MUNICIPALITY OF ACHARNAI

INTERREG IIIB
PROJECT: RAINDROP

ACTION 4.2: GUIDELINES FOR THE CHOICE OF SWM STRATEGIES IN THE CADSES AREA

GUIDELINES FOR STORM WATER MANAGEMENT

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INTERREG IIIB CADSES European Union

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1 INTRODUCTION

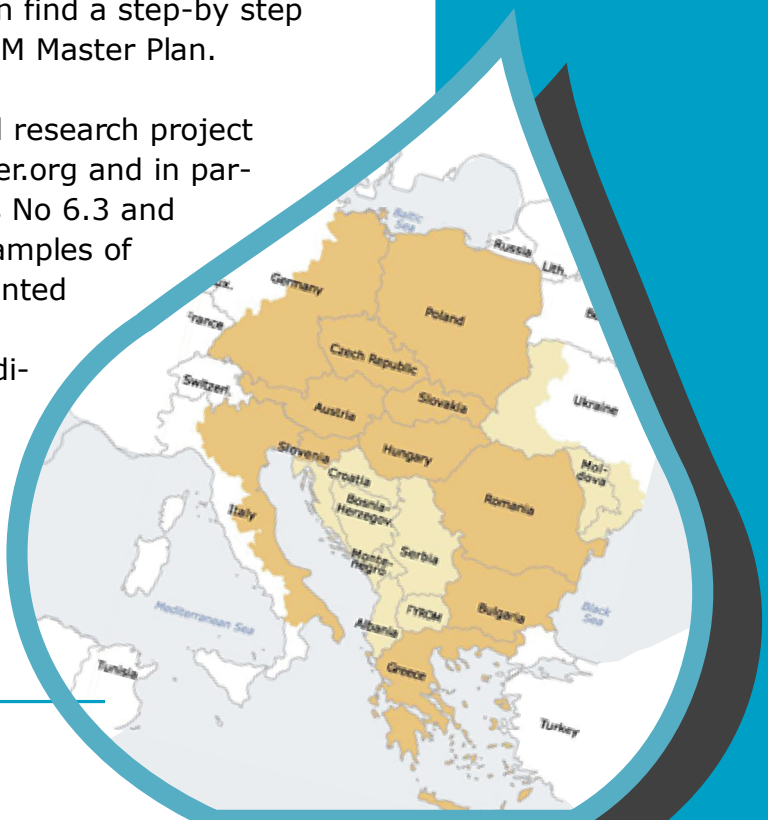
This document provides guidelines for selecting the Storm Water Management strategies that are most suitable depending on the characteristics, particularities, and restrictions of the various urban areas. The proposed guidelines include the knowledge acquired from the RAINDROP project partners throughout the entire project both in the techniques applied as well as on the local conditions studied in the CADSES area.

The Guidelines present the criteria that must be taken into consideration when proceeding into applying SWM techniques and the rationale based on which the various techniques and/or combinations thereof may be implemented. Through the knowledge of the criteria and the rationale, the engineers and state officials can select the optimal strategy that best fits for their city.

This document must be read in conjunction with:

- The report titled "Codification of methodology for SWM Master Planning" presented under Action 4.1 of the RAINDROP project, where one can find a step-by step approach for the drafting of a SWM Master Plan.

- The deliverables of the EU funded research project named Daywater at www.daywater.org and in particular WP6/Task 6.3/Deliverables No 6.3 and 6.4, in which the most typical examples of source control schemes are presented with their technical and financial characteristics as well as the conditions that would favor their application.



2 RATIONALE FOR SELECTING STORM WATER MANAGEMENT STRATEGIES

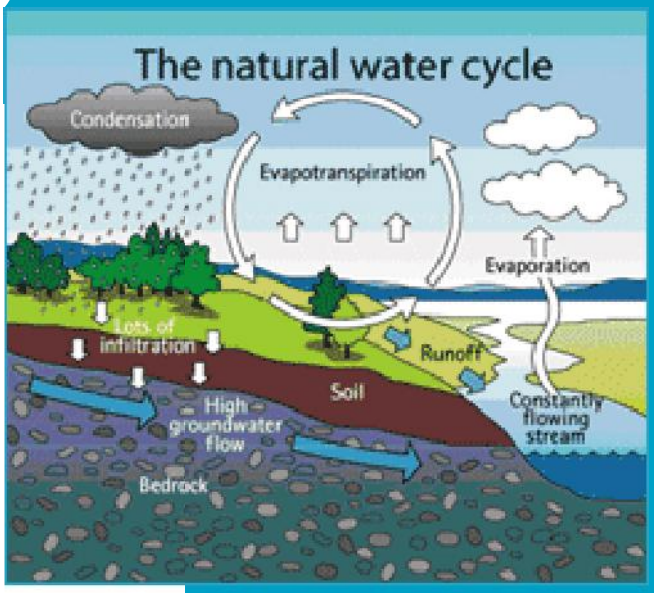
The principle behind the application of SWM is to achieve the dual goal of:

