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Study of low impact development applied into a residential area

Ştefănescu Camelia[1]

Abstract: Urbanization and development alter and inhibit the natural hydrologic process of surface water infiltration, percolation to groundwater, evapotranspiration, and transpiration. Past traditional engineering approaches tended to route storm water runoff rapidly from developed surfaces into drainage systems, discharging storm flows and pollutants to downstream surface waters. This paper aims to determine the optimal method for collecting and directing rainwater from residential area housing newly built in a big town where there are no channels for collecting rain water and where in case of heavy rain there is a potential risk of flooding due waterproofing surfaces. This will choose the optimal method of achieving these retention basins, which will be placed on each parcel or, where appropiate, a common retention pond will be located on the surface under study .
Keywords: air pollution, protection and conservation of the environment, environmental protection, rainwater, retention basins, retention pond.

1. INTRODUCTION

Urbanization and development alter and inhibit the natural hydrologic process of surface water infiltration, percolation to groundwater, evapotranspiration, and transpiration. Past traditional engineering approaches tended to route storm water runoff rapidly from developed surfaces into drainage systems, discharging storm flows and pollutants to downstream surface waters.

One of the greatest sources of urban imperviousness is transportation infrastructure including roadways, driveways, sidewalks, and parking facilities. To maintain and improve the main hydrologic functions after development, reducing the overall imperviousness of a site is one of the most important design strategies.

That can be achieved in multiple ways including applying low impact development (LID) storm water management practices, alternative layouts of street design, and other methodologies for reducing development footprints and disconnecting directly connected impervious areas from the storm water collection systems[1].

The methodology of minimal impact is based on many of the functional unit processes found in the natural environment to treat storm water runoff, balancing the need for engineered systems during urban development with natural features and treatment processes [1].

By using the functional unit processes of the natural environment to provide storm water treatment and control, and employing distributed controls to maximize water storage and re-use opportunities, the methodology of minimal impact techniques can enhance infiltration, percolation, and evapotranspiration to reduce adverse effects on surface waters, encourage groundwater recharge, and enhance water quality.

The methodology of minimal impact methods offer great versatility in design, and can be incorporated into new urban development, redevelopment designs, and alternative transportation design with relative ease [2].

2. STORM WATER RETENTION

On-site, underground storm water retention/detention accomplishes the capture and storage of storm water collected from surrounding impervious areas. Riser pipes or curb cuts lead surface storm water to subsurface vaults or systems of large diameter interconnected storage pipes or chambers. In some cases stored water can be allowed to infiltrate to recharge groundwater (if soil types are suitable and the groundwater table is located sufficiently below the water storage units).

Advantages of use include:

•Reduction of storm water runoff flow.
•Extended storage and slow, measured release of collected storm water runoff.
•Being a good option for high density or urban areas with limited available space or unusual shapes or where land is expensive.
•System instillation can be accomplished rapidly using prefabricated modular systems.
•Durability and long life (50 years plus for most systems).
•Increased level of public safety over open ponds and other surface storm water.
•Insulation from freezing
•Aesthetically pleasing to public in that such systems are out-of-sight and thus out-of-mind [3].

[1] "Politechnica" University of Timişoara, Department of Hydrotechnical Engineering, George Enescu Street, no.1A, Zip code 300022,Timisoara, Romania, e-mail: achim_camelia@yahoo.co.uk

1. MINIMAL IMPACT METHOD APPLIED FOR A RESIDENTIAL HOUSING AREA OF TIMISOARA

We take two cases in the study, although the idea of this work was to study several cases of location of underground tanks. The other possible cases will be another subject to other works.

Case 1 - retention basins for rainwater placed on each parcel [4].

Area under study is 10 hectares and is divided into 122 plots with an average of 615 m^2 individual plot (Fig. 3).

Each plot is divided into two approximately equal parts, one buildable and other lawn or less likely to agriculture, fruit trees.

$$Q_m = i \cdot m \cdot \sum S \cdot \Phi \qquad (1)$$

Where: i - is the intensity of the rain standardized computing duration tp [l/s·ha]
t_p - the maximum water needs to cover the distance of topmost point of the basin, to the section considered;
m – reduction coefficient which is a function of storage capacity while the sewage system and rain duration calculation. Keep in mind that the early rain water occupies a small part of the channel section; S -

Surface basin for the section considered [ha];
Φ - runoff coefficient corresponding to the area S.

The rain intensity calculation (i) is determined by computing tp during rain, the normal frequency f and the curves of equal intensity for rainfall frequency.

The rain duration calculation is considered the maximum drainage ts of dropping points up to the calculation. If $t_s = t_p$ resulting a maximum flow.

Time runoff ts will determine by the relationship:

$$t_s = t_{cs} + t_c = t_{cs} + \frac{L}{60} \cdot v_i \ [\text{min}] \qquad (2)$$

t_{cs} - is the superficial time of concentration on surface flow in channel type, relief, in lowland areas may be considered 5-12 min;

t_c - time runoff in channels, from the origin to the computation section [min];

L – channel length [m];
v_i – initial velocity (0,6-1,2 m/s);

The minimum duration of the rain could be considered in the lowland areas:

- 15 min for slopes It< 2 ‰;
- 10 min for slopes 2 ‰ < It < 5 ‰;
- 5 min for slopes It > 5 ‰;

The frequency of rain is the annual number of lasting rains t_p whose intensity exceeds computing rain. Not included are calculations exceptional torrential rains. Equal intensity curves for a normal frequency of rain STAS 9470-73 are given in various areas, Timisoara being in the 13 zone (fig. 1).

