Oslo kommune

ACTION PLAN FOR STORMWATER MANAGEMENT IN

The City of Oslo

Executive summary

ACTION PLAN

APPROVED 9 FEBRUARY 2016

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FOREWORD

More frequent and powerful rainfalls, combined with a growing population and higher-density urban areas are putting our city to the test when it comes to successful stormwater management.

In the “Stormwater Management Strategy for Oslo”, adopted by the City Council on 5 February 2014, we set the course for future stormwater management in the city. It is a course of action that will help reduce the risk of flooding when it rains, contribute to a vibrant city where water is used actively and provide added value in urban development, as well as contribute to the transportation of clean stormwater to our watercourses.

We want to make room for stormwater in our cityscape.

We must work on several fronts to achieve good, climate-adapted and sustainable stormwater management. This action plan will help us work in a structured, targeted and unified way to realize the goals set out in our stormwater management strategy. The action plan describes important measures for the next five years, with the aim of ensuring that we work together more closely as a municipality, that we involve others and important stakeholders in our work and that we find the right solutions and implement these in the right places in our city.

The City of Oslo should lead by example. Whether we are building bicycle paths, schools or kindergartens, rehabilitating sewers or refurbishing roads, building squares, parks or other meeting places, we must work to ensure that our own projects both help us acquire new knowledge and demonstrate opportunities for different and forward-thinking stormwater management.

We must all contribute. The stormwater challenges facing the city cannot be solved by a single sector, or by the municipality alone. National and local government, developers and other professional stakeholders and private individuals, must all take their share of the responsibility for ensuring that the city develops in the direction we want and need, so that Oslo can become an even safer, smarter and greener city in the future.

What is the action plan about and why do we need it?

In our "Stormwater Management Strategy for Oslo", we set targets for how stormwater management in the city should be developed. With open and local stormwater solutions, we will ensure that:

- damage caused by stormwater and urban flooding are avoided
- all stormwater that is conveyed to a recipient is of a quality that can be handled by the recipient, so that targets specified in the water regulations are achieved
- stormwater is infiltrated, retained and used locally where practicable, using open and multifunctional retention networks

This action plan systemizes the implementation of these goals so that both new developments and existing urban areas can be developed in a more sustainable and climate-adapted way. We have identified five areas of focus and which activities the City of Oslo should and must prioritze over the coming years:

- Acquire more knowledge
- Prevent negative impacts
- Develop model projects
- Establish closer working relationships
- Improve information and guidance

However, the City of Oslo cannot do the entire job alone. We need everyone to make a contribution, both the business sector and private individuals. The action plan aims to bring together municipal agencies to work on common tasks, but we also need to involve and give responsibility to people outside of municipal agencies. The action plan will help the City of Oslo to set the agenda and ensure that everyone is pulling in the same direction when it comes to stormwater management, from the forest to the fjord.

In practice, this means to build a floodway and retention network that works.

Building a floodway and retention network requires structure and a comprehensive perspective

The effects of flooding in the city when it rains are becoming more visible and more frequent than before. In addition, areas that were not previously affected are also experiencing flooding more often. On 26 June 2014, the Norwegian Meteorological Institute measured new rainfall records of 44.5 mm of rain in one hour and 72.8 mm in one day, which caused major flooding in parts of the city. This is mainly attributable to a large proportion of impervious surfaces and the limited capacity of our sewer system. On that particular occasion, the flooding quickly subsided and caused little damage, but the future may bring higher levels of precipitation with greater consequences.

In September 2015, large parts of the city were affected by heavy rain over a longer period. The rainfall led to a surplus of water in urban rivers and closed stretches formed bottlenecks that caused heavy flooding and damage.

These two events are very different in character, but both represent the "new normal" for our city and the diverse challenges to which we must adapt.

The action plan will help the City of Oslo to set the agenda and ensure that everyone is pulling in the same direction when it comes to stormwater management, from the forest to the fjord.

Figure 1 Flooding at the Oslo School of Architecture and Design. Photo: Hanne Johnsrud