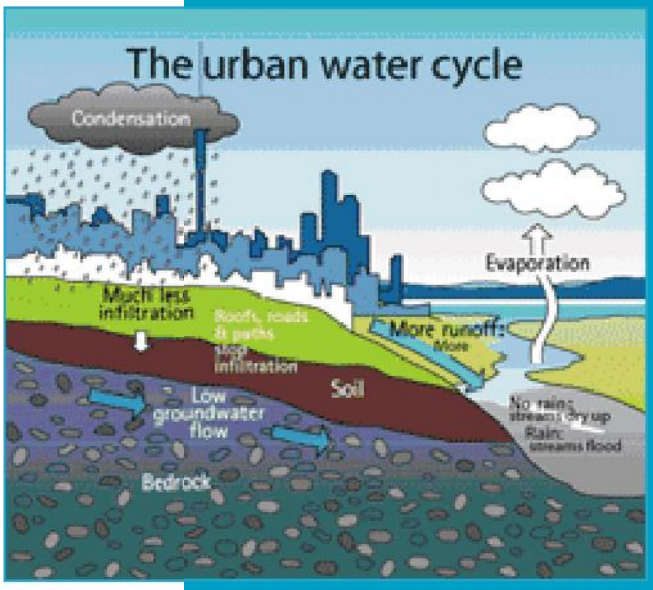
- Maintaining after urbanization through infiltration, retention and detention as undisturbed as possible the relationship between the values of Precipitation (P), Evaporotranspiration (ET), Infiltration (I) and Runoff (Q) of the hydrological cycle before urbanization.

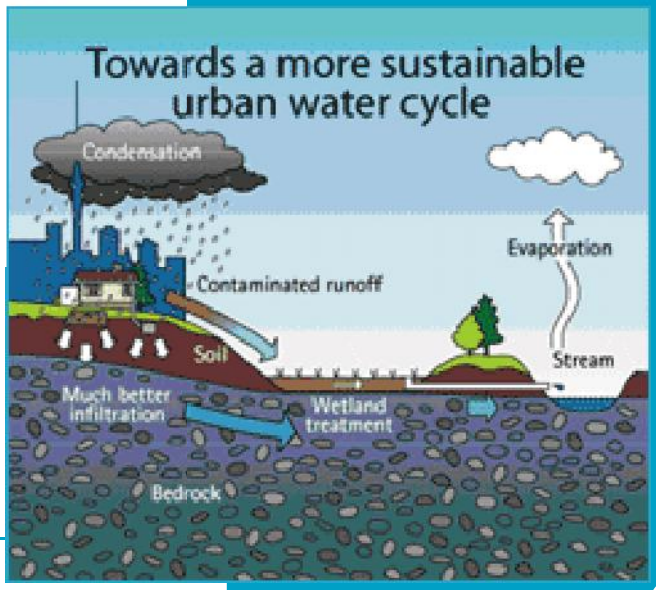
The design of SWM schemes is trying to satisfy the condition that peak flows and flow volumes will not exceed those before urbanization.

