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Green solutions applied in urban areas for minimize the stormwater from precipitations

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Abstract: Due to the development of a policy of urban agglomerations need arises storm water management in order to achieve drainage conditions in regime arranged as close to natural. This avoids the undesirable effects that occur due to reduced water infiltration waterproofed surfaces due to the increase in construction (platforms, roads, buildings, parking lots, etc.). The paper presents, in summary, technical and ecological solutions for reducing surface runoff water from precipitation, thus achieving conditions close to natural drainage prior arrangement.

Keywords: Rainwater runoff, reducing runoff, open underground retention channels, bioretention cell, rainwater, green roofs, green facades.

1. GENERAL CONSIDERATIONS

Although stagnating population and economy grow only at a reduced rate, new construction is carried out continuously. This is achieved urbanization unincorporated territories. Urbanization has the effect of changing local microclimate (so-called oasis effect). In addition, building materials store heat and prevent ventilation of the soil. Because of this, the city is one to two degrees more than the surroundings, which raises the potential evapotranspiration

Surface waters near towns are also negatively influenced by urbanization. By strengthening surfaces is prevented infiltration of rainwater, so get more rainwater in public sewerage.

For medium and low rainfall frequency leakage increases in volume and amplitude offsets to the wave front. Through such a situation infiltration of the soil is reduced and subjected to shocks debit emissary.

2. RAINWATER RUNOFF FROM URBANIZED AREAS

Spatial requires human intervention on its natural state. A key role of the changes in precipitation leakage, namely flow and volume changes ([PWG], [OGC]).

This requires consideration of two regimes of water:

- Flow regime in untouched condition (found in the literature as pre development);
- Flow regime when fitted (found in the literature as post development);

This division and these concepts were introduced in the last 10 years especially in spatial design. Until the 1970s in developed countries, the main aim was that the storm water from towns to reach as soon as the emissary. Following these concerns storm water sewerage networks and related installations reached gigantic proportions. To reduce costs found alternatives that by reducing maximum flows and water quantities lead to more economical investment and create optimal operating conditions [1], [2], [5].

The purpose of this solution is to turn abruptly hydrograph (ascending and descending branch) of rainwater in a hydrograph that would occur under natural conditions (slower) that reduce the amount of water and maximum flow value.

These two categories are[1]:

1. Methods used before water to the sewer network:
   1.a local storage;
   1.b mitigate leakage to lower peak flow.
2. Methods used after the water has reached the sewer.

1.a Local energy storage, which is achieved by:
- Water seeping through wooded land.
- Infiltration in open channels (grooves), Fig. 1

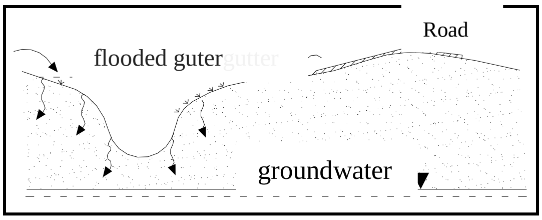

Fig. 1: Infiltration in open channels

- Lakes infiltration - Must be permeable bottom of the lake. Dangerous increase in water level can prevent the overflow drain existing sewerage network related
- Accumulation in groundwater basins, where the water has the possibility of seepage field (Fig. 2). If an impermeable soil, groundwater basins are arranged by materials with high porosity (crushed stone).

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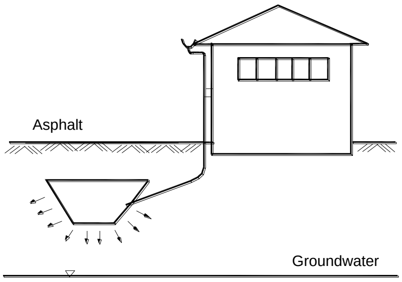

Fig.2. Underground retention basin permeable wall

- Using permeable coverings. This solution is applied more often in countries with a developed infrastructure, where due to the high density of channels decreased groundwater levels.
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If local water storage solutions above, to consider the requirements of groundwater quality protection. Because water drained from the main arteries, can cause water pollution of groundwater layer [Horner, 2002)

1.b Spill mitigation methods for decreasing peak flow
- Increasing the time of concentration - a means to achieve mitigation with increasing time of concentration is roughening by paving roads or using stone instead of asphalt. Another advantage is to increase the amount of water infiltrated into the ground

3. LEAK FOR REDUCING ENVIRONMENTAL SOLUTIONS BY INFILTRATION

The most used part of the stormwater management area means-nature is to remove rainwater from residential areas and streets to where you are going to infiltrate. Infiltration measures in addition to the criteria mentioned before about the area can be classified into ground and underground methods [3].

