LIST OF CONTENTS

1. INTRODUCTION 1
1.1. CONTRACT FOR ENGINEERING SERVICES 1
1.2. PURPOSE OF STUDY 1

2. INSTITUTIONAL FRAMEWORK FOR EIA 3
2.1. ENVIRONMENTAL ORGANISATION IN CYPRUS 3
2.1.1. CENTRAL GOVERNMENT LEVEL 3
2.1.2. LOCAL LEVEL 4
2.1.3. NON GOVERNMENTAL ORGANISATIONS 5
2.2. CYPRUS NATIONAL LAW 57(I)/2001 ON EIA 5
2.2.1. OBLIGATION FOR EIA STUDY 5
2.2.2. CYPRUS NATIONAL LAW 57(I)/2002 ON EIA 5
2.3. OTHER NATIONAL LAWS 6
2.4. EU ENVIRONMENTAL DIRECTIVES 7
2.4.1. EU DIRECTIVE 97/11/EC ON EIA 7
2.4.2. OTHER EU DIRECTIVES 7
2.5. INTERNATIONAL AGREEMENTS AND CONVENTIONS 8

3. PROJECT DESCRIPTION 9
3.1. PROJECT JUSTIFICATION 9
3.2. PROJECT LOCATION 9
3.3. PROJECT CHARACTERISTICS 10
3.3.1. SERVICED AREA 10
3.3.2. EXISTING ANTHOUPOLIS SEWAGE TREATMENT PLANT 10

3.3.3. SEWAGE TREATMENT PLANT 12
3.3.4. EMERGENCY STORAGE RESERVOIR 22
3.3.5. LONG TERM STORAGE RESERVOIRS 23
3.3.6. SEWERS AND PUMPING STATIONS 23
3.4. IMPLEMENTATION SCHEDULE 25
3.5. PROJECT COST 25

4. DESCRIPTION OF THE ENVIRONMENTAL BASELINE 26
4.1. MAIN FEATURES OF THE PROJECT AREA 26
4.2. PHYSICAL ENVIRONMENT 27
4.2.1. TOPOGRAPHY, GEOLOGY AND SOILS 27
4.1.2. CLIMATE 29
4.1.3. SURFACE WATER RESOURCES 33
4.1.4. GROUNDWATER RESOURCES 34
4.2. ECOLOGICAL ENVIRONMENT 34
4.2.1. VEGETATION 34
4.2.2. WILD LIFE 37
4.2.3. PROTECTED OR RESTRICTED AREAS 37
4.3. PLANNING ZONES AND LAND USE 37
4.3.1. ADMINISTRATIVE BOUNDARIES 37
4.3.2. PLANNING ZONES 38
4.3.3. EXISTING INFRASTRUCTURE 38
4.3.4. LAND OWNERSHIP 39
4.3.5. LAND USE 39
4.3.6. BUILD UP PROPERTIES 40
4.4. SOCIO-ECONOMIC ENVIRONMENT 40
4.4.1. POPULATION DISTRIBUTION 40
4.4.2. SOCIO-ECONOMIC INDICATORS 41

4.4.3. CULTURAL AND ARCHAEOLOGICAL VALUES 47
4.5. PUMPING STATIONS 47

5. ENVIRONMENTAL IMPACT ANALYSIS 48
5.1. IMPACT SCREENING 48
5.2. ASSESSMENT OF POTENTIAL IMPACTS AND MITIGATION MEASURES 50
5.2.1. IMPACTS DUE TO PROJECT LOCATION 50
5.2.2. IMPACTS RELATED TO PROJECT DESIGN 53
5.2.3. IMPACTS DURING THE CONSTRUCTION STAGE 54
5.2.4. IMPACTS DURING PROJECT OPERATION 58
5.2.5. IMPACTS FROM THE PRODUCTION AND REUSE OF SEWAGE SLUDGE 61
5.2.6. REUSE OF TREATED EFFLUENT IN AGRICULTURE 67

6. PROJECT ALTERNATIVES 83
6.1. ALTERNATIVE SEWAGE TREATMENT METHODS 83
6.2. SCREENING OF OPTIONS AND ALTERNATIVES 87
6.2.1. ALTERNATIVE SCHEMES 87
6.2.2. ALTERNATIVE SITES FOR THE SEWAGE TREATMENT PLANTS 90
6.3. SELECTION OF FINAL SCHEMES 92
6.4. EVALUATION OF ALTERNATIVES 93

7. ENVIRONMENTAL MANAGEMENT PLAN 107
7.1. PURPOSE AND OBJECTIVES OF THE EMP 107
7.2. SUMMARY OF IMPACTS AND MITIGATION MEASURES 107
7.3. MITIGATION MEASURES 116
7.3.1. CONTRACTUAL BACKGROUND FOR ENVIRONMENTAL MANAGEMENT 116
7.3.2. COMPENSATION FOR LAND ACQUISITION 119
7.3.3. COMPENSATION FOR THE LOSS OF TREES 119

7.3.4. PROJECT COMPLETION: RECLAMATION OF TEMPORARY USED SITES 119

7.8. MONITORING PROGRAMMES... 120

7.8.1. WATER QUALITY MONITORING DURING CONSTRUCTION 120

7.8.2. WATER QUALITY MONITORING DURING OPERATION 123

7.8.3. AIR AND NOISE MONITORING 124

7.8.4. SLUDGE CONTROL MONITORING.. 125

7.8.5. MONITORING PROGRAMME FOR THE REUSE OF THE TREATED EFFLUENT 130

7.8.6. MONITORING OF CONSTRUCTION ACTIVITIES 133

7.9. ENVIRONMENTAL MANAGEMENT ORGANISATION.. 134

8. PUBLIC CONSULTATION 136

LIST OF TABLES

TABLE 3.1: NICOSIA AREA (GROUP A) COMMUNITITES...10
TABLE 3.2: WATER DEMAND...10
TABLE 3.3: WASTEWATER FLOW 13
TABLE 3.4: SEWAGE TREATMENT PLANTS...13
TABLE 3.5: LAND REQUIREMENTS FOR THE ASTROMERITIS SEWAGE TREATMENT PLANT 13
TABLE 3.6: PROPOSED WASTEWATER POLLUTION UNIT LOADING RATES 14
TABLE 3.7: WASTEWATER POLLUTANT LOAD ESTIMATES (BOD) 14
TABLE 3.8: SUGGESTED DISCHARGE STANDARDS FOR THE DESIGN OF THE ASTROMERITIS STP 15
TABLE 3.9: SUGGESTED DISCHARGE STANDARDS FOR THE ANTHOUPOLIS STP...15
TABLE 3.10: EXPECTED SLUDGE PRODUCTION..17
TABLE 3.11: ADVANTAGES AND DISADVANTAGES OF AEROBIC AND ANAEROBIC STABILISATION...19
TABLE 3.12: DEWATERING TECHNIQUES AND THEIR EFFICIENCY 20
TABLE 3.13: EMERGENCY STORAGE RESERVOIRS 22
TABLE 3.14: LAND REQUIREMENTS FOR THE EMERGENCY STORAGE RESERVOIRS...22
TABLE 3.15: LONG TERM STORAGE RESERVOIRS..23
TABLE 3.16: LAND REQUIREMENTS FOR THE LONG TERM STORAGE RESERVOIRS..23
TABLE 3.17: CALCULATED LENGTH OF THE COLLECTION NETWORK...24
TABLE 3.18 : LOCATION OF PUMPING STATIONS..24
TABLE 3.19: SUMMARY OF THE TOTAL PROJECT COSTS 25
TABLE 4.1 : SOIL CHARACTERISTICS AND PRESENT SANITARY SITUATION IN THE PROJECT COMMUNITIES 28
TABLE 4.2 : POPULATION FIGURES 40
TABLE 4.3 : POPULATION PROJECTION BY COMMUNITY...41
TABLE 4.4: LAND USE IN THE ASTROMERITIS – AKAKI REGION (1994)...41
TABLE 4.5: AREA OF TEMPORARY CROPS IN THE ASTROMERITIS – AKAKI REGION (1994)..42
TABLE 4.6: AREA OF PERMANENT CROPS IN THE ASTROMERITIS – AKAKI REGION (1994)..42
TABLE 4.7: AGRICULTURAL LAND USE BY VILLAGE (1994) 42
TABLE 4.8: AGRICULTURAL LAND USE BY VILLAGE (1994) 43
TABLE 4.9: TEMPORARY CULTIVATIONS BY COMMUNITY (1994) 43
TABLE 4.10: IRRIGATED AGRICULTURAL LAND BY VILLAGE (1994) 44
TABLE 4.11: WATER DEMAND PER CROP (M^3 /M^2/YEAR, 2001)..44
TABLE 4.12: NUMBER OF ANIMALS BY VILLAGE (1994)...45
TABLE 4.13: EMPLOYMENT IN THE BROAD AGRICULTURAL SECTOR IN THE NICOSIA DISTRICT (1994) 45
TABLE 4.14: EMPLOYMENT IN CROP AND LIVESTOCK IN THE NICOSIA DISTRICT (1994)...46
TABLE 4.15: EMPLOYMENT ON THE FARM (1994) (FULL-TIME EQUIVALENT NUMBER OF PERSONS).....................................46

TABLE 4.16: LOCATIONS OF PUMPING STATIONS 47
TABLE 5.1 : SCREENING OF ENVIRONMENTAL IMPACTS: POSSIBLE IMPACTS FROM THE PROJECT 48
TABLE 5.2 : LAND REQUIREMENTS FOR THE ASTROMERITIS STP 51
TABLE 5.3 : LAND REQUIREMENTS FOR THE ANTHOUPOLIS STP 51
TABLE 5.4: TYPICAL MAXIMUM NOISE LEVELS PERMITTED AT CONSTRUCTION SITES 56
TABLE 5.5: NOISE LEVELS FROM MACHINERY USED DURING CONSTRUCTION AT VARIOUS DISTANCES 56
TABLE 5.6:AVERAGE COMPOSITION OF SLUDGE IN CYPRUS 61
TABLE 5.7: SAFE-SLUDGE MATRIX 65
TABLE 5.8: PROPOSED HEAVY METAL CONCENTRATION LIMIT VALUES IN THE SOIL 65
TABLE 5.9: PROPOSED HEAVY METAL CONCENTRATION LIMIT VALUES IN THE SLUDGE USED IN AGRICULTURE 66
TABLE 5.10: PROPOSED LIMIT VALUES FOR AMOUNTS OF HEAVY METALS WHICH MAY BE ADDED ANNUALLY TO SOIL, BASED ON A TEN YEAR AVERAGE 66
TABLE 5.11: SUGGESTED LIMIT STANDARDS FOR TREATED EFFLUENT QUALITY 68
TABLE 5.12: SUGGESTED TREATED EFFLUENT QUALITY FOR THE ANTHOUPOLIS SEWAGE TREATMENT PLANT 68
TABLE 5.13: AREAS IRRIGATED BY BOREHOLES AND NOT-IRRIGATED AREAS (CENSUS OF AGRICUTLTURE, 1994) 69
TABLE 5.14: RELATIVE SALT TOLERANCE OF AGRICULTURAL CROPS 70
TABLE 5.15: RELATIVE TOLERANCE OF SELECTED CROPS TO EXCHANGEABLE SODIUM 74
TABLE 5.16: CHLORIDE TOLERANCE OF SOME FRUIT CROP CULTIVARS AND ROOTSTOCKS 76
TABLE 5.17: RELATIVE BORON TOLERANCE OF AGRICULTURAL CROPS[1] 77
TABLE 6.1: COMPARISON OF TREATMENT PROCESSES 86
TABLE 6.2: ALTERNATIVE SCHEMES 87
TABLE 6.3 : EVALUATION OF ALTERNATIVE SITES 96
TABLE 6.4 : EVALUATION OF ALTERNATIVE SCHEMES 101
TABLE 7.1: EXPECTED IMPACTS AND PROPOSED MITIGATION MEASURES 107
TABLE 7.2: SCHEDULE OF ACTIVITIES FOR WATER QUALITY MONITORING 123
TABLE 7.3: SCHEDULE OF ACTIVITIES FOR AIR QUALITY AND NOISE MONITORING 125
TABLE 7.4: PROPOSED ANALYSIS FREQUENCY FOR SLUDGE 126
TABLE 7.5: PROPOSED HEAVY METAL CONCENTRATION LIMIT VALUES IN THE SLUDGE USED IN AGRICULTURE 126
TABLE 7.6: PROPOSED HEAVY METAL CONCENTRATION LIMIT VALUES IN THE SOIL 128
TABLE 7.7: PROPOSED LIMIT VALUES FOR AMOUNTS OF HEAVY METALS WHICH MAY BE ADDED ANNUALLY TO SOIL, BASED ON A TEN YEAR AVERAGE 129
TABLE 7.8: SLUDGE APPLICATION AND HARVESTING GUIDELINES 129
TABLE 7.9: SUGGESTED DISCHARGE STANDARDS FOR THE TREATED EFFLUENT QUALITY 130
TABLE 7.10: HEAVY METAL CONCENTRATION LIMITS 131
TABLE 7.11: MONITORING OF IRRIGATION METHODS 132
TABLE 7.12: SCHEDULE OF ACTIVITIES FOR CONSTRUCTION ACTIVITIES MONITORING 134

APPENDICES

APPENDIX 1: QUALITY STANDARDS IN CYPRUS AND EU

APPENDIX 2: WATER CONSUMPTION

APPENDIX 3: PUMPING STATIONS

APPENDIX 4: PROJECT IMPLEMENTATION PROGRAMME

APPENDIX 5: CLIMATIC DATA

APPENDIX 6: DESCRIPTION OF THE COMMUNITIES

APPENDIX 7: AGRICULTURAL LAND IN THE REGION

APPENDIX 8: SLUDGE COMPOSITION AND QUALITY

APPENDIX 9: LAND REQUIREMENTS FOR IRRIGATION

APPENDIX 10: ALTERNATIVE SCHEMES

APPENDIX 11: ENVIRONMENTAL SCREENING OF ALTERNATIVES

APPENDIX 12: DRAWINGS

APPENDIX 13: CONSULTATION LETTERS

APPENDIX 14: SITE PICTURES

APPENDIX 15: REFERENCES

APPENDIX 16: OPINION OF THE PUBLIC AUTHORITY

LIST OF DRAWINGS

EIA – **A** – 1	Proposed Location for the Astromeritis Sewage Treatment Plant
EIA – **A** – 2	Location of the Existing Anthoupolis Sewage Treatment Plant
EIA – **A** – 3	Sewage Conveyance System
EIA – **A** – 4	Geological Map of the Project Region
EIA – **A** – 5	Key to the Geological Map
EIA – **A** – 6	Administrative Boundaries of the Communities which will be connected to the Astromeritis Sewage Treatment Plant and the Location of the Plant
EIA – **A** – 7	Administrative Boundaries of the Communities which will be connected to the Anthoupolis Sewage Treatment Plant and the Location of the Plant
EIA – **A** – 8	Astromeritis Sewage Treatment Plant Communities: Planning Zones
EIA – **A** – 9	Anthoupolis Sewage Treatment Plant Communities: Planning Zones
EIA – **A** – 10	Cadastral Map of the Astromeritis Sewage Treatment Plant Site
EIA – **A** – 11	Satellite Image of the Astromeritis Sewage Treatment Plant Location
EIA – **A** – 12	Satellite Image of the Anthoupolis Sewage Treatment Plant Location
EIA – **A** – 13	Alternative Locations for the Sewage Treatment Plants
EIA – **A** – 14	Agricultural Land in the Project Region for Irrigation

EXECUTIVE SUMMARY

As a future member of the European Union, Cyprus must fulfil the EU pre-accession requirements concerning the protection of the environment and therefore meet the obligations and requirements of Council Directive 91/271/EEC on urban wastewater treatment. The Directive concerns the collection, treatment and discharge of wastewater from sufficiently populated areas.

As a part of the "Implementation Programme of the Council Directive 91/271/EEC" and in the context of the Council Directive 91/271/EEC, a project was launched by the Water Development Department of the Ministry of Agriculture, Natural Resources and Environment to upgrade the sewage systems of communities with equivalent population of more than 2000 which are not already equipped with a centralised collection and treatment system. The project includes 28 communities, which have been divided into 4 groups according to their district areas. This study concerns Nicosia communities of Group A, which includes the villages of Kokkinotrimithia, Palaiometocho, Astromeritis, Peristerona and Akaki.

PROJECT DESCRIPTION

The project includes the design of the collection, conveyance and centralized treatment of the urban sewage effluents from the Nicosia communities. During the feasibility stage a number of alternative schemes were evaluated based on technical, financial and environmental criteria and a final scheme was selected as the preferred alternative. This included the construction of one sewage treatment plant to the west of Astromeritis, at the site of an abandoned mine, within the buffer zone, which will service the communities of Astromeritis, Peristerona and Akaki, as well as the connection of Kokkinotrimithia and Palaiometocho to the existing Anthoupolis sewage treatment plant, which will be replaced by a new unit that will be constructed at the site as part of the Greater Nicosia Sanitary Sewage project.

Astromeritis Sewage Treatment Plant

Regarding the treatment process for the Astromeritis sewage treatment plant, the activated sludge process combined with tertiary treatment has been suggested. This is a proven and reliable process, which is currently in operation in three of the main treatment plants in Cyprus. Strict effluent quality standards will be applied for the design of the plant, which are a combination of the Cyprus and EU Standards for the quality of treated sewage waters. The main objective is the reuse of the treated water for irrigation purposes. For the long term storage of the treated effluents during the winter months, when the demand for water will be limited, a reservoir will be constructed at the plant site. Additionally, there will be an emergency storage reservoir for the untreated effluent in case there are problems in the treatment process.

The main objective for the sludge that will be produced from the process is agricultural reuse, as a fertilizer. The selection of the treatment process will be based on this assumption.

Anthoupolis Sewage Treatment Plant

In the case of the new Anthoupolis sewage treatment plant, the biofilter process has been suggested due to the restricted land that is available at the existing plant site. This technology is also proven and reliable, and combined with tertiary treatment it will achieve the quality standards that have been set for the treated effluents for their reuse for agricultural purposes.

Regarding the sludge, a treatment process is suggested, which will include sludge thickening using a gravity thickener, dewatering by centrifuge and stabilisation by lime treatment. This line is optimised for the treatment of sludge that is produced from the biofilter sewage treatment process, and will offer sludge that can be stored, transferred and reused in agriculture without problems.

To minimise the risk of any impacts arising as a result of noise or smells, the plant will be completely covered, since the area is expected to be urbanised in the near future, and an odour collection and treatment system will be installed.

For the storage and reuse of the treated effluents, a separate study will be conducted.

IMPACT EVALUATION AND MITIGATION MEASURES

Following a description of the baseline environment of the area, the environmental impacts that could result from the project have been identified and mitigation measures have been proposed to eliminate or minimise such impacts. Impacts have been examined in relation to project location and design, the project construction and operation phases, the reuse of the treated effluent for irrigation, and the reuse of sludge for agricultural purposes.

A summary of the impacts that have been identified is outlined in the table below.

ANTICIPATED IMPACTS	PROPOSED MITIGATION MEASURES
IMPACTS RELATED TO PROJECT LOCATION	
Astromeritis Sewage Treatment Plant	
Permanent Land Acquisition Permanent acquisition of private land for construction of the STP, the storage reservoirs and the pumping stations	- Compensation for loss of land, agricultural trees and possible loss of income.
Impacts on Ecological Values - No adverse ecological impacts expected. - Positive impacts from the creation of a wetland habitat (storage reservoir) and park in an otherwise degraded region.	No mitigation measures required.
Anthoupolis Sewage Treatment Plant	
Permanent Land Acquisition - In the case of the Anthoupolis STP there will be no additional land acquisition since the new plant will be constructed within the existing area of the STP. - Permanent land acquisition for the construction of the pumping stations.	- Compensation for loss of land, agricultural trees and possible loss of income in the case of the pumping stations.
Impacts on Ecological Values - No adverse ecological impacts expected. - Positive impacts from the creation of a wetland habitat (storage reservoir) and park in the area.	- A lake will be created where various fish species and ducks will be introduced and planting of wetland bushes and vegetation around this. - Planting of trees and vegetation in the STP area. - Effective landscaping.
IMPACTS RELATED TO PROJECT DESIGN	
Astromeritis Sewage Treatment Plant	
No significant impacts are expected	- Treatment process is reliable and proven and effluent will meet the set performance

	standards. - Emergency storage will safeguard against problems in treatment process. - Sludge treatment to be chosen will be effective in achieving required standards.
Anthoupolis Sewage Treatment Plant	
No significant impacts are expected	- The biofilter method is proven and reliable and the quality of the treated effluents will meet the set performance standards. - Emergency storage will safeguard against problems in treatment process. - The sludge treatment process which has been selected is optimized for the treatment of sludge produced from the biofilter method and will offer sludge that can be stored, transferred and reused in agriculture without problems.
IMPACTS DURING THE CONSTRUCTION STAGE	
Temporary Land Acquisition Temporary acquisition of land for workers' facilities, construction storage sites, pipe laying. This will result in possible loss of natural vegetation, grazing or agricultural land.	- Compensation for the temporary use of land, loss of production, or inconvenience created. - Design to minimise construction land requirements. - Special obligation on contractor to minimise impacts on temporarily acquired agricultural land so that it can be put back to production quickly. Measures include the preservation of soil through profiling of the top and sub soil to the original level. Building material must be fenced and the land should be cleared after construction. - Full rehabilitation of sites to be required form contractor.
Vegetation Clearing Clearing of vegetation for construction of the sewage treatment plants, the storage reservoirs, the pumping stations and the conveyance system.	- Compensation for the destruction of agriculture, particularly trees (permanent crops). - Prior to construction a rapid survey of affected trees and vegetation should be carried out to clearly indicate the number of trees to be cleared. - An equivalent number of trees and vegetation to be planted by contractor.
Soil Impacts	
- Soil erosion: resulting from uncovered and unconsolidated materials during construction	- Strict clauses regarding earthworks management during construction to be imposed to the contractor. - Careful design of construction operations, including the selection of haulage routes into the site and the location of stockpiles. - Pipe construction should be divided into sub-sections, after excavating one section, backfilling it and clearing the area. - Timely carry away discarded soil. The temporary deposits should be kept within barriers to prevent erosion. - Avoid large scale excavations during rainfall or strong winds.

	• Remove as little vegetation as possible during construction and revegetate bare areas as soon as possible after construction. • Avoid creating large expanses of bare soil. If such expanses are created, then windbreaks may be required.
• Soil disaggregation	• Take the soil out in horizons and keep each horizon in a separate pile.
• Soil compaction	• Use wide tires to spread the weight of vehicles. • Use a single or as few tracks as possible to bring vehicles to construction sites. • Till the area after compaction has taken place.
Dust, Fumes and Noise	
• Dust: from stockpiles and vehicle movement, particularly in dry weather and strong winds.	• Frequent spraying of stockpiles and haulage roads with water. • Regular sweeping of access roads. • Covering of vehicles carrying materials. • Early planting of peripheral tree screens where they will be part of the development. • A system of monitoring site accesses and stockpiles should be implemented.
• Noise: from construction operations, machinery and vehicle movements.	• Use equipment with low noise outputs. • Where it is necessary for construction sites to operate at night, causing an impact on residents, it is required that noise reduction measures are taken so that reasonable noise levels are maintained. • Blasting and other operations with significant noise outputs should be restricted to certain hours of the day, while being prohibited at night. • A plan for the management of construction activities, so as to minimise noise impacts and ensure compliance with noise control measures to be imposed on contractor. • Construction operations must be carefully planned to minimise construction time.
• Air Pollution: from car and truck traffic and from machinery.	• Plan routes to minimise vehicle movements as far as possible.
On-Site Safety	• Strict clauses imposed on contractor for the implementation of on-site health and safety measures and standards. • Regular maintenance of construction equipment, machinery and vehicles must be ensured. • Measures to ensure traffic security to be adopted. • Preparedness procedures in case of accidents and emergency situations to be established.
Waste Management Construction waste, domestic solid waste.	• Contractors must make arrangements for the collection and transportation of domestic waste to official landfill sites. • The contractor must prepare a plan for the collection and appropriate disposal of

	construction waste and transportation plans must be made. - Transportation at peak hours must be avoided. - Spoil and wastes should be transported along specified routes and disposed of at designated sites. - Inspection should be carried out to ensure that the plans are properly implemented.
Pollution Air water and soil pollution resulting from heavy operating machinery and vehicles, and from the storage of potential pollutants, such as petrol, motor oils and concrete.	- Strict clauses regarding the operation and maintenance of construction equipment to be imposed on contractor. - Regular monitoring of water and air quality near construction sites must be carried out. - Procedures must be taken for the containment of pollutants at storage sites. - Measures must be taken to avoid impacts from any accidental spillages, including the containment of storage tanks on concrete floors will walls to prevent the release of effluents on the soil. - Preparation and implementation of a management plan for the collection, storage and disposal of used oils and other pollutants.
Traffic As a result of increased vehicle movement and road excavations.	- The construction of the conveyance system should be phased and excavation, pipe laying and trench refilling should be completed as quickly as possible. - For busy roads, construction at peak hours should be avoided. - Spoil soils on roads under construction should be kept to a minimum so as not to affect local traffic. - Specific routing must be prepared for vehicles.
IMPACTS DURING OPERATION	
Landscape Impacts	
Astromeritis Sewage Treatment Plant Limited impacts: the area has already been degraded, while the treatment plant will be constructed at the site of the old quarry and will not be clearly visible from the surrounding areas.	- Landscaping of the site. - Appropriate architectural design. - Trees and other vegetation will be planted so that the area will have the appearance of a park.
Anthoupolis Sewage Treatment Plant Limited impacts	- Landscaping of the site. - The site will be planted and will have the appearance of a park. - A lake will be created and wetland bushes and vegetation will be planted. - The park will be completed with paths. - Appropriate architectural design which will provide harmonization with the surrounding environment (future residential area) and shall emphasize the high-tech quality of treatment to be implemented.

Noise At STP sites and pumping stations. Impacts at STP sites are limited as they are at sufficient distance from residential areas, however certain pumping stations are within urban areas. In the case of the Anthoupolis sewage treatment plant, the risk of impacts is greater since the area is expected to be urbanised in the near future.	- Enclose sources to insulate noise and incorporate specific acoustic features in the design of buildings. - Use low noise equipment. - Application of noise control equipment where necessary. - Use of noise screens, including tree plantings. - The noisiest sources should be monitored four times a year and noise measurements should be carried out near the plant and pumping stations two times a year during the day and night. - In the case of the Anthoupolis STP, the entire plant will be covered to reduce impacts.
Odours At STP sites and pumping stations. Impact at STP sites limited as they are at as sufficient distance from residential areas, however pumping stations are within urban areas. In the case of the Anthoupolis sewage treatment plant, the risk of impacts is greater since the area is expected to be urbanised in the near future.	- Enclose sources to insulate noise and incorporate specific acoustic features in the design of buildings. - Use low noise equipment. - Application of noise control equipment where necessary. - Use of noise screens, including tree plantings. - The noisiest sources should be monitored four times a year and noise measurements should be carried out near the plant and pumping stations two times a year during the day and night. - In the case of the Anthoupolis sewage treatment plant, the entire plant will be covered and an odour removal system will be installed (the air will be collected and treated).
Impacts on Groundwater Resources Positive impact: reduction in groundwater pumping, and reduction in nitrates released in the environment	No measures required.
Impacts from Sludge Production and Reuse	- Choice of treatment process to meet standards for reuse in agriculture. - Correct soil application methods according to the Code for the Use of Sewage Sludge in Agriculture. - Monitoring of sludge and soil quality in accordance with the Code.
Risk of System Overload Minimum risk: emergency storage available, design includes seasonal variations	No measures required.
Risk of Insufficient Treatment of Effluents	- Regular monitoring of effluent quality - Design for maximum flow - Emergency storage reservoir
Reuse of Treated Effluent for Irrigation	- Regular monitoring of effluent quality according to the Code of Practice for the Use of Treated Effluent for Irrigation. - Choice of irrigation methods according to the Code.

	↳ Crop selection to avoid adverse impacts on crop yields.
Urban Reuse of Treated Effluent	↳ Regular monitoring of effluent quality. ↳ Labeling of pipes and use of signs in areas irrigated with treated effluent. ↳ Choice of irrigation methods according to the Code of Practice.
Groundwater Recharge	↳ Monitoring of effluent and groundwater quality to avoid risk of aquifer pollution.

MITITGATION MEASURES FOR PUMPING STATIONS
⇩ Use of low noise equipment ⇩ Use of odour control systems ⇩ Landscaping to avoid impacts on the built or natural environment ⇩ Use of energy efficient systems
MITIGATION MEASURES FOR THE REUSE OF SLUDGE
Misuse of the agricultural value of sludge Leaching of nitrates to groundwater
⇩ Better knowledge of sludge content in terms of compounds of agricultural value
❑ Adequate sampling procedures (frequency, number of samples, etc.)
❑ Adequate analysis protocols
⇩ Improve use of sludge agricultural value
❑ Determination of the sludge agricultural value (N, P, K, content)
❑ Planning and application adapted according to: ⇨ Plant needs ⇨ Other fertiliser sources ⇨ N remaining in the soil ⇨ Nutrient bioavailability ⇨ Adequate spreading periods according to agricultural and environmental constraints
❑ Regular soil analyses to establish increase in nutrient content
❑ Information from farmers about quantities spread
Soil contamination by heavy metals and organic pollutants
⇩ Determination of background levels in soil
⇩ Determination of pollutant content in sludge
⇩ Safe storage of sludge
❑ Safe storage to reduce leaching
❑ Sufficient storage capacity
❑ Reduction of storage duration in the field
Water contamination by heavy metals and organic contaminants
⇩ Forbid sludge spreading in sensitive areas, especially:
❑ On sloping land ❑ Near surface water ❑ On wet areas ❑ Within water resource protection areas ❑ On sandy soils ❑ On frozen grounds ❑ In areas where the water table is near the surface
⇩ Encourage fast ploughing down in order to reduce the risk of runoff and the use of close-to-ground techniques in order to reduce the formation of aerosols
⇩ Safe storage of sludge
Crop contamination by heavy metals and organic pollutants
⇩ Reduce transfer in the food chain

❑ Encourage sludge spreading before non-food crops
⇩ Limit plant uptake
❑ Adapt sludge spreading to soil types (mainly according to pH and CEC)
❑ Take into consideration heavy metal bioavailability in soil
❑ Define a crop/sludge type matrix with specific recommendations
❑ Prohibit sludge spreading on plant/crops which are known to accumulate heavy metals
⇩ Limit deposition on plant
❑ Limit use of sludge on vegetable and certain fruit productions
⇩ Analyses of the metal level in crops and foodstuff
Animal contamination by heavy metals and organic pollutants
⇩ Limit pollutant transfer to animals
❑ Tighten limits concerning quantity and quality of sludge which may be applied
❑ Grazing land: ⇨ Introduce a time period before harvesting ⇨ Favour sludge ploughing down
❑ Grassland: ⇨ Allow spreading before sowing and after each cut
⇩ Control of the metal levels in foodstuffs
❑ Analysis of the pollutant levels in animal products (especially in offal and milk)
Human contamination
⇩ Limit pollutant transfer in the food chain (see above)
⇩ Protection of operating equipment
❑ Ensure safe manipulation of sludge
❑ Material cleaning and maintenance
❑ Protective clothes
Contamination by pathogens
⇩ Animal contamination
❑ Grazing land: introduce a time period before grazing
❑ Grassland: allow spreading before sowing and after each cut
❑ Encourage fast ploughing down of sludge
⇩ Human contamination
❑ Prohibition of sludge spreading on products which are to be consumed raw
❑ Safe transportation of sludge
❑ Prohibition of sludge spreading in the vicinity of houses and near bathing water and drinking water supply areas
MITIGATION MEASURES FOR THE REUSE OF THE TREATED EFFLUENTS FOR IRRIGATION PURPOSES
Impacts on soil productivity; groundwater contamination; health impacts; impacts on crop growth and quality
⇩ Drafting of Reuse Management Plan, incorporating:
❑ Appropriate site identification (for reuse in areas outside the Irrigation Scheme) ❑ Crop water requirements ❑ Crop selection ❑ Irrigation methods and scheduling ❑ Evaluation of nutrient and salt loading rates
Nitrogen leaching to groundwater, accumulation in soil
⇩ Balance nitrogen loading rates with crop requirements
Phosphorous leaching to groundwater, accumulation in soil
⇩ Balance phosphorous loading rates with crop requirements

Adverse impacts on soil productivity and risk of groundwater contamination
⇩ Determine salt loading rates
⇩ Ensure irrigation practices do not result in off-site run-off, appropriate leaching and drainage provisions
Adverse impacts on crop yields and quality
⇩ Crop selection based on crop sensitivity to treated effluent constituents
Adverse impacts on health
⇩ Timing of irrigation prior to harvesting
⇩ Correct irrigation practices
⇩ Minimise site access during irrigation periods
⇩ Use of signs specifying that treated effluent is used
⇩ Establishment of buffer zones around irrigated areas where necessary
Quality considerations
⇩ Implements treated effluent quality monitoring programme to ensure compliance with the set standards
⇩ Implement soil quality monitoring programme
⇩ Monitoring of irrigation methods and practices
⇩ Monitoring of application rates of heavy metals, nutrients and slats.

ENVIRONMENTAL MANAGEMENT PROGRAMME

An Environmental Management Programme has been prepared outlining a set of mitigation measures and monitoring programmes, in relation to the project construction and operation, with the purpose of avoiding and controlling any adverse environmental impacts that might arise. As a result many of the impacts that have been identified will be effectively mitigated limiting the projects resulting effect on the environment.

1. INTRODUCTION

As a future member of the European Union, Cyprus must fulfil the EU pre-accession requirements concerning the protection of the environment and therefore meet the obligations and requirements of Council Directive 91/271/EEC on the collection, treatment and discharge of wastewater from sufficiently populated areas

The Water Development Department of the Ministry of Agriculture, Natural Resources and the Environment has elaborated an "Implementation Programme of the Council Directive 91/271/EEC" (a full compliance programme including projects' timetables and costs). The programme covers 32 communities of more than 2,000 p.e., 4 greater urban areas (Nicosia, Larnaca, Limassol and Paphos) and 2 major summer resorts. It covers development in collection networks and treatment plants including technical studies, designs, tendering, construction and supervision. The financial needs of the Programme will be met through commercial loans guaranteed by the Government which subsidises part of the cost. The implementation of the Programme will assure conformity with the Directive's requirements in the year 2012. This implementation Programme has been submitted to the European Commission and derogation for Cyprus has been granted up to 2012.

As a part of the Programme, and in the context of the Council Directive 91/271/EEC, a project was launched by the Water Development Department of the Ministry of Agriculture, Natural Resources and Environment to upgrade the sewage systems of communities with equivalent population of more than 2000 which are not already equipped with a centralised collection and treatment system.
The number of these communities is 28. They have been split in 4 groups. These groups which are related to district areas are as follows:

- **Group A: Nicosia district**: Peristerona, Astromeritis, Palaiometocho, Kokkinotrimithia, Akaki and Lympia
- **Group B: Larnaca district**: Aradippou, Kiti, Perivolia, Dromolaxia/Meneou, Livadia and Athienou
- **Group C: Famagusta district**: Xylotymvou, Achna, Ormideia, Avgorou, Xylofagou, Agios Georgios Acheritou, Liopetri, Frenaros, Sotira and Deryneia
- **Group D: Limassol and Paphos districts**: Ypsonas, Kolossi, Episkopi, Trachoni, Erimi and Polis.

1.1. CONTRACT FOR ENGINEERING SERVICES

A contract for engineering services EuropeAid/113561/D/SV/CY was signed with the consortium SOGREAH, France and A.F.Modinos & S.A. Vrahimis, Cyprus.

The specific objective of engineering assignment is to provide technical and detailed studies for collection networks and appropriate treatment for the sewage system upgrading of the above mentioned communities.

The engineering services are composed of the following stages:

- Inception stage,
- Technical studies (feasibility studies, financial studies, EIA)
- Detailed studies.

1.2. PURPOSE OF STUDY

The purpose of the Environmental Impact Assessment Study for the Nicosia Group is to evaluate the environmental impacts that will result from the proposed project and to propose mitigation measures and monitoring requirements through the Environmental Management Programme that has been drafted.

2. INSTITUTIONAL FRAMEWORK FOR EIA

2.1. ENVIRONMENTAL ORGANISATION IN CYPRUS

2.1.1. CENTRAL GOVERNMENT LEVEL

In Cyprus, environmental policy is coordinated through the **Minister of Agriculture, Natural Resources and Environment (MANRE)**, although responsibilities for town and country planning issues rest with the **Minister of the Interior** and for air pollution control/air quality with the **Minister of Labour and Social Security**.

The **Council for the Protection of the Environment** which is an advisory body, chaired by MANRE, advises the Council of Ministers on issues, legislation and policy relating to the environment and sustainable development.

The **Environment Committee**, chaired by the Permanent Secretary of MANRE and constituted of representatives from all the ministries and government services involved in environmental issues, deals with the formulation and determination of the environmental policy objectives and assists in their co-ordination and implementation.

There are also two **Technical Committees** concerned by environmental issues, one responsible for evaluating the Environmental Impact Assessment (EIA) studies and the other for reviewing the Licensing of Discharges and the Registration of Processes under the laws for the Protection of Water and the Protection of Air. The Environment Committee and the Technical Committees are the main formal bodies through which the Government agencies communicate with each other, and through which inter-departmental issues are addressed.

The key Ministries and Agencies involved in Environmental Management in Cyprus are the following:

The **Ministry of Agriculture, Natural Resources and Environment (MANRE)** has prime responsibility for many different aspects of the environment. These responsibilities are distributed among the Environment Service and seven separate Departments.

The **Environment Service** is the coordinating agency for Government programs for the protection of the environment. It heads the Technical Committee on the Environmental Impact Assessment (TCEIA) of projects, advises on environmental policy and is mandated to ensure the implementation of the environmental policy. Among its responsibilities, the ES is in charge of the co-ordination of the adoption of the EU environmental acquis in co-operation with the Planning Bureau of the Ministry of Finance. The **ES** is also in charge of the TCEIA (which responsibility is to review EIA studies for environmental clearance), and is responsible for the enforcement of the Law on the Control of Water Pollution, for the promotion of environmental awareness and training, and for the provision of support to the Environment Committee and the Council for the Environment. The **ES** acts as the National Focal Point for a wide range of international agreements, conventions and organisations related to biodiversity and environmental protection.

The **Water Development Department (WDD)** is the largest single department of MANRE, reflecting the critical importance of water resources in Cyprus. It is responsible for most aspects of the implementation of water policy and the management of water resources (supply and use). This includes hydrological and hydrogeological water resources, the planning, design, construction and operation of water supply infrastructure, sewerage and wastewater treatment (outside the major urban areas) and the monitoring of water resources quality and quantity.

The **Department of Agriculture (DoA)** is the second largest department of MANRE, after WDD. Aside from responsibilities in the general agricultural development sector, the DoA is particularly responsible for those components as wastewater reuse and utilisation of STP sludge for agricultural production.

The **Department of Forests (DoF)** of MANRE is responsible for the management and exploitation of state forests (which account for 19% of the area of Cyprus), including environmental aspects, and can declare nature reserves and national forest parks within those forests.

The **Ministry of Interior (MoI)** is responsible for town and country planning, including related environmental issues. The Department of Town Planning and Housing (DTPH) of the MoI is not only responsible for policy and legislation in this area but also acts as planning authority outside the four major conurbations of Nicosia, Larnaca, Limassol, and Paphos. It is responsible for imposing environmental conditions (based on recommendations of the ES and the EIA Technical Committee) through the planning permit, and participates in the EIA Technical Committee.

The **Ministry of Health (MoH)** also has an important role in relation to the environment in general and health impacts in particular. The State General Laboratory (SGL) of the MoH is the main government laboratory in Cyprus.

The **Public Health Service (PHS)** of the MoH has a large inspectorate responsible primarily for the monitoring of drinking water quality but also other environment-related aspects of public health. This includes the monitoring of groundwater quality (where this is used for drinking water), public health aspects of waste management (including, with ES and WDD, landfill site inspection), seawater quality (bathing beaches) and swimming pools.

2.1.2. LOCAL LEVEL

A total of **24 Municipalities** cover the major conurbations and larger towns in Cyprus, with a further 9 in the area occupied by Turkey. Populations range from almost 90,000 (Limassol) to less than 1,000 (Lefkara), although the average is around 16,500. Nicosia is covered by seven different Municipalities representing a total population of some 170,000. The Municipalities are represented by the Union of Cyprus Municipalities.

Under the Municipalities Law, the Municipalities are nominally responsible for water supply, sewerage and wastewater treatment, rainwater drainage, street cleaning, refuse collection and disposal and the protection of the natural environment.

The major Municipalities (greater Nicosia, Limassol, Larnaca and Paphos) are also Town Planning Authorities, responsible for issuing permits for the construction and operation of new developments in their areas. The major Municipalities discharge their responsibilities for wastewater collection, treatment and disposal through Municipal Sewage Boards (MSBs), which are established as separate entities but linked to the Municipalities. The Municipalities also work together where appropriate (particularly in Nicosia) on joint projects, for example sewage treatment works and waste disposal sites.

In addition to these Municipalities, there are **352 Communities** in the rural areas of Cyprus. These cover only about 40% of the population but 80% of the land area. The average population served by a Community is only around 750 and many are much smaller than this. They are represented by the Union of Cyprus Communities, and have a more limited role in relation to environmental issues. Like the Municipalities, the Communities also work together where appropriate.

In practice, neither the Municipalities nor the Communities have the financial resources or the staff to discharge their environmental responsibilities effectively. It follows that responsibility for infrastructure investment required by the local authorities generally falls to central government, as for example the Water Development Department of MANRE.

2.1.3. NON GOVERNMENTAL ORGANISATIONS

There are more than 30 purely environmental or environmentally-concerned NGOs in Cyprus, and their involvement in environmental policy formulation is actively encouraged. Under law 57(1) on EIA, the Federation of Environmental and Ecological Organizations participates as a member in the TCEIA.

Several NGOs are members of the Council for the Environment and of steering committees for protected areas. They are also invited to express their views during hearings at the Parliamentary Environment Committee. The awareness-raising activities of NGOs are supported by financial assistance from Government for specific actions.

2.2. CYPRUS NATIONAL LAW 57(I)/2001 ON EIA

2.2.1. OBLIGATION FOR EIA STUDY

According to Cyprus Law 57(1) of 2001, STPs with a capacity above 2,000 equivalent-population are subject to full EIA study. This level is extremely low when compared to the same requirement of EU Directive 97/11/EC which is 150,000 equivalent-population, but understandable when considering the limited size and population of Cyprus.

The Law, however, does not mention any environmental requirements specific to the construction of sewer networks.

What will be considered for the present EIA study is:

- Full EIA will be carried out for all the STPs proposed, as all the projects will serve more than 2,000 people each.
- For groups of villages to be connected to an existing STP, Preliminary Environmental Impact Assessment (PEIR) will be carried out, complemented by an Environmental Management Plan (EMP) focusing on mitigation and monitoring measures during the construction stage.

In the Proposal of the Consultant, it was anticipated to carry out one EIA study for each group (cluster) of villages, or 4 EIAs. It is obvious that the splitting of some initial groups into two different systems will complicate the task. According to the Environment Service of MANRE, in such situation, one EIA report may still be maintained, considering that a two facilities scheme is the preferred alternative. We may presently stick to this suggestion, but final presentation of documents (common or separate reports) will be decided later according to needs.

2.2.2. CYPRUS NATIONAL LAW 57(I)/2002 ON EIA

A significant part of the harmonization procedure of Cyprus with the EU 'acquis' has been the adoption of the Law for the Assessment of the Environmental Impacts from Certain Projects (No. 57(I)/2001, Gazette No. 3488 of April 12th, 2001), which is now fully implemented, with responsibilities resting primarily with the Environmental Service. The Law deals with the environmental impacts from projects and activities, and aims at minimising these impacts taking into consideration the environmental parameters before the issuing of a permit for the execution of the project.

The Law is based on the EU Directive 85/337/EEC, as amended by Directive 97/11/EEC. It has replaced the system of assessing the impacts to the environment that was applied based on a Council of Ministers Decision (No. 35/700, dated 20/6/1991).

According to this Law, the granting of a permit or approval for a project, including public projects, that may have significant environmental impacts, should be done only after assessing its potential impacts on the environment. This applies for every project that falls in the project categories of Annex I or II of the Law. The projects which are included under Annex I are those that could potentially result in significant adverse impacts on the environment and must go through a full assessment of their impacts. Annex II projects do not necessarily and in all occasions have significant environmental impacts, and for this they are subject to a Preliminary Environmental Impact Report (PEIR). Following evaluation of the PEIR, it is decided whether a full environmental assessment is required. Therefore, when an application is submitted for a planning permit or project approval, an EIA must be submitted for Annex I projects, or a PEIR for Annex II projects. With regards to sewage treatment plants, those with a capacity above 2 000 population-equivalent are included in Annex I and are thus subject to a full EIA. (Articles 9 and 10, Law 57(I)/2001).

The EIA must contain the information specified in Annex III of the Law. It must identify, describe and evaluate the direct and indirect impacts likely to result from the project on a number of factors, including human beings; flora and fauna; the natural, as well as the historic and traditional man-made landscape; water, air and climate, and soils; material assets; and the architectural, cultural and archaeological heritage. (Article 12, Law 57(I)/2001)

Following the submission of the EIA, the developer (public or private authority) must publicise a Notification in two local daily newspapers announcing the submission of the EIA, the project and the area where it will be executed and the place where the study can be inspected. Any person can submit opinions or representations regarding the scope of the EIA or the possible environmental impacts of the project to the Environmental Authority (which is the Director of the Environment Service) within 30 days from the publication of the notification. (Article 20, Law 57(I)/2001)

The EIA is evaluated by the Environmental Authority who is advised by a permanent Committee (Committee for the Assessment of Environmental Impacts). This comprises representatives of all key Ministries and Departments related to the environment, as well as representatives of civil society. The Committee must take into consideration any justified opinions or representations made by any persons, organisation or authorities. It then makes recommendations to the Environmental Authority which delivers a justified opinion to the planning authority proposing measures to be imposed with the permit or even that the project is not executed. (Article 13, Law 57(I)/2001). In issuing the permit, the opinion of the environmental authority must be taken into account as a fundamental factor in the decision-making. (Article 4, Law 57(I)/2001)

2.3. OTHER NATIONAL LAWS

The use of sewage sludge in agriculture is not yet practiced except on an experimental basis. The disposal of sewage sludge is covered by the Water Pollution Control Law. Limit values for heavy metals are set in permits for land-spreading operations. A study financed by the European Investment Bank has been prepared, considering the options available (including for agricultural purposes) for the re-use of such sludge from the various treatment plants. The study indicates that the sludge produced could find use in agriculture and as an alternative low cost fuel in cement factories. A Code of Good Agricultural Practice (Use of Sewage Sludge in Agriculture), used as a guide for the discharge consent terms, has been completed and adopted in the beginning of 2002, under the Water Pollution Control Law.

The Quality of Water Intended for Human Consumption Law was enacted in May 2001 (Law No.87 (I) 2001), which fully covers requirements to safeguard drinking water quality

2.4. EU ENVIRONMENTAL DIRECTIVES

2.4.1. EU DIRECTIVE 97/11/EC ON EIA

EIA is a procedure required under the terms of European Union Directive 85/337/EEC amended by **EU Directive 97/11/EC** on assessment of the effects of certain public and private projects on the environment. Article 2 of the Directives requires that *"Member States shall adopt all measures necessary to ensure that, before consent is given, projects likely to have significant effects on the environment by virtue, inter alia, of their nature, size or location are made subject to a requirement for development consent and an assessment with regard to their effects."* Article 8 then requires that *"The results of consultations and information gathered pursuant to* [the EIA procedure] *must be taken into consideration in the development consent procedure"*.

These requirements are elaborated further in the Directive and in the EIA system introduced in Cyprus (Law 57(1) of 2001).

The environmental information that developers are required to provide under the EIA procedure is defined in Article 5(3) and Annex IV of Directive 97/11/EC. Article 5(3) requires that the information must include "*at least*

- *A description of the project comprising information on the site, design and size,*
- *A description of the measures envisaged in order to avoid, reduce and, if possible, remedy significant adverse effects,*
- *The data required to identify and assess the main effects which the project is likely to have on the environment,*
- *An outline of the main alternatives studied by the developer and an indication of the main reasons for his choice, taking into account the environmental effects,*
- *A non technical summary of the information mentioned in the previous indents*".
- Article 5(1) provides that the developers must supply the information in Annex IV "*in an appropriate form (…) in so much as:*
- *The Member State considers that the information is relevant to a given stage of the consent procedure and to the specific characteristics of a particular project or type of project and of the environmental features likely to be affected;*
- *The Member State considers that a developer may reasonably be required to compile this information having regard to current knowledge and methods of assessment*."

In most Member States, as in Cyprus, the information is provided in the form of an Environmental Impact Statement or EIS.

