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LANDSCAPE AND IRRIGATION DESIGN OF GREEN SPACES IN RURAL AREAS OF CANDESTI PLATEAU. CASE STUDY. PICIOR DE MUNTE VILLAGE, DAMBOVITA COUNTY

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Abstract

This paper aims to present the results of researches conducted in the Cândesti Plateau between 2009 and 2012 concerning the design and execution of the landscaping and irrigation works of green spaces. This kind of works was mandatory to be done in this area, having as final objective the improvement of the environment quality and the residents' access to an enjoyable recreational space. As specific methods we used data collection in the geographical area, measuring and interpreting information regarding the climatic and pedagogical condition, soil geology, vegetation, hydrology, ground water and social conditions. To define the values of the irrigation elements we have used "the soil water balance method". We have obtained results regarding the optimal landscape solution, the average values of the irrigation elements and technical elements of the irrigation systems. Therefore, during the planning, scheduling design and execution of the green areas landscaping and irrigation works, all crucial data must be considered in order to determine one or several best and legally, technically and economically-feasible solutions.

Key words*: irrigation, landscape design, green spaces, environment.*

INTRODUCTION

The development of green spaces constitutes a major and indispensable chapter in the evolution of urban and rural development, both globally and nationally for Romania, being treated as a long-term national strategy for improving the environmental quality in populated areas (Chiper, 2012).
The quality and the long life of landscaping may be enhanced through use of competitive procedures and technology and through sound land use according to the type of landscape and the incident of the pedoclimatic area.
Green area watering is a requisite regenerating practice aiming to manage the necessary water for plants to grow and for the landscape to be maintained fully and constantly operational and aesthetically balanced according to its intended purpose (Cimpeanu et al., 2002).
The objectives of the study consisted in the landscaping design and operation of an irrigation system for a public green space which has been properly laid out in Picior de Munte locality and is functional in terms of equipment and has general positive effects on the social life of inhabitants in the area. This park must provide a playground and recreational area under safe conditions for children, its settlement being well chosen because it is located near the locality's kindergarten and school.
On the other hand, the installation of the irrigation system must allow the watering in optimum and economic quantities of the seeded vegetation and lawn and according to the irrigation elements set up for the studied location: Cândesti Piedmont, Picior de Munte locality.

MATERIALS AND METHODS

During the research, many working methods, which have been deemed efficient, have been applied by consulting the specialty bibliography at international and national level in order to achieve the objectives proposed by the conducted study. Specific methods have been applied depending on the objectives followed for the natural background research, the settlement of the irrigation elements in order to design the landscaping in the proposed location and the analysis of the technical landscaping solution in parallel with the determination of the technical watering elements which are necessary for the design and operation of the site.

Regarding the natural background, research has been conducted in order to obtain results on geographical, pedoclimatic, social and economic conditions in the studied area. The annual and multiannual climatic data measured by the National Meteorological Administration in Târgoviste station has been collected, being monthly interpreted for the average air temperature, rainfall, wind speed and relative air humidity (ANM, 2008).

It was necessary to determine and calculate the irrigation elements for the watering rate, irrigation rate, watering time, watering periods, watering number.

To calculate the landscape irrigation, *"The Soil Water Balance Method has* been applied (Jinga et al., 2009; Grumezea et al., 2005).

The method has been established for the growing season of component ecosystems, i.e. April 1 to September 30 for lawn, trees and shrubs and April 15 to September 30 for herbaceous flowers.

Thus, according to the method presented by Jinga in 2009, using the hydrologic balance equations for the growing season, the monthly and annual irrigation water demand has been determined by the following general formula:

“$\sum_m = ETRO - P_v - A_f - (R_i - R_f)$ (m^3/ha)

where:

- $\sum m$ - is the annual demand (irrigation rate) of irrigation water in m^3/ha;
- ETRO - optimal real evapotranspiration or total water consumption during the growing season through the plant transpiration and evaporation at the soil surface of an ecosystem, cultivated in a soil moisture which ensures the viability and normal development of plants, in m^3/ha;
- P_v - useful amount of rainfall during the growing season to ensure 80%, in m^3/ha;
- A_f - water input of underground water, in case of the closed circuit balance (Rota de Jos), in m^3/ha;
- R_i - soil water reserve at the beginning of the growing season, in m^3/ha;
- R_f - soil water reserve at the end of the growing season, in m^3/ha."