The above-ground infiltration of rainwater remains part in unsaturated soil. In this area the soil is performed infiltrated water treatment thus achieving water protection. Infiltration is the above-ground surface, depressions and basins.

The disadvantages of the method compared with the above-ground percolation are in its low reliability [4].

In addition to the measures mentioned have many combinations of which can remind depression-channel system.

3.1 Bioretention

Bioretention term was designed to describe the integrated management of storm water using physical chemical properties and biological properties of plants, microbes and soil to retain and transport of pollutants in surface water drainage [3]. Areas of bioretenion are:
- Depression shallow, designed for mixed soil and plants adapted to the local climate;
- Bioretention cells are shallow depressions mixed with soil and a variety of plants including trees, shrubs, grass and / or herbaceous plants. Bioretention cells may or may not laid underground drains;
- Biodetention, is a model that uses vegetation barriers arranged as a hedge of a side of the slope in order to infiltrate, spread and treat rainwater [6], [7].

3.2 Applications of bioretention

Bioretention concept focuses on removing pollutants coming from rainwater, and water quality control. Where the nearby soil are suitable infiltration, bioretention can be used as a normal retention.

The following figure shows a cross section of an element based on bioretention without drainage.

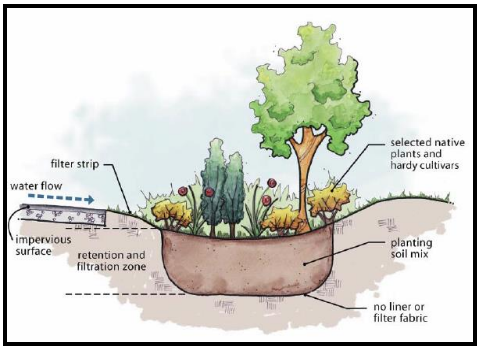

Fig. 3 Cross section of a basic bioretention cell with no under drain[LID]

The following figure presents a bioretention with under drain

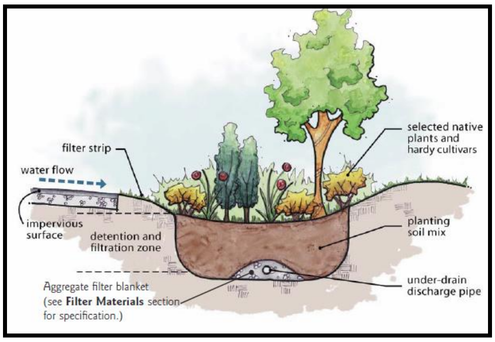

Fig. 4 Bioretention with under drain[LID]

In Fig. 4 it is shown a natural drainage system

- Bioretention area in center of apartament building courtyard

Fig.5: Bioretention area in center of apartament building courtyard, Portland, Oregon [Hinman]

3.3 Types of bioretention surfaces

The types of bioterention include:

- bioretention cell integrated into gardens on individual lots [6]

Fig. 6 bioretention cell integrated into landscaping[Coffman]

-curbs or curbles bioretention in landscapes parking lot islands

Fig. 7 Bioretention landscapes islands with curb cut to allow flows to enter [Coffman]

- green roofs

Fig. 8 Area with grass roofs in Germany [4]

3.4 Infiltration through the depression-channel

Of all the measures combined it became known and is therefore considered as "independent". Under depressions infiltration trenches are arranged with a network of drainage pipes which collects water from depression.

At the end of each gutter is a device for limiting the spill and emergency spillway. Several elements of depression-channel can be joined together by pipes and thus form a drainage system.

By combining the above-ground underground infiltration becomes possible to use the advantages of both methods. Passages of ground vegetation are responsible for cleaning the system.

Using drainage pipes leak limiter, depression-channel system is effective and the infiltration facility and as a temporary storage and delayed drainage.

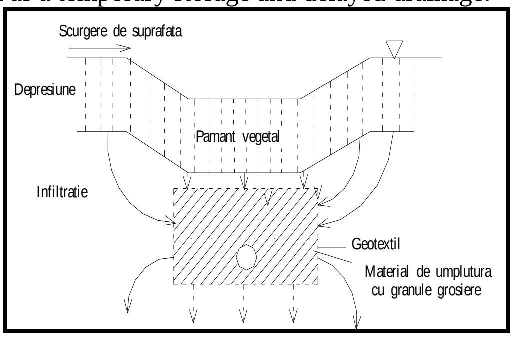

Fig.9 Cross section through a depression channel

3.5 Passages plant

The arrangement of passages loading plant materials surface water (the emissaries) is reduced greatly. Clarifying effect is based on filtering storm water leakage. Consequently arrangement of passages of vegetation is required only when you cannot achieve a decentralized storm sewage leakage, ie by passing through a layer of active earth (fig. 10)