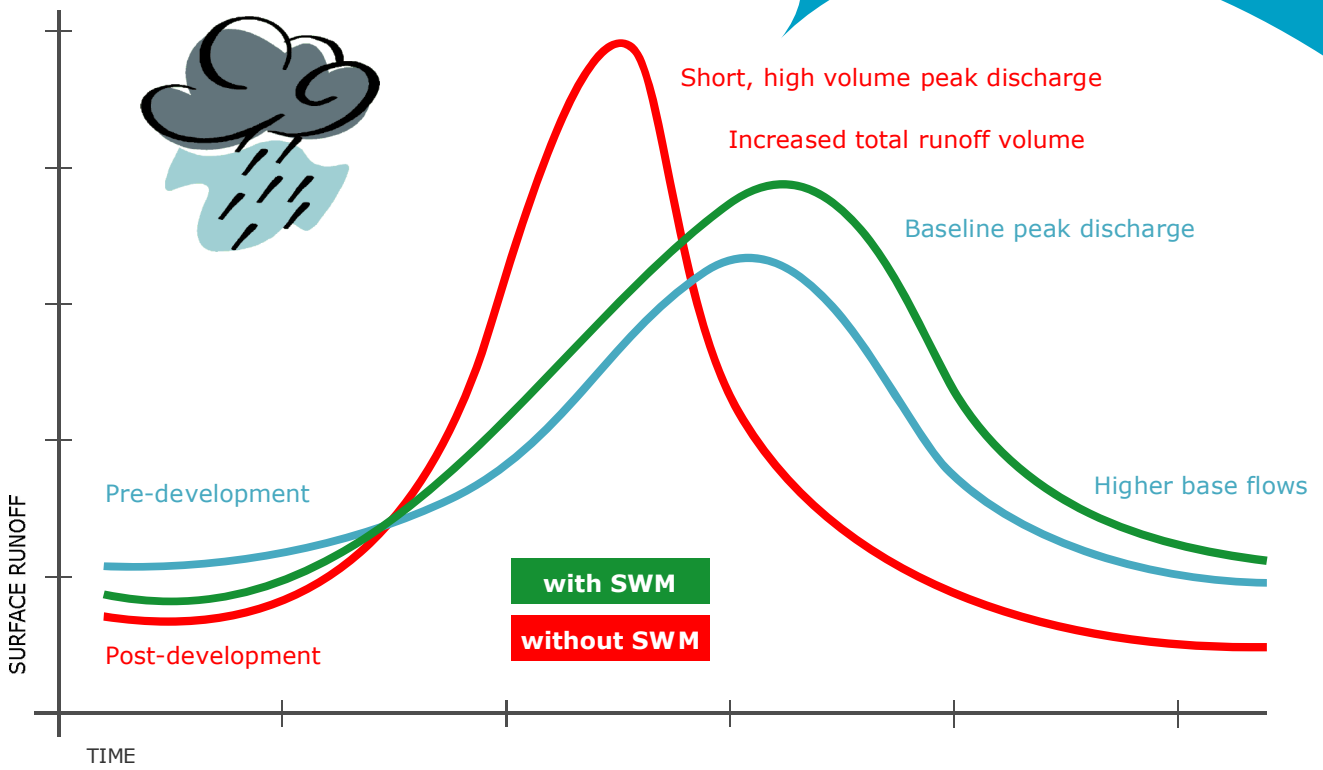
- Protecting the subsoil and the receiving waters from the pollutants of the urban surface.

Satisfying both conditions constitutes a fundamental ecological approach of SWM.

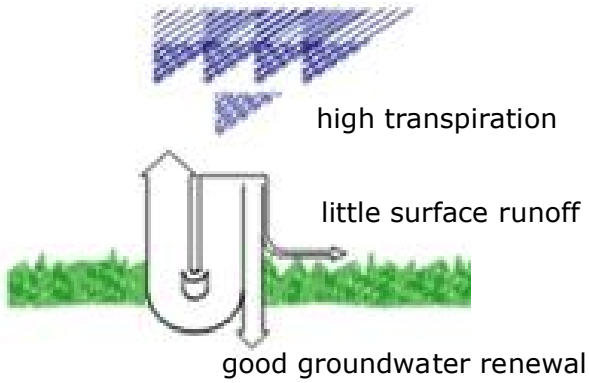


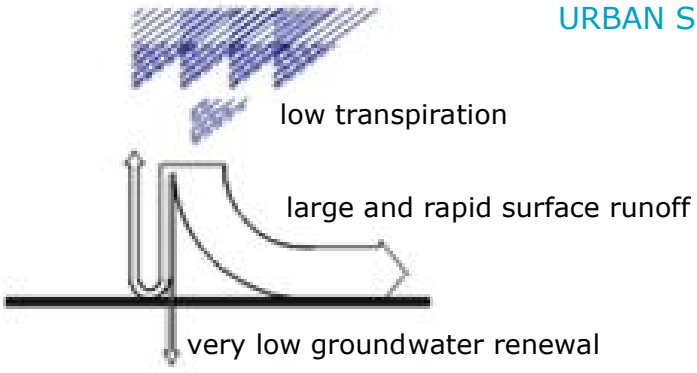






Runoff vs time before and after urbanization





Effect of urbanization on surface runoff

2.1 Decentralized Storm Water Management

The above principle in practice is best served by the application of the approach called "Decentralized Storm Water Management". This approach requires that the relationship between the values of Precipitation (P), Evaporotranspiration (ET), Infiltration (I) and Runoff (Q) of the hydrological cycle is maintained at the smallest surface scale possible within the urban catchment, that is at building block or even at land plot level.

This strategy limits to the minimum the requirement for storm water conduits. The typical schemes applied in ODecentralized SWMO constitute of small scale interventions with a relatively limited runoff retention, detention, and infiltration capacity that are used to control the additional runoff due to urbanization at local scale and as close as possible to the source, that is as close as possible to where the runoff is created with minimal piping or even without piping at all.