To determine the technical watering elements necessary to design and operate the landscape, a series of essential data has been considered for the application of the general design principles of irrigation systems observing: the form and size of surfaces to be irrigated, the component vegetation, the irrigation water demand, the water supply and its hydrodynamic parameters (pumping height, provided water flow and pump flow), the diagram and the optimal irrigation solution (in the studied case by sprinkling plants, column elbows and valves water losses, watering equipment operating parameters, namely sprinklers: sprinkler operating pressure, net flow, pluviometry, watering radius and angle of action, judicious division of irrigated areas into watering areas depending on the sprinklers parameters, available flow and water pipe pressure, determining the operating time in area control units supplied by valves, in order to supply the determined watering rates by the soil water balance method (Water Management Committee of the Irrigation Association, 2010).

RESULTS AND DISCUSSIONS

This area has climate, pedological, geographical and social features, forms of relief specific to piedmont plateau, the determined vegetation being diversified and specific to Subcarpathian areas. Hydrogeology is correlated to hydrology and geology and the area is influenced economically, socially and demographically by the urban centres nearby (Găesti, Titu, Târgoviste and Pitesti).

Based on the pedogeological structure of the predominant soil in the area determined by the cartographic study, hydrophysical indications of the soil could be determined depending on the active layer thickness (Table 1) and the watering rates determined for the three studied ecosystems.

Table 1. The hydro-physical indices of soil in Cândesti Plateau, Picior de Munte village

Ecosystem	Vegetation	Thickness of the active layer of soil (H)	Bulk density (Da)	Wilting factor (CO)		Field water capacity (CC)		Active moisture range (IUA=CC–CO)		Minimum Floor of Humdity (p.min)	
		(m)	(t/m^3)	% gr.	m^3/ha	% gr.	m^3/ha	% gr.	m^3/ha	% gr.	m^3/ha
Flowers	15.04-31.09	0,40	1,31	8,40	550,00	27,80	1821,00	19,40	1271,00	21,33	1397,33
Trees and shrubs	01.04-31.09	0,75	1,33	9,50	895,67	27,53	2456,00	18,03	1560,33	21,52	1935,89
Turf (lawn)	01.04-31.09	0,75	1,33	9,50	895,67	27,53	2456,00	18,03	1560,33	21,52	1935,89

The monthly average rainfall quantity during the growing season in Cândesti Piedmont, namely in Picior de Munte locality has been calculated considering the multiannual monthly values measured in Târgoviste meteorological station by the National Meteorological Administration and made available based on the convention between it and the Faculty of Land Reclamation and Environmental Engineering in Bucharest. They are presented according to the multiannual monthly average values during 1980-2010 (Table 2).

Table 2. The multiannual monthly averages and useful rainfalls during the growing season in Cândesti Plateau, Picior de Munte village

$P_v = 10\delta P$ unde δ=0,76							
Month	**April**	**May**	**June**	**July**	**August**	**September**	**Total**
No. of days in a month	30	31	30	31	31	30	-
mm/month	52,7	70,9	91,8	86,2	77,4	52,3	431
mm/day	1,8	2,3	3,1	2,8	2,5	1,7	-
δ	0,76	0,76	0,76	0,76	0,76	0,76	-
Useful precipitation (P_v) (m^3/ha)	400,5	538,8	697,7	655,1	588,2	397,5	3.278

The irrigation elements necessary to design and operate the irrigation systems for green spaces in Cândesti Piedmont, Picior de Munte locality for the three types of studied ecosystems are presented in Table 3.

Table 3. The summary of the irrigation regime elements in Cândesti Plateau, Picior de Munte village

No. crt.	Crop	Watering norm (m^3/ha)		Watering month date	No. of watering	Irrigation norm (m^3/ha)	
		Nett	Gross			Nett	Gross
1.	**Flowers**	339	400	15.IV; 02,12.V; 04.VI; 01.VIII; 01,14.IX	7	2373	2800
2.	**Trees and shrubs**	601	650	02.VI; 01,13.VII; 06.VIII	4	2404	2600
3.	**Turf (lawn)**	601	650	02.V;09.VI ; 07.VII; 11.VIII ; 01.IX	4	2404	2600

In order to provide viable solutions for the responsible and efficient operation of the irrigation system it is necessary to present the technical landscaping design (planting plan) and implicitly the constructive solution of the irrigation systems in the studied areas.

