drainage Systems (SUDS)
## SUDS techniques

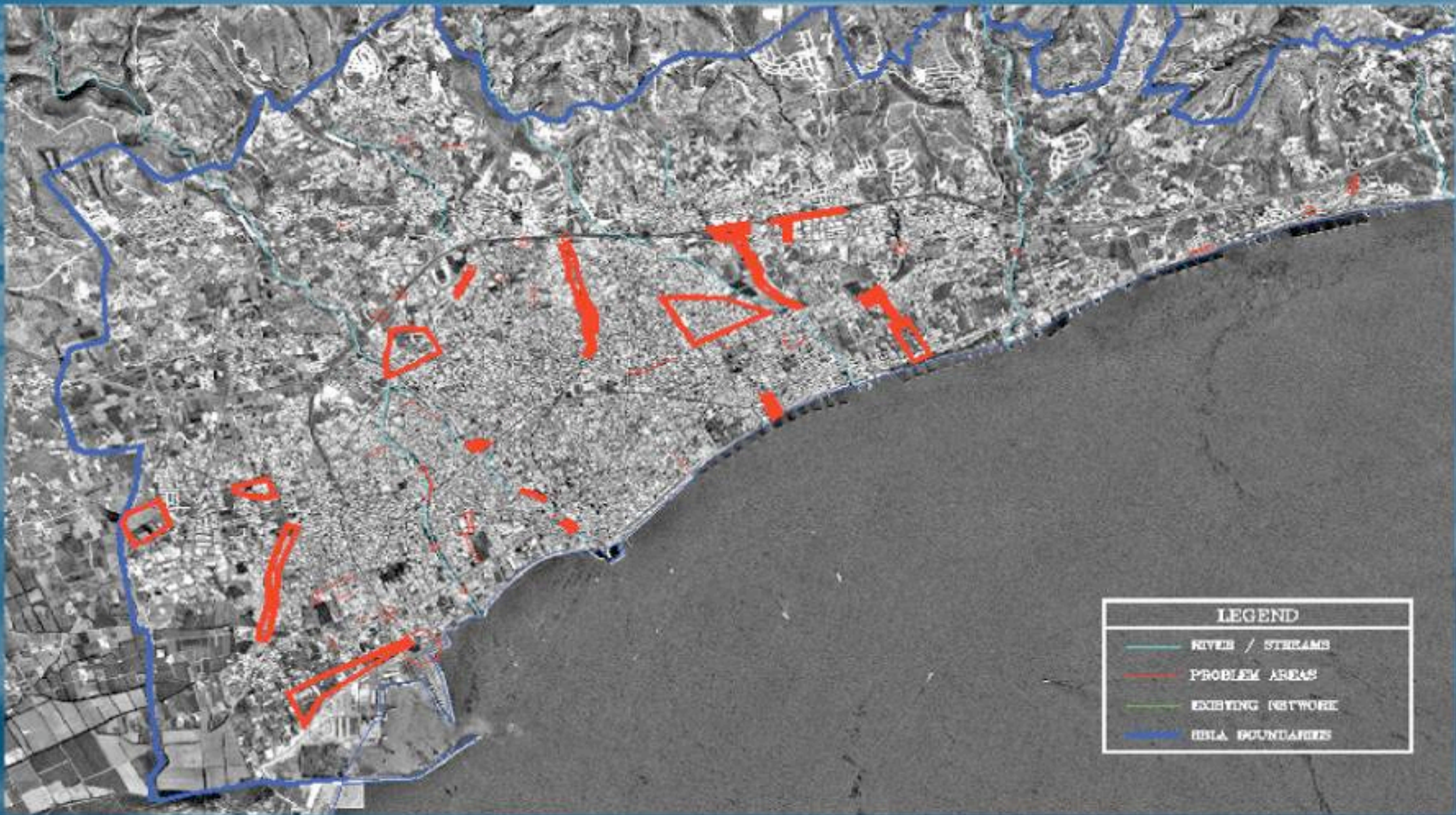
SUDS are made up of one or more structures built to manage surface water runoff. They are used in conjunction with good management of the site, to prevent flooding and pollution. There are a number of general methods of control:

- Prevention-Consider Prevailing Hydrologic and Ground water Conditions
- Filter strips and swales
- Permeable surfaces and filter drains-Use less concrete and Asphalt
- Infiltration devices
- Basins and Retention ponds
- Storm Water Absorption Pits and Storage Techniques such as Sterns

