Natural wastewater treatment systems in Greek communities: Mesoropi and Moustheni constructed wetlands plants

D. Markou[1], I.E. Margaritou[1], G.D. Gikas[2]*, G. Sylaios[2], and V.A. Tsihrintzis[3]

[1]Sustainable Development Engineering & Consulting (SD-ECO), 2 Souliou, 64007 Nea Peramos, Greece

[2]Department of Environmental Engineering, School of Engineering, Democritus University of Thrace, 67100 Xanthi Greece, 12 V. Sofias, 67100 Xanthi, Greece

[3]Centre for the Assessment of Natural Hazards and Proactive Planning & Laboratory of Reclamation Works and Water Resources Management, School of Rural and Surveying Engineering, National Technical University of Athens, 9 Iroon Polytechniou St., Zografou 157 80, Athens, Greece

*Corresponding author:

E-mail: ggkikas@env.duth.gr, Tel: +30 25410 79381

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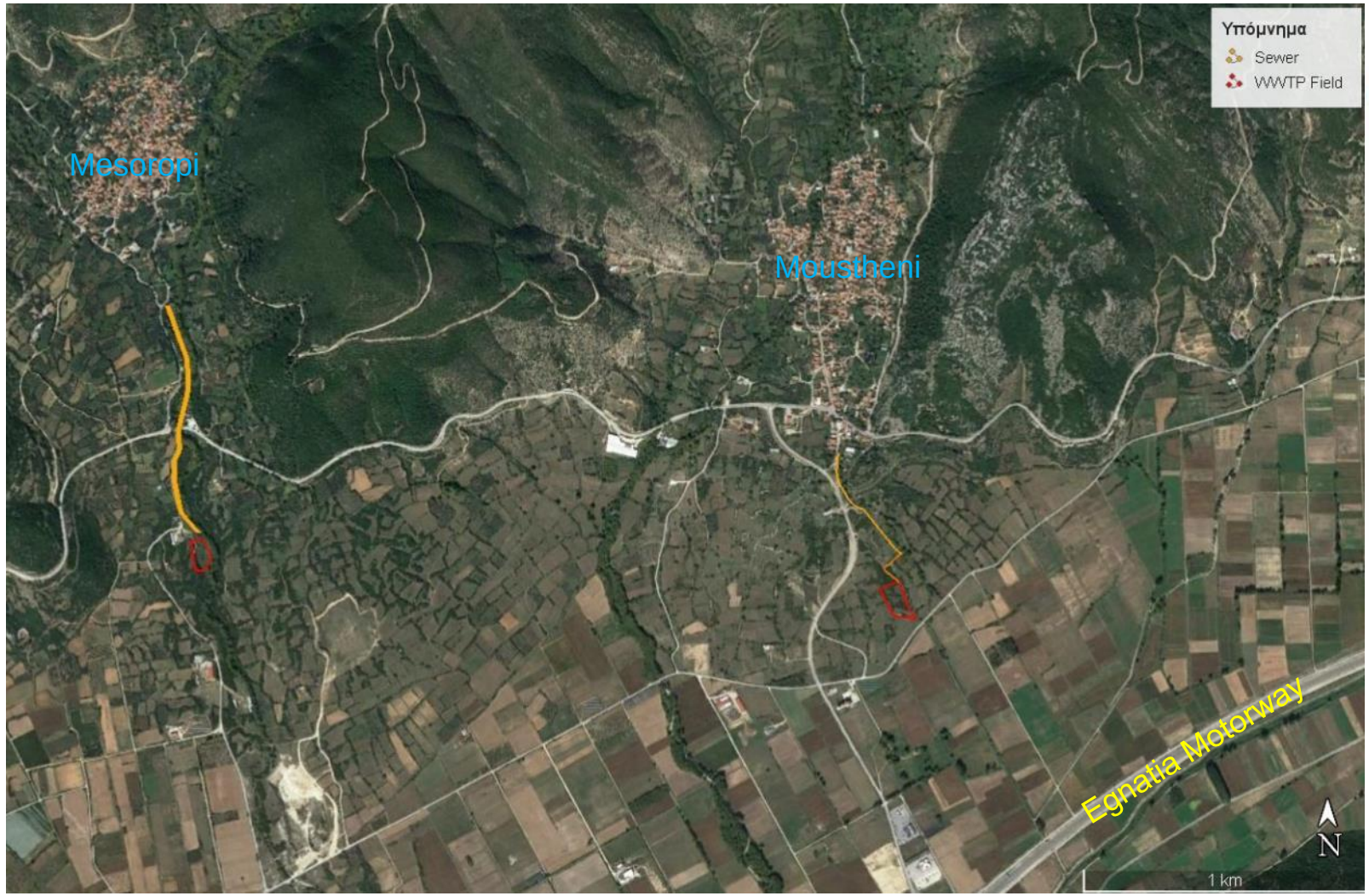
Study area