The park project and execution were done based on the *"National program for environmental quality improvement by establishing green spaces in localities"* provided for in GEO 59/2007 (OUG 59/2007)" and implied:

- setting up green spaces by planting dendrological material consisting of trees, shrubs, green fences and establishment of lawns;
- installation of an automatic irrigation system which is operational throughout the entire landscape surface;
- installation of a functional lighting system with photovoltaic panels;
- establishment of a rectangular fountain;
- installation of street furniture: benches, trash bins and chess tables;
- installation of a playground for children;
- construction of ecologic stone alleys;
- park endowment with ecological toilets;
- landscape fencing with wooden fence.

Thus, considering the pedoclimatic conditions of the area, the following have been designed and executed:

- plantation of small, average and high size vegetation resistant to contaminants and adapted to the climatic conditions of the studied area according to the plan presented in figure 1 and centralized in table 4, namely 111 deciduous trees, 24 rooted trees and 49 shrubs;
- settlement of 1073 m^2 of lawn by grass seeding (*mixture of Lolium perenne, Poa pratensis* and *Festuca arundinacea*);
- automatic irrigation system for landscapes 1073 m^2 .

Table 4. Plants used in green spaces landscaping of the Picior de Munte village

No. Crt.	Type / Species	Pieces		No. Crt.	Type / Species	Pieces
Deciduous tree				**Resinous trees**		
1.	*Acer negundo*	4		**8.**	*Picea pungens*	14
2.	*Acep platanoides*	19		**9.**	*Pinus nigra*	10
3.	*Catalpa bignonioides*	71		**Deciduous shrub**		
4.	*Fraxinus excelsior*	8		**10.**	*Cotoneaster dammerii*	13
5.	*Platanus acerifolia*	2		**11.**	*Ligustrum ovalifolium*	18
6.	*Prunus cerasifera*	5		**12.**	*Spiraea vanhouttei*	10
7.	*Rhus typhina*	2		**Resinous shrubs**		
				13.	*Juniperus horizontalis*	8

The irrigation system designed and executed for providing the necessary quantity of water on the green spaces in Picior de Munte locality consists of a PEHD-type polyethylene pipe assembly (High-density polyethylene) with a rated diameter of Φ32 mm, connections between pipes made of polyethylene fittings with pressure seal PN10, dripping hose, solenoid valves DV/DVF Series and rotor-type sprinklers 5004 series 5000 / 5000 Plus / 5000 Plus PRS Rotors, equipped with MPR-25 nozzles, rotary multijet with nozzles RN Series Nozzle, spray (UNI-Spray™ Series) and nozzles VAN Series (Rainbrid.com).

The operation of this equipment is provided by a programmable controller TBOS provided with 14 stations, equivalent to the number of areas. The watering schedule memorized by the program consists in setting up the start hour, the watering duration in an area and the sequence for each solenoid valve of the irrigation system (area).

For the irrigation system to operate under optimum conditions, it has been divided into 13 different areas which are individually connected to a water source supplied from an average depth borehole (25 m), provided with a submersible pump. The water supply must provide the calculated water flow which is necessary for the system operation to a proper pressure (3.2 m^3/h, 35 mca).

Figure 2 presents the water flows related to the area supplied by the system's solenoid valves, the dimension and location of the water supply pipes to sprinklers and their types.

Figure 3 presents the way of covering the space with irrigation systems depending on the sprinkler, type of nozzle, radius and angle of action of sprinklers.

The operation of the designed irrigation system involves the administration of a watering rate of 650 m^3/ha, namely a water volume of 70 m^3/landscape (1073 m^2), in 5 stages (consecutive days), 5 hours each, according to the watering schedule presented in table 3. Concurrently, the duration of those stages represent the sum of the individual operating times which is supplied by each solenoid valve of the system.

