Interreg
Greece-Bulgaria
European Regional Development Fund

EUROPEAN UNION

GREENPUMP

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Interreg V-A "Greece-Bulgaria 2014-2020" Cooperation Programme.

INTERREG V-A "GREECE - BULGARIA 2014 – 2020" COOPERATION PROGRAMME

PROJECT BENEFICIARY:	**Municipality of Pilea - Hortiatis**
PROJECT:	**Management of underground water resources for the needs of non-portable water, heating and underground areas protection (GREEN PUMP) within the framework of INTERREG V-A ''Greece-Bulgaria 2014-2020.**
OBJECTIVE:	**Preparation & supervision of initial tests' good performance, technical reports, improvement proposals & trial operation of installations**
OPERATION:	**4.5.1 Elaboration of criteria for site selection in the schools' premises**
BUDGET :	*«TOTAL BUDGET FOR THE OPERATION (CONTRACTED BUDGET in €) (ERDF: 766.194,23 € / National Funds: 135.210,75 €)»*

ALTEREN S.A.
Proektasi Egnatias, 55535 PYLAIA THESSALONIKI
Tel: +30 2310282528
GREECE

ALTEREN A.E.
ΕΝΕΡΓΕΙΑ ΚΑΙ ΠΕΡΙΒΑΛΛΟΝ
ΑΝΩΝΥΜΗ ΜΕΛΕΤΗΤΙΚΗ ΤΕΧΝΙΚΗ ΕΤΑΙΡΕΙΑ
Προέκταση Εγνατίας, ΤΘ 2119, 55535 ΠΥΛΑΙΑ ΘΕΣ/ΝΙΚΗΣ
Τηλ.: 2310282528, 263930 FAX: 2310283725
Α.Φ.Μ.. 084055550 - Δ.Ο.Υ. Φ.Α.Ε. ΘΕΣ/ΝΙΚΗΣ
ΑΜΑΕ 49375/62/Β/01/0156

CONTENTS

1. GENERAL

The report refers to services related to WP4/4.5.1 package ''Developing criteria for the optimal selection of shallow premises primarily for energy purposes (heating, air conditioning) but also for secondary uses. The purpose is the creation of a system (tool) for the support of decisions by defining the weighting factors of the above criteria''. This service package relates to the contract between ALTEREN S.A. and the Municipality of Pilea-Hortiatis that is part of the project *"Management of underground water resources for the needs of non-potable water, heating and underground areas protection (GREEN PUMP)"* within the framework of INTERREG V-A "Greece-Bulgaria 2014 – 2020". The report includes the following:

- Definitions of shallow aquifer water use and use of gray water.
- Criteria for selection:
  - over the location of the buildings for the implementation of such installations
  - over the use of the facilities for energy purposes
  - over the use of the facilities for secondary uses
- Weight of criteria and procedures for the selection of buildings
- Example application in the 1st High school of Pilea

2. SMALL DEEP AQUATORS AND GRAY WATER

2.1. Shallow aquifer water and their uses

Aquifers are in fact geological formations that contain water and allow the passage of significant water quantities.

Therefore they consist of soil material and empty space in which water is collected. Water quality in the aquifer depends on several factors, such as the type and the extent of industrial and agricultural activities in the wider area. On the contrary, the amount of water of the groundwater aquifers depends on rainfalls, geological and soil characteristics of the area (type of vegetation, soil slope, etc.).

The water potential of these aquifers is an important asset that should be managed rationally. One of the basic properties of groundwater is its temperature, which depends on the intensity of the thermal flow that develops in the basin.

Therefore, energy is stored in any groundwater mass and in the surrounding geological formations, even when they do not have the high temperatures of geothermal water.

In the sedimentary basins of Greece, the heat intensity is often twice as high and temperatures of 17-20°C are met in shallow hydrological systems and aquifers (15-100m). The water contained in these systems can be used in energy applications such as geothermal heat pump air conditioning systems.

Thus, in areas where the aquifer is shallow, it has sufficient quantities of good quality water and geological formations do not make it difficult to drill it for use in energy uses or uses similar to gray water (irrigation and sanitation). For the sake of completeness, the following paragraph gives the definition of gray water and their usual uses.

