HELSINKI GREEN AREA FACTOR TOOL
User manual for the Excel-based tool

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1 BACKGROUND

1.1. Origins

As a part of the EU-funded "Climate-proof city – tools for planning" (ILKKA) project a tool for calculating the ratio between scored green area and total area for a lot was developed. The first version of the Excel-based Helsinki Green Factor Tool was released in 2014. Based on the experiences with the tool's usage and due to the increasing importance of stormwater management, which starts with the planning of lot-wise measures, an updated version of this tool was to be developed within the iWater (Integrated Storm Water Management) project.

1.2. Objectives and updates

Main objectives were the removal of the minimum level, revision and densification of the overall selectable elements (primarily bonus elements) and the implementation of stormwater as an additional scoring category. Additionally, information about the estimated amount of stormwater originating from the lot, as well as necessary detention volume, were to be provided within the results. Examples and descriptions of selectable stormwater management structures were provided by the iWater research group from Aalto University and added as a new info sheet.

2 DESCRIPTION OF THE UPDATED GREEN FACTOR TOOL

2.1. Introduction

The tool is Excel based and contains macros (xlsm file), which are essential for using the tool. Therefore, depending on the Microsoft Office version, a question or warning is shown when opening the file. The user must press "Enable Content" to use the file properly (Figure 1). Additionally, the workbook contains protected cells and areas. Their modification is denied when trying to access or change the contents. These cells are usually slightly greyed and any attempted change will cause an automatic message (Figure 2).
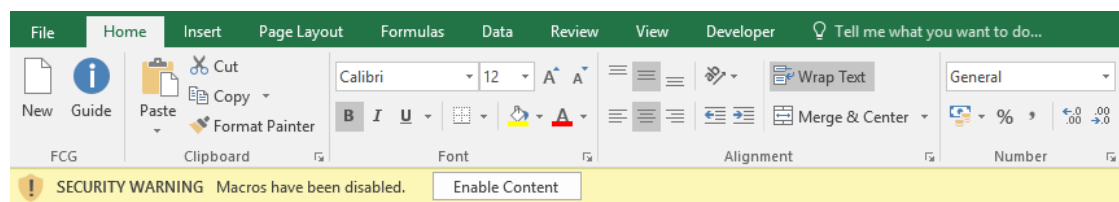
Figure 1. For activating macros, enable contents.
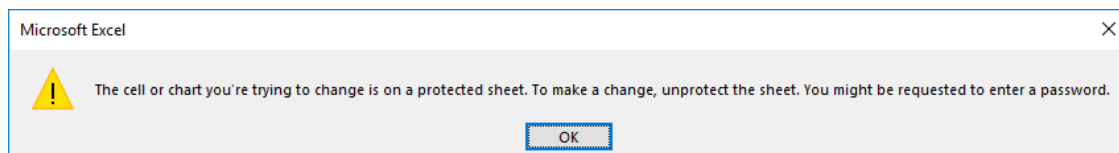
Figure 2. Certain cells are locked / read-only and their contents (formulas or default values) cannot be changed without unlocking the workbook. The necessary password can be requested from Jari Viinanen (mailto:jari.viinanen@hel.fi).

2.2. Using the tool

The tool contains five different sheets "Instructions", "Limitations", "Green Factor", "Results" and "iWater Toolsheet" – the first four of which guide the user step-by-step through the calculation. The user can freely select the sheets using the mouse. However, it is recommended to use the buttons within the sheets to move forward and backward through the tool, since this enables internal checks

when switching between the steps. A new fifth sheet contains examples for stormwater management structures collected and summarised during the iWater project by Aalto University.

The "Instructions" sheet contains valuable information about the usage and the contents of the tool, as well as a description of the terminology. Especially, first-time users are therefore encouraged to start from here and read the instructions carefully.

2.3. Calculating the Green Factor in three steps

2.3.1. Step 1: Limitations

The calculation starts with filling in basic information and boundary conditions for the planned lot (Figure 3). The structure and amount of elements have changed compared to the previous version, particularly based on the removal of the minimum level.

The user should start with filling in basic data about the lot within the small table on the right border (a), such as Block and Lot ID. The site's area, building footprint and floor area are essential for the calculation and should be entered as accurately as possible.