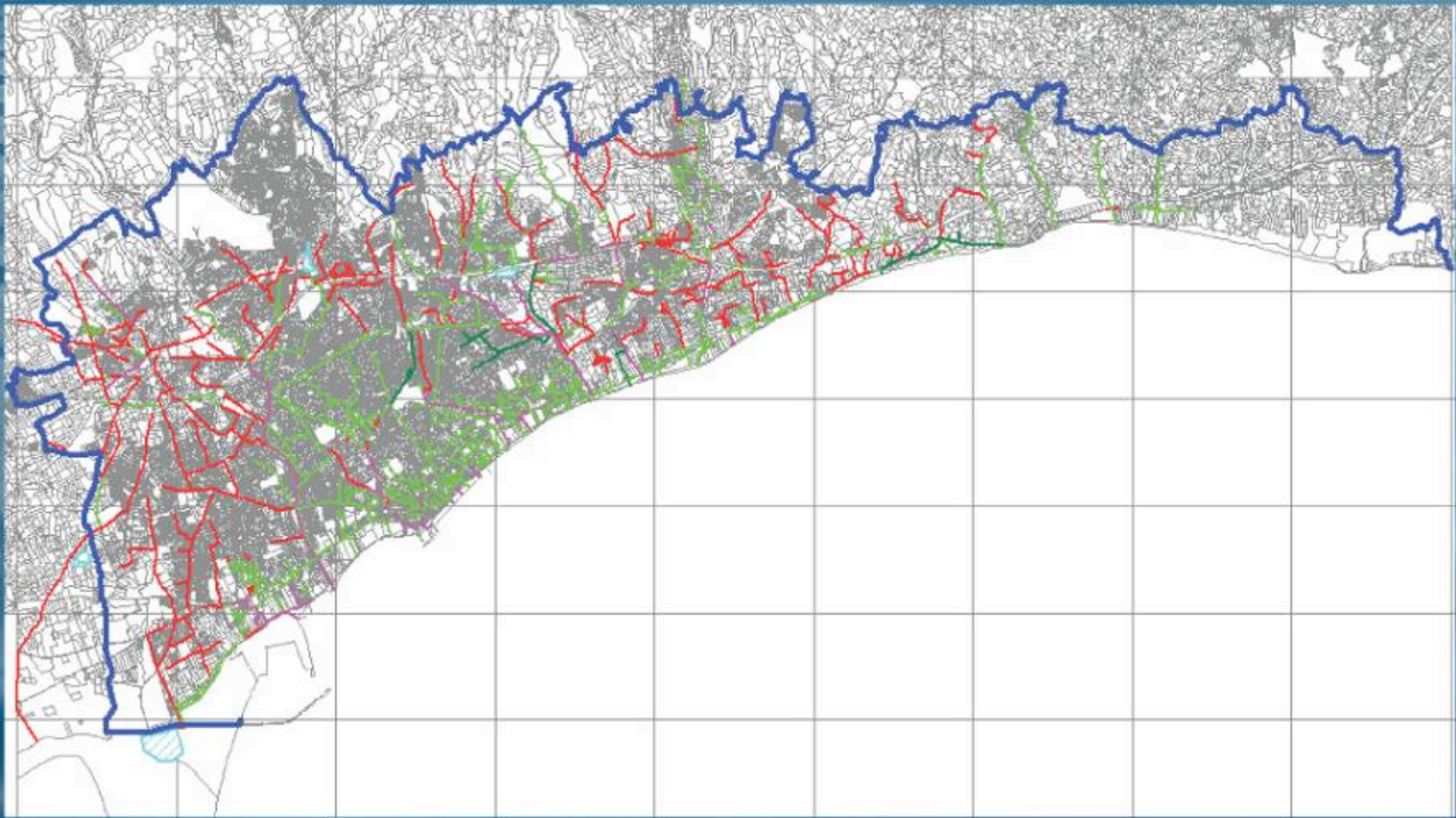
ΣΥΜΒΟΥΛΙΟ ΑΠΟΧΕΤΕΥΣΕΩΝ ΛΕΜΕΣΟΥ ΑΜΑΘΟΥΝΤΑΣ

# Storm Water Drainage Master Plan 2002

# Satellite Map - Priority Areas



# Drainage Works Completed and in Progress



# Major Flood Control Project in progress

# Storm Water Outfall - Use of Permeable Material

# Storm Water Canal - Use of Solid Removal Grids

# “Makria” Storm Water Retention Pond

ΣΥΜΒΟΥΛΙΟ ΑΠΟΧΕΤΕΥΣΕΩΝ ΛΕΜΕΣΟΥ ΑΜΑΘΟΥΝΤΑΣ

# Thank you for your Attention

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