2.2. Definition of gray water and their use

Gray water (semi-unclean) is defined as the water flow resulting from the use of the WC sink, bathtub, shower and wash basins, dishwashers and laundry and not those derived from the WC basin (unclean).The gray water is usually characterized by low to moderate levels of germs.

The utilization of gray water constitutes a method of water saving as it reduces the use of potable water. Gray water can be used in flushes as well as for irrigation – watering green spaces. Gray water is usually collected and transported by a discrete network of pipes to a temporary storage tank, where it is treated, cleaned and then transported to a storage tank, where it is stored for future use in flushes and irrigation.

3. SHORT AQUATOR WATER USE SYSTEM

As already mentioned, the water of these aquifers is utilized by pumping through a well,. The system consists of:

- Drilling
- Storage tank of pumped water
- Pipeline network from drilling to tank and from tank to end use

The end use can be either for irrigation and water supply networks in sanitary facilities or for energy use in heat pumps.

<u>Irrigation systems using shallow water drillings</u>

Irrigation systems include distribution piping network, automations and water transfer terminals usually in the root system of the plant. It is suitable for irrigation of green areas, ornamental trees and flowers. The design of these systems does not require any specification other than pipeline marking.

<u>Water supply systems using shallow water drilling</u>

This system focus on the use in toilets, particular in the flushes. The use in other indoor facilities of buildings is forbidden. It cannot be connected to existing networks but through new networks with appropriate signage.

Figure 1. Typical use of non-potable water

<u>Energy use of shallow wells</u>

The use of water for energy reasons is mainly focused on geothermal pump systems for space heating/cooling. Exploiting the temperature difference between groundwater and the earth's surface can be done using Geothermal Heat Pumps (GHPs), which utilize the energy potential called shallow geothermal energy, mainly for heating in winter and cooling in summer period as long as for hot water supply.

The good use of energy is achieved by the application of a borehole-coupled heat pump combination. A properly designed and manufactured system operates at 30% higher energy efficiency than the best air-to-air heat pump system.

Geothermal systems, which utilize shallow geothermal energy, are divided in two categories: a) closed and b) opened circuit.
The closed looped geothermal heat exchangers consist of an underground network of high strength plastic pipes, which act as a heat exchanger. The pipes are connected to the heat pump where a circuit terminates. Inside the circuit, a water solution with an environmentally friendly antifreeze circulates. A closed circuit circulates continuously, under pressure, the heat transfer solution. The system connecting the land and the building is closed and consequently no salt deposits occur. This results in low maintenance requirements for the system.

Figure 2. Geothermal heat pump (1st Gymnasium of Pilea)

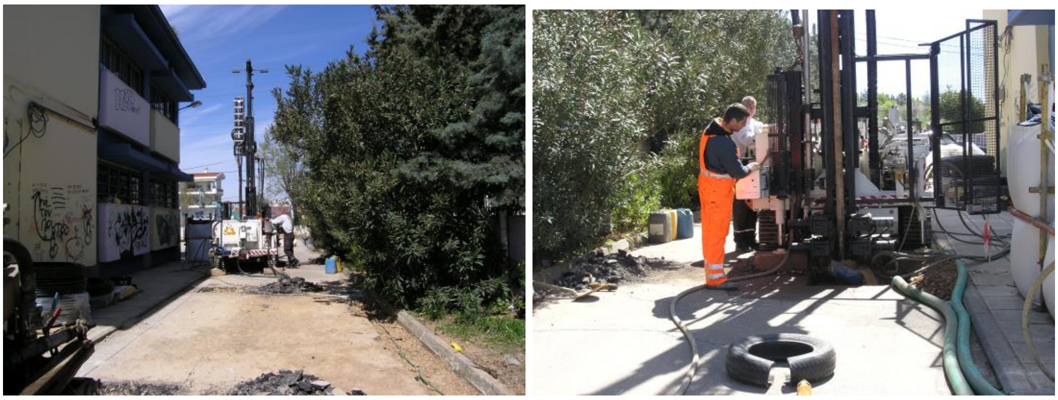

Figure 3. Shallow geothermal drilling (1st Gymnasium of Pilea)

The following section discusses the criteria for selecting and using water, whether in energy or in water and irrigation systems for public buildings.