Such schemes are:

- Green roofs
- Enhanced dry swales (Mulden Rigolen) applied at plot level or street level
- Simple swales applied at plot level or street level
- Wet swales applied at plot level or street level
- Porous pavings
- Permeable pavings
- Stone filled soakaways
- Soakaways with plastic cells
- Under pavement storing structures
- Dry ponds plot level or street level

Porous pavings

Simple swale

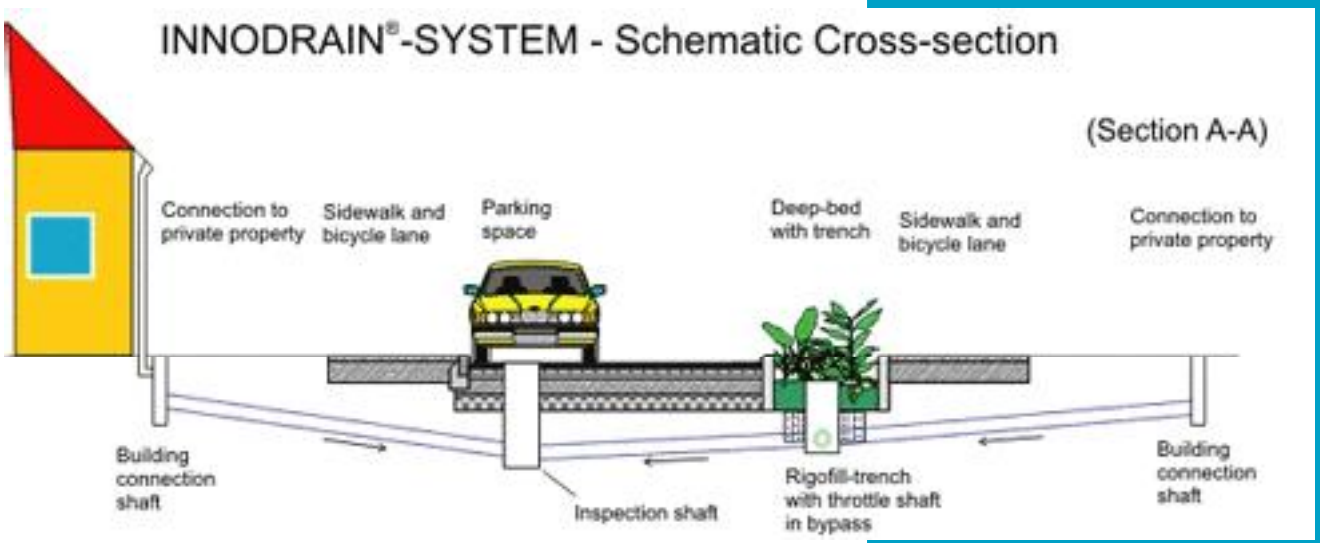
StormTech, subsidiary to Infiltrator Systems, Inc, 2002

Under paving storage structures (under construction)

Stone filled soakaways (under construction)

Permeable paving & Enhanced dry swales

Innodrain® system developed by Ingenieurgesellschaft Prof. Dr. Sieker mbH.



Green roof

Dry ponds for infiltration and retention at building/plot level

2.2 "End-of-pipe" systems

The opposite of "Decentralized" SWM is the so-called "End-of-pipe" approach in which the SWM schemes for retention, detention, and infiltration are placed right before the outflow of the main collectors to the receptors. The schemes applied in this approach constitute of extended structures, often built with concrete, for the retention, detention, and infiltration of large volumes of surface runoff.

Typical schemes of that kind are:

- Retention tanks
- Detention tanks
- Detention bassins
- Wet or dry ponds
- Constructed wetlands