2.4.2. OTHER EU DIRECTIVES

Council Directive 91/271/EEC of 21May 1991 on urban wastewater treatment;

Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture;

Birds Directive 79/409/EEC: This Directive was implemented in April 1981 and imposes strict legal obligations on European Union Member States to maintain populations of naturally occurring wild birds at levels corresponding to ecological requirements, to regulate trade in birds, to limit hunting to species able to sustain exploitation, and to prohibit certain methods of capture and killing. Article 1 applies to the conservation of birds and also to their eggs, nests and habitats. Article 4 requires Member States to take special measures to conserve the habitat of certain listed threatened species through the designation of **Special Protection Areas** (SPAs).

Habitats Directive 92/43/EEC (Directive on the Conservation of Natural and Semi-natural Habitats and of Wild Fauna and Flora) aims to conserve fauna, flora and natural habitats of EU importance. The fundamental purpose of this directive is to establish a network of protected areas throughout the Community designed to maintain both the distribution and the abundance of threatened species and habitats, both terrestrial and marine. The network of **Special Areas of Conservation** (SAC) is called **Natura 2000**, and will include SPAs of the Birds Directive. Criteria for selection include priority habitats and species, as identified in its Annexes.

Under the Habitats Directive, **Natura 2000** is defined in Article 3(1) as a coherent European ecological network of special areas of conservation. This network, composed of sites hosting the natural habitat types listed in Annex I and habitats of species listed in Annex II, would enable the natural habitat types and the species' habitats concerned to be maintained or, where appropriate, restored at a favourable conservation status in their natural range.

Based on the Bird and Habitat Directives, the network sets the minimum standard for biodiversity conservation in the Member States, encompassing a wide range of issues and containing a number of concrete obligations. This concept is strengthened by the Maastricht Treaty, according to which all Community policies and instruments must comply with the Community's environmental statutes, including the Habitats and Birds Directives.

In Cyprus, 38 sites Natura 2000 have already been proposed.

2.5. INTERNATIONAL AGREEMENTS AND CONVENTIONS

Several international conventions for the protection of the environment have also been ratified such as the Convention for the Conservation of the European Wildlife and Natural Habitats, the Convention on Biological Diversity, the Convention on the International Trade of Endangered Species (C.I.T.E.S.), the Convention for the Protection of the Mediterranean Sea Against Pollution and its four Protocols (MARPOL), the Global Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal, the Vienna Convention and the Montreal Protocol on the Protection of the Ozone Layer, the Climate Change Convention, the Convention for Migratory Species, the Convention on EIA in a Transboundary Context, the Convention to Combat Desertification, and the Convention on Wetlands of International Importance (RAMSAR).

3. PROJECT DESCRIPTION

3.1. PROJECT JUSTIFICATION

As a future member of the European Union, Cyprus must fulfill the EU pre-accession requirements concerning the protection of the environment and therefore must meet the obligations and requirements of Council Directive 91/271/EEC on urban wastewater treatment. The Directive 91/271/EEC on urban wastewater treatment concerns the collection, treatment and discharge of wastewater, including biodegradable industrial wastewater discharges, from sufficiently populated areas. It sets deadlines until 31 December 2005, to provide for collection systems and at least for secondary treatment for communities of different levels of populations, ranging from 2 000 population equivalent (p.e.) to more than 100 000 p.e. More advanced tertiary treatment is required for sensitive areas, including communities of less than 2 000 p.e. It also requires prior regulations and authorisations for all discharges of wastewater into the environment, for industrial discharges into urban wastewater systems and for the disposal of sewage sludge.

The current project involves the design of sewerage systems for the communities of the Nicosia area (Group A), which include the villages of Astromeritis, Peristerona, Akaki, Kokkinotrimithia, and Palaiometocho. The sewage systems will consist of the collection and conveyance systems, and the central sewage treatment plants. For this purpose, during the feasibility study stage, a number of alternative schemes was evaluated, in connection with possible alternative sites for the construction of the sewage treatment plants, based on technical, financial and environmental criteria and a final scheme was selected as the preferred alternative. This includes the construction of a sewage treatment plant near Astromeritis, for the connection of the communities of Astromeritis, Peristerona and Akaki; and the connection of the communities of Kokkinotrimithia and Palaiometocho to the existing Anthoupolis treatment plant, which will be reconstructed as part of the project for the Greater Nicosia Sanitary Sewage System.

3.2. PROJECT LOCATION

The proposed location for the construction of the sewage treatment plant which will service the communities of Astromeritis, Peristerona and Akaki, including the emergency and storage reservoirs, is presented in Drawing EIA – A – 1. The site is within the buffer zone, at a distance of approximately 0.8 km from the boundary of the residential zone of Astromeritis, to the west of the village. The area is designated as an Agricultural Zone G3, and the proposed location is at the site of a disserted quarry.

The location of the existing Anthoupolis sewage treatment plant, to which the communities of Kokkinotrimithia and Palaiometocho will be connected, is shown in Drawing EIA – A – 2. The STP site is in the village of Pano Deftera, approximately 2.5 km to the north of the community's residential area, and 11 km southwest from the centre of Nicosia. The area is designated as an Agricultural Zone G3.

Drawing EIA – A – 3 shows the suggested sewer routes for the conveyance system and the positions of the pumping stations, however, these are only preliminary and subject to the final detailed design of the system.

3.3. PROJECT CHARACTERISTICS

3.3.1. SERVICED AREA

Table 3.1 lists the Nicosia area communities that are included in Group A, and which will be service by the proposed sewage treatment plants.

TABLE 3.1: NICOSIA AREA (GROUP A) COMMUNITITES

COMMUNITY NUMBER	COMMUNITY
α1	Astromeritis
α2	Peristerona
α3	Akaki
α4	Kokkinotrimithia
α5	Palaiometocho

The water demand analysis is summarised in the table below.

TABLE 3.2: WATER DEMAND

COMMUNITIES	AVERAGE WATER DEMAND IN 2005 (INTO BRACKET AVERAGE WATER DEMAND INCLUDING ADDITIONAL SUMMER CONSUMPTION) m^3/day	AVERAGE WATER DEMAND IN 2030 (INTO BRACKET AVERAGE WATER DEMAND INCLUDING ADDITIONAL SUMMER CONSUMPTION) m^3/day
Astromeritis	335 (335)	498 (498)
Peristerona	303 (303)	410 (410)
Akaki	377 (377)	537 (537)
Kokkinotrimithia	444 (444)	711 (711)
Palaiometocho	580 (580)	895 (895)

3.3.2. EXISTING ANTHOUPOLIS SEWAGE TREATMENT PLANT

3.3.2.2. EXISTING TREATMENT PLANT

Originally, the Anthoupolis sewage treatment plant, which began operation in 1993, was constructed to service the refugee estate of Pano Lakatamia, and later that of Chrysospiliotissa. The plant was designed with an ultimate design flow of approximately 900 m^3/day and a designated BOD_5 load of 450 mg/l. today the plant treats about 320 m^3/day, from 4 500 residents, with a BOD_5 load of approximately 750 mg/l.

The plant treatment process consists of an aerated lagoon, two facultative lagoons, which operate in parallel, and a maturation pond.

	Area, m^2	Volume, m^3
Aerated lagoon	1 907 m^2	4 768 m^3
Facultative lagoons		
⇨ First lagoon	18 565 m^2 total	11 354 m^3
⇨ Second lagoon		16 494 m^3

Maturation pond	4 609 m^2	5 992 m^3

3.3.2.2. IMPROVED TREATMENT PROCESS PLANT

As part of the project for the Greater Nicosia Sanitary Sewage System, a new sewage treatment plant will be constructed at the same location as the Anthoupolis treatment plant, for the connection of more communities in the area, and which will replace the existing plant.

The new sewage treatment plant has been designed with an average daily design flow of 10 300 m^3/day and a peak daily design flow of 14 500 m^3/day. The design includes the connection of the communities of Kokkinotrimithia and Palaiometocho.

For design purposes the proposed wastewater pollution concentrations are as follows:

BOD_5	600 mg/l
COD	1 275 mg/l
SS	400 mg/l
TKN	100 mg/l
P	30 mg/l

The corresponding pollution loads at average flow conditions for the year 2025 have been calculated to be:

	Reference Pollutant Load, kg/day	Average Pollutant Load, kg/day
BOD_5	8 700	6 180
COD	18 500	13 150
SS	5 800	4 120
TKN	1 450	1 030
P	435	310

The following discharge standards have been set for the treated effluents:

BOD_5	10 mg/l
COD	90 mg/l
Suspended Solids	10 mg/l
Total – N (TKN and nitrates)	10 mg/l
Faecal coliforms	5 units / 100 ml (in 80% of the samples) 15 units / 100 ml (maximum)
Intestinal worms	Nil
Total – P	Provision for future removal

All the facilities and structures of the new sewage treatment plant must be located within the existing site, since no additional land is available for the extension. The land available for the new Anthoupolis sewage treatment plant is an 8 600 m^2 area to the north of the existing administration building, which also includes this building.

One of the existing facultative lagoons will be maintained for the short term storage of the treated wastewater, providing a little more than a one-day storage. This reservoir must have a minimum capacity of 14 000 m^3. This will be sufficient to balance the daily variations in the wastewater flow, sot that the treated water pumping stations can be operated on a constant flow basis. The other lagoons will be filled and landscaped so as to turn the site into a park.

Regarding the long term storage and reuse of the treated wastewater from the station, a separate study will be conducted which will cover all the treated sewage that will be produced following the completion of the Greater Nicosia sanitary sewage system.

3.3.3. SEWAGE TREATMENT PLANT

3.3.3.1. EXPECTED CAPACITY

Wastewater production was derived from the data on water demand taking into account

- The return rate from the water supply to the sewers
- The corresponding flow from the summer houses
- A peak day factor
- A peak hour factor

Concerning the return of water to the wastewater system, studies made for the Greater Nicosia Sanitary System indicate that approximately 85% of domestic consumption could enter into the sewerage system, assuming a connection existed. Such a figure is in the range of those encountered elsewhere and was used in this study.

Infiltration resulting from the presence of ground water can be introduced in the waste water production. Groundwater infiltration occurs in gravity pipes where water leaks into the system through joints, cracks and other defects. With proper design, pipe material choice and construction the infiltration is minimized. Furthermore, infiltration is likely to occur in winter months when water consumption is low. For the purpose of this study the infiltration was taken into account as provision. According to the obtained data groundwater levels in the study area are generally lower that invert levels of the collection system except for parts of the Livadia and Perivolia. The flow from the infiltration is calculated using the value of 30m3/day/km which is the value commonly used in Europe and USA. According to the geological investigations it was estimated that approximately 30 % of the collection systems in Livadia and Perivolia will be bellow the ground water elevation. Furthermore it was estimated that in year 2005 only 25 % of the collection system will be in operation, while in year 2015, 75 % will be constructed. On the basis of these assumptions the additional flow due to the infiltration was estimated.

The average dry weather flow (ADWF) was calculated as a sum of domestic, non domestic and additional summer houses and hotel flow. In addition infiltration is added as a provision. Peak factors in sewerage systems correlate to a certain extent to those in water supply. In the GNSS project the peak water consumption was 1.4 times the average water consumption. This factor has been used to derive a Maximum Dry Weather flow (MDWF). The factor is not applied to the infiltration flow. The estimated wastewater production is given in Table 3.3 for the years 2005, 2015 and 2030.

Dry weather flow varies during the day with a major peak typically occurring in the early morning. It depends on the number of the inhabitants as well as on the size of the catchment area. As the catchment areas expand, the peak value decreases due to the superposition of different dry weather flow hydrographs and flow attenuation in the network.

The peak factor for the maximum hour varies for different consumers (domestic and industrial). On average the Peak hour factor is approximately 2.00, while for industries it rises to 3.8, relative to average day flow.

TABLE 3.3: WASTEWATER FLOW

COMMUNITIES	2005 ANNUAL PRODUCTION IN m³/year	2005 MAXIMUM DRY WEATHER FLOW IN m³/day	2015 ANNUAL PRODUCTION IN m³/year	2015 MAXIMUM DRY WEATHER FLOW IN m³/day	2030 ANNUAL PRODUCTION IN m³/year	2030 MAXIMUM DRY WEATHER FLOW IN m³/day
Astromeritis Sewage Treatment Plant						
Astromeritis	122 275	399	142 350	464	181 770	593
Peristerona	110 595	361	124 465	406	149 650	488
Akaki	137 605	449	157 315	513	196 005	639
Total	*370 475*	*1 209*	*424 130*	*1 383*	*527 425*	*1 720*
Anthoupolis Sewage Treatment Plant						
Kokkinotrimithia	162 060	528	194 180	633	259 515	846
Palaiometocho	211 700	690	250 025	815	326 675	1 065
Total	*373 760*	*1 218*	*444 205*	*1 448*	*586 190*	*1 911*
TOTAL	**744 235**	**2 427**	**868 335**	**2 831**	**1 113 615**	**3 631**

TABLE 3.4: SEWAGE TREATMENT PLANTS

LOCATION		NOMINAL CAPACITY (m³/day)
Sewage Treatment Plant	Urban / Rural / Government	
Astromeritis	Rural	1 720
Anthoupolis (Kokkinotrimithia and Palaiometocho)	Rural	1 911
TOTAL		**3 631**

The area requirements for the Astromeritis sewage treatment plant have been estimated to be 1.6 m^2/m^3/day, assuming a unit wastewater flow of 145 l/cap/day, or 0.3 m^2/population equivalent. The land requirements for the sewage treatment plants will be as follows:

TABLE 3.5: LAND REQUIREMENTS FOR THE ASTROMERITIS SEWAGE TREATMENT PLANT

SEWAGE TREATMENT PLANT	AREA REQUIREMENTS FOR SEWAGE TREATMENT PLANT	AREA REQUIREMENTS INCLUDING NEEDS FOR SLUDGE STORAGE, PARKING SPACE, OFFICES, BUFFER ZONE, ETC
Astromeritis	2 751 m^2	2 800 m^2

In the case of the Anthoupolis sewage treatment plant, the new plant will be constructed within the area available at the existing site, which is approximately 8 600 m^2.

3.3.3.2. ESTIMATED POLLUTANT LOAD

There is no data available on the quality of the wastewater for the villages and it is difficult to characterize wastewater from a few spot analyses. Therefore, the wastewater pollution loadings have been estimated using per capita loading rates in accordance with the EU Directive 91/271/EEC. The following unit loading rates have been used:

TABLE 3.6: PROPOSED WASTEWATER POLLUTION UNIT LOADING RATES

BOD g/cap/d	COD g/cap/d	SS g/cap/d	TKN g/cap/d	P g/cap/d	Total coli MPN/cap/d	Faecal coli MPN/cap/d
60	135	75	12	4	10^8	10^7

The resulting average and peak pollutant loads presently and at medium and long term are given in Table 3.7 for the BOD which is the basic design parameter for the sewage treatment plants.

TABLE 3.7: WASTEWATER POLLUTANT LOAD ESTIMATES (BOD)

COMMUNITY	2005 ANNUAL LOAD kg BOD/yr	2005 PEAK DAILY LOAD kg BOD/day	2015 ANNUAL LOAD kg BOD/yr	2015 PEAK DAILY LOAD kg BOD/day	2030 ANNUAL LOAD kg BOD/yr	2030 PEAK DAILY LOAD kg BOD/day
Astromeritis Sewage Treatment Plant						
Astromeritis	54 684	178	62 919	205	77 636	253
Peristerona	49 582	162	54 903	179	63 970	209
Akaki	61 539	201	69 620	227	83 970	273
Sub Total	*165 805*	*541*	*187 442*	*611*	*225 576*	*735*
Anthoupolis Sewage Treatment Plant						
Kokkinotrimithia	72 555	237	85 936	280	83 746	361
Palaiometocho	94 871	309	110 661	361	110 792	454
Sub Total	*167 426*	*546*	*196 597*	*641*	*250 142*	*815*
TOTAL	**333 231**	**1 087**	**384 039**	**1 252**	**475 718**	**1 550**

3.3.3.3. EXPECTED QUALITY OF THE TREATED EFFLUENT

A combination of the standards specified by both the EU Directive 91/271/EEC and the Cyprus Codes of Practice for the disposal or reuse of treated effluents (Law 106(I)/2002 on the Control of Water and Soil Pollution) will be used (Appendix 1), and the most stringent values will be applied for the design of the wastewater treatment plant. Removal of nitrogen will be governed by the EU standards, whereas the limits for BOD, Suspended Solids (SS) and micro-organisms will follow the Cyprus Standards.

- ASTROMERITIS SEWAGE TREATMENT PLANT

According to the EU Directive, the effluent discharged to sensitive areas should have concentrations of Nitrogen and Phosphorus not exceeding 15 mg/l (N) and 2 mg/l (P) respectively. However, the Government of Cyprus has requested deviation from the EU Directive in the case of phosphorus removal when the treated effluent will be used for irrigation purposes. In light of this it has been suggested that the treatment plant should be designed in a way as to ensure that the nitrogen concentration of the treated effluent does not exceed 15 mg/l, while with regards to phosphorus removal, only provision for future installation shall be provided for in the plant. Nevertheless, for the reuse of the treated effluent for irrigation or aquifer recharge purposes, the removal of phosphorus, in accordance with the European Standards, is also recommended here to avoid any risk of groundwater or soil pollution. Table 3.8 outlines the proposed limit values for the treated effluent as compared with the EU and Cyprus Standards.

TABLE 3.8: SUGGESTED DISCHARGE STANDARDS FOR THE DESIGN OF THE ASTROMERITIS STP

PARAMETER	EU STANDARDS	CYPRUS REGULATION 517/2002 (FOR IRRIGATION OF ALL CROPS	PROPOSED LIMIT VALUES
BOD_5	25 mg/l	10 mg/l	10 mg/l
COD	90 mg/l	< 125 mg/l	< 125 mg/l
Suspended Solids	35 mg/l	10 mg/l	10 mg/l
Total N	15 mg/l	–	15 mg/l
Faecal coliforms	–	5 units/100 ml (in 80% of samples) 15 units/100 ml (maximum)	5 units/100 ml (in 80% of samples) 15 units/100 ml (maximum)
Intestinal worms	–	Nil	Nil
Total P	2 mg/l	–	2 mg/l

- ANTHOUPOLIS SEWAGE TREATMENT PLANT

In the case of the Anthoupolis Sewage Treatment Plant, the following discharge standards have been suggested during the preliminary design stage:

TABLE 3.9: SUGGESTED DISCHARGE STANDARDS FOR THE ANTHOUPOLIS STP

PARAMETER	SUGGESTED DISCHARGE LIMITS
BOD_5	10 mg/l
COD	90 mg/l
Suspended Solids	10 mg/l
Total N	10 mg/l
Faecal coliforms	5 units/100 ml (in 80% of samples) 15 units/100 ml (maximum)
Intestinal worms	Nil
Total P	Provision for future removal

3.3.3.4. TYPE OF TREATMENT PROCESS

Three of the alternative treatment methods which have been examined could offer the level of treatment that is required for the disposal and reuse of the treated effluents, according to the quality standards which have been set:

- The activated sludge process with tertiary treatment,
- The bio aerated filters with tertiary treatments, and
- The membrane bioreactors.

Due to the advantages of the activated sludge process, including low costs, stable performances and reliability, it will represent the basic option for the sewage treatment plants. Other, more compact processes, such as the bio aerated filters, will be examined in cases when the available land is restricted to allow the use of the activated sludge process, or where there are particular environmental constraints, such as proximity to residential areas and the need for a complete cover-up of the treatment facilities.

- ASTROMERITIS SEWAGE TREATMENT PLANT: ACTIVATED SLUDGE PROCESS

The activated-sludge process is one of the most common treatment processes and is currently in operation in three of the main treatment plants in Cyprus (Paralimni, Limassol and Larnaca). The process can be designed in many modified forms, including: selection of the reactor type, oxygen requirements and transfer, and types of settling tanks, but fundamentally the theoretical aspects of the process are similar:

- Wastewater is introduced into a reactor (aeration basin) where an aerobic bacterial culture is maintained in suspension. The reactor contents are referred to as the “mixed liquor”. In the reactor, the bacterial culture carries out the conversion of the organic matter into biological solids (biological cells).
- The aerobic environment in the reactor is achieved by the use of diffused or mechanical aeration, which also serves to maintain the mixed liquor in a completely mixed regime.
- After a specific period of time, the mixture of biological solids is passed into a settling tank, where some of the settled sludge is recycled to maintain the desired concentration of organisms in the reactor and the remainder is removed from the system.
- The level at which the biological mass in the reactor should be kept (mean cell - residence time) depends on the desired treatment efficiency and other considerations, including the nature of the wastewater, and the local environmental conditions.

Different parameters can be used for the design of the activated-sludge process:

- The food to micro-organism ratio or mass loading defined as the mass of BOD applied per day to the treatment system divided by the mass of mixed liquor suspended solids (MLSS) in the aeration tank.
- The mean cell-residence time or sludge age that is the ratio of the mass of MSS in the aeration tank to the mass of sludge removed per day from the system.
- The volume loading defined as the mass of BOD applied per day to the treatment system divided by the aeration tank volume.

The activated sludge process was initially designed for removal of dissolved organic pollution (expressed as BOD, COD and SS), where removal rates up to 90%-95% can be expected depending on the design parameters. In the later years, the removal of nitrogen by biological nitrification and denitrification has been largely developed, requiring an increase of the sludge age in the tank and specific mixing, aeration and recycling arrangements. It has also been shown that biological phosphorus reduction can be achieved if an anaerobic tank is added at the inlet of the biological reactor and this development is now gaining more and more interest.

Aeration equipment for injecting oxygen into the MLSS can consist of mechanical aerators or diffused air systems that blow air into the MLSS.

Final settling tanks are used to separate the biological solids produced in activated sludge from the treated wastewater. Settling tanks are mainly designed on the basis of an overflow rate. Overflow rates may range from 0.5 to 0.7 m/h at peak flows.

It should be pointed out that an activated-sludge process does not provide any significant reduction in coliform counts (only a factor 10 to 100). Where coliform reduction is required, as the case is here, a tertiary treatment should be added to the treatment train, most often consisting in sand filtration and disinfection by chlorine or UV radiation.

Provided with tertiary treatment, the activated sludge process would meet the set performance requirements. However, due to the space requirements, the process could be difficult to locate where little land is available and leads to high costs if the plant should be covered and odour treated.

In the case of the Astromeritis sewage treatment plant, where the available land is sufficient to satisfy the necessary land requirements, the activated sludge process is recommended as the appropriate treatment process for the plant.

- ANTHOUPOLIS SEWAGE TREATMENT PLANT: BIOAERATED FILTER PROCESS

In the case of the Anthoupolis sewage treatment plant, the available land at the existing site is restricted to less than 9 000 m^2, while there is also an additional requirement for the cover-up of all facilities as a mitigation measure to ensure there will be no odour impacts in the future. These limitations exclude the use of the activated sludge process, since the relatively large area extents that are required for this process cannot be satisfied by the available space at the plant site, while additionally the cover-up of the installations would be difficult and expensive.

The biofiltration technology presents a certain number of advantages compared to the membrane bioreactor process:

- The technology is proven through a large number of large-scale plants in operation worldwide,
- The level of treatment can be adjusted to fit with the day-to-day requirements, thus the operation and maintenance costs can be optimized, and
- The process can be easily adopted to load variations.

In conclusion, for the purposes of the preliminary design the bioaerated filters process has been proposed for the Anthoupolis sewage treatment plant.

The bio aerated filter technology is an attached growth process, i.e. the purifying biomass is attached on a substrate (the contrary is the suspended growth process, e.g. activated sludge, where the biomass is kept in suspension in the biological reactor). In a biofilter, the substrate consists in grains with size in the range 1 to 4 mm with a high specific favourable to bacterial development. This material combines the functions of biological reactor and solid-liquid separation and therefore, no additional sedimentation tank is required.

The result of progress made during the last decade is that today, bio filtration has become a particularly advantageous treatment process. In municipal wastewater treatment, it makes it possible to carry out secondary biological treatment (removal of BOD and nitrogen) and retention of the SS at the same time.

The biofiltration process uses biomass of greater concentration and, above all, of greater activity than activated sludge and have the following advantages:

- savings in land space, particularly due to elimination of the secondary clarifier stage. This compactness makes it easier to cover units, control harmful effects (odours and sound) and produce aesthetic units,
- no risk of leaching since the biomass is attached to a support such that flow variations can be readily handled,
- quick restarting, even after stopping for several months, and therefore suitable to seasonal variations in load,
- modular construction and easy automation.

The filtration could be either upflow or downflow depending on the supplier. The biofiltration is normally used after primary settling or flotation (these steps can be preceded by flocculation).

The process provides a high degree of treatment of BOD and SS and can also perform nitrification-denitrification to desired level. However, as most intense biological processes, the faecal coliform reduction is low and the process needs to be completed by tertiary disinfection to provide a quality required for reuse.

3.3.3.5. SLUDGE TREATMENT AND DISPOSAL

The expected sludge production for the years 2005, 2015 and 2030 is outlined in Table 3.10.

TABLE 3.10: EXPECTED SLUDGE PRODUCTION

COMMUNITY	ANNUAL DRY SOLIDS PRODUCTION, kg DS/YEAR		
	2005	2015	2030
Astromeritis Sewage Treatment Plant			
Astromeritis	54 684	62 919	77 636

COMMUNITY	ANNUAL DRY SOLIDS PRODUCTION, kg DS/YEAR		
	2005	2015	2030
Peristerona	49 582	54 903	63 970
Akaki	61 539	69 620	83 746
Sub Total	*165 805*	*187 442*	*225 352*
Total Sludge Volume at 30% DS Content	**553 m^3/year**	**625 m^3/year**	**751 m^3/year**
Anthoupolis Sewage Treatment Plant			
Kokkinotrimithia	72 555	85 936	110 792
Palaiometocho	94 871	110 661	139 350
Sub Total	*167 426*	*196 597*	*250 142*
Total Sludge Volume at 30% DS Content	**558 m^3/year**	**655 m^3/year**	**834 m^3/year**
Total Quantitites			
Total Annual Dry Solids Production, kg DS/year	*333 231*	*384 039*	*475 494*
Total Sludge Volume at 30% DS Content	**1 111 m^3/year**	**1 280 m^3/year**	**1 585 m^3/year**

❑ ASTROMERITIS SEWAGE TREATMENT PLANT

The experience from other wastewater treatment plants in Cyprus shows that sludge can easily be reused in agriculture and, due to the low rate of industrial wastewater of the total, that the sludge meets EU requirements for agricultural use without problems. It is therefore anticipated that the sludge from the treatment plant will be used as soil amendment in agriculture in accordance with the Code of Practice for the Use of Sludge for Agricultural Purposes (Law 106(I)/2002) and the standards imposed by it. The process selection for the sludge treatment will be based on this assumption.

The construction of a storage site will be necessary for the reuse of sludge. This will be located at the sewage treatment plant site, since this is at a sufficient distance from residential areas, and it will provide sufficient capacity for the storage of sludge during periods when its application is not possible.

Nevertheless, a significant percentage of the sludge produced will be disposed in landfills despite objectives for reuse, particularly during the first years of operation of the STP. Disposal must take place in an official controlled landfill site appropriate for the disposal of such wastes, which will incur additional costs for the transport of sludge.

Three different steps in the sludge treatment can normally be distinguished: thickening, stabilisation and dewatering. Sometimes, thickening and dewatering can be combined or stabilisation be omitted. An additional drying stage could also sometimes be required.

⇩ SLUDGE THISCKENING

The excess sludge which is withdrawn from the secondary clarifier has a dry solids (DS) content of around 8 g/l and, in consequence, a water content of 99.2%. The sludge at this stage is thus very liquid, "dirty water". The purpose of sludge thickening is to concentrate the solids to a solids content of around 30 g/l or 3%. The sludge is after thickening still a liquid but with the volume reduced to around ¼ of the initial volume. Sludge thickening is generally carried out either by gravity thickeners, air flotation or drainage screens.

Gravity thickener: it is the most common type of sludge thickening device. It gives excellent results on primary sludge and acceptable results on digested secondary sludge. The principle and the operation are simple and robust. Gravity thickeners cannot be used if biological phosphorus removal is used, since anaerobic conditions will appear in the thickener with subsequent phosphorus release as a result.

Dissolved air flotation: it is used when the sludge is light and difficult to settle, typically for unstabilised activated sludge or sludge from biofilters. It is also a preferred option when biological phosphorus removal is used. The process is however more complicated to operate and more costly in operation and maintenance.

Drainage screens: they are mainly used in small treatment facilities and can be an interesting and space saving option.

⇩ SLUDGE STABILISATION

The purpose of the sludge stabilisation is to reduce the content of organic matter in the sludge and thereby reduce the potential for further fermentation or putrefaction and, in the same time, eliminate offensive odours. The stabilisation will also reduce pathogens in the sludge to some extent. The processes used are:

- anaerobic digestion
- aerobic digestion
- lime stabilisation
- thermal treatment

Anaerobic digestion: by methane fermentation is a powerful means of removing substantial quantities of organic matter. The process most generally used is mesophilic digestion at 35°C. For normal wastewater treatment sludge, a reduction of 45 to 50% of the organic matter content can be expected. The digestion is producing biogas, mainly consisting of methane and carbon dioxide. A part of the produced biogas is used for the heating of the digestor and the surplus can be used for heating other facilities or for producing electricity for the aerators of the plant.

Aerobic stabilization: it is usually employed in open-air units provided with air diffusers or surface aerators. The aerobic stabilisation is rather energy consuming and is therefore rarely used as a specific unit. However, in an extended aeration activated sludge process, sludge is partly aerobically stabilised within the treatment process.

The advantages and disadvantages of aerobic and anaerobic stabilisation are compared in the following table (from Degrémont Water Treatment Handbook):

TABLE 3.11: ADVANTAGES AND DISADVANTAGES OF AEROBIC AND ANAEROBIC STABILISATION

	AEROBIC STABILISATION	ANAEROBIC STABILISATION
Products	CO_2 H_2O NO_3^-	CH_4 CO_2 H_2O NH_4^+
Energy released in liquid medium per g of organic matter removed	20 kJ	0.8 kJ
Energy generated in gas form per g of organic matter removed	0	20.9 kJ
Rate of breakdown	+	-
Final reduction of organic matter	-	+
BOD_5 of filtered supernatant	30-50 mg/l	200-400 mg/l

	AEROBIC STABILISATION	ANAEROBIC STABILISATION
Resistance to inhibitors	+	-
Long-term storability	-	+
Sludge filterability	-	+

Stabilisation with lime treatment: The fermenting capacity of sludge can be temporarily reduced by adding chemical agents in bacteriostatic dosages. Lime is the most widely used reagent because it is cheap, offers the right alkalinity and enhances the physical structure of the sludge. Lime can be added to the liquid sludge or to the dewatered sludge. The advantage of lime treatment is the absence of heavy investments in civil works and equipment, but this saving should be seen in the light of the relatively high operating costs.

Thermal treatment: is principally used for the conditioning of the sludge by release of bound water in the cells and for deactivation of pathogenic agents.

As a matter of fact, in many cases it is a combination of these processes that are used. In an extended aeration process, sludge is first partly stabilised in the aeration tank, thus aerobic digestion, before undergoing anaerobic digestion. The digested sludge is then often treated with lime in order to improve the physical properties and to ensure that the sludge could be stored for long periods without any renewed fermentation.

⇩ SLUDGE DEWATERING

The purpose of the dewatering process is to further reduce the moisture content in the sludge, thereby also reducing the volume. Typically, dewatered sludge has a dry matter content between 20% and 40% depending on the process, which means a tenfold reduction of the volume. The degree of dewatering depends on the type of equipment being used and it should be selected depending on the final destination of the sludge. Where sludge should be transported over long distances, additional drying up to 60% or even 90% DS could be considered in order to reduce the transportation costs.

Some kind of chemical conditioning is most often required to improve the dewatering characteristics of the sludge. Various types of chemicals are used: metal salts such as ferric chloride and aluminium sulphate, polymers (very commonly used) and lime. The most commonly used dewatering devices and their performances are given in the following table:

TABLE 3.12: DEWATERING TECHNIQUES AND THEIR EFFICIENCY

DEVICE	PERFORMANCE FOR STABILISED BIOLOGICAL SLUDGE	ENERGY CONSUMPTION
Centrifuge	20% - 30%	55-70 kWh/ton dry matter
Belt filter	18% - 26%	40 kWh/ton dry matter
Plate filter press	30% - 40%	30-40 kWh/ton dry matter

Dewatering of sludge on drying beds is a very inexpensive solution, but is limited to small treatment plants due to the large surface areas required. About 0.25 m² of land per population equivalent is required, which would double the required surface for an activated sludge plant.

❑ ANTHOUPOLIS SEWAGE TREATMENT PLANT

In the case of the Anthoupolis sewage treatment plant, the reuse of sludge for agricultural purposes is also recommended as the most appropriate solution, since

⇨ In the long term, it is an environmentally sustainable solution for recycling organic matter,

- ⇨ Due to the strict monitoring of the industrial units that will be connected to the treatment plant the heavy metal levels in the sludge are expected to be well under the maximum acceptable limits,
- ⇨ There is sufficient agricultural land available around Nicosia for sludge spreading, and
- ⇨ According to experience from other treatment plants in Cyprus, sludge is accepted by farmers as an organic fertiliser.

For this purpose, in the preliminary design of the sewage treatment plant a treatment process is suggested which includes the stages of sludge thickening using a gravity thickener, sludge dewatering with a centrifuge, and the stabilization of sludge through lime treatment. This process line is optimised for the sludge that is produced from the biofilter process and will provide sludge that can be easily stored, transported and reused is agriculture without any odour problems.

A storage area for the treated sludge is necessary when the sludge will be applied in agriculture, since the spreading of sludge is limited to certain periods of the year. To avoid any risk of odour impacts, it is not judged appropriate to locate such as storage area at the Anthoupolis plant site, and furthermore the land available at the site does not allow the installation of such a sludge storage space. For these reasons, only a limited storage capacity will be provided for at the Anthoupolis plant, providing storage space for only a few days, after which the plant will be transported to the sludge storage area at the Vathia Gonia STP site (part of the Greater Nicosia Sanitary Sewage System Project).

3.3.3.6. ODOUR CONTROL

❑ ASTROMERITIS SEWAGE TREATMENT PLANT

Generally, three types of odour removal systems are used in applications related to wastewater conveyance and treatment:
- ⇨ Chemical scrubbers
- ⇨ biological filters
- ⇨ activated carbon filters

Chemical scrubbers, including three (or two) scrubber towers and using acid, alkaline and oxidising agents are able to remove satisfactorily all odorous compounds in the air. The system requires daily verification but not any complicated operation procedures. The chemicals used need to be renewed at intervals.

Biological filters are now being developed more and more for odour treatment. Until recently, the biological filter consisted of an organic filter media, normally made up by peat and ligneous fibres which needed to be replaced every five years. However, mineral filter media are now being developed that do not need replacement. Sprinkling with fertiliser is required at intervals to maintain the biological activity on the filter. The biological filters are being more and more efficient with the recent development and can now remove most odorous components, but with reduced efficiency on nitrogen components.

Activated carbon filters can be used to adsorb some odorous compounds. The type of odorous compounds to be removed depends on the treatment of the activated carbon. Hydrogen sulphide (H_2S) can be well removed, but nitrogen compounds are difficult to remove by this system. The activated carbon filter media gets saturated and needs to be replaced from time to time. The design life depends on the applied load, but does generally not exceed six months.

Chemical scrubbers is the system used in a large majority of odour removal systems for wastewater treatment plants and pumping stations in France because of the high efficiency and the relatively low operation costs. Biological filters tend also to be used more frequently.

The use of activated carbon filters is limited to very small installations with low air flows and with a temporary operation, e.g. for odour control of a storm water holding tank, where the air treatment is only operated 10 to 20 days per year.

In normal cases, odour treatment is applied to the facilities that generate the most odours, i.e. pre-treatment and sludge treatment. In some particularly sensitive cases, where the treatment plant is close to housing areas, the whole plant could be covered and the air treated.

Regarding the Astromeritis sewage treatment plant, the final selection of the appropriate odour removal systems will be done during the detailed design of the plant. Due to the distance of the proposed site for the construction of the STP from residential areas, it is not judged necessary to cover the entire plant.

- ANTHOUPOLIS SEWAGE TREATMENT PLANT

In the case of the Anthoupolis sewage treatment plant, it is locate within an area which is expected to be urbanized in the near future when residential areas will be developed near the site. To minimize any risk of disturbances as a result of odours or noise, the plant will be covered and an odour removal system will be installed. Therefore, the entire plant will be covered, and the air will be collected and transported for treatment prior its release into the atmosphere.

Regarding the treatment method, the method of the chemical scrubbers continues to be today the most functional, performing and reliable process for odour removal at sewage treatment plants. It is therefore recommended at the preliminary design to retain a solution of three chemical scrubber towers for the odour treatment at the plant.

- PUMPING STATIONS

Odour treatment systems will also be installed at the pumping stations, particularly those which will be sited near residential areas.

3.3.4. EMERGENCY STORAGE RESERVOIR

An emergency storage reservoir will be constructed for each of the two sewage treatment plants, to provide for the storage of the untreated effluents in case of problems in the treatment process. The reservoirs will provide emergency storage for 7 days.

The depth of the reservoirs will be 5 m, with a resulting area requirement of 1.4 m^2/m^3/day.

TABLE 3.13: EMERGENCY STORAGE RESERVOIRS

LOCATION		VOLUME (m^3)
Sewage Treatment Plant	Urban / Rural / Government Land	
Astromeritis	Rural	12 036 m^3
Anthoupolis (Kokkinotrimithia and Palaiometocho)	Rural	13 377 m^3

The land requirements for the emergency storage reservoirs will be as follows:

TABLE 3.14: LAND REQUIREMENTS FOR THE EMERGENCY STORAGE RESERVOIRS

SEWAGE TREATMENT PLANT	AREA REQUIREMENTS FOR THE EMERGENCY STORAGE RESERVOIR
Astromeritis	2 407 m^2
Anthoupolis (Kokkinotrimithia and Palaiometocho)	2 676 m^2

3.3.5. LONG TERM STORAGE RESERVOIRS

Provisions must be made for the long term storage of the treated effluents, which will be a necessity, particularly during the winter months when the demand for irrigation will be low. Each reservoir will provide storage for 120 days, and, having a depth of 5 m, the resulting area requirement will be $24m^2/m^3$/day.

TABLE 3.15: LONG TERM STORAGE RESERVOIRS

LOCATION		VOLUME REQUIRED (m^3)
Sewage Treatment Plant	Urban / Rural / Government Land	
Astromeritis	Rural	206 346 m^3
Anthoupolis (Kokkinotrimithia and Palaiometocho)	Rural	229 336 m^3

The land requirements for each long term storage reservoir are as follows:

TABLE 3.16: LAND REQUIREMENTS FOR THE LONG TERM STORAGE RESERVOIRS

SEWAGE TREATMENT PLANT	LAND REQUIREMENTS FOR THE LONG TERM STORAGE RESERVOIR
Astromeritis	41 270 m^2
Anthoupolis (Kokkinotrimithia and Palaiometocho)	45 867 m^2

In the case of the Astromeritis sewage treatment plant, the long term storage reservoir will be constructed at the STP site. For the storage and reuse of the treated effluent from the Anthoupolis sewage treatment plant, a separate study will be conducted, and if the construction of a long term storage reservoir is required, this will be sited at a different location, as the available land at the STP area is restricted.

3.3.6. SEWERS AND PUMPING STATIONS

3.3.5.1. SEWERAGE COLLECTION SYSTEMS

The sewerage collection networks for each community will be completed in two Phases. Phase A covers the areas to be presently connected to the network, while Phase B includes the areas to be connected in the future and its boundaries are in most cases the same as the water supply boundaries.

For the gravity pipes in the collection system the PVC pipes will be used while for the force mains the HDPE are predicted. For the detailed design of the collection system the following criteria will be used:

In the Nicosia sewerage scheme the minimum diameter adopted is 200 mm which is also the case in mainland Europe. It is proposed in this study to use 160 mm as a minimum diameter for the collection system while it is 110 mm for the house connections. The minimum depth from cover to the top of the pipe should be 1.6 m. This takes into account that house connections have a minimum depth to cover between 1.2 and 1.0m and generally a minimum slope of 1%.

The estimated total length of the sewerage collection networks is given in Table 3.17.

TABLE 3.17: CALCULATED LENGTH OF THE COLLECTION NETWORK

VILLAGE	LENGTH (m)	MIN GROUND ELEVATION (masl)	MAX GROUND ELEVATION (masl)
Astromeritis	19 400	131.00	206.00
Peristerona	16 170	202.00	242.00
Akaki	15 290	189.00	225.00
Kokkinotrimithia	27 660	193.00	231.00
Palaiometocho	30 600	190.00	275.00
TOTAL	**109 120**		

3.3.5.2. CONVEYANCE SYSTEM AND PUMPING FACILITIES

The conveyance system and the pumping facilities consist of the pipelines and pumping stations which are needed to transfer the wastewater flow from each community to the centralized treatment system. Pipelines are divided in two categories depending on the way the water is forced to flow. If the water flows by gravity, the pipelines are gravity sewers. If the flow is pushed by pumps, the pipelines are forcemains.

In forcemains the wastewater is in a closed environment without the presence of air. Formation of sulphides, which causes creation of unpleasant odours, is possible in case of long transfer of water without aeration which lasts a few hours – approximately 6 hours. With appropriate standard design, no problem of creation of sulphides, and therefore unpleasant odours, is anticipated for lengths of forcemain below 10 km, which corresponds to a transfer time of approximately 3 hours.

The proposed scheme includes two sewage treatments plants, one near Astromeritis and the existing Anthoupolis STP.

The communities of Astromeritis, Peristerona and Akaki will be connected to the new sewage treatment plant which will be constructed in Astromeritis. The sewage will be transferred from Akaki to Peristerona, mainly by gravity, while only a small part of the conveyance pipe will be a forcemain. The wastewater will then be conveyed from Peristerona to Astromeritis by gravity, from there they will be pumped to the sewage treatment plant.

The communities of Kokkinotrimithia and Palaiometocho will be connected to the existing Anthoupolis sewage treatment plant, which will be replaced by extended and replaced by a new improved treatment unit as part of the project for the Greater Nicosia Sanitary Sewage System. The sewage from Kokkinotrimithia will be pumped to Palaiometocho. The connection from Palaiometocho to the treatment plant will be partly gravity pipe and partly forcemain.

The main components of the conveyance system will be as follows:

⇨ The total length of the gravity pipes is 11.3 km with the diameter ranging between 200 mm to 300 mm.

⇨ The total length of the forcemains is 12.2 km with the diameter being from 125 mm to 200 mm.

⇨ Four pumping stations have been estimated, with the discharge capacity varying from 7.0 l/s to 22.07 l/s and installed power from 2.0 kW to 20.0 kW.

Table 3.18 gives the preliminary position of the pumping stations.

TABLE 3.18 : LOCATION OF PUMPING STATIONS

PUMPING STATION	POSITION	LOCATION
CP1	Astromeritis	Within the residential area.

PUMPING STATION	POSITION	LOCATION
CP2	Akaki	Within the residential area.
CP3	Kokkinotrimithia	Within the residential area.
CP4	Palaiometocho	Within the residential area.
CP5	Agioi Trimithias	Outside the residential area. In an agricultural zone.

The area required for each pumping station will be 500 m^2 (0.05 ha), with a total area of 2 500 m^2 (0.25 ha). The preliminary locations for the pumping stations are included in Appendix 3. These will be finalized following the detailed design of the conveyance system.

3.4. IMPLEMENTATION SCHEDULE

The project schedule is outlined in the Project Implementation Programme (Appendix 4).

3.5. PROJECT COST

TABLE 3.19: SUMMARY OF THE TOTAL PROJECT COSTS

		COST (£ CY)
CAPITAL COSTS		
Collection networks		10 289 600
Conveyance system (pipes and pumping stations)		*2 173 100*
	Gravity pipes	1 020 600
	Forcemains	813 100
	Pumping stations and odour constrol	339 400
Sewage treatment plants and emergency storage reservoirs		*3 615 700*
	Astromeritis sewage treatment plant	2 214 400
	Existing Anthoupolis sewage treatment plant	1 401 300
Long term storage reservoirs		*1 182 600*
	Astromeritis sewage treatment plant	570 000
	Existing Anthoupolis sewage treatment plant	612 600
Total Capital Costs		**17 261 000**
OPERATIONAL COSTS		
	Conveyance system	39 300
	Sewage treatment plants and emergency storage reservoirs	338 300
Total Operational Costs		**377 600**

4. DESCRIPTION OF THE ENVIRONMENTAL BASELINE

4.1. MAIN FEATURES OF THE PROJECT AREA

The project includes the following communities:

Communities	Indicative Ground Level of the Urban Area: Lowest and Highest (masl)
Astromeritis	132 – 206
Peristerona	202 – 242
Akaki	189 – 224
Kokkinotrimithia	193 – 231
Palaiometocho	190 – 275

The five villages are arranged along a West-East line on a total distance of approximately 15 kilometres along highway B9 in Mesaoria Plain. The area presents a descending slope westwards and northwards from Kokkinotrimithia, at an approximate ground level of 220 metres asl to Astromeritis at 150 metres asl. The area is included in the upper catchment of the Serrakhis river reaching the sea on the northern coast. The land is mainly occupied by culture, and in particular meadows and cereals.

4.2. PHYSICAL ENVIRONMENT

4.2.1. TOPOGRAPHY, GEOLOGY AND SOILS

Drawings EIA – A – 4 and EIA – A – 5 provide the geological map of the project area.

4.2.1.1. GENERAL GEOLOGICAL ENVIRONMENT

The area covered by the communities of Palaiometocho, Kokkinotrimithia, Akaki, Peristerona and Astromeritis forms part of the Western Mesaoria Plain, a flat lowland between Pentadaktylos Range in the north and Troodos Range in the south. Elevations rise from about 150 m at Astromeritis to 250 m at Palaiometocho with the ground surface sloping to the north-west towards Morfou Bay. The area is traversed by the rivers of Palaiometocho, Akaki and Peristerona which flow from south to north in their upper reaches, but gradually turn to the northwest and west as they approach Morfou Bay.

The whole of the investigated area is covered by a reddish brown soil of sandy silt with clay. Its composition is fairly uniform throughout the area and its plasticity is moderate to high. The thickness of the soil is fairly variable. It is very thin or absent in the northern part of Kokkinotrimithia where kafkalla and calcerenite outcrop on the surface as well as where fluviatile deposits have formed in river valleys. Elsewhere it may attain thickness approaching one metre.

The soil layer rests on a horizon of very dense, hard secondary limestone referred to as kafkalla in the northern part of the Kokkinotrimithia area or on a layer of coarse gravels with sand and boulders cemented at places and referred to as fanglomerates which spreads out from the Troodos Foothills in the south to the mid-axis of the Western Mesaoria Plain in the rest of the investigated areas in the north. The thickness of kafkalla ranges from a few centimetres to over one metre while that of fanglomerates ranges from a few metres in the south to about 10 metres in the north and west. A softer deposit of secondary limestone several metres thick referred to as havara develops below the layer of kafkalla.

Shallow valleys or topographic depressions in the investigated area are infilled with loose superficial alluvial and colluvial deposits which represent products of erosion from the Troodos range as well as from the neighbouring geological formations. In the valleys of Akaki and Peristerona these deposits consist of highly permeable coarse gravels with sands and boulders having a thickness of about 20 m.

The above superficial deposits of Upper Pleistocene – Recent age rest on a succession of gravels and sands, silts, sandy marls, marls, biocalcerenites and sandstones which constitute what is known as the Western Mesaoria Upper Aquifer of Upper Pliocene – Pleistocene age. The biocalcarenites develop principally along an EW trending strip of land in the northern part of Kokkinotrimithia where they attain a thickness of about 20 m. Elsewhere they appear in the form of thin layers within the succession of arenaceous deposits. The thickness of the Upper aquifer sediments ranges from about 20 m in the Kokkinotrimithia and Palaiometocho areas to over 100 m in the areas in the north of Peristerona and Astromeritis.

The Western Mesaoria Upper Aquifer is extensive and fairly thick and considered as the most important aquifer of Cyprus. Over its larger part it can be subdivided into two sub-aquifers, a phreatic one on top and a confined one below separated by an extensive layer of marls. Pollution of the aquifer with nitrates has been observed to the south and southeast of Peristerona towards Orounda where several pig farms have been established.

The base of the aquifer which is the horizon representing the basement in the whole of the investigated area consists of Pliocene (Nicosia) marls and has the shape of a bowl tilted towards Morfou Bay. It does not outcrop in the investigated areas and has no direct relation to the scope of the current investigations, but outcrops of it occur at a short distance from the border of the investigated area to the south of Akaki.

At the location of the existing Anthoupolis sewage treatment plant and the surrounding area, the ground consists of calcareous sandstones and sandy marls. In some places the calcareous sandstones become very hard due to the solidification of calcareous solutes (kafkalla and havara).