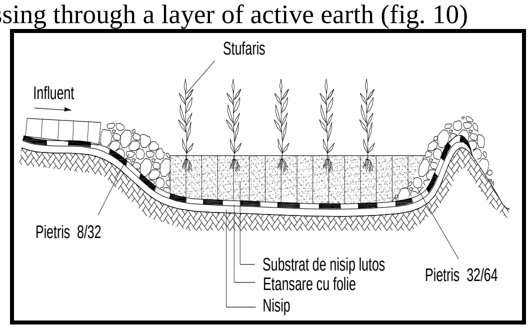

Fig. 10: Longitudinal profile through a passage vegetable

Topsoil is placed downstream of conventional storm water sewer so that the effluents from a pool of rainwater retention are clarified through a filter system before flowing into the environment. The power of such a construction upstream passage requires retention

3.6 Use of rainwater

Using rainwater for watering gardens is particularly prevalent in neighborhoods with houses housing (rainwater tanks). Measures to replace household drinking water (water in toilet, washing machine) are the exception rather palette even if the so-called solutions has always been widened in recent years and the introduction of a second water circuit, at least in connections within us is related to additional expenses low.

The use of rainwater storage in a retention basin with a volume of buffer storage (fig. 11) should apply to a certain height of the overflow that allows leaking sewage system [Balousek, 2001].

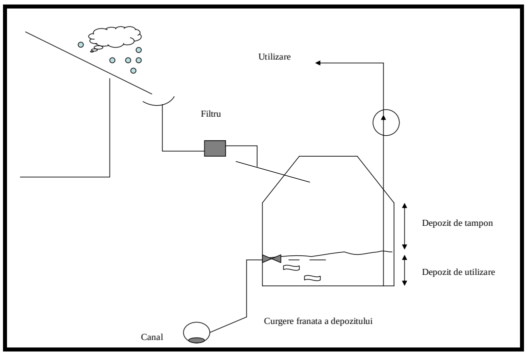

Fig. 11: Outdoor rainwater with buffer volume

4. THE NEW TECHNOLOGIES FOR REDUCING STORMWATER

4.1 Green walls

Greenwalls are soil-less vertical gardens grown on the surface of built structures. They are designed to mimic the growing conditions found where greenwalls occur in nature. Plants on a greenwall or greenroof live without soil using many adapted strategies to survive, poor nutrition, exposed conditions and seasonal drought.

They colonise only those rocks and trees that provide adequate growing conditions: aspect, light, air movement, water and nutrients.

Green walls show much promise because they can cover four sides of a building instead of just the top (Fig. 12, 13, 14). A similar option is a vine covered trellis suspended over a roof known as a green cloak. In Maryland, Schumann and Tilley reported that a green cloak reduced maximum daily indoor temperatures by as much as 3.1 °C during July. This reduction is comparable to a green roof in terms of energy savings and has the advantage of being without most of the additional weight of a green roof

Bio wall is a thin profile, closed loop interior ecosystem. It's comprised of tropical plants, soilless media, and a waterproof backing. Bio wall thrives in a bright indoor location; energy efficient lighting can be supplemented in locations that do not have adequate natural light. Bio wall reduces the demand for energy consumptive mechanical air filtration systems by harnessing the natural phytoremediation capabilities of tropical plants. This process effectively removes common airborne pollutants. Bio wall can be customized to fit your specific needs [9], [10].

Fig. 12 Green walls

Fig. 13 Green wall at the Universidad del Claustro de Sor Juana in the historic center of Mexico City

Fig. 14 Green wall

4.2 Green facades

A façade is a part of a building and visible from the outside. Usually, a façade is made of stone, concrete, glass, metal or wood.

The first green wall can be trace up to the XI century and the Viking's period. The Viking used stones timber and peat's bricks to construct their habitations. Peat is an accumulation of partially decayed vegetation matter; it is formed in swamps or likewise environment. When the Vikings used peat's brick, grass naturally grew on this organic material. The habitation was therefore covered with vegetation. The grass's roots helped the bricks to "fuse" in one huge brick and therefore made the walls stronger. These kinds of construction could be found in the north hemisphere wherever went the Vikings: from Canada to Norway via Island, Ireland, Sweden, Denmark. But there is no evidence found that these early green walls were created on purpose. None can pretend for sure that it was a will of the builder to have vegetation covering the facades of huts. It is very likely that it was only the work of nature [11,12].

Fig. 15 Reconstitution of a Viking hut in Terre Neuve

Natural colonization of walls by plants is happening with or without men’s help. Everyone knows a building which is covered or partially covered by vegetation. Especially buildings covered with ivy. In humid tropical zones, the plants from the jungle grow on any kind of buildings. And the examples of temples covered with vegetation are numerous in Central America and South East Asia. [10],[11].