Wet pond

Constructed wetland

Retention concrete tank

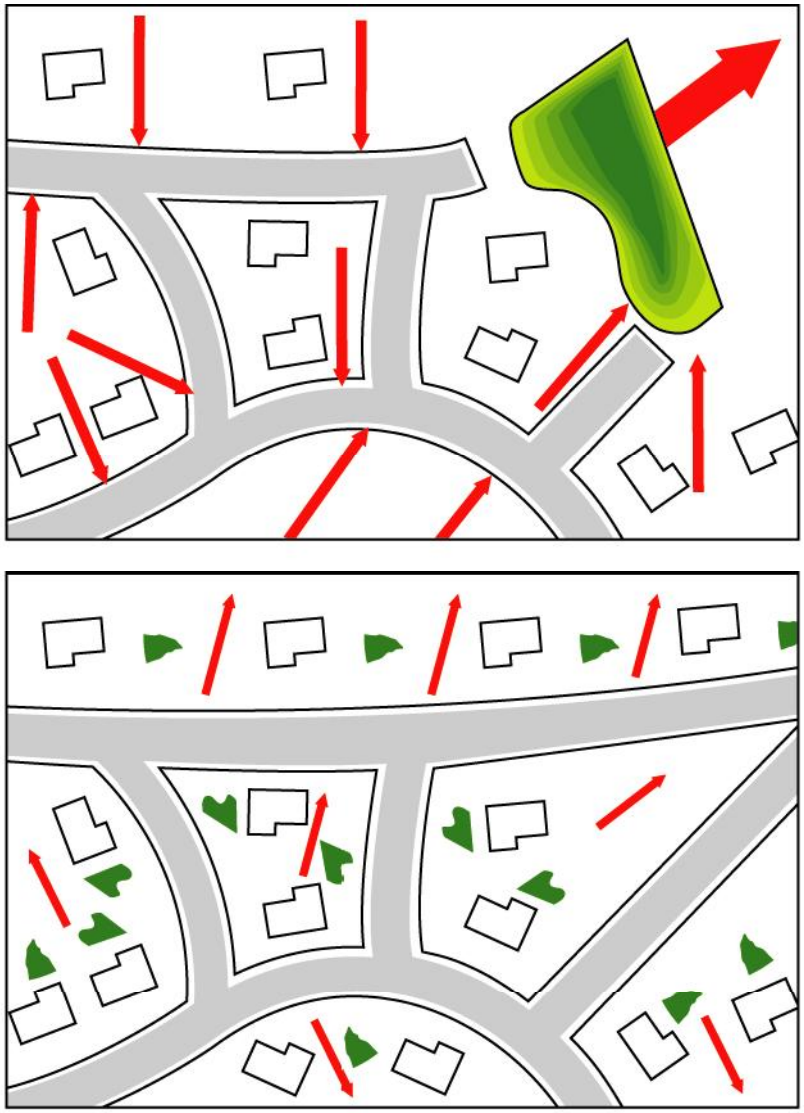
Detention wetland

Open detention tank (multipurpose facility: BMP and water sports arena)

Dry ponds (large scale)

2.3 Combining Decentralized SWM with «End-of-pipe» approach

Decentralized SW Management is a more sustainable and environmentally friendly approach. However, in the context of urban SW management it not always possible to rely solely on Decentralized SW schemes, and therefore, a combination of both approaches is often the best possible way to proceed.



"Decentralized SWM" VS "End-of-pipe" approach

3 Criteria for Selecting Storm Water Management Strategies

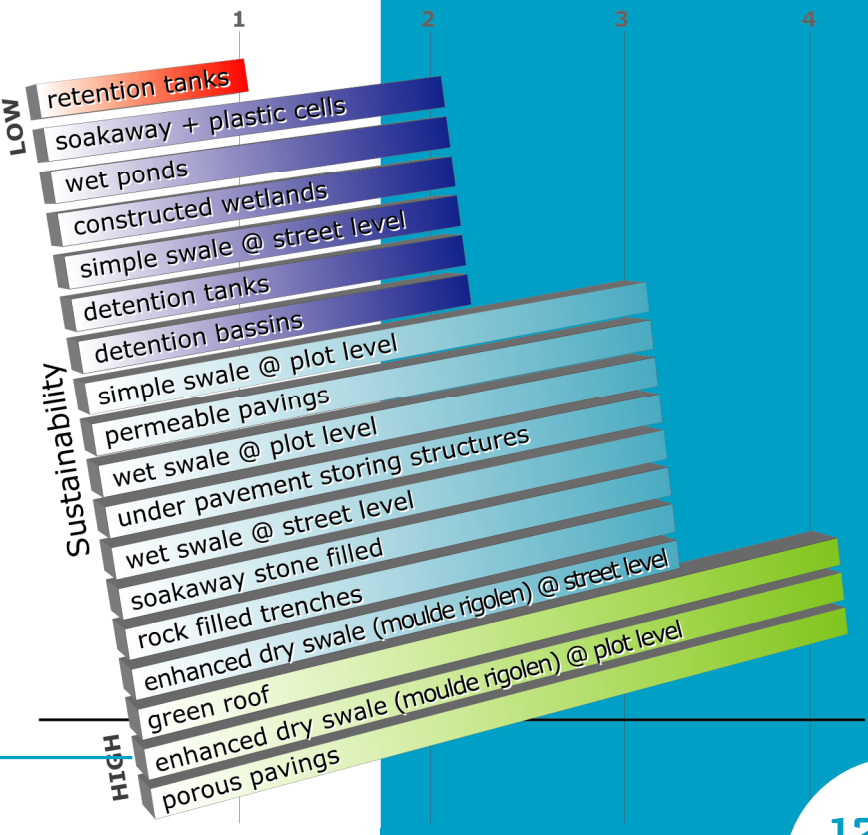
3.1 Sustainability

For the selection of the suitable SWM schemes (BMPs) three conditions must be satisfied in order to obtain a sustainable SWM strategy:

- **Principle No1:** Protect the receiving waters from urban pollution. In practice this means that infiltration must always be applied in conjunction with the need to protect the subsoil and the groundwater from the surface contaminants
- **Principle No2:** The strategy selected must respect the hydrological balance in the post-urbanization conditions by using infiltration and retention/detention.
- **Principle No3:** Consider the environmental friendliness of the overall strategy in the entire life span of the structures, that is the application the "life cycle" approach considering the impact of the proposed SWM schemes (BMPs)
  - during construction
  - during operation and maintenance
  - for demolition-renewal-substitution

The closer to nature a SWM scheme is the more sustainable it is. For example ponds formed with simple topographical modifications in public parks are significantly more sustainable compared to underground concrete retention tanks with pumping schemes.