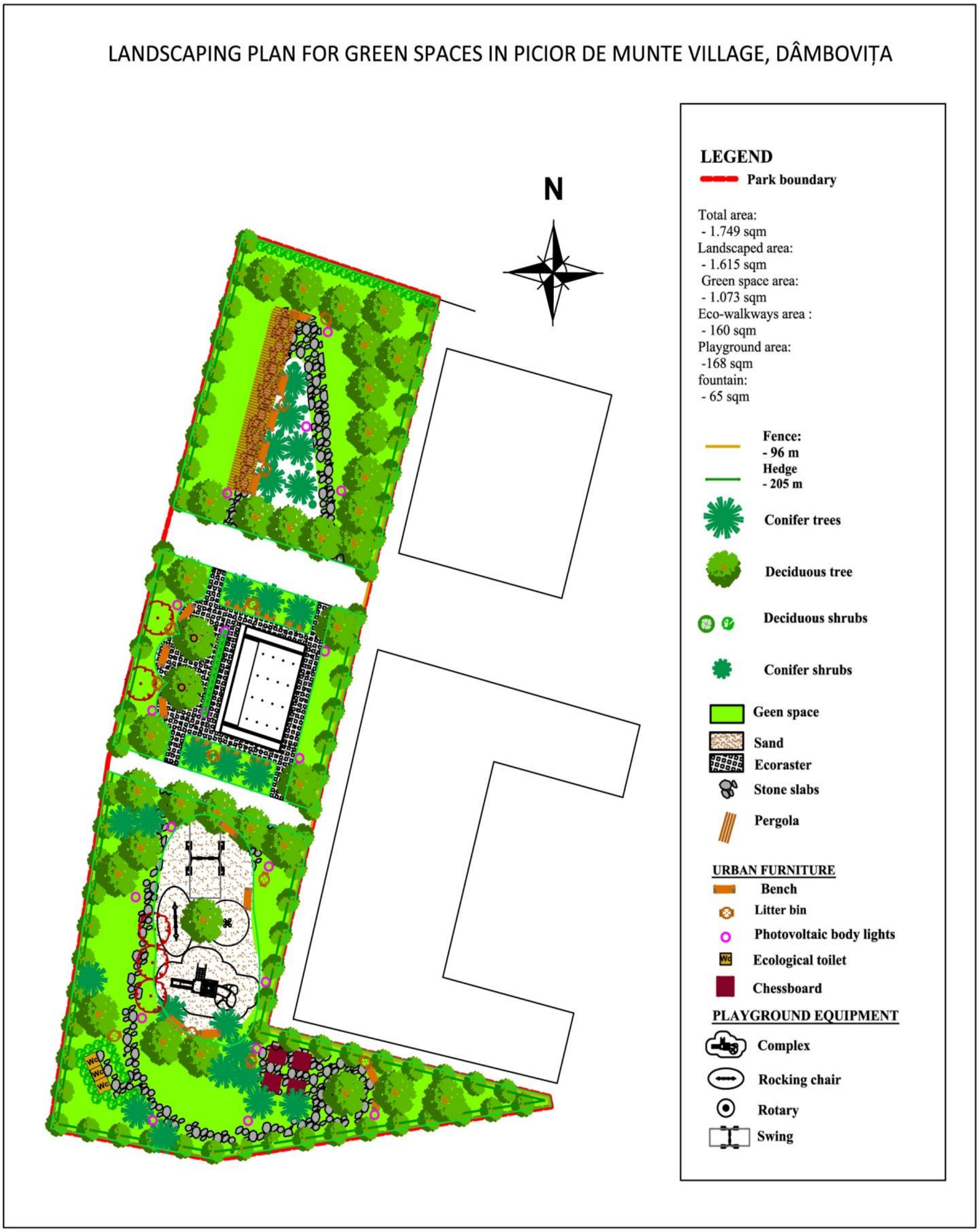

Figure 1. Landscaping plan for green spaces in Picior de Munte village, Dâmbovița

Thus, in order to best operate the irrigation system an operating time has been established for the solenoid valves so that they can provide the sprinklers‘ operation at the parameters specified in tables 4 and equal to the operating time of the type of sprinkler which is a predominant component of the wing, as seen in the above-mentioned table