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Study area

The communities Mesoropi (N: 40°51'10", E: 24°05'05") and Moustheni, (N: 40°51'04", E: 24°06'53") are located in the Municipality of Paggaio, Northern Greece.

Based on census data for 1991, 2001 and 2011, the population of Mesoropi was 546, 523 and 456 residents, respectively, representing a 4.2% decrease during the first decade and a decrease of 12.8% during the second decade. The population of Moustheni was 788, 828 and 647 residents for 1991, 2001 and 2011 respectively, representing a 5%, increase initially, and a significant decrease of 22% thereafter. In 2016, when the project was designed, the population of Mesoropi and Moustheni was 456 and 647 residents, respectively.

Up to date, the sewage of each community is discharged, untreated into its adjacent stream, which eventually confluences to the Marmara Stream. These streams are also chosen as the recipient of the systems' treated discharge

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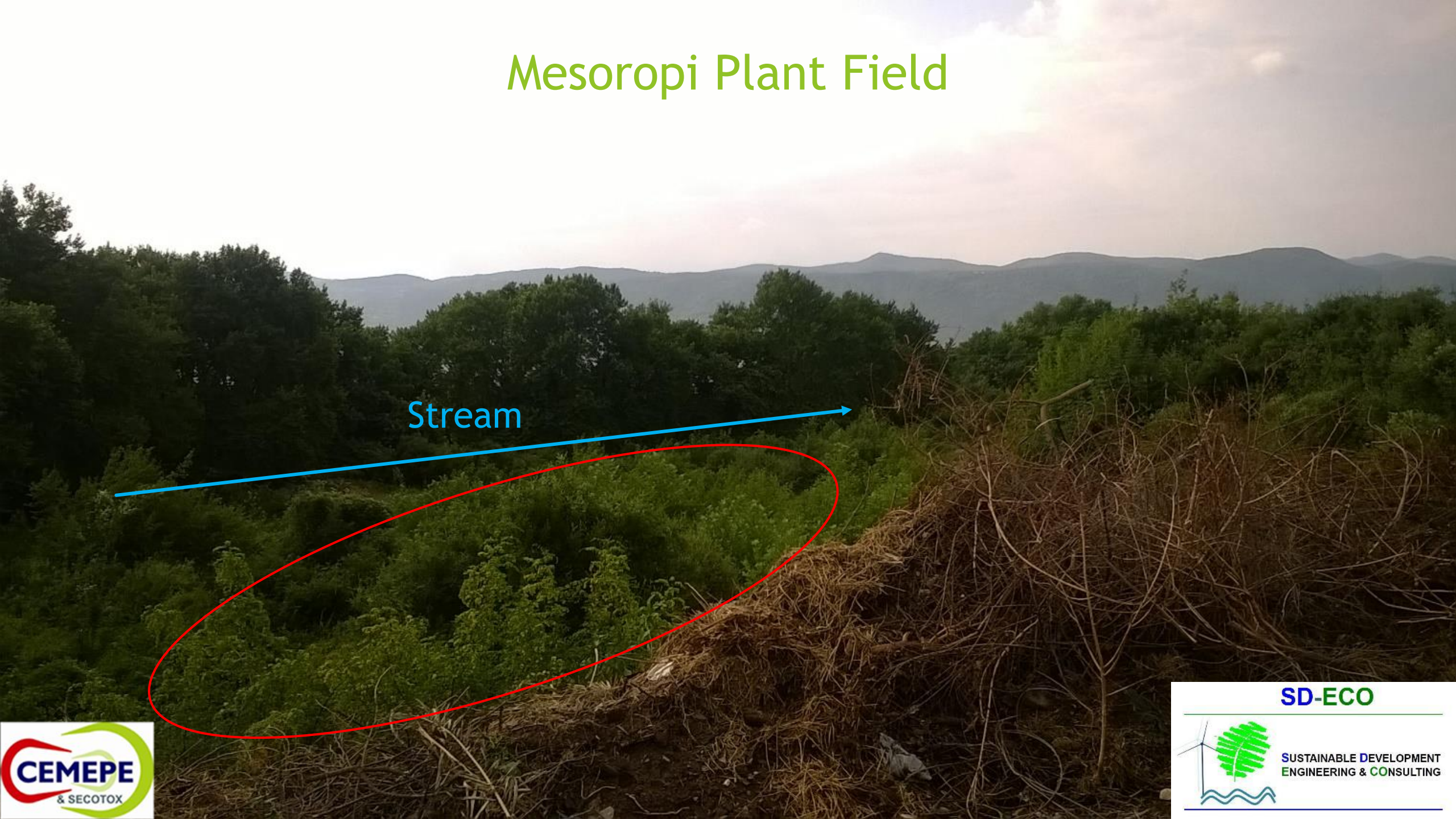
Mesoropi Plant Field