The graph on the right gives a qualitative classification of the available techniques in terms of sustainability.

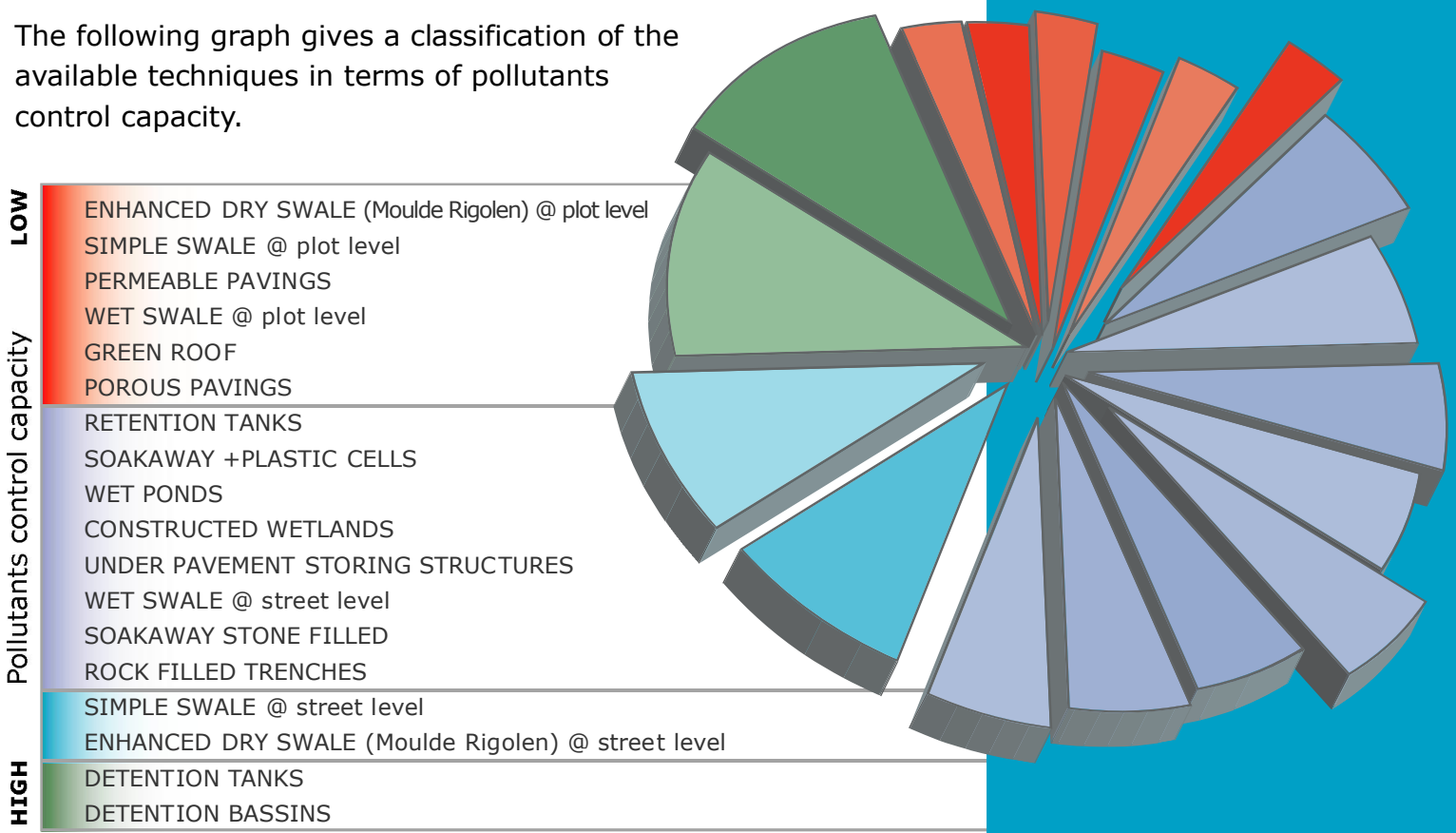


3.2 POLLUTANTS CONTROL

SWM schemes initiated as peak flow and volume control schemes in urban settlements. As the pressure on the urban environment increased SWM schemes gained a second -equally important- role that of pollutants control.

Collecting and treating pollutants washed away from the streets, roofs and terraces has become a priority, and therefore, the performance of SWM schemes on pollutants' control will play a decisive role upon selecting which of the applicable schemes will be implemented in order to achieve the overall quantitative and qualitative goals stipulated in the SW Management Master Plan.