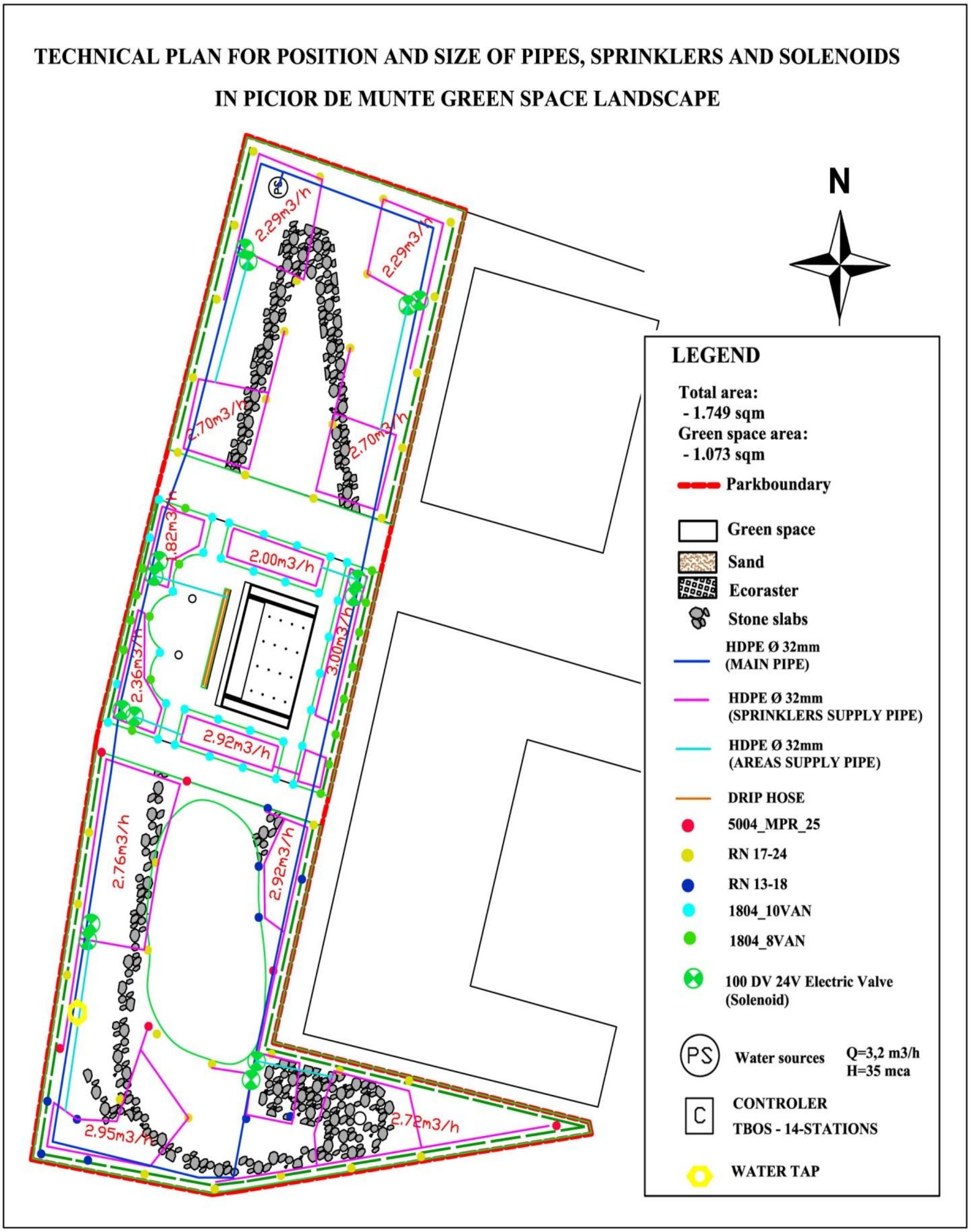

Figure 2. Technical plan for position and size of pipes, sprinklers and solenoids in Picior de Munte green space landscape