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Moustheni Plant Field (from SW end to North)

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Design parameters of Mesoropi and Moustheni plants

Mesoropi	Wastewater unit discharge	150 L/p.e./d
	Design population	825 p.e.
	Total winter flow	68.4 m^3/d
	Total summer flow	123.7 m^3/d
Moustheni	Wastewater unit discharge	150 L/p.e./d
	Design population	1138 p.e.
	Total winter flow	97.1 m^3/d
	Total summer flow	170.7 m^3/d

According to the latest data of Paggaio's Municipal Enterprise for Water Supply and Sewerage (2015), there is an increase of 80% in water consumption during the summer months, which can be attributed to the increase in population at that time. Thus, the wastewater treatment plants were designed considering current (2016) and future population (2036).

The climatic conditions of the area are suitable for natural systems, as the average monthly temperature throughout the year, with certain exceptions, is higher than 0 °C. The occasional drop in air temperature will not affect the operation of the system, as the temperature of the incoming wastewater is always above 0°C and its flow will take place underground for the entire system.

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	Parameters	Influent		Effluent	Units
		Winter	Summer		
Mesoropi	BOD_5	60			g/p.e./d
	BOD_5 Load	27.4	49.5		kg/d
	BOD_5 Concentration	400		25	mg/L
	COD Concentration	600		125	mg/L
	SS	60			g/ p.e./d
	SS Load	27.4	49.5		kg/d
	SS Concentration	400		35	mg/L
	TN	10			g/ p.e./d
	TN Load	4.6	8.2		kg/d
	TN Concentration	67		15	mg/L
	TP	1			g/ p.e./d
	TP Load	0.5	0.8		kg/d
	TP Concentration	6.7		2	mg/L
	EColi Concentration	1,E+08			MPN/100 ml
Moustheni	BOD_5	60			g/ p.e./d
	BOD_5 Load	38.5	38.5		kg/d
	BOD_5 Concentration	400		100	mg/L
	COD Concentration	600			mg/L
	SS	60			g/ p.e./d
	SS Load	38.8	38.8		kg/d
	SS Concentration	400			mg/L
	TN	10			g/ p.e./d
	TN Load	6.5	6.5		kg/d
	TN Concentration	67			mg/L
	TP	1			g/ p.e./d
	TP Load	0.6	0.6		kg/d
	TP Concentration	6.7			mg/L
	EColi Concentration	1,E+08			MPN/100 ml

