KLIMA 2050

RISK REDUCTION THROUGH CLIMATE ADAPTATION
OF BUILDINGS AND INFRASTRUCTURE

KLIMA 2050

CONSORTIUM

Private sector

SKANSKA
MESTERHUS
Multiconsult
Finans Norge
SKJÆVELAND GRUPPEN
NORGESHUS
weber SAINT-GOBAIN
isola
powel

Public sector

Statens vegvesen
NVE
AVINOR
Jernbaneverket
STATSBYGG
TRONDHEIM KOMMUNE

Research & education

SINTEF
BI
NTNU
Meteorologisk institutt
NGI

Klima2050 – hvordan håndtere overvannsutfordringene

Tone M. Muthanna (PhD)
Institutt for Vann- og miljøteknikk
NTNU

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Sentre for forskningsdrevet innovasjon (SFI)

Klima 2050 er ett senter for forskningsdrevet innovasjon (SFI) finansiert av Norges forskningsråd og partnerne i konsortiet.

SFI-statusen gir mulighet til langsiktig forskning i nært samarbeid med næringsliv og forskningspartnerne med mål om å styrke Norges innovasjonsevne og konkurransekraft innen klimatilpasning.

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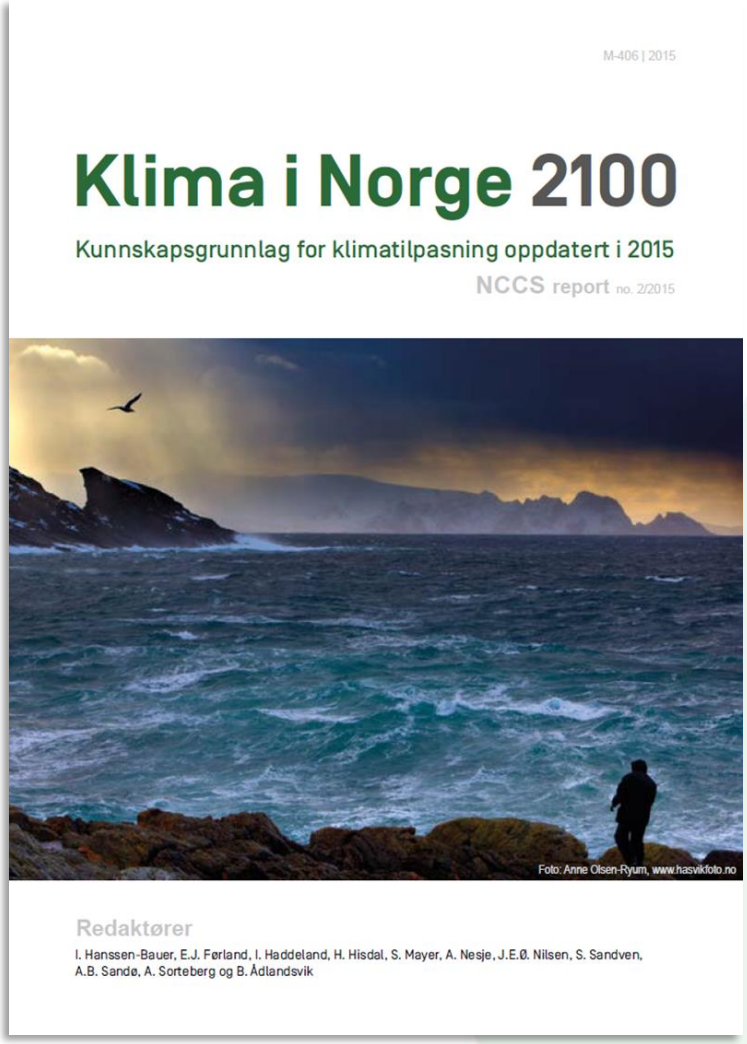
- " Det blir varmere
- Det blir våtere
- Styrtregnet blir kraftigere
- Flommønsteret blir endret
- Snøsesongen blir kortere i lavlandet
- Det blir færre og mindre isbreer
- Havnivået øker
- Mer skredfare
- Blir det mer "ekstremvær" og vind? "



Kilde: Hans Olav Hygen, met.no

Klimagassreduserende versus klimatilpassende tiltak

Mitigation (eks. zeb.no) versus **Adaptation** (eks. klima2050.no)

Nyheter Oppdraget Trondheim Sør-Trøndelag Nord-Trøndelag Møre og Romsdal Været

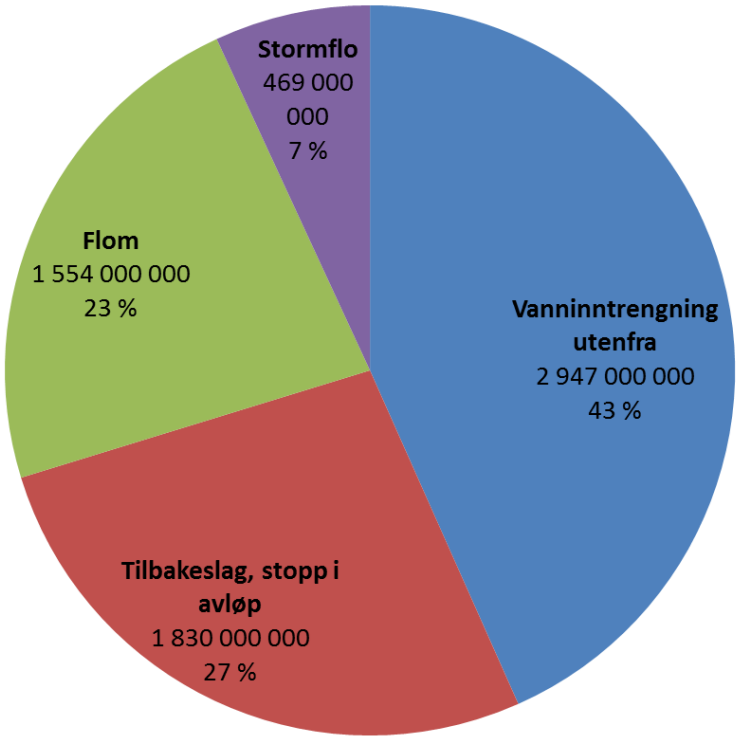
Flere byer og tettsteder på Østlandet opplevde oversvømmelser og overvann etter et kraftig regnskyll søndag. Her fra Karl Johans gate i Oslo, som en stund minnet mer om en innsjø enn en travel turist- og handlegate. Avløpene greide ikke å ta unna i samme takt som vannet fosset ned. FOTO: NTB SCANPIX

Styrtregn i byene koster langt mer enn flom

Voldsomme regnbyger på Østlandet skapte oversvømmelser i flere byer og tettsteder søndag.

Adresseavisen 02.06.2013

Forsikringsutbetalinger



Damages caused by water penetrating the building from outside from 2009 – 2013

Source: Finance Norway, NHO

Målsetning

Hovedmål er å redusere samfunnsrisiko på grunn av klimaendringer og økt nedbør- og flomvannseksponering på det bygde miljø.

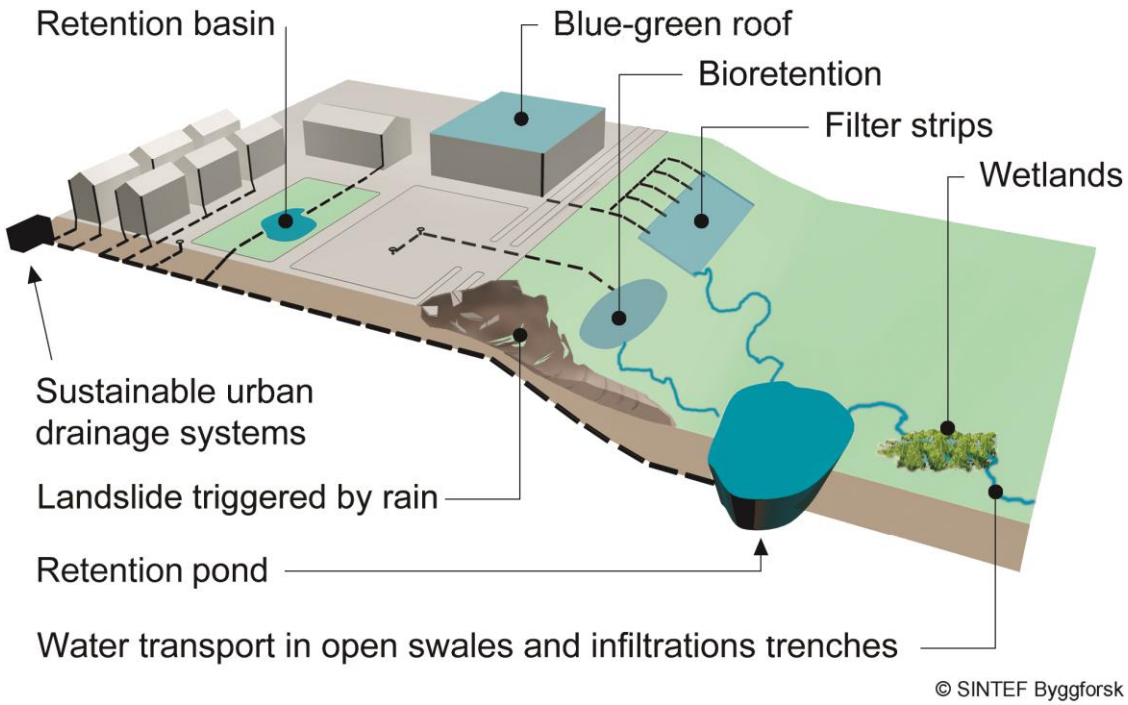
Fokus er på utvikling av

- Fuktsikre bygninger
- Overvannshåndtering
- Blå-grønne løsninger
- Tiltak for å hindre vannutløste skred
- Samfunnsøkonomiske insentiver og beslutningsprosesser

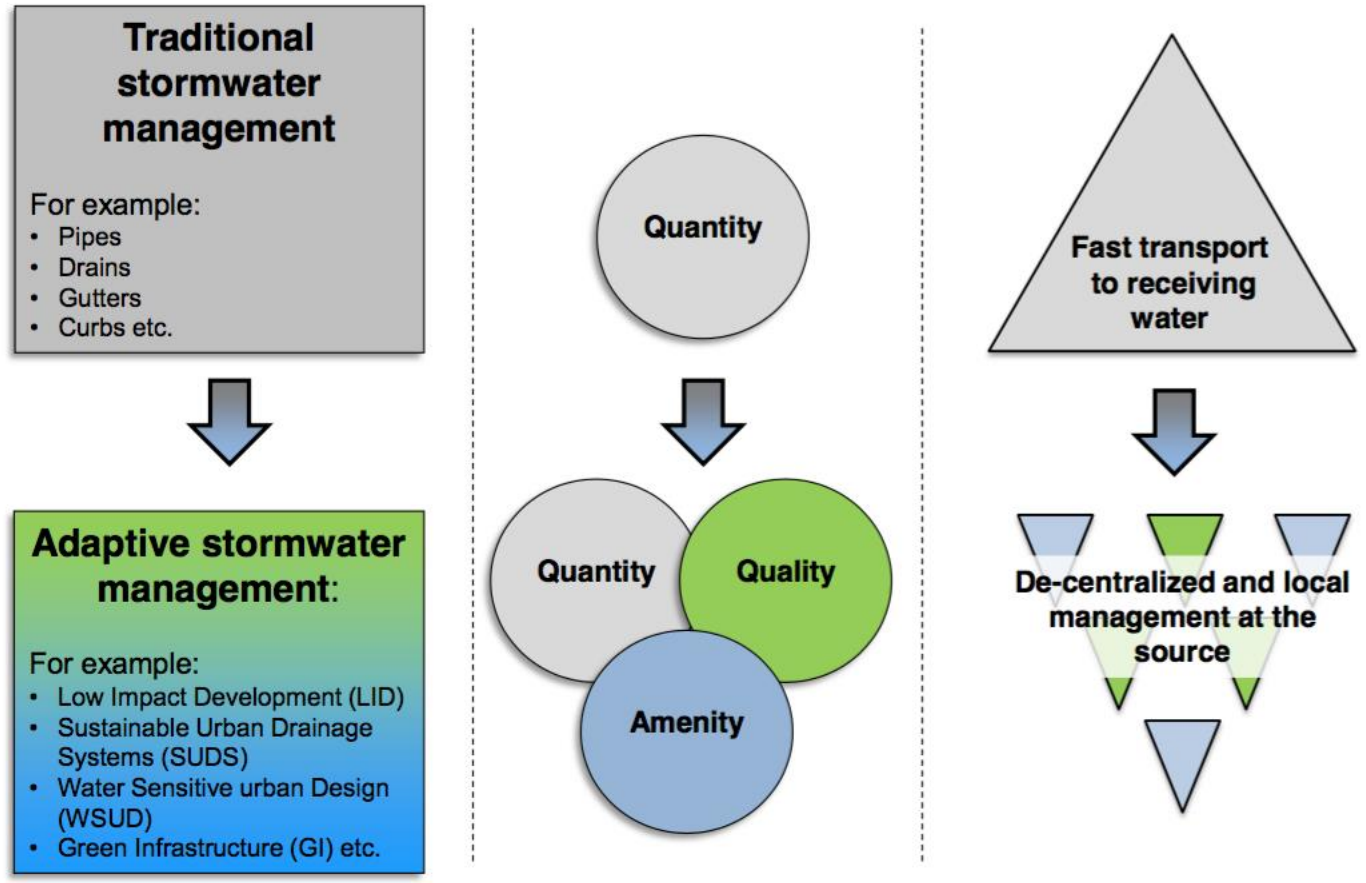
Både ekstremvær og gradvise endringer i klima vil bli adressert.



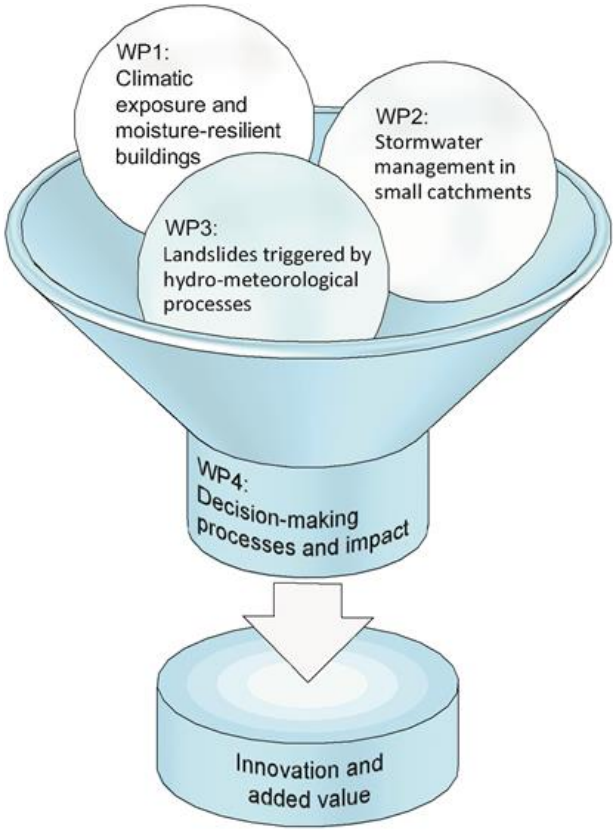
Vannveien !