Deleted: ¶

4.1.1.1. SOIL CHARACTERISTICS AND PRESENT SANITARY SITUATION

The present sewerage system in the project communities consists of septic tanks and absorption pits, however the soil conditions in some cases are not appropriate for such a sanitation system. This results in serious absorption problems and health hazards. Therefore, the construction of centralised sewage collection and treatment systems is judged as a necessity. Table 4.1 gives the soil characteristics in each community.

TABLE 4.1 : SOIL CHARACTERISTICS AND PRESENT SANITARY SITUATION IN THE PROJECT COMMUNITIES

COMMUNITIES	SOIL CHARACTERISTICS	EXISTING SANITATION SITUATION
Astromeritis	Reddish brown soil of sandy silt with clay and some gravels, 0.5-1.0 m thick, rests on a layer of fanglomerates, about 10 m thick consisting of coarse gravels with cobbles in a sandy-clayey matrix. Thin alluvial and colluvial deposits of silts with sands and some gravels appear in shallow valleys and depressions. The above succession rests on a sequence of gravels with sands and silts with marly layers down to a depth of 40-100 m. The basement consists of impermeable marls. The permeabilities of the various formations are generally high and infiltration conditions are very good. The water table is very low (> 50 m).	
Peristerona	Reddish brown soil of sandy silt with clay, 0.3-1.0 m thick is present over most of the area, except where alluvial and recent fluviatile deposits have developed along Peristerona river valley. Soil rests on layer of fanglomerates consisting of coarse gravels with boulders in a sandy-silty matrix about 10 m thick, cemented in their upper part at places. Kafkalla or havara rarely encountered between soil and fanglomerates. Alluvial deposits of gravels with sands and silts occur in the Peristerona river valley. Above succession rests on a sequence of gravels with sands and silts with marly layers, 60-100 m thick. Basement consists of impermeable marls. Parmeabilities of arenaceous deposits are high and infiltration conditions very good. Water table very low (> 50 m).	
Akaki	Reddish brown soil of sandy silt with clay, 0.5-1.0 m thick overlies alluvial and fanglomerate deposits. Alluvial deposits of coarse gravels, sands and silts with boulders develop along the Akaki river valley in the middle of the investigated area. Fanglomerates appear on higher ground on either side of the valley and consist of coarse gravels and boulders in sandy-clayey matrix, partly cemented at places. Kafkalla and havara encountered in eastern part. Above succession rests on	

COMMUNITIES	SOIL CHARACTERISTICS	EXISTING SANITATION SITUATION
	sequence of gravels with sands and silts with marly layers to 50-80 m. Basement consists of impermeable marls. Permeabilities mainly high and infiltration conditions good. Water table low (> 40 m).	
Kokkinotrimithia	Red soil of sandy silt with clay is thin (0-0.3m) in the north and west but thicker (0.5-1.0m) in the south. It is followed below by hard kafkalla up to 1.5m thick which is fairly extensive, especially in the north and northwest and havara of variable hardness, fairly widespread, 4-5m thick. Above layers rest on calcareous sandstone (calcarenite) in the north and fanglomerates of coarse gravels in sandy-clayey matrix in the south. Above succession followed below by sequence of sands, silts and marls with some gravels. Basement consists of impermeable marls and lies at about 35m in the north and 60-70 m in the south and west. Permeabilities of calcarenite in the north low to medium and that of arenaceous deposits medium to high. Infiltration intermediate to high. Water table low (> 30 m)	In some areas there are absorption problems.
Palaiometocho	Reddish brown soil of sandy silt with clay, 0.3-1.0 m thick, covers most of the area. Alluvial deposits of gravels and sands with silts, partly without any soil cover outcrop in the river valley passing through the village. Below soil there is at some places thin hard kafkalla. Havara is fairly widespread with thickness exceeding 3 m. It is hard near the surface but softer below and may contain gravels. Above layers rest on fanglomerates of coarse gravels with boulders in sandy-silty matrix, about 5m thick, followed below by succession of sands, silts and marls with gravel layers down to 60-70m. Calcareous sandstones outcrops in NW corner of area. Basement made of impermeable marls. Permeabilities of arenaceous rocks medium to high. Infiltration fairly good. Water table low.	There are absorption problems, 60-70% of pits are emptied once a month.

4.1.2. CLIMATE

In terms of climate, the year in Cyprus can be divided in two seasons: the winter period, between October to March, and the summer period, between April to September. During the winter period there are significant fluctuations in the climatic conditions, with large variations in temperature and pressure, and frequent alterations in wind directions and speed. In contrast, during the summer period climatic conditions are largely stable.

4.1.2.1. TEMPERATURE

- ASTROMERITIS SEWAGE TREATMENT PLANT

The mean annual temperature in the Astromeritis area for the decades 1981 – 1990 and 1991 – 2000 were approximately 20°C, while the mean monthly temperatures were in the range of 10.5 °C, for January, and 29.0 °C, for July and August.

The mean annual temperatures for the periods 1981 – 1990 and 1991 – 2000 were as follows:

1981 – 1990	Mean annual temperature	19.8 °C
	Mean monthly temperature range	10.6 °C (January) – 28.6 °C (July)
1991 – 2000	Mean annual temperature	19.9 °C
	Mean monthly temperature range	10.5 °C (January) – 28.8 °C (July, August)

- ANTHOUPOLIS SEWAGE TREATMENT PLANT

The temperatures in the area of the Anthoupolis sewage treatment plant will be taken to be similar as for the Nicosia area. According to measurements from the Nicosia meteorological station, the mean annual temperature in the area during the periods 1981 – 1990, 1991 – 2000 and 1961 – 1990 was around 20 °C, as for the Astromeritis region. The mean monthly temperatures were ranged between 10 °C – 11 °C for January, and 29 °C – 31 °C for July and August.

The mean annual and monthly temperatures for the periods 1981 – 2000 and 1961 – 1990 were as follows:

1981 – 1990	Mean annual temperature	20.2 °C
	Mean monthly temperature range	10.3 °C (January – 29.9 °C (July)
1991 – 2000	Mean annual temperature	20.7 °C
	Mean monthly temperature range	10.8 °C (January, February) – 30.8 °C (August)
1961 - 1990	Mean annual temperature	19.5 °C
	Mean monthly temperature range	10.4 °C (January) – 29.1 °C (July)

4.1.2.2. PRECIPITATION

- ASTROMERITIS SEWAGE TREATMENT PLANT

The mean annual precipitation in the Astromeritis region for the period 1991 – 2000 was 267.4 mm, with the normal mean annual precipitation being 287.3 mm. The average monthly precipitation for the same period was in the range of 0.0 mm for July, and 54.5 mm for December, while the normal mean monthly temperature ranges between 0.6 mm and 54.7 mm for the same months respectively.

Average precipitation values for the area are as follows:

1991 – 2000	Mean annual precipitation	267.4mm
	Mean monthly precipitation range	0.0 mm (July) – 54.5mm (December)
1961 – 1990	Normal mean annual precipitation	287.3
	Normal mean monthly precipitation range	0.6mm (July) – 54.7mm (December)

For Peristerona, the normal mean annual precipitation (1961 – 1990) is 291.0 mm, with the mean monthly range being between 1.0 mm for July and August, and 53.0 mm for December.

- ANTHOUPOLIS SEWAGE TREATMENT PLANT

The mean annual precipitation for the Nicosia region during the period 1991 – 2000 was 284.0 mm, with the normal annual precipitation being 322.9 mm. The average mean monthly values for the same period are in the range of 0.2 mm for August, and 52.9 mm for November, while the normal monthly precipitation ranges between 1.6 mm and 58.6 mm during the months of July and December respectively. It will be assumed that these measurements are also representative of the area of the existing treatment plant.

Average precipitation values for the Nicosia region are as follows:

1991 – 2000	Mean annual precipitation	284.0mm
	Mean monthly precipitation range	0.2 mm (August) – 52.9mm (November)
1961 – 1990	Normal mean annual precipitation	322.9mm
	Normal mean monthly precipitation range	1.6mm (July) – 58.6mm (December)

4.1.2.3. EVAPORATION

- ASTROMERITIS SEWAGE TREATMENT PLANT

In the Astromeritis area, the mean daily evaporation for the period 1991 – 2000 was in the range of 1.3 mm and 8.3 mm during the months of January and July respectively, with a mean annual value of 4.4 mm.

1991 – 2000	Mean daily evaporation range	1.3mm (January) – 8.3mm (July)
	Annual mean daily evaporation	4.4mm

- ANTHOUPOLIS SEWAGE TREATMENT PLANT

In the Nicosia area, the mean daily evaporation for the period 1991 – 2000 ranged between 1.2 mm and 9.7 mm during the months of December and July respectively, with the annual mean daily evaporation being 5.0 mm.

1991 – 2000	Mean daily evaporation range	1.2mm (December) – 9.7mm (July)
	Annual mean daily evaporation	5.0mm

4.1.2.4. RELATIVE HUMIDITY (RH)

- ASTROMERITIS SEWAGE TREATMENT PLANT

The mean annual RH, in the Astromeritis area, at 08:00 hrs LST, during the periods 1981 – 1990 and 1991 – 2000 was 60%. The mean monthly measurements for the decade 1981 – 1990 were in the range of 45% and 77%, for the months of July and January respectively, while for the period 1991 – 2000 they ranged between 43% for June, and 78% for December and January.

The mean annual RH at 13:00 hrs LST for the period 1981 -1990 was 47%, and for the period 1991 – 2000, 46%. The mean monthly values ranged between 39% to 56%, and 39% to 57% for the two periods respectively.

The average values for the relative humidity in the region were as follows:

1981 – 1990	08:00 LST	Mean monthly RH range	45% (June) – 77% (January)
		Mean annual RH	60%
	13:00 LST	Mean monthly RH range	39% (July) – 56% (December, January)
		Mean annual RH	47%
1991 – 2000	08:00 LST	Mean monthly RH range	43% (June) – 78% (December, January)
		Mean annual RH	60%
	13:00 LST	Mean monthly RH range	39% (June) – 57% (December, January)
		Mean annual RH	46%

❑ ANTHOUPOLIS SEWAGE TREATMENT PLANT

For the Nicosia area, the mean annual RH at 08:00 hrs LST for the period 1981 – 1990 was 66%, and for the period 1991 – 2000, 64%. The average monthly values were in the range of 47% to 83%, and 47% to 84% for the two periods respectively.

The mean annual RH at 13:00 hrs LST for the periods 1981 – 1990 and 1991 – 2000 was 40%. The average monthly measurements ranged between 27% and 56% for the period 1981 – 1990, and 27% to 58% for the period 1991 – 2000.

The mean values for the relative humidity in the area were as follows:

1981 – 1990	08:00 LST	Mean monthly RH range	47% (June) – 83% (December, January)
		Mean annual RH	66%
	13:00 LST	Mean monthly RH range	27% (July, August) – 83% (December, January)
		Mean annual RH	40%
1991 – 2000	08:00 LST	Mean monthly RH range	47% (June) – 84% (December)
		Mean annual RH	64%
	13:00 LST	Mean monthly RH range	27% (July) – 58% (December)
		Mean annual RH	40%
1961 – 1990	08:00 LST	Mean monthly RH range	48%(June) – 83% (December, January)
		Mean annual RH	67%
	13:00 LST	Mean monthly RH range	28% (July) – 59% (January)
		Mean annual RH	42%

4.1.2.5. WIND DIRECTION

Measurements regarding the wind direction for the Nicosia District are available from the Nicosia and Athalassa meteorological stations.

- NICOSIA METEOROLOGICAL STATION

During the year, except for February, the prevailing winds in the area have a southwest to west direction, with angles between 210^o and 270^o during the months between November and January, and between 240^o and 270^o for the months between March and October. In February the prevailing winds have a south direction, with angles of 180^o.
For the months between April and August, northwestern winds, with angles of 300^o, also have a high percentage of occurrence, as do the eastern wind during the months between November and January, and March to April.

- ATHALASSA METEOROLOGICAL STATION

Between the months of April and August, the prevailing wind in the area have western direction, with angles of 270^o, while the southwest and northwest winds, with angles between 240^o and 300^o, also have a high percentage of occurrence.

In February, and during the months between October and December, the prevailing winds have southwest to west direction, with angles between 240^o and 270^o. In January and March the prevailing winds have a south direction, with angles of 180^o.

During the months between April and August, and in February, winds with a northwest direction also have a high percentage of occurrence.

Generally, in the greater Nicosia region, including the project area, it is estimated, based on the above data, that the prevailing winds have a southwest to west direction.

The meteorological data for the area are included analytically in Appendix 5.

4.1.3. SURFACE WATER RESOURCES

4.1.3.1. NATURAL STREAMS AND SURFACE WATER BODIES

- ASTROMERITIS SEWAGE TREATMENT PLANT

The proposed site for the construction of the Astromeritis sewage treatment plant is traversed by the 'Potami' river, which for the biggest part of the year is dry. The 'Komitis' river, which is also a seasonal stream, is at a distance of approximately 500 m from the selected STP location.

- ANTHOUPOLIS SEWAGE TREATMENT PLANT

A large seasonal stream drain the area of the existing sewage treatment plant, which consists of two main tributaries, of which one is next to the STP site, while the other, which is also the biggest of the two, is at a distance of approximately 700 m from the site. To the north of area and at a distance of about 1.6 km is the Pediaios river which is a winter river.

4.1.3.1. EXISTING RESERVOIRS

- ASTROMERITIS SEWAGE TREATMENT PLANT

There are no existing reservoirs near the site proposed for the Astromeritis sewage treatment plant, therefore it will be necessary to construct a long term storage reservoir for the treated effluents. Nevertheless, the reservoir will be located within the area of the old quarry which is suitable in terms of geomorphology for its construction.

❑ ANTHOUPOLIS SEWAGE TREATMENT PLANT

There are no existing dams near the site of the existing Anthoupolis sewage treatment plant, which could potentially provide storage for the treated effluents. However, regarding the storage and reuse of the treated effluents from the plant, a separate study will be conducted which will examine a number of alternative options and will include the effluents from other treatment plants in Nicosia. If the construction of a long term storage reservoir is judged necessary, this will be constructed at a different location since the available land at the existing plant site is restricted and the acquisition of additional land in the area is not possible.

4.1.4. GROUNDWATER RESOURCES

The Western Mesaoria Upper Aquifer is extensive and fairly thick and considered as the most important aquifer of Cyprus. Over its larger part it can be subdivided into two sub-aquifers, a phreatic one on top and a confined one below separated by an extensive layer of marls. It is fairly permeable with permeabilities varying mainly in the range 190 – 397 m/day ($2.2x10^{-3}$ – $4.6\ x10^{-3}$ m/s). The water of the aquifer is essentially fresh with chloride concentrations varying between 60 and 250 ppm. It is replenished from rainfall (about 20%) and from river flow. In the last 40 years the aquifer has been pumped heavily and water levels have fallen considerably. In the Kokkinotrimithia area water levels are almost down to the base of the aquifer while further west in the Peristerona – Astromeritis area they have fallen to depths nearly 100 metres below ground surface.

Pollution of the aquifer with nitrates has been observed to the south and southeast of Peristerona towards Orounda where several pig farms have been established.

4.2. ECOLOGICAL ENVIRONMENT

4.2.1. VEGETATION

❑ ASTROMERITIS SEWAGE TREATMENT PLANT

The Astromeritis sewage treatment plant, including the emergency and long term storage reservoirs, will be constructed within the area of the old quarry, which due to its nature and geomorphology, consists of barren land, with only some natural vegetation.

❑ ANTHOUPOLIS SEWAGE TREATMENT PLANT

Most of the land surrounding the existing sewage treatment plant site is used as agricultural land for the cultivation of temporary plants, and mainly cereal. There are also some uncultivated areas covered by brushwood and natural vegetation. The following table lists the vegetation species which have been registered in the area.

LATIN NAME	POPULATION STATUS			COMMENDS
	Brushwood	Cultivated Land	STP Site	
Allium ampeloprasum	S	S		
Allium cupani ssp. cypricum	S			
Allium curtum	S			Endemic
Allium lefkarense		S		
Alyssum strigosum	S			

LATIN NAME	POPULATION STATUS			COMMENDS
	Brushwood	Cultivated Land	STP Site	
Amaranthus graecizans ssp. sylvestris		S	S	
Anagallis arvensis	S			
Asparagus stipularis	S	S	S	
Asperula cypria	C		S	Endemic
Asphodelus aestivus	S	S		
Aster squamatus			C	
Atractylis cancellata	S		C	
Avena sp.	C	S	S	
Beta vulgaris ssp. maritima		S		
Briza maxima	S			
Bromus sp.	S			
Capparis spinosa var. canescens	S	S	S	
Carlina involucrate ssp. cyprica	S		S	Endemic
Carlina pygmaea	S			Endemic
Carthamus lanatus ssp. baeticus	S	S	S	
Centaurea hyalolepis	S		S	
Chenopodium sp.		S		
Chondrila juncea	S		S	
Chrozophora tinctoria		S	S	
Chrysanthemum coronarium	S	C	S	
Cistus creticus var. creticus	S			
Citrullus colocynthis		S		
Convolvulus althaeoides		S	S	
Convolvulus arvensis		S	S	
Conyza bonariensi		S	C	
Crataegus azarolus	C	S	S	
Crupina crupinastrum	S		S	
Cynodon dactylon		S	A	
Echinops spinosissimus	C	S	S	
Echium angustifolium	S	S	S	
Eryngium creticum	S	S		
Euphorbia cassia ssp. cassia	S			
Euphorbia chamaesyce			S	
Ficus carica		S		
Filago sp.	S			
Fumana Arabica	S			
Fumana thymifolia	S			
Glaucium corniculatum	S			
Helianthemum salicifolium	S		S	
Helianthemum stipulatum	S			
Heliotropium hirsutissimum		S	S	

LATIN NAME	POPULATION STATUS			COMMENDS
	Brushwood	Cultivated Land	STP Site	
Hirschfeldia incana	S	S		
Hypparhenia hirta	C		S	
Inula graveolens	S	S	S	
Kochia indica		C	S	
Lactuca serriola		S	C	
Lagurus ovatus	S	S	S	
Linum strictum	S			
Lithodora hispidula ssp. versicolor	S			
Malva sylvestris	S	S		
Muscari comosum			S	
Nigella nigellastrum	S	S		
Noaea mucronata	A	S	S	
Olea europaea		S		
Ononis spinosa ssp. leiosperma var. leiosperma	S	S		
Omopordum cyprium		S	S	Endemic
Onosma fruticosa	S			Endemic
Oryzopsis miliacea		S		
Paronychia macrosepala	S			
Phagnalon rupestre ssp. rupestre	S			
Phragmites australis		S	C	
Picnomon acarna	S	S		
Plantago afra			S	
Polygonum equisetoforme		S	C	
Reseda orientalis	S	S		
Salsola kali			S	
Sarcopoterium spinosum	S		S	
Silene vulgaris		S		
Sinapis alba		C	S	
Sonchus oleraceus		S	S	
Stachys cretica		S		
Teucrium micropodioides	S		S	Endemic
Thymus capitatus	A		S	
Trfolium stellatum	C	S	S	
Urginea maritima	C			
Valantia hispida	S			
Verbascum sinuatum		S	S	
Ziziphus lotus	C	S	S	

S	Sporadic
C	Common
A	Abundant

4.2.2. WILD LIFE

The proposed location for the construction of the Astromeritis sewage treatment plant, as well as the site of the existing Anthoupolis plant, are within agricultural areas which are of no particular ecological interest. In both areas only the most common fauna species of the Mesaoria plain are observed.

4.2.3. PROTECTED OR RESTRICTED AREAS

- ASTROMERITIS SEWAGE TREATMENT PLANT

Part of the proposed location for the construction of the Astromeritis sewage treatment plant is within a Z3 Protected Zone, which extends along the river which traverses the area. Areas designated as Protection Zones include archaeological sites, sites of natural beauty, forests, protected landscapes, geological formations, rivers, good agricultural land, drinking water supply borehole areas, etc. As in this case, all surface water bodies, including rivers, dams, etc. have been classified as Z3 Protected Zones, for which the strictest construction provisions and measures apply, so as to deter development in such areas.

At the same time, the suggested site is within the buffer zone which is controlled by the United Nations, and their relevant approval is required for the construction of the sewage treatment plant.

The Z3 Protection Zone and the buffer zone boundaries are indicated in Drawing EIA – A – 8.

- ANTHOUPOLIS SEWAGE TREATMENT PLANT

The location of the existing Anthoupolis sewage treatment plant is at a distance of approximately 1.5 km from the Z3 Protection Zone which extends along the Pediaios River, to the south of the site. There are no other protected areas near the plant.

4.3. PLANNING ZONES AND LAND USE

4.3.1. ADMINISTRATIVE BOUNDARIES

- ASTROMERITIS SEWAGE TREATMENT PLANT

Although the proposed location for the construction of the sewage treatment plant in Astromeritis is within the administrative boundaries of the community, it is now within the buffer zone and for the construction of the plant it is necessary to obtain the approval of the United Nations. The community of Astromeritis covers a total area of approximately 18.2 km^2, 25% of which is within the buffer zone. The administrative boundaries of the area and the site of the sewage treatment plant are shown in Drawing EIA – A – 6.

- ANTHOUPOLIS SEWAGE TREATMENT PLANT

The existing Anthoupolis sewage treatment plant is within the administrative boundaries of Deftera (Pano Deftera), which covers a total area of approximately 24.9 km^2. The plant is to the northeast of Pano Deftera (area: 17.4 km^2), next to the border with Kato Deftera. Drawing EIA – A – 7 gives the administrative boundaries and the location of the sewage treatment plant.

Deleted: ARADIPPOU STP SITE

Deleted: EXISTING LARNACA STP

Deleted: The existing Larnaca STP is within a designated Da2 Protection Zone, as a result of its proximity to the Larnaca Salt Lakes. Areas designated as Protection Zones include sites of natural beauty, forests, parks, public recreation areas, archaeological sites and buffer zones. Protection zones are classified as Da2, Da3 and Da5, with the associated construction provisions being more restrictive for Da2 areas. The 1% land coverage that is permitted in Da2 zones, significantly increases the land requirements for construction, thus effectively diverting development away from such sites. ¶
¶
The Larnaca Salt Lakes are of a significant ecological value, being one of the most important wetland habitats on the island. This includes the lakes to the northwest and south-southeast of the airport, as well as the lake fringes. ¶
¶
In 1997 the Council of Ministers approved the Programme for the Protection and Management of the Larnaca Salt Lakes, aimed at the protection and conservation of the lake habitats, and the protection and conservation of the area from any kind of pollution or environmental degradation. The Larnaca District Plan endorses the proposals of the Programme, which must be taken into account by the Planning Authority and other bodies in connection to any development plans examined for the area. ¶
¶
The lake to the northwest of the airport is a designated Ramsar site, having being recognised as a wetland of international importance, significant for the conservation of biodiversity. Furthermore, it has been proposed that the lakes be included in the Natura 2000 network.¶
¶
According to the District Plan, there will be no development of the area to the south of the airport (to the southwest of the existing STP) as a result of its designation as a Natura 2000 site and its status as part of the sensitive lake ecosystem, as well as due to its proximity to the airport, the STP and the desalination plant.¶ ... [1]

4.3.2. PLANNING ZONES

- ASTROMERITIS SEWAGE TREATMENT PLANT

Part of the area of the proposed site for the construction of the sewage treatment plant is within a Z3 Protection Zone, while the remaining area is within a G3 Agricultural Zone.

For developments within a G3 Agricultural Zone the following planning provisions apply:

Maximum Construction Coefficient	0.10 : 1
Maximum Number of Floors	2
Maximum Height	8.30 m
Maximum Percentage of Coverage	0.10 : 1

The Z3 Protection Zone extends along the river which traverses the area. As in this case, areas where there are surface water bodies, including rivers, dams, etc, are defined as Protection Zones.

For developments within a Z3 Protection Zone the following planning provisions apply:

Maximum Construction Coefficient	0.01 : 1
Maximum Number of Floors	1
Maximum Height	5.00 m
Maximum Percentage of Coverage	0.01 : 1

The planning zones in the area are indicated in Drawing EIA – A – 8.

- ANTHOUPOLIS SEWAGE TREATMENT PLANT

The existing Anthoupolis sewage treatment plant is within a G3 Agricultural Zone, for which the following planning provisions apply:

Maximum Construction Coefficient	0.10 : 1
Maximum Number of Floors	2
Maximum Height	8.30 m
Maximum Percentage of Coverage	0.10 : 1

Drawing EIA – A – 9 gives the planning zones in the area.

4.3.3. EXISTING INFRASTRUCTURE

- ASTROMERITIS SEWAGE TREATMENT PLANT

The proposed location for the construction of the Astromeritis sewage treatment plant is at a distance of approximately 500 m from the main Nicosia – Troodos road. From the main road, a track road provides access to the buffer zone and plant site. Due to the location of the site within the buffer zone there are no asphalt roads in the area to provide access. The nearest electricity transmission line (66kV), is at a distance of approximately 1 km from the proposed location.

- ANTHOUPOLIS SEWAGE TREATMENT PLANT

The location of the existing Anthoupolis sewage treatment plant is at a distance of approximately 1.5 km for the main Nicosia – Klirou road, while access to the site is provided via a track road. The plant already has electricity supply.

4.3.4. LAND OWNERSHIP

- ASTROMERITIS SEWAGE TREATMENT PLANT

The land requirements for the construction of the sewage treatment plant are as follows:

Sewage treatment plant	2 800 m^2
Emergency storage reservoir	2 410 m^2
Long term storage reservoir	41 300 m^2

The total area of land that will be taken up for the construction of the STP is approximately 46 500 m^2 (4.7 ha), including the land that will be taken up for the construction of roads, parking places, landscaping and planting around the treatment plant and storage reservoirs, sludge storage etc. Drawing EIA – A – 10 provides a cadastral map of the area, indicating the plots which will be acquired for the construction of the sewage treatment plant. Although the area where the plant will be sited is within the buffer zone, it consists of private land.

- ANTHOUPOLIS SEWAGE TREATMENT PLANT

The installations of the new plant that will replace the existing Anthoupolis sewage treatment plant, and to which the communities of Kokkinotrimithia and Palaiometocho will be connected, will be placed within the existing site of the plant since no more additional land can be acquired in the area. The available land for the new plant is approximately 8 600 m^2.

Regarding the long term storage and reuse of the treated sewage effluents a separate study will be conducted. If the construction of a long term storage reservoir is required, this will be located at a different site since the available land at the existing plant site is restricted. The construction of the reservoir will then result in the acquisition of additional private land. The area required for the storage of the treated effluent from the two project communities alone will be approximately 45 900 m^2.

- PUMPING STATIONS

Each of the five pumping stations will cover a maximum area of approximately 500 m^2, and the maximum total land requirements for their construction will be 2 500 m^2. The exact locations of the pumping stations will be determined during the detailed design of the conveyance system, therefore it cannot be assessed at this stage which plots will be acquired and whether the land will be governmental or privately owned.

4.3.5. LAND USE

- ASTROMERITIS SEWAGE TREATMENT PLANT

The proposed site for the construction of the Astromeritis sewage treatment plant is located at an abandoned quarry within the buffer zone. The area of the quarry consists of barren land, with some low natural vegetation. The area around the quarry is agricultural land, which is used for the cultivation of temporary crops, such as cereal and fodder.

- ANTHOUPOLIS SEWAGE TREATMENT PLANT

The installations of the new plant will be constructed within the existing site of the sewage treatment plant since no additional land can be acquired in the area. If, from the study that will be conducted regarding the reuse of the treated effluents, it is decided to construct a long term storage reservoir, this will be located in a different area which will be determined from the study, since the available land at the plant site is restricted.

- PUMPING STATIONS

The pumping stations will be located mainly within the urban areas of the communities.

4.3.6. BUILD UP PROPERTIES

- ASTROMERITIS SEWAGE TREATMENT PLANT

There are no other development or constructions on the plots where the sewage treatment plant will be constructed, or in the surrounding area. The only other construction in the area is the United Nations post which is on the track road to the proposed site. Therefore there will be no destruction of or adverse effects on private property as a result of the project.

- ANTHOUPOLIS SEWAGE TREATMENT PLANT

The final design of the new Anthoupolis sewage treatment plant includes the connection of the communities of Kokkinotrimithia and Palaiometocho. The new installations will be constructed within the existing area of the plant and there will be no destruction of property as a result of the project.

- PUMPING STATIONS

The pumping stations will be sited in plots where there are no other developments or constructions present, therefore their constructions will not result in the destruction of any other existing structures or build-up property.

4.4. SOCIO-ECONOMIC ENVIRONMENT

4.4.1. POPULATION DISTRIBUTION

4.4.1.1. POPULATION PROFILE

A summary of the population distribution in the project communities, according to the 2001 Census of Population, is given in Table 4.2.

Deleted: A summary of the population figures for the communities, according to the 2001 Census of Population, is given in Table 4.4.

TABLE 4.2 : POPULATION FIGURES

COMMUNITY	HOUSING UNITS			HOUSEHOLDS		INSTITUTIONS		TOTAL POPULATION
	Total	Used as Usual Residence	Vacant or Temporary Residence	Number	Population	Number	Population	
Palaiometocho	1259	1174	85	1178	4074	0	0	4074
Kokkinotrimithia	999	918	81	918	3096	0	0	3096
Akaki	845	779	66	780	2675	0	0	2675
Peristerona	762	703	59	703	2173	0	0	2173
Astromeritis	774	705	69	706	2347	1	14	2361

4.4.1.2. POPULATION PROJECTIONS

TABLE 4.3 : POPULATION PROJECTION BY COMMUNITY

COMMUNITY	2001	2005	2010	2015	2020	2025	2030
Astromeritis	2361	2497	2678	2873	3081	3305	3545
Peristerona	2173	2264	2382	2507	2638	2776	2921
Akaki	2675	2810	2989	3179	3381	3595	3824
Sub Total	*7209*	*7571*	*8049*	*8559*	*9100*	*9676*	*10290*
Kokkinotrimithia	3096	3313	3606	3924	4271	4648	5059
Palaiometocho	4074	4332	4679	5053	5456	5893	6363
Sub total	*7170*	*7645*	*8285*	*8977*	*9727*	*10541*	*11422*
TOTAL	14379	15216	16334	17536	18827	20217	21712

4.4.2. SOCIO-ECONOMIC INDICATORS

4.4.2.1. AGRICULTURAL LAND IN THE REGION

The only available date regarding the agricultural land in the project region are from the 1994 Census of Agriculture. Therefore, this section outlines information regarding only the total cultivated area, the types of crops and the land uses in the area, as these were recorded in 1994. More detailed data from the Census, including the areas reported as irrigated on non-irrigated agricultural land, are provided in Appendix 7.

❑ GENERAL DATA FOR THE REGION

General data are included in the Census of Agriculture (1994) for the Astromeritis – Akaki region, which belong in the Dry agro-geographical zone, and includes the villages of Astromeritis, Peristerona, Orounta, Akaki, Menico, Agioi Trimithias, Palaiometocho and Kokkinotrimithia.

General data regarding the agricultural land in the Astromeritis – Akaki region (Census of Agriculture, 1994), are as follows:

Number of plots	20 570
Cultivated land (donums)	87 595
Irrigable land (donums)	24 503
Total area (donums)	91 207

TABLE 4.4: LAND USE IN THE ASTROMERITIS – AKAKI REGION (1994)

	Total Area (Donums)	Percentage of Total Agricultural land
Temporary crops	79 353	87.0 %
Permanent crops	6 416	7.0 %
Fallow land	1 823	2.0 %
Grazing land	12	0.01 %
Forest land	105	0.1 %
Uncultivated land	2 938	3.2 %
Scrub land	555	0.6 %
Total Agricultural Land	**91 202**	**100.0 %**

TABLE 4.5: AREA OF TEMPORARY CROPS IN THE ASTROMERITIS – AKAKI REGION (1994)

Temporary Crops	Total Area (donums)	Percentage of Total Area of Temporary Crops (%)
Cereals	69 546	85.7 %
Pulses	1 590	2.0 %
Industrial crops	0	0.0 %
Aromatic plants	9	0.01 %
Fodder crops for grain	12	0.01 %
Green fodder for grazing	452	0.6 %
Green fodder for hay	695	0.9 %
Vegetables	8 875	11.0 %
Flowers	16	0.02 %
Total	**81 195**	**100.0 %**

TABLE 4.6: AREA OF PERMANENT CROPS IN THE ASTROMERITIS – AKAKI REGION (1994)

Permanent Crops	Total Area (donums)	Percentage of Total Area of Permanent Crops (%)
Table grapes	39	0.6 %
Wine grapes	112	1.8 %
Citrus	4 166	65.0 %
Dry nuts	291	4.5 %
Fruits	291	4.5 %
Olives	1 473	23.0 %
Carobs	40	0.6 %
Total	**6 412**	**100.0 %**

Most of the agricultural land in the region is used for the cultivation of temporary crops (86% in 1994), and mostly cereal (85.7% of the total area of temporary crops). From the permanent cultivations, citrus are the most widely grown crops (65.0%), followed by olive trees (23.0%).

- AGRICULTURAL LAND BY VILLAGE

TABLE 4.7: AGRICULTURAL LAND USE BY VILLAGE (1994)

Community	Area (Donums)
Kokkinotrimithia	8 665
Palaiometocho	16 083
Total	*24 748*
Astromeritis	9 860
Peristerona	12 139
Akaki	9 638
Total	31 637
Total	**56 385**

TABLE 4.8: AGRICULTURAL LAND USE BY VILLAGE (1994)

Village	Temporary Crops (donums)		Permanent Crops (donums)		Fallow Land (donums)		Uncultivated Forest and Scrub Land (donums)	
	Donums	%	Donums	%	Donums	%	Donums	%
Kokkinotrimithia	7 474	86.3 %	358	4.1 %	175	2.0 %	658	7.6 %
Palaiometocho	14 317	89.0 %	533	3.3 %	344	2.1 %	892	5.6 %
Total	*21 791*	*88.0 %*	*891*	*3.6 %*	*519*	*2.1 %*	*1 550*	*6.3 %*
Astromeritis	7 537	76.5 %	1 319	13.4 %	322	3.3 %	681	6.9 %
Peristerona	8 288	68.3 %	2 376	19.6 %	469	3.9 %	1 006	8.3 %
Akaki	8 405	87.2 %	712	7.4 %	161	1.7 %	359	3.7 %
Total	*24 230*	*76.6 %*	*4 407*	*13.9 %*	*952*	*3.0 %*	*2 046*	*6.5 %*
Total	**46 021**	**81.6 %**	**5 298**	**9.4 %**	**1 471**	**2.6 %**	**3 596**	**6.4 %**

TABLE 4.9: TEMPORARY CULTIVATIONS BY COMMUNITY (1994)

Village	Cereals (%)	Pulses (%)	Industrial (%)	Fodders] (%)	Potatoes (%)	Vegetables (%)
Kokkinotrimithia	88.8 %	1.0 %	0.0 %	5.9 %	1.4 %	2.8 %
Palaiometocho	94.5 %	0.2 %	0.0 %	0.3 %	2.1 %	2.8 %
Total	*92.6 %*	*0.5 %*	*0.0 %*	*2.2 %*	*1.8 %*	*2.8 %*
Astromeritis	66.8 %	3.3 %	0.0 %	9.7 %	15.5 %	4.7 %
Peristerona	62.5 %	8.0 %	0.0 %	5.5 %	18.1 %	5.9 %
Akaki	70.6 %	1.3 %	0.0 %	1.6 %	17.6 %	8.9 %
Total	*66.7 %*	*4.2 %*	*0.0 %*	*5.4 %*	*17.1 %*	*6.6 %*
Total	**78.7 %**	**2.5 %**	**0.0 %**	**3.9 %**	**10.0 %**	**4.9 %**

	Main cultivation		Second main cultivation

Most of the agricultural land in the project communities is used for the cultivation of temporary crops, and mainly cereal.

Regarding the reuse of the treated sewage effluents, all temporary cultivations, with the exception of vegetables, can be irrigated, as well as all permanent cultivations. The suggested effluent standards allow , according to the Code of Practice, for the irrigation of all crops, except leafy vegetables. It is, however, recommended that the irrigation of vegetables is altogether avoided, particularly in the case of those vegetables eaten raw, so as to avoid any risk of health hazards that could arise from the misuse of the treated effluent.

TABLE 4.10: IRRIGATED AGRICULTURAL LAND BY VILLAGE (1994)

Community	Percentage of the Total Agricultural Land	
	Irrigated	Not-Irrigated
Kokkinotrimithia	16.1 %	83.9 %
Palaiometocho	9.8 %	90.2 %
Total	*12.0 %*	*88.0 %*
Astromeritis	46.3 %	53.7 %
Peristerona	61.7 %	38.3 %
Akaki	62.4 %	37.6 %
Total	*57.1 %*	*42.9 %*
Total	**37.3 %**	**62.7 %**

Table 4.10 gives the percentages of the irrigated and not-irrigated land in each community, as it was in 1994. According to the Census of Agriculture the waster demand for the irrigated areas was covered almost entirely through the pumping of groundwater supplies. The treated effluents from the Astromeritis plant can be used for the irrigated of the areas that are currently irrigated through groundwater pumping, as well as in the not-irrigated areas, in the communities of Astromeritis, Peristerona and Akaki. Drawing EIA – A – 11 indicated the agricultural land in the communities where the treated sewage effluents could be used.

The communities of Kokkinotrimithia and Palaiometocho will be connected to the existing Anthoupolis sewage treatment plant, which will be replaced by a new extended unit. Regarding the treated effluent from the plant, a separate study will be carried out for their reuse.

- ❑ IRRIGATION WATER DEMAND IN THE REGION

TABLE 4.11: WATER DEMAND PER CROP (m^3 /m^2/YEAR, 2001)

Crops	Astromeritis	Kokkinotrimithia	Nicosia
Permanent Cultivations			
Citrus	0.75	0.80	0.80
Deciduous	0.80	0.85	0.90
Olives	0.48	0.50	0.50
Table grapes	0.27	0.30	0.30
Fodders	1.15	1.20	1.30
Almonds	0.55	0.60	0.65
Temporary Cultivations			
Tomatoes GH[1]	0.85	0.90	1.00
Cucumbers GH	0.85	0.90	1.00
Beans GH	0.60	0.65	0.75
Peppers GH	0.85	0.90	1.00
Melons GH	0.60	0.65	0.75
Strawberries GH	0.70	0.75	0.85
Flowers GH	0.95	1.00	1.10
Potatoes	0.30	0.35	0.45

Crops	Astromeritis	Kokkinotrimithia	Nicosia
Tomatoes OF[2]	0.60	0.65	0.75
Cucumber OF	0.60	0.65	0.75
Beans OF	0.60	0.65	0.75
Squash	0.35	0.40	0.50
Onions	0.45	0.50	0.60
Peppers OF	0.60	0.65	0.75
Groundnuts	0.55	0.60	0.70
Cabbage	0.45	0.50	0.60
Parsley	0.75	0.80	0.90
Carnation	0.90	0.95	1.05
Artichoke	0.70	0.75	0.85
Kolokasse	2.04	2.10	2.22
Spices	0.35	0.40	0.50
Carrots	0.44	0.48	0.56
Beets	0.25	0.30	0.40
Watermelon	0.45	0.50	0.60
Broad beans	0.10	0.15	0.25
1. Greenhouse, 2. Open Field			

4.4.2.2. LIVESTOCK PRODUCTION

TABLE 4.12: NUMBER OF ANIMALS BY VILLAGE (1994)

Community	Sheep	Goats	Cattle	Pigs	Chicken
Kokkinotrimithia	1 317	1 130	0	0	155 283
Palaiometocho	697	1 501	346	36 097	41 007
Total	*2 014*	*2 631*	*346*	*36 097*	*196 290*
Astromeritis	1 711	608	169	1	3 354
Peristerona	1 427	541	343	6 770	31 724
Akaki	2 846	1 609	357	17 630	10 171
Total	*5 984*	*2 758*	*869*	*24 401*	*45 249*
Total	**19 867**	**7 121**	**11 001**	**58 142**	**287 210**

4.4.2.3. EMPLOYMENT

TABLE 4.13: EMPLOYMENT IN THE BROAD AGRICULTURAL SECTOR IN THE NICOSIA DISTRICT (1994)

	Holders of Agricultural land and Family Members			Employees			Total		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
Crop production	2 704	1 798	4 502	732	449	1 181	3 436	2 247	5 683

	Holders of Agricultural land and Family Members			Employees			Total		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
Livestock production	840	535	1 375	746	272	1 018	1 586	807	2 393
Forestry	44	29	73	129	29	158	173	58	231
Fishing	5	1	6	6	4	10	11	5	16
Total	**3 593**	**2 363**	**5 956**	**1 613**	**754**	**2 367**	**5 206**	**3 117**	**8 323**

TABLE 4.14: EMPLOYMENT IN CROP AND LIVESTOCK IN THE NICOSIA DISTRICT (1994)

	Holders of Agricultural land and Family Members			Employees			Total		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
Total	745	433	1 178	246	168	414	991	601	1 592

TABLE 4.15: EMPLOYMENT ON THE FARM (1994) (FULL-TIME EQUIVALENT NUMBER OF PERSONS)

	Holders of Agricultural Land and Family Members	Employees (permanent and casual)	Total
Kokkinotrimithia			
Men	59	24	83
Women	42	22	64
Total	**101**	**46**	**147**
Palaiometocho			
Men	94	45	139
Women	56	7	63
Total	**150**	**52**	**202**
Akaki			
Men	157	52	209
Women	92	7	99
Total	**249**	**59**	**308**
Astromeritis			
Men	144	26	170
Women	81	54	135
Total	**225**	**80**	**305**
Peristerona			
Men	147	45	192
Women	71	48	119
Total	**218**	**93**	**311**

4.4.3. CULTURAL AND ARCHAEOLOGICAL VALUES

There are no archaeological or historic sites near the location proposed for the construction of the Astromeritis sewage treatment plant, or near the existing Anthoupolis STP.

4.5. PUMPING STATIONS

TABLE 4.16: LOCATIONS OF PUMPING STATIONS

	KOINOTHTA	LOCATION IN THE AREA AND THE NETWORK
CP1	Astromeritis	⇨ Within the residential zone
CP2	Akaki	⇨ Within the residential zone
CP3	Kokkinotrimithia	⇨ Within the residential zone
CP4	Palaiometocho	⇨ Within the residential zone
CP5	Agioi Trimithias	⇨ Outside the residential areas. Within an agricultural zone.

5. ENVIRONMENTAL IMPACT ANALYSIS

5.1. IMPACT SCREENING

A screening of the impacts that could potentially result from the development was carried out in relation to project location and design, and the construction and operational phases. Table 6.1 outlines the probable impacts that have been identified.

TABLE 5.1 : SCREENING OF ENVIRONMENTAL IMPACTS: POSSIBLE IMPACTS FROM THE PROJECT

	ENVIRONMENTAL IMPACTS
Impacts due to Project Location	*Permanent land acquisition* Permanent acquisition of land for construction of the Astromeritis STP, the storage reservoirs and the pumping stations.
	Impacts on surface water hydrology Positive impacts – additional surface water body
	Ecological impacts Positive impacts from the creation of new wetland habitats with the construction of long term storage reservoirs.
Impacts due to Project Design	*No significant impacts are expected* - Treatment process is reliable and proven and effluent will meet the set performance standards. - Emergency storage will safeguard against problems in treatment process. - Sludge treatment to be chosen will be effective in achieving required standards.
Impacts due to Construction	*Temporary land acquisition* Temporary acquisition of land for workers' facilities, construction storage sites, pipe laying. This will result in possible loss of natural vegetation, grazing or agricultural land.
	Vegetation clearing Clearing of vegetation for construction of the STPs, the storage reservoirs, the pumping stations and the conveyance system.
	Soil impacts - Soil erosion: resulting from uncovered and unconsolidated materials during construction - Soil disaggregation - Soil compaction

	ENVIRONMENTAL IMPACTS
	Dust, fumes and noise • Dust: from stockpiles and vehicle movement, particularly in dry weather and strong winds. • Noise: from construction operations, machinery and vehicle movements. • Fumes: from vehicle movements and machinery.
	On-site safety Risk of accidents at construction sites
	Waste management Construction waste, domestic solid waste
	Pollution Air water and soil pollution resulting from heavy operating machinery and vehicles, and from the storage of potential pollutants, such as petrol, motor oils and concrete.
	Traffic. Off-site public safety and inconvenience As a result of increased vehicle movement and road excavations.
Impacts Related to Operation	*Landscape impacts* Limited adverse impacts
	Noise Impacts w
	Odour Impacts At STP sites and pumping stations. Impact at the Astromeritis STP site limited as it is at a considerable distance from residential areas, however, in the case of the Anthoupolis STP, the area is expected to be urbanised in the near future. Also, some of the pumping stations will be within urban areas.
	Impacts on groundwater resources In the case of the Anthoupolis STP the area is expected to be urbanised in the near future.
	Impacts from sludge production and reuse
	Risk of system overload Minimum risk: emergency storage available, design includes seasonal variations
	Risk of insufficient treatment of effluents
	Impacts from the reuse of the treated effluents in agriculture Possible impacts on agricultural production, the soil and groundwater, plants and animals.
	Urban reuse of treated effluents Possibility of inappropriate use of treated water and impacts on public health
	Groundwater recharge Possibility of aquifer contamination

5.2. ASSESSMENT OF POTENTIAL IMPACTS AND MITIGATION MEASURES

5.2.1. IMPACTS DUE TO PROJECT LOCATION

5.2.1.1. PERMANENT LAND ACQUISITION

- PROCESS FOR THE ACQUISITION OF LAND

Subject to the provisions of Article 23 of the Constitution and of the Compulsory Acquisition of Property Law 15/62, any property may be acquired compulsorily for a purpose which is to the public benefit.

When immovable property needs to be acquired compulsorily the acquiring authority:
1. Shall publish a notice of the intended acquisition in the Official Gazette of the Republic.
2. Shall serve a copy of the notice of the intended acquisition to any interested person.
3. Shall invite any interested person to submit to the acquiring authority any objections within 30 days from the date of service of the notice.
4. Will proceed to the examination of any objections to the acquisition made. The acquisition must be confirmed with the publication of an order of acquisition within 12 months from the date of publication of the notice. If an order is not publish the procedure is deemed to have been abandoned.
5. shall, within fourteen months from the date of publication of the notice, send a written offer relating to the compensation payable for the property to be acquired.

Upon receipt of the offer, any interested person may:
1. Accept the compensation for full and final settlement of any claims relating to the acquisition of the property.
2. Accept the amount offered reserving the right to apply to Court for the fixing of the final amount of compensation.
3. Refuse or ignore the offer, in which case either the acquiring authority or the interested person may apply to the Court for the determination of the final compensation.

Where the whole property is subject to compulsory acquisition, the amount of the compensation shall be assessed with reference to the market value of the property as at the date of publication of the notice of acquisition. Where only part of the property is acquired the compensation is also assessed with reference to the market value of that part of the property as at the date of publication of the notice. In these cases, the Law provided the set-off of betterment and compensation for injurious affection/severance, trade disturbance, reinstatement and any other damages or losses sustained by the owner. Finally, it provides that an interest of 9% should be added to the amount of compensation starting from the date of publication of the notice to the date of payment.

The exchange of state land with property or part of a property which has been acquired compulsorily is also possible where:
1. The compensation for the acquisition of the property has been finally determined.
2. Such acquisition deprives the applicant of the whole or part of his property which was used either:
   i) As a dwelling-house or was intended for the construction of a dwelling-house for use by the applicant or his family,
   ii) For the carry-on of any business, trade, profession or vocation,
   iii) The applicant's financial situation is considered to be poor, and
   iv) The state land that is to be exchanged:
      (a) Is situated in the same district and preferably in the same area as the acquired property.
      (b) Is suitable for the purposes for which the property was also used.
      (c) Is of an almost equal value with the compensation finally determined.

- ASTROMERITIS SEWAGE TREATMENT PLANT

The following table summarises the land requirements for the construction of the sewage treatment plant, the emergency and long term storage reservoirs, and the pumping stations for the conveyance system. The figures given take into account the additional land that is required for sludge storage, parking spaces, offices, and for landscaping and planting around the installations and the storage reservoirs.

TABLE 5.2 : LAND REQUIREMENTS FOR THE ASTROMERITIS STP

Sewage treatment plant		2 800 m^2 (≈ 0.3 ha)
Emergency storage reservoir		2 410 m^2 (≈ 0.25 ha)
Long term storage reservoir		41 300 m^2 (≈ 4.1 ha)
Pumping stations	Each pumping station	500 m^2
	Total area	1 000 m^2
Total Area		47 510 m^2 (≈ 4.8 ha)

The total land requirements for the construction of the sewage treatment plant and the emergency and long term storage reservoirs will be approximately 46 510 m^2, which includes the areas that will be required for sludge storage, offices, parking lots and for landscaping and planting around the installations.

The sewage treatment plant, including the emergency and long term storage reservoirs, will be constructed within the area of the old quarry which is private land, therefore the necessary compensation will be paid for its acquisition in accordance with the law. Since the quarry consists of barren land and is not used for agricultural purposes, and since the quarry has been abandoned and is not in operation, no additional compensation will be required for the destruction of cultivations or the loss of income.