Design parameters of Mesoropi and Moustheni plants

(according to the EU Urban Wastewater Treatment Directive 1991/271/EEC)

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System description

Two hybrid wastewater treatment plants in two adjacent communities, Mesoropi and Moustheni, located in the Municipality of Paggaio, Northern Greece were designed. Each system comprises in series:

- a screen
- an anaerobic tank consisting of two chambers,
- two stages of vertical flow CW beds
- one stage of horizontal subsurface flow CW bed
- a chlorination tank for disinfection purposes
- a sludge drying bed

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Technical specifications of Mesoropi and Moustheni plants

Parameter		1st stage	2nd stage	3rd stage	Sludge Treatment
Type of bed		VF	VF	HSF	SDB
Number of beds		3	2	1	1
Depth (cm)		90	90	50	20
Mesoropi	Length (m)	16.8	20.6	26.2	11.05
	Width (m)	14.3	11.7	16.0	5.5
	Area (m^2)	240.5	240.5	420.7	60.775
Moustheni	Length (m)	20.6	20.6	37.6	11
	Width (m)	16.1	16.1	15.7	5.5
	Area (m^2)	331.1	331.1	589.8	60.5

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Technical specifications of Mesoropi and Moustheni plants

Geomembrane

1 mm thick high density polyethylene (HDPE) geomembrane, for the complete waterproofing of the beds

Special Geotextile

on both sites, to avoid damage to the geomembrane (holes, tearing, etc.) caused by direct contact with sharp-edge stones or gravel

Porous media

1st and 2nd stage CW

4 layers (bottom to top):

- cobbles 0.2 m (Ø30-60 mm),
- coarse gravel 0.3 m (Ø8-20 mm),
- fine gravel 0.3 m (Ø3-10 mm) and
- (coarse) sand 0.1 m (Ø0.2-3 mm)

3rd stage CW

- 50 cm of coarse gravel (Ø18-30 mm).

Vegetation

All CW beds are planted with *Phragmites australis*

(4 plants/m^2).

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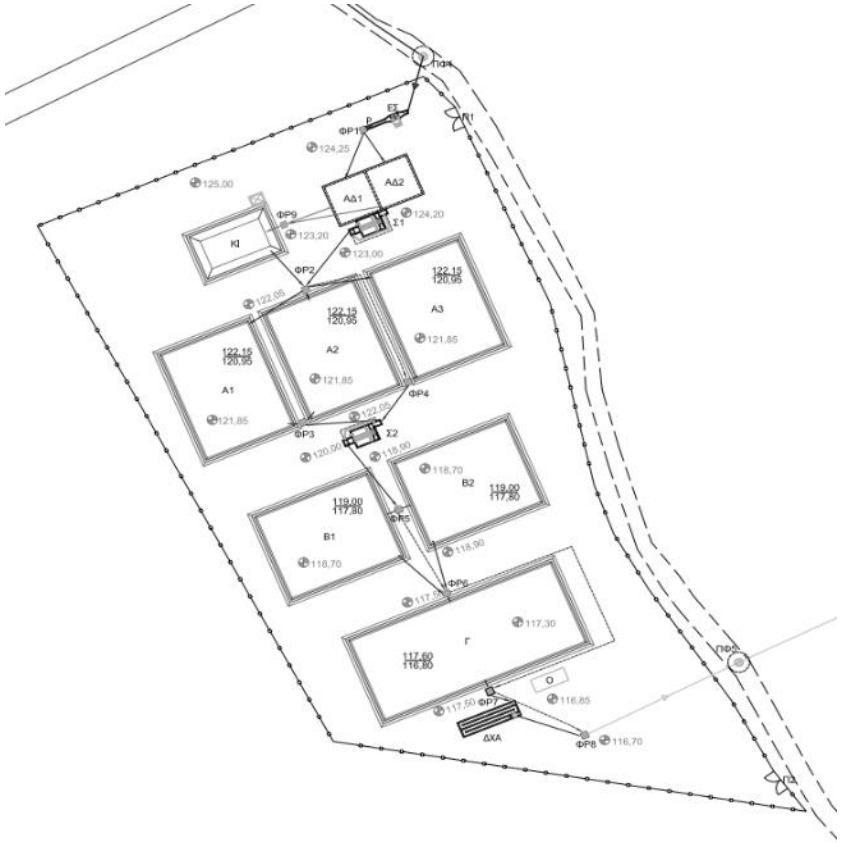
Plan view of (a) Mesoropi and (b) Moustheni WWTPs