The coefficient m is a function of time t_s:

- For $t_s < 40$ min ⇒ m = 0,8;
- For $t_s > 40$ min ⇒ m = 0,9;

The runoff coefficient Φ is determined by the provisions of the systematization plan of the village which channels and building regime characteristic of each area with the relationships:

$$\varphi = \frac{\sum S_i \cdot \varphi_i}{\sum S_i} \qquad (3)$$

Where: S_i the components surface of localities;

Φ_i - The runoff coefficient corresponding to the surface Si (conform STAS 1846-90) it is given in the table 1:

Table 1: Leakage coefficient, [Mirel, 1992]

Type of surface	Leakage coefficient Φ_i
Metal roofing, tile, glass	0,95
Paved terraces	0,85 – 0,90
Paving asphalt, stone or other materials with joints filled with mastic	0,80 – 0,85
Paving stone or grout filled with sand	0,60 – 0,70
Crushed stone roads	0,25 – 0,50
Paved roads	0,15 – 0,30
Sports fields and gardens	0,10 – 0,20
Enclosures and paved courtyards	0,15 – 0,25
Agricultural land	0,05 – 0,15
Parks and woodland	0,05 – 0,10

For Timisoara we take two coefficient $\Phi_1 = 0,95$ şi $\Phi_2 = 0,05$ because half of the area is built and the other half is considered infield or pitch. To calculate the flow meteoric be considered:
The intensity of calculation rain i = 80 l/s*ha:

- m = 0,8
- $S_1 = 350$ m^2
- $S_2 = 350$ m^2

With this data meteoric flow is calculated as follows:

$$Q_m = 80 \cdot 0.8 \cdot (0.95 \cdot 0.035 + 0.05 \cdot 0.035) = 2.24 \ l/s$$

The retention basin volume is calculated taking into account this flow control rate previously calculated as follows:

$$v_B = Q_m \cdot t = 2.24 \cdot 20 \cdot 60 = 2268 \ l = 3000 \ l = 3 \ m^3$$

Because on the surface there are 122 plots studied to calculate the total meteoric volume (v_{tm}):

$$v_{tm} = 122 \cdot 3 = 366 \ m^3$$

In addition to this meteoric calculated must take into account the street meteoric water (Q_{ms}), which is calculated as follows:

Figure1.Determination of the rainwater flow

$$Q_{ms} = 85 \cdot 0.8 \cdot (1665 \cdot 10 \cdot 0.9) = 100.7 \ \text{l/s}$$

The streets meteoric volume will be V_{ms}:

$$Q_{ms} = 100 \cdot 20 \cdot 60 = 120000 \ \text{l} = 120 \ \text{m}^3$$

The total volume consists of volumes of surfaces and volumes studied street will be:

$$V_t = 366 + 120 = 486 \ \text{m}^3 \approx 500 \ \text{m}^3$$

Case 2 - A single retention basin common to the entire area studied [4]:

$$S = 1.5 + 6.8 + 1.14 + 0.59 = \ 10.03 \ \text{ha} \approx 10 \ \text{m}^3$$

$$L = 255 + 297 = \ 552 \ \text{m}$$

$$t_s = 15 + \frac{552}{60 \cdot 0.6} = \ 30.33 \ \text{min}$$

$$i = 60 \ \text{l/s} \cdot \text{ha}$$

$$Q_m = 60 \cdot 0.8 \cdot 5{,}0 \cdot (0.95 + 0.005) = \ 229.2 \ \text{l/s}$$

$$V_m = 229 \cdot 30 \cdot 60 = 412200 \ \text{l} \ = 412.2 \ \text{m}^3 = 400 \ \text{m}^3$$

$$V_{mst} = 120 \ \text{m}^3$$

$$V_{mst} = 400 + 120 \ = 520 \ \text{m}^3$$

Although the volume of meteoric water in the two cases is approximately equal to individual housing blocks is advantageous alternative to tanks (tanks) individual

The cost of the pool is approximately 1500 - 1700 RON common when a container is much higher.

At blocks housing is recommended collecting rainwater in enclosures built tanker individual and rainwater surfaces alleys and streets movement paved and asphalted to be collected in separate tanks whose volume is relatively low without affecting surfaces owners. Then these waters will be infiltrated landscaped green areas along roads, green areas and other surfaces roundabout landscaped green surface village [4].

If conditions allow storm water landscaping previously treated (NPTA 001 - 2005 NPTA 002-2005) in drainage channels, it will be an attractive alternative for resolving such issues.

CONCLUSIONS

In theory, redistribution leak in the system will reproduce arranged hydrological theory leakage rate, frequency, duration and volume of the spill to form predevelopment. In addition, if the first stream containing pollutants in large quantities, they can be scattered and isolated on surfaces with bio retentions. This reduction of pollutants can be especially important downstream. This does not preclude use of existing infiltration surfaces such as pavements, dry wells, infiltration trenches and infiltration basins which are also part of the LID.

However in practice, the use of existing methods for control of penetration of the tip of the maximum flow rate has been performed before setting up the low intensity areas or permeable soils, or by using high possibility of infiltration.

Flow scattering method is a new strategy that has been applied to improve the intensity of infiltration or decrease the permeability of the soil, which solves many problems in the management of wastewater.

Land can be arranged so that leakages from each building, parking lot, or any impervious surface can be used on individual plots spreading infiltrated flow and cumulative volumes due to these plots will be equal to the volume before fitting leaks.

As a general conclusion, the final results support the idea that for a LID correctly the first gush heavily polluted can be retained on the surface of these bio retentions and flow that will be scattered on the surface (which is divided into debit natural flow caused by arrangement) will be reduced.

Natural drainage will be carried downstream while spatial planning could be due to leaking underground seepage about the conditions prior arrangement. Thus they were kept predevelopment hydrological conditions of the initial situation.

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