4. CRITERIA FOR THE SELECTION OF BUILDINGS FOR THE USE OF SHALLOW AQUIFER WATER

4.1. General

Building selection (i.e. schools and other public buildings) for the implementation of projects concerning the use of shallow drilling for irrigation, sanitation and energy use should be evaluated by a number of criteria related to:

- The existence of an aquifer.
- The location of the building.
- The size.
- The facilities and areas of the building.

4.2. Existence of an aquifer

4.2.1. Groundwater maps

Indication, but not accurate, of groundwater availability could be given by Geodata maps (http://geodata.gov.gr/maps). The website of MoE provides maps that include the Greek groundwater boundaries. Groundwater is the sum of the water beneath the surface of the soil, in the saturation zone and in direct contact with the soil or underground. The last revision of these maps took place on 4/11/2015.

Therefore, if the location of the building is included in similar groundwater maps, it means that water is likely to be at a shallow depth.

4.2.2. Hydrogeological study

The existence of an aquifer is certified, for each area, through an appropriate hydrogeological study. The main purpose of the study is to record the current status of the groundwater reserves and to propose plans for future groundwater reuse projects. In addition, it provides knowledge of the hydrological behavior of the formations, estimation of their water potential and identifying problems that may arise during their exploitation. Furthermore, it provides information on separation into good and bad quantitative zones and suggestions to manage them.

Therefore, it is the basic tool for documenting the existence of groundwater in the wider area of the building.

4.3. Criteria for the location of the building

4.3.1. Buildings outside urban zone

Buildings within the urban zone usually do not have green spaces in the backyard. As a result, buildings with green facilities outside the urban zone should be preferred so that a drilling can take place. Drilling has to be accompanied by proper permits, which is difficult to be done in the case of buildings within the urban zone.

4.3.2. Available surface for drilling

There should be room for drilling. The usual required space is not large (~ 4-5 m^2). A fence for protection has to be installed and at a suitable location has to be chosen in order to minimize the risk of accidents. This area should also be within walking distance of the drilling water use points, in order to reduce the cost of construction of the water network and its proper operation.

4.3.3. Ability to enter the building site vehicles for construction work and especially for drilling work.

Basic and necessary condition. Drilling cannot exist without direct access and routing for heavy duty machinery.

4.4. Size of building

The size of the building is a criterion of low weight but it affects the size of the premises. It is believed that larger and newer buildings have large population buildings, in which interventions can be done. In addition, they have higher consumption so the installation of drilling to meet water needs in sanitary facilities makes sense. It is also noted that larger schools are more likely to have green facilities for the use of irrigation water.

4.5. Facilities and spaces of the building

4.5.1. Gathered sanitary facilities

In most school buildings, sanitation facilities are concentrated in one place per floor. As a result, drilling water networks can be made without high cost of piping and high running costs.

In the case of old buildings, there is the possibility of scattered installations that do not fit the network. It is, therefore, important to state that sanitation facilities are concentrated on one side of the building.

4.5.2. Lands of greenery for irrigation

As mentioned in the previous paragraph, there should be such installations otherwise it is useless to use drilling water for irrigation.

4.5.3. Electromechanical installation facilities

The criterion of space is very essential for the electromechanical installations. A space of 30 m² is required near the sanitary facilities. If not, it is difficult to locate the positioning of the facilities.

5. CRITERIA FOR DESIGNING PLANTS FOR ENERGY PURPOSES

5.1. Specifying the energy uses

Drilling water can also be used for purposes other than irrigation and sanitation. Heating and cooling needs of buildings, as well as hot water (energy uses), utilizing geothermal energy are some examples. Geothermal energy is defined as the use of energy from the inside of the soil by means of geothermal pumps (heat transfer from and to the ground).