(a)



(b)

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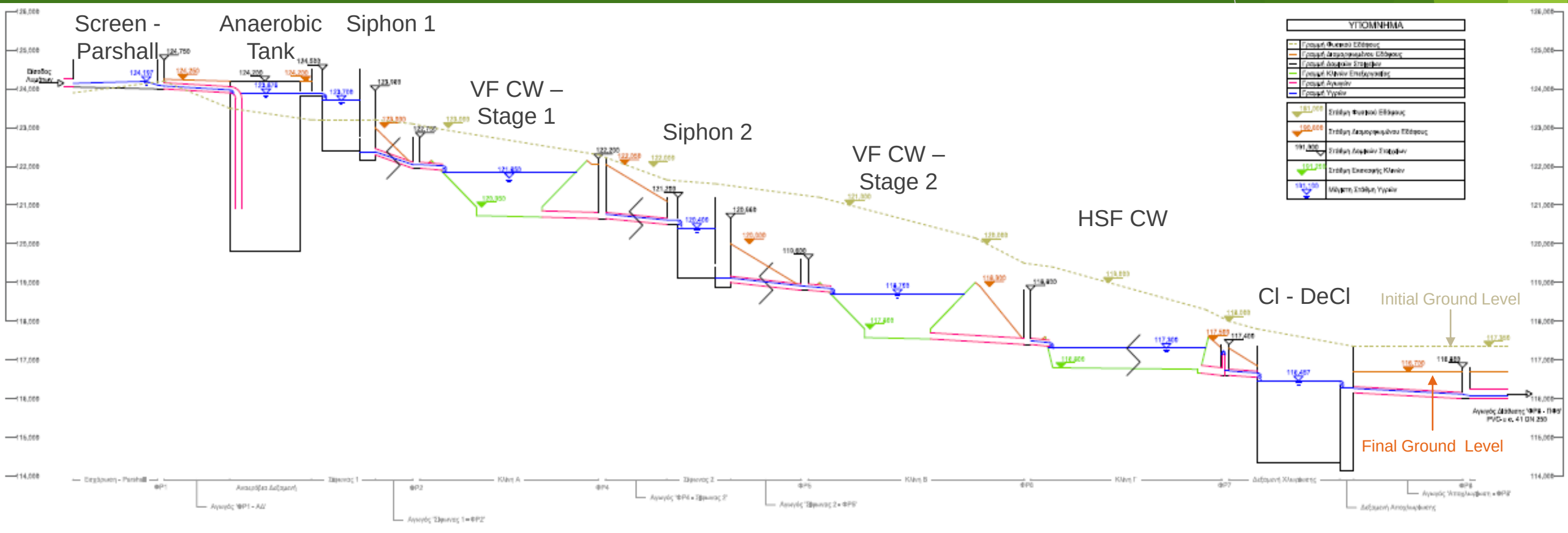
Longitudinal Section of Moustheni WWTP