Retention basin
Blue-green roof
Bioretention
Filter strips
Wetlands
Sustainable urban drainage systems
Landslide triggered by rain
Retention pond
Water transport in open swales and infiltrations trenches
© SINTEF Byggforsk

A Shift from Traditional to Adaptive Stormwater Management

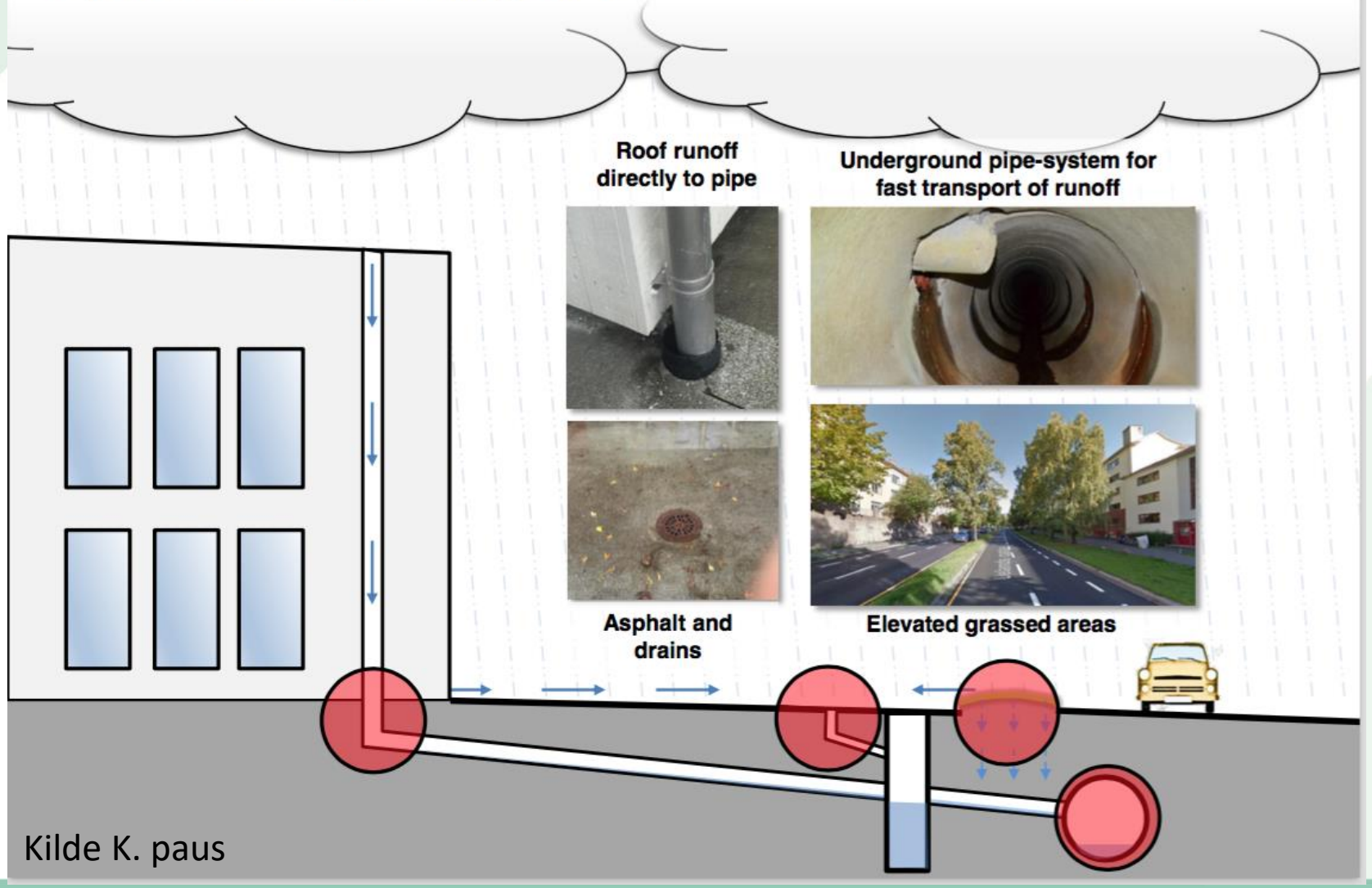


Klima 2050s fire arbeidspakker, innovasjon og verdiskapning



A Shift from Traditional to Adaptive Stormwater Management

Aspects of traditional management



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A Shift from Traditional to Adaptive Stormwater Management

High Vulnerability to Flooding

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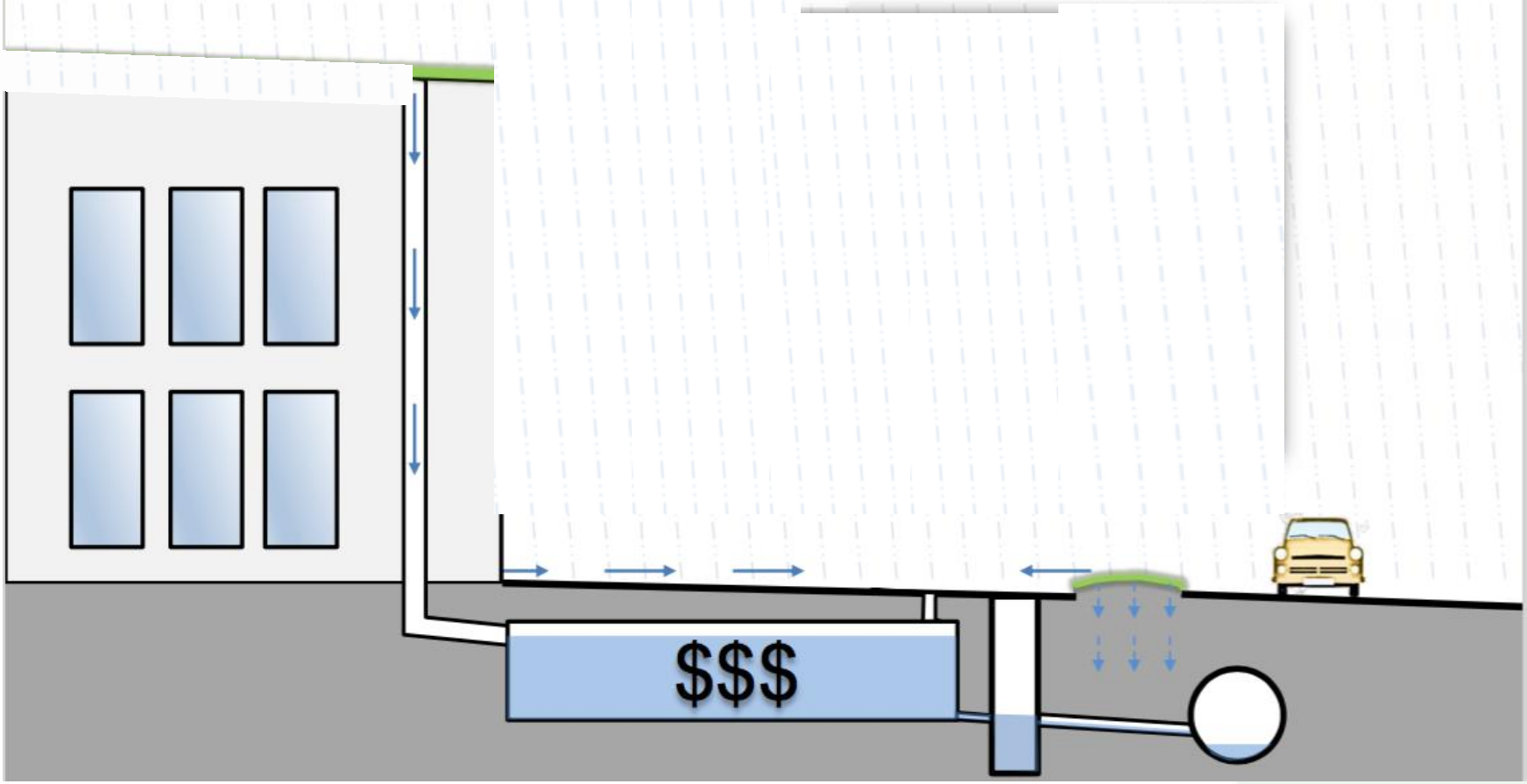
A Shift from Traditional to Adaptive Stormwater Management

We can Build Large Underground Storage Tanks to Manage Volumes



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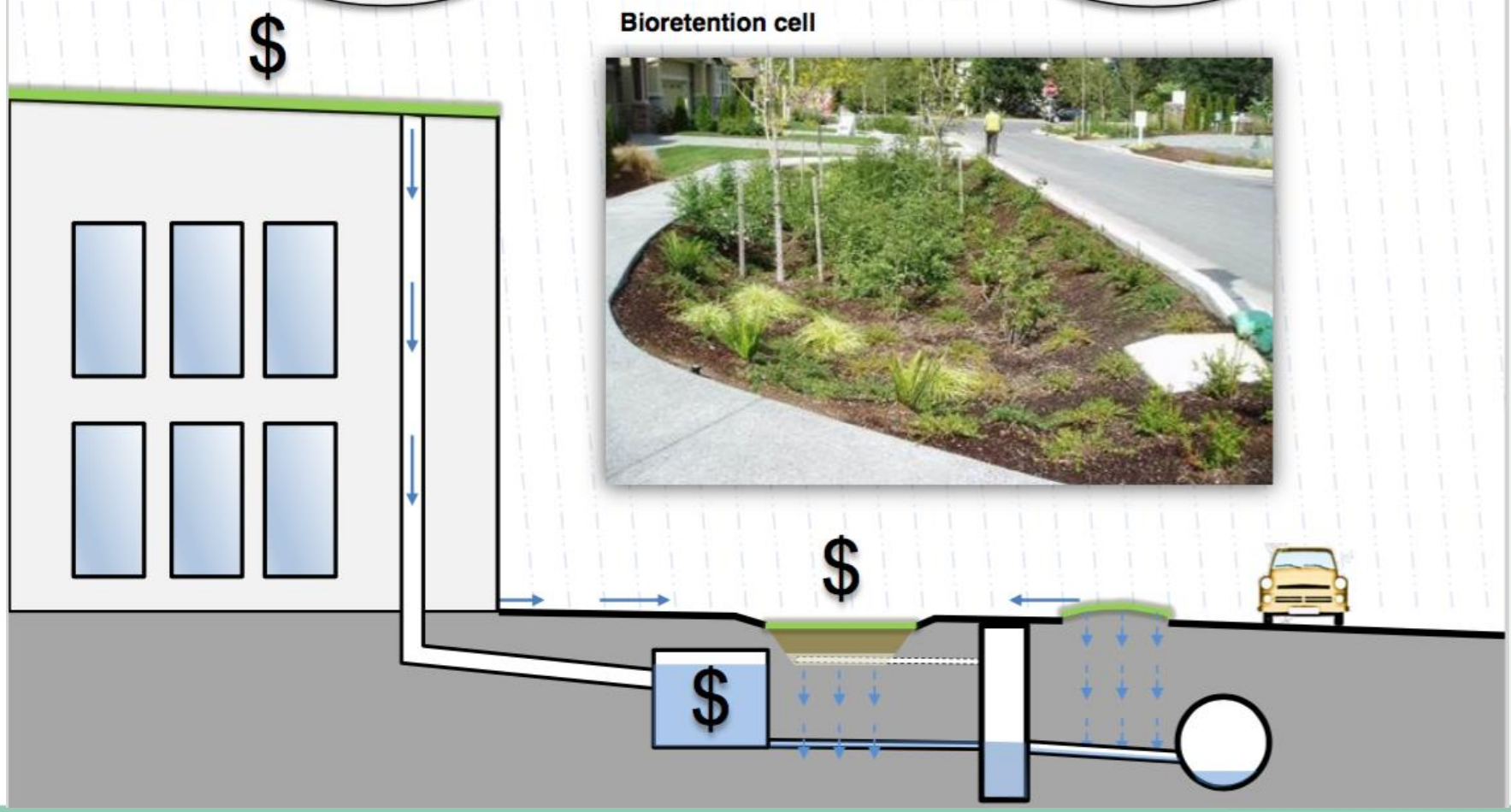
A Shift from Traditional to Adaptive Stormwater Management

Bioretention Cells will Reduce the Storage Tank Volume Even More and Provide Added Values



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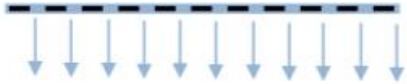
Complementary Measures

Five groups of stormwater management measures based on their principle characteristics

1. Storage

2. Pervious Surfaces



3. Storage and Outflow

4. Transport

5. Non-Structural

Complementary measures
1. Storage

Investigating the use of green roof for reduction of storm water runoff in cold climate

Photo: Trondheim kommune

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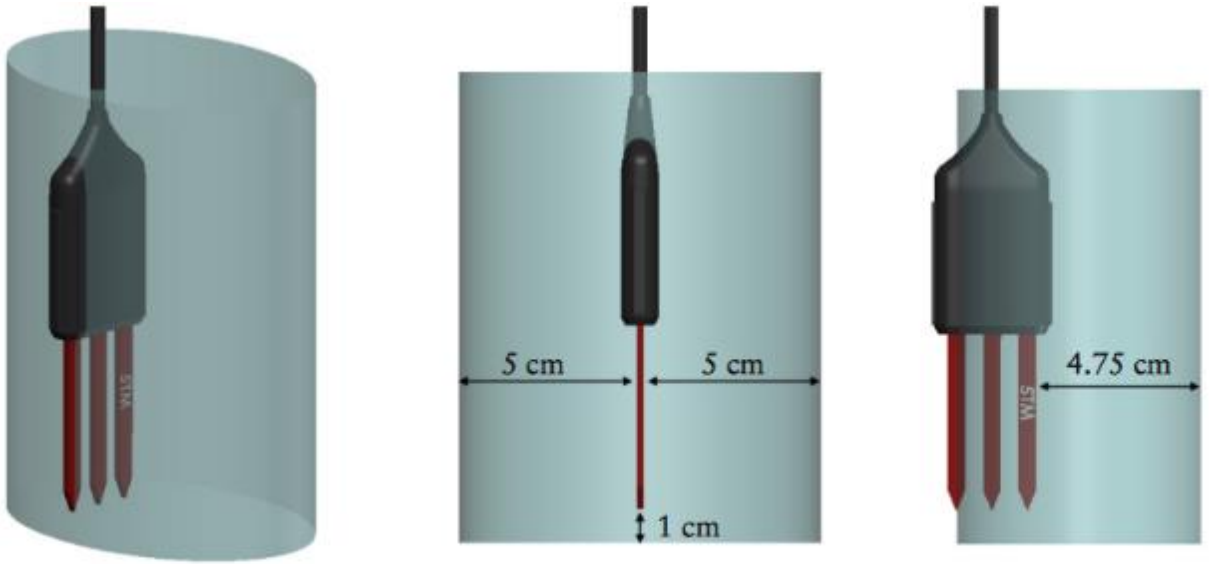