Additionally, some boundary conditions have to be specified within the left table (b):

1. **Land use:** This choice will directly influence the basic value for the Target Level. The Target Level of the updated version varies between 0,9 for Residential and 0,5 for Industrial/Logistic lots.

2. **Type of yard:** Depending on the share of rooftop courtyard on the site, this will influence the selection of green roof elements. If the share is larger than 50%, the user will be reminded to add a significant amount of green roof elements.

3. **Drainage system:** In case the site has to be connected to a combined sewer system instead of a separate stormwater drainage system, the user will be reminded to add at least one significant stormwater detention element.

4. **Surrounding region:** This has mainly informative/reminding character. If there is a green corridor comprising a nature reserve/body of water/natural vegetation located within ≤ 50 m of the site, this has to be taken in to account during the planning phase. An example would be to provide a proper green/natural axes for traveling of the flying squirrel.

5. **Soil/groundwater:** This will affect the final Target Level. If high groundwater level or impermeable soil levels like rock or clay exist close to the surface, especially infiltration and detention capacities of the remaining soil level limit options for on-site stormwater control. Therefore, the Target Level will be reduced by the factor of 0,2.

6. **Stormwater management solutions:** These options will influence directly the calculation of potential and necessary detention volumes on the site. The user has to estimate an average depth for two types of stormwater elements. The average depth in combination with the planned area will define the available volume. Pure detention/retention elements are limited in their possible depths only by necessary elevation differences (slopes) to connect the outflow of the element on the lot either to a surrounding stormwater sewer or an open ditch. For biofiltration elements it is usually recommended to limit the maximum water depth to 30–40cm. Further instructions can be found below the table.
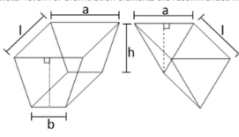
Figure 3. Limitations sheet. Section (a) contains basic lot information, section (b) specifies the necessary limitations.

> **NB. Having filled in all necessary options and boundary conditions, the user may switch to the second step to fill in the different elements on the site.**

2.3.2. Step 2: Green Factor calculation

2.3.2.1. Filling in the Green Factor sheet

The "Green Factor" sheet (Figure 4) contains a table for filling in elements according to five basic groups: "Preserved vegetation and soil", "Planted and/or new vegetation", "Pavements", "Stormwater elements" and "Bonus elements" (a). Compared to the previous version, this table has been restructured, some elements have been added, removed or grouped. For instance, the green roof elements – although not providing any specific detention volume – have been moved to the "Stormwater elements" group. Despite not providing a separate detention volume, they decrease the amount of stormwater originating from the lot by reducing the size of sealed roof surface and the total runoff-coefficient.

If possible, the user should choose at least one element from each group with exception of the "Bonus elements" which are not obligatory. When filling in elements, it is recommended to pay attention to the units: some elements come in numbers with a pre-set surface area per element, while others come in m^2. Because its underground location does not occupy any exterior surface area, the "Retention/Detention pit" element's unit is the only one given in m^3.

Based on the user's choice of elements, the tool automatically calculates the weighted areas based on the built-in weighting system, their total sum and the derived Green Factor. Both values in comparison to the Target Level are shown on the left side of the element table (b).

Additionally, compared to the previous version the tool now calculates an average runoff-coefficient of the lot based on built-in element-specific coefficients for each type providing a surface (c). Based on the chosen elements' sizes the remaining area will be set automatically as impermeable with a runoff-coefficient of 1.

5

The runoff-coefficients are based on various sources. For most general land-use types a wide variety of published tables exist with different ranges of coefficients. For some elements, several different land-use types had to be merged and averaged (e.g. semi-permeable pavements). The coefficients for the green roofs are taken from published guidelines of the Building Information Group (Finnish: Rakennustieto or RT-kortisto), in particular guideline RT 85-11203 for green roofs and rooftop court-yards.

Due to the variety and large amount of sources, as well as the partially different land-use types combined in one element, the runoff-coefficients should be seen as an estimation, and not as an exact definition. Additionally, runoff-coefficients are time-dependent and therefore vary with rainfall amount and intensity, and usually also depend on the type of soil and its saturation. Using a single set of coefficients for all conditions thus holds risks of over- or underestimation. Since the overall task of this tool is NOT to replace a proper stormwater assessment and management plan by experts on this matter, but rather to give the lot planner the opportunity of a rough estimation on the potential need for detention, a certain degree of uncertainty has to be accepted.