5.2. Drilling water utilization criteria for energy uses

Air conditioning (heating, cooling) is the main area – energy use. Therefore, utilizing geothermal energy will help save energy and reduce greenhouse gas emissions (climate change). This criterion is critical for large area buildings and users (such as public buildings, schools) and old buildings (exposed buildings, high temperature openings, etc.). It is emphasized that in order to improve the energy performance of a building, the design and installation of energy efficient air conditioning systems is not enough. Several interventions in the building shell (building blocks, openings) is necessary to be done. In addition, if the use of geothermal heat pumps is economically acceptable, it could be used for cooling in the building.

The criteria for the use of geothermal energy include the following:

- Sufficiently insulated buildings of category B+ of KENAK
- Cooling need of the building
- Available spaces for installation of equipment

6. IMPORTANCE OF CRITERIA

The evaluation of the criteria mentioned in the previous chapter is based on the following table:

Table 1. Importance factors and criteria evaluation

A/A	CRITERION	YES	NO	IMPORTANCE
1.	**Existence of aquifer**			
1.1.	Initial indication from Geodata groundwater maps			□□
1.2	Groundwater hydrogeological study of the wider area of the building			□□□
2.	**Criteria for the position of the school**			
2.1.	Building outside the urban zone			□□
2.2	Available surface for drilling			□□□
2.3	Ability to enter in the school premises vehicles for work			□□□
3.	**Building size**			
3.1	Population			□
4.	**Facilities and premises**			
4.1	Gathered sanitary facilities			□□
4.2	Lands of greenery for irrigation			□□□
4.3	Available spaces for installation of electromechanical installation			□□
5.	**Good use of energy**			
5.1	Building rating by KENAK (>B+)			□□□
5.2	Building cooling needs			□□□
5.3	Available spaces for installation of electromechanical installations			□□

7. PRESENTATION OF IMPLEMENTATION OF CRITERIA IN THE 1ST HIGH SCHOOL OF PILEA

The school is selected for use in similar applications as long as the criteria of importance □□□ are met with YES in the above table. As an example, the criteria table is filled out for the 1st High School of Pilea. The selection of the school is justified by the criteria.

Table 2. Criteria selection for 1st High School				
A/A	CRITERION	YES	NO	IMPORTANCE
1. 1. Aquifer existence				
1.1.	Initial indication from Geodata groundwater maps	✓		□□
1.2	Hydrogeological study of groundwater of the wider area of the building		✓	□□□
2. Criteria for the position of the school				
1.1.	School outside the urban zone	✓		□□
1.2	Available surface for drilling	✓		□□□
1.3	Ability to enter in the school premises vehicles for work	✓		□□□
3. Building size				
3.1	Over 100 students	✓		□
4. Facilities and premises				
4.1	Gathered sanitary facilities	✓		□□
4.2	Lands of greenery for irrigation	✓ (> 300 m²)		□□□
4.3	Available spaces for installation of electromechanical installation	✓ (> 30 m²)		□□
5. Good use of energy				
5.1	Building rating by KENAK (>B+)			□□
5.2	Building cooling needs		✓	□□□
5.3	Available spaces for installation of electromechanical installations	✓		□□

The application of the above qualifies for use in the 1st High School in irrigation and water supply facilities.

8. PRESENTATION OF THE INSTALLATION IN THE 1ST HIGH SCHOOL OF PILEA

8.1. Subsystems

The water drilling facilities and the irrigation and hygiene needs of the schools are composed of several subsystems. These subsystems are:

- Drilling
- Water storage tanks
- Drilling connection network with tanks
- Supply networks for sanitary facilities from tanks
- Irrigation networks

To understand the content of these facilities a technical description of the facility designed for the 1st High School of Pilea – Hortiatis is provided.

8.2. Technical description of the installation in the 1st High School of Pilea

A drilling will be done in the area of the school. Its pump will feed irrigation system through tanks of the neighboring trees, as well as specific WC of ground floor, according to the projects' plans.