The following graph gives a classification of the available techniques in terms of pollutants control capacity.



More information on the particularities of SWM schemes concerning their performance on pollutants' control as well as design issues and tips for each of the schemes can be found in the Deliverables No 6.3 and 6.4 of the WP6/Task 6.3/ of the Daywater at www.daywater.org.

3.3 Flood control potential

The flood control potential may be determined by the retention/detention volume available per m^2 of land used, and if infiltration is possible, by the infiltration capacity of the underlying soil strata. Large retention/detention volumes per m^2 can be typically achieved in increasing the depth of underground structures and by designing their shape as orthogonal as possible. However, only some of the SWM schemes offer that possibility such as concrete tanks and enhanced dry swales, whereas others such as open ponds and green roofs are not as efficient.

Generally, for "decentralized" SWM the most suitable SMW schemes (BMPs) are:

- smaller structures with high flood control potential (enhanced dry swales, stormwater storage tanks at plot level), and
- SWM schemes with small flood control potential (green roofs, porous pavements, dry ponds)

For "semi-central" and "end-of-pipe" SWM approach the most suitable SMW schemes (BMPs) are:

- large structures with high flood control potential (tanks, constructed swales),

"FLOOD CONTROL POTENTIAL" of the techniques

The following graph gives a classification of the available techniques in terms of flood control potential. Given the particularities of each urban site, it should be noted that the graph provides a qualitative overview rather than an absolute classification of the flood control potential of the various SWM schemes (BMPs) and should, therefore, be used accordingly.

More information on the particularities of SWM schemes concerning their flood control potential and performance as well as design issues and tips for each of the schemes can be found in the Deliverables No 6.3 and 6.4 of the WP6/Task 6.3/ of the Daywater at www.daywater.org.

3.4 Cost

The cost of SWM schemes (BMPs) should be considered in conjunction with their flood control potential and their performance in pollutants' control. Therefore, two indices may be used for total cost (including construction and O&M):

- Total cost per m^3 of runoff retention
- Total cost per mg of pollutants removal or alternatively, total cost per pollutants' concentration reduction

The estimation of these costs is a relatively tricky task with a high error risk. A wide array of parameters that depend on the local particularities may determine the real cost of SWM schemes (BMPs) in any given location:

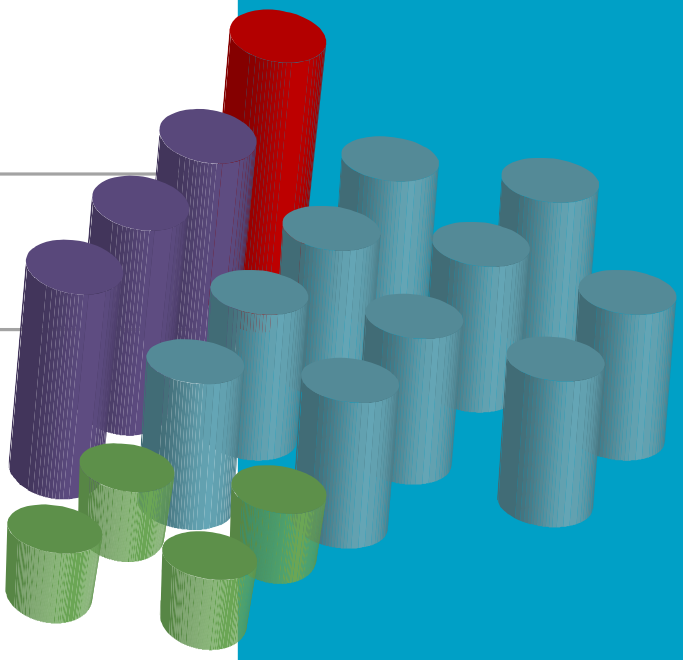
- Materials' cost. A typical example is the variation of aggregates' cost between southern and central/northern European states were plastic storage cubes are cheaper than aggregates for creating underground storage volumes in swales and under pavement structures.
- Labour costs.
- Real estate cost.
- Possibility to combine SWM schemes (BMPs) with other functions in order to explore synergies such as underground parkings, water sports facilities, additional garden space on rooftops with green roofs and others.

The task of comparing costs is equally hard even if one attempts simply to evaluate the relative cost of the various SWM schemes (BMPs) that may be technically suitable in a certain urban settlement. Therefore, we deem appropriate to consult local engineers and experts rather than relying on general cost charts and tables.

The following graphs give a classification of the available techniques in terms of Construction and O&M cost.

Given the particularities of each urban site and the economical characteristics of each country/region, it should be noted that the graph provides a qualitative overview rather than an absolute classification of the costs of the various SWM schemes (BMPs) and should, therefore, be used accordingly.

"Relative Construction Cost" of the techniques



LOW

- ENHANCED DRY SWALE (Moulde Rigolen) @ street level
- RETENTION TANKS
- DETENTION TANKS
- DETENTION BASSINS

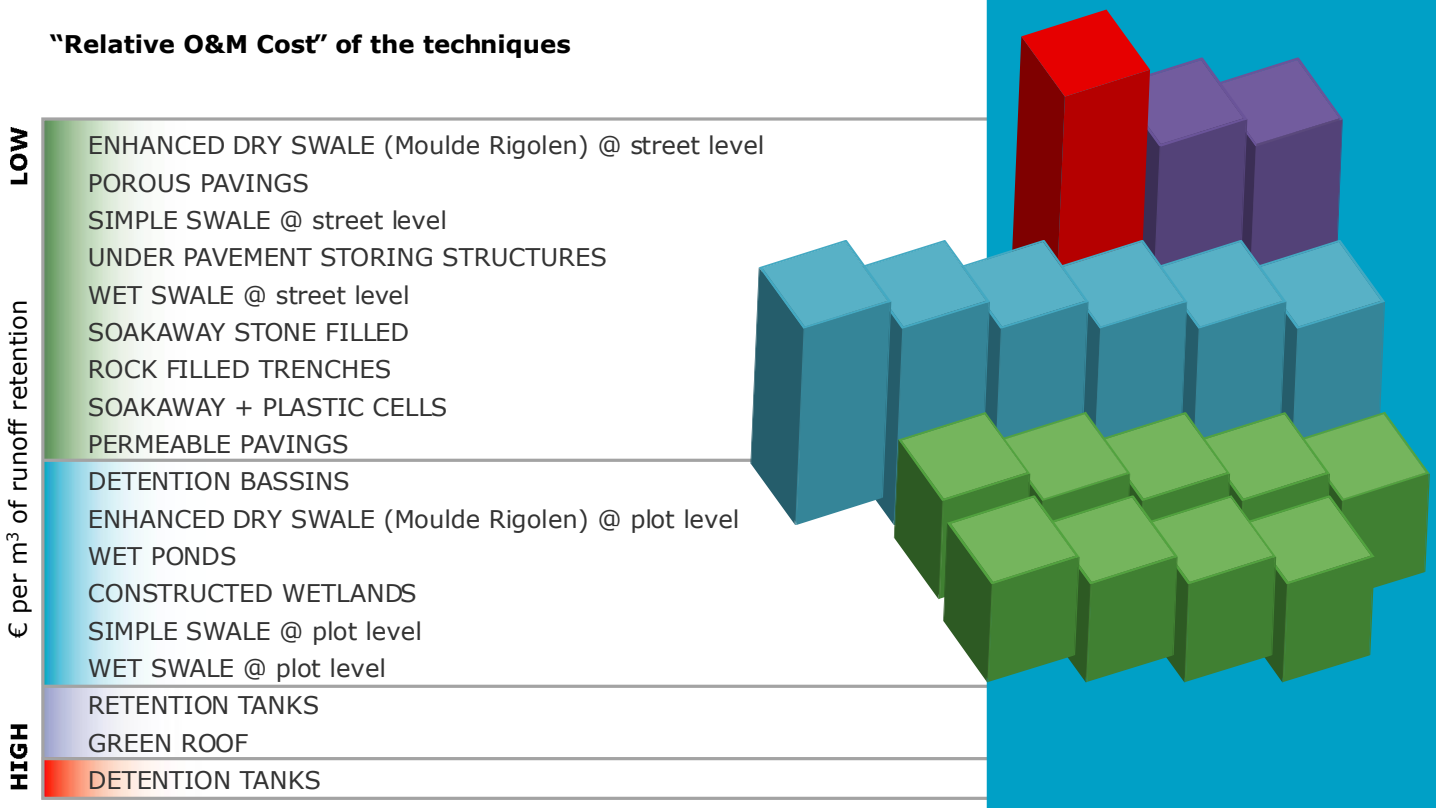
€ per m³ of runoff retention

- ENHANCED DRY SWALE (Moulde Rigolen) @ plot level
- POROUS PAVINGS
- SIMPLE SWALE @ street level
- UNDER PAVEMENT STORING STRUCTURES
- WET SWALE @ street level
- SOAKAWAY STONE FILLED
- ROCK FILLED TRENCHES
- SOAKAWAY +PLASTIC CELLS
- WET PONDS
- CONSTRUCTED WETLANDS

HIGH

- SIMPLE SWALE @ plot level
- PERMEABLE PAVINGS
- WET SWALE @ plot level
- GREEN ROOF

"Relative O&M Cost" of the techniques



More information on the particularities of SWM schemes concerning their cost structure as well as design issues and tips for each of the schemes can be found in the Deliverables No 6.3 and 6.4 of the WP6/Task 6.3/ of the Daywater at www.daywater.org.

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