Figure 3: Idealized Measurement Volume of Decagon 5TM and 5TE Sensor

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Soil moisture

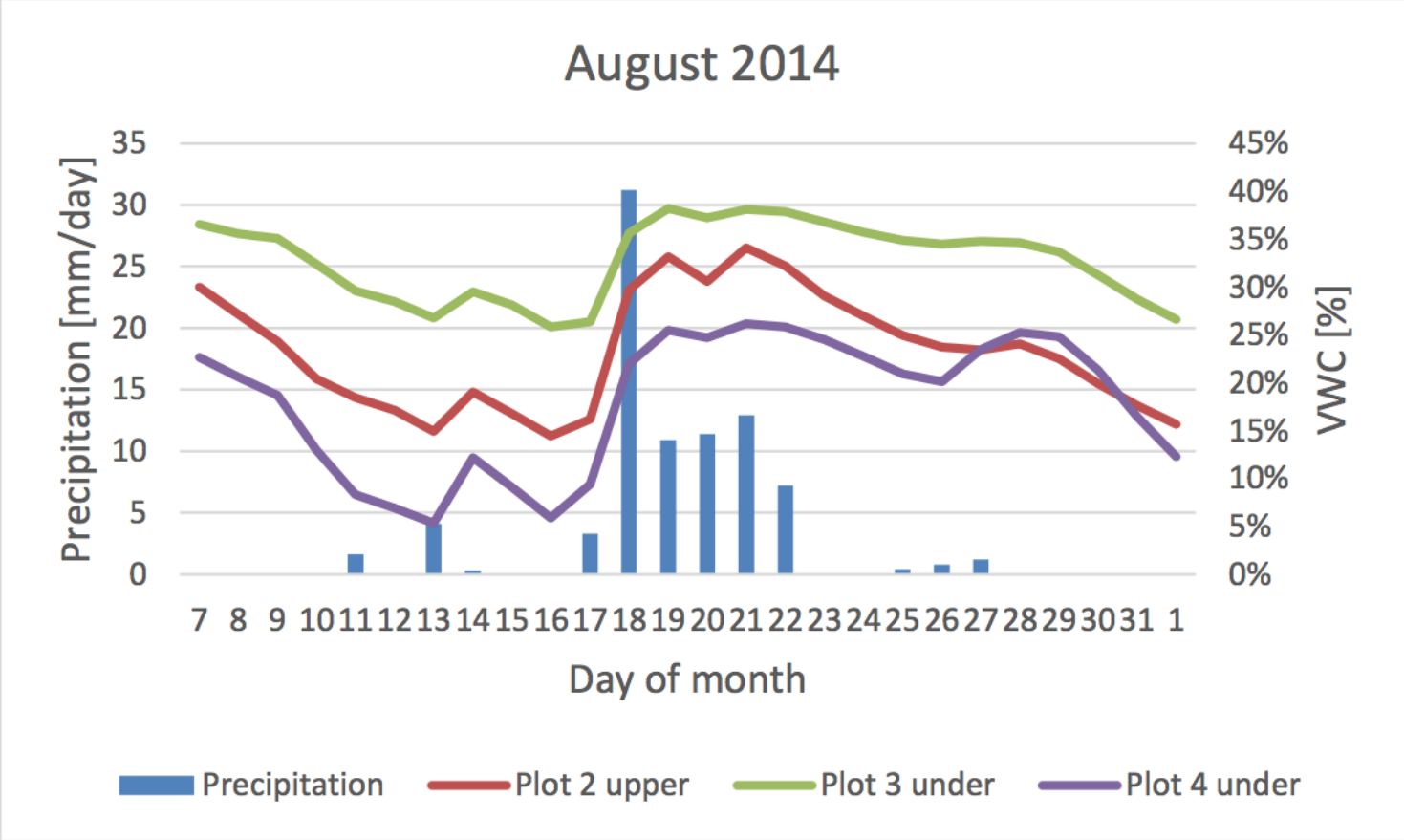
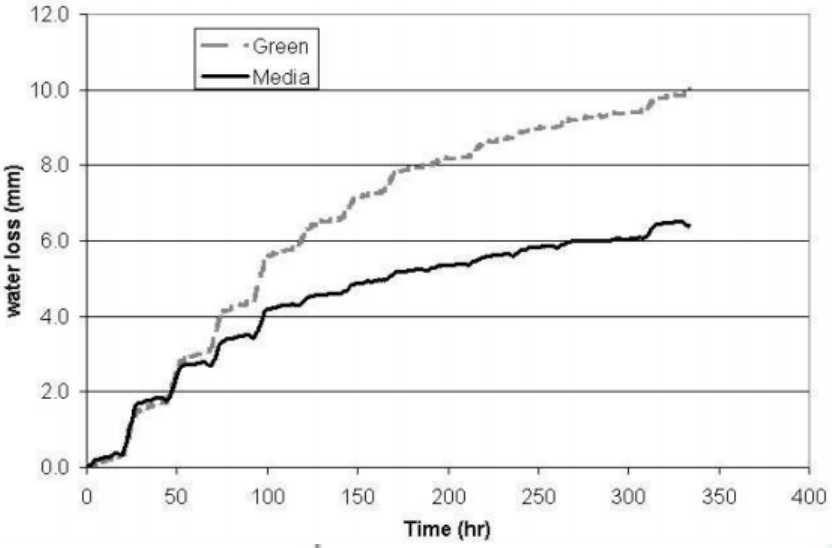
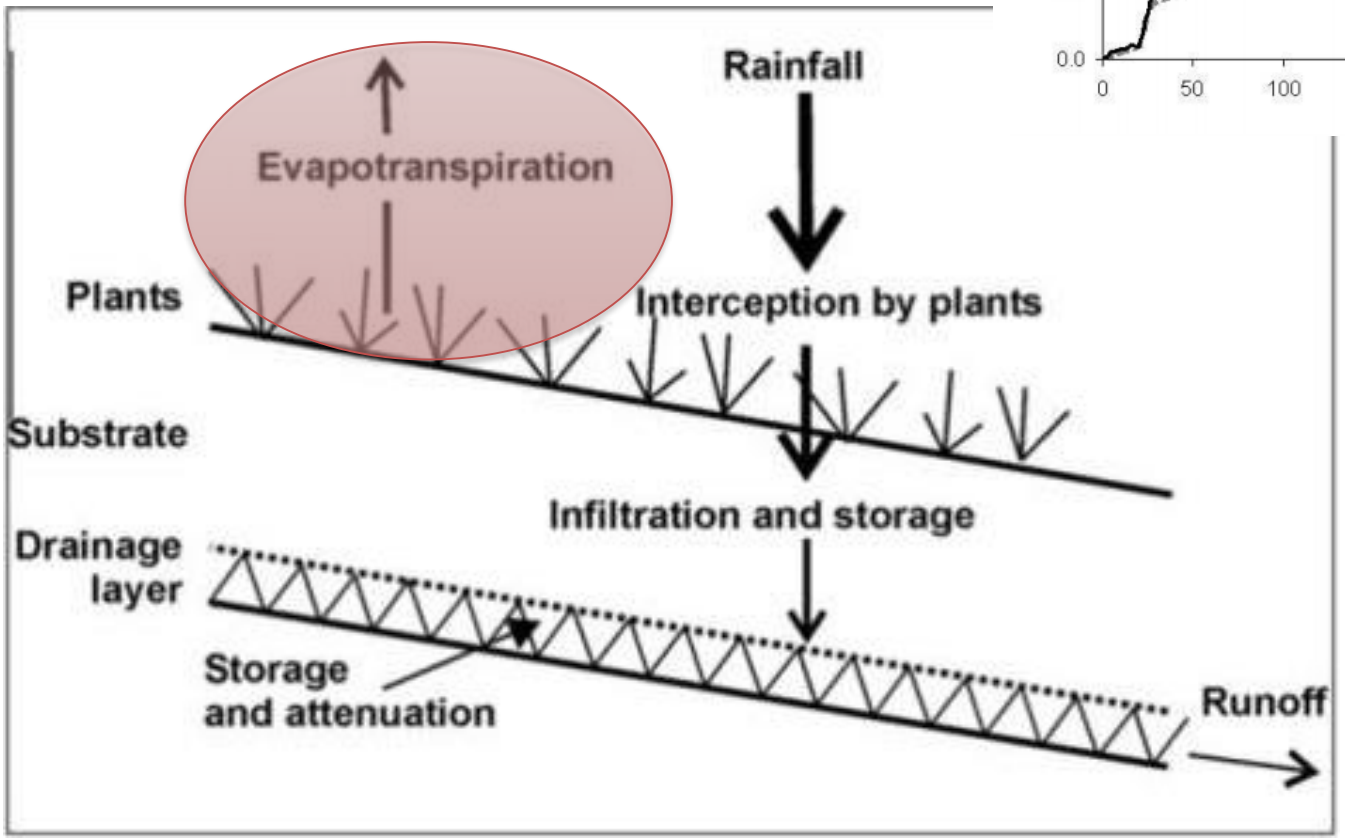


FIGURE 7.14 STORM EVENT IN AUGUST 2014 WITH DRY PERIODS BEFORE AND AFTER

Green roofs





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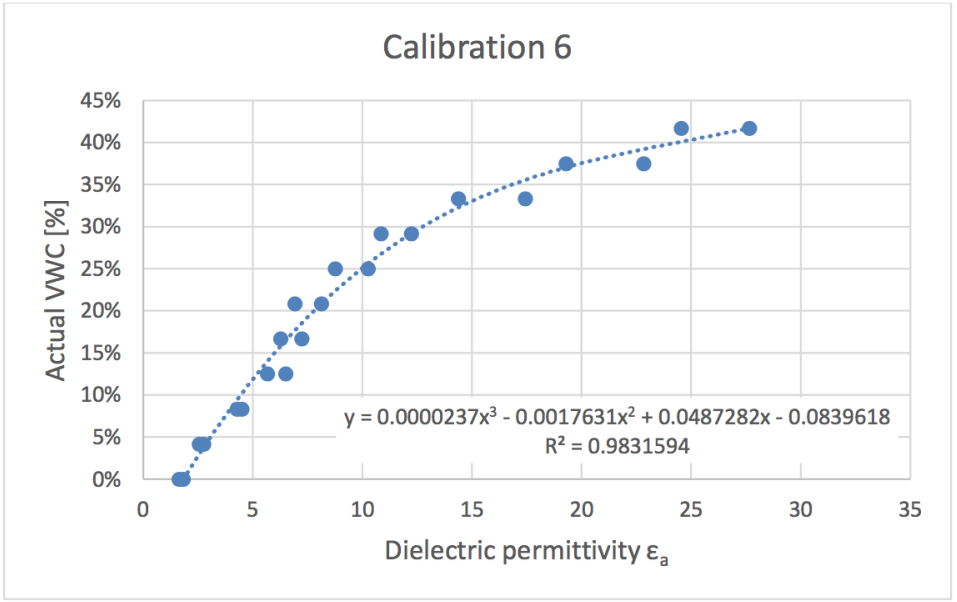
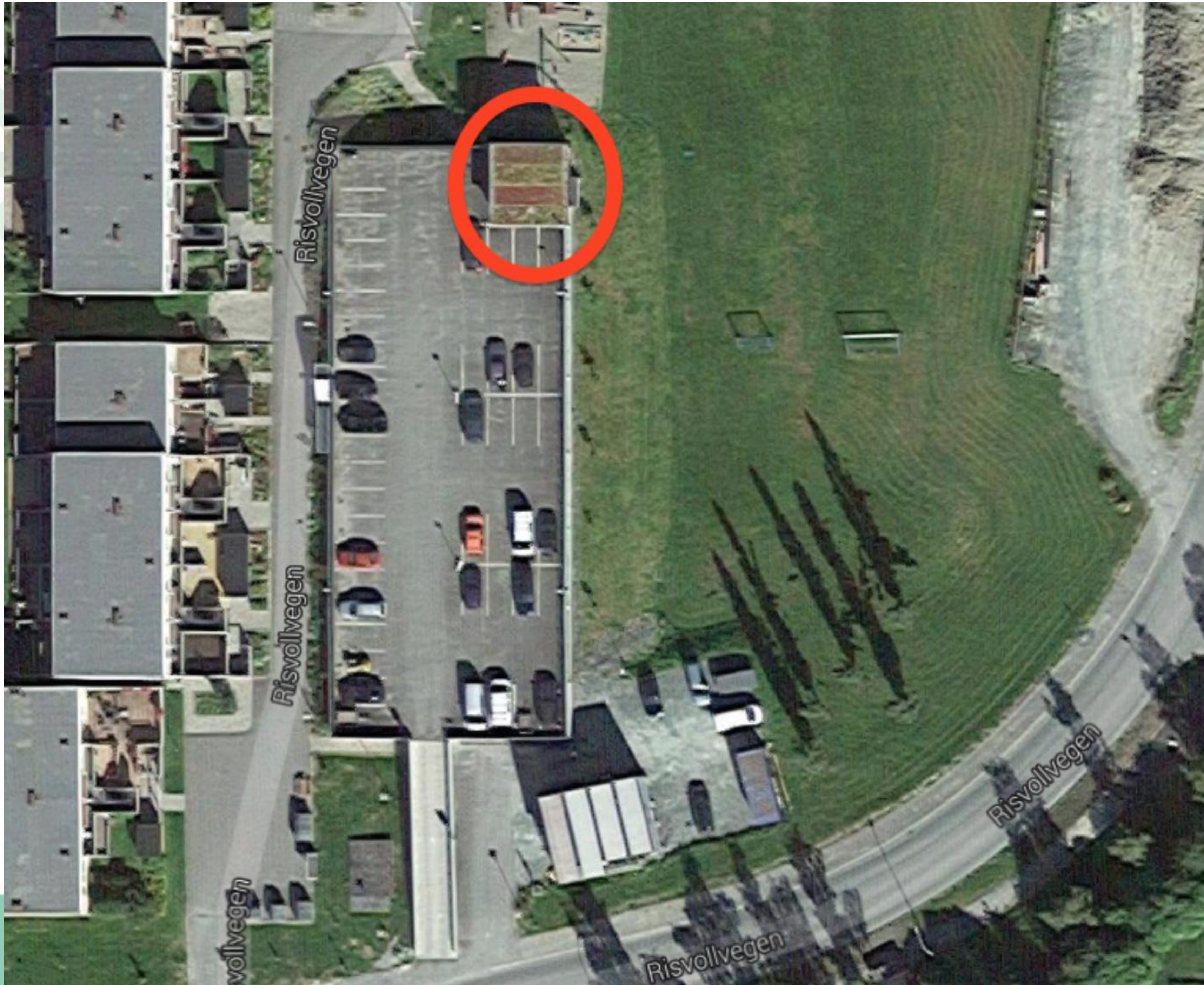
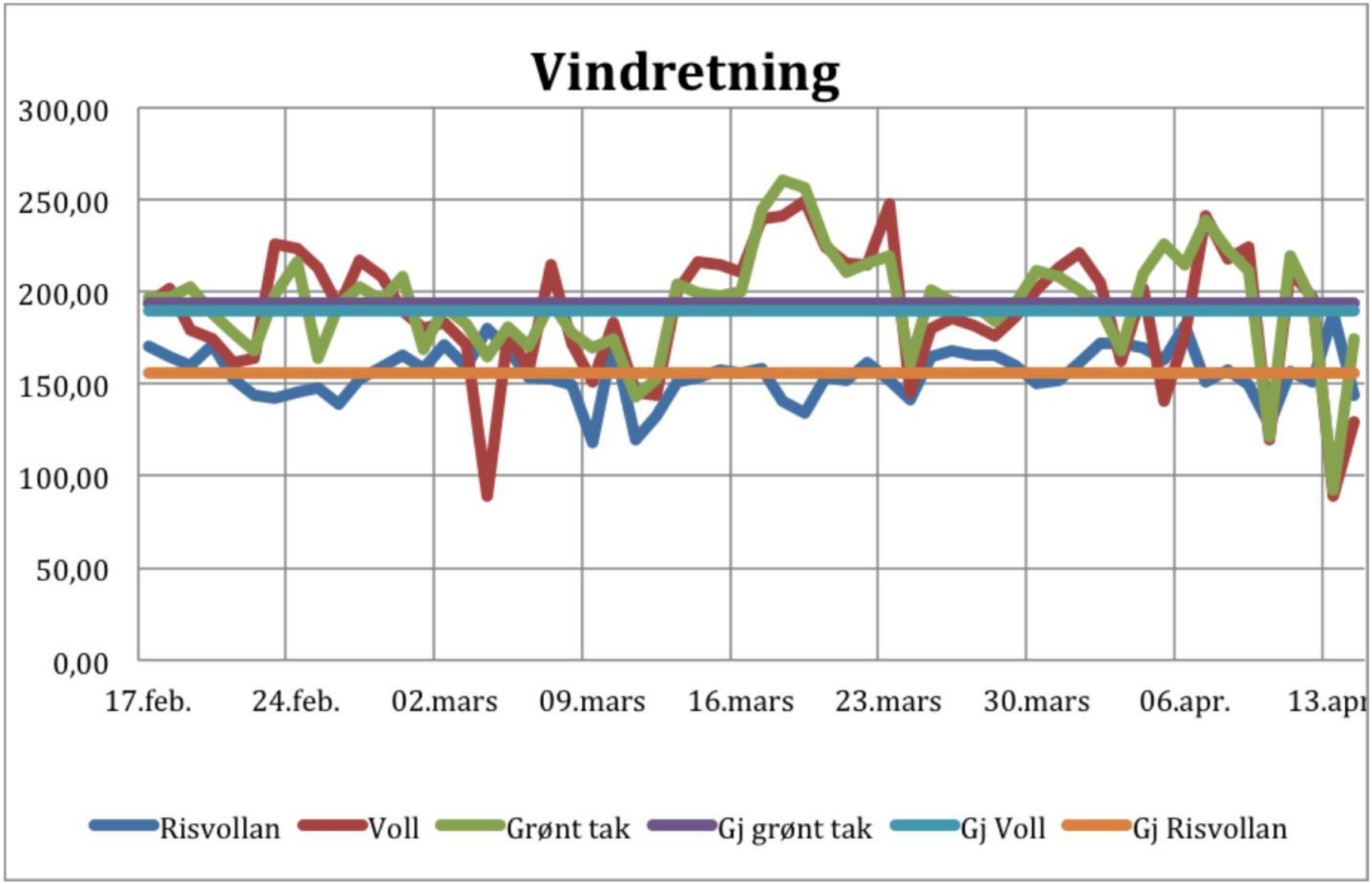


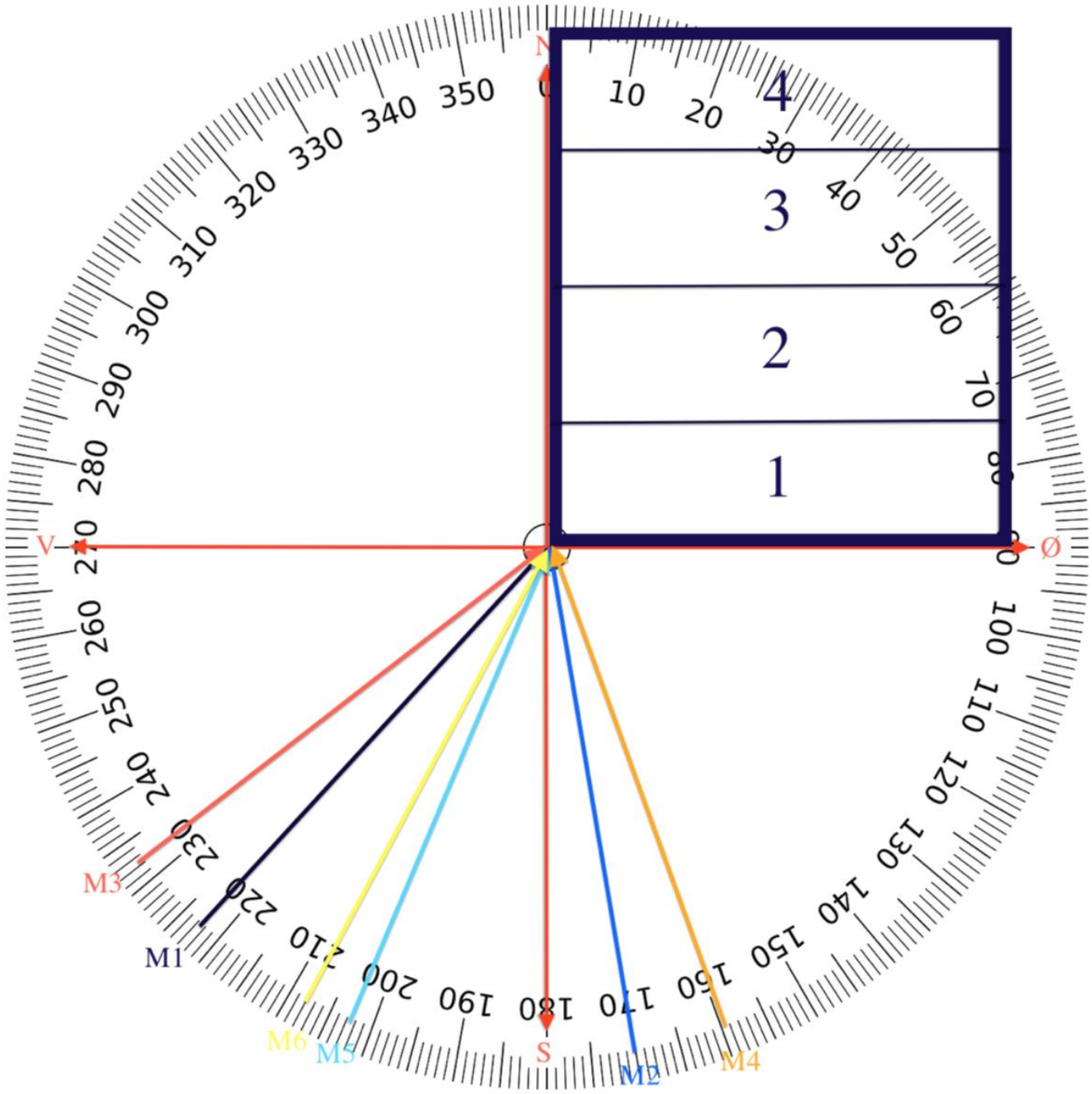
FIGURE 7.8 FIELD SPECIFIC CALIBRATION FOR ROOF PLOT 3, WITH SUBSTRATE S2


Risvollvegen
Risvollvegen
Risvollvegen
Risvollvegen
Risvollvegen

Figur 41: Oppe til venstre: 28. Januar etter snøfall. Oppe til høyre: 27. Januar kl 11. Nede til venstre: 30. Januar etter mye avrenning. Nede til høgre: 2. Februar etter snøfall før snø-prøven ble tatt.

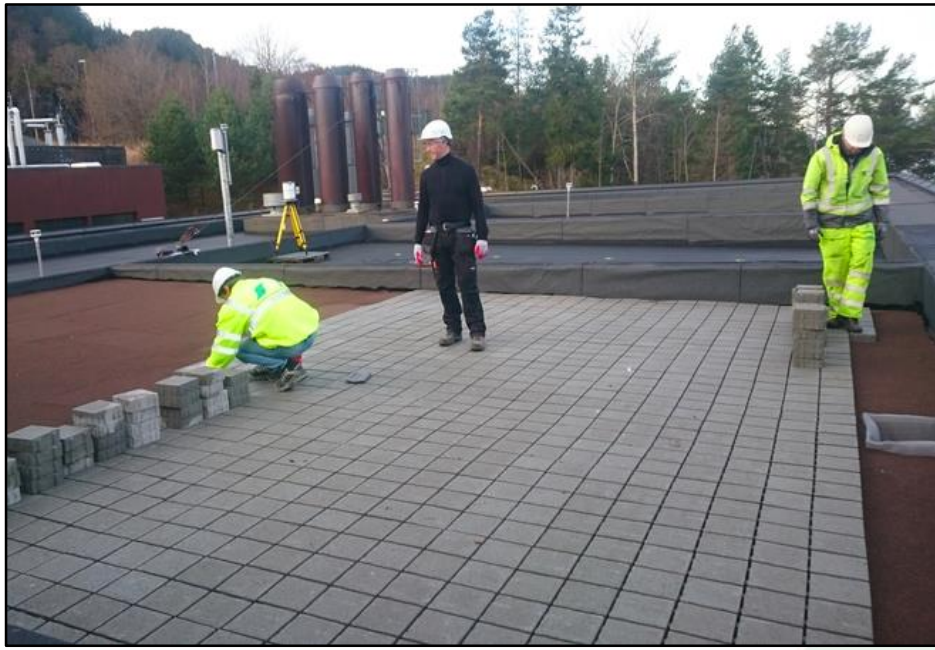


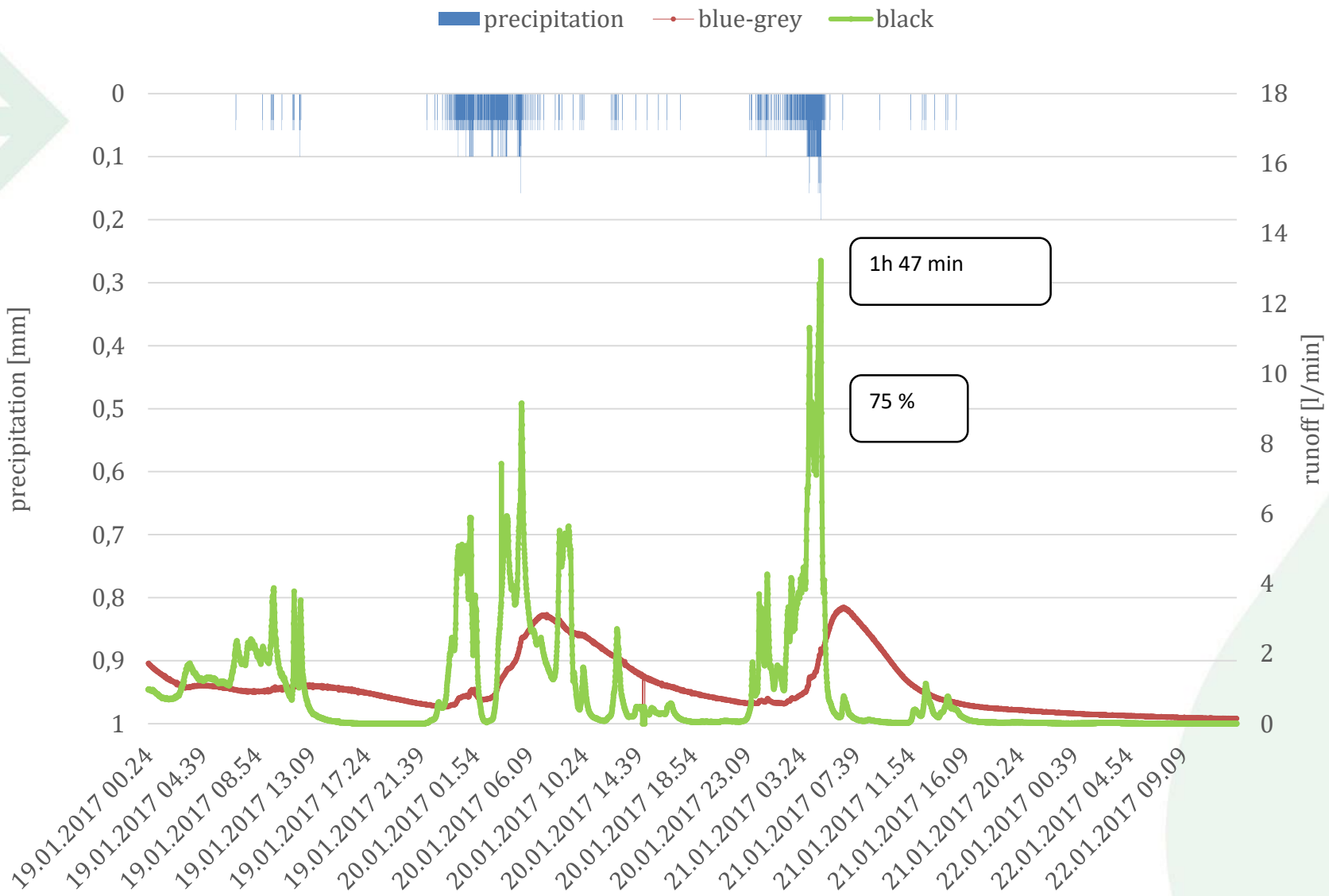
Figur 19: Gjennomsnittlig vindretning for perioden 17. februar - 13. april.

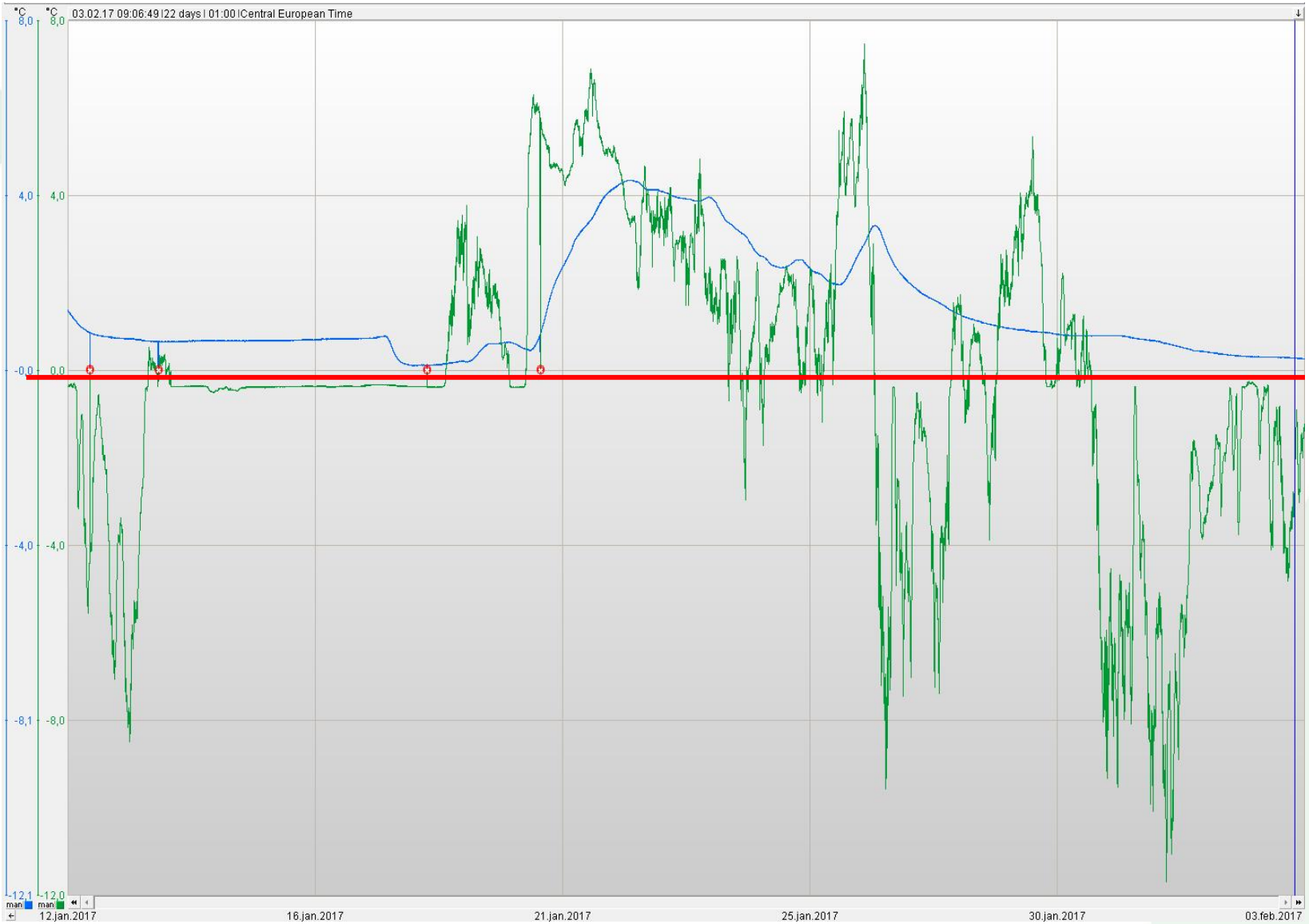


Figur 27: Gjennomsnittlig vindretning for de ulike snømålingene i Trondheim.

Figur 13: Statisk kalibrering av nedbørmåler.




precipitation
blue-grey
black
precipitation [mm]
runoff [l/min]
0
0,1
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
1
18
16
14
12
10
8
6
4
2
0
1h 47 min
75 %
19.01.2017 00.24
19.01.2017 04.39
19.01.2017 08.54
19.01.2017 13.09
19.01.2017 17.24
19.01.2017 21.39
20.01.2017 01.54
20.01.2017 06.09
20.01.2017 10.24
20.01.2017 14.39
20.01.2017 18.54
20.01.2017 23.09
21.01.2017 03.24
21.01.2017 07.39
21.01.2017 11.54
21.01.2017 16.09
21.01.2017 20.24
22.01.2017 00.39
22.01.2017 04.54
22.01.2017 09.09



8° C

0° C

-12° C

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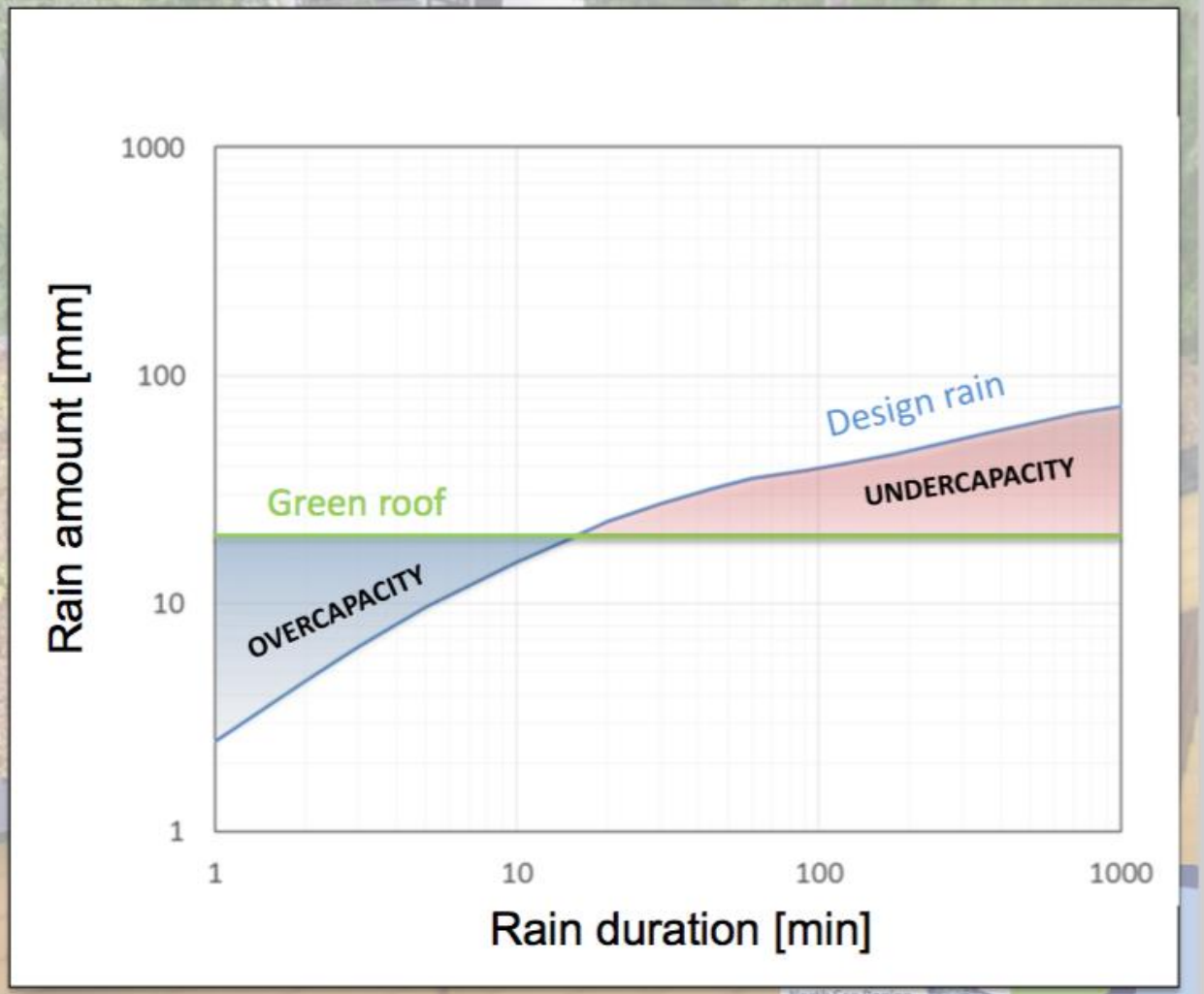
Complementary Measures

1. Storage

Assuming:

- 40 mm media thickness
- 0.35 of effective porosity
- 4 mm depression storage
- Flat / low slope
- Not limited by infiltration

A green roof has a fixed capacity to retain 18 mm



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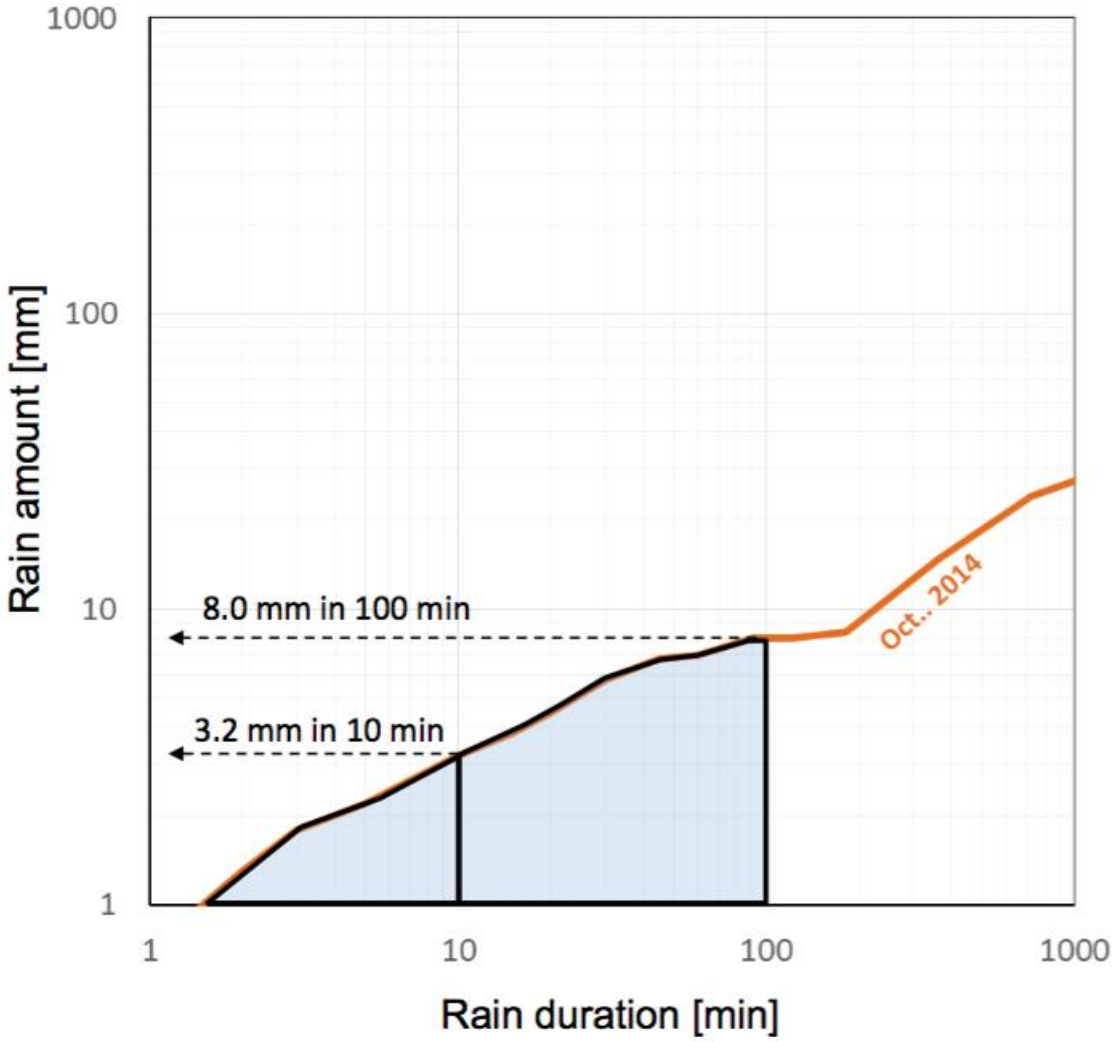
Design Rain

Rain Amounts and Durations



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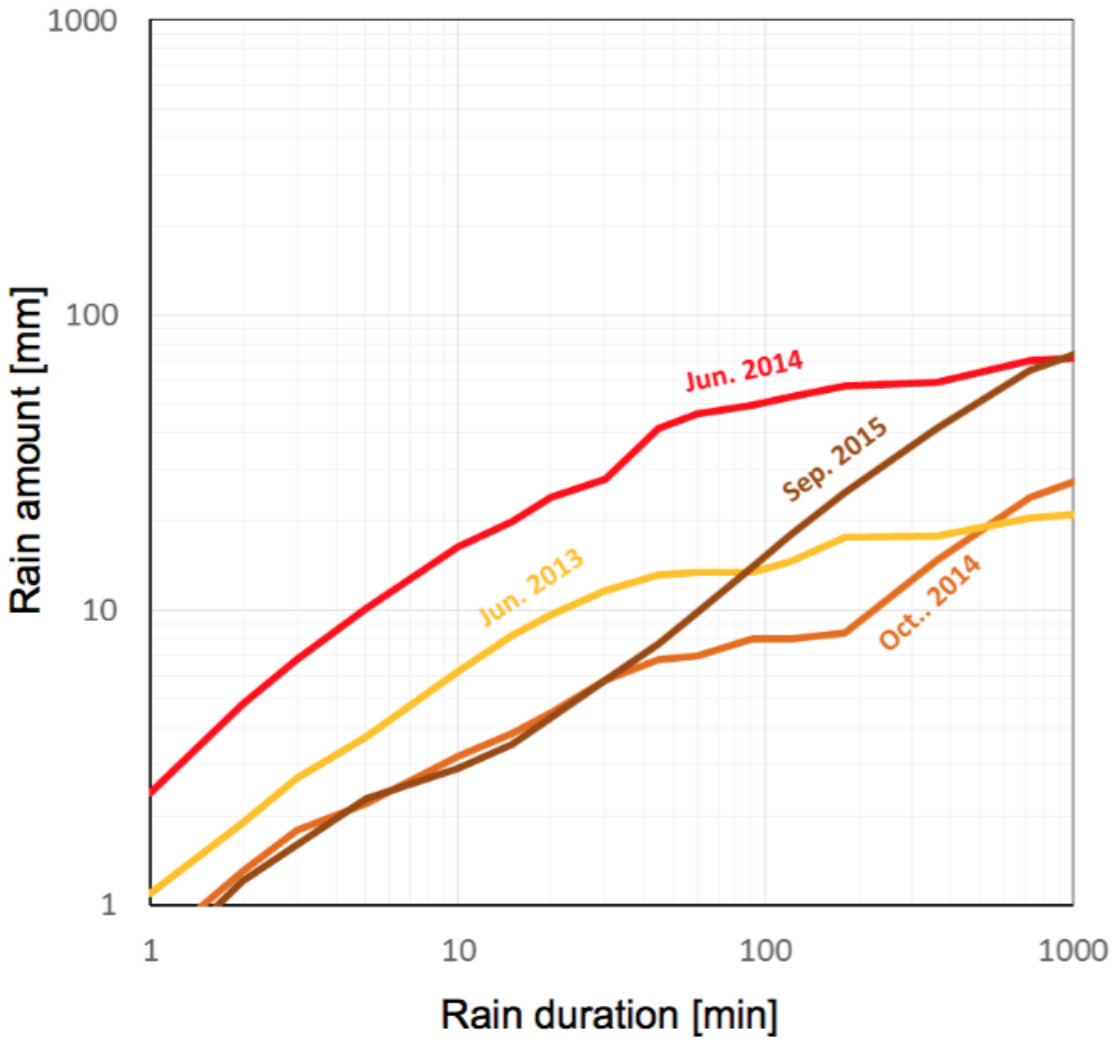
Design Rain

Rain Amounts, Durations and Return Period



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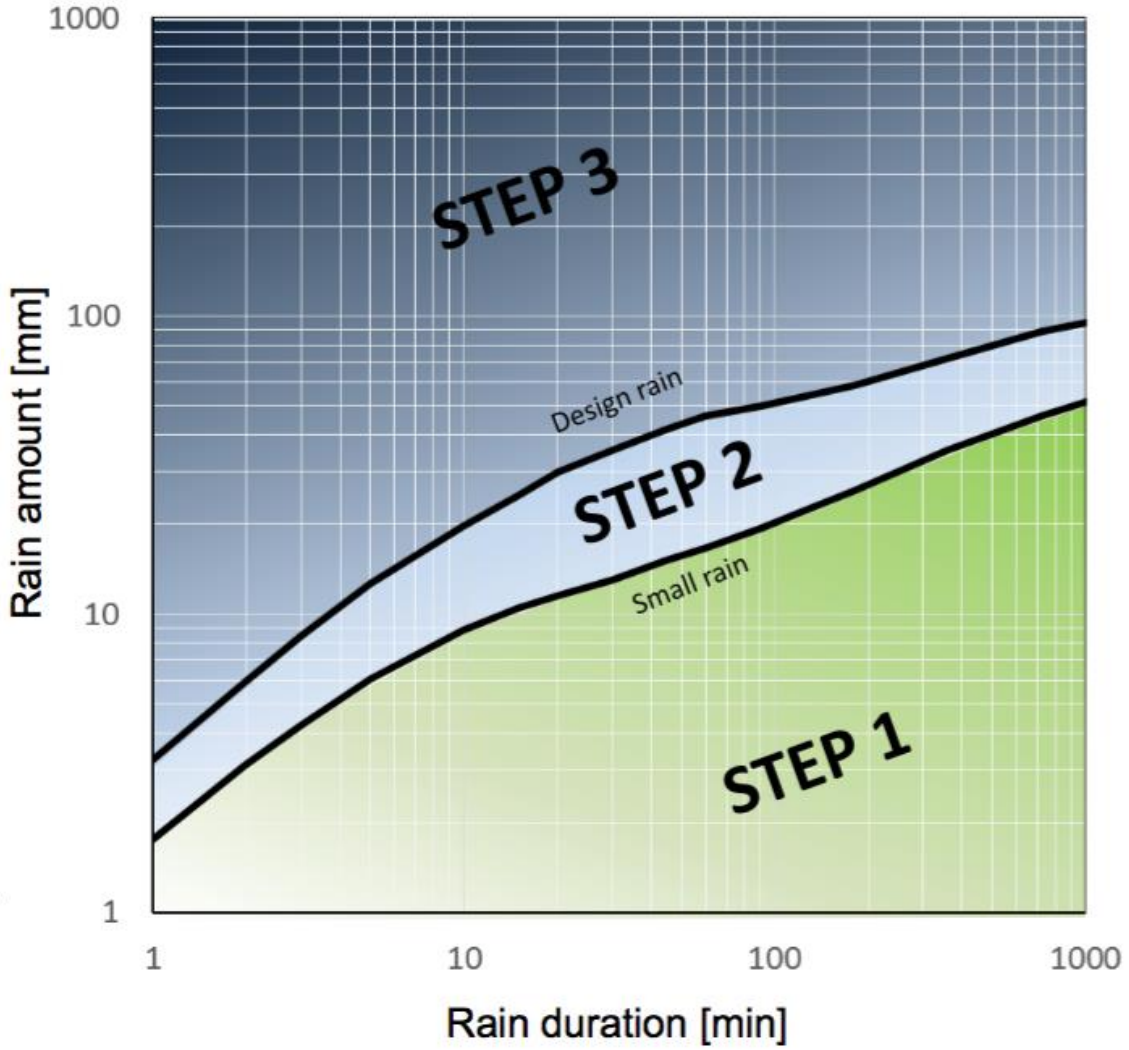
Design Rain

3-Step-Strategy

STEP 1:
Catch and infiltrate

STEP 2:
Delay and retain

STEP 3:
Safe conveyance



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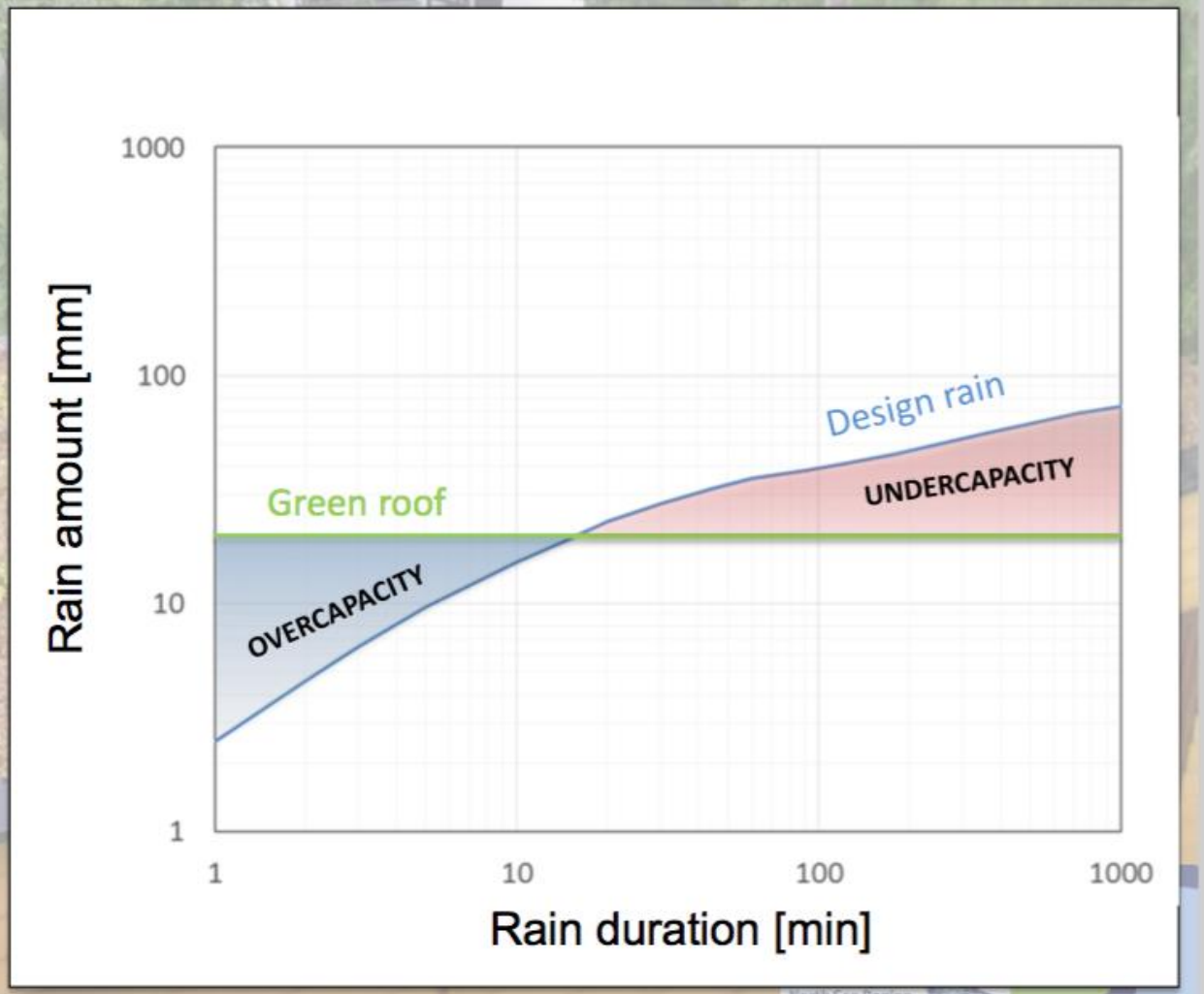

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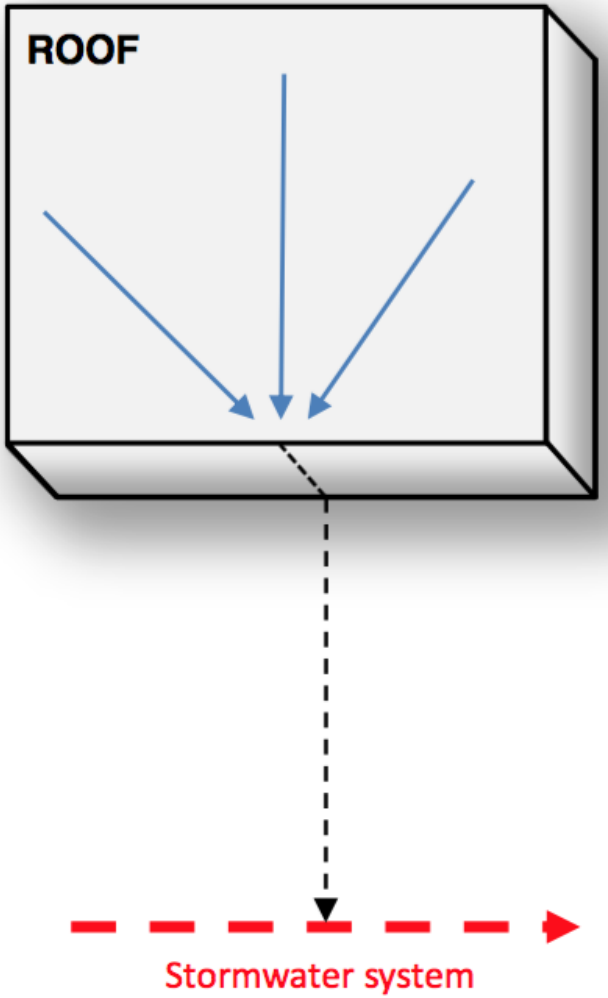
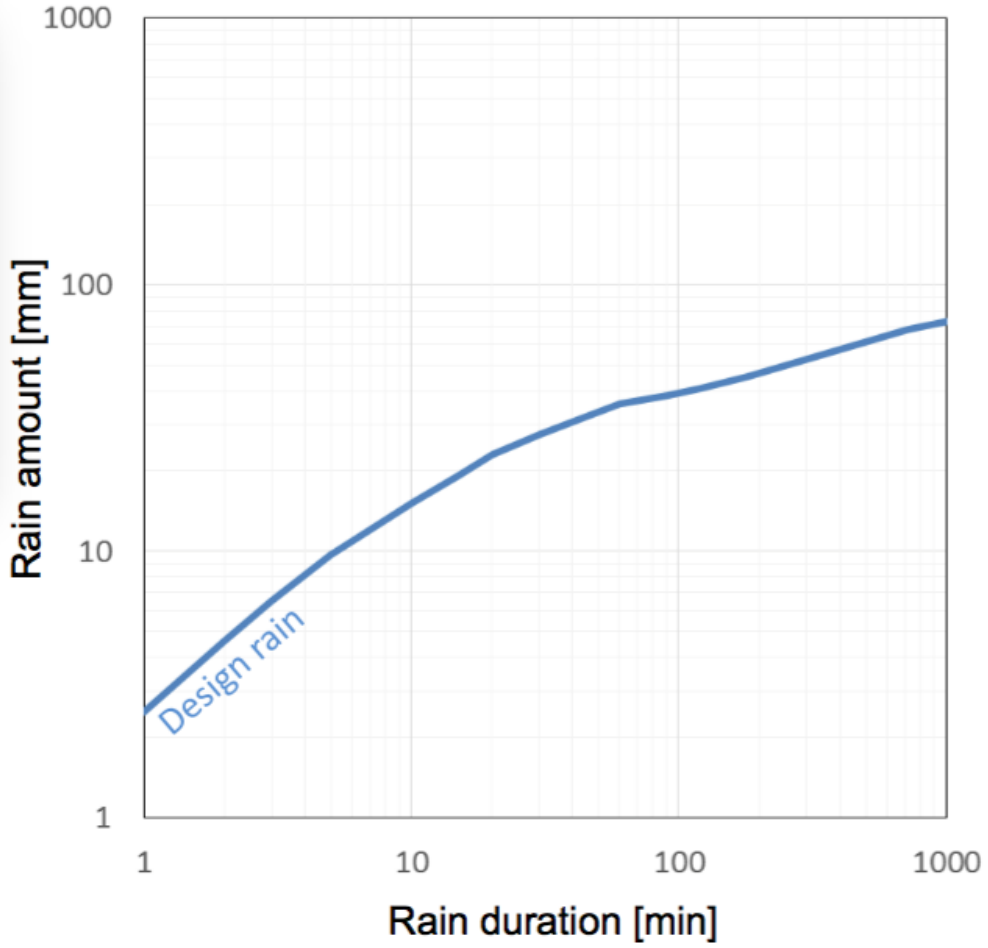
Optimization by Combining Measures at Local Scale

Example 1: Bioretention Cell and Green Roof





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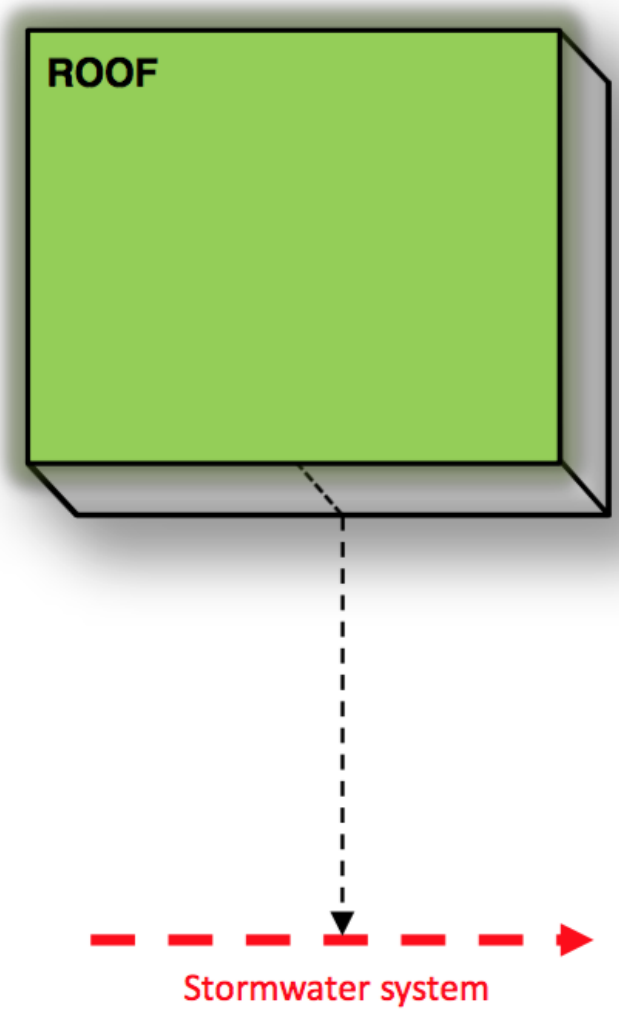

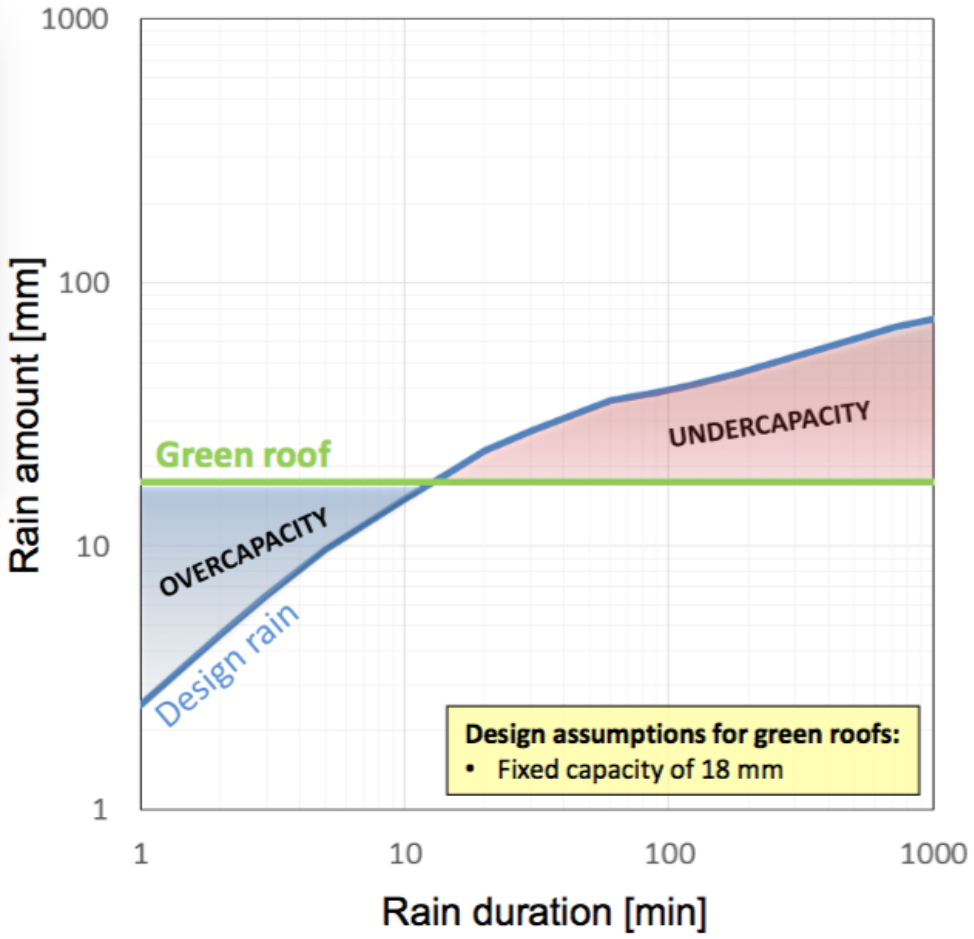

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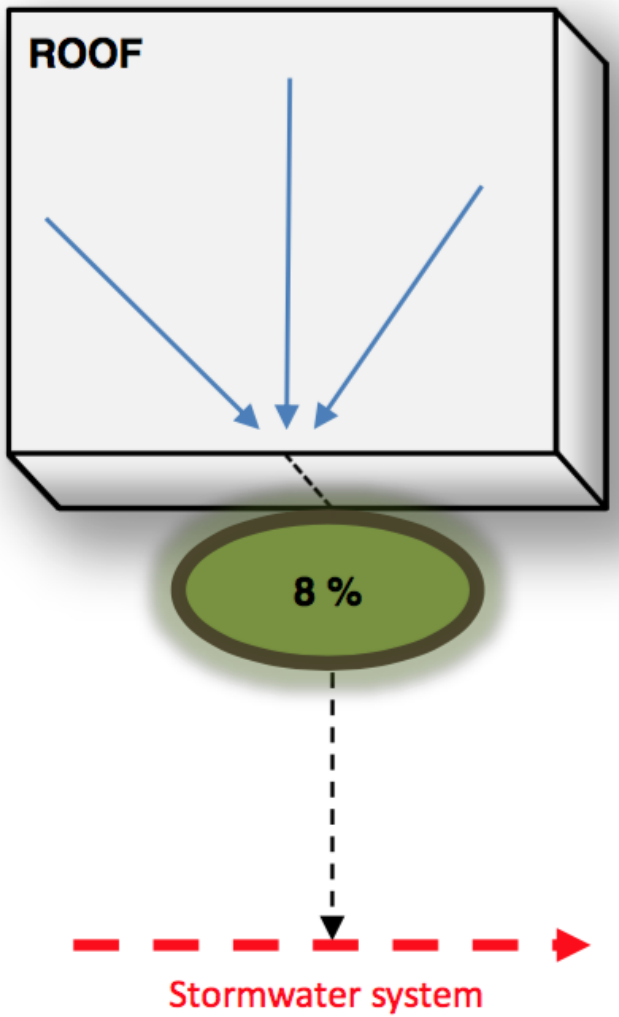

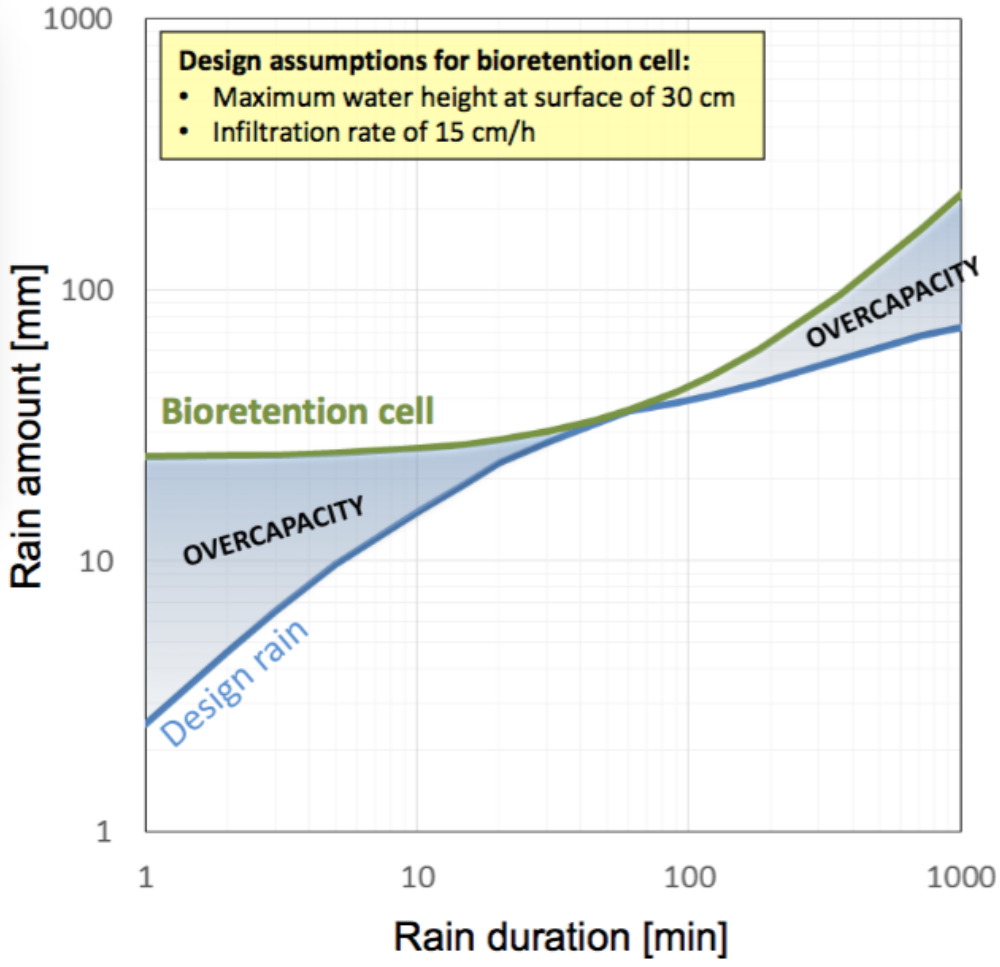

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Optimization by Combining Measures at Local Scale

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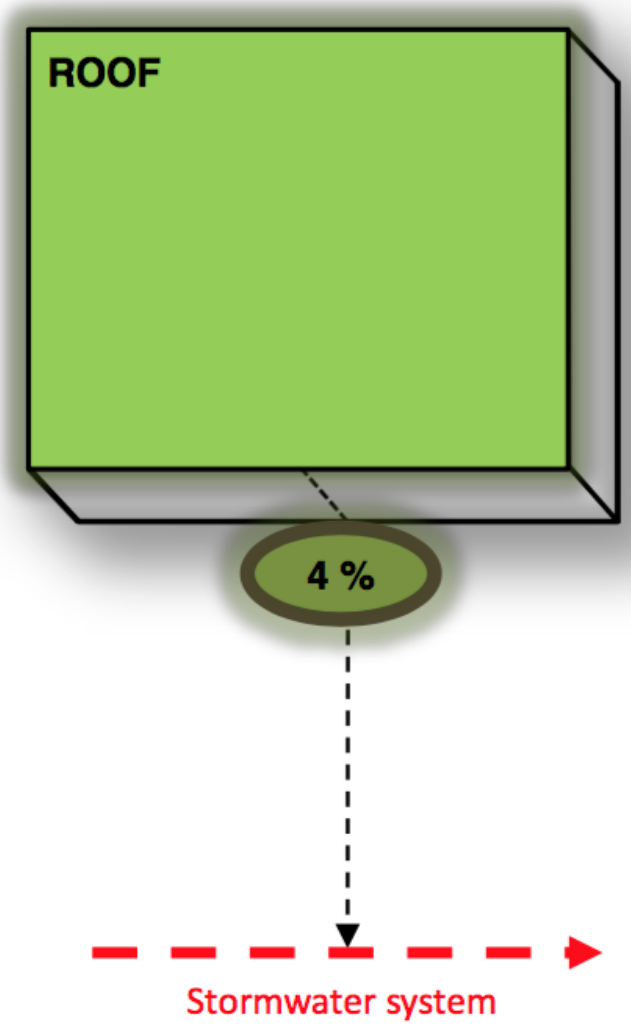

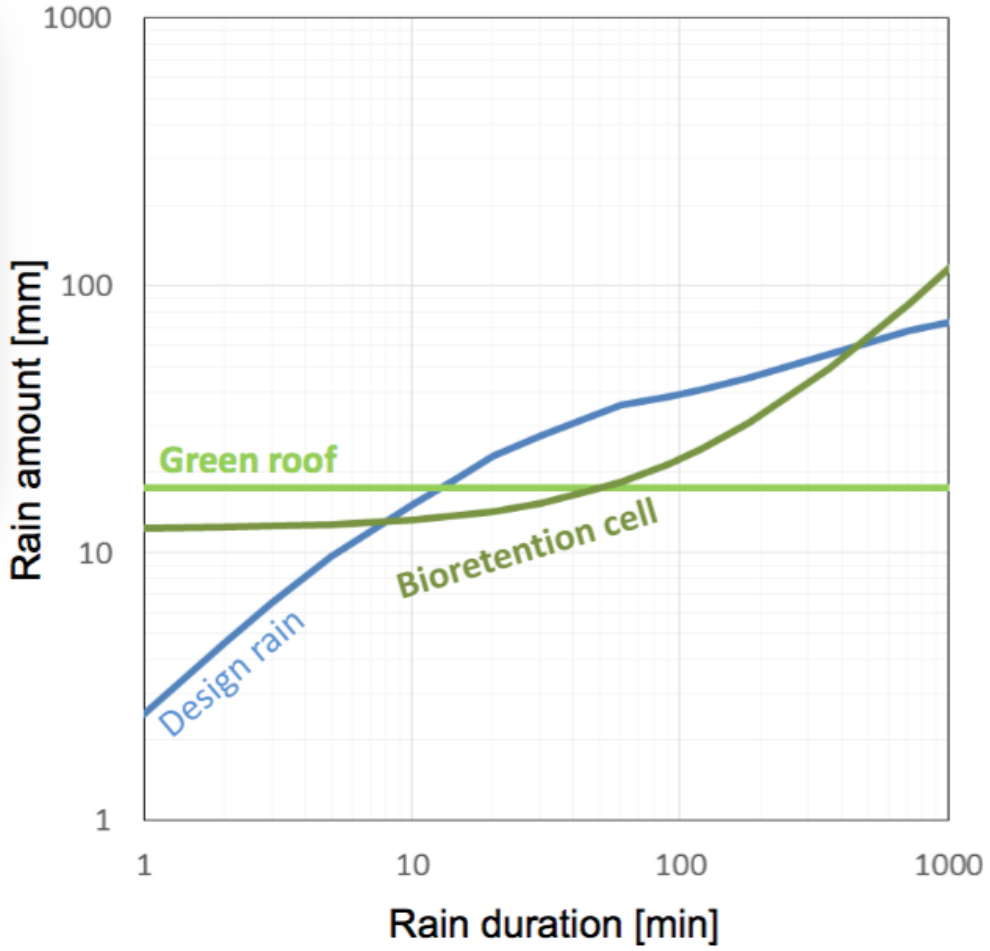

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Optimization by Combining Measures at Local Scale

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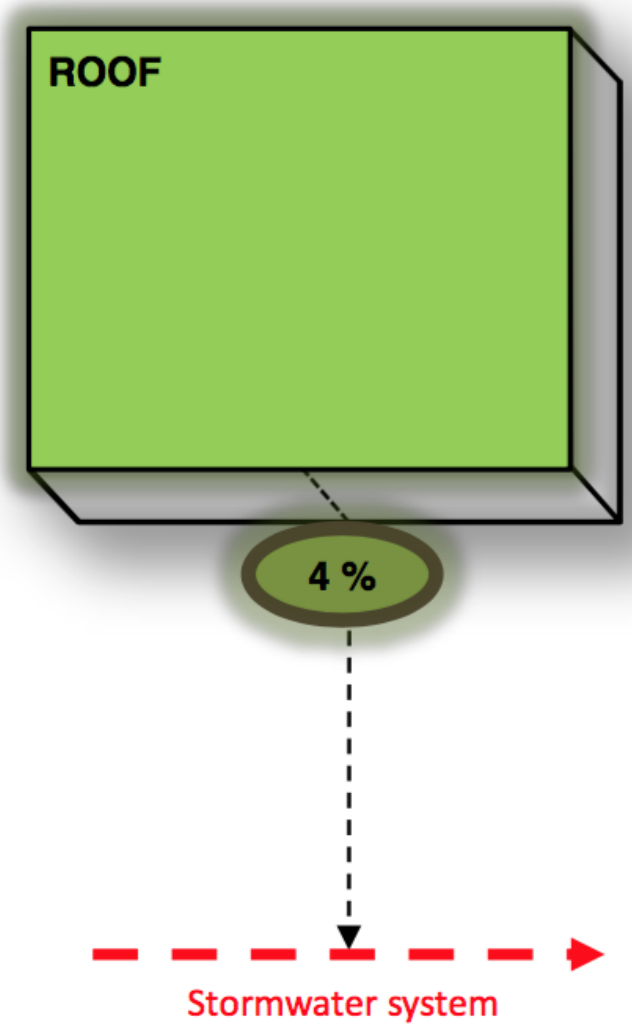

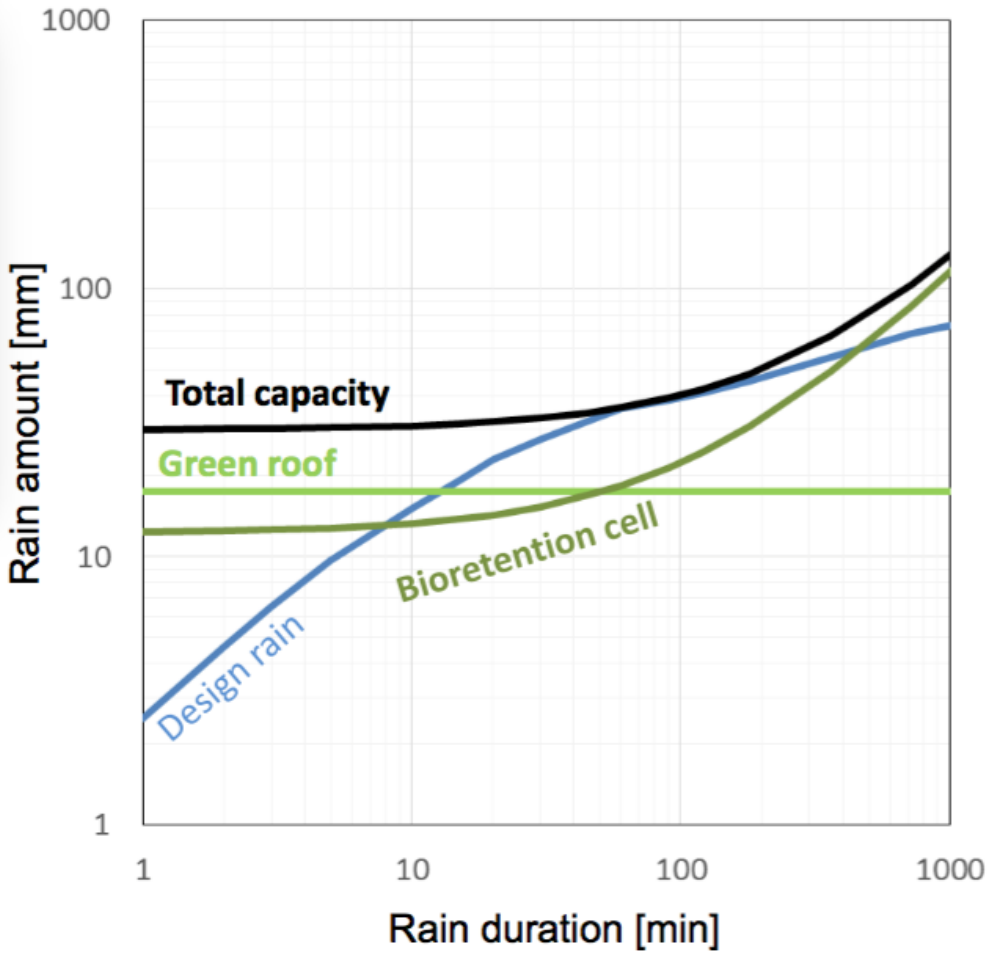

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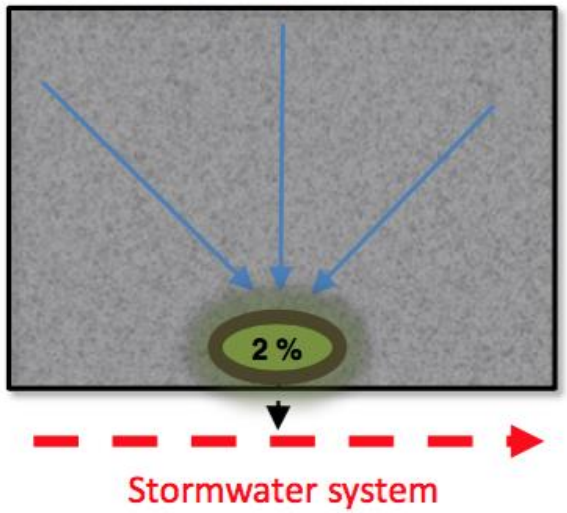
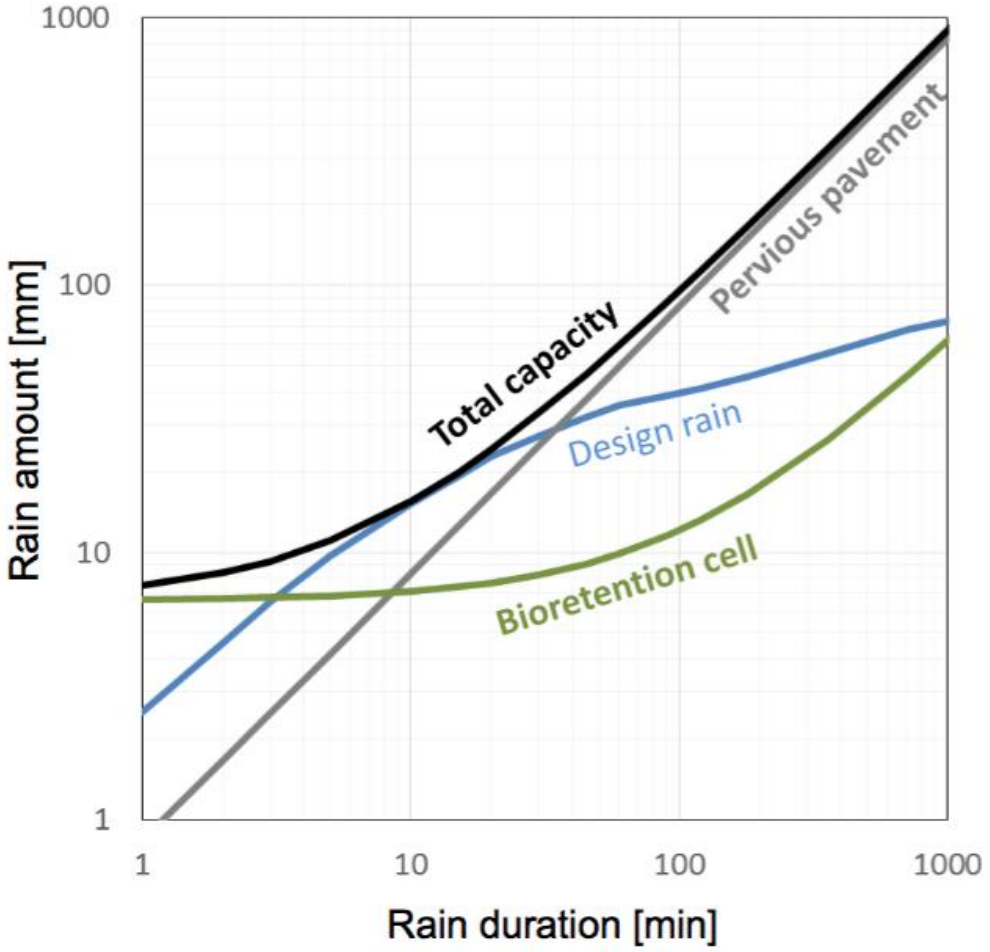
Optimization by Combining Measures at Local Scale

Example 2: Bioretention Cell and Pervious Pavement





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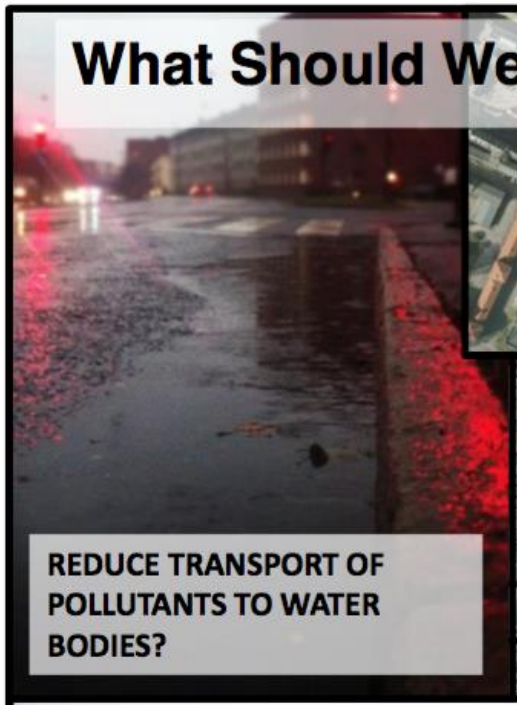
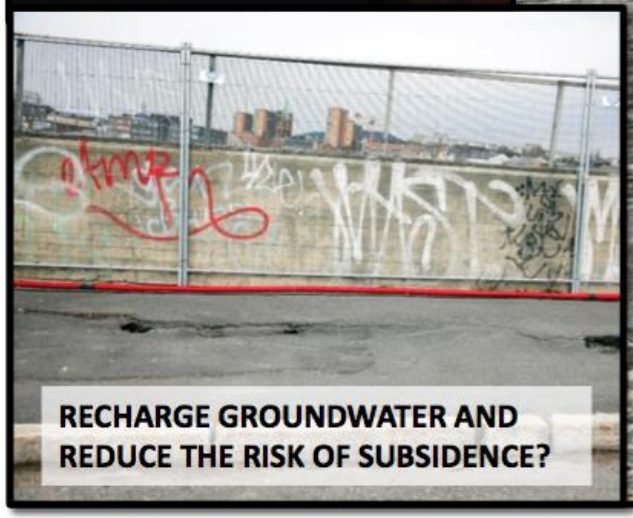
What Should We Optimize for?



REDUCE TRANSPORT OF POLLUTANTS TO WATER BODIES?

HIGH Ddensification?

MORE BLUE/GREEN SURFACES AND INCREASED BIOLOGICAL DIVERSITY IN OUR CITIES?



RECHARGE GROUNDWATER AND REDUCE THE RISK OF SUBSIDENCE?

REDUCE THE INCREASED RISK OF FLOODING AND ADAPT TO CLIMATE CHANGE?

LOWEST COST POSSIBLE?

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CONSORTIUM

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SKJÆVELAND GRUPPEN
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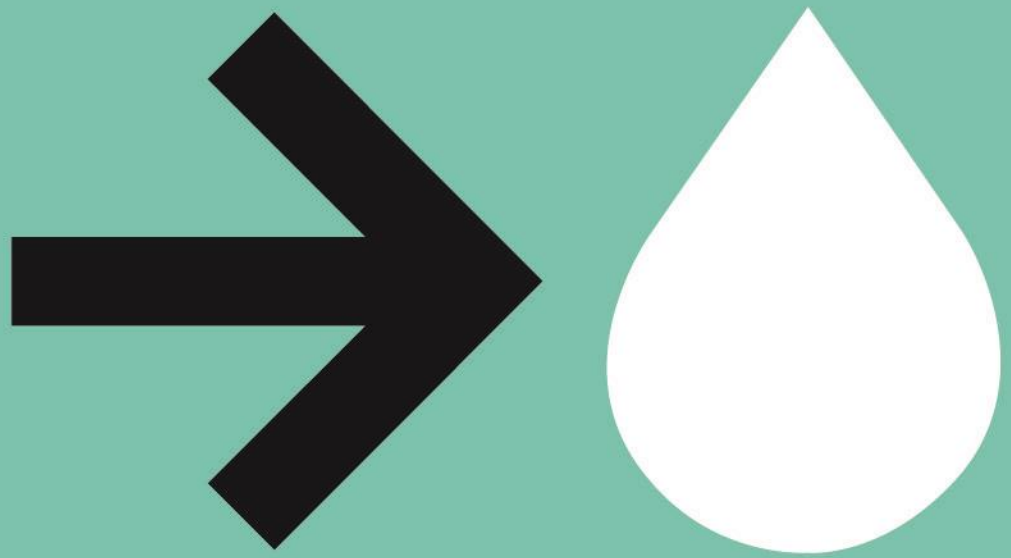

www.klima2050.no