The drill pump will feed four (4) tanks, each 500 liters (L), which will be located in the basement of the school, as shown in drawings. After that, the tanks will feed the irrigation network and water supply of the WC via a pipeline network, through two different pumps. The electrical supply of the drilling pump will be through a suitable wiring that will go underground on the external part of the building to a depth of 70cm and which end in a panel in the tank area. The electrical supply of each pump will be through suitable wiring that will run on the wall in the area where the tanks will be placed.

An appropriate water use gauge will be inserted in the hydraulic circuit before supplying the tanks.

8.2.1. Drilling

The drilling position will be at the point as shown below:

Figure 3. Drilling position

The drilling will have the following features:

- Drilling depth 25 ± 5 m.
- Inflow 2 m^3/h.
- Pipe diameter 6in.
- Enclosed pipe, diameter: 12 in and depth: 4 m.
- Access pipe, dimeter: 1½ in and length: 18 m.
- Prefabricated concrete precast slabs, dimensions: 1X1X0,2 with corresponding top cap.

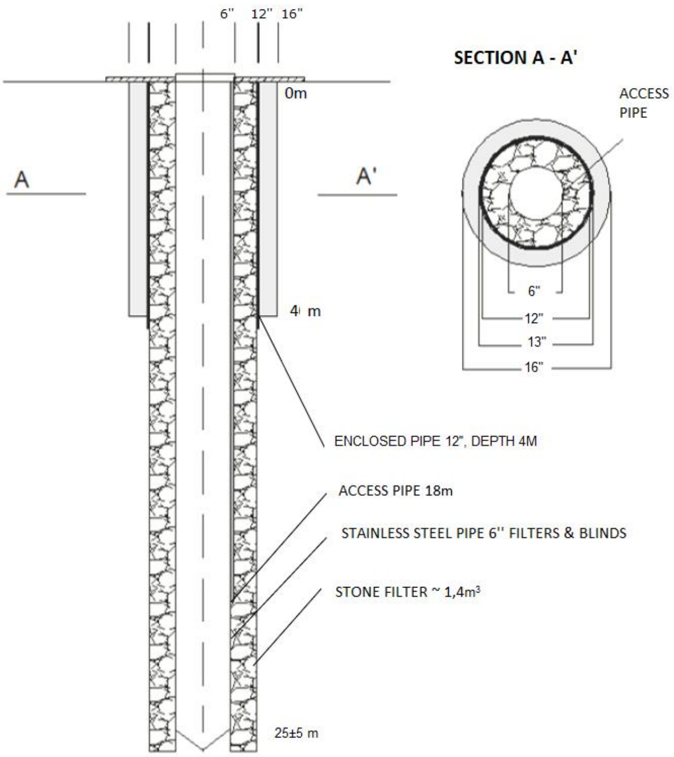

Figure 4. Drilling section

8.2.2. Storage tanks

There will be 4 tanks, 500L capacity each, made of plastic, which will be installed in the basement and will function under atmospheric pressure. In order to determine the location of the tanks, the following were taken into account:

- The elevation and the spatial position of the drilling point.
- The altitude and spatial distribution of the water and irrigated areas.

Valves and such systems will be expected. Furthermore:

- Evacuation device.
- Tubular interconnections.
- Filters.
- Non return valve.
- Between connection of the tanks for the even filling.
- Tank filling control system.

8.2.3. Irrigation facilities

The irrigation installation is fed from the storage tanks through a horizontal multi-stage pump of the fixed-coupled motor - pump type with a conventional constant-speed motor and a mechanical shaft seal and a single-phase asynchronous motor. The network includes:

- An irrigation network that includes a water distribution system on individual bushes and trees, scattered within the adjacent plot. For the above-mentioned extent, mainly due to the topography that distinguishes it, the implementation of the irrigation with small static water sprinklers of a special type is proposed, which will be placed in the pits of planting the trees, around their roots.
- A water distribution piping will be made of a second-generation polyethylene (PE) of low density (LD) according to DIN 8074/8075, with an internal pressure resistance of 10atm and will run underground at a depth of about 50cm. The nominal diameter of the piping for the entire irrigation network was calculated: DN20. The cover material of the trench, which will carry the pipes, should be free from stones and other sharp objects that could injure them. The use of sand without excluding rock-free excavation materials is also recommended. Furthermore, the use of 3A above the pipe, which can be compressed on either side, is proposed, while the final coating can be made from the excavation materials that are compressed per layer to the full ground level coverage. The use of supporting rings is recommended inside the building. The openings in the

masonry should be made in such a way that during installation the pipe does not suffer deformation stresses.