- ANTHOUPOLIS SEWAGE TREATMENT PLANT

The installations for the new treatment plant which will replace the existing one, the design of which already includes the connection of the communities of Kokkinotrimithia and Palaiometocho, will be constructed within the available area of the plant, therefore the acquisition of additional land will not be necessary.

Regarding the storage and reuse of the treated effluents a separate study will be carried out. The land requirements for the construction of the emergency storage, only in connection with the two project communities, and for the pumping stations for the conveyance network are summarised in the following table.

TABLE 5.3 : LAND REQUIREMENTS FOR THE ANTHOUPOLIS STP

Emergency storage reservoir (Kokkinotrimithia and Palaiometocho)		2 700 m^2 (≈ 0.3 ha)
Pumping stations	Each pumping station	500 m^2
	Total area	1 500 m^2
Total Area (Kokkinotrimithia and Palaiometocho)		4 200 m^2 (≈ 0.4 ha)

❑ PUMPING STATIONS

The locations of the pumping stations will be determined during the detailed design of the conveyance system. The construction of the five pumping stations will result in the acquisition of a maximum total area of approximately 2 500 m^2. Where these pumping stations will be located on private land the necessary compensation will be paid to the owners for the acquisition, as well as for any possible loss of income that might be incurred as a result.

5.2.1.2. IMPACTS ON ECOLOGY

❑ ASTROMERITIS SEWAGE TREATMENT PLANT

Due to the nature and character of the proposed location no significant negative impacts are expected on ecology, or any destruction of natural habitats as a result of the construction of the Astromeritis sewage treatment plant.

Most of the area at the proposed site fall within a G3 Agricultural Zone, and even though a small part of the it belongs in a designated Z3 Protection Zone which extends along the river which traverses the site, and which is for the most part of the year dry, in general the region present no significant interest in terms of ecology and therefore the impacts from the project are expected to be minimal.

The sewage treatment plant, including the emergency and long term storage reservoirs, will be constructed at the site of the old quarry, which is within the buffer zone and consists of barren land. The area has already been significantly degraded as a result of the past operation of the quarry, since there was no site rehabilitation following its closure.

In the contrary, the construction of the long term storage reservoir for the treated effluents could possibly have a positive influence through the creation of wetland habitat in the area, which could have the potential of attractive bird and other fauna and flora species, this enhancing the biodiversity in the region. At the same time, the landscaping of the plant site will create a green area in an otherwise barren region.

❑ ANTHOUPOLIS SEWAGE TREATMENT PLANT

The existing Anthoupolis sewage treatment plant is within a G3 Agricultural Zone, in an area which presents no particular ecological interest, and most of the fauna and flora species there are common and found extensively in the region.

Additionally, the installations for the new plant will be constructed within the existing area of the plant, since no additional land can be acquired. As a result no significant ecological impacts are expected from the construction of the new sewage treatment station.

Generally, the construction period will temporarily affect the ecology of the area. The increased movement of vehicles and the operation of machinery will have short-term impacts on the fauna, particularly the noise from the construction activities, which could result in a temporary decrease of sensitive species. However, the implementation of the mitigation measures that are suggested for the construction stage will minimise the impacts, while these will only be temporary and the affected species are expected to return or be replaced following completion.

The fauna and flora of the artificial environment within the treatment plant area will be replaced once the construction period is over, while the appropriate landscaping of the site will significantly reduce any small losses in vegetation. With the completion of the project the site will have the appearance of a park. Durable trees and plant species will be used, while the trees that will both deciduous and evergreen trees will be planted. Additionally, one of the existing lagoons will be turned into a lake to which various fish species and ducks will be introduced, while wetland bushes and vegetation will be planted around the lake. In conclusion, the project is expected to have positive impacts on the ecology of the area, turning the site into an area of green and a wetland habitat.

During the operation of the sewage treatment plant no significant adverse impacts are expected on the ecology of the area, since the plant has been in operation for a number of years without causing any significant problems.

Regarding the storage and reuse of the treated effluent a separate study will be conducted. If the construction of a long term storage reservoir is necessary, this will be located at a different site. Any impacts on ecology as a result of the construction of the reservoir will be examined in the relevant study.

- PUMPING STATIONS

Although the positions of the pumping stations are still preliminary and will be defined during the detail design of the conveyance system, these will not be constructed in ecologically sensitive areas, therefore no significant adverse impacts are expected.

5.2.2. IMPACTS RELATED TO PROJECT DESIGN

- ASTROMERITIS SEWAGE TREATMENT PLANT

No significant impacts are anticipated in relation to the design of the STPs and the conveyance systems. The activated sludge process that has been proposed for the treatment of sewage in the case of the Astromeritis sewage treatment plant, is a proven and reliable process, and, as it will be provided with tertiary treatment, the treated effluent will meet the set performance standards.

With the activated sludge process there will be stable performances despite variations in the hydraulic road. The process will ensure the removal of dissolved organic pollution (BOD, COD and SS), while the tertiary treatment will reduce the coliform counts, in accordance with the specified standards. Additionally, the process will be configured to achieve nitrogen reduction, thus reducing the nutrient levels of the receiving waters and soil, while provisions will also be made for the future removal of phosphorus. Therefore, in terms of performance, the process will ensure the adequate treatment of wastewaters, thus minimising the risk of any impacts arising as a result of insufficient treatment of the effluents.

The design of the sewage treatment plants includes the construction of an emergency storage reservoir for each plant to address the possibility of emergency problems in the treatment process. This will provide storage for 7 days, thus reducing the risk of any impacts resulting from emergency conditions.

The process selection for the sludge treatment will be based on the assumption that the treated sludge will be reused in agriculture as fertilizer in accordance with the specified standards, and will follow the stages of sludge thickening, stabilization and dewatering.

- ANTHOUPOLIS SEWAGE TREATMENT PLANT

In the case of the Anthoupolis Sewage Treatment Plant, the bio aerated treatment process that is proposed in the preliminary design is also a reliable and proven process, which combined with tertiary treatment will meet the set quality standards for the treated effluents.

With the biofiltration technology the level of treatment can be adjusted to fit the day-to-day requirements, and the process cab be easily adopted to load variations. The method offers a high level of treatment for BOD and Suspended Solids, while at the same time it can achieve nitrification-denitrification at the desired levels. The tertiary treatment can reduce the number of faecal coliforms, and thus the quality of the treated effluent will be in accordance to the set standards.

For the treatment of sludge a process line is proposed which includes the thickening of the sludge with a gravity thickener, dehydration by centrifuge, and stabilization though lime treatment. This process is optimized for sludge that is produced from the biofilter process and will produce sludge that can be stored, transferred and reused in agriculture without any odour problems and in accordance with the desired standards.

- SEWAGE CONVEYANCE SYSTEM

The design of the conveyance systems will ensure that there will be no problem of creation of sulphides along the forcemains.

5.2.3. IMPACTS DURING THE CONSTRUCTION STAGE

5.2.3.1. TEMPORARY LAND ACQUISITION

During the construction phase land will be required for the construction facilities, which include worker camps, workshops, and storage and disposal areas. This could potentially lead to the temporary take up of additional land. Where it is necessary to acquire additional land, measures should be taken up to ensure that such sites are limited to the minimum possible area required. Following the construction stage all land which was acquired temporarily must be rehabilitated.

5.2.3.2. VEGETATION CLEARING

- ASTROMERITIS SEWAGE TREATMENT PLANT

In the case of the Astromeritis sewage treatment plant, the extend of the vegetation cover that will be destroyed will be limited. The treatment plant, and the emergency and long term storage reservoirs, will be constructed at the site of the old quarry, which consists of barren land, with only some low natural vegetation, common in the wider region, therefore no significant negative impacts are expected as a result of project construction.

Following the completion of the project, the plant site will be landscaped and various plant and tree species will be planted, thus compensating for any small losses in vegetation that will result from construction.

- ANTHOUPOLIS SEWAGE TREATMENT PLANT

In the case of the Anthoupolis sewage treatment plant, the new installations will be constructed within the existing area of the plant, thus there will be no destruction of natural vegetation or cultivations in the surrounding areas outside the plant site. The flora of the artificial environment within the plant site will be replaced following the completion of the construction period, and resilient trees and plants will be planted, including both deciduous and evergreen trees. In conclusion, the effective landscaping and rehabilitation that will be carried out will significantly compensate for any small losses in vegetation.

- SEWAGE CONVEYANCE SYSTEM

During the construction of the conveyance systems, it is possible that vegetation, including cultivations, trees and natural vegetation, along the pipe routes will need to be cleared. In most cases this will only be temporary, and the vegetation can be restored following the construction phase. In the case of the pumping stations, the extent of vegetation destruction that will result from construction will be limited as most of the pumping stations will be within the urban or agricultural areas.

Where crop cultivations are destroyed compensation must be paid to the owners for any loss of income that might result from the destruction of crop yields and trees.

5.2.3.3. SOIL IMPACTS

Impacts on the soil of the site and along the conveyance routes could arise during the construction phase if appropriate measures are not implemented. Such impacts mainly include the erosion, disaggregation and compaction of the soil.

- ⇨ Soil Erosion: This concerns mainly earthworks and spoil areas and is usually caused by rainfall, and mainly be wind. To prevent soil erosion it must be ensured that the earth piles are correctly shaped (e.g. with gentle gradients) and protected against erosion by protective walls. The creation of large expanses of bare soil must be avoided and the removal of vegetation must be reduced to the minimum possible. Additionally, the construction of the pipe network should be done by segmentation in order to minimise the spoil production.

- ⇨ Soil Disaggregation: This is the mixing up of soils and arises particularly when soil is removed from one location to another. Soil disaggregation can be prevented by removing the soil in order of horizons and keeping each horizon in a separate pile.

- ⇨ Soil Compaction: This is an inevitable impact during the construction stage, resulting from the movement of vehicles over soil, as well as the storage of soil heaps or other materials. A number of mitigation measures can be taken to reduce soil compaction, including the use of only a single or a few tracks by vehicles; the use of wider tyres which will spread the weight of vehicles; or by tilling the area once compaction has occurred.

Generally, during the construction phase, the topsoil must be effectively preserved for eventual use.

5.2.3.4. DUST, FUMES AND NOISE

⇩ IMPACTS ON AIR QUALITY DURING CONSTRUCTION

During the construction phase of the sewage treatment plants and the collection and conveyance systems, the main sources of air pollution will be the machines and vehicles through the burning of fuel, as well as the generation of dust from vehicle movement and construction activities.

To minimise the impacts the construction field and any access roads which are not asphalted will be watered several times a day, particularly during the summer, to reduce the amount of dust produced, while the regular maintenance of machinery and vehicles should be ensured. Provided that dust control and site management measures are adopted, the impacts will be localized, temporary and are not expected to be significant.

⇩ NOISE DURING THE CONSTRUCTION STAGE

During the construction phase the levels of noise to be generally anticipated are in the range 92 – 95 dB (A) at 5m. More specifically, it will vary between the different stages of the construction process, including:

- ❑ Site clearance
- ❑ Foundation work
- ❑ Building construction
- ❑ Road construction
- ❑ Pipe laying

The main sources of noise will be the operation of construction machines, the vehicles transporting materials and personnel, and the vibration caused by activities such as blasting.

TABLE 5.4: TYPICAL MAXIMUM NOISE LEVELS PERMITTED AT CONSTRUCTION SITES

CONSTRUCTION EQUIPMENT AND VEHICLES	dB(A)
Lorries	85
Bulldozer	120
Diesel mechanical shovel	110
Diesel earth excavator	105
Concrete breaker	110
Diesel winch	105
Dumper trucks	100
Diesel ground compactor	110
Concrete mixer	115
Concrete pump	115
Tractor	120
Soil grader	120
Pneumatic drill	125
Fixed compressor	115
Loader	115
Electric motor (300HP)	105
Electric pump (300HP)	120
Car	75
Bus	85

TABLE 5.5: NOISE LEVELS FROM MACHINERY USED DURING CONSTRUCTION AT VARIOUS DISTANCES

	EQUIPMENT	15 m	30 m	50 m	100 m	200 m
1.	Excavator	78	72	67	61	53
2.	Bulldozer	78	72	67	61	53
3.	Drilling machine	89	83	78	72	66
4.	Air compressor	75	69	64	58	52
5.	Vibrator	76	70	65	59	53
6.	Mixer	75	69	64	58	52
7.	Truck	76	70	65	59	53

Noise impacts during the construction phase will arise mainly from the construction of the collection systems, as works will take place within the residential areas, and partly from construction of the conveyance systems. In the case of the STPs, there will be no noise impacts on the resident population as all three sites are at a sufficient distance from housing areas.

Although during the construction phase noise control measures can be incorporated in the contract with the constructors, such measures are rather restricted. Construction takes place in the open with the use of heavy machinery and only limited control measures are feasible, such as the use of low noise compressors, engines and equipment. Furthermore, any construction during the night hours, when background noise levels are low, should be strictly controlled to minimise impacts.

Mitigation measures to be adopted include:

⇨ The use of low noise compressors, engines and equipment

- ⇨ A specification on the hours when construction will commence, while construction during the night hours when background noise levels are low should be strictly controlled to minimize impacts.

To ensure the effective adoption of mitigation measures these will be incorporated in the environmental specifications of the constructor as part of the contract.

5.2.3.5. ON-SITE SAFETY

Health and safety measures must be implemented on the construction sites by the contractor to ensure the avoidance of accidents in relation to the work force and the environment. The construction equipment and machinery, and all vehicles must undergo regular maintenance, while measures to ensure traffic security must be adopted and applied at all times. Regarding the work force, personal protective equipment must be provided and used at all times, medical assistance should be readily available, and preparedness procedures in case of accidents or emergency situations must be established.

5.2.3.6. WASTE MANAGEMENT

Waste is expected to arise as a result of construction activities, including construction waste and domestic solid waste from the workers' facilities. Domestic waste should be collected and transported to the appropriate official landfill site. In the case of construction waste, where these cannot be reused elsewhere, they should also be disposed at an official landfill site. Measures must also be taken for the handling of effluents from workers' sanitary facilities to prevent any risk of effluent runoffs.

5.2.3.7. POLLUTION

During the construction phase there is the possibility of soil or water pollution as a result of effluents from camps, oils from engines, effluents from concrete production, or from other building materials used. Such effluents pose a risk for soil pollution and, potentially, aquifer pollution if the aquifer is near the surface. The risk for surface water pollution is lower, unless there is water runoff leading to the transport of pollutants into surface water bodies. Where the release of effluents is considered to pose a serious threat of soil pollution or when there is a possibility for runoff, procedures must be taken for the containment of pollutants.

Pollution, and particularly soil pollution, may also be the result of accidental spillages on construction sites, particularly in the case of storage tanks or on-site pumps. Measures must be taken to minimise the impacts of any accidental spillages, including the containment of such tanks on concrete floors with walls to prevent the release of effluents on the soil in case of a spillage.

5.2.3.8. OFF-SITE PUBLIC SAFETY AND INCONVENIENCE

During the construction of the sewage treatment plants there will be increased vehicle movement to and from the sites for the transportation of materials, equipment and personnel. This could potentially lead to driver delays along these roads, as well as increased risk of road traffic accidents.

The impacts during the construction of the collection and conveyance systems, however, will be more significant. The proposed collection and conveyance systems will, in most cases, be constructed along main roads, often within the community residential areas, which will cause inconveniences for the resident population. The opening of trenches and the partial or total closing of roads during the excavation and pipe-laying stages will lead to traffic congestions, especially along the main roads, and increase the risk of car accidents.

Mitigation measures are rather restricted. In the case of increased vehicle movements, these should be restricted to avoid hours of peak traffic. Good site management during the construction stage and the adoption and adherence to road safety measures will, to some extent, minimise these impacts.

5.2.4. IMPACTS DURING PROJECT OPERATION

5.2.4.1. LANDSCAPE IMPACTS

- ASTROMERITIS SEWAGE TREATMENT PLANT

The landscape and visual impacts that will result from the construction of the Astromeritis sewage treatment plant will be limited. The plant, including the emergency and long term storage reservoirs, will be located at the site of the old quarry, in an area that has been significantly degraded as a result of the past operation of the quarry. The site has the form of a crater since no actions have been taken for rehabilitation following the closure of the mine. Additionally, due to this geomorphology of the area, the treatment plant will not be clearly visible from the surrounding areas.

Additionally, measures will be taken for the further minimization of any negative impacts. The site of the plant will be landscaped, and the trees and other plant species will be planted, so the area will have the appearance of a park. Furthermore, there will be appropriate architectural design of the installations to ensure that the plant will be in line with the built and natural environment of the wider region.

- ANTHOUPOLIS SEWAGE TREATMENT PLANT

There will be no further impacts on the landscape of the area from the construction of the new sewage treatment plant, while on the contrary the landscaping of the site that will be carried out will result in positive impacts for the region. With the completion of the plant the site will be planted and will have the appearance of a park or a green area. Resilient trees and plant species will be used, while both deciduous and evergreen trees will be planted that will offer green throughout the year. Additionally, one or more of the existing reservoirs will be transformed into a lake into which various fish species and ducks will be introduced, while around the lake bushes and vegetation, typical of wetlands will be planted. The park will be completed with paths.

At the same time, the contractor will take into account that the existing agricultural land around the plant site will eventually be turned into a residential area. Therefore, the architectural design of the building must be chosen to be in harmony with its surroundings. Generally, the project will include high quality architectural features, offering harmony with the surrounding area, and giving emphasis on the advanced technology procedures at place, as well as a positive image by bringing out the landscaping of the site and measures which have been taken for environmental protection.

- PUMPING STATIONS

Any landscape impacts that may result from the construction of the pumping stations will be minimised through the landscaping of the areas that will be carried, and the appropriate architectural design of the installations.

5.2.4.2. IMPACTS ON THE QUALITY OF LIFE

- ASTROMERITIS SEWAGE TREATMENT PLANT

No significant impacts are expected as a result of noise or odours on the residents of the community from the operation of the Astromeritis sewage treatment plant. The location that is proposed for the construction of the plant is at a sufficient distance from the housing area, thus ensuring that there will be no risk or impacts as a result of noise or odours. The site is at a distance of approximately 0.8 km from the boundary of the Astromeritis residential zone, and 2.3 km from the centre of the village.

Regarding wind direction, throughout the year the prevailing winds in the Nicosia region have southwest to west directions, with angles of 210^o to 270^o, while northwest winds also have a high percentage of occurrence. Although the prevailing winds are in the direction of the Astromeritis housing area, the distance of the proposed site from the residential zone and the fact that the plant will be in the crater of the old quarry, ensure the avoidance of any odour risks.

- ANTHOUPOLIS SEWAGE TREATMENT PLANT

The site of the Anthoupolis sewage treatment plant is at a distance of approximately 1.3 km from the Anthoupolis residential are, a distance which ensures that there will be risks as a result of noise or odours, even though in this case as well the prevailing winds are in the direction of the housing area.

However, the plant site is within an area which is expected to be urbanized in the near future when housing areas will be developed near the site. To minimise any risks of disturbance as a result of noise or odours, the plant will be covered and an odour removal system will be installed. The air in the plant will be collected and transferred for treatment prior its release in the atmosphere.

Additional to the sufficient distance of the site from the communities, with regards to odours, the plant design will ensure the effective control of odours as it will incorporate an odour removal system. Moreover, noise impacts are also addressed by the Environmental Management Programme through the introduction of a noise monitoring programme and mitigation measures to ensure the avoidance of any impacts that could arise.

In conclusion, the plant design and the Environmental Management Programme, in conjunction with the distance of the STP site from residential areas ensure that there will be no adverse impacts on the quality of life for the concerned communities.

⇩ Noise Impacts During the Operation of the Sewage Treatment Plants

Noise levels in the range 65 – 70 dB (A) may be expected near equipment such as pumps, ventilators and air compressors. However, as mentioned above, the distance of the site from residential areas is itself a mitigation measure against impacts on the resident population. Other measures include:

- Use of low noise equipment
- The application of noise control equipment at various stages of the treatment process
- Enclosing the sources of noise
- Use of noise screens, including tree plantings

In the case of the Anthoupolis sewage treatment plant the entire plant will be covered, thus minimising the possibility of impacts as a result of noise

A monitoring programme for the control of noise is addressed in the Environmental Management Programme.

⇩ Noise at Pumping Stations

The careful design of pumping stations will ensure the minimization of any noise produced during operation. As pumping stations work intermittently, operation will be more frequent during peak hours which are not usually during the night time, therefore any impacts are inherently minimised. The use of low noise equipment and the design of buildings to incorporate specific acoustic features, together with their sitting at appropriate locations as far away from residential areas as possible and again the use of natural barriers will ensure the mitigation of any such impacts.

⇩ Odour Impacts During the Operation of the Sewage Treatment Plants and the Pumping Stations

During the operation of the sewage treatment plants and the conveyance systems, odours can potentially arise from a number of sources, including screenings and grit removal facilities, primary settling tanks, organically overloaded biological treatment processes, sludge thickening tanks, sludge conditioning and dewatering facilities, or sludge digesting and composting operations. However, the risk of odour impacts can be effectively mitigated through:

- The application and adherence to proper process procedures
- The covering of process areas and the provision for adequate air filtration
- The regular monitoring of processes and the conducting of all appropriate chemical and biochemical analyses
- The regular maintenance of the plant and pumping stations.

In the case of the Anthoupolis sewage treatment plant the entire plant will be covered and an odour removal system will be installed. The air will be collected and conveyed for treatment prior to its release in the atmosphere.

The introduction of odour control systems in the STP design and the distance of the site from residential areas, as mentioned above, in conjunction with these measures will effectively mitigate odour impacts.

Regarding the formation of sulphides in the case of the forcemains along the conveyance system, with appropriate design no impacts are expected for lengths of forcemain below 10m, which corresponds to a transfer time of approximately 3 hours.

5.2.4.3. IMPACTS ON UNDERGROUND WATER RESOURCES

The project is expected to have positive impacts on the groundwater resources. The treated effluent quantities that will be produced from the sewage treatment plants in 2005, 2015 and 2030 are as follows:

	TREATED EFFLUENT QUANTITIES (m^3/ year)
Astromeritis Sewage Treatment Plant	
2005	370 475
2015	424 130
2030	527 425
Anthoupolis Sewage Treatment Plant (Kokkinotrimithia and Palaiometocho)	
2005	373 760
2015	444 205
2030	586 190

The treated effluents from the Astromeritis sewage treatment plant can be reused for irrigation purposes in the region, thus providing a permanent water resource for the communities. This will result in a decrease in the amount of groundwater that is pumped, therefore reducing the risk of groundwater depletion. In the case of the Anthoupolis sewage treatment plant, a separate study will be conducted regarding the storage and reuse of the treated effluents.

Additionally, the project will result in a reduction of nitrates and phosphorus which are currently released into the soil from the existing sanitary system (septic tanks) in the project area.

5.2.4.4. IMPACTS ON SURFACE WATER HYDROLOGY

The site where the Astromeritis sewage treatment plant will be constructed is traversed by a dry seasonal stream. In case the construction of the plant, or the emergency and long term storage reservoirs, influences the course of the river, all necessary measures will be taken for appropriate river training.

Regarding the Anthoupolis sewage treatment plant, there will be no negative impacts on the surface hydrology of the area. Additionally, in both cases the treated effluents will provide an additional surface water resource.

5.2.4.5. RISK OF SYSTEM OVERLOAD

The risk of system overload is minimum. The STP design parameters will be based on the population projections for the year 2030, while by accounting for the summer tourism requirements for each of the communities the risk of seasonal overload is not anticipated. Any accidental overload from equipment failure will be mitigated though the construction of the emergency storage reservoir.

5.2.4.6. RISK OF INSUFFICIENT TREATMENT OF EFFLUENTS

The risk of system overload is minimum. The design parameters for the sewage treatment plants will be based on the population projections for the year 2030, while by accounting for the summer tourism requirements for each of the communities the risk of seasonal overload is not anticipated. Any accidental overload from equipment failure will be mitigated though the construction of the emergency storage reservoir.

5.2.5. IMPACTS FROM THE PRODUCTION AND REUSE OF SEWAGE SLUDGE

The sludge quantities that are expected to be produced are outlined in the following table.

	EXPECTED SLUDGE QUANTITY, 30% DS CONTENT (m^3/year)		
	2005	2015	2030
Astromeritis sewage treatment plant	553 m^3/ year	625 m^3/ year	752 m^3/ year
Anthoupolis sewage treatment plant (Kokkinotrimithia and Palaiometocho)	558 m^3/ year	655 m^3/ year	834 m^3/ year
Total	**1 111 m^3/ year**	**1 280 m^3/ year**	**1 585 m^3/ year**

Table 5.6 gives the average sludge composition in Cyprus. Detailed information regarding sludge quality and constituents are outlined in Appendix 8.

TABLE 5.6:AVERAGE COMPOSITION OF SLUDGE IN CYPRUS

	MEAN VALUE
Date	1995 – 1999
Dry Matter (%)	22 – 73
Organic Matter (% DM)	67 – 72
N % DM	3.75 – 4.53
P % DM	1.97 – 2.27
K % DM	0.25 – 0.26
mg/kg DM	

	MEAN VALUE
Cd	1.85 – 3.5
Cr	22 – 133
Cu	129 – 202
Hg	0.4
Ni	30 – 32
Pb	44 – 70
Zn	659 – 1173
nb/g wm	
Enteric virus	4.3 x 10^4/100g
Viable Helminth eggs	0

5.2.5.1. SLUDGE DISPOSAL AND REUSE

Particularly during the first years of operation of the sewage treatment plants, the main disposal route for the sewage sludge will be landfill, which will accommodate a significant percentage of the quantities produced annually. Regarding landfill disposal, two options are available:

- ⇩ Either the sludge will be transported for disposal to the nearest official controlled landfill site that is appropriately designed to receive such waste, or,
- ⇩ A site will be identified within the region to be serviced by the STPs for the creation of a new controlled landfill, designed to accommodate such waste as sewage sludge, in addition to the solid waste from the villages.

For this purpose, a feasibility study must be conducted to:

- ⇨ Assess the costs of the two options, i.e. the costs for the transport of sludge to the existing landfill site as compared to the costs for the creation of a new site(s) near the STPs.
- ⇨ Identify possible locations for a new landfill site/sites
- ⇨ Evaluate the costs and benefits of each option in economic, technical and environmental terms.

However, the volume of sludge that is disposed in landfill must be reduced, primarily through the reuse of sludge for agricultural purposes. Based on this objective, the quality of the treated sludge must be according to the set standards, while provisions must be made for the storage and drying of the sludge at the STP sites. A minimum storage period of two months is recommended, in addition to the treatment process, to further reduce the pathogens present in sludge to appropriate levels. Such reuse will recycle the constituents of sludge which are important nutrients in crop production, while at the same time reducing the need for fertilisers, and the quantities of sludge that are disposed in landfills. For the efficient use of sludge in agriculture, a regional management plan must be drafted which will increase the percentage of sludge that is recycled and ensure safe reuse practices.

5.2.5.2. SLUDGE REUSE: MANAGEMENT PLANT

The drafting of a regional management plan is proposed to ensure the availability and efficiency of long term disposal and, more importantly, recycling possibilities for sludge.

Although landfills are currently the main disposal route for sludge, and will continue to be the base option for a significant percentage of the total sludge quantities that will be produced, EU policy is in favour of developing the use of sludge in agriculture, as it is considered to be the best option from both the economic and environmental perspectives.

To increase the percentage of sludge used in agriculture and ensure the sustainability and acceptance of this route, together with the adoption and adherence to appropriate management practices, the development of a regional reuse plan is recommended. This plan will seek to increase the extent and possibility for sludge recycling and secure that the reuse of sludge shall be carried out in such a way as to minimise any risk of negative effects to:

- ⇨ Human, animal and plant health

- ⇨ The quality of groundwater and surface water
- ⇨ The long term quality of the soil

The reuse plan must be based on the following criteria:

- ❑ Sludge quality: sludge quality must be according to the set standards regarding heavy metal concentrations, as well as N and P concentrations.

- ❑ Application rates**:** they must be determined based on the N and P requirements of the specific crops, the N and P levels in the sludge, the metal concentrations in the sludge and the application rates specified in the set standards, and the quality of the soil.

- ❑ Crop selection: based on crop nutrient requirements and crop tolerance to certain sludge constituents.

- ❑ Application methods: depending of the physical characteristics of the sludge and soil, and the types of crops.

- ❑ Scheduling of application: the timing of land applications must be scheduled around the tillage, planting and harvesting operations for the crops grown, also taking into account climate and soil properties.

- ❑ Site identification**:** possible sites where sludge can be used (also securing acceptance by farmers).

- ❑ Measures to encourage use of sludge and reduce constraints**:** including
  - ⇩ Technical options:
    - ⇨ Implement regular monitoring of sludge quality
    - ⇨ Guarantee quality of sludge recycling practices
  - ⇩ Economic and regulatory options:
    - ⇨ Establish clear provisions on producer responsibility ensuring that sludge producers are responsible for the quality of the sludge supplied and shall guarantee its suitability for use.
    - ⇨ Measures to ensure that sludge suppliers accept liability for any economic or damage associated with the use of sludge
    - ⇨ Establishment of guarantee funds or insurance systems in case of accidents.
    - ⇨ Arrange voluntary agreements between farmers and food suppliers to ensure no discriminative measures are taken against products grown with the use of sludge.

5.2.5.3. MITIGATION MEASURES FOR THE APPROPRIATE USE OF SLUDGE IN AGRICULTURE

Misuse of the agricultural value of sludge Leaching of nitrates to groundwater
⇩ Better knowledge of sludge content in terms of compounds of agricultural value
❑ Adequate sampling procedures (frequency, number of samples, etc.)
❑ Adequate analysis protocols
⇩ Improve use of sludge agricultural value
❑ Determination of the sludge agricultural value (N, P, K, content)
❑ Planning and application adapted according to: ⇨ Plant needs ⇨ Other fertiliser sources ⇨ N remaining in the soil ⇨ Nutrient bioavailability ⇨ Adequate spreading periods according to agricultural and environmental

constraints

- ❑ Regular soil analyses to establish increase in nutrient content
- ❑ Information from farmers about quantities spread

Soil contamination by heavy metals and organic pollutants

- ⇩ Determination of background levels in soil
- ⇩ Determination of pollutant content in sludge
- ⇩ Safe storage of sludge
  - ❑ Safe storage to reduce leaching
  - ❑ Sufficient storage capacity
  - ❑ Reduction of storage duration in the field

Water contamination by heavy metals and organic contaminants

- ⇩ Forbid sludge spreading in sensitive areas, especially:
  - ❑ On sloping land
  - ❑ Near surface water
  - ❑ On wet areas
  - ❑ Within water resource protection areas
  - ❑ On sandy soils
  - ❑ On frozen grounds
  - ❑ In areas where the water table is near the surface
- ⇩ Encourage fast ploughing down in order to reduce the risk of runoff and the use of close-to-ground techniques in order to reduce the formation of aerosols
- ⇩ Safe storage of sludge

Crop contamination by heavy metals and organic pollutants

- ❑ Reduce transfer in the food chain
  - ⇨ Encourage sludge spreading before non-food crops
- ⇩ Limit plant uptake
  - ⇨ Adapt sludge spreading to soil types (mainly according to pH and CEC)
  - ⇨ Take into consideration heavy metal bioavailability in soil
  - ⇨ Define a crop/sludge type matrix with specific recommendations
  - ⇨ Prohibit sludge spreading on plant/crops which are known to accumulate heavy metals
- ⇩ Limit deposition on plant
  - ❑ Limit use of sludge on vegetable and certain fruit productions
- ⇩ Analyses of the metal level in crops and foodstuff

Animal contamination by heavy metals and organic pollutants

- ⇩ Limit pollutant transfer to animals
  - ❑ Tighten limits concerning quantity and quality of sludge which may be applied
  - ❑ Grazing land:
    - ⇨ Introduce a time period before harvesting
    - ⇨ Favour sludge ploughing down
  - ❑ Grassland:
    - ⇨ Allow spreading before sowing and after each cut
- ⇩ Control of the metal levels in foodstuffs

❑ Analysis of the pollutant levels in animal products (especially in offal and milk)
Human contamination
⇩ Limit pollutant transfer in the food chain (see above)
⇩ Protection of operating equipment
❑ Ensure safe manipulation of sludge
❑ Material cleaning and maintenance
❑ Protective clothes
Contamination by pathogens
⇩ Animal contamination
❑ Grazing land: introduce a time period before grazing
❑ Grassland: allow spreading before sowing and after each cut
❑ Encourage fast ploughing down of sludge
⇩ Human contamination
❑ Prohibition of sludge spreading on products which are to be consumed raw
❑ Safe transportation of sludge
❑ Prohibition of sludge spreading in the vicinity of houses and near bathing water and drinking water supply areas

Sludge must be used according to the following table.

TABLE 5.7: SAFE-SLUDGE MATRIX

	ADVANCED TREATMENTS	CONVENTIONAL TREATMENTS
Pastureland	Yes	Yes, deep injection and 6-week no-grazing
Forage crops	Yes	Yes, 6-week no-harvest
Arable land	Yes	Yes, deep injection or immediate ploughing down
Fruit and vegetable crops in contact with the ground	Yes	No. no harvest for 12 moths following application
Fruit and vegetable crops in contact with the ground – eaten raw	Yes	No. no harvest for 30 moths following application
Fruit trees, vineyards, tree plantations and reforestation	Yes	Yes, deep injection and 10-month no-access to the public

5.2.5.4. SUGGESTED LIMIT STANDARDS FOR SLUDGE QUALITY

A set of limit values are suggested for the concentrations of heavy metals in the sludge, the soils on which sludge will be applied and for the heavy metal application rates. These are lower than the standards set by the Regulations on the Use of Sludge in Agriculture (517/2002) and the Code of Practice for the Use of Sludge for Agricultural Purposes.

TABLE 5.8: PROPOSED HEAVY METAL CONCENTRATION LIMIT VALUES IN THE SOIL

PARAMETER	LIMIT VALUES (mg/kg DS)			
	Regulation 517/2002 6<pH<7	Proposed Limit Values		
		5 ≤ pH < 6	6 ≤ pH < 7	pH ≥ 7
Cadmium (Cd)	1 – 3	0.5	1	1.5
Copper (Cu)	50 – 140	20	50	100
Nickel (Ni)	30 – 75	15	50	70
Lead (Pb)	50 – 300	70	70	100
Zinc (Zn)	150 – 300	60	150	200
Mercury (Hg)	1 – 1.5	0.1	0.5	1
Chromium (Cr III)	–	30	60	100

TABLE 5.9: PROPOSED HEAVY METAL CONCENTRATION LIMIT VALUES IN THE SLUDGE USED IN AGRICULTURE

PARAMETER	LIMIT VALUES (mg/kg DS)		LIMIT VALUES (mg/kg P)
	Regulation 517/2002	Proposed Limit Values	Proposed Limit Values
Cadmium (Cd)	20 – 40	10	250
Copper (Cu)	1 000 – 1 750	1 000	25 000
Nickel (Ni)	300 – 400	300	7 500
Lead (Pb)	750 – 1 200	750	18 750
Zinc (Zn)	2 500 – 4 000	2 500	62 500
Mercury (Hg)	16 – 25	10	250
Chromium (Cr III)	–	1 000	25 000

TABLE 5.10: PROPOSED LIMIT VALUES FOR AMOUNTS OF HEAVY METALS WHICH MAY BE ADDED ANNUALLY TO SOIL, BASED ON A TEN YEAR AVERAGE

PARAMETER	LIMIT VALUES (kg/ha/year)	
	Regulation 517/2002	Proposed Limit Values
Cadmium (Cd)	0.15	0.03
Copper (Cu)	12	3
Nickel (Ni)	3	0.9
Lead (Pb)	15	2.25
Zinc (Zn)	30	7.5
Mercury (Hg)	0.1	0.03
Chromium (Cr III)	–	3

5.2.5.5. MONITORING PROGRAMME

In addition to the mitigation measures and the sludge management plan, a monitoring programme is required regarding sludge and soil quality, and application rates and practices, to ensure that implementation of the mitigation measures and good practice guidelines, as well as the adherence to the set standards. This is outlined in the Environmental Management Programme.

5.2.6. REUSE OF TREATED EFFLUENT IN AGRICULTURE

5.2.6.1. TREATED EFFLUENT QUANTITIES

The maximum expected quantities of treated effluent for the years 2005, 2015 and 2030 have been estimated as follows:

	EXPECTED EFFLUENT QUANTITY
Astromeritis Sewage Treatment Plant	
2005	370 475 m^3/year
2015	424 130 m^3/year
2030	527 425 m^3/year
Anthoupolis Sewage Treatment Plant	
2005	373 760 m^3/year
2015	444 205 m^3/year
2030	586 190 m^3/year

5.2.6.2. REUSE OF TREATED EFFLUENT IN AGRICULTURE

The low rainfall patterns in Cyprus have often resulted in long periods of drought and, as a result, water shortages with their associated impacts on the agricultural sector. During the years between 1997 and 2000, for instance, the supplies for irrigation water were severly limited due to the low rainfall, with the available water in dams having reached critical levels. Irrigation water was rationalised and the amount allocated to farmers ranged between 30 – 70 % of the normal demand. Priority was given only to permanent crops, at the expense of annual cultivations. To overcome shortages groundwater supplies were excessively pumped to meet demand, while, at the same time, the agricultural sector had suffered severe losses. Taking the situation in Cyprus with regard to such shortages, the reuse of the treated effluents for irrigation purposes is recommended, since it will provide an additional permanent water resource. Additionally, as the regulations regarding the disposal of treated effluents in water bodies in essence prohibits discharges in dry rivers, as the quantity of the effluent must not exceed 10 % of the river flow, and while government policy discourages disposal in the sea, then agricultural reuse is the only viable option.

According to the 1994 Census of Agriculture, 99.5 % of the water demand for the irrigated areas in the project region is satisfied by boreholes and wells. However, although groundwater is still the main source for the irrigations demands in the area, the resource has been mismanaged over the past decades and, on many occasions, nearly depleted through over pumping. The reuse of the treated effluents for irrigation purposes will not only provide an additional permanent water resource, it will also reduce pumping, and in turn, the risk of depletion of the groundwater bodies.

In consideration of the above, it is recommended that the treated effluents be used for irrigation purposes, either directly or indirectly through aquifer recharge.

5.2.6.3. QUALITY OF THE TREATED EFFLUENTS

The suggested limit standards regarding the quality of the treated effluent are a combination of EU and Cyprus Standards. As a result the discharge limits will be those imposed by the Code of

Practice for the use of Treated Sewage Effluents in Irrigation, for the irrigation of all crops; while also addressing the removal of nitrogen and phosphorus as indicated by the EU Standards. This will ensure that no adverse impacts arise from the reuse of the treated effluent.

TABLE 5.11: SUGGESTED LIMIT STANDARDS FOR TREATED EFFLUENT QUALITY

PARAMETER	LIMIT
BOD_5	10 mg/l
COD	< 125 mg/l
Suspended Solids	10 mg/l
Total N	15 mg/l
Faecal Coliforms	5 units/100 ml (in 80% of the samples) 15 units/100 ml (maximum)
Intestinal Worms	Nil
Total P	2 mg/l

In the case of the Anthoupolis sewage treatment plant the following limit standards have been suggested in the preliminary design:

TABLE 5.12: SUGGESTED TREATED EFFLUENT QUALITY FOR THE ANTHOUPOLIS SEWAGE TREATMENT PLANT

PARAMETER	SUGGESTED LIMITS
BOD_5	10 mg/l
COD	90 mg/l
Suspended Solids	10 mg/l
Total N	10 mg/l
Faecal Coliforms	5 units/100 ml (in 80% of the samples) 15 units/100 ml (maximum)
Intestinal Worms	Nil
Total P	Provision for future removal

5.2.6.4. LAND REQUIREMENTS FOR THE REUSE OF THE TREATED EFFLUENT

Taking an average water demand of 800 m^3/donum/year, the total land requirements for the reuse of the treated effluent for crop irrigation are as follows:

YEAR	QUANTITY OF TREATED EFFLUENT (m^3)	LAND REQUIREMENTS (DONUMS)
Astromeritis Sewage Treatment Plant		
2005	370 475 m^3/year	463 donums
2015	424 130 m^3/year	530 donums
2030	527 425 m^3/year	659 donums
Anthoupolis Sewage Treatment Plant (Kokkinotrimithia and Palaiometocho)		
2005	373 760 m^3/year	467 donums
2015	444 205 m^3/year	555 donums

2030	586 190 m^3/year	733 donums

Table 5.13 provides estimates of the amount of agricultural land in each village that is either irrigated using boreholes or is not irrigated cultivated land. The treated effluents can be used for the irrigation of these cultivated areas.

TABLE 5.13: AREAS IRRIGATED BY BOREHOLES AND NOT-IRRIGATED AREAS (CENSUS OF AGRICUTLTURE, 1994)

	AREA (DONUMS)
ANTHOUPOLIS SEWAGE TREATMENT PLANT	
Kokkinotrimithia	
Areas irrigated by boreholes	1 387
Not-irrigated areas	7 271
Palaiometocho	
Areas irrigated by boreholes	1 567
Not-irrigated areas	14 508
Total area irrigated by boreholes	*2 954*
Total not-irrigated area	*21 779*
ASTROMERITIS SEWAGE TREATMENT PLANT	
Astromeritis	
Areas irrigated by boreholes	4 540
Not-irrigated areas	5 297
Peristerona	
Areas irrigated by boreholes	7 448
Not-irrigated areas	4 654
Akaki	
Areas irrigated by boreholes	5 988
Not-irrigated areas	3 620
Total area irrigated by boreholes	*17976*
Total not-irrigated area	*13 571*

Although the actual area which will be required for reuse of the treated effluent will depend on the crops to be irrigated, taking the average water demand to be 800 m^3/donum/year, the treated effluent from the three sewage plants can be reused for the irrigation of agricultural land within the project villages, since the land which is currently irrigated by boreholes or which is not irrigated cultivated land is sufficient to satisfy requirements until the year 2030.

In the case of the Anthoupolis sewage treatment plant, although the agricultural land areas that are currently irrigated by boreholes are sufficient to satisfy the land requirements for the reuse of the treated effluents from the communities of Kokkinotrimithia and Palaiometocho, a separate study will be conducted for the reuse of the treated effluents from the plant.

5.2.6.5. TREATED EFFLUENT REUSE FOR IRRIGATION: REGIONAL MANAGEMENT PLANT

To ensure the efficiency and sustainable reuse of the treated effluent for irrigation the drafting of a Regional Management Plan is recommended, aimed at optimising crop yields and quality, maintaining soil productivity and safeguarding the environment.

❑ COMPOSITION OF THE TREATED EFFLUENT

One of the key considerations in drafting an agricultural reuse management plan is the composition of the treated effluent in nutrients and other constituents.

A number of constituents in treated effluents are of concern in connection with its reuse for agricultural irrigation, including salinity, sodium, trace elements, chlorine and nutrients. Treated water tends to have higher concentrations of these constituents than groundwater or surface water and a reuse scheme must take into account the sensitivity of the crops to be irrigated in relation to these constituents.

⇩ Salinity

Salinity is one of the most important agricultural water parameters affecting plant growth, and crop yield and quality, while the tolerance of plants to salinity varies widely. Generally, crops must be chosen carefully to ensure that they can tolerate the salinity of the treated effluent that will be used for irrigation, while the soil must be properly drained and adequately leached to prevent salt build-up.

Salinity has an influence on the soil's osmotic potential and specific ion toxicity, and may result in degradation of the soil physical conditions. These could result in reduced plant growth rates or reduced yields. Table 5.12 gives the relative salt tolerance of certain agricultural crops. To avoid any adverse effects, the salinity of the treated effluents must be monitored regularly and the crops to be irrigated must be carefully selected in accordance with their sensitivity.

TABLE 5.14: RELATIVE SALT TOLERANCE OF AGRICULTURAL CROPS

Tolerant	
Fibre, Seed and Sugar Crops	
Barley	*Hordeum vulgare*
Cotton	*Gossypium hirsutum*
Jojoba	*Simmondsia chinensis*
Sugarbeet	*Beta vulgaris*
Grasses and Forage Crops	
Alkali grass	*Puccinellia airoides*
Alkali sacaton	*Sporobolus airoides*
Bermuda grass	*Cynodon dactylon*
Kallar grass	*Diplachne fusca*
Saltgrass, desert	*Distichlis stricta*
Wheatgrass, fairway crested	*Agropyron cristatum*
Wheatgrass, tall	*Agropyron elongatum*
Wildrye, Altai	*Elymus angustus*
Wildrye, Russian	*Elymus junceus*
Vegetable Crops	
Asparagus	*Asparagus officinalis*
Fruit and Nut Crops	
Date palm	*Phoenix dactylifera*
Moderately Tolerant	

Fibre, Seed and Sugar Crops	
Cowpea	*Vigna unguiculata*
Oats	*Avena sativa*
Rye	*Secale cereale*
Safflower	*Carthamus tinctorius*
Sorghum	*Sorghum bicolor*
Soybean	*Glycine max*
Triticale	*X Triticosecale*
Wheat	*Triticum aestivum*
Wheat, Durum	*Triticum turgidum*
Grasses and Forage Crops	
Barley (forage)	*Hordeum vulgare*
Brome, mountain	*Bromus marginatus*
Canary grass, reed	*Phalaris, arundinacea*
Clover, Hubam	*Melilotus alba*
Clover, sweet	*Melilotus*
Fescue, meadow	*Festuca pratensis*
Fescue, tall	*Festuca elatior*
Harding grass	*Phalaris tuberosa*
Panic grass, blue	*Panicum antidotale*
Rape	*Brassica napus*
Rescue grass	*Bromus unioloides*
Rhodes grass	*Chloris gayana*
Grasses and Forage Crops	
Ryegrass, Italian	*Lolium italicum multiflorum*
Ryegrass, perennial	*Lolium perenne*
Sudan grass	*Sorghum sudanense*
Trefoil, narrowleaf birdsfoot	*Lotus corniculatus tenuifolium*
Trefoil, broadleaf	*L. corniculatus arvenis*
Wheat (forage)	*Triticum aestivum*
Wheatgrass, standard crested	*Agropyron sibiricum*
Wheatgrass, intermediate	*Agropyron intermedium*
Wheatgrass, slender	*Agropyron trachycaulum*
Wheatgrass, western	*Agropyron smithii*
Wildrye, beardless	*Elymus triticoides*
Wildrye, Canadian	*Elymus canadensis*
Vegetable Crops	
Artichoke	*Helianthus tuberosus*
Beet, red	*Beta vulgaris*
Squash, zucchini	*Cucurbita pepo melopepo*
Fruit and Nut Crops	
Fig	*Ficus carica*
Jujube	*Ziziphys jujuba*

Olive	*Olea europaea*
Papaya	*Carica papaya*
Pineapple	*Ananas comosus*
Pomegranate	*Punica granatum*
Moderately Sensitive	
Fibre, Seed and Sugar Crops	
Broadbean	*Vicia faba*
Castorbean	*Ricinus communis*
Maize	*Zea mays*
Flax	*Linum usitatissimum*
Millet, foxtail	*Setaria italica*
Groundnut/peanut	*Arachis hypogaea*
Rice, paddy	*Oryza sativa*
Sugarcane	*Saccarum officinarum*
Sunflower	*Helianthus annuus palustris*
Grasses and Forage Crops	
Alfalfa	*Medicago sativa*
Bentgrass	*Agrostisstoloniferapalustris*
Bluestem, Angleton	*Dichanthium aristatum*
Brome, smooth	*Bromus inermis*
Buffelgrass	*Cenchrus ciliaris*
Burnet	*Poterium sanguisorba*
Clover, alsike	*Trifolium hydridum*
Grasses and Forage Crops	
Clover, Berseem	*Trifolium alexandrinum*
Clover, ladino	*Trifolium repens*
Clover, red	*Trifolium pratense*
Clover, strawberry	*Trifolium fragiferum*
Clover, white Dutch	*Trifolium repens*
Corn (forage) (maize)	*Zea mays*
Cowpea (forage)	*Vigna unguiculata*
Dallis grass	*Paspalum dilatatum*
Foxtail, meadow	*Alopecurus pratensis*
Grama, vlue	*Bouteloua gracilis*
Lovegrass	*Eragrostis sp.*
Milkvetch, Cicer	*Astragalus deer*
Oatgrass, tall	*Arrhenatherum, Danthonia*
Oats (forage)	*Avena saliva*
Orchard grass	*Dactylis glomerata*
Rye (forage)	*Secale cereale*
Sesbania	*Sesbania exaltata*
Siratro	*Macroptilium atropurpureum*
Sphaerophysa	*Spaerophysa salsula*

Timothy	*Phleum pratense*
Vetch, common	*Vicia angustifolia*
Vegetable Crops	
Broccoli	*Brassica oleracea botrytis*
Brussel sprouts	*B. oleracea gemmifera*
Cabbage	*B. oleracea capitata*
Cauliflower	*B. oleracea botrytis*
Celery	*Apium graveolens*
Corn, sweet	*Zea mays*
Cucumber	*Cucumis sativus*
Eggplant	*Solanum melongena esculentum*
Kale	*Brassica oleracea acephala*
Kohlrabi	*B. oleracea gongylode*
Lettuce	*Latuca sativa*
Muskmelon	*Cucumis melon*
Pepper	*Capsicum annum*
Potato	*Solanum tuberosum*
Pumpkin	*Cucurbita peop pepo*
Radish	*Raphanus sativus*
Spinach	*Spinacia oleracea*
Squash, scallop	*C. pepo melopepo*
Sweet potato	*Ipomoea batatas*
Tomato	*Lycopersicon lycopersicum*
Turnip	*Brassica rapa*
Watermelon	*Citrullus lanatus*
Fruit and Nut Crops	
Grape	*Vitis sp.*
Sensitive	
Fibre, Seed and Sugar Crops	
Bean	*Phaseolus vulgaris*
Guayule	*Parthenium argentatum*
Sesame	*Sesamum indicum*
Vegetable Crops	
Bean	*Phaseolus vulgaris*
Carrot	*Daucus carota*
Okra	*Abelmoschus esculentus*
Onion	*Allium cepa*
Parsnip	*Pastinaca sativa*
Fruit and Nut Crops	
Almond	*Prunus dulcis*
Apple	*Malus sylvestris*
Apricot	*Prunus armeniaca*
Avocado	*Persea americana*

Blackberry	*Rubus sp.*
Boysenberry	*Rubus ursinus*
Cherimoya	*Annona cherimola*
Cherry, sweet	*Prunus avium*
Cherry, sand	*Prunus besseyi*
Currant	*Ribes sp.*
Gooseberry	*Ribes sp.*
Grapefruit	*Citrus paradisi*
Lemon	*Citrus limon*
Lime	*Citrus aurantifolia*
Loquat	*Eriobotrya japonica*
Mango	*Mangifera indica*
Orange	*Citrus sinensis*
Passion fruit	*Passiflora edulis*
Peach	*Prunus persica*
Pear	*Pyrus communis*
Persimmon	*Diospyros virginiana*
Plum: Prune	*Prunus domestica*
Pummelo	*Citrus maxima*
Raspberry	*Rubus idaeus*
Rose apple	*Syzgium jambos*
Sapote, white	*Casimiroa edulis*
Strawberry	*Fragaria sp.*
Tangerine	*Citrus reticulata*

The concentration of specific ions in the treated water may cause trace elements to accumulate in the soil and plants, while long term build-up may potentially result in animal and human health impacts or phytotoxicity in plants. Of particular concern are sodium, chloride and boron ions, as they may be present in treated wastewaters in concentrations such as to cause toxicity. Toxicity normally results in impaired growth, reduced yields and changes the morphology of the plant.