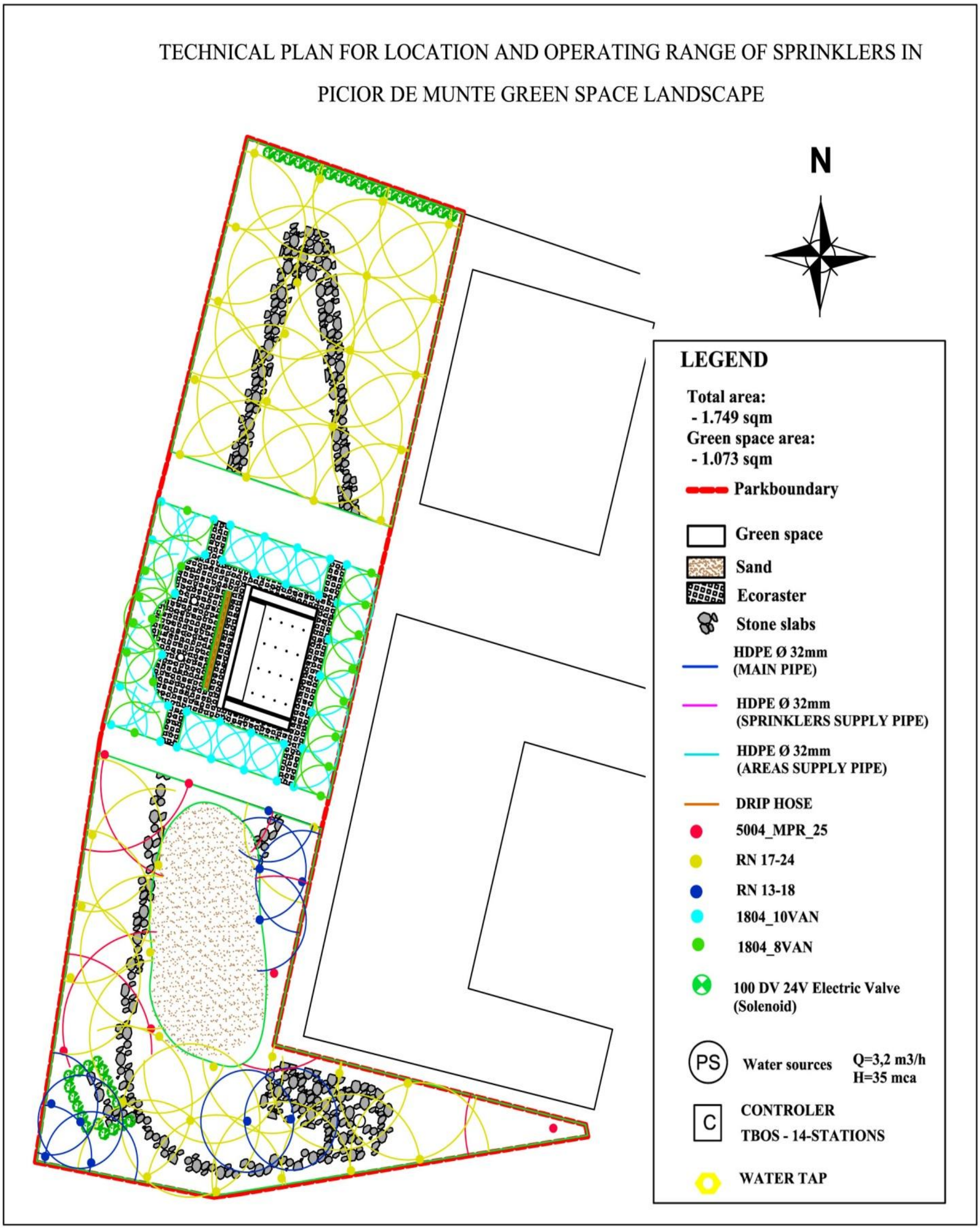

Figure 3. Technical plan for location and operating range of sprinklers in Picior de Munte green space landscape

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CONCLUSIONS

The benefits of the automatic irrigation system installation works related to the green spaces established in Picior de Munte locality, in Cândesti Piedmont are multiple and consist in the sustainable and aesthetic operation of green spaces (resistant to dryness and water deficit), namely saving resources (financial, human, water, energy) by optimizing the watering program depending on the plants' water demand and the allocation of the determined irrigation rates.

The balance of irrigation system installation costs, namely 3.7%, is less in relation to the total costs of the green space establishment works; instead the benefits resulted from its establishment and optimum operation are important, exponentially reducing the risk of compromising the viability of plants during dryness and alteration of park's aesthetics and operation.

The landscaping works, such as all public or private sustainable utility investments must be treated as the normal performance of the stages for fulfilling and implementing a project.

The stages must be structured and approached during the planning, programming, designing, noticing, executing, accepting and operating phases of the fulfilled investments.

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