Based on the average runoff-coefficient and an amount of precipitation (d) set by the user, the approximate amount of stormwater originating from the lot is calculated automatically (e). The amount of precipitation or rainfall should be set according to the rules for designing stormwater management systems applying to the location of the lot. The lot's estimated stormwater volume is calculated as follows: lot area * lot's average runoff-coefficient * precipitation.

A common approach for estimating the recommended lot-wise detention of stormwater is to use a rain intensity of 150 l/(s*ha) corresponding to a 10-minute rain event occurring every five years. According to statistical examinations, the amount of rainfall of about 85–90% of all occurring rain events in Finland is 10mm or less. However, in some cases, particularly in heavily built-up areas with a high percentage of sealed surfaces, this amount can be hard or impossible to achieve and the user is free to reduce the rain amount to a smaller value (e.g. 5mm).

As a new feature, the updated version includes links for selected stormwater elements with brief descriptions provided by the iWater research group from Aalto University, which are collected in the "iWater Toolsheet". By clicking an element within the table, a hyperlink will directly switch to the corresponding example.

The only adjustable cells within this sheet are the "Areas or quantity" (with the exception of the impermeable surface) and the precipitation, all other cells are locked and cannot be changed. Areas and quantities can be freely set and cleared or cleared completely by pressing the "Clear Values" button at the bottom of the table. The latter will result in a pop-up security query.

After filling in the table by trying to reach or exceed the Target Level, the user should press the "Next" button to automatically run a couple of internal checks, which might result in adjusting the previously chosen design. If the checks result in no further necessary adjustments, the tool will switch to the "Results" sheet.

Element group	Element description	Unit	Area or quantity	Weighting	Weighted area, m²	Runoff coefficient C
Preserved vegetation and soil	Preserved large (fully grown > 10 m) tree in good condition, at least 3 m (25 m² each)	pcs	4	3.5	346.7	0.1
	Preserved small (fully grown ≤ 10 m) tree in good condition, at least 3 m (15 m² each)	pcs	2	3.0	91.0	0.1
	Preserved tree in good condition (1.5–3 m) or a large shrub (3 m² each)	pcs	0	2.4	0.0	0.15
	Preserved natural meadow or natural ground vegetation	m²	40	2.2	88.3	0.1
More info	Preserved natural bare rock area (at least partially bare rock surface, not many trees)	m²	0	1.9	0.0	0.7
Planted/new vegetation	Large tree species, fully grown > 10 m (25 m² each)	pcs	12	2.8	843.2	0.1
	Small tree species, fully grown ≤ 10 m (15 m² each)	pcs	15	2.3	515.5	0.1
	Large shrubs (3 m² each)	pcs	13	1.7	66.4	0.1
	Other shrubs	m²	415	1.4	588.5	0.15
	Perennials	m²	0	1.6	0.0	0.2
	Meadow or dry meadow	m²	405	1.9	778.1	0.2
	Cultivation plots	m²	22	2.0	44.2	0.3
	Lawn	m²	1828	1.1	2014.0	0.25
	Perennial vines (2 m² each)	pcs	3	1.3	7.8	0.15
More info	Green wall, vertical area	m²	19	0.9	17.7	-
Pavements	Semipermeable pavements (e.g. grass stones, stone ash)	m²	373	1.0	380.6	0.6
	Permeable pavements (e.g. gravel and sand surfaces)	m²	286	1.8	515.1	0.35
More info	Impermeable surface (calculated automatically)	m²	6168	-	-	1
Stormwater management solutions	Rain garden (biofiltration area) with a broad range of layered vegetation	m²	0	2.8	0.0	0.2
	Intensive green roof / roof garden, depth of substrate 20 – 100 cm	m²	0	2.0	0.0	0.1
	Semi-intensive green roof, depth of substrate 15 – 30 cm	m²	0	1.5	0.0	0.4
	Extensive green roof, depth of substrate 6-8 cm	m²	0	1.4	0.0	0.6
	Infiltration basin or swale covered with vegetation or aggregates (no permanent pool of water, permeable soil)	m²	0	2.3	0.0	0.1
	Infiltration pit (underground)	m²	0	1.5	0.0	0.1
	Pond, wetland or water meadow with natural vegetation (permanent water surface at least part of the year; at other times the ground remains moist)	m²	0	2.8	0.0	0.1
	Retention or detention[1] basin or swale covered with vegetation or aggregates (permeable soil)	m²	0	2.0	0.0	0.2
	Retention or detention[1] pit, tank or cistern (underground, notice units: volume!)	m³	0	1.4	-	-
More info	Biofiltration basin or swale	m²	0	2.7	0.0	0.15
Bonus elements, max score 1 per category	Capturing stormwater from impermeable surfaces for use in irrigation or directing it in a controlled manner to permeable vegetated	m²	440	0.7	292.1	
	Directing stormwater from impermeable surfaces to constructed water features, such as ponds and streams, with flowing water	m²		0.8	0.0	
	Shading large tree (25 m² each) on the south or southwest side of the building (especially deciduous trees)	pcs	6	0.9	134.3	
	Shading small tree (15 m² each) on the south or southwest side of the building (especially deciduous trees)	pcs	10	0.9	134.3	
	Fruit trees or berry bushes suitable for cultivation (10 m² each)	pcs	17	1.0	250.9	
	A selection of native species – at least 5 species/100 m²	m²	0	0.9	0.0	
	Tree species native to Helsinki and flowering trees and shrubs – at least 3 species/100 m²	m²	0	0.9	0.0	
	Butterfly meadows or plants with pleasant scent or impressive blooming	m²	480	0.8	393.9	
	Boxes for urban farming/cultivation	m²	11	0.6	7.1	
	Permeable surface designated for play or sports (e.g. sand- or gravel-covered playgrounds, sports turf)	m²	125	0.7	88.9	
	Communal rooftop gardens or balconies with at least 10% of the total area covered by vegetation	m²	120	0.6	73.0	
More info	Structures supporting natural and/or animal living conditions such as preserved dead wood/stumps or birdboxes (5 m² each)	pcs	2	1.2	11.6	