⇩ Sodium

Then present in exchangeable form, sodium salts may cause adverse physico-chemical changes in the soil, particularly soil structure, lowering the permeability and affecting the tilth of the soil. Although sodium does not impair the uptake of water by the plants, it impairs the infiltration of water into the soil, thus affecting the growth of plants through the unavailability of soil water.

Cadmium and magnesium act as stabilising ions in contrast to the destabilising effect of sodium, regarding soil structure. However, treated water may be high in sodium relative to calcium and may cause soil permeability problems if not properly managed. Regular monitoring is required to ensure that adverse effects are avoided.

TABLE 5.15: RELATIVE TOLERANCE OF SELECTED CROPS TO EXCHANGEABLE SODIUM

Sensitive	Semi-tolerant	Tolerant
Avocado	Carrot	Alfalfa
(Persea americana)	*(Daucus carota)*	*(Medicago sativa)*
Deciduous Fruits	Clover, Ladino	Barley
Nuts	*(Trifolium repens)*	*(Hordeum vulgare)*
Bean, green	Dallisgrass	Beet, garden
(Phaseolus vulgaris)	*(Paspalum dilatatum)*	*(Beta vulgaris)*
Cotton (at germination)	Fescue, tall	Beet, sugar
(Gossypium hirsutum)	*(Festuca arundinacea)*	*(Beta vulgaris)*
Maize	Lettuce	Bermuda grass
(Zea mays)	*(Lactuca sativa)*	*(Cynodon dactylon)*
Peas	Bajara	Cotton
(Pisum sativum)	*(Pennisetum typhoides)*	*(Gossypium hirsutum)*
Grapefruit	Sugarcane	Paragrass
(Citrus paradisi)	*(Saccharum officinarum)*	*(Brachiaria mutica)*
Orange	Berseem	Rhodes grass
(Citrus sinensis)	*(Trifolium alexandrinum)*	*(Chloris gayana)*
Peach	Benji	Wheatgrass, crested
(Prunus persica)	*(Mililotus parviflora)*	*(Agropyron cristatum)*
Tangerine	Raya	Wheatgrass, fairway
(Citrus reticulata)	*(Brassica juncea)*	*(agropyron cristatum)*
Mung	Oat	Wheatgrass, tall
(Phaseolus aurus)	*(Avena sativa)*	*(Agropyron elongatum)*
Mash	Onion	Karnal grass
(Phaseolus mungo)	*(Allium cepa)*	*(Diplachna fusca)*
Lentil	Radish	
(Lens culinaris)	*(Raphanus sativus)*	
Groundnut (peanut)	Rice	
(Arachis hypogaea)	*(Oryza sativus)*	
Gram	Rye	
(Cicer arietinum)	*(Secale cereale)*	
Cowpeas	Ryegrass, Italian	
(Vigna sinensis)	*(Lolium multiflorum)*	
	Sorghum	
	(Sorghum vulgare)	
	Spinach	
	(Spinacia oleracea)	
	Tomato	
	(Lycopersicon esculentum)	
	Vetch	
	(Vicia sativa)	
	Wheat	
	(Triticum vulgare)	

⇩ Trace Elements and Heavy Metals

Trace elements are present in treated effluents normally in concentrations less than a few mg/L. Although some are essential for plants and animals, at elevated concentrations they become toxic. Trace elements include aluminium (Al), beryllium (Be), cobalt (Co), fluoride (F), iron (Fe), lithium (Li), manganese (Mn), molybdenum (Mo), selenium (Se), tin (Su), titanium (Ti), Tungsten (W) and Vanadium (V).

Heavy metals are a group of trace elements that have been shown to create health impacts when taken up by plants. These include arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg) and zinc (Zn). Of particular concern are cadmium, copper and molybdenum as they can be toxic to animals at concentrations too low to affect plants.

⇩ Chlorine

Free chlorine residual at concentrations less than 1 mg/L usually poses no problems to plants. However, some sensitive crops may be damaged at levels as low as 0.05 mg/L, while some woody crops may accumulate chlorine in the tissue to toxic levels. Chlorine at concentrations greater than 5 mg/L causes sever damage to most plants.

TABLE 5.16: CHLORIDE TOLERANCE OF SOME FRUIT CROP CULTIVARS AND ROOTSTOCKS

Crop	Rootstock or Cultivar	Maximum permissible Cl^- without leaf injury[1]	
		Root zone (Cl_e) (me/l)	Irrigation water (Cl_w)[2 3] (me/l)
	Rootstocks		
Avocado *(Persea americana)*	West Indian	7.5	5.0
	Guatemalan	6.0	4.0
	Mexican	5.0	3.3
Citrus *(Citrus spp.)*	Sunki Mandarin	25.0	16.6
	Grapefruit		
	Cleopatra mandarin		
	Rangpur lime		
	Sampson tangelo	15.0	10.0
	Rough lemon		
	Sour orange		
	Ponkan mandarin		
	Citrumelo 4475	10.0	6.7
	Trifoliate orange		
	Cuban shaddock		
	Calamondin		
	Sweet orange		
	Savage citrange		
	Rusk citrange		
	Troyer citrange		
Grape*(Vitis spp.)*	Salt Creek, 1613-3	40.0	27.0
	Dog Ridge	30.0	20.0
Stone Fruits *(Prunus spp.)*	Marianna	25.0	17.0
	Lovell, Shalil	10.0	6.7
	Yunnan	7.5	5.0

	Cultivars		
Berries *(Rubus spp.)*	Boysenberry	10.0	6.7
	Olallie clackberry	10.0	6.7
	Indian SUmmer	5.0	3.3
	Raspberry		
Grape*(Vitis spp.)*	Thompson seedless	20.0	13.3
	Perlette	20.0	13.3
	Cardinal	10.0	6.7
	Black Rose	10.0	6.7
Strawberry *(Fragaria spp.)*	Lassen	7.5	5.0
	Shasta	5.0	3.3

[1] For some crops, the concentration given may exceed the overall salinity tolerance of that crop and cause some reduction in yield in addition to that caused by chloride ion toxicities.
[2] Values given are for the maximum concentration in the irrigation water. The values were derived from saturation extract data (EC_e) assuming a 15-20 percent leaching fraction and $EC_d = 1.5\ EC_w$.
[3] The maximum permissible values apply only to surface irrigated crops. Sprinkler irrigation may cause excessive leaf bum at values far below these.

TABLE 5.17: RELATIVE BORON TOLERANCE OF AGRICULTURAL CROPS[1]

Very Sensitive (<0.5 mg/l)	
Lemon	*Citrus limon*
Blackberry	*Rubus spp.*
Sensitive (0.5-0.75 mg/l)	
Avocado	*Persea americana*
Grapefruit	*Citrus X paradisi*
Orange	*Citrus sinensis*
Apricot	*Prunus armeniaca*
Peach	*Prunus persica*
Cherry	*Prunus avium*
Plum	*Prunus domestica*
Persimmon	*Diospyros kaki*
Fig, kadota	*Ficus carica*
Grape	*Vitis vinifera*
Walnut	*Juglans regia*
Pecan	*Carya illinoiensis*
Cowpea	*Vigna unguiculata*
Onion	*Allium cepa*
Sensitive (0.75-1.0 mg/l)	
Garlic	*Allium sativum*
Sweet potato	*Ipomoea batatas*
Wheat	*Triticum eastivum*
Barley	*Hordeum vulgare*
Sunflower	*Helianthus annuus*
Bean, mung	*Vigna radiata*
Sesame	*Sesamum indicum*

Lupine	*Lupinus hartwegii*
Strawberry	*Fragaria spp.*
Artichoke, Jerusalem	*Helianthus tuberosus*
Bean, kidney	*Phaseolus vulgaris*
Bean, lima	*Phaseolus lunatus*
Groundnut/Peanut	*Arachis hypogaea*
Moderately Sensitive (1.0-2.0 mg/l)	
Pepper, red	*Capsicum annuum*
Pea	*Pisum sativa*
Carrot	*Daucus carota*
Radish	*Raphanus sativus*
Potato	*Solanum tuberosum*
Cucumber	*Cucumis sativus*
Moderately Tolerant (2.0-4.0 mg/l)	
Lettuce	*Lactuca sativa*
Cabbage	*B. oleracea capitata*
Celery	*Apium graveolens*
Turnip	*Brassica rapa*
Bluegrass, Kentucky	*Poa pratensis*
Oats	*Avena sativa*
Maize	*Zea mays*
Artichoke	*Cynara scolymus*
Tobacco	*Nicotiana tabacum*
Mustard	*Brassica juncea*
Clover, sweet	*Melilotus indica*
Squash	*Cucurbita pepo*
Muskmelon	*Cucumis melo*
Tolerant (4.0-6.0 mg/l)	
Sorghum	*Sorghum bicolor*
Tomato	*L. lycopersicum*
Alfalfa	*Medicago sativa*
Vetch, purple	*Vicia benghalensis*
Parsley	*Petroselinum crispum*
Beet, red	*Beta vulgaris*
Sugarbeet	*Beta vulgaris*
Very Tolerant (6.0-15.0 mg/l)	
Cotton	*Gossypium hirsutum*
Asparagus	*Asparagus officinalis*

[1] Maximum concentrations tolerated in soil water without yield or vegetative growth reductions. Boron tolerances vary depending upon climate, soil conditions and crop varieties. Maximum concentrations in the irrigation water are approximately equal to these values or slightly less.

- Nutrients

Treated sewage effluents contain nutrients important for crop growth. The most beneficial nutrient is nitrogen, however, the concentrations in treated water are not sufficient enough to produce satisfactory crop yields and supplementary fertiliser is necessary. Similarly, the concentrations of phosphorus are usually too low to meet plant requirements, yet over time it can build-up in the soil and reduce the need for phosphorus supplementation.

- REUSE MANAGEMENT PLAN

In consideration of the above, the reuse management plan must be based on a combination of criteria.

⇩ Site Selection

The objective is the identification of suitable sites for reuse, in case reuse will be in areas outside the Irrigation Scheme, where the long term application of the treated effluent will be feasible without adverse environmental or health impacts.

⇩ Crop Water Requirements

Assessment of the specific crop water demands to estimate the required amounts of water to be applied and the resulting total land requirements for reuse. Information on crop water demand and indicative land requirements for the irrigation of specific crops are given in Appendix 9.

⇩ Crop Selection

An evaluation must be made of viable combinations of the cropping options possible on the land available, taking into consideration crop sensitivity to specific effluent constituents, as outlined above, in conjunction with a selection of types of crops to be irrigated to eliminate the risk of adverse health impacts. Based on the suggested treated effluent quality standards, the irrigation of all crops is possible, with the exception of leaved vegetables, bulbs and corms eaten uncooked (Code of Practice).

⇩ Irrigation Methods

Appropriate irrigation methods must be identified, based on the types of crops to be irrigated and the site specific characteristics, such as soil type and structure.

CROP TYPE	IRRIGATION METHODS
Vines	⇩ Drip irrigation ⇩ Mini sprinklers and sprinklers ⇩ *Movable irrigation systems are not allowed*
Fruit trees	⇩ Drip irrigation ⇩ Hose basin irrigation ⇩ Bubblers irrigation ⇩ Mini sprinklers
Vegetables	⇩ Subsurface irrigation ⇩ Drip irrigation
Vegetables eaten cooked	⇩ Sprinklers ⇩ Subsurface irrigation ⇩ Drip irrigation
Industrial and fodder crops	⇩ Subsurface irrigation ⇩ Bubblers ⇩ Drip irrigation ⇩ Pop-up sprinklers ⇩ Surface irrigation methods ⇩ Low capacity sprinklers

	⇩ Spray or sprinkler irrigation with a buffer zone of about 300 m

⇩ Irrigation Scheduling

This encompasses timing and quantity determination on two levels:
- ⇨ Timing of application prior to harvesting
- ⇨ Ensuring that the loading rates of water, nutrients and salts are balanced with a site's ability to safely convert, absorb, use or store the nutrients and salts over the long term.

⇩ Nutrient Loading Rates

The nutrient balance must be determined to ensure that nutrients are applied at an optimal rate and load for each specific crop.
- ⇨ Nitrogen: The nitrogen loading rate must be balanced annually with the crop requirements to prevent excessive nitrogen leaching to groundwater.
- ⇨ Phosphorus: The loading rates must be determined to prevent phosphorus leaching to groundwater or accumulation in the surface layers of soils.

⇩ Salt Loading Rates

A salt balance must be undertaken so as to limit its potential to contaminate groundwater and affect soil productivity.

Overall, the performance objectives of the Reuse Management Plan will include:
- ⇨ The optimisation of water and nutrient uptake by plants
- ⇨ The prevention of adverse changes to soil structure, chemistry and therefore productivity
- ⇨ The prevention of adverse environmental and health impacts.

5.2.6.6. MITIGATION MEASURES FOR THE REUSE OF THE TREATED EFFLUENTS IN AGRICULTURE

MITIGATION MEASURES FOR THE REUSE OF THE TREATED EFFLUENTS FOR IRRIGATION
❑ Impacts on soil productivity; groundwater contamination; health impacts; impacts on crop growth and quality
⇨ Drafting of Reuse Management Plan, incorporating:
⇩ Appropriate site identification (for reuse in areas outside the Irrigation Scheme) ⇩ Crop water requirements ⇩ Crop selection ⇩ Irrigation methods and scheduling ⇩ Evaluation of nutrient and salt loading rates
❑ Nitrogen leaching to groundwater, accumulation in soil
⇨ Balance nitrogen loading rates with crop requirements
❑ Phosphorus leaching to groundwater, accumulation in soil
⇨ Balance phosphorus loading rates with crop requirements
❑ Adverse impacts on soil productivity and risk of groundwater contamination
⇨ Determine salt loading rates
⇨ Ensure irrigation practices do not result in off-site run-off, appropriate leaching and drainage provisions
❑ Adverse impacts on crop yields and quality
⇨ Crop selection based on crop sensitivity to treated effluent constituents
❑ Adverse impacts on health

MITIGATION MEASURES FOR THE REUSE OF THE TREATED EFFLUENTS FOR IRRIGATION
⇨ Timing of irrigation prior to harvesting
⇨ Correct irrigation practices
⇨ Minimise site access during irrigation periods
⇨ Use of signs specifying that treated effluent is used
⇨ Establishment of buffer zones around irrigated areas where necessary
❑ Quality considerations
⇨ Implementation of treated effluent quality monitoring programme to ensure compliance with the set standards
⇨ Implementation of soil quality monitoring programme
⇨ Implementation of monitoring programme for the application rates of heavy metals, nutrients and salts
⇨ Monitoring of irrigation methods and practices

5.2.6.7. URBAN REUSE OF THE TREATED EFFLUENTS

The treated sewage effluents can be reused for the irrigation of public parks and recreation centres, hotel gardens, athletic fields, highway medians and shoulders, landscaped areas surrounding public buildings and facilities, or commercial office and industrial developments, golf courses, decorative water features (e.g. fountains), sanitary facilities in commercial buildings, dust control and concrete production in construction activities, etc.

In the case of urban reuse of the treated effluent system reliability must be ensured regarding the quality of the treated effluent, so as to avoid any adverse public health impacts. Additionally, a number of safeguards must be adopted, including:

- ⇨ Assurance that the treated water delivered meets the quality requirements for the intended uses
- ⇨ Prevention of improper operation of the system through regular monitoring and maintenance
- ⇨ Prevention of improper use of the water through a clear labeling of any pipes conveying treated effluent and of areas irrigated with such water
- ⇨ Prevention of cross connections with drinking water supply lines.

5.2.6.8. GROUNDWATER RECHARGE

The treated sewage effluents can alternatively be used indirectly for agricultural purposes through the recharge of groundwater aquifers. Apart from providing an additional supply of water in aquifers that are currently over-pumped and in danger of depletion, recharge can offer a number of additional advantages:

- ⇩ Provision of further treatment of effluents: Infiltration and percolation of the treated water takes advantage of the sub-soil's natural ability for biodegradation and filtration, thus providing additional in situ treatment of the wastewater and additional treatment reliability to the overall system.
- ⇩ Provision of storage for the treated effluent: Groundwater aquifers provide a natural mechanism for storage and subsurface transmission of the treated wastewater. Groundwater recharge eliminates the need for additional storage facilities. Aquifers also serve as a natural distribution system and may reduce the need for surface conveyance systems.
- ⇩ Groundwater recharge helps provide a loss of identity between the treated effluents and groundwater. This has a positive psychological impact where reuse is considered, particularly for irrigation purposes, and is an important factor in making reclaimed water acceptable for a variety of uses.

- INFILTRATION BASINS

Surface spreading is a direct method of recharge, whereby the water moves from the land surface to the aquifer by infiltration and percolation through the soil matrix.

Infiltration basins are the most widely used method of groundwater recharge, affording high loading rates, and relatively low maintenance and land requirements. Rapid infiltration basins require highly permeable soil to achieve high hydraulic loading rates. For additional treatment, the soil must be fine enough to provide sufficient soil surfaces for biochemical and microbiological reactions.

- DIRECT INJECTION

This involves the pumping of the treated effluent directly into the groundwater zone. This is used where groundwater is deep or where the hydrogeological conditions are not conducive to surface spreading, including unsuitable soils of low permeability, unfavourable topography for construction of basins, or scarcity of land.

Direct injection requires water of higher quality that surface spreading because of the absence of the soil matrix treatment.

Groundwater recharge may increase the risk of aquifer contamination, particularly in the case of direct injection, therefore a monitoring programme is required regarding the quality of the treated effluents to be recharged, as well as the quality of the groundwater, to ensure that any impacts are avoided.

6. PROJECT ALTERNATIVES

6.1. ALTERNATIVE SEWAGE TREATMENT METHODS

In order to achieve the suggested discharge standards, the requirements for the treatment process are high. The discharge standards are stringent and therefore the treatment process needs to be highly performing on a wide range of parameters. In addition to these requirements purely related to process performances, further requirements related to the protection of the area, the architectural insertion and the limited space available should be met depending on the location of the site. A number of processes have been examined including:

- Activated sludge
- Trickling filters
- Bio aerated filters:
- Membrane bio reactors
- Stabilization ponds
- Anaerobic reactors

6.1.1. ACTIVATED SLUDGE PROCESS

The activated-sludge process is one of the most common treatment processes and is currently in operation in three of the main treatment plants in Cyprus (Paralimni, Limassol and Larnaca). The process can be designed in many modified forms, including: selection of the reactor type, oxygen requirements and transfer, and types of settling tanks, but fundamentally the theoretical aspects of the process are similar:

- Wastewater is introduced into a reactor (aeration basin) where an aerobic bacterial culture is maintained in suspension. The reactor contents are referred to as the “mixed liquor”. In the reactor, the bacterial culture carries out the conversion of the organic matter into biological solids (biological cells).
- The aerobic environment in the reactor is achieved by the use of diffused or mechanical aeration, which also serves to maintain the mixed liquor in a completely mixed regime.
- After a specific period of time, the mixture of biological solids is passed into a settling tank, where some of the settled sludge is recycled to maintain the desired concentration of organisms in the reactor and the remainder is removed from the system.
- The level at which the biological mass in the reactor should be kept (mean cell - residence time) depends on the desired treatment efficiency and other considerations, including the nature of the wastewater, and the local environmental conditions.

Different parameters can be used for the design of the activated-sludge process:

- The food to micro-organism ratio or mass loading defined as the mass of BOD applied per day to the treatment system divided by the mass of mixed liquor suspended solids (MLSS) in the aeration tank.
- The mean cell-residence time or sludge age that is the ratio of the mass of MSS in the aeration tank to the mass of sludge removed per day from the system.
- The volume loading defined as the mass of BOD applied per day to the treatment system divided by the aeration tank volume.

The activated sludge process was initially designed for removal of dissolved organic pollution (expressed as BOD, COD and SS), where removal rates up to 90%-95% can be expected depending on the design parameters. In the later years, the removal of nitrogen by biological nitrification and denitrification has been largely developed, requiring an increase of the sludge age in the tank and specific mixing, aeration and recycling arrangements. It has also been shown that biological phosphorus reduction can be achieved if an anaerobic tank is added at the inlet of the biological reactor and this development is now gaining more and more interest. Aeration equipment for injecting oxygen into the MLSS can consist of mechanical aerators or diffused air systems that blow air into the MLSS. Final settling tanks are used to separate the biological solids produced in activated sludge from the treated wastewater. Settling tanks are mainly designed on the basis of an overflow rate. Overflow rates may range from 0.5 to 0.7 m/h at peak flows.

It should be pointed out that an activated-sludge process does not provide any significant reduction in coliform counts (only a factor 10 to 100). Where coliform reduction is required, as the case is here, a tertiary treatment should be added to the treatment train, most often consisting in sand filtration and disinfection by chlorine or UV radiation.

Provided with tertiary treatment, the activated sludge process would meet the set performance requirements. However, due to the space requirements, the process could be difficult to locate where little land is available and leads to high costs if the plant should be covered and odour treated.

In the case of the Astromeritis sewage treatment plant where the available land is sufficient to satisfy the area requirements, the activated sludge method is proposed as the appropriate treatment process.

6.1.2. TRICKLING FILTERS

The tricking filter consists of a bed of a highly permeable medium to which micro-organisms are attached and through which wastewater is percolated or trickled. The filter medium consisted in the past of carefully graded rock. Rock has been replaced by synthetic medium (plastic essentially) in the recent trickling filters. Plastic medium offers better specific surface area (surface area per unit of volume of the medium) and air circulation than the rock medium. Another advantage of the plastic medium is the best resistance to plugging due to its important void space and the lower mass to unit volume enabling lower surface area than for the rock medium. In terms of efficiency, operation and maintenance, the plastic medium has the best advantages and has to be recommended, although rock medium has the advantage of low cost.

In comparison with activated-sludge process, trickling filters have the following disadvantages:

- important transportation costs of the specific medium filter, that has to be imported,
- necessity of a primary sedimentation, in order to avoid nozzle plugging of the rotary distributor that causes reduced performance,
- problems of odours and flies especially during the summer,
- the flow of air in a trickling filter is governed by the temperature difference and wind forces. During the summer, when the temperature is hot and wind is weak, airflow could be decreased and problems of odours and flies increased.

The trickling filters are particularly adapted where the incoming wastewater is concentrated and where the discharge requirements are not too strict. But for our case, several additional steps of treatment would be required to treat nitrogen, to further reduce BOD and SS and to reduce the coliform count. The trickling filter process is therefore not recommended for the treatment plants in this project.

6.1.3. BIO AERATED FILTERS

The bio aerated filter technology is an attached growth process, i.e. the purifying biomass is attached on a substrate (the contrary is the suspended growth process, e.g. activated sludge, where the biomass is kept in suspension in the biological reactor). In a biofilter, the substrate consists in grains with size in the range 1 to 4 mm with a high specific favourable to bacterial development. This material combines the functions of biological reactor and solid-liquid separation and therefore, no additional sedimentation tank is required.

The result of progress made during the last decade is that today, bio filtration has become a particularly advantageous treatment process. In municipal wastewater treatment, it makes it possible to carry out secondary biological treatment (removal of BOD and nitrogen) and retention of the SS at the same time.

The biofiltration process uses biomass of greater concentration and, above all, of greater activity than activated sludge and have the following advantages:

- savings in land space, particularly due to elimination of the secondary clarifier stage. This compactness makes it easier to cover units, control harmful effects (odours and sound) and produce aesthetic units,
- no risk of leaching since the biomass is attached to a support such that flow variations can be readily handled,
- quick restarting, even after stopping for several months, and therefore suitable to seasonal variations in load,
- modular construction and easy automation.

The filtration could be either upflow or downflow depending on the supplier.

The biofiltration is normally used after primary settling or flotation (these steps can be preceded by flocculation).

The process provides a high degree of treatment of BOD and SS and can also perform nitrification-denitrification to desired level. However, as most intense biological processes, the faecal coliform reduction is low and the process needs to be completed by tertiary disinfection to provide a quality required for reuse.

6.1.4. MEMBRANE BIO REACTORS

The development of submerged membrane bioreactor technology started in the 1980s and there are today several thousands of facilities implemented around the world. The membrane bioreactor technology combines a biological treatment of pollutants (BOD, N, P) with a membrane separation of the biomass and the treated water. The biological treatment used is an activated sludge process with high sludge concentration. The solid-liquid separation is carried out by microfiltration (MF) membranes, which most often are submerged directly in the aeration tank. Depending on suppliers, either flat sheet membranes, hollow fibre membranes or tubular membranes are used.

The most visible advantage with a membrane bioreactor, compared with an activated sludge plant, is the reduced footprint. This is due to, on one hand, that there is no more need for sedimentation tanks. The biological reactor is also operated at much higher MLVSS concentrations (in the range of 12 to 15 g/l) and the reactor can therefore be smaller.The process is therefore very well adapted where the site is small and the plant needs to be covered in order to reduce odour and noise problems. Due to the high sludge age, the production of sludge is reduced. Some sources indicate a reduction of up to 40% compared with an activated sludge process. The high sludge age also favours biological nitrification. The microfiltration membranes have a pore size in the range of 0.1 to 0.4 microns, which retains suspended solids and some bacteria but not macro-molecules and virus. However, experience show that the membranes are rapidly covered by a layer of cellular material which enhances the filtration performances.

The replacement of membranes is an important item in the operating cost budget. Nevertheless, membranes are today guaranteed by the suppliers for at least 5 years operation and could in many cases operate for more than 10 years.

The capital cost for a membrane bioreactor plant is higher than a conventional activated sludge plant, when only BOD and SS reduction to "normal' level (25-30 mg/l) is imposed. But when reuse of the treated effluent is planned and treatment requirements are tougher, including coliform reduction, then the membrane bioreactor becomes competitive.

6.1.5. STABILIZATION PONDS

Aerobic stabilisation lagoons are large, shallow earthen basins of wastewater where the treatment is provided by natural processes involving the use of both algae and bacteria. Natural aeration processes are used to supply some or all of the oxygen needed by the bacteria to metabolise organic matter and reduce the BOD. Stabilisation lagoons have become very popular in small communities, because they are simple and economical to operate, requiring minimal operation and maintenance, namely one sludge removal of the primary lagoon once every two to three years and one sludge removal of the secondary lagoon once every five years.

Aerobic lagoons are designed with a maximum depth of 1.5 m. A large surface area is then required to maximise the natural aeration capacity of the system. The rate of surface area may range from 6 to 10 m²/inhabitant, depending on the variation of water temperature. This area requirement includes only the lagoons themselves, with no allowance for access roads or other facilities. With a maximum depth of 1.5 m, the retention time is about 60 days, which is the minimum required to achieve a significant reduction in coliform counts (reduction of about 10^4).

The process would be expected to meet the discharge requirements regarding coliforms and, with addition of tertiary sand filters, the requirements for SS and possibly BOD. The standards for nitrogen would probably not be met. However, the most significant disadvantage is the large size of the plants, and stabilisation ponds are therefore not retained in this case.

6.1.6. ANAEROBIC REACTORS

Anaerobic reactors, of UASB type, represent a simple and reliable solution with low operating costs. This technology, which has been much developed during the latest decade, is much used for industrial pre-treatment, for initial reduction of the organic pollution of strong wastewater. However, its use for treatment of urban wastewater is not very widespread, in particular not for large size plants. The current discharge standards for BOD (10 mg/l) are largely below the expected performance limits of the process (50 mg/l at the best). This process is therefore not further considered.

6.1.7. COMPARISON OF PROCESSES

A number of these processes have been eliminated at an early stage as they cannot meet the requirements and the remaining processes have been compared in more detail. Table 6.1 summarises the advantages and disadvantages of these processes.

TABLE 6.1: COMPARISON OF TREATMENT PROCESSES

PROCESS	ADVANTAGES	DISADVANTAGES
Activated sludge	❑ Proven and reliable process. ❑ Stable performances at variations in hydraulic load. ❑ Moderate cost for the base process.	❑ Additional tertiary treatment required to meet treatment requirements. ❑ High sludge production. ❑ Relatively high land requirements. ❑ Large basins, difficult to cover. ❑ Long start-up of the biological process, can not treat peak loads.

Bio aerated filters	❑ Compact process, easy to cover. ❑ Modular design makes easy to adapt the process to incoming loads and flows. ❑ Quick restarting, therefore suitable to seasonal variations in load. ❑ Modular construction and easy automation.	❑ Additional tertiary treatment required to meet treatment requirements. ❑ High sludge production. ❑ Higher investment costs than for activated sludge (~30%)
Membrane bioreactors	❑ Very high treatment performances, also on faecal coliforms. ❑ No chlorination or UV disinfection required. ❑ Low sludge production. ❑ Compact process, easy to cover. ❑ Modular construction and easy automation.	❑ Some uncertainty regarding the membrane life length and related replacement cost. ❑ Higher investment costs.

The three processes can provide treatment to the level required for discharge and reuse according to current regulations. However, for the purpose of the study, the activated sludge process with tertiary treatment will be retained as base solution for sewage treatment.

6.2. SCREENING OF OPTIONS AND ALTERNATIVES

6.2.1. ALTERNATIVE SCHEMES

6.2.1.1. PRELIMINARY SELECTION OF ALTERNATIVE SCHEMES

Five alternative schemes were examined initially based on a different number of STPs, locations and conveyance routes. These are outlined in Table 6.2.

TABLE 6.2: ALTERNATIVE SCHEMES

SCHEME	STP LOCATION	CONVEYANCE SYSTEM
A1a	One single STP – near Astromeritis	Kokkinotrimithia and Palaiometocho are connected East of Akaki, from where wastewaters are conveyed through Akaki, Peristerona and Astromeritis towards STP located West of Astromeritis.
A1b	One single STP – Existing Anthoupolis STP	Conveyance pipeline goes from Astromeritis, through Peristerona, Akaki and Palaiometocho where it is connected with the pipe transferring sewage from Kokkinotrimithia. From that point wastewater goes towards STP Anthoupolis.
A2a	Two STPs – one near Astromeritis and one in Palaiometocho	The waste water from Astromeritis and Peristerona are conveyed to the STP located West of Astromeritis. Sewage from Akaki, Kokkinotrimithia and Palaiometocho is transferred towards STP located West of

SCHEME	STP LOCATION	CONVEYANCE SYSTEM
		Kokkinotrimithia, within the boundaries of Palaiometocho community
A2b	Two STPs – one existing Anthoupolis STP and one near Astromeritis	The waste water from Astromeritis, Peristerona and Akaki are conveyed to the STP located West of Astromeritis. Sewage from Kokkinotrimithia and Palaiometocho is conveyed towards existing Anthoupolis STP.
A5	Five STP – in each community	Each community has its own STP

Schematic presentations of the schemes are included in Appendix 10.

In the case of the Anthoupolis sewage treatment plant, a new plant will be constructed at the site, which will replace the existing installations. The communities of Kokkinotrimithia and Palaiometocho are already included in the design of the new unit.

6.2.1.2. BRIEF DESCRIPTION OF THE COMPONENTS OF THE ALTERNATIVE SCHEMES

⇩ SCHEME A1A

Scheme A1a is a scheme with one single Sewerage treatment plant located West of Astromeritis.

All communities are connected to the STP Astromeritis. Waste water from Kokkinotrimithia is pumped towards connection with the gravity pipe from Paliometocho From this connection water is conveyed partly by pumping and partly by gravity towards Akaki. From Akaki water is conveyed by gravity with a short forcemain part to Peristerona. Conveyance pipe between Peristerona and Astromeritis is gravity pipe, while from this point on wastewater has to be pumped to the location of STP.

The main components of the system are:

⇨ Gravity pipes	Total length of gravity pipes is 12.6 km with the diameter from 200mm to 350 mm.
⇨ Forcemains	Length of forcemains is 8.7km with the diameter from 150mm to 250mm
⇨ Pumping stations	Four pumping stations are estimated with the discharge capacity varying from 10.0 l/s to 43.0 l/s and installed power from 2 kW to 22 kW.
⇨ Sewage treatment plant	Location of STP is west of Astromeritis, with the nominal capacity of 3 630 m3/d. Required area for STP and emergency storage is 1.6 ha.

⇩ SCHEME A1B

Scheme A1b is a scheme with one single Sewerage treatment plant for all the communities, STP Anthoupolis.

All communities are connected to the STP Anthoupolis. Wastewater from Astromeritis is pumped towards Peristerona. Connection between Peristerona and Akaki is partly forcemain and partly by gravity. From Akaki to Palaiometocho water is mainly conveyed by gravity with a short forcemain. Connection of Kokkinotrimithia and Palaiometocho is forcemain. From Palaiometocho wastewater is conveyed towards STP Anthoupolis partly by gravity and partly by forcemains.

The main components of the system are:

⇨ Gravity pipes	Total length of gravity pipes is 9.0 km with the diameter from 200mm to 400 mm.
⇨ Forcemains	Length of forcemains is 18.2 km with the diameter from 125 mm to 200 mm
⇨ Pumping stations	Six pumping stations are estimated with the discharge capacity varying from 7.0 l/s to 43.0 l/s and installed power from 3 kW to 38 kW.
⇨ Sewage treatment plant	Location of STP is on the location of existing Anthoupolis STP, with the nominal capacity of 3 630 m3/d. Required area for STP and emergency storage is 1.6 ha.

⇩ SCHEME A2A

Scheme A2a is a scheme with two Sewerage treatment plants, one near Astromeritis and one within the boundaries of Palaiometocho community, west of Kokkinotrimithia.

Waste water from Peristerona is transferred by gravity towards Astromeritis. From this point on water is pumped to the STP Astromeritis. Sewage from Palaiometocho is conveyed by gravity pipe to the connection point where the forcemain from Kokkinotrimithia is connected. Wastewater from Akaki is transferred to the same connection and the pipe is partly forcemain and partly gravity. From this connection point there is a short forcemain to the STP within the area of Palaiometocho community.

The main components of the system are:

⇨ Gravity pipes	Total length of gravity pipes is 9.1 km with the diameter from 150 mm to 200 mm.
⇨ Forcemains	Length of forcemains is 7.9 km with the diameter from 150 mm to 200 mm
⇨ Pumping stations	Four pumping stations are estimated with the discharge capacity varying from 7.0 l/s to 30.0 l/s and installed power from 2 kW to 7.0 kW.
⇨ Sewage treatment plants	⇩ STP Astromeritis is with the nominal capacity of 1 080 m3/d.Required area for STP and emergency storage is 0.6 ha. ⇩ Location of the second STP is within the boundaries of Palaiometocho. The nominal capacity of the second STP is 2 550 m3/d, while the required area for STP and emergency storage is 1.0ha.

⇩ SCHEME A2B

Scheme A2b is a scheme with two Sewerage treatment plants, one STP Anthoupolis and one near Astromeritis.

Conveyance from Akaki to Peristerona is mainly by gravity with a short forcemain. From Peristerona wastewater is transferred by gravity to Astromeritis and the pumped towards STP Astromeritis. The other treatment plant Anthoupolis will serve communities of Kokkinotrimithia and Palaiometocho. Wastewater from Kokkinotrimithia is pumped to Palaiometocho. Connection from Palaiometocho and STP is partly by gravity and partly forcemain.

The main components of the system are:

⇨ Gravity pipes	Total length of gravity pipes is 11.3 km with the diameter from 200 mm to 300 mm.
⇨ Forcemains	Length of forcemains is 12.2 km with the diameter from 125 mm to 200 mm
⇨ Pumping stations	Five pumping stations are estimated with the discharge capacity varying from 7.0 l/s to 22.0 l/s and installed power from 2 kW to 20.0 kW.
⇨ Sewage treatment plants	⇩ STP Anthoupolis on the location of existing treatment plant is with the nominal capacity of 1 910 m3/d.Required area for STP and emergency storage is 0.85 ha. ⇩ Location of the second STP is west of Astromeritis with the nominal capacity is 1 720 m3/d, while the required area for STP and emergency

	storage is 0.75 ha.

⇩ SCHEME A5

Scheme A5 is a scheme with the Sewerage treatment plant for each community. There are five sewerage treatment plants and the connection of each municipality to the treatment plant is assumed to be part of the collection system.

The location of STPs is predicted to be at the lowest area of the community. The nominal capacities of the treatment plants are as follows:

COMMUNITY	TREATMENT PLANT CAPACITY
Astromeritis	593 m^3/day
Peristerona	488 m^3/day
Akaki	639 m^3/day
Kokkinotrimithia	846 m^3/day
Palaiometocho	1 065 m^3/day

6.2.2. ALTERNATIVE SITES FOR THE SEWAGE TREATMENT PLANTS

A number of alternative sites have been examined for the construction of the sewage treatment plants that will service the communities of the project, including 3 sites in Astromeritis, for Schemes A1a and A2a; one site in Palaiometocho, for Scheme A2a; as well as the possibility of the existing Anthoupolis sewage treatment plant, for Schemes A1b and A2b. The results of the preliminary evaluation of these alternative sites are included in Appendix 11.

The alternative sites for the sewage treatment plants were selected at a preliminary level based on the following criteria:

- Location at a low point so as to reduce the needs for pumping installations for the conveyance of the wastewaters.
- Position at the barycentre of the group of communities in order to reduce the length of the wastewater conveyance pipes.
- Environmental criteria, including distance from residential areas, land uses, etc.
- Existing storage options in the area for the treated effluents, like dams or suitable geological formations for the easy construction of a reservoir.

6.2.2.1. ALTERNATIVE 1: NEAR ASTROMERITIS

Schemes A1a, A2a and A2b include the construction of a STP near the village of Astromeritis to service either all (A1a) or some (A2a, A2b) of the communities in the Nicosia (Group A) area. Three alternative sites have been selected for the construction of the plant.

⇩ ALTERNATIVE SITE 1(A): SOUTHWEST OF ASTROMERITIS

The first alternative site which has been selected is at a distance of approximately 1.0 km from the boundary of the residential zone of the Astromeritis village, to the southwest. The distance of the proposed location from housing areas is sufficient so as to ensure that there will be no adverse impacts as a result of noise or odours on the resident population.

The main advantage of this location is its nature and geomorphology, which are due to the fact that in the past the site was a quarry for the extraction of gravel and which has been recently been abandoned without any rehabilitation measures following completion. The operation permit for the quarry has now been renewed, but only for a short period. Geologically the area is in the form of a crater, which would allow for the easy construction of the long term storage reservoir that is required for the plant.

Regarding land use, the area of the quarry consists of barren land. In terms of land cover and land use, the area of the old quarry consists of barren land. Outside the quarry, the surrounding area is mostly agricultural land with some barren plots. Although some of this agricultural land might need to be acquired for the construction of the STP, the construction of the long term storage reservoir would result in no significant impacts as the site of the quarry is barren. The only negative impact on the land use in the area from the construction of the long term storage reservoir will be the closure of the quarry, nevertheless its future operation is currently questionable since the permit extends only for a few months.

Regarding landscape and visual impacts, these are expected to be limited. The landscape at the site has already been degraded as a result of the past quarrying activities. Visual impacts will also be limited as the site is largely hidden from views and is not visible from the main road or any residential or recreational areas. Lastly, no ecological impacts are anticipated as the area is not an environmentally sensitive one.

⇩ ALTERNATIVE SITE 1(B): WEST OF ASTROMERITIS

The second location that has been examined near Astromeritis is to the west of the community, at a distance of approximately 0.7 km from the boundary of the residential zone. The main disadvantage of the location is that it is within the buffer zone and approval is required from the United Nations for the construction of the sewage treatment plant.

A significant advantage of this location is its nature and geomorphology since in the past the area was a quarry, which has been abandoned without any rehabilitation following closure. The difference with this site as compared with the previous alternative is that the area is considerably larger and can satisfy all the area requirements for the construction of the sewage treatment plant. Additionally, because of this, the area is significantly degraded. Geologically the site, which is in the form of a crater, would allow for the easy construction of the long term storage reservoir that is required for the treated effluent.

Regarding land use, the area of the quarry consists of barren land. The surrounding area is agricultural land, part of which may be used for the construction of the sewage treatment plant.

The impacts on the landscape of the area are expected to be limited since this has already been degraded as a result of the presence of the quarry. Visually there may be some impacts if the plant is constructed outside the area of the quarry as it would then be visible from the main Troodos road.

⇩ ALTERNATIVE SITE 1(C): NORTHWEST OF ASTROMERITIS

The third alternative location that has been examined near Astromeritis is to the northwest of the community, at a distance of approximately 0.7 km from the boundary of the residential zone. The main disadvantage of this location, as in the previous case, is that it is within the buffer zone and the approval of the United Nations is required for the construction of the sewage treatment plant.

Another disadvantage of this site is that the area consists of agricultural land and as a consequence the construction of the plant and the storage reservoirs would result in adverse impacts on land use and the destruction of cultivations. Additionally, there are no suitable geological formations for the construction of the long term storage reservoir.

The construction of the sewage treatment plant is expected to result in negative impacts on the landscape since the area is flat and undeveloped. Furthermore, the plant will be visible from the residential area.

6.2.2.2. ALTERNATIVE 2: NEAR PALAIOMETOCHO

The second STP included in Scheme A2a is between Akaki and Kokkinotrimithia and would service these two communities together with Palaiometocho. The site that has been selected is near the Forest Industries at a distance of 3.5 km from the centre of Kokkinotrimithia to the west, and approximately 2 km from the nearest houses in the village. Therefore, the distance of the site from any housing areas will eliminate the risk of any noise or odour impacts on the resident population of the communities.

One disadvantage of the site is that the area consists largely of agricultural land, thus the construction of the STP would lead to land use impacts. Additionally, the site is next to a ruined bridge where the old railway line crossed the river, which is a historic structure.

Another disadvantage of the site arises from the need to construct a long term storage reservoir. Apart from the increased land requirement, which is however the case for all the sites examined, this site is relatively flat and there are no suitable formations for the easy construction of the reservoir.

Construction of the STP will lead to some landscape impacts since the area is flat, however these will not be as significant since the landscape in the area is already degraded to an extent as a result of the proximity to the industrial area and particularly the forest industries. Visual impacts will be limited as the site is not visible from the main road or any residential or recreation areas.

6.2.2.3. ALTERNATIVE 3: EXISTING ANTHOUPOLIS SEWAGE TREATMENT PLANT

Schemes A1b and A2b address the possibility of extending the existing Anthoupolis STP to service either all Group A communities (A1b) or only the villages of Kokkinotrimithia and Palaiometocho (A2b). The existing STP is to the west of the Anthoupolis, at a distance of approximately 1.3 km from the nearest houses, which eliminates the risk of any odour or noise impacts on the resident population. The land surrounding the STP is agricultural land with some barren plots.

A new STP is planned to be constructed on this site within the framework of the Greater Nicosia Sanitary Sewerage (GNSS) Project. The capacity of the plant will be 14 500 m^3/day. The Consultant has been informed that there would be major urban development taking place in the Anthoupolis area in the coming years. The planned GNSS treatment plant will therefore be implemented as a completely enclosed plant, provided with odour removal facilities. It is anticipated that additional flows can be accommodated in the new STP within the limits of the existing site and no additional land acquisition would be required.

Regarding the construction of a long term storage reservoir, the GNSS project anticipates that such storage will be constructed elsewhere, according to an agreement with the WDD. This would also apply to any additional flow from the Group A communities.

The alternative sites are presented in Drawing EIA – A – 13. The preliminary evaluation of the alternative location for the sewage treatment plant is included in Appendix 11.

6.3. SELECTION OF FINAL SCHEMES

Once the alternative schemes and possible locations for the sewage treatment plants were examined, and based on the suggestions from the relevant authorities (Appendix 13), the site west of Kokkinotrimithia, within the administrative boundaries of Palaiometocho (alternative site 2), was rejected for the following reasons:

- ⇨ There are land redistribution plans for the area,
- ⇨ The area is next to the new highway which will be constructed according to plans,
- ⇨ Environmentally this option was considered the worst since it is next to a river.

As a consequence, scheme A2a was excluded from the possible options since it includes the construction of a sewage treatment plant at this particular location for the connection of the communities of Akaki, Kokkinotrimithia and Palaiometocho.

6.4. EVALUATION OF ALTERNATIVES

Based on the probable impacts that might result from the proposed development, as identified in the impact scoping stage, the alternative sites and schemes, including the 'no action' alternative, have been evaluated in terms of their expected impact on the environment.

The extent of each impact that is expected as a result of the project was assessed, for each alternative option, based on the following criteria:

- The expected severity of the impact,
- Its duration,
- The expected probability of occurrence for the impact.

The added score based on these parameters was then calculated by the extent of mitigation following the implementation of measures, to obtain the final impact score. For each of the environmental impacts assessed a weight was assigned according to their significance in relation to the environment, the extent to which the impact would immediately affect the concerned population, the sensitivity of the environmental receptor, and the cumulative impact potential of the impact. The final impact scores were then multiplied with the respective weights for each environmental aspect to provide the weighted impact scores for each alternative. The evaluation was carried out for each of the final alternative sites examined, and then for each of the alternative schemes.

The following tables summarise the evaluation criteria, and the weight of each environmental parameter which were used for the evaluation of the total weighted score of the impacts for each alternative location and scheme studied. Tables 6.3 and 6.4 outline the results of the evaluation, and Table 6.5 provides a summary of the environmental impacts and score of each alternative option.

From the evaluation of the alternative locations for the sewage treatment plants, the site of the existing Anthoupolis plant had the highest score, mostly because the new installations that will replace the existing plant will be constructed within the available area of the STP, thus significantly reducing the impacts that will arise on land use, from the destruction of cultivations, and from the acquisition of further private land. Second in the evaluation is the location west of Astromeritis, at the site of the old mine, within the buffer zone. The site that was selected in Palaiometocho must be excluded because, not only the impacts that will arise as a result of the construction of the plant at this location will be comparatively large, the site in next to the river which traverses the area, while there are also land redistribution plans and plans for a road network for the area.

From the evaluation of the alternative scheme, scheme A2b, which includes the construction of a sewage treatment plant at the location west of Astromeritis for the connection of the communities of Astromeritis, Palaiometocho and Akaki, as well as the connection of the communities of Kokkinotrimithia and Palaiometocho to the new Anthoupolis treatment plant, has the highest score, since the impacts that are expected to arise will be comparatively less. Scheme A1b, according to which all the communities will be connected to the Anthoupolis sewage treatment plant, must be excluded because the available area at the plant site is restricted to allow for the relative extension that would be required, while no additional land can be acquired. Additionally, Scheme A2a must also be excluded as it includes the construction of a treatment plant at the location in Palaiometocho.

The evaluation of the alternative locations and schemes indicates that the proposed scheme is the preferred option for the project, while at the same time it justifies the development of the project since the impacts associated with the no action alternative are significantly higher.