4.2.1 Difference between green façades and green wals

Green façades differ from green walls in that their vegetative layer is rooted in the ground and grows up. The plants use a vertical surface, such as a wall, for structural support but do not receive any moisture or nutrients from it. A common example is an ivy wall.

A major disadvantage is that the plants take a long time to cover the wall completely (often more than a decade!). In addition some climbers can do permanent damage.

Their aerial roots penetrate small cracks and as they grow and expand it jeopardizes the structural integrity of a building. This method also limits the number of plant species that can be used.

Fig. 16 A wall of living plants designed by Patrick Blanc at Caixa Forum near Atocha station, Madrid.

4.2.2 The benefits of green walls

- Reduces urban heat island effect and smog
- Cleans outside air of pollutants and dust and offsets the carbon footprint of people and fuel emissions
- Cleans interior air space by removing and other harmful toxins like benzene and formaldehyde
- Acts as a sound proofing barrier
- Soil and plants are a natural filter that can clean the water that flows through the wall
- Insulates and cools the building envelope, as well as protecting it from the elements
- Creates habitats for birds and beneficial insects, increasing biodiversity [8],[9].
- Can be used for growing food in urban settings, creating sustainable and local control of food sources
- Increases real estate value
- Increases foot traffic in retail spaces
- Reduces absenteeism in the workplace and boosts employee morale
- Green walls can be utilized as wastewater treatment media for gray water. Other features, such as the incorporation of compost tea from a composting toilet, is another way for green walls to aid in the reduction of wastewater [10],[11].
- Green walls can provide additional insulation and natural cooling, which reduces a building's reliance on mechanical systems.
- Green walls may contribute to innovative wastewater or ventilation systems.

5. Green roorfs

Green roofs entail growing plants on rooftops, which partially replaces the vegetation that was destroyed when the building was constructed. In doing so they provide numerous benefits that can help offset the negative aspects of pollution, especially in the urban environment. They can improve stormwater management by reducing runoff and improving water quality, conserve energy, mitigate the urban heat island, increase longevity of roofing membranes, reduce noise and air pollution, sequester carbon, increase urban biodiversity by providing habitat for wildlife, provide a more aesthetically pleasing environment to work and live, and improve return on investment compared to traditional roofs.

Depending on the plants chosen for coatings, differentiates two types of roofs: extensive intensive type, semi intensive (Fig 16). Extensive roof type involves a very thin layer of soil that plants grow extremely tolerant involves not require special care or hardly care. It is generally recommended for cultivation native and resistant to extreme temperatures which take root in a shorter time to avoid drying and strengthening soil.

In contrast, intensive roof type implies the existence of a much thicker layer of soil and loose and that may look like any other garden with trees and bushes. Modern technology allows even growing trees [6], [8], [9].

Some roofs are true vegetable greenhouses and garden ornaments. The roof requires the same care as an ordinary garden and can only be achieved if it supports loading solid roofs.

Fig. 16 Semi-intensive Green Roof example (fotoby Graeme Hopkins)

They are generally categorized as either 'intensive' or 'extensive'. Intensive green roofs are frequently designed as public places and may include trees, shrubs, and hardscapes similar to landscaping found at ground level (Fig. 17). Intensive roofs also tend to be more expensive than extensive roofs because of the need for a more structurally sound building to support the weight. In contrast, extensive green roofs often never seen, require minimal maintenance, and are generally built with substrate depths less than 15 cm (Fig. 18).

Fig. 17 An intensive green roof on the Coast Plaza Hotel in Vancouver, British Columbia (Photo by Brad Rowe).

Fig. 18 Portion of extensive green roof on an assembly plant at Ford Motor Company in Dearborn, Michigan. Plant material consists of 13 species and cultivars of Sedum (Photo by Brad Rowe).

6. Conclusions

The methods outlined above have positive effect on water quality, water quantity decreases discharged into sewage system, thus avoided overloading of the sewerage network. In densely built areas, the lack of other space, you can arrange a retention basin, downstream of the village, in bed Envoy (formation of a polder).

Due to the advantages it presents, these methods of reducing stormwater runoff due to efficiency, simplicity in implementation and operation, these methods will expand and will fit into the ambient. It should be mentioned disadvantages of these systems, however, infiltration, such as:

- At low temperatures is not possible infiltration;
- Existence of minimum distance to neighboring buildings to avoid flooding basements;
- Due siltation finely ground and other materials, permeability decreases with time lows, so there may be a capacity to continuous operation.

The realization of such systems will be considered in addition to economic and technical aspects of long-term advantages and disadvantages thereof.

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