1) Detention: no permanent pool of water (dry pond), good quantity but limited quality control. Retention: holds permanent pool of water (wet pond), permanent water level reduces detention space but increases quality control.

Side panel:
- **Green Factor** 0.81
- Target level 0.90
- Site area, m² 9537
- Total weighted area, m² 7683
- **Stormwater volume m³** 67
- Precipitation mm 10
- Runoff coefficient C 0.7
- Date 17.11.2017
- Block ID XYZ
- Lot ID ABC

Buttons: Instructions | Clear values | Previous | Next

Figure 4. Green Factor calculation sheet.

2.3.2.2. Weighting system

Pressing the "More Info" button will temporarily open a new sheet "More information" (Figure 5) containing a brief explanation for all the different elements concerning their significance for each of the categories. It also shows the weightings for each element under each group, as well as global weighting derived from specialist interviews.

The global category weightings for Ecology, Functionality, Cityscape and Maintenance were originally derived by interviewing experts from different relevant groups such as land-use planners, landscape architects, developers, and environmental specialists regarding their views on the importance and value of the different categories. For the updated version, these weightings were preserved (for more information, please check the report for the previous Green Factor version).

Assessing the weighting of the new stormwater category was difficult, because its importance was previously covered by, and included in, the weightings of the original four categories (focusing mainly on Ecology). It was therefore based on the average weightings of the original categories by its assumed importance for stormwater management and then adjusted by testing and comparing the resulting Green Factors on model sites. Thus, the final score of 1,25 was derived.

The element-specific weightings of the previous four categories were kept unchanged, while Stormwater elements were set by assessing the importance of each individual element concerning stormwater management. Also, the individual weightings were tested and calibrated based on the model sites.

Both category- and element-specific stormwater weightings underwent several test phases during various workshops for verification.