- The connections of the pipes to each other will be welded and the connections to other gauges and components of the network will be made by self-welding or welding to avoid leakage to the environment. Self-welding of the components is because of the continuously heating the outer surface of the pipe and its internal component until the welding temperature is reached. After that, the binding is kept constant until it is brought to ambient temperature.
- The central irrigation pipeline, within the hydro-station, will be equipped with an electric normally closed automatic solenoid, which will be triggered by the central irrigation programmer.
- The system allows the program to be maintained even at a power outage and it is possible to insert a battery for greater security. By connecting the automation with a rain sensor, the automatic watering function is suspended in the event of a rainfall. The sensor must be installed externally, exposed to rain and at a designated distance from the developer.

8.2.4. Water supply facilities

The irrigation installation is fed from the storage tanks via a horizontal multi-stage pump of the fixed-coupled pump type with a conventional constant-speed motor and a mechanical shaft seal and a single-phase asynchronous motor. Prior to each type of sanitary (basins), switches or brass valves (stopping devices) will be installed. The connection of the receptacles of the washing containers to the water supply network will be carried with special pieces and with the insertion of a corner switch. A non – return valve will be installed in case of a risk of the water flowing in the opposite direction. In order to decongest the water supply network from the air, ventilation valves (ventilators) will be placed in the appropriate positions.

8.2.5. Flowchart

The following figure gives the flowchart of the installation of the particular school that corresponds to the above description.

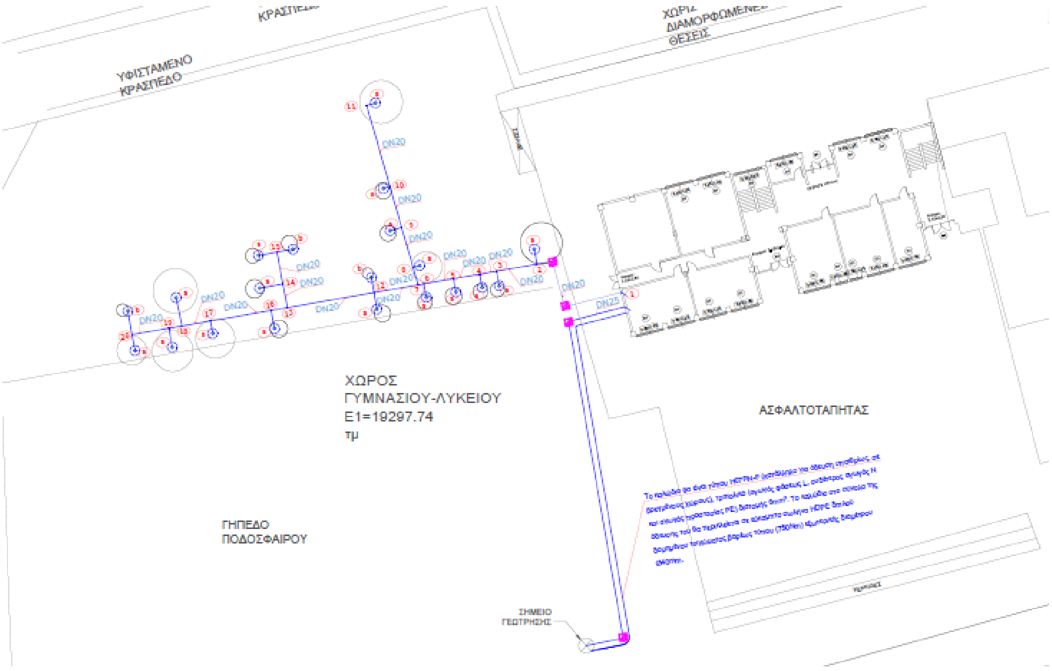

Figure 5. Flow chart of drainage water use networks