IMPACT EXTENT

Severity		Duration		Possibility of Occurrence		Total Score
Negative Impacts		*Negative Impacts*		*Negative Impacts*		Severity + Duration + Possibility of Occurrence
Major negative	-15	Permanent	-10	High probability	-10	
Moderate negative	-10	Short term	-5	Low probability	-5	
Minor negative	-5					
No Impact	0	*No Impact*	0	*No Impact*	0	
Positive Impacts		*Positive Impacts*		*Positive Impacts*		
Minor positive	5	Permanent	10	High probability	10	
Moderate positive	10	Short term	5	Low probability	5	
Major positive	15					

IMPACT SCORE

Impact Extent		Impact Mitigation		Impact Score
Negative Impacts		*Negative Impacts*		Impact Extent x Impact Mitigation
	-35	Not possible to mitigate impact	2	
	-30	Impact reduced	1	
	-25	Impact prevented	0	
	-20	Impact prevented and positive impacts derived	-(2)	
	-15			
No Impact	0	*No Impact*	0	
Positive Impacts		*Positive Impact*	2	
	15			
	20			
	25			
	30			
	35			

WEIGHT OF ENVIRONMENTAL PARAMETERS	
	WEIGHT
Impacts Related to Project Location	
Land Availability	5
Permanent land acquisition	3
Impacts on surface water hydrology	2
Impacts on geology and soils	2
Impacts on ecological values	3
Impacts on land use and land cover	2
Impacts Related to Project Design	4
Impacts During Project Construction	
Temporary land acquisition	1
Vegetation clearing	2
Ecological impacts	2
Soil impacts	4
Air pollution (dust, fumes)	3
Noise impacts	3
On-site safety	2
Waste management	1
Pollution	4
Off-site public safety	2
Traffic	2
Impacts During Project Operation	
Landscape impacts	3
Noise and odours	5
Impacts on soils	5
Impacts on underground resources	5
Impacts of sludge production and reuse	4
Risk of system overload	2
Risk of insufficient treatment of effluents	5
Impacts from the Reuse of the Treated Effluents	
Use for agricultural irrigation	4
Urban reuse	4
Groundwater recharge	5
TOTAL	**84**

TABLE 6.3 : EVALUATION OF ALTERNATIVE SITES

Alternative Site 1(a): Southwest of Astromeritis

	Severity	Duration	Possibility	Impact Extent	Mitigation	Score	Weight	Weighted Score
Impacts Related to Project Location								
Permanent land acquisition	-15	-10	-10	-35	2	-70	3	-210
Impacts on surface water hydrology	0	0	0	0	0	0	2	0
Impacts on geology and soils	-5	-10	-5	-20	1	-20	2	-40
Impacts on ecological values	10	10	10	30	2	60	3	180
Impacts on land use and land cover	-15	-10	-10	-35	2	-70	2	-140
Impacts Related to Project Design	0	0	0	0	0	0	4	0
Impacts During Project Construction								
Temporary land acquisition	-5	-5	-5	-15	1	-15	1	-15
Vegetation clearing	-5	-5	-5	-15	1	-15	2	-30
Ecological impacts	0	0	0	0	0	0	2	0
Soil impacts	-10	-10	-10	-30	1	-30	4	-120
Air pollution (dust, fumes)	-5	-5	-5	-15	1	-15	3	-45
Noise impacts	-10	-5	-5	-20	1	-20	3	-60
On-site safety	-5	-5	-5	-15	0	0	2	0
Waste management	-5	-5	-10	-20	1	-20	1	-20
Pollution	-10	-5	-5	-20	1	-20	4	-80
Off-site public safety	-5	-5	-5	-15	1	-15	2	-30
Traffic	-5	-5	-5	-15	2	-30	2	-60
Impacts During Project Operation								
Landscape impacts	-10	-10	-5	-25	1	-25	3	-75
Noise and odours	-5	-10	-5	-20	0	0	5	0
Impacts on soils	15	10	10	35	2	70	5	350
Impacts on underground resources	15	10	10	35	2	70	5	350
Impacts of sludge production and reuse	-10	-5	-5	-20	1	-20	4	-80
Risk of system overload	-10	-5	-5	-20	0	0	2	0
Risk of insufficient treatment of effluents	-15	-5	-5	-25	1	-25	5	-125
Impacts from the Reuse of the Treated Effluents								
Use for agricultural irrigation	-10	-5	-5	-20	-2	40	4	160
Urban reuse	-10	-5	-5	-20	-2	40	4	160
Groundwater recharge	-15	-5	-5	-25	-2	50	5	250
TOTAL				**-345**		**-80**	**89**	**320**

Alternative Site 1(b): West of Astromeritis ((proposed alternative)

	Severity	Duration	Possibility	Impact Extent	Mitigation	Score	Weight	Weighted Score
Impacts Related to Project Location								
Permanent land acquisition	-10	-10	-10	-30	1	-30	3	-90
Impacts on surface water hydrology	-5	-10	-5	-20	1	-20	2	-40
Impacts on geology and soils	-5	-10	-5	-20	1	-20	2	-40
Impacts on ecological values	10	10	10	30	2	60	3	180
Impacts on land use and land cover	-5	-10	-5	-20	1	-20	2	-40
Impacts Related to Project Design	0	0	0	0	0	0	4	0
Impacts During Project Construction								
Temporary land acquisition	-5	-5	-5	-15	1	-15	1	-15
Vegetation clearing	-5	-5	-5	-15	1	-15	2	-30
Ecological impacts	0	0	0	0	0	0	2	0
Soil impacts	-10	-10	-10	-30	1	-30	4	-120
Air pollution (dust, fumes)	-5	-5	-5	-15	1	-15	3	-45
Noise impacts	-10	-5	-5	-20	1	-20	3	-60
On-site safety	-5	-5	-5	-15	0	0	2	0
Waste management	-5	-5	-10	-20	1	-20	1	-20
Pollution	-10	-5	-5	-20	1	-20	4	-80
Off-site public safety	-5	-5	-5	-15	1	-15	2	-30
Traffic	-5	-5	-5	-15	2	-30	2	-60
Impacts During Project Operation								
Landscape impacts	-5	-10	-5	-20	1	-20	3	-60
Noise and odours	-5	-10	-5	-20	0	0	5	0
Impacts on soils	15	10	10	35	2	70	5	350
Impacts on underground resources	15	10	10	35	2	70	5	350
Impacts of sludge production and reuse	-10	-5	-5	-20	1	-20	4	-80
Risk of system overload	-10	-5	-5	-20	0	0	2	0
Risk of insufficient treatment of effluents	-15	-5	-5	-25	1	-25	5	-125
Impacts from the Reuse of the Treated Effluents								
Use for agricultural irrigation	-10	-5	-5	-20	-2	40	4	160
Urban reuse	-10	-5	-5	-20	-2	40	4	160
Groundwater recharge	-15	-5	-5	-25	-2	50	5	250
TOTAL				**-340**		**-5**	**89**	**515**

Alternative Site 1(c): Northwest of Astromeritis

	Severity	Duration	Possibility	Impact Extent	Mitigation	Score	Weight	Weighted Score
Impacts Related to Project Location								
Permanent land acquisition	-15	-10	-10	-35	2	-70	3	-210
Impacts on surface water hydrology	-5	-10	-5	-20	1	-20	2	-40
Impacts on geology and soils	-10	-10	-10	-30	2	-60	2	-120
Impacts on ecological values	10	10	10	30	2	60	3	180
Impacts on land use and land cover	-10	-10	-10	-30	2	-60	2	-120
Impacts Related to Project Design	0	0	0	0	0	0	4	0
Impacts During Project Construction								
Temporary land acquisition	-5	-5	-5	-15	1	-15	1	-15
Vegetation clearing	-5	-5	-5	-15	1	-15	2	-30
Ecological impacts	0	0	0	0	0	0	2	0
Soil impacts	-10	-10	-10	-30	1	-30	4	-120
Air pollution (dust, fumes)	-5	-5	-5	-15	1	-15	3	-45
Noise impacts	-10	-5	-5	-20	1	-20	3	-60
On-site safety	-5	-5	-5	-15	0	0	2	0
Waste management	-5	-5	-10	-20	1	-20	1	-20
Pollution	-10	-5	-5	-20	1	-20	4	-80
Off-site public safety	-5	-5	-5	-15	1	-15	2	-30
Traffic	-5	-5	-5	-15	2	-30	2	-60
Impacts During Project Operation								
Landscape impacts	-10	-10	-10	-30	1	-30	3	-90
Noise and odours	-5	-10	-5	-20	0	0	5	0
Impacts on soils	15	10	10	35	2	70	5	350
Impacts on underground resources	15	10	10	35	2	70	5	350
Impacts of sludge production and reuse	-10	-5	-5	-20	1	-20	4	-80
Risk of system overload	-10	-5	-5	-20	0	0	2	0
Risk of insufficient treatment of effluents	-15	-5	-5	-25	1	-25	5	-125
Impacts from the Reuse of the Treated Effluents								
Use for agricultural irrigation	-10	-5	-5	-20	-2	40	4	160
Urban reuse	-10	-5	-5	-20	-2	40	4	160
Groundwater recharge	-15	-5	-5	-25	-2	50	5	250
TOTAL				**-375**		**-135**	**89**	**205**

Alternative Site 2: Near Palaiometocho

	Severity	Duration	Possibility	Impact Extent	Mitigation	Score	Weight	Weighted Score
Impacts Related to Project Location								
Permanent land acquisition	-15	-10	-10	-35	2	-70	3	-210
Impacts on surface water hydrology	-5	-10	-5	-20	1	-20	2	-40
Impacts on geology and soils	-10	-10	-10	-30	2	-60	2	-120
Impacts on ecological values	10	10	10	30	2	60	3	180
Impacts on land use and land cover	-10	-10	-10	-30	2	-60	2	-120
Impacts Related to Project Design	0	0	0	0	0	0	4	0
Impacts During Project Construction								
Temporary land acquisition	-5	-5	-5	-15	1	-15	1	-15
Vegetation clearing	-5	-5	-5	-15	1	-15	2	-30
Ecological impacts	0	0	0	0	0	0	2	0
Soil impacts	-10	-10	-10	-30	1	-30	4	-120
Air pollution (dust, fumes)	-5	-5	-5	-15	1	-15	3	-45
Noise impacts	-10	-5	-5	-20	1	-20	3	-60
On-site safety	-5	-5	-5	-15	0	0	2	0
Waste management	-5	-5	-10	-20	1	-20	1	-20
Pollution	-10	-5	-5	-20	1	-20	4	-80
Off-site public safety	-5	-5	-5	-15	1	-15	2	-30
Traffic	-5	-5	-5	-15	2	-30	2	-60
Impacts During Project Operation								
Landscape impacts	-10	-10	-10	-30	1	-30	3	-90
Noise and odours	-5	-10	-5	-20	0	0	5	0
Impacts on soils	15	10	10	35	2	70	5	350
Impacts on underground resources	15	10	10	35	2	70	5	350
Impacts of sludge production and reuse	-10	-5	-5	-20	1	-20	4	-80
Risk of system overload	-10	-5	-5	-20	0	0	2	0
Risk of insufficient treatment of effluents	-15	-5	-5	-25	1	-25	5	-125
Impacts from the Reuse of the Treated Effluents								
Use for agricultural irrigation	-10	-5	-5	-20	-2	40	4	160
Urban reuse	-10	-5	-5	-20	-2	40	4	160
Groundwater recharge	-15	-5	-5	-25	-2	50	5	250
TOTAL				**-375**		**-135**	**89**	**205**

Alternative Site 3: Anthoupolis Sewage Treatment Plant (proposed alternative)

	Severity	Duration	Possibility	Impact Extent	Mitigation	Score	Weight	Weighted Score
Impacts Related to Project Location								
Permanent land acquisition	0	0	0	0	0	0	3	0
Impacts on surface water hydrology	0	0	0	0	0	0	2	0
Impacts on geology and soils	-5	-10	-5	-20	1	-20	2	-40
Impacts on ecological values	10	10	10	30	2	60	3	180
Impacts on land use and land cover	-5	-5	-5	-15	2	-30	2	-60
Impacts Related to Project Design	0	0	0	0	0	0	4	0
Impacts During Project Construction								
Temporary land acquisition	-5	-5	-5	-15	1	-15	1	-15
Vegetation clearing	-5	-5	-5	-15	-2	30	2	60
Ecological impacts	0	0	0	0	0	0	2	0
Soil impacts	-10	-10	-10	-30	1	-30	4	-120
Air pollution (dust, fumes)	-5	-5	-5	-15	1	-15	3	-45
Noise impacts	-10	-5	-5	-20	1	-20	3	-60
On-site safety	-5	-5	-5	-15	0	0	2	0
Waste management	-5	-5	-10	-20	1	-20	1	-20
Pollution	-10	-5	-5	-20	1	-20	4	-80
Off-site public safety	-5	-5	-5	-15	1	-15	2	-30
Traffic	-5	-5	-5	-15	2	-30	2	-60
Impacts During Project Operation								
Landscape impacts	-5	-10	-5	-20	1	-20	3	-60
Noise and odours	-15	-10	-10	-35	0	0	5	0
Impacts on soils	15	10	10	35	2	70	5	350
Impacts on underground resources	15	10	10	35	2	70	5	350
Impacts of sludge production and reuse	-10	-5	-5	-20	1	-20	4	-80
Risk of system overload	-10	-5	-5	-20	0	0	2	0
Risk of insufficient treatment of effluents	-15	-5	-5	-25	1	-25	5	-125
Impacts from the Reuse of the Treated Effluents								
Use for agricultural irrigation	-10	-5	-5	-20	-2	40	4	160
Urban reuse	-10	-5	-5	-20	-2	40	4	160
Groundwater recharge	-15	-5	-5	-25	-2	50	5	250
TOTAL				**-300**		**80**	**89**	**715**

TABLE 6.4 : EVALUATION OF ALTERNATIVE SCHEMES

Scheme A1a: Sewage Treatment Plant in Astromeritis (Site 1(b))

	Severity	Duration	Possibility	Impact Extent	Mitigation	Score	Weight	Weighted Score
Impacts Related to Project Location								
Land Availability	15	0	0	15	2	30	5	150
Permanent land acquisition	-10	-10	-10	-30	1	-30	3	-90
Impacts on surface water hydrology	-5	-10	-5	-20	1	-20	2	-40
Impacts on geology and soils	-5	-10	-5	-20	1	-20	2	-40
Impacts on ecological values	10	10	10	30	2	60	3	180
Impacts on land use and land cover	-5	-10	-5	-20	1	-20	2	-40
Impacts Related to Project Design	0	0	0	0	0	0	4	0
Impacts During Project Construction								
Temporary land acquisition	-5	-5	-5	-15	1	-15	1	-15
Vegetation clearing	-10	-5	-5	-20	1	-20	2	-40
Ecological impacts	0	0	0	0	0	0	2	0
Soil impacts	-15	-10	-10	-35	1	-35	4	-140
Air pollution (dust, fumes)	-10	-5	-10	-25	1	-25	3	-75
Noise impacts	-15	-5	-10	-30	1	-30	3	-90
On-site safety	-5	-5	-5	-15	0	0	2	0
Waste management	-5	-5	-10	-20	1	-20	1	-20
Pollution	-10	-5	-5	-20	1	-20	4	-80
Off-site public safety	-10	-5	-5	-20	1	-20	2	-40
Traffic	-15	-5	-10	-30	2	-60	2	-120
Impacts During Project Operation								
Landscape impacts	-5	-10	-5	-20	1	-20	3	-60
Noise and odours	-10	-10	-5	-25	0	0	5	0
Impacts on soils	15	10	10	35	2	70	5	350
Impacts on underground resources	15	10	10	35	2	70	5	350
Impacts of sludge production and reuse	-10	-5	-5	-20	1	-20	4	-80
Risk of system overload	-10	-5	-5	-20	0	0	2	0
Risk of insufficient treatment of effluents	-15	-5	-5	-25	1	-25	5	-125
Impacts from the Reuse of the Treated Effluents								
Use for agricultural irrigation	-10	-5	-5	-20	-2	40	4	160
Urban reuse	-10	-5	-5	-20	-2	40	4	160
Groundwater recharge	-15	-5	-5	-25	-2	50	5	250
TOTAL				**-380**		**-40**	**89**	**505**

Scheme A1b: Anthoupolis Sewage Treatment Plant

	Severity	Duration	Possibility	Impact Extent	Mitigation	Score	Weight	Weighted Score
Impacts Related to Project Location								
Land Availability	-15	0	0	-15	2	-30	5	-150
Permanent land acquisition	-15	-10	-10	-35	2	-70	3	-210
Impacts on surface water hydrology	0	0	0	0	0	0	2	0
Impacts on geology and soils	-5	-10	-5	-20	1	-20	2	-40
Impacts on ecological values	10	10	10	30	2	60	3	180
Impacts on land use and land cover	-10	-10	-10	-30	2	-60	2	-120
Impacts Related to Project Design	0	0	0	0	0	0	4	0
Impacts During Project Construction								
Temporary land acquisition	-5	-5	-5	-15	1	-15	1	-15
Vegetation clearing	-10	-5	-5	-20	1	-20	2	-40
Ecological impacts	0	0	0	0	0	0	2	0
Soil impacts	-15	-10	-10	-35	1	-35	4	-140
Air pollution (dust, fumes)	-10	-5	-10	-25	1	-25	3	-75
Noise impacts	-15	-5	-10	-30	1	-30	3	-90
On-site safety	-5	-5	-5	-15	0	0	2	0
Waste management	-5	-5	-10	-20	1	-20	1	-20
Pollution	-10	-5	-5	-20	1	-20	4	-80
Off-site public safety	-10	-5	-5	-20	1	-20	2	-40
Traffic	-15	-5	-10	-30	2	-60	2	-120
Impacts During Project Operation								
Landscape impacts	-5	-10	-5	-20	1	-20	3	-60
Noise and odours	-15	-10	-10	-35	1	-35	5	-175
Impacts on soils	15	10	10	35	2	70	5	350
Impacts on underground resources	15	10	10	35	2	70	5	350
Impacts of sludge production and reuse	-10	-5	-5	-20	1	-20	4	-80
Risk of system overload	-10	-5	-5	-20	0	0	2	0
Risk of insufficient treatment of effluents	-15	-5	-5	-25	1	-25	5	-125
Impacts from the Reuse of the Treated Effluents								
Use for agricultural irrigation	-10	-5	-5	-20	-2	40	4	160
Urban reuse	-10	-5	-5	-20	-2	40	4	160
Groundwater recharge	-15	-5	-5	-25	-2	50	5	250
TOTAL				**-415**		**-195**	**89**	**-130**

Scheme A2a: **Σταθμοί** Sewage Treatment Plants in Astromeritis and Palaiometocho (Sites 1(b) and 2)

	Severity	Duration	Possibility	Impact Extent	Mitigation	Score	Weight	Weighted Score
Impacts Related to Project Location								
Land Availability	15	0	0	15	2	30	5	150
Permanent land acquisition	-15	-10	-10	-35	2	-70	3	-210
Impacts on surface water hydrology	-10	-10	-5	-25	1	-25	2	-50
Impacts on geology and soils	-10	-10	-10	-30	2	-60	2	-120
Impacts on ecological values	10	10	10	30	2	60	3	180
Impacts on land use and land cover	-10	-10	-10	-30	2	-60	2	-120
Impacts Related to Project Design	0	0	0	0	0	0	4	0
Impacts During Project Construction								
Temporary land acquisition	-5	-5	-5	-15	1	-15	1	-15
Vegetation clearing	-10	-5	-5	-20	1	-20	2	-40
Ecological impacts	0	0	0	0	0	0	2	0
Soil impacts	-15	-10	-10	-35	1	-35	4	-140
Air pollution (dust, fumes)	-10	-5	-10	-25	1	-25	3	-75
Noise impacts	-15	-5	-10	-30	1	-30	3	-90
On-site safety	-5	-5	-5	-15	0	0	2	0
Waste management	-5	-5	-10	-20	1	-20	1	-20
Pollution	-10	-5	-5	-20	1	-20	4	-80
Off-site public safety	-10	-5	-5	-20	1	-20	2	-40
Traffic	-15	-5	-10	-30	2	-60	2	-120
Impacts During Project Operation								
Landscape impacts	-10	-10	-10	-30	1	-30	3	-90
Noise and odours	-5	-10	-5	-20	0	0	5	0
Impacts on soils	15	10	10	35	2	70	5	350
Impacts on underground resources	15	10	10	35	2	70	5	350
Impacts of sludge production and reuse	-10	-5	-5	-20	1	-20	4	-80
Risk of system overload	-10	-5	-5	-20	0	0	2	0
Risk of insufficient treatment of effluents	-15	-5	-5	-25	1	-25	5	-125
Impacts from the Reuse of the Treated Effluents								
Use for agricultural irrigation	-10	-5	-5	-20	-2	40	4	160
Urban reuse	-10	-5	-5	-20	-2	40	4	160
Groundwater recharge	-15	-5	-5	-25	-2	50	5	250
TOTAL	**-175**	**-115**	**-125**	**-415**	**22**	**-175**	**89**	**185**

Scheme A2b: Sewage Treatment Plants in Astromeritis and Anthoupolis (Sites 1(b) and 3)

	Severity	Duration	Possibility	Impact Extent	Mitigation	Score	Weight	Weighted Score
Impacts Related to Project Location								
Land Availability	15	0	0	15	2	30	5	150
Permanent land acquisition	-5	-10	-10	-25	1	-25	3	-75
Impacts on surface water hydrology	-5	-10	-5	-20	1	-20	2	-40
Impacts on geology and soils	-5	-10	-5	-20	1	-20	2	-40
Impacts on ecological values	10	10	10	30	2	60	3	180
Impacts on land use and land cover	-5	-10	-5	-20	1	-20	2	-40
Impacts Related to Project Design	0	0	0	0	0	0	4	0
Impacts During Project Construction								
Temporary land acquisition	-5	-5	-5	-15	1	-15	1	-15
Vegetation clearing	-10	-5	-5	-20	1	-20	2	-40
Ecological impacts	0	0	0	0	0	0	2	0
Soil impacts	-15	-10	-10	-35	1	-35	4	-140
Air pollution (dust, fumes)	-10	-5	-10	-25	1	-25	3	-75
Noise impacts	-15	-5	-10	-30	1	-30	3	-90
On-site safety	-5	-5	-5	-15	0	0	2	0
Waste management	-5	-5	-10	-20	1	-20	1	-20
Pollution	-10	-5	-5	-20	1	-20	4	-80
Off-site public safety	-10	-5	-5	-20	1	-20	2	-40
Traffic	-15	-5	-10	-30	2	-60	2	-120
Impacts During Project Operation								
Landscape impacts	-5	-10	-5	-20	1	-20	3	-60
Noise and odours	-10	-10	-5	-25	0	0	5	0
Impacts on soils	15	10	10	35	2	70	5	350
Impacts on underground resources	15	10	10	35	2	70	5	350
Impacts of sludge production and reuse	-10	-5	-5	-20	1	-20	4	-80
Risk of system overload	-10	-5	-5	-20	0	0	2	0
Risk of insufficient treatment of effluents	-15	-5	-5	-25	1	-25	5	-125
Impacts from the Reuse of the Treated Effluents								
Use for agricultural irrigation	-10	-5	-5	-20	-2	40	4	160
Urban reuse	-10	-5	-5	-20	-2	40	4	160
Groundwater recharge	-15	-5	-5	-25	-2	50	5	250
TOTAL				**-375**		**-35**	**89**	**520**

Scheme A5: Sewage Treatment Plant in Each Community

	Severity	Duration	Possibility	Impact Extent	Mitigation	Score	Weight	Weighted Score
Impacts Related to Project Location								
Land Availability	5	0	0	5	2	10	5	50
Permanent land acquisition	-15	-10	-10	-35	2	-70	3	-210
Impacts on surface water hydrology	-5	-10	-5	-20	1	-20	2	-40
Impacts on geology and soils	-10	-10	-10	-30	2	-60	2	-120
Impacts on ecological values	5	10	10	25	2	50	3	150
Impacts on land use and land cover	-15	-10	-10	-35	2	-70	2	-140
Impacts Related to Project Design	0	0	0	0	0	0	4	0
Impacts During Project Construction								
Temporary land acquisition	-5	-5	-5	-15	1	-15	1	-15
Vegetation clearing	-10	-5	-5	-20	1	-20	2	-40
Ecological impacts	0	0	0	0	0	0	2	0
Soil impacts	-10	-10	-5	-25	1	-25	4	-100
Air pollution (dust, fumes)	-10	-5	-10	-25	1	-25	3	-75
Noise impacts	-15	-5	-10	-30	1	-30	3	-90
On-site safety	-5	-5	-5	-15	0	0	2	0
Waste management	-5	-5	-10	-20	1	-20	1	-20
Pollution	-15	-5	-5	-25	1	-25	4	-100
Off-site public safety	-10	-5	-5	-20	1	-20	2	-40
Traffic	-15	-5	-10	-30	2	-60	2	-120
Impacts During Project Operation								
Landscape impacts	-15	-10	-10	-35	1	-35	3	-105
Noise and odours	-10	-10	-5	-25	0	0	5	0
Impacts on soils	15	10	10	35	2	70	5	350
Impacts on underground resources	15	10	10	35	2	70	5	350
Impacts of sludge production and reuse	-10	-5	-5	-20	1	-20	4	-80
Risk of system overload	-10	-5	-5	-20	0	0	2	0
Risk of insufficient treatment of effluents	-15	-5	-5	-25	1	-25	5	-125
Impacts from the Reuse of the Treated Effluents								
Use for agricultural irrigation	-10	-5	-5	-20	-2	40	4	160
Urban reuse	-10	-5	-5	-20	-2	40	4	160
Groundwater recharge	-15	-5	-5	-25	-2	50	5	250
TOTAL	**-200**	**-115**	**-120**	**-435**	**22**	**-210**	**89**	**50**

No Action Alternative (continuation of current situation)

	Severity	Duration	Possibility	Impact Extent	Mitigation	Score	Weight	Weighted Score
Impacts Related to Project Location								
Land Availability	0	0	0	0	0	0	5	0
Permanent land acquisition	0	0	0	0	0	0	3	0
Impacts on surface water hydrology	-15	-10	-5	-30	2	-60	2	-120
Impacts on geology and soils	-15	-10	-10	-35	2	-70	2	-140
Impacts on ecological values	-15	-10	-5	-30	2	-60	3	-180
Impacts on land use and land cover	0	0	0	0	0	0	2	0
Impacts Related to Project Design	-15	-10	-10	-35	2	-70	4	-280
Impacts During Project Construction								
Temporary land acquisition	0	0	0	0	0	0	1	0
Vegetation clearing	0	0	0	0	0	0	2	0
Ecological impacts	0	0	0	0	0	0	2	0
Soil impacts	0	0	0	0	0	0	4	0
Air pollution (dust, fumes)	0	0	0	0	0	0	3	0
Noise impacts	0	0	0	0	0	0	3	0
On-site safety	0	0	0	0	0	0	2	0
Waste management	0	0	0	0	0	0	1	0
Pollution	0	0	0	0	0	0	4	0
Off-site public safety	0	0	0	0	0	0	2	0
Traffic	0	0	0	0	0	0	2	0
Impacts During Project Operation								
Landscape impacts	0	0	0	0	0	0	3	0
Noise and odours	-5	-5	-5	-15	2	-30	5	-150
Impacts on soils	-15	-10	-10	-35	2	-70	5	-350
Impacts on underground resources	-15	-10	-10	-35	2	-70	5	-350
Impacts of sludge production and reuse	0	0	0	0	0	0	4	0
Risk of system overload	-15	-5	-5	-25	2	-50	2	-100
Risk of insufficient treatment of effluents	-15	-10	-10	-35	2	-70	5	-350
Impacts from the Reuse of the Treated Effluents								
Use for agricultural irrigation	0	0	0	0	0	0	4	0
Urban reuse	0	0	0	0	0	0	4	0
Groundwater recharge	0	0	0	0	0	0	5	0
TOTAL				**-275**		**-550**	**89**	**-2020**

7. ENVIRONMENTAL MANAGEMENT PLAN

7.1. PURPOSE AND OBJECTIVES OF THE EMP

A key objective of the Impact Assessment process is to identify the potential impacts on the environment of the activities anticipated and to develop a set of mitigation measures technically appropriate, financially acceptable and practically implementable. These mitigation measures are usually identified during the EIA stage and then set out in a practical and co-ordinated way in the EMP.

The role of the EMP is to outline the mitigation, monitoring and institutional measures to be taken during project implementation and operation to avoid or control adverse environmental impacts, and the actions needed to implement these measures. The EMP provides the crucial link between alternative mitigation measures evaluated and described in the EIA and ensuring that such measures are effectively implemented.

For each proposed measure, the EMP defines the technical content, the estimated cost, the schedule of implementation, the role and responsibilities of Government Agencies, the source of funding and the way to monitor the results.

7.2. SUMMARY OF IMPACTS AND MITIGATION MEASURES

TABLE 7.1: EXPECTED IMPACTS AND PROPOSED MITIGATION MEASURES

ANTICIPATED IMPACTS	PROPOSED MITIGATION MEASURES
IMPACTS RELATED TO PROJECT LOCATION	
Astromeritis Sewage Treatment Plant	
Permanent Land Acquisition Permanent acquisition of private land for construction of the STP, the storage reservoirs and the pumping stations	- Compensation for loss of land, agricultural trees and possible loss of income.
Impacts on Ecological Values - No adverse ecological impacts expected. - Positive impacts from the creation of a wetland habitat (storage reservoir) and park in an otherwise degraded region.	No mitigation measures required.
Anthoupolis Sewage Treatment Plant	
Permanent Land Acquisition - In the case of the Anthoupolis STP there will	- Compensation for loss of land, agricultural trees and possible loss of income in the case of the pumping stations.

be no additional land acquisition since the new plant will be constructed within the existing area of the STP. • Permanent land acquisition for the construction of the pumping stations.	
Impacts on Ecological Values • No adverse ecological impacts expected. • Positive impacts from the creation of a wetland habitat (storage reservoir) and park in the area.	• A lake will be created where various fish species and ducks will be introduced and planting of wetland bushes and vegetation around this. • Planting of trees and vegetation in the STP area. • Effective landscaping.
IMPACTS RELATED TO PROJECT DESIGN	
Astromeritis Sewage Treatment Plant	
No significant impacts are expected	• Treatment process is reliable and proven and effluent will meet the set performance standards. • Emergency storage will safeguard against problems in treatment process. • Sludge treatment to be chosen will be effective in achieving required standards.
Anthoupolis Sewage Treatment Plant	
No significant impacts are expected	• The biofilter method is proven and reliable and the quality of the treated effluents will meet the set performance standards. • Emergency storage will safeguard against problems in treatment process. • The sludge treatment process which has been selected is optimized for the treatment of sludge produced from the biofilter method and will offer sludge that can be stored, transferred and reused in agriculture without problems.
IMPACTS DURING THE CONSTRUCTION STAGE	
Temporary Land Acquisition Temporary acquisition of land for workers' facilities, construction storage sites, pipe laying. This will result in possible loss of natural vegetation, grazing or agricultural land.	• Compensation for the temporary use of land, loss of production, or inconvenience created. • Design to minimise construction land requirements. • Special obligation on contractor to minimise impacts on temporarily acquired agricultural land so that it can be put back to production quickly. Measures include the preservation of soil through profiling of the top and sub soil to the original level. Building material must be fenced and the land should be cleared after construction. • Full rehabilitation of sites to be required form contractor.
Vegetation Clearing	• Compensation for the destruction of agriculture, particularly trees (permanent crops).

Clearing of vegetation for construction of the sewage treatment plants, the storage reservoirs, the pumping stations and the conveyance system.	- Prior to construction a rapid survey of affected trees and vegetation should be carried out to clearly indicate the number of trees to be cleared. - An equivalent number of trees and vegetation to be planted by contractor.
Soil Impacts	
- Soil erosion: resulting from uncovered and unconsolidated materials during construction	- Strict clauses regarding earthworks management during construction to be imposed to the contractor. - Careful design of construction operations, including the selection of haulage routes into the site and the location of stockpiles. - Pipe construction should be divided into sub-sections, after excavating one section, backfilling it and clearing the area. - Timely carry away discarded soil. The temporary deposits should be kept within barriers to prevent erosion. - Avoid large scale excavations during rainfall or strong winds. - Remove as little vegetation as possible during construction and revegetate bare areas as soon as possible after construction. - Avoid creating large expanses of bare soil. If such expanses are created, then windbreaks may be required.
- Soil disaggregation	- Take the soil out in horizons and keep each horizon in a separate pile.
- Soil compaction	- Use wide tires to spread the weight of vehicles. - Use a single or as few tracks as possible to bring vehicles to construction sites. - Till the area after compaction has taken place.
Dust, Fumes and Noise	
- Dust: from stockpiles and vehicle movement, particularly in dry weather and strong winds.	- Frequent spraying of stockpiles and haulage roads with water. - Regular sweeping of access roads. - Covering of vehicles carrying materials. - Early planting of peripheral tree screens where they will be part of the development. - A system of monitoring site accesses and stockpiles should be implemented.
- Noise: from construction operations,	- Use equipment with low noise outputs.

machinery and vehicle movements.	• Where it is necessary for construction sites to operate at night, causing an impact on residents, it is required that noise reduction measures are taken so that reasonable noise levels are maintained. • Blasting and other operations with significant noise outputs should be restricted to certain hours of the day, while being prohibited at night. • A plan for the management of construction activities, so as to minimise noise impacts and ensure compliance with noise control measures to be imposed on contractor. • Construction operations must be carefully planned to minimise construction time.
• Air pollution: From vehicle transport and from mechanical equipment.	• Plan routes to minimise vehicle movements as far as possible.
On-Site Safety	• Strict clauses imposed on contractor for the implementation of on-site health and safety measures and standards. • Regular maintenance of construction equipment, machinery and vehicles must be ensured. • Measures to ensure traffic security to be adopted. • Preparedness procedures in case of accidents and emergency situations to be established.
Waste Management Construction waste, domestic solid waste.	• Contractors must make arrangements for the collection and transportation of domestic waste to official landfill sites. • The contractor must prepare a plan for the collection and appropriate disposal of construction waste and transportation plans must be made. • Transportation at peak hours must be avoided. • Spoil and wastes should be transported along specified routes and disposed of at designated sites. • Inspection should be carried out to ensure that the plans are properly implemented.
Pollution Air water and soil pollution resulting from heavy operating machinery and vehicles, and from the storage of potential pollutants, such as petrol, motor oils and concrete.	• Strict clauses regarding the operation and maintenance of construction equipment to be imposed on contractor. • Regular monitoring of water and air quality near construction sites must be carried out. • Procedures must be taken for the containment of pollutants at storage sites. • Measures must be taken to avoid impacts from any accidental spillages, including the containment of storage tanks on concrete floors will walls to prevent the release of

	effluents on the soil. - Preparation and implementation of a management plan for the collection, storage and disposal of used oils and other pollutants.
Traffic As a result of increased vehicle movement and road excavations.	- The construction of the conveyance system should be phased and excavation, pipe laying and trench refilling should be completed as quickly as possible. - For busy roads, construction at peak hours should be avoided. - Spoil soils on roads under construction should be kept to a minimum so as not to affect local traffic. - Specific routing must be prepared for vehicles.
IMPACTS DURING OPERATION	
Landscape Impacts	
Astromeritis Sewage Treatment Plant Limited impacts: the area has already been degraded, while the treatment plant will be constructed at the site of the old quarry and will not be clearly visible from the surrounding areas.	- Landscaping of the site. - Appropriate architectural design. - Trees and other vegetation will be planted so that the area will have the appearance of a park.
Anthoupolis Sewage Treatment Plant Limited impacts	- Landscaping of the site. - The site will be planted and will have the appearance of a park. - A lake will be created and wetland bushes and vegetation will be planted. - The park will be completed with paths. - Appropriate architectural design
Noise At STP sites and pumping stations. Impact at STP sites limited as they are at as sufficient distance from residential areas, however pumping stations are within urban areas. In the case of the Anthoupolis sewage treatment plant, the risk of impacts is greater since the area is expected to be urbanised in the near future.	- Enclose sources to insulate noise and incorporate specific acoustic features in the design of buildings. - Use low noise equipment. - Application of noise control equipment where necessary. - Use of noise screens, including tree plantings. - The noisiest sources should be monitored four times a year and noise measurements should be carried out near the plant and pumping stations two times a year during the day and night. - In the case of the Anthoupolis STP, the entire plant will be covered to reduce impacts.
Odours At STP sites and pumping stations. Impact at STP sites limited as they are at as sufficient distance from residential areas, however pumping stations	- Enclose sources to insulate noise and incorporate specific acoustic features in the design of buildings. - Use low noise equipment. - Application of noise control equipment where

are within urban areas. In the case of the Anthoupolis sewage treatment plant, the risk of impacts is greater since the area is expected to be urbanised in the near future.	necessary. - Use of noise screens, including tree plantings. - The noisiest sources should be monitored four times a year and noise measurements should be carried out near the plant and pumping stations two times a year during the day and night. - In the case of the Anthoupolis sewage treatment plant, the entire plant will be covered and an odour removal system will be installed (the air will be collected and treated).
Impacts on Groundwater Resources Positive impact: reduction in groundwater pumping, and reduction in nitrates released in the environment	No measures required.
Impacts from Sludge Production and Reuse	- Choice of treatment process to meet standards for reuse in agriculture. - Correct soil application methods according to the Code for the Use of Sewage Sludge in Agriculture. - Monitoring of sludge and soil quality in accordance with the Code.
Risk of System Overload Minimum risk: emergency storage available, design includes seasonal variations	No measures required.
Risk of Insufficient Treatment of Effluents	- Regular monitoring of effluent quality - Design for maximum flow - Emergency storage reservoir
Reuse of Treated Effluent for Irrigation	- Regular monitoring of effluent quality according to the Code of Practice for the Use of Treated Effluent for Irrigation. - Choice of irrigation methods according to the Code. - Crop selection to avoid adverse impacts on crop yields.
Urban Reuse of Treated Effluent	- Regular monitoring of effluent quality. - Labeling of pipes and use of signs in areas irrigated with treated effluent. - Choice of irrigation methods according to the Code of Practice.
Groundwater Recharge	- Monitoring of effluent and groundwater quality to avoid risk of aquifer pollution.
MITIGATION MEASURES FOR PUMPING STATIONS	
- Use of low noise equipment - Use of odour control systems	

⇩ Landscaping of the site to avoid impacts on the natural or built environment ⇩ Use of energy efficient systems
MITIGATION MEASURES FOR THE REUSE OF SLUDGE
Misuse of the agricultural value of sludge Leaching of nitrates to groundwater
⇩ Better knowledge of sludge content in terms of compounds of agricultural value
❑ Adequate sampling procedures (frequency, number of samples, etc.)
❑ Adequate analysis protocols
⇩ Improve use of sludge agricultural value
❑ Determination of the sludge agricultural value (N, P, K, content)
❑ Planning and application adapted according to: ⇨ Plant needs ⇨ Other fertiliser sources ⇨ N remaining in the soil ⇨ Nutrient bioavailability ⇨ Adequate spreading periods according to agricultural and environmental constraints
❑ Regular soil analyses to establish increase in nutrient content
❑ Information from farmers about quantities spread
Soil contamination by heavy metals and organic pollutants
⇩ Determination of background levels in soil
⇩ Determination of pollutant content in sludge
⇩ Safe storage of sludge
❑ Safe storage to reduce leaching
❑ Sufficient storage capacity
❑ Reduction of storage duration in the field
Water contamination by heavy metals and organic contaminants
⇩ Forbid sludge spreading in sensitive areas, especially:
❑ On sloping land ❑ Near surface water ❑ On wet areas ❑ Within water resource protection areas ❑ On sandy soils ❑ On frozen grounds ❑ In areas where the water table is near the surface
⇩ Encourage fast ploughing down in order to reduce the risk of runoff and the use of close-to-ground techniques in order to reduce the formation of aerosols
⇩ Safe storage of sludge

Crop contamination by heavy metals and organic pollutants
⇩ Reduce transfer in the food chain
❑ Encourage sludge spreading before non-food crops
⇩ Limit plant uptake
❑ Adapt sludge spreading to soil types (mainly according to pH and CEC)
❑ Take into consideration heavy metal bioavailability in soil
❑ Define a crop/sludge type matrix with specific recommendations
❑ Prohibit sludge spreading on plant/crops which are known to accumulate heavy metals
⇩ Limit deposition on plant
❑ Limit use of sludge on vegetable and certain fruit productions
⇩ Analyses of the metal level in crops and foodstuff
Animal contamination by heavy metals and organic pollutants
⇩ Limit pollutant transfer to animals
❑ Tighten limits concerning quantity and quality of sludge which may be applied
❑ Grazing land: ⇨ Introduce a time period before harvesting ⇨ Favour sludge ploughing down
❑ Grassland: ⇨ Allow spreading before sowing and after each cut
⇩ Control of the metal levels in foodstuffs
❑ Analysis of the pollutant levels in animal products (especially in offal and milk)
Human contamination
⇩ Limit pollutant transfer in the food chain (see above)
⇩ Protection of operating equipment
❑ Ensure safe manipulation of sludge
❑ Material cleaning and maintenance
❑ Protective clothes
Contamination by pathogens
⇩ Animal contamination
❑ Grazing land: introduce a time period before grazing
❑ Grassland: allow spreading before sowing and after each cut
❑ Encourage fast ploughing down of sludge
⇩ Human contamination

- ❑ Prohibition of sludge spreading on products which are to be consumed raw
- ❑ Safe transportation of sludge
- ❑ Prohibition of sludge spreading in the vicinity of houses and near bathing water and drinking water supply areas

MITIGATION MEASURES FOR THE REUSE OF THE TREATED EFFLUENTS FOR MITIGATION PURPOSES

Impacts on soil productivity; groundwater contamination; health impacts; impacts on crop growth and quality

- ⇩ Drafting of Reuse Management Plan, incorporating:
  - ❑ Appropriate site identification (for reuse in areas outside the Irrigation Scheme)
  - ❑ Crop water requirements
  - ❑ Crop selection
  - ❑ Irrigation methods and scheduling
  - ❑ Evaluation of nutrient and salt loading rates

Nitrogen leaching to groundwater, accumulation in soil

- ⇩ Balance nitrogen loading rates with crop requirements

Phosphorus leaching to groundwater, accumulation in soil

- ⇩ Balance phosphorus loading rates with crop requirements

Adverse impacts on soil productivity and risk of groundwater contamination

- ⇩ Determine salt loading rates
- ⇩ Ensure irrigation practices do not result in off-site run-off, appropriate leaching and drainage provisions

Adverse impacts on crop yields and quality

- ⇩ Crop selection based on crop sensitivity to treated effluent constituents

Adverse impacts on health

- ⇩ Timing of irrigation prior to harvesting
- ⇩ Correct irrigation practices
- ⇩ Minimise site access during irrigation periods
- ⇩ Use of signs specifying that treated effluent is used
- ⇩ Establishment of buffer zones around irrigated areas where necessary

Quality considerations

- ⇩ Implements treated effluent quality monitoring programme to ensure compliance with the set standards
- ⇩ Implement soil quality monitoring programme
- ⇩ Monitoring of irrigation methods and practices
- ⇩ Monitoring of application rates of heavy metals, nutrients and slats.

7.3. MITIGATION MEASURES

7.3.1. CONTRACTUAL BACKGROUND FOR ENVIRONMENTAL MANAGEMENT

7.3.1.1. CONTRACTUAL DISPOSITIONS

From experience, it has been observed that obtaining any specific task from a contractor requires first that the task is specified in the contract documents and then, that a specific payment is allocated to that task. This is the basis for any construction contract which relies on detailed technical specifications and their related bills of quantities.

To be effective, the environmental and social obligations of a contractor must be comprehensively specified and individually payable through the contract documents. Both actions work together because the payment system will influence the way specifications are displayed and prepared.

In case of a project, the Environmental Impact Assessment report is generally mentioned in the Assurances in a way that all mitigation measures recommended have to be implemented.

Thus, the preparation of detailed environmental and social specifications for the Contractor is proposed prior to the bidding process, with the objective to have eventually a legal document which establishes clearly the obligations of the contractor, the quantities of work involved and the related cost of measures.

7.3.1.2. PREPARATION OF TECHNICAL ENVIRONMENTAL SPECIFICATIONS

The environmental and social specifications for the Contractor will be organised into 4 sections:

- Section A**:** Environmental Protection Management
- Section B**:** Labour Camps and Worker Health Management
- Section C**:** Safety Management
- Section D**:** Social Management

Each section will address the 2 following aspects :
Sub-Section 1**:** description of the Contractor's obligations with regards to those aspects covered by the section.
Sub-Section 2**:** description of indicators that will be monitored for payment

- DESCRIPTION OF CONTRACTOR OBLIGATIONS

⇩ Section A : Environment Protection Management

The Section A will specify the Contractor obligations with regards to the preparation of a Construction Site Environmental Management Program (CSEMP) aiming at protecting the work sites and their surroundings against potentially adverse impacts. The Contractor's CSEMP will include the facilities and procedures for the management of solid wastes, the soil conservation measures and proposed rehabilitation works once the construction ends, the measures aiming at protecting the local fauna and flora, the preventive measures against water pollution and the monitoring program (air, water). For each aspect, the environmental specifications will provide the contractor with standards or quality objectives to be achieved.

⇩ Section B : Labour Camps and Worker Health Management

The Section B will address the minimum standards to be implemented in the labour camps and facilities regarding issues as accommodation, food supply and canteen, waste management, water supply, treatment of sewage and sanitary conditions on site. The following topics will be addressed:

- Maximisation of employment of locally based labour who will be transported to the sites by bus;
- Mechanisms to ensure contractors provide their work force and camps with adequate quantities and standards of the following :
  - Water supply
  - Sanitation and solid waste disposal
  - Health checks
  - Security and lighting
  - Disease pathogen and vector control
  - Fire extinguishers and fire drills
  - Training for specific tasks, particularly safety training
  - Catering and canteen services
  - Personal Protective Equipment (PPE)
  - Transport to public transport facilities
- Actual volumes, quantities and standards for the above mentioned items.

Section C : Safety Management

For safety issues, Environmental Specifications will have to address two distinct aspects:

- The **On-site Safety**, PPE, and Medical issues, and
- The **Off site Safety**, Medical and Road traffic issues

The *On-site Safety, PPE, and Medical Aspects* will address all the measures the Contractor needs to implement to ensure a safety standard close to international standards, and appropriate medical evacuation of the workforce.

For most *Off-site Safety accident and Medical issues*, the Environmental Specifications will fix the objectives. In its offer, the Contractor will detail which measures he intends to apply for achieving these objectives. Major issues to be covered under this headline include:

- Road signs
  - Road accidents
  - Speed limits through populated areas and speed control bumps (near schools, at the entrance of villages)
  - Project traffic regulations including: night-stop regulations, truck cleaning, washing and cargo transfers, use of headlights, carriage of unofficial persons and goods, educating project drivers in safety matters, regular inspections of vehicle condition, compulsory first aid kits, fire extinguishers, use of vehicle log books, seat belts, etc.
  - First aid and emergency medical facilities,
  - Third party, livestock and property accident insurance cover,
  - Hazardous cargo movement and accident procedures,
  - Exceptional load movement procedures,
  - Accident reporting procedures,
  - Off-site damage / injury claim procedures,
  - Village liaison and discussion arrangements,
  - Repairs of local roads and bridges damaged by project traffic,
  - Load shedding and spillage accidents.

Section D : Social Management

The Section D will fix the minimum conditions to be applied by the Contractor while managing all social aspects related to construction activities. Most of them will focus on how to reduce nuisance to villagers.

Meetings must be arranged between the contractors and the village authority of all villages likely to experience nuisance events.

As a result of the meetings, the contractors will prepare a nuisance control program which will be posted in public places in affected villages. This program includes measures to deal with at least the following issues:

Traffic density:	Possible by-pass route, Speed bumps near villages, Crossing places, Prohibition of night traffic
Noise:	Regulations about traffic and working hours in/near residential areas, Regulations about use of klaxons in villages.
Fumes, dust	Regulations on refuelling, fly ash or cement transfer in or near residential areas, Road watering, Effective covering of truck loads such as sand or gravel.
Traffic obstruction:	Temporary parking, regulations for keeping open roads even during upgrading works or during movements of exceptional loads.
Social relation:	Monthly meeting between contractor and representative of potentially affected village to be organised for solving conflict issues.

Public information can be carried out among concerned villages to use the monthly meeting with contractor to ensure the nuisance reduction program continues to serve their interests.

❑ DESCRIPTION OF MONITORING INDICATORS

For the four specification sections, the indicators that will be monitored during the site inspections must be specified.

⇩ Measurable Items

Most of the contractor environmental and social obligations are actually measurable. For these ones, indicators to be monitored will be quantities and the Contractor will be paid only if these quantities are observed on the sites.

For example in section B "Labour Camps and Worker Health Management", the following obligations and indicators could be considered with regards to Restrooms:

⇨ Description of the Contractor's obligations

"The Contractor shall provide washrooms and other facilities, as necessary, to satisfy the needs and customs of its workforce. Washrooms shall be located and sized based upon the size of the workforce and shall include adequate lighting and appropriate number of facilities. Separate facilities shall be provided for men and women. Washrooms shall be constructed in well-ventilate areas, and supplied with an adequate amount of hot and cold water (potable) and other ancillaries"

⇨ Description of indicators

"As a minimum, the following shall be provided :

- toilets: 1 unit per 15 persons. Each unit being supplied with toilet paper and holders, waste receptacle, and deodorant ;
- urinals: 1 unit per 25 men ;
- shower stalls: 1 per 10 persons ;
- washbasins and mirrors: 1 per 5 persons.

⇩ Non-Measurable Items

Some environmental and social obligations remain difficult to quantify. A typical example is the protection of areas adjacent to construction areas: It is not realistic to specify a penalty for a number of trees cut at a wrong place, or for any cubic meter of material cast aside the road.

But for these non-measurable items, it is important to specify the methods anticipated to reduce adverse impacts and also to specify clearly which condition would constitute a non-payment situation.

- PAYMENT PROCEDURES FOR ENVIRONMENTAL AND SOCIAL OBLIGATIONS

An adapted payment procedure is the most efficient tool to oblige a Contractor to fulfil its obligations. The payment procedures should provide the executive agency with the maximum guarantee that money is to be paid only when the work is totally and satisfactorily completed. Also, the payment procedure should act as an incentive for the Contractor, exacerbating its willingness to fulfil its environmental and social obligations with the best results. In such case, the budget considered for the services should be significantly higher than what should be the expenses to implement the measures.

These issues will be discussed when preparing the environmental specifications for the contractor, and they will consider the most appropriate and acceptable solutions for the remuneration of Contractor Environmental and Social Obligations.

7.3.2. COMPENSATION FOR LAND ACQUISITION

Compensation must be paid for all permanent land acquisitions as well as temporary acquisitions.

7.3.3. COMPENSATION FOR THE LOSS OF TREES

The executing authority will carefully confirm the number of trees affected by the Project and discuss with the Contractor to identify any possibility to minimise the loss during the construction.

The Contractor will make provisions for the planting of an equivalent number of trees lost because of construction activities. These trees will be planted in an area to be determined with the relevant authority and resident representatives.

The cost for purchase of plants, their transport to the project site, their planting and 2 years of follow up will be included in the environmental budget of the contractor.

7.3.4. PROJECT COMPLETION: RECLAMATION OF TEMPORARY USED SITES

Decommissioning refers to the dismantling, decontamination and removal of process equipment and facility structures, at the end of the construction stage, and to recontouring the land and planting vegetation to prevent soil erosion as appropriate. Assuming there is no other use for field facilities, all structures and related infrastructure facilities are to be dismantled by the contractor.

All the sites used temporary by the contractor installations will be fully rehabilitated at the end of the construction stage and shall be returned to their initial use. This concerns areas for borrowing earth, for temporary access roads, for workers camps and facilities, for material storage and for machinery parking and maintenance.

7.4. **Site Reclamation:** Construction related sites to be decommissioned and reclaimed will be re-contoured and restored so that the pre-disturbance vegetation can re-establish itself in a short period of time. Reclamation will be limited to disturbed areas of the site. To facilitate re-vegetation, mitigation measures that may apply include fertilising and seeding, mulching and surface texturing. Close attention will be paid to areas where erosion potential is high. Large plots of land such as storage yards, borrow areas, and main camp sites will be re-vegetated and maintained until plant growth is established.

7.5. Grading and Surface Reclamation: Disturbed areas where temporary construction facilities existed will be returned to natural contours where possible. Areas of high erosion will be identified in the field and treated with special design measures that may include anti erosion mats or mulching. Compaction of the sub-soil will be relieved by scarification in areas of disturbance. The topsoil stored during the initial phase of construction will be returned to the site, evenly spread and lightly packed to prevent depressions and water pockets. In areas where topsoil was not stripped, the surface will be ripped or scarified to relieve compaction. Grading and surface reclamation activities will not take place when the topsoil is muddy or the subsoil wet.

7.6. Revegetation: If seeding and planting are needed, native seed mixtures or plant seedlings used will be compatible with local soil conditions and climatic zones. Seed will be applied uniformly in a manner appropriate for the type of seed used and will be placed in a firm, moist seedbed at a suitable depth. Seedlings will be planted at a density and in a manner conducive to successful growth. In disturbed temporary construction site areas with little topsoil or naturally sparse vegetation, fertilisation and mulching may be included in the site reclamation works. Seeded or planted sites failing to show successful growth after one growing season will be assessed to determine cause for failure, and corrections will be made as appropriate.

7.7. Temporary Storage of Removed Topsoil: will be done at appropriate sites in a manner that maintains its fertility (i.e. storage of removed topsoil for less than 6 months, protection of topsoil stockpiles from surface drainage).

7.8. MONITORING PROGRAMMES

Environmental monitoring programs are designed to provide the necessary feedback about the actual impacts of the projects during its construction and operation stage. Monitoring helps judge the success of mitigation measures in protecting the environment. Monitoring is also used to ensure compliance of activities with existing standards, as for example, effluent quality discharged in a water body.

If efficiently backed up by powers to ensure corrective action when the results of monitoring show it necessary, a monitoring program is a proven way to ensure effective implementation of mitigation measures.

7.8.1. WATER QUALITY MONITORING DURING CONSTRUCTION

7.8.1.1. OBJECTIVES OF MONITORING

The objectives of water quality monitoring are:

- To ensure a strict control of pollution from construction activities and to check the efficiency of water quality protection measures set up by the civil work contractor;
- To ensure that construction activities do not alter significantly the river or reservoir or aquifer water quality.

To satisfy these objectives, two monitoring systems must be organised: one, focussing on construction sites and on the release of pollutants, the other on the condition of the receiving water bodies.

The first monitoring system is called a Compliance Monitoring, which will compare discharges from the site activities with existing standards. Implicit in this system is the assumption that if a characteristic being monitored is within acceptable limits, then the effects will also be within acceptable limits.

The second system is called an Effect Monitoring, as it tries to link specific human activities to any changes in the environmental characteristics of the receiving water body. This monitoring is the most widely used in EIA, but unfortunately, too frequently with very limited results.

7.8.1.2. LOCATION OF SAMPLING SITES

For the construction sites monitoring (compliance monitoring), sampling sites will be distributed in points where the control of effluents from construction activities can be easily implemented: surface drainage channels from construction sites, from concrete preparation plant, from worker camps sewage facilities, from disposal areas for earth-fill or for solid waste, from machinery reparation yards and from petrol products storage areas.

For the follow up of water body quality, the selection of sampling stations located upstream and downstream the anticipated influence zone will be considered.

All the sites for monitoring will have to be determined at the early stage of project implementation, when the Contractor has already submitted the location for camps, storage and major earthworks.

7.8.1.3. SAMPLING AND ANALYSIS

- PARAMETERS TO BE MEASURED

The selection of parameters to be measured depends on the potential pollution expected, the type of water body and water use concerned, and the sensitivity of the biological environment.

Two types of indicators should be considered:
- ⇨ Those related to the follow up of potential pollution sources resulting from construction activities, and
- ⇨ Those related to larger characterisation of the receiving (or threatened) water body in relation to its quality and sensitivity for the biodiversity.

The most frequently observed pollution types from construction works are mainly suspended solids due to earthworks, acidification due to concrete related activities, and hydrocarbons from engine leakage and maintenance. Potential pollution from workers camps is mainly of bacteriological nature and related to sanitation systems. The parameters to be followed must be the best indicators of activities anticipated in the sites, which may clearly establish the presence or not of a nuisance directly induced by the activities.

The other group of parameters concerns those providing more general information on the condition of the receiving water body, either a river or a reservoir. Sampling stations have to be located at a greater distance from the construction sites, to ensure that they reflect the wider influence (if any) of the construction activities on the receiving water body and on the biodiversity it supports. In this case, sampling is performed simultaneously upstream the activity area and downstream.

Therefore, the recommended parameters to be monitored are:

Group 1: Indicators of Pollution:

- ⇩ At any discharge point from the construction sites: Temperature, pH, electrical conductivity, Dissolved Oxygen (DO).
- ⇩ At the treated effluent discharge point from the labour camps: faecal coliforms, total coliforms, Ammonia, Biochemical Oxygen Demand in 5 days (BOD_5).
- ⇩ At the outlet of concrete production effluent (if any): Total Suspended Solids (TSS) pH
- ⇩ At the outlet/drains draining construction activities and mechanical maintenance areas: pH, Turbidity or (TSS), Lead, Hydrocarbons (HPA), oils.

Group 2: Indicators of Water Body Quality:

- Temperature, pH, electrical conductivity, TSS, TDS, Chemical Oxygen Demand (COD), Ammonia, Total Nitrogen, Total Phosphorus.

- TYPE OF SAMPLING AND FREQUENCY OF COLLECTION

- Sampling for Group 1 indicators should be performed on a weekly basis[1]. The Contractor will be requested to carry out the sampling and the analysis, the implementing Agency being mainly in charge of random control sampling.
- Sampling for Group 2 indicators should be performed on a monthly basis

Samples should be kept in the dark and maintained as cool as possible within a chilled insulated container and returned to the laboratory promptly after collection. Samples should be analysed as soon as possible and preferably within 8h of collection. Samples storage is recommended not to exceed 24h at 5°C.

Temperature, turbidity, TSS, pH and Dissolved Oxygen could be measured directly on site in using a multi-parameter probe, with regular laboratory calibration.

BOD_5 , Lead, Hydrocarbons (HPA) and bacteriology must be measured in a Water Quality Laboratory.

- REPORTING AND DATA INTERPRETATION

All results (site and laboratory) will be recorded in a logbook and computerised so as to ensure proper data record and an easy data interpretation with graphs.

7.8.1.4. ORGANISATION

The Contractor will be requested to follow up on a *weekly basis* the pollution load from its installations, in imposed sampling sites and in accordance with sampling procedures determined. Samples have to be delivered to an agreed laboratory for analysis.

It is advisable to carry out on a random basis control sampling to ensure the results provided by the Contractor are true and correct. A minimum control sampling of once per month is recommended. For the monitoring of the larger receiving water bodies, sampling and analysis will be carried out once a month during the construction period by the relevant authorities.

7.8.1.5. REPORTING

Weekly results from compliance monitoring compiled by the Contractor will be immediately submitted to the relevant authority. Monthly report with results and interpretative analysis will be submitted monthly together with other monitoring material by. The monthly report will also include results from random control analysis and of water bodies monitoring.

[1] *Weekly basis the first few months of construction, then twice a month if results appear satisfactory.*

7.8.1.6. SCHEDULE OF ACTIVITIES

TABLE 7.2: SCHEDULE OF ACTIVITIES FOR WATER QUALITY MONITORING

PERIOD	ACTIVITIES	COMMENTS
Prior to Construction	Prepare Contractor specifications for water quality compliance monitoring	Defines number of sites, location, parameters to analyse, frequency of sampling, procedures for sampling, laboratory designated for analysis, reporting of results.
	Identify suitable sites on receiving water body and carry out preliminary sampling & analysis	Sites must be selected for easy access and representativeness of conditions prevailing in the area. If possible should rely on existing stations used for long term monitoring of the whole river system.
Construction Stage	Sampling in selected sites on weekly basis, deliver samples to laboratory and provide weekly report on results	Weekly report submitted to relevant authority.
	Carry out monthly random sampling to control accuracy of contractor's monitoring	Results to be submitted to relevant authority for further action if required.
	Prepare formal notice to Contractor if results do not comply with standards	Follow up for effective implementation of corrective action by Contractor, if required.
	Carry out monthly sampling of receiving water body	Results to be submitted to the relevant authority for further action if required.
	Monthly report of water quality results to be prepared	Report with conclusions to be submitted to relevant authority.
	Quarterly report on water quality monitoring	Report with conclusions to be submitted to relevant authority.
Operational Stage	Carry out monthly sampling of receiving water body	Regular monitoring of the receiving water quality in case of groundwater recharge

7.8.2. WATER QUALITY MONITORING DURING OPERATION

During the operation of the STP, if the treated effluent is stored in an existing dam, or if it is used for groundwater recharge purposes, regular monitoring of the quality of the receiving waters is required.

The following parameters must be examined:

- ⇨ Temperature, pH
- ⇨ Electrical conductivity
- ⇨ Suspended Solids
- ⇨ BOD_5, COD
- ⇨ Coliforms, intestinal worms
- ⇨ Total N
- ⇨ Total P

Monitoring must be carried out on a weekly basis

7.8.3. AIR AND NOISE MONITORING

7.8.3.1. OBJECTIVES OF MONITORING

Air quality is anticipated to be locally and temporally altered by the construction activities in 3 fields: Generation of exhaust fumes from trucks and heavy machinery, production of noise and emission of dust because of earthworks.

- PRODUCTION OF FUMES AND GASES

Direct monitoring of possible sources of pollution is strongly recommended. Direct control of exhaust systems on trucks may limit the production of exhaust gas resulting from the use of old or badly maintained trucks. The strict enforcement of speed limitation in urbanised areas will also reduce the production of exhaust gas. General control of air quality will not provide usable information, as few dozens of trucks or bulldozers will not alter significantly the air quality of widely opened and windy areas.

- PRODUCTION OF NOISE

Noise must be monitored at workers camps level, on the construction sites (within the worker safety component) and in the nearby villages or residential areas. Monitoring of noise does not just concern measuring a point, but also collecting any claims of nearby population or of workers suffering from noise. Request or suggestion boxes have to be opened in various places where people may express their inconvenience regarding noise, and from where the breaking of the rules by the Contractor can be proved and discussed. Strict rules have to be established regarding the use of noisy equipment near residences, including the traffic of trucks.

During the operation of the sewage treatment plants noise levels must be regularly monitored near plant equipment, such as pumps, ventilators and air conditioners; near pumping stations; and in the nearby villages or residential areas; or recreation areas

- PRODUCTION OF DUST

Dust will be produced in several places where construction and pipe laying will commence, particularly during the summer when the dry climate will increase the risk of soil erosion from winds. Dust will also be produced by the trucks along the earth roads and with a particular adverse influence when crossing residential areas. For the well being of the workforce and of the surrounding population, dust emission has to be minimised in the most critical areas. For that purpose, regular watering of such areas is necessary. Strict clauses will be established regarding the obligation of the Contractor to water soil regularly along the roads crossing villages, inside camps and construction sites and on the disposal areas for earth fill.

7.8.3.2. LOCATION OF MEASURE SITES

Specific sites for regular measurement of air quality are not anticipated. If disputes arise between the Contractor and workers or resident population on a specific air quality issue, appropriate analysis in appropriate locations will be conducted in order to assess the magnitude of the inconvenience and its level compared to existing standards. This will probably mainly concern noise and dust emissions. Selective measurements of exhaust gas may also be carried out in case doubtful equipment is used.

However, before construction starts, it is advisable to carry out a campaign of measures in the project area, in villages crossed by the access road in order to establish a broad baseline of local conditions which may eventually referred to in case of dispute or claim. Parameters to be checked are Total Suspended Particulate (TSP), No_x, SO_2 and noise level at various times of the day.

7.8.3.3. ORGANISATION

The concerned authorities will carry out on a random basis control measures of noise, dust or exhaust gases to ensure that the Contractor is operating within the Standards or to oblige it to appropriate measures in case standards are not respected.

7.8.3.4. SCHEDULE OF ACTIVITIES

TABLE 7.3: SCHEDULE OF ACTIVITIES FOR AIR QUALITY AND NOISE MONITORING

PERIOD	ACTIVITIES	MONITORING
Prior to Construction	Prepare Contractor specifications for air quality compliance to existing standards	Includes also specifications for maintenance of engines, watering of roads and stock piles, noise limitation, and traffic in urbanised areas
	Identify suitable sites in project area and carry out preliminary sampling & analysis	Sites must be selected for easy access and representativeness of conditions prevailing in the area.
Construction Stage	Carry out public information about obligations of contractor regarding fumes, dust & noise Inform villagers on grievance procedure.	Open grievance boxes in villages concerned. Link with specifications on traffic control imposed to Contractor
	Review monthly grievance, and if justified meet with concerned villagers/head of village to identify corrective measure	Impose measures on contractor if required. Request analysis to be carried out if justified
	Carry out random sampling to control respect by Contractor of standards and specifications	Results to be submitted to relevant authority for further action if required
	Prepare formal notice to Contractor if results do not comply with standards or obligations	Follow up for effective implementation of corrective action by Contractor, if required
	Monthly report of air related activities to be prepared	Report with conclusions to be submitted to relevant authority
	Quarterly report on air quality activities	Report with conclusions to be submitted to relevant authority
Operational Stage	No activity anticipated	

7.8.4. SLUDGE CONTROL MONITORING

A sludge control monitoring programme must be implemented incorporating:

- Monitoring of sludge quality
- Monitoring of soil quality
- Monitoring of sludge application rates
- Monitoring of application methods and practices

The Code of Practice for the Use of Sludge for Agricultural Purposes (Appendix 1) and the Regulations on the Use of Sludge for Agriculture (517/2002) set out the minimum monitoring requirements and limit values. A more detailed monitoring programme, incorporating these requirements, is recommended to ensure the safe reuse of sewage sludge in agriculture.

7.8.4.1. MONITORING OF SLUDGE QUALITY

The following parameters must be analysed in order to characterise and monitor the composition of sludge in terms of heavy metal and nutrient content:

- ⇨ Dry matter and organic matter
- ⇨ pH
- ⇨ Primary nutrients: Nitrogen (as Total N and NH_4^-N), Phosphorus (P) and Potassium (K)
- ⇨ Secondary nutrients: Calcium (Ca), Magnesium (Mg), Sulphur (S)
- ⇨ Micro-nutrients: Boron (B), Cobalt (Co), Iron (Fe), Manganese (Mn), Molybdenum (Mo)
- ⇨ Heavy metals: Cadmium (Cd), Nickel (Ni), Lead (Pb), Zinc (Zn), Mercury (Hg) and Chromium (Cr III).

Values for the maximum permissible heavy metal content in the sludge according to the Regulations and the proposed limit values are outlined in Table 5.9.

According to the Regulations and the Code of Practice, the sludge must be analysed every 6 months. In cases where change is observed in the quality of the sewage, the frequency of the analyses will need to be adjusted accordingly. If the analyses results do not differ significantly during the period of one year the sludge can be analysed every 12 months.

However, to ensure the safe use of sludge in agriculture, the following analysis frequency is recommended as a minimum, depending on the sludge quantity produced.

TABLE 7.4: PROPOSED ANALYSIS FREQUENCY FOR SLUDGE

QUANTITY OF SLUDGE PRODUCED PER YEAR AND PER PLANT (TONNES OF DS)	MINIMUM NUMBER OF ANALYSES PER YEAR		
	Agronomic Parameters	Heavy Metals	Micro-organisms
< 250	2	2	2
250 – 1 000	4	4	4
1 000 – 2 500	8	4	8
2 500 – 4 000	12	8	12
> 4 000	12	12	12

The analyses must be carried out at regular intervals during the year.

Sludge will be assumed to conform to the recommended limit values for heavy metals, or to a maximum to the set regulation standards, if for each concentration limit considered, the 90-percentile of the samples within a twelve-month period are at or below the threshold value and if the 10-percentile of the samples exceed only one threshold value and by less than 50%.

TABLE 7.5: PROPOSED HEAVY METAL CONCENTRATION LIMIT VALUES IN THE SLUDGE USED IN AGRICULTURE

PARAMETER	LIMIT VALUES (mg/kg DS)		LIMIT VALUES (mg/kg P)
	Regulation 517/2002	Proposed Limit Values	Proposed Limit Values
Cadmium (Cd)	20 – 40	10	250
Copper (Cu)	1 000 – 1 750	1 000	25 000
Nickel (Ni)	300 – 400	300	7 500

Lead (Pb)	750 – 1 200	750	18 750
Zinc (Zn)	2 500 – 4 000	2 500	62 500
Mercury (Hg)	16 – 25	10	250
Chromium (Cr III)	–	1 000	25 000

❑ SAMPLING

The samples must be representative of the final sludge to be applied on land, and sampling must be carried out after the treatment of sludge and before its delivery to the user. To achieve this, samples must be representative of the entire amount of sludge being sampled, collected after the last treatment process, and taken from the same location each time monitoring is performed.

Ideally, sampling locations must be as close as possible to the stage before final application. It is therefore recommended that samples are taken at the storage site prior to track loading for transport to the application sites.

Sample collection and sampling procedures must be clearly defined and followed consistently to minimise process errors. For this a sampling procedure must be drafted, which will include:

- Specification of the personnel responsible for the sampling
- Identification of the appropriate sampling equipment
- Description of sample mixing procedures
- Specification of the size and type of sample containers
- Specification of sample preservation procedures and holding times
- Specification of equipment cleaning procedures to ensure that cross contamination of samples does not occur
- Description of procedures to ensure that the integrity of samples is maintained during transport and analyses.

7.8.4.2. MONITORING OF SOIL QUALITY

The frequency of the analyses will depend on the initial condition of the soil and its heavy metal content, which must be verified before the application of sludge begins, together with the heavy metal content of the sludge and the frequency of the sludge deposition.

Analyses must be carried out for the following parameters (according to Regulations):

- pH
- Cadmium, copper, nickel, lead, zinc, mercury and chromium.

In addition, further analyses are recommended to determine the soil characteristics and chemical parameters in order to assess the sludge application rates depending on crop requirements in nutrients. Monitoring of the following parameters is suggested:

❑ MONITORING PRIOR TO SLUDGE APPLICATION

- Surface layer:
  - Particle size distribution
  - Electrical conductivity
  - Cation exchange capacity (CEC)
  - Lime requirement (acid soils)
  - Plant available P and K
  - Soil N parameters:
    - NO_3^-N
    - NH_4^-N
    - Organic matter

- Organic N
- O:N ratio
- Soil microbial biomass C and N
- N mineralization potential

⇩ Subsurface layers:
- ⇨ Particle size distribution
- ⇨ Electrical conductivity
- ⇨ Cation exchange capacity (CEC)

❑ MONITORING FOLLOWING SLUDGE APPLICATION

⇩ Surface layer:
- ⇨ Electrical conductivity
- ⇨ Lime requirements (acid soils)
- ⇨ Plant available P and K
- ⇨ Soil N parameters
  - Organic matter
  - Organic N

⇩ Subsurface layers:
- ⇨ Electrical conductivity

The concentrations of heavy metals in the soil must be according to the proposed standards, or to a maximum according to the set regulation standards.

TABLE 7.6: PROPOSED HEAVY METAL CONCENTRATION LIMIT VALUES IN THE SOIL

PARAMETER	LIMIT VALUES (mg/kg DS)			
	Regulation 517/2002 6<pH<7	Proposed Limit Values		
		5 ≤ pH < 6	6 ≤ pH < 7	pH ≥ 7
Cadmium (Cd)	1 – 3	0.5	1	1.5
Copper (Cu)	50 – 140	20	50	100
Nickel (Ni)	30 – 75	15	50	70
Lead (Pb)	50 – 300	70	70	100
Zinc (Zn)	150 – 300	60	150	200
Mercury (Hg)	1 – 1.5	0.1	0.5	1
Chromium (Cr III)	–	30	60	100

Sampling must be carried out up to a depth of 0.25 m below the soil surface. Where this is difficult, sampling can be carried out for depths up to 0.10 m. A representative sample is that which is prepared by the mixture of 5 samples from different points per hectare. For smaller areas, mixtures must contain samples that have been taken proportionally at 1 sample per hectare.

7.8.4.3. MONITORING OF APPLICATION RATES

The sludge application rates must be in accordance with the recommended limit values for the heavy metal concentrations that can be added annually to soils.

TABLE 7.7: PROPOSED LIMIT VALUES FOR AMOUNTS OF HEAVY METALS WHICH MAY BE ADDED ANNUALLY TO SOIL, BASED ON A TEN YEAR AVERAGE

PARAMETER	LIMIT VALUES (kg/ha/year)	
	Regulation 517/2002	Proposed Limit Values
Cadmium (Cd)	0.15	0.03
Copper (Cu)	12	3
Nickel (Ni)	3	0.9
Lead (Pb)	15	2.25
Zinc (Zn)	30	7.5
Mercury (Hg)	0.1	0.03
Chromium (Cr III)	–	3

7.8.4.4. MONITORING OF APPLICATION METHODS AND PRACTICES

Regular monitoring is required to ensure that the sludge application practices followed are in accordance to the specifications of the Sludge Management Plan and the Regulations for the Use of Sludge in Agriculture, regarding:

- Crop selection
- Application methods
- Scheduling of application and harvesting

Harvesting following sludge application must follow the following guidelines:

TABLE 7.8: SLUDGE APPLICATION AND HARVESTING GUIDELINES

	ADVANCED TREATMENTS	CONVENTIONAL TREATMENTS
Pastureland	Yes	Yes, deep injection and 6-week no-grazing
Forage crops	Yes	Yes, 6-week no-harvest
Arable land	Yes	Yes, deep injection or immediate ploughing down
Fruit and vegetable crops in contact with the ground	Yes	No. no harvest for 12 moths following application
Fruit and vegetable crops in contact with the ground – eaten raw	Yes	No. no harvest for 30 moths following application
Fruit trees, vineyards, tree plantations and reforestation	Yes	Yes, deep injection and 10-month no-access to the public

7.8.4.5. INFORMATION REQUIREMENTS AND RECORD KEEPING

Records must be kept on the following information requirements:

- The quantity of sludge produced and the quantities supplied for use in agriculture
- The composition and properties of the sludge in relation to the agronomic parameters suggested above
- Results of the analyses of the sludge in relation to the heavy metal content
- Names and addresses of the receivers of sludge
- Location of the plots of land on which the sludge will be applied, their area and the quantities of sludge received for use

- Type of land use, i.e. crops grown
- Results of the analyses of the soil
- Monitoring results in relation to the application rates and practices

7.8.5. MONITORING PROGRAMME FOR THE REUSE OF THE TREATED EFFLUENT

7.8.5.1. MONITORING OF THE QUALITY OF THE TREATED EFFLUENT

The quality of the treated effluent must be regularly monitored to ensure compliance with the set standards. Monitoring must be carried out for the following parameters:

PARAMETER	SUGGESTED FREQUENCY
pH	Weekly
BOD_5	Weekly
COD	Weekly
SS	Daily
Coliform, intestinal worms	Daily
Turbidity	Continuous
Cl_2 residual	Periodic monitoring
Nitrogen, phosphorus	Periodic monitoring
Total Dissolved Solids (TDS)	Periodic monitoring
Heavy Metals	Periodic monitoring

Concentration limits must be according to the suggested design standards for the quality of the treated effluent.

TABLE 7.9: SUGGESTED DISCHARGE STANDARDS FOR THE TREATED EFFLUENT QUALITY

PARAMETER	LIMIT VALUES
BOD_5	10 mg/l
COD	< 125 mg/l
SS	10 mg/l
Total N	15 mg/l
Faecal coliforms	5 units/100 ml (in 80% of the samples) 15 units/100 ml (maximum)
Intestinal worms	Nil
Total P	2 mg/l
Free Chlorine	> 0.5 mg/l and < 2 mg/l

These values must not be exceeded in 80 % of the samples per month (minimum number of samples: 5).

TABLE 7.10: HEAVY METAL CONCENTRATION LIMITS

METAL	MAXIMUM CONCENTRATION LIMIT (MG/L)
Aluminium	5.0
Arsenic	0.1
Beryllium	0.1
Boron	0.75
Cadmium	0.01
Chromium	0.1
Cobalt	0.05
Copper	0.2
Iron	5.0
Lead	5.0
Lithium	2.5
Manganese	0.2
Molybdenum	0.01
Nickel	0.2
Selenium	0.02
Vanadium	0.1
Zinc	2.0
Mercury	0.005

These values must not be exceeded for 75 % of the samples yearly. For the total concentration of metals the following relationship must be valid:

$C_{M1}/L_{M1} + C_{M2}/L_{M2} + \text{--------} + C_{Mi}/L_{Mi} \leq 1,$
where, C_{Mi} is the metal concentration and L_{Mi} the permissible metal concentration limit.

- SAMPLING LOCATION

The most representative sample of the treated effluent is from a point where the effluent is thoroughly mixed and close to the outlet from the treatment plant.

7.8.5.2. MONITORING OF SOIL QUALITY

Soil quality must be monitored to ensure that there are no adverse impacts on soil quality and productivity as a result of irrigation with treated effluents.

The soil should be analysed at least every 2 to 3 years, including the initial baseline monitoring for the following parameters:
- pH
- Electrical conductivity
- Exchangeable cations
- Total N, P and K
- Total cation concentration
- Sodium absorption ratio
- Heavy metal concentrations

- SAMPLING LOCATIONS

The number and location of sampling sites will depend on the distribution of soil types in the area to be irrigated. If there is little variation, 3 to 5 sites may be sufficient for 5 to 10 hectares. More sites will be required for more complex land systems.

7.8.5.3. MONITORING OF IRRIGATION PRACTICES

Monitoring of the irrigation practices followed is recommended to ensure that the appropriate methods are implemented in accordance with the Reuse Management Plan and the Code of Practice.

The irrigation methods applied must be as follows:

TABLE 7.11: MONITORING OF IRRIGATION METHODS

CROP TYPE	IRRIGATION METHODS
Vines	⇩ Drip irrigation ⇩ Mini sprinklers and sprinklers ⇩ *Movable irrigation systems are not allowed*
Fruit trees	⇩ Drip irrigation ⇩ Hose basin irrigation ⇩ Bubblers irrigation ⇩ Mini sprinklers
Vegetables	⇩ Subsurface irrigation ⇩ Drip irrigation
Vegetables eaten cooked	⇩ Sprinklers ⇩ Subsurface irrigation ⇩ Drip irrigation
Industrial and fodder crops	⇩ Subsurface irrigation ⇩ Bubblers ⇩ Drip irrigation ⇩ Pop-up sprinklers ⇩ Surface irrigation methods ⇩ Low capacity sprinklers ⇩ Spray or sprinkler irrigation with a buffer zone of about 300 m

The timing of irrigation prior to harvesting must also be monitored. As a minimum, the following conditions are suggested for application and harvesting:

- Fodder crops: Irrigation is recommended to stop at least one week before harvesting
- Vines: No crops must be collected from the ground
- Fruit trees: In case where crops are wetted, irrigation must stop one week before harvesting

7.8.5.4. INFORMATION REQUIREMENTS AND RECORD KEEPING

Records must be kept on the following information requirements:
- The quantity of the treated effluent supplied for irrigation
- The plots of land irrigated with the treated effluent
- Type of crops irrigated
- Results of the analyses of the treated effluent
- Monitoring results for soil quality and irrigation management.

7.8.6. MONITORING OF CONSTRUCTION ACTIVITIES

7.8.6.1. IMPORTANCE OF MONITORING CONSTRUCTION ACTIVITIES

Past experience has shown that many construction contractors do not fully understand their obligations with respect to environmental mitigation measures. Most of the time, they do not make adequate provision for the work to be done during bid preparation and they find themselves without sufficient funds to fully implement the mitigation measures. This is unfortunately frequent for the works which come at the end of a project construction and which often concern the rehabilitation of construction or disposal sites.

It is thus of utmost importance that the construction contract includes provisions to ensure:

- The contractor understands clearly environmental mitigation measures and its obligations,
- The mitigation measures are specified in sufficient detail that the contractor can make reasonable estimates of actual costs in its tender document,
- The project management has the legal and financial power to enforce the application of mitigation measures through the contractor.
- The project management has the capability to monitor the contractor's performance in this regard.

Practically this means that to be effective, the EMP must rely on 1) clear contractual dispositions, 2) clear technical environmental specifications and 3) a capable body empowered with legal and technical authority to monitor contractor environmental activities.

Contractual dispositions and technical environmental specifications are major mitigation measures proposed and discussed in the following section.

7.8.6.2. CONTENT AND IMPLEMENTATION OF THE MONITORING

The environmental monitoring of construction activities is at the heart of the effective implementation of the EMP. The objective is to carry a regular and comprehensive review of the actual status of the environmental obligations of the Contractor. This monitoring aims at ensuring compliance of Contractor activities with its contractual commitments and the environmental regulations and standards. It is carried out all along the project construction on a monthly basis

In accordance with the Environmental specifications, monitoring will be carried out for all aspects relevant to the 4 sections of the specifications: Environmental Protection Measures Section, Labour camps and Worker Health Management Section, Safety Management Section and Social Management Section.

For each section, a *Standard Review Sheet (SRS)* will be prepared at the early beginning of the project. The SRS system should allow 1) a rapid review of the status of all components, 2) an easy way for ranking the level of satisfaction for each group of components, and 3) a formal way to check if requirements expressed to the Contractor the previous month have been given due attention and satisfaction. The results on the review being the approval or not of payments for the concerned issues. For information purpose, some examples of SRS are provided in Appendix 2.

Prior to the start of construction, responsibilities must be assigned by the relevant authorities for the preparation of the environmental specifications for the contractor and organisation of programmes and reviews.

7.8.6.3. SCHEDULE OF ACTIVITIES

TABLE 7.12: SCHEDULE OF ACTIVITIES FOR CONSTRUCTION ACTIVITIES MONITORING

PERIOD	ACTIVITIES	COMMENTS
Pre-construction	Recruit personnel	
	Organise training of personnel	Training on EIA standards and formats, training on monitoring construction activities
	Prepare Technical Environmental Specifications for construction activities	To be included in the bidding documentation
	Prepare Standard Review Sheets and working Program	
	Participate to Tender evaluation and contract negotiation with contractor	Review all aspects related to social and environmental matters
Construction	Review with contractor location of borrow areas, disposal sites, camps, temporary access roads	Determine clearly land allocated and ensure compensation is fair and received by affected people.
	Review weekly standard of camps and facilities, of request made to contractor, of implementation of mitigation measures	Impose measures on contractor if required.
	Carry out control analysis if justified	
	Co-ordination of responsible bodies	Co-ordination of all monitoring programs at sub-project level
	Prepare formal notice to Contractor if results do not comply with standards or obligations	All orders or advises to Contractor to be forwarded through the responsible authority. Follow up for effective implementation of corrective action by Contractor, if required.
	Monthly Review	
	Monthly report on monitoring of construction activities	Report based on monthly review plus weekly reports from
	Quarterly report on monitoring of construction activities	Report with conclusions to be submitted to authority
Operation	Follow up of sites rehabilitation the first 2-3 years after completion of construction	Reporting of problems to relevant authority

7.9. ENVIRONMENTAL MANAGEMENT ORGANISATION

The Water Development Department (WDD) will be responsible for the implementation of the mitigation measures required during the construction stage. Responsibility for the operation of the

STP and monitoring programmes will be with the Sewage Board that will direct the STP with the assistance of the WDD.

7.10. COST ESTIMATE FOR THE EMP

ITEM	ANNUAL BUDGET (CYP)	5 YEAR BUDGET (CYP)	RESPONSIBILITY EXECUTION
Investments	(Year 1 Only)		
Creation of Internet Site	15 000	15 000	WDD/Consultant
Technical Assistance to WDD	20 000	20 000	WDD/Consultant
Communication campaign	15 000	15 000	WDD/Consultant
Land Acquisition & Compensation	1 820 000	1 820 000	WDD
Total	*1 870 000*	*1 870 000*	
Operation costs			
Environmental Manager (WDD)	20 000	100 000	WDD
Environmental Supervisor (CSE)	18 000	90 000	
Budget for Ad Hoc expertise	10 000	50 000	WDD/Consultant
Budget for Construction EMP	120 000	600 000	Contractor
Construction Monitoring			
Water quality	2 400	12 000	WDD/Consultant
Air quality and noise	2 000	10 000	WDD/Consultant
Monitoring during operation			
Water quality	1 000	-	
Air quality and noise	1 000	-	
Sludge quality	1 000		WDD/Sewerage Board
Treated water quality	1 000		WDD/Sewerage Board
Sub-Total	*17 6400*	*862 000*	
Total Cost	2 046 400	2 732 000	

8. PUBLIC CONSULTATION

There have been consultation with the appropriate authority including:

- ⇨ The Water Development Department
- ⇨ The Environmental Service
- ⇨ The Town and Country Planning Department

The consultations took place during the technoeconomical study during which the selection of the scheme and location took place. The recommendations mde from the above authorities were taken into consideration on the final choise of the location. These suggestions can be foung in Appendix 13.

Consultation also took place with the local authorities. Their suggestions were taken into consideration in the preliminary stage of the selection of a location from the sewage treatment plants. After the completion of the preliminary evaluation of the locations and the submittal of the feasibility study, a presentation of the technical, economical and environmental aspects of the project was given to the representatives of the community counsils. Representatives of the Sewarage Board of Nicosia were present for the presentation as two of the communities, namely Kokkinotrimithia and Palaiometocho, were to get connected to the existing Anthoupolis treatment plant. The opinions of the communities were taken into consideration during the final choice of scheme and STP location. For this reason, location 1(b) was included for the case of Astromeritis, during the preliminary evaluation which also constitutes the recommended location for the project to be completed.

APPENDIX 14

SITE PICTURES

APPENDIX 10

ALTERNATIVE SCHEMES

APPENDIX 11

ENVIRONMENTAL SCREENING OF ALTERNATIVE OPTIONS

APPENDIX 13

CONSULTATION LETTERS

APPENDIX 1

STANDARDS IN CYPRUS AND THE EU

CODE OF PRACTICE FOR THE USE OF TREATED WASTEWATER IN IRRIGATION

A Sewage Effluent Technical Committee Cyprus has developed draft regulation concerning the reuse of wastewater effluents in the irrigation of crops for human consumption, of fodder crops, industrial crops and amenity areas. These regulations are presented in Table A1.1.

TABLE A1.1: CYPRUS STANDARDS FOR URBAN TREATED EFFLUENT USED FOR IRRIGATION

IRRIGATION OF	BOD_5 (mg/l)	SS (mg/l)	FAECAL COLIFORMS / 100 ml	INTESTINAL WORMS/L	TREATMENT REQUIRED
All crops (a)	(A) 10*	10*	5* 15**	Nil	Tertiary and disinfection
Amenity areas of unlimited access and vegetables eaten cooked (b)	(A) 10* 15**	10* 15**	50* 100**	Nil	Tertiary and disinfection
Crops for human consumption Amenity areas of limited access	(A) 20* 30**	30* 45**	200* 1000**	Ni	Secondary and storage > 7 days and disinfection or Tertiary and disinfection
	(B) –	–	200* 1000**	Ni	Stabilisation – maturation ponds total retention time > 30 days or Secondary and storage > 30 days
Fodder crops	(A) 20* 30**	– 30* 45**	1000* 5000*	Nil	Secondary and storage > 7 days and disinfection or Tertiary and disinfection
	(B) –	–	1000* 5000*	Nil	
Industrial crops	50* 70**	–	3000* 10000**	-	Secondary and disinfection
	(B) –	–	300** 10000*	-	Stabilisation – maturation ponds total retention time > 30 days or Secondary and storage > 30 days

A: Mechanised methods of treatment (activated sludge, etc.)
B: Stabilisation ponds
*: These values must not be exceeded in 80 % of samples per month
**: Maximum value allowed
COD < 125 mg/l

For the purpose of this project, the category corresponding to unrestricted irrigation (all crops) has been assumed. The WDD would thus have the flexibility to reuse the wastewater for any purpose.

Furthermore, it is understood that most of the treated wastewater reuse currently practiced in Cyprus is for irrigation of hotel lawns and gardens and golf courses, for which a high quality effluent is required.

TABLE A1.2: CONTROL OF METALS
METAL CONCENTRATION LIMITS FOR THE TREATED WATER FOR PURPOSES OF CONTINUOUS IRRIGATION

METAL	CONCENTRATION, mg/l
Aluminium	5.0
Arsenic	0.1
Beryllium	0.1
Boron	0.75
Cadmium	0.01
Chromium	0.1
Cobalt	0.05
Copper	0.2
Iron	5.0
Lead	5.0
Lithium	2.5
Manganese	0.2
Molybdenum	0.01
Nickel	0.2
Selenium	0.02
Vanadium	0.1
Zinc	2.0
Mercury	0.005

For the total concentration of metals, the following relationship must be valid:

$$\frac{C_{M1}}{L_{M1}} + \frac{C_{M2}}{L_{M2}} + \text{- - - -} + \frac{C_{Mi}}{L_{Mi}} \leq 1$$

Where, C_{Mi} = the metal concentration and
L_{Mi} = the permissible metal concentration limit

The values must not be exceeded for 75% of the samples yearly.

- The sewage treatment and disinfection must be kept and maintained continuously in satisfactory and effective operation so long as treated sewage effluent are intended for irrigation, and according to the license that will be issued under the existing legislation.

- Skilled operators should be employed to attend the treatment plant, following formal approval by the appropriate authority that the persons are competent to perform the required duties, necessary to ensure that the above conditions are satisfied.

- The treatment and disinfection plant must be attended every day according to the programme issued by the Authority and records to be kept of all operations performed according to the instructions of the appropriate Authority. A copy must be kept for easy access within the treatment facilities.

- All outlets, taps and valves in the irrigation system must be secured to prevent their use by unauthorised persons. All such outlets must be coloured red and clearly labelled so as to warn the public that the water is unsafe for drinking.

- No cross connections with any pipeline or works conveying potable water, is allowed. All pipelines conveying sewage effluent must be satisfactorily marked with red tape so as to distinguish them from domestic water supply. In unavoidable cases where sewage/effluent and domestic water pipes must be laid close to each other the sewage pipes should be buried at least 0.5 m below the domestic water pipes.

- Irrigation methods allowed and conditions of application differ between plantations as follows:

  - *Park lawns and ornamental in amenity areas of unlimited access*
    - Subsurface irrigation methods
    - Drip irrigation
    - Pop-up, low pressure and high precipitation rate, low angle sprinklers (less than 11 degrees). Sprinkling preferably to be practiced at night and when people are not around.

  - *Park lawns and ornamental in areas of limited access, industrial and fodder crops*
    - Subsurface irrigation
    - Bubblers
    - Drip irrigation
    - Pop-up sprinklers
    - Surface irrigation methods
    - Low capacity sprinklers
    - Spray or sprinkler irrigation is allowed with a buffer zone of about 300 m

    For fodder crops, irrigation is recommended to stop at least one week before harvesting and no milking animals should be allowed to graze on pastures irrigated with sewage. Veterinary Services should be informed.

  - *Vines*
    - Drip irrigation
    - Minisprinklers and sprinklers (in case where crops get wetted, irrigation should stop two weeks before harvesting)
    - Movable irrigation systems are not allowed
    - No crops should be selected from the ground

  - *Fruit trees*
    - Drip irrigation
    - Hose basin irrigation
    - Bubblers irrigation
    - Mini sprinklers

    No fruits to be collected from the ground except for nut trees. In case where crops are wetted, irrigation should stop one week before harvesting.

  - *Vegetables*
    - Subsurface irrigation
    - Drip irrigation

    Crops must not come in contact with the ground or the effluents (only vegetables which are supported).

    Other irrigation methods could also be considered.

  - *Vegetable eaten cooked*
    - Sprinklers
    - Subsurface irrigation
    - Drip irrigation

Other irrigation methods may be allowed after the approval of the appropriate Authority. Restrictions may be posed to any method of irrigation by the appropriate authority in order to protect public health or environment.

The following tertiary treatment methods are acceptable:
- Coagulation plus flocculation followed by Rapid Sand Filtration
- Slow Sand Filters
- Any other method, which may secure the total removal of helminth ova and reduce faecal coliforms to acceptable levels. Must be approved by the appropriate authority.

Appropriate disinfection methods must be applied when sewage effluent are to be used for irrigation. In the case of chlorination the total level of free chlorine in the effluent at the outlet of the chlorination tank, after an hour of contact time should be at least 0.5 mg/l and not greater than 2 mg/l.

Suitable facilities for monitoring the essential quality parameters should be kept on the site of treatment.

CODE OF PRACTICE FOR THE DISPOSAL OF TREATED SEWAGE WATER IN SURFACE WATERS

- The disposal of treated water in the water bodies mentioned below only if any other method of disposal is practically impossible or excessively costly and provided it does not create any dangers to public health and following an environmental study.

- The recycled water must have the quality specified in the specifications for the purposes of irrigation of all cultivations. (BAO_5 < 10mg/l, SS < 10mg/l, Faecal Coliform < 5/100ml, eggs of intestinal parasites = none.)

- Also there will be toxicity tests and control according to Appendix E1 and control for the concentration of heavy metals according to Appendix A1.

- In case of disposal of recycled water in sensitive water bodies it is imposed that (total) nitrogen concentrations in the recycled water must not exceed 10mg/l.

- For the disposal of recycled water from treatment plants with equivalent population above 100 000 the phosphorus concentration in the recycled water must not exceed 1mg/l, while from plants with equivalent population between 10 000 – 100 000 the concentration must not exceed 2mg/l. Alternatively a minimum reduction (phosphorus) of 80% must be achieved during treatment.

- The disposals must stop in cases where eutrophication appears.

- IN RIVERS/STREAMS ACCORDING TO THE FOLLOWING CONDITIONS:
  - Disposal is not allowed in rivers/streams that are directly related to water supply sources.
  - In cases of disposal in rivers/streams that are indirectly related to sources of water supply there must be no possibility of contamination/pollution.
  - In no case must the disposal rate for the recycled water exceed 10% of the river/stream flow at the moment of disposal. The percentage will be smaller if other disposals are being carried out, depending on distances and the natural purification capacity of the water.

- DAMS/BARRAGES ACCORDING TO THE FOLLOWING CONDITIONS:
  - Under no circumstances will the direct disposal of recycled water of any degree of treatment be allowed in dams/barrages where the water is used for water supply purposes. However,

such a disposal can be examined in the case of rivers/streams which end up in sources of water supply if the disposal is carried out at a distance of at least 10km from them.
- In dams/barrages that are used only for irrigation purposes. The total daily volume of disposals of recycled water must not exceed 5% of the stored volume during the time of disposal. Also, denitrification must be carried out (total nitrogen < 15mg/l) and the phosphorus must be observed.
- In rivers/streams, dams/barrages where there are fish or where there is aquaculture the disposals must be such so as to ensure the water quality as it is defined by the EU directive 78/659/EEC.

- IN NATURAL LAKES/WETLANDS ACCORDING TO THE FOLLOWING CONDITIONS:
  - The disposal in rivers and wetlands is not permitted.

Relaxations of these terms may be granted if with the relaxations public health is not endangered and under the condition that the environmental impact assessment will indicate that any negative environmental impacts will be marginal.

TABLE A1.3: TOXICITY CONTROL, TESTS AND TOXICITY LIMITS FOR THE DISPOSAL OF TREATED SEWAGE WATER IN WATER BODIES

TESTS	DISPOSAL IN STREAMS[1]	DISPOSAL IN DAMS AND LAKES[1]
Acute Toxicity Microtox: organism Photobacterium phosphorium (Vibrio fischeri) Algaltox 72 hours: organism Selenastrum capricornutum Daphtox: organism Daphnia magna Straus	Applicable	Applicable
Gene Toxicity 1 Mutatox with and without activation with hepatic enzymes S9: organism Photobacterium phosphorium (Vibrio fischeri)	Not requested	Applicable
Acceptable Limits The results and the limits are expressed in Toxic Units TU*	In accordance with the term that the maximum daily disposal < or equal to 10% of the running water and provided that the streams are not directly related to irrigation the 75% of the samples will have to be consistent with the following limits fro acute toxicity: Microtox: TU50 ≤ 1 or/and TU20 ≤ 1.5 Daphnia: TU50 ≤ 1 Algae: TU50 ≤ 1	In accordance with the term that the maximum daily disposal < or equal to 3% of the stored water and provided that the water will not be used for irrigation the 75% pf samples will have to be consistent with the following limits for acute toxicity: Microtox: TU50 ≤ 1 or/and TU20 ≤ 1.5 Daphnia: TU50 ≤ 1 Algae: TU50 ≤ 1 Mutatox: The treated waste must not be positive in the direct or

		following the activation with S9 Mutatox test

1. The acute toxicity control is carried out 4 times a year and the control at least once a year. If it is confirmed that the waste because of its quality and in conjunction with the quality or dilution does not have a reasonable potential a) to be toxic and b) its specific use to contribute directly or indirectly to the degradation of the receivers and the environment, then the control for toxicity could be restricted appropriately.
2. TU50, TU20: toxic units for 50% and 20% influence of the organism under trial or the equivalent biological action.

CODE OF PRACTICE FOR THE USE OF SLUDGE FROM THE TREATMENT OF SEWAGE FOR AGRICULTURAL PURPOSES

- The installations for the treatment of sludge that is expected to be used or made available according to the license or licenses issued from the Competent Authority must continuously operate to a satisfactory level.

- The storage area for the treated sludge must be such so as not to create any danger to public health or environmental problems including the danger of underground or surface water resources.

- The quality of the sludge must be monitored according to the programme approved by the Competent Authority.

- The sludge treatment installations must be supervised and kept at a satisfactory level of operation by suitably qualified staff approved by the Competent Authority.

- The following sludge treatment methods are acceptable:
  - Anaerobic digestion
  - Mesofile
  - Regular
  - Aerobic digestion
  - Heat treatment
  - Deposition in shallow reservoirs for a period of two years
  - Sludge stabilization and use of lime (CaO)
  - Sludge stabilization after a complete biological cleaning or extended aeration
  - Drying in specially designed areas
  - Storage of sludge for a year
  - Any other method which will be approved by the Competent Authority and through which the quality standards for the use of sludge can be ensured.

- The rate and quantity of sludge deposition on the soil for agricultural purposes will depend on the quality of the sludge, the type of soil and cultivation and the time period for the deposition.

- The use of sludge is not recommended for the following cases:
  - In areas where it is possible to cause impacts on, or the degradation of, the quality of surface waters (dams, water sources, rivers, etc.).
  - In areas where it is possible to cause impacts on, the degradation of, the quality of underground water bodies (e.g. underground water beds).

- The use of sludge is forbidden in the following cases:
  - In places of pasture or in the cases where stock-breeding plants are cultivated and will be harvested in less than three weeks from the time of the sludge deposition.

- On soil where the cultivation of fruits and vegetables is in process with the exception of fruit-bearing trees.
- On soil where there is intention to cultivate fruit and vegetables which will be in direct contact with the soil and are usually eaten raw unless the sludge is deposited at least 12 months prior harvesting the cultivations.
- On grass, unless the sludge is deposited at least 12 months before its use.

- For monitoring the use of sludge for agricultural purposes the following programme of analysis is defined:

  - Analyses of sludge: The sludge must be analyzed every 6 months. In cases where change is observed in the quality of the sewage the frequency of the analyses will need to be adjusted accordingly. If the analyses results do not differ significantly during the period of one whole year, the sludge can be analyzed at least every 12 months.

    Analyses must be carried out for the following parameters:
    - Dry matter, organic matter
    - pH
    - nitrogen, phosphorus
    - cadmium, copper, nickel, lead, zinc, mercury and chromium (Table A1.3)

  - Soil analysis: the frequency of the analyses will depend on the initial condition of the soil and its heavy metal content which will be verified before the use of sludge begins, as well as the quality and heavy metal content of the sludge and the frequency of sludge deposition and other relevant influencing factors.

    The analyses frequency will be decided taking into consideration the metal concentration in the soil before the use of the sludge, the quantity and composition of the sludge to be used, as well as other relevant influencing factors.

    Analyses must be carried out for the following parameters:
    - pH
    - cadmium, copper, nickel, lead, zinc, mercury and chromium (Table A1.4)

    The maximum permissible heavy metal content of the soil is shown in Table 2 and the maximum permissible quantity that can be deposited every year on agricultural land is shown in Table A1.5.

- The following sampling methods are acceptable:
  - For the soil: Sampling must be carried out up to a depth of 0.25 m bellow the soil surface. Where this is difficult, sampling can be carried out for depths up to 0.10 m. A representative sample is that which is prepared by the mixture of 5 samples from different points per hectare. For smaller areas mixtures will contain samples that have been taken proportionally at 1 sample per hectare.
  - For the sludge**:** The samples must be representative and sampling must be carried out after the treatment of the sludge and before its delivery to the user.

- Methods of analysis: The analyses for the heavy metals must be carried out after digestion with the use of strong oxidizing acids. The method of reference is that of atomic absorption (AAS) and the detection level for each metal must not be greater than 10% of the corresponding level value.

- For the purposes of correct management, analyses of the sludge and soil are considered useful for the following elements:
  - Nitrogen (N)
  - Phosphorus (P)
  - Potassium (K)
  - Sodium (Na)
  - Calcium (Ca)
  - Manganese (Mg)

- Iron (Fe)
- Boron (B)

TABLE A1.4: MAXIMUM PERMISSIBLE HEAVY METAL CONTENT IN THE SLUDGE (MG/KG OF DRY MATTER)

PARAMETERS	MAXIMUM VALUE (MG/KG)
Cadmium (Cd)	40
Copper (Cu)	1750
Nickel (Ni)	400
Lead (Pb)	1200
Zinc (Zn)	4000
Mercury (Hg)	25
Chromium (Cr III)	1000

TABLE A1.5: MAXIMUM PERMISSIBLE HEAVY METAL CONTENT IN THE SOIL (MG/KG OF DRY MATTER)

PARAMETERS	MAXIMUM VALUE (MG/KG)
Cadmium (Cd)	3
Copper (Cu)	140
Nickel (Ni)	75
Lead (Pb)	300
Zinc (Zn)	300
Mercury (Hg)	1.5
Chromium (Cr III)	150

TABLE A1.6: MAXIMUM PERMISSIBLE QUANTITY OF HEAVY METALS THAT CAN BE ADDED EVERY YEAR ON AGRICULTURAL LAND, BASED ON A TEN YEAR AVERAGE (KG/HA/YR)

PARAMETERS	MAXIMUM VALUE (MG/KG)
Cadmium (Cd)	0.15
Copper (Cu)	12
Nickel (Ni)	3
Lead (Pb)	15
Zinc (Zn)	30
Mercury (Hg)	0.1
Chromium (Cr III)	-

DISCHARGE STANDARDS ACCORDING TO THE EU DIRECTIVE 91/271/EEC

The EU Directive 91/271/EEC of 21 May 1991 concerning urban wastewater treatment sets the following standards for wastewater that shall be discharged to the receiving waters:

TABLE A1.7: DISCHARGE STANDARDS ACCORDING TO THE EU DIRECTIVE

PARAMETER	VALUE
BOD_5	25 mg/l
COD	90 mg/l
SS	35 mg/l

For discharge to sensitive water bodies, the following additional limits shall apply:

TABLE A1.8: ADDITIONAL DISCHARGE STANDARDS ACCORDING TO THE EU DIRECTIVE FOR DISCHARGE TO SENSIBLE WATER BODIES

PARAMETER	VALUE
Total-N	15 mg/l N (10,000 to 100,000 PE) 10 mg/l N (> 100,000 PE)
Total-P	2 mg/l (10,000 to 100,000 PE) 1 mg/l (> 100000 PE)

In the case that the treated wastewater could not be reused, a possibility for discharge should be provided. The discharge point would in most cases be into a small, non permanent, water course in the vicinity of the treatment plant. Since these water courses most often are dry, they should be considered as sensible areas according to the EU directive and the additional standards in should apply.

APPENDIX 4

PROJECT IMPLEMENTATION PROGRAMME

APPENDIX 8

SLUDGE COMPOSITION AND QUALITY

SLUDGE QUALITY

Sewage sludge contains several plant macronutrients, principally nitrogen (N) and phosphorus (P), and, in most cases, varying amounts of micronutrients, such as boron (B), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo) and zinc (Zn), making its use relevant as an organic fertiliser. However, since at high concentrations several of these components, and in particular the heavy metals and organic chemicals, as well as the pathogens present in sludge could be toxic, the use of sludge in agriculture should be carried out following the procedures set out in the Code of Practice for the Use of Sludge for Agricultural Purposes, and regularly monitored, including the monitoring of sludge and soil quality, to ensure that no adverse impacts result from improper practices and insufficient sludge treatment.

The composition of the untreated sludge will depend on the sewage treatment process. Typical compositions are given in Tables A8.1 and A8.2.

TABLE A8.1: IMPACT OF TREATMENT ON THE SEWAGE SLUDGE COMPOSITION AND PROPERTIES

		A	B1	B2	C	D
Dry matter (DM)	**g/L**	12	9	7	10	30
Volatile matter (VM)	**%DM**	65	67	77	72	50
pH		6	7	7	6,5	7
C	**% VM**	51,5	52,5	53	51	49
H	**% VM**	7	6	6,7	7,4	7,7
O	**% VM**	35,5	33	33	33	35
N	**% VM**	4,5	7,5	6,3	7,1	6,2
S	**% VM**	1,5	1	1	1,5	2,1
C/N	**-**	11,4	7	8,7	7,2	7,9
P	**% DM**	2	2	2	2	2
Cl	**% DM**	0,8	0,8	0,8	0,8	0,8
K	**% DM**	0,3	0,3	0,3	0,3	0,3
Al	**% DM**	0,2	0,2	0,2	0,2	0,2
Ca	**% DM**	10	10	10	10	10
Fe	**% DM**	2	2	2	2	2
Mg	**% DM**	0,6	0,6	0,6	0,6	0,6
Fat	**% DM**	18	8	10	14	10
Protein	**% DM**	24	36	34	30	18
Fibres	**% DM**	16	7	10	13	10
Calorific value	**kWh/t DM**	4 200	4 100	4 800	4 600	3 000

A	Primary sludge
B1	Biological sludge (low load)
B2	Biological sludge from clarified water (low and middle load)
C	Mixed sludge (A and B2 types)
D	Digested sludge

TABLE A8.2: PHYSICOCHEMICAL CHARACTERISTICS OF SEWAGE SLUDGES

PARAMETER		ANAEROBIC SLUDGE		AEROBIC SLUDGE	
		MEAN	STD	MEAN	STD
Dry matter	%	20.29	8.18	22.12	12.39
Humidity	%	79.71	8.18	77.15	12.73
Ash	%	40.22	11.97	45.22	8.41
Organic matter	%	59.85	11.97	55.05	8.11
Organic C	%	30.4	7.56	26.57	3.92
Total N	%	4.08	1.58	3.21	1.13
Total P	%	0.9	0.51	2.08	1.39

PARAMETER		ANAEROBIC SLUDGE		AEROBIC SLUDGE	
		MEAN	STD	MEAN	STD
Total K	%	0.39	0.21	0.37	0.12
pH		7.42	0.41	7.1	0.66
Cd	mg/kg	2.52	2.07	3.86	5.06
Total Cr	mg/kg	414.57	355.27	113.58	76.27
Hg	mg/kg	21.69	29.98	0.98	0.5
Ni	mg/kg	164.04	248.18	76.02	50
Pb	mg/kg	196.53	80.44	221.11	114.68
Cu	mg/kg	414.18	350.49	367.09	201.23
Zn	mg/kg	1619.92	887.04	1228.48	576.77
As	mg/kg	2.82	2.15	6.51	10.19
Se	mg/kg			0.92	0.7
B	mg/kg			51.48	51.05

The average sludge composition in Cyprus is given below.

TABLE A8.3: AVERAGE SLUDGE COMPOSITION IN CYPRUS

	CYPRUS
Date	1995 – 1999
Dry Matter (%)	22 – 73
Organic Matter (% DM)	67 – 72
N % DM	3.75 – 4.53
P % DM	1.97 – 2.27
K % DM	0.25 – 0.26
mg/kg DM	
Cd	1.85 – 3.5
Cr	22 – 133
Cu	129 – 202
Hg	0.4
Ni	30 – 32
Pb	44 – 70
Zn	659 – 1173
nb/g wm	
Enteric virus	4.3 x 10^4/100g
Viable Helminth eggs	0

The sludge characteristics for the Limassol Sewage Treatment Plant are given below.

TABLE A8.4: LIMASSOL SEWAGE TREATMENT PLANT: SLUDGE CHARACTERISTICS

PARAMETER	CONCENTRATION
Nitrogen %	1.4
Phosphorus %	0.2
Potassium %	2.5
O.M. %	72
Sodium %	0.14
Boron (B), mg/l	31
Zinc (Zn), mg/l	605
Copper (Cu), mg/l	128

Cadmium (Cd), mg/l	3
Nickel (Ni), mg/l	17
Lead (Pb), mg/l	28
Chromium (Cr III), mg/l	22

SEWAGE SLUDGE COMPONENTS

- pH

The pH of sewage sludge can affect crop production at land application sites by altering the pH of the soil and influencing the uptake of metals by soil and plants. Low pH sludge (< 6.5) promotes leaching of heavy metals, while high pH sludge (> 11) kills many bacteria and, in conjunction with soils of neutral or high pH, can prohibit movement of heavy metals through the soils.

- ORGANIC MATTER

The relatively high level of organic matter in sewage sludge allows it to be used for soil improvement, including the improvement of the physical properties of soil, such as structure; the retention capacity of minerals and water; the soil bearing strength; and the reduction of the potential for surface runoff and water erosion.

The table below compares the content of organic matter of different types of sludge and other wastes that have been used as fertilisers.

TABLE A8.5: CONTENT OF ORGANIC MATTER IN SLUDGE AFTER DIFFERENT TREATMENTS AND IN OTHER URBAN WASTE AND ANIMAL MANURE

	ORGANIC MATTER CONTENT (% OF DM)
Urban Sludge	
Aerobic digestion	60 – 70
Anaerobic digestion	40 – 50
Thermal treatment	< 40
Lime treatment	< 40
Composting	50 – 85
Urban Compost	40 – 60
Animal Manure	45 – 85

- NUTRIENTS

Nutrients present in sewage sludge, such as nitrogen (N), phosphorus (P) and potassium (K), are essential for plant growth. Nutrient levels are key determinants of sludge application rates, as excessive levels due to high application rates may result in groundwater or surface water pollution. The proportion of phosphorus and nitrogen in sewage sludge is given in Table A8.6.

TABLE A8.6: CONTENT OF NITROGEN AND PHOSPHORUS IN SLUDGE AFTER DIFFERENT TREATMENTS AND IN OTHER URBAN WASTE AND ANIMAL MANURE

	TOTAL N % OF DM	N – NH_4 % OF N TOTAL	P % OF DM
Urban Sludge			0.9 – 5.2
Liquid	1 – 7	2 – 70	
Semi-solid	2 – 5	< 10	
Solid	1 – 3.5	< 10	
Composted	1.5 – 3	10 – 20	0.2 – 1.5
Urban Compost	0.96		0.39
Litter	2.2 – 4.4	10	0.61 – 1.61
Manure	4 – 7	50 – 70	0.91 – 3.3

⇩ Nitrogen

Nitrogen is mostly found under organic form in sludge, and to a lesser extent under ammoniac form. As plants can assimilate only mineral nitrogen, the agricultural value of the sludge is also determined by the aptitude of its organic N to be mineralised. Loss of nitrogen may also result from volatilisation of the ammoniac, or if nitrates are leached. This may represent a risk of groundwater pollution and can occur when the amount of sludge applied is in the excess of the plant needs in nutrients or because of the fast degradation of sludge-borne organic matter which could give rise to a peak of nutrient in the soil. Table A8.8 gives the nitrogen availability of different sludge types.

TABLE A8.7: INFLUENCE OF TREATMENT ON THE NITROGEN CONTENT OF SOME SEWAGE SLUDGE

	TOTAL N (% of DM)	N-NH_4^+ (% OF TOTAL N)
Liquid Sludge		
Aerobic digestion, gravity thickening	5 – 7	5 – 10
Aerobic digestion, mechanical thickening	4 – 7	2 – 8
Anaerobic digestion	1 – 7	20 – 70
Lagooning	1 – 2	N/A
Semi-solid Sludge		
Aerobic digestion, mechanical dewatering	3 – 5.5	< 5
Anaerobic digestion, mechanical dewatering	1.5 – 3	< 5
Lime treatment	3.4 – 5	< 10
Solid sludge		
Aerobic digestion, lime treatment	2.5	< 10
Composted	1.5 – 3	10 – 20
Aerobic, dewatered on drying beds	2 – 3.5	< 10
Anaerobic, dewatered on drying beds	1.5 – 2.5	< 10
Dried sludge	3.5 – 6	10 – 15

TABLE A8.8: NITROGEN AVAILABILITY ACCORDING TO LABORATORY TESTS

SLUDGE TYPE	AVAILABILITY (%)
Aerobic digested sludge	24 – 61 %
Anaerobic digested sludge	4 – 48 %
Digested composted sludge	7 %
Composted raw sludge	4 %
Thermally dried sludge	7 – 34 %

⇩ Phosphorus

Phosphorus is used by the plants for growth, cell wall rigidity and the development of root systems. Sludge-borne phosphorus is of particular value as phosphorus is a limited natural resource. Phosphorus in sludge is mostly present under mineral form.

TABLE A8.9: INFLUENCE OF TREATMENT ON THE PHOSPHORUS CONTENT OF SEWAGE SLUDGE

	P_2O_5 (% of DM)	P (% of DM)
Liquid sludge: aerobic digestion	4.9 – 6.9	2.1 – 3
Aerobic digestion	2.5 – 12.65	1.1 – 5.5
Primary sludge, lime treated	2.5 – 12	1.1 – 5.2

⇩ Other Compounds

Other compounds present in sludge, such as potassium, sulphur, magnesium and sodium, may also be of interest in crop production, however, they are present in sludge under various forms and their efficiency will depend on their availability.

❑ HEAVY METALS

Sewage sludge may contain varying amounts of heavy metals, some of which are nutrients needed for plant growth. However, at high concentrations they may be toxic to plants, animals and humans, affecting plant health and growth, soil properties and microorganisms, livestock and human health, and accumulate in the environment. The average content of 7 heavy metals in the member states is given below.

TABLE A8.10: AVERAGE CONTENT IN SEWAGE SLUDGE OF 7 HEAVY METALS IN THE MEMBER STATES

	DIRECTIVE 86/278/EEC mg/kg DM	RANGE IN THE MEMBER STATES mg/kg DM
Cd	20 – 40	0.4 – 3.8
Cr	1 000 – 1 750	16 – 275
Cu	1 000 – 1 750	39 – 641
Hg	16 – 25	0.3 – 3
Ni	300 – 400	9 – 90
Pb	750 – 1 200	13 – 221
Zn	2 500 – 4 000	142 – 2 000

- ORGANIC POLLUTANTS

A wide variety of organic chemicals with diverse physical and chemical properties may be present in sewage sludge. However, most sludge contains low levels of these chemicals and does not pose a significant risk on humans or the environment.

- PATHOGENS

Stabilisation greatly reduces the number of pathogens in sewage sludge, including bacteria, parasites, protozoa and viruses, together with odour potential. However, even stabilised sludge will usually contain some pathogens. Following land application, generally none of these microorganisms will leach through the soil system to pollute the receiving groundwaters. Where surface runoff occurs though, buffers should be used to filter out pathogens and prevent entry into the receiving water bodies.

APPENDIX 15

REFERENCES

1. Recycling and Disposal of Sewage Sludge, European Commission, 2001
2. Pollutants in Urban Waste Water and Sewage Sludge, European Commission, 2001
3. Evaluation of Sludge Treatments for Pathogen Reduction, European Commission, 2001
4. Extensive Wastewater Treatment Practices: Adapted to Small and Medium Sized Communities
5. Απογραφή Γεωργίας 1994, Τμήμα Στατιστικής και Ερευνών, Υπουργείο Οικονομικών
6. Γεωργικές Στατιστικές 2001, Στατιστική Υπηρεσία
7. The Assessment of Water Demand of Cyprus, Ministry of Agriculture, Natural Resources and the Environment, FAO, 2001

APPENDIX 12

DRAWINGS

APPENDIX 2

WATER CONSUMPTION AND EFFLUENT PRODUCTION

APPENDIX 3

PUMPING STATIONS

TABLE A3.1: PUMPING STATIONS

LOCATION		HEAD (m)	FLOW (l/s)	INSTALLED POWER (kW)	ANNUAL ENERGY CONSUMPTION (kWh)
	URBAN/RURAL/ GOVERNMENTAL				
PS Akaki	U	66.5	12.3	12.27	76 770
PS Astromeritis	U	33	28.5	14.11	88 273
PS Kokkinotrimithia	U	56.4	20.0	16.92	105 871
PS Palaiometocho	U	34	56.0	28.56	178 704

TABLE A3.2: GRAVITY CONVEYORS

LOCATION		PIPE	QUANTITY (m)
	URBAN/RURAL/ GOVERNMENTAL	DIAMETER (mm)	
AP1	U	300	1 093
AP2	U	200	737
AP3	U	200	133
AP4	U	200	30
AP5	U	300	141
		TOTAL	2 134

TABLE A3.3: PUMPING MAINS

LOCATION		PIPE	QUANTITY (m)
	URBAN/RURAL/ GOVERNMENTAL	DIAMETER (mm)	
AP1	U	225	1 288
AP3	U	160	2 861
AP4	U	200	3 039
AP5	U	250	3 172
		TOTAL	10 360

APPENDIX 5

CLIMATIC DATA

APPENDIX 6

Description of Communities

ASTROMERITIS

GENERAL DESCRIPTION

Astromeritis is located on the main national Nicosia-Troodos road about 20 km. west of Kokkinotrimithia, bordering on the 'buffer zone' adjacent to Morphou. It grows at a very marginal rate well below the all Cyprus rural average. This is due to its 'buffer zone' position.

POPULATION TRENDS

The population of Astromeritis has grown marginally from 2,224 in 1992 to 2,361 in 2001, corresponding to an absolute growth of only 1.6%.

There appear to exist a range of projections of future population growth with several intermediate ones. One projection is base on the current population growth rate and the other based on the capacity of the designated housing zone area. These projections give significantly different estimates. A third one is considered on the assumption of Morphou becoming accessible following a Solution of the Cyprus Problem.

TABLE A6.1: POPULATION PROJECTIONS FOR ASTROMERITIS

SCENARIOS	POPULATION (HOUSEHOLDS)			
	2001	**2010**	**2020**	**2030**
Present trend scenario (1.6% absolute growth every 10 years)	3 041	4 810	7 600	12 000
Housing land stock scenario (The additional estimated housing development capacity of vacant land stock in the housing zone apportioned evenly over the 30-year period). It implies an annual population growth of 2.3% over the next 30 years which is rather unlikely.	3 041	3 471	3 900	4 340
Probable scenario (Growth rate will most probably increase to between the rural and the urban average (1.35%) if Morphou becomes accessible and economically dynamic as in the past.	3 041	*2.0%* 3 700	*1.65%* 4 400	*1.65%* 5 200

JUSTIFICATION OF THE PROBABLE GROWTH SCENARIO

At present the main source of population growth in Astromeritis is agriculture. Its location relative ti the national and regional road network is not a significant advantage as reflected in the low population growth. It has good agricultural land and animal husbandry farms. Urbanization is unlikely to be an important future growth factor. If the buffer zone is abolished following the solution of the Cyprus problem, Astromeritis will assume a kind of suburban role relative to Morphou, justifying the assumption that it will then probably grow at about 1.35% (between the urban and the rural average rate).

The village, together with the surrounding ones, form part of a prosperous agricultural region, while its proximity to Nicosia will be a secondary factor.

Policy changes associated with membership to the European Union (purchase of houses by other European nationals) will not be relevant in this area. The solution of the Cyprus problem, as mentioned above, will stimulate additional growth relative to recent experience.

As a conclusion, a population of approximately 3 550 inhabitants is projected at the horizon of 2030.

DENSIFICATION OF THE POPOULATION

The spatial development pattern of Astromeritis is typical of most villages. It has an old village core with old houses and traditional shops, around which new shops and offices are concentrated, and a spread out of new housing development area stretch out along both sides of the main road. The area of the village housing development zone is about 300 ha of which only about 100 ha is built up. The remaining area of 220 ha is predominantly empty with scattered houses and semi-undeveloped road network. There are also scattered houses outside the designated housing development zone (about 45).

Housing development is at present controlled by the Policy for the Countryside. The housing zone has not been increased in the 2002 revision of the village planning zones. From the point of view of future infrastructure planning (such as water supply and sewerage), the area of the housing development zones is a misleading indication of the expected level of development as its population capacity in term of the land stock it includes is far greater that the realistic housing needs for the foreseeable future. The housing development zone of 320 ha corresponds to a population capacity of about 13,000, while the presently vacant land stock (about 68% of the area) could accommodate an additional amount of 1,100 housing units.

The densification of the population in the residential area is estimated to be approximately 12 inhabitants/ha.

PERISTERONA

GENERAL DESCRIPTION

Peristerona is located on the main national Nicosia-Troodos road about 13 km. west of Kokkinotrimithia, an area considered an “economic growth corridor” extending west of Nicosia to the foothills of Troodos running parallel to the present “buffer zone”. Between 1992-2001 the village experienced a population decrease.

POPULATION TRENDS

The population of Peristerona has declined from 2,275 in 1992 to 2,173 in 2001, corresponding to an absolute decrease of 4.5%. The decline is probably due to the fact that the village is surrounded by a group of larger villages with moderate population growth, and also because some young refugees staying in the village previously are reported to have moved to other villages closer to Nicosia after marriage (like Akaki, Kokkinotrimithia and Ayia Tremithias).

There appear to exist a range of projections of future population growth with several intermediate ones. One projection is base on the current population growth rate and the other based on the capacity of the designated housing zone area. These projections give different estimates.

TABLE A6.2: POPULATION PROJECTIONS FOR PERISTERONA

SCENARIOS	POPULATION (HOUSEHOLDS)			
	2001	**2010**	**2020**	**2030**
Decline population scenario (decline of 4.5% every 10 years)	703	670	640	610
Housing land stock scenario (The additional estimated housing development capacity of vacant land stock in the housing zone apportioned evenly over the 30-year period). It implies an annual population growth of 2.6% over the next 30 years which is rather unlikely.	703	960	1 220	1 500

SCENARIOS	POPULATION (HOUSEHOLDS)			
	2001	**2010**	**2020**	**2030**
Probable scenario (Growth rate will most probably gradually reach the rural average of 1.0% roughly similar to that in the neighbouring villages.	703	775	855	945

JUSTIFICATION FOR THE PROBABLE SCENARIO

The village of Peristerona has the advantage of location on the national Nicosia-Troodos road. It includes a large number of refugee houses built after 1974 (about 450) and some of the second-generation refugees move to other areas. Agricultural activity does not attract young couples. Although Nicosia is only a 30-minute travel distance away (20-25 minutes in the morning peak traffic time), urbanisation is unlikely to be an important future growth factor. The whole area lies close to the "buffer zone" and, after the solution of the Cyprus Problem it may be expected that the Turkish-Cypriot population of the village may return. It is reasonable to expect population growth will pick up to reach (1.0 % p.a.).

The village, together with the surrounding ones, form part of a prosperous agricultural region, while its proximity to Nicosia will contribute to future moderate population growth.

Policy changes associated with membership to the European Union (purchase of houses by other European nationals) will not be relevant in this area. The solution of the Cyprus Problem, as mentioned above, will increase the local population.

As a conclusion, a population of approximately 2920 inhabitants is projected at the horizon 2030.

DENSIFICATION OF THE POPULATION

The spatial development pattern of Peristerona (Akaki and Astromeritis) is typical of most villages. It has an old village core with old houses and traditional shops, around which new shops and offices are concentrated, and a spread out new housing development area stretch out along both sides of the main road. The area of the village housing development zone is about 300 ha of which only about 135 ha is built up. The remaining area of 165 ha is predominantly empty with scattered houses and semi-undeveloped road network. There are also scattered houses outside the designed housing development zone (about 35).

Housing development is at present controlled by the Policy for the Countryside. The housing zone has not been increased in the 2002 revision of the village planning zones. From the point of view of future infrastructure planning (such as water supply and sewerage), the area of the housing development zones is a misleading indication of the expected level of development as its population capacity in term of the land stock it includes is far greater that the realistic housing needs for the foreseeable future. The housing development zone of 300 ha corresponds to a population capacity of about 12,600, while the presently vacant land stock (about 55% of the area) could accommodate an additional amount of 800 housing units.

The densification of the population in the residential area is estimated to be approximately 10 inhabitants/ha.

AKAKI

GENERAL DESCRIPTION

Akaki is located on the main national Nicosia-Troodos road about 10 km. west of Kokkinotrimithia, an area considered an "economic growth corridor" extending west of Nicosia to the foothills of Troodos running parallel to the present "buffer zone". It grows at a moderate rate above the all District average, thus well below Kokkinotrimithia, Ayi Trimithithias and Palaiometocho.

POPULATION TRENDS

The population of Akaki has grown from 2,375 in 1992 to 2,675 in 2001, corresponding to an absolute growth of just under 12.6% (or 1.2% p a.)
There appear to exist a range of projections of future population growth with several intermediate ones. One projection is base on the current population growth rate and the other based on the capacity of the designated housing zone area. These projections give different estimates.

TABLE A6.3: POPULATION PROJECTIONS FOR AKAKI

SCENARIOS	POPULATION (HOUSEHOLDS)			
	2001	**2010**	**2020**	**2030**
Average 1.2% p.a. population growth scenario	780	880	990	1 115
Housing land stock scenario (The additional estimated housing development capacity of vacant land stock in the housing zone apportioned evenly over the 30-year period. It implies an annual population growth of 2.3% over the next 30 years which is rather unlikely.	780	1 480	1 780	1 580
Probable scenario (Growth rate will most probably increase to around the same rate of 1.2% until 2030.	780	880	990	1 115

JUSTIFICATION FOR THE PROBABLE GROWTH SCENARIO

The main source of population growth in Akaki is its location relative to the national and regional road network, its agricultural production and the availability of wage employment in the area (Kokkinotrimithia). Nicosia is only a 30-minute travel distance away (20-25 minutes in the morning peak traffic time). It also has good agricultural land and animal husbandry farms. Urbanisation is unlikely to be an important future growth factor. The whole area lies close to the "buffer zone" and the solution of the Cyprus Problem will add to the vitality of the area not in any significant way. It is reasonable to expect population growth will remain the same as in the recent past (1,2% p.a.).

The village, together with the surrounding ones, form part of a prosperous agricultural region, while its proximity to Nicosia explains the moderate population growth rate above the rural average. There are no further potential sources of future growth in the community such as significant increase in retail or light manufacturing employment.

Policy changes associated with membership to the European Union (purchase of houses by other European nationals) will not be relevant in this area. The Solution of the Cyprus Problem (refugee houses vacated and recycled in the housing market) may reduce the level of demand for new local housing although, equally, this factor may stimulate some new development due to the proximity to the northern area (Kyrenia region) now inaccessible.

As a conclusion, a population of approximately 3800 inhabitants is projected at the horizon 2030.

DENSIFICATION OF POPULATION

The spatial development pattern of Akaki (Peristerona and Astromeritis) is typical of most villages. It has an old village core with old houses and traditional shops, around which new shops and offices are concentrated, and a spread out new housing development area stretch out along both sides of the main road. The area of the village housing development zone is about 300 ha of which only about 134 ha is built up. The remaining area of 166 ha is predominantly empty with scattered houses and semi-undeveloped road network. There are also scattered houses outside the designed housing development zone (about 50).

Housing development is at present controlled by the Policy for the Countryside. The housing zone has not been increased in the 2002 revision of the village planning zones. From the point of view of future infrastructure planning (such as water supply and sewerage), the area of the housing development zones is a misleading indication of the expected level of development as its population capacity in term of the land stock it includes is far greater that the realistic housing needs for the foreseeable future. The housing development zone of 300 ha corresponds to a population capacity of about 12,600, while the presently vacant land stock (about 55% of the area) could accommodate an additional amount of 800 housing units.

The densification of the population in the residential area is estimated to be approximately 13 inhabitants/ha.

KOKKINOTRIMITHIA

GENERAL DESCRIPTION

Kokkinotrimithia is located very close west of Nicosia within the “growth corridor” extending west of Nicosia around the main road to Troodos almost parallel to the present “buffer zone”. It is the second fastest growing village in the area that includes Ayi Trimithias, Palaiometocho, Astromeritis and Akaki. The village has a high growth rate of 1.6% p.a. just higher than the urban average of Nicosia and suburbs (1.5% p.a.). It is directly connected to the Nicosia Troodos highway and the Nicosia Klirou-Palechori main road, through Ayi Trimithias, and close to a concentration of manufacturing establishments next to the sprawling residential area of the village.

POPULATION TRENDS

The population of Kokkinotrimithia has grown from 2,375 in 1992 to 2,675 in 2001, corresponding to an absolute growth of just under 17% (or 1.6% p a.).

There appear to exist a range of projections of future population growth with several intermediate ones. One projection is base on the current population trend and one based on the population capacity of the designated housing zone area, which roughly corresponds to the housing needs up to the year 2030 if the presently high population growth rate is increased to an average of 2.5% per annum.

TABLE A6.4: POPULATION PROJECTIONS FOR KOKKINOTRIMITHIA

SCENARIO	POPULATION (HOUSEHOLDS)			
	2001	**2010**	**2020**	**2030**
Average 1.6% p.a. population growth scenario	910	1 065	1 245	1 460
Housing land stock scenario (The additional estimated housing development capacity of vacant land stock in the housing zone apportioned evenly over the 30-year period. It implies an annual population growth of 2.5% over the next 30 years which is highly unlikely).	910	1 240	1 580	1 900
Probable scenario (Growth rate will most probably increase to around 2% until 2010 and dropping to 1.5% after that until 2030, similar to the Nicosia urban average).	910	1 110	1 290	1 500

JUSTIFICATION FOR THE PROBABLE GROWTH SCENARIO

The main source of population growth in Kokkinotrimithia is its location relative to the national and regional road network and the adjacent manufacturing employment center. Nicosia is only a 10-minute travel distance away (20-25 minutes in the morning peak traffic time). It also has good agricultural land and animal husbandry farms. Urbanisation will continue to be a major growth factor. The whole area lies close to the "buffer zone" and the solution of the Cyprus Problem will add to the vitality of the area. Due to its advantageous location the Cyprus Land Development Corporation is planning a housing scheme for 400 units between Kokkinotrimithia and Mammar for low-income families. Population growth may be estimated to increase to 2.0% p.a. but gradually reduced to 1.5% p.a.

The village, together with the surrounding ones, form part of the most prosperous peri-urban zone in the Nicosia District. There are potential source of future growth in the community such retail or industrial employment.

There is also potential for further agricultural development, but if land will continue to be converted to housing this sector will be of secondary importance relative to urban employment.

Policy changes associated with membership to the European Union (purchase of houses by other European nationals) will not be relevant in this area. The solution of the Cyprus Problem (refugee houses vacated and recycled in the housing market) may reduce the level of demand for new local housing although, equally, this factor will stimulate new development due to the proximity to the northern area (Yerolakkos and Kyrenia) now inaccessible.

As a conclusion, a population of approximately 5060 inhabitants is projected at the horizon 2030.

DENSIFICATION OF THE POPULATION

The spatial development pattern of Kokkinotrimithia is typical of most villages. It has an old village core with old houses and traditional shops, around which new shops and offices are concentrated, and a spread out new housing development area. The area of the village housing development zone is about 400 ha of which only about 140 ha is built up. The remaining area of 260 ha is predominantly empty with scattered houses and semi-undeveloped road network. There are also scattered houses outside the designed housing development zone (about 45).

Housing development is at present controlled by the Policy for the Countryside. The housing zone has not been increased in the 2002 revision of the village planning zones. From the point of view of future infrastructure planning (such as water supply and sewerage), the area of the housing development zones is a misleading indication of the expected level of development as its population capacity in term of the land stock it includes is far greater that the realistic housing needs for the foreseeable future. The housing development zone of 400 ha corresponds to a population capacity of about 17,500, while the presently vacant land stock (about 65% of the area) could accommodate an additional amount of 1,000 housing units.

The densification of the population in the residential area is estimated to be approximately 13 inhabitants/ha.

PALAIOMETOCHO

GENERAL DESCRIPTION

Palaiometocho is located very close west of Nicosia within the “growth corridor” extending west of Nicosia around the main road to Troodos almost parallel to the present “buffer zone”. It lies west of Ayi Trimithias and south of Kokkinotrimithia. It is a fast growing village although not as fast as Ayi Trimithias and Kokkinotrimithia. The village has a growth rate of 1.4% p.a. just lower than the urban average of Nicosia and suburbs (1.5% p.a.). It is directly connected to the Nicosia Troodos highway and the Nicosia Klirou-Palechori main road, through Ayi Trimithias, and close to a concentration of manufacturing establishments in Kokkinotrimithia.

POPULATION TRENDS

The population of Palaiometocho has grown from 3,536 in 1992 to 4,074 in 2001, corresponding to an absolute growth of just under 15.2% (or 1.4% p a.).

There appear to exist a range of projections of future population growth with several intermediate ones. One projection is base on the current population trend and one based on the population capacity of the designated housing zone area, which roughly corresponds to the housing needs up to the year 2030 if the presently high population growth rate of about 2.0% per annum average.

TABLE A6.5: POPULATION PROJECTIONS FOR PALAIOMETOCHO

SCENARIOS	POPULATION (HOUSEHOLDS)			
	2001	**2010**	**2020**	**2030**
Average 1.4% p.a. population growth scenario	1 178	1 355	1 560	1 790
Housing land stock scenario (The additional estimated housing development capacity of vacant land stock in the housing zone apportioned evenly over the 30-year period). It implies an annual population growth of 2.0% over the next 30 years which is rather unlikely.	1 178	1 480	1 780	2 080
Probable scenario (Growth rate will most probably increase to around 1.5% until 2010 and remain constant thereafter.	1 178	1 360	1 580	1 840

JUSTIFICATION OF THE PROBLE GROWTH SCENARIO

The main source of population growth in Palaiometocho is its location relative to the national and regional road network and the adjacent manufacturing employment center. Nicosia is only a 10-minute travel distance away (20-25 minutes in the morning peak traffic time). It also has good agricultural land and animal husbandry farms. Urbanisation will continue to be a major growth factor. The whole area lies close to the "buffer zone" and the solution of the Cyprus Problem will add to the vitality of the area. It is reasonable to expect population growth to match the Nicosia urban average of 1.5% and remain constant at that level.

The village, together with the surrounding ones, form part of the most prosperous peri-urban zone in the Nicosia District. There are potential source of future growth in the community such retail or light manufacturing employment.

There is also potential for further agricultural development, but if land will continue to be converted to housing this sector will be of secondary importance relative to urban employment.

Policy changes associated with membership to the European Union (purchase of houses by other European nationals) will not be relevant in this area. The solution of the Cyprus Problem (refugee houses vacated and recycled in the housing market) may reduce the level of demand for new local housing although, equally, this factor will stimulate new development due to the proximity to the northern area (Yerolakkos and Kyrenia) now inaccessible.

As a conclusion, a population of approximately 6400 inhabitants is projected at the horizon 2030.

DENSIFICATION OF THE POPULATION

The spatial development pattern of Palaiometocho is typical of most villages. It has an old village core with old houses and traditional shops, around which new shops and offices are concentrated, and a spread out new housing development area. The area of the village housing development zone is about 340 ha of which only about 175 ha is built up. The remaining area of 165 ha is predominantly empty with scattered houses and semi-undeveloped road network. There are also scattered houses outside the designed housing development zone (about 40).

Housing development is at present controlled by the Policy for the Countryside. The housing zone has not been increased in the 2002 revision of the village planning zones. From the point of view of future infrastructure planning (such as water supply and sewerage), the area of the housing development zones is a misleading indication of the expected level of development as its population capacity in term of the land stock it includes is far greater that the realistic housing needs for the foreseeable future. The housing development zone of 340 ha corresponds to a population capacity of about 14,000, while the presently vacant land stock (about 50% of the area) could accommodate an additional amount of 900 housing units.

The densification of the population in the residential area is estimated to be approximately 19 inhabitants/ha.

APPENDIX 7

AGRICULTURAL LAND IN THE AREA

AGRICULTURAL ASTROMERITIS – AKAKI REGION

TABLE A7.1: LAND USE IN THE REGION (1994)

	IRRIGABLE AREA (DONUMS)	NOT IRRIGABLE AREA
Temporary crops	17 114	62 239
Permanent crops	5 597	819
Fallow land	1 048	775
Grazing land	–	12
Forest land	–	105
Uncultivated land	741	2 197
Scrub land	–	555
Total	*24 500*	*66 702*
TOTAL AGRICULTURAL LAND		**91 202**

TABLE A7.2: IRRIGATED LAND BY SOURCE OF WATER IN THE REGION (1994)

	AREA (DONUMS)	PERCENTAGE (%)
Borehole / Well	24 368	99.5 %
Dam	47	0.2 %
River	48	0.2 %
Spring	39	0.2 %
TOTAL	**24 502**	**100.0 %**

TABLE A7.3: AREAS OF TEMRORARY CROPS IN THE REGION (1994)

TEMPORARY CULTIVATIONS	IRRIGATED AREA (DONUMS)	NOT IRRIGATED AREA (DONUMS)
Cereals	9 779	59 767
Pulses	1 561	29
Industrial crops	–	–
Aromatic plants	7	2
Fodder crops for grain	5	7
Green fodder for grazing	109	343
Green fodder for hay	237	458
TOTAL	**11 699**	**60 607**

TABLE A7.4: AREA OF VEGETABLES AND FLOWERS IN THE REGION (1994)

	VEGETABLES (DONUMS)	FLOWERS (DONUMS)
Open field	8 870	0

	VEGETABLES (DONUMS)	FLOWERS (DONUMS)
Greenhouses	5	16
Tunnels	–	–
TOTAL	**8 875**	**16**

TABLE A7.5: AREA AND CROPS PLANTED IN NURSERIES (1994)

PLANTS	AREA (m^2)
Ornamental plants	–
Vegetable plants	–
Seedlings	1 005
Forest plants	–
Mushrooms	5 200
Other plants	–
TOTAL	**6 205**

TABLE A7.6: AREAS OF PERMANENT CROPS IN THE REGION (1994)

CROPS	IRRIGATED AREA (DONUMS)	NOT IRRIGATED AREA (DONUMS)
Table grapes	15	24
Wine grapes	11	101
Citrus	4 160	6
Dry nuts	143	148
Fruits	281	10
Olives	1 173	300
Carobs	3	37
TOTAL	**5 786**	**626**

TABLE A7.7: TOTAL NUMBER OF TREES IN THE AREA (1994)

	NUMBER OF TREES
Citrus	185 411
Dry nuts	8 797
Fruits	11 047
Olives	27 405
Carobs	518
TOTAL	**233 178**

AGRICULTURAL LAND BY COMMUNITY

TABLE A7.8: AGRICULTURAL LAND BY COMMUNITY (1994)

COMMUNITY	AGRICULTURAL AREA (DONUMS)		
	Irrigated	Not Irrigated	Total
Kokkinotrimithia	1 394	7 271	8 665
Palaiometocho	1 575	14 508	16 083
Total	*2 969*	*21 779*	*24 748*
Astromeritis	4 563	5 297	9 860
Peristerona	7 485	4 654	12 139
Akaki	6 018	3 620	9 638
Total	*18 066*	*13 571*	*31 637*
TOTAL	**21 035**	**35 350**	**56 385**

TABLE A7.9: AGRICULTURAL LAND USE BY COMMUNITY (1994)

COMMUNITY	LAND USE (DONUMS)			
	Temporary Crops	Permanent Crops	Fallow Land	Uncultivated Forest and Scrub Land
Kokkinotrimithia	7 474	358	175	658
Palaiometocho	14 317	533	344	892
Total	*21 791*	*891*	*519*	*1 550*
Astromeritis	7 537	1 319	322	681
Peristerona	8 288	2 376	469	1 006
Akaki	8 405	712	161	359
Total	*24 230*	*4 407*	*952*	*2 046*
TOTAL	**46 021**	**5 298**	**1 471**	**3 596**

TABLE A7.10: AREAS OF TEMPRORAARY CROPS BY COMMUNITY (1994)

COMMUNITY	CULTIVATED AREAS (DONUMS)					
	Cereals	Pulses	Industrial	Fodders	Potatoes	Vegetables
Kokkinotrimithia	6 675	78	–	446	106	209
Palaiometocho	13 757	34	–	49	298	414
Total	*20 432*	*112*	*0*	*495*	*404*	*623*
Astromeritis	5 192	257	–	751	1 203	366
Peristerona	5 413	691	–	477	1 568	514
Akaki	6 447	121	–	147	1 609	809
Total	*17 052*	*1 069*	*0*	*1 375*	*4 380*	*1 689*

COMMUNITY	CULTIVATED AREAS (DONUMS)					
	Cereals	Pulses	Industrial	Fodders	Potatoes	Vegetables
TOTAL	**37 484**	**1 181**	**0**	**1 870**	**4 784**	**2 312**

TABLE A7.11: PERMANENT CULTIVATIONS BY COMMUNITY (1994) (NUMBER OF TREES)

COMMUNITY	Vines (donums)	Citrus	Fruits	Nuts	Olives	Carobs
Kokkinotrimithia		5 684	2 608	591	3 089	32
Palaiometocho	1	6 732	3 171	1 202	6 794	3
Total	*1*	*12 416*	*5 779*	*1 793*	*9 883*	*35*
Astromeritis	–	51 442	1 982	783	3 068	10
Peristerona	–	96 972	762	559	3 316	15
Akaki	1	17 687	756	54	4 623	160
Total	*1*	*166 101*	*3 500*	*1 396*	*11 007*	*185*
TOTAL	**2**	**178 517**	**9 279**	**3 189**	**20 890**	**220**

TABLE A7.12: UNIT CROP IRRIGATION WATER DEMAND (m^3/Decar/Year, 2001)

CULTIVATIONS	ASTROMERITIS	KOKKINOTRIMITHIA	NICOSIA
Permanent Cultivations			
Citrus	750	800	800
Deciduous	800	850	900
Olives	480	500	500
Table grapes	270	300	300
Fodders	1 150	1 200	1 300
Almonds	550	600	650
Temprary Cultivations			
Tomatoes GH[1]	850	900	1 000
Cucumbers GH	850	900	1 000
Beans GH	600	650	750
Peppers GH	850	900	1 000
Melons GH	600	650	750
Strawberries GH	700	750	850
Flowers GH	950	1 000	1 100
Potatoes	300	350	450
Tomatoes OF[2]	600	650	750
Cucumber OF	600	650	750
Beans OF	600	650	750
Squash	350	400	500
Onions	450	500	600
Peppers OF	600	650	750

CULTIVATIONS	ASTROMERITIS	KOKKINOTRIMITHIA	NICOSIA
Groundnuts	550	600	700
Cabbage	450	500	600
Parsley	750	800	900
Carnation	900	950	1 050
Artichoke	700	750	850
Kolokasse	2 040	2 100	2 220
Spices	350	400	500
Carrots	440	480	560
Beets	250	300	400
Watermelon	450	500	600
Broad beans	100	150	250
2. Greenhouse, 2. Open Field			

TABLE A13: CILTIVATED AREAS AND WATER DEMAND ON AREAS OUTSIDE THE GOVERNMENT IRRIGATION SCHEMES (2001)

	Citrus	Deciduous	Olives	Fodder	Potatoes	Vegetables
Akaki						
Cultivated areas (donums)	502			63	1 017	4036.5
Water demand (m^3/year)	536 904			100 440	476 245	3 510 000
Unit ittigation water demand (m^3/donum/year)	1 070			1 594	468	870
Astromeritis						
Cultivated areas (donums)	1 062	19		45	809.5	1 906
Water demand (m^3/year)	1 065 930	19 808		69 115	324 825	1 530 000
Unit ittigation water demand (m^3/donum/year)	1 004	1 059		1 536	401	803
Kokkinotrimithia						
Cultivated areas (donums)	184			66.5	54	374
Water demand (m^3/year)	197 112			107 352	25 200	325 000
Unit ittigation water demand (m^3/donum/year)	1 071			1 614	467	869
Palaiometocho						
Cultivated areas (donums)	155			10.5	183	822

	Citrus	Deciduous	Olives	Fodder	Potatoes	Vegetables
Water demand (m^3/year)	165 376			16 800	85 575	715 000
Unit ittigation water demand (m^3/donum/year)	1 067			1 600	468	870
Peristerona						
Cultivated areas (donums)	2 705	11	135	13.5	898.5	3 513
Water demand (m^3/year)	2 714 213	12 304	86 372	20 125	360 675	2 820 000
Unit irrigation water demand (m^3/donum/year)	1 003	1 119	640	1 491	401	803

APPENDIX 9

LAND REQUIREMENTS FOR IRRIGATION

APPENDIX 16

OPINION OF THE PUBLIC AUTHORITY

Page 37: [1] Deleted **Nasia** **22/03/2004 16:07:00**

The existing Larnaca STP is within a designated Da2 Protection Zone, as a result of its proximity to the Larnaca Salt Lakes. Areas designated as Protection Zones include sites of natural beauty, forests, parks, public recreation areas, archaeological sites and buffer zones. Protection zones are classified as Da2, Da3 and Da5, with the associated construction provisions being more restrictive for Da2 areas. The 1% land coverage that is permitted in Da2 zones, significantly increases the land requirements for construction, thus effectively diverting development away from such sites.

The Larnaca Salt Lakes are of a significant ecological value, being one of the most important wetland habitats on the island. This includes the lakes to the northwest and south-southeast of the airport, as well as the lake fringes.

In 1997 the Council of Ministers approved the Programme for the Protection and Management of the Larnaca Salt Lakes, aimed at the protection and conservation of the lake habitats, and the protection and conservation of the area from any kind of pollution or environmental degradation. The Larnaca District Plan endorses the proposals of the Programme, which must be taken into account by the Planning Authority and other bodies in connection to any development plans examined for the area.

The lake to the northwest of the airport is a designated Ramsar site, having being recognised as a wetland of international importance, significant for the conservation of biodiversity. Furthermore, it has been proposed that the lakes be included in the Natura 2000 network.

According to the District Plan, there will be no development of the area to the south of the airport (to the southwest of the existing STP) as a result of its designation as a Natura 2000 site and its status as part of the sensitive lake ecosystem, as well as due to its proximity to the airport, the STP and the desalination plant.