Scale (ecology, functionality, cityscape – Note: maximum score for bonus elements is 1)
3 = Major significance
2 = Moderate significance
1 = Minor significance
0 = No significance

Scale (Maintenance – Note: Maximum score for bonus elements is 1)
3 = Maintenance need is less than once a year.
2 = Maintenance need 1–2 times a year
1 = Maintenance need more than 3 times a year
0 = Maintenance need more than once a month

Overall weighting of categories calculated from specialist interviews

Categories	Overall weighting (1–3)	Category functions
Ecology	1.59	Quantitative and qualitative management of stormwater
		Carbon sequestration and storage
		Biodiversity of species and habitats, the ecological network
Functionality	1.51	Microclimate regulation (cooling, sequestration of air pollutants, reduction of noise and wind conditions, visual screen)
		Food production by urban farming, learning from nature, play
		Safety
Cityscape	0.84	Link to the surrounding cityscape, effect on the scenery (e.g. flowers and berries)
Maintenance	0.70	Low-maintenance solutions (how many times)
Stormwater	1.25	Capture and treatment of stormwater

Note. Costs have not been taken into account in the scoring (e.g. need for manual labour).

Note. There is a reducing effect on the scoring due to lack of experience with the maintenance of the element in Finland.

Figure 5. Information sheet containing weightings and descriptions for each element.

> **NB. The scaling/scoring factors are fixed and cannot be changed. By pressing the "Back" button, the sheet is closed and the "Green Factor" sheet is activated again.**

2.3.3. Step 3: Checking and printing the results

The "Results" sheet (Figure 6) offers a pre-defined summary of the calculation and its results designed for a standard DIN-A4 sheet printout. It contains information about all important settings and results in numerical and graphical form, such as the Target Level and Green Factor, the share of each element group and elements within a group or the shares of weighted areas.

As part of the updated version, this section now also contains specific information from the stormwater management point of view: the blue-coloured section provides data on the total estimated amount of stormwater originating from the site (a) and its average runoff-coefficient (b) as well as the share of Total Impervious Area or TIA (c). Depending on the given option of a certain percentage of the stormwater that can be handled outside of the lot, the total volume will be reduced to a final amount that needs to be taken care of on the lot itself (d). Based on the user-defined detention volume (e), this results in a remaining retention demand (f), which should be minimised.

Score card

Date: 17.11.2017 | Block ID: XYZ | Lot ID: ABC

Green Factor calculation

g Green Factor is below target level!	**0.81**
Target level	0.90

a Stormwater volume m³	
66.7	

b Average runoff coefficient C	Possibility to retain stormwater outside block/lot
0.7	Yes

d Necessary retention vol. m³ on the ...	
53.4	

e Retention volume of chosen elements m³	**f** Remaining retention demand m³
0.0	53.4

c Share of total impermeable surface	
65 %	

Elements included in the green factor

| Element group	Elements filled	Total number of elements in group
Preserved vegetation	3	5
Planted vegetation	9	10
Pavements	2	2
Stormwater solutions	**h** no elements!	9
Bonus elements	9	12
Total	23	38

Comments **i**
- Share of rooftop courtyard > 50%, please add a green roof element!
- Add at least one stormwater detention system!
- Nature reserve/body of water/natural vegetation located within ≤ 50 m of the site!

Share of total weighted area, %
- 6.8 % Preserved vegetation
- 63.5 % Planted vegetation
- 11.7 % Pavements
- 0.0 % Stormwater solutions
- 18.0 % Bonus elements

Element groups (% of total number of chosen elements)

Weighting of different categories in the green factor, %
- 26.0 % Ecology
- 29.2 % Functionality
- 14.9 % Cityscape
- 11.9 % Maintenance
- 17.9 % Stormwater
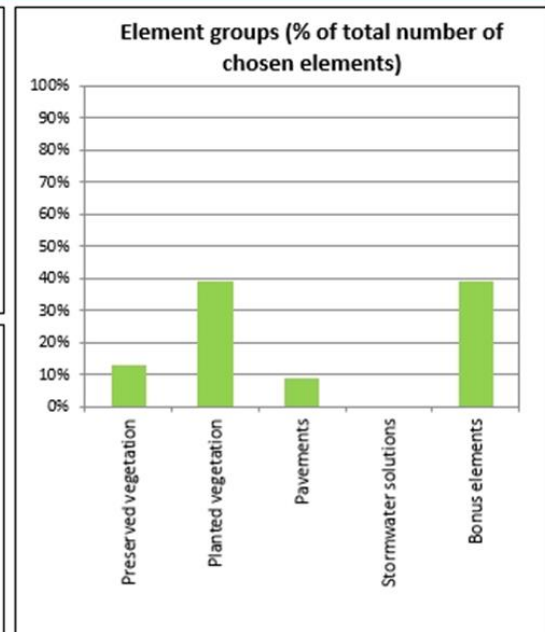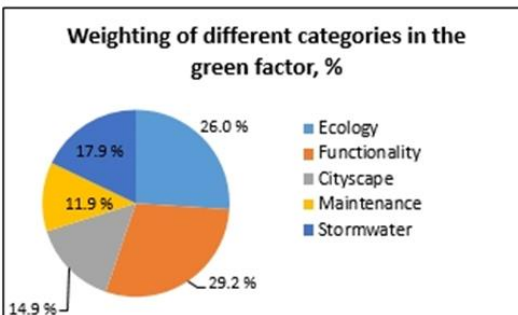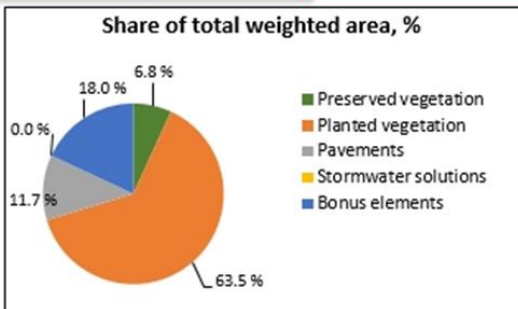
Figure 6. Results sheet.