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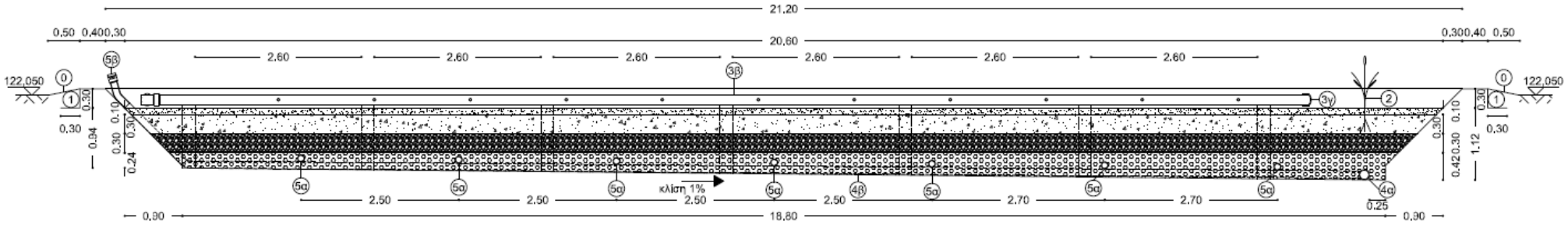
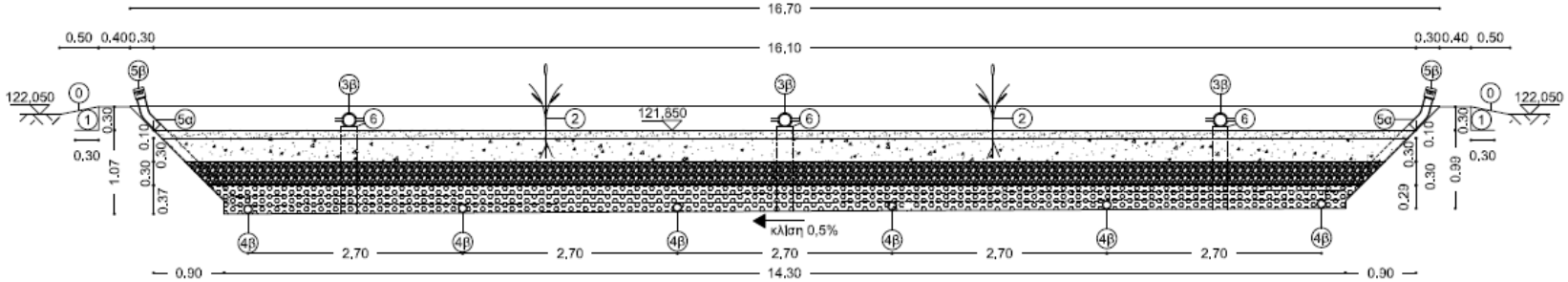
Cross Sections of VF CWs





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Construction and operation cost

Construction costs were estimated at 400.000 Euros and 610.000 Euros for Mesoropi and Moustheni systems, respectively.

Electrical consumption is estimated to be about 2 MWh/yr for each plant.

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Conclusions

Conventional wastewater treatment methods are difficult to maintain for small municipalities. On the other hand, the constructed wetlands technology is proving to be a highly efficient alternative for wastewater treatment for small communities, like Moustheni and Mesoropi.

The proposed project will contribute to the upgrading of the natural and man-made environment of the area by treating the wastewater of the communities, which are currently disposed of untreated in the adjacent stream. After the completion of the projects the wastewater of both Moustheni and Mesoropi will end up treated in the adjacent stream, and, finally, in the Marmara Stream.

CWs could contribute to the Greek economy, since there is no need for mechanical and electrical equipment (which is usually imported from other countries) for their construction.

The construction and operation of the facilities are of aid to the economic development of the area.

During the dry periods of the year, the wetlands will contribute to the indirect enrichment of the underground aquifer.

Overall, CWs are the ideal choice for wastewater treatment in small communities in rural areas of Greece.

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