Additionally, the user will now be visually warned, if for instance the Target Level has not been reached (g) or certain elements are missing (h). Furthermore, all important notifications resulting from automatic internal checks will be listed in the top section of the "Comments" field (i). This part cannot be manually changed and adjusts itself automatically depending on the settings within the tool.

For printing out the results sheet, make sure you define the Scaling and Print Area correctly within the Excel settings for Print and Page Setup (Figure 7). The table should be scaled to fit one page (wide and tall) and the "Print Area" should be set to A1:I46, which represents the extent of the results sheet.
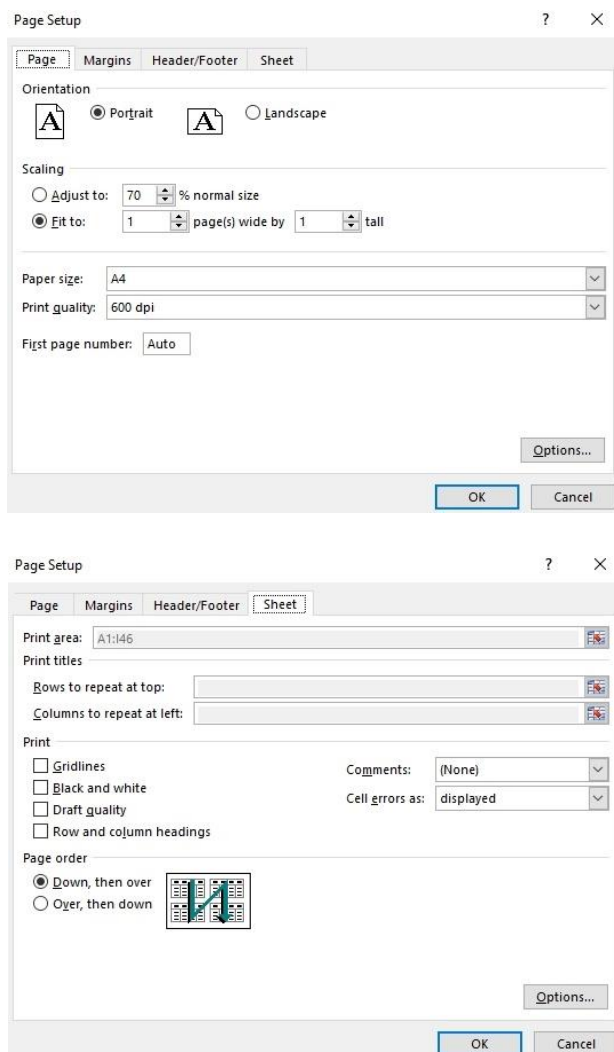
Figure 7. Page and printing setup.

This manual was developed within the iWater - Integrated Storm Water Management project (2015–2018).

iWater aims at improving the urban planning in the cities of the Baltic Sea Region through development of integrated storm water management system. Project provides new approaches and tools for urban planning – for greener, safer, more sustainable and attractive cities.

For more details please visit project website at www.integratedstormwater.eu

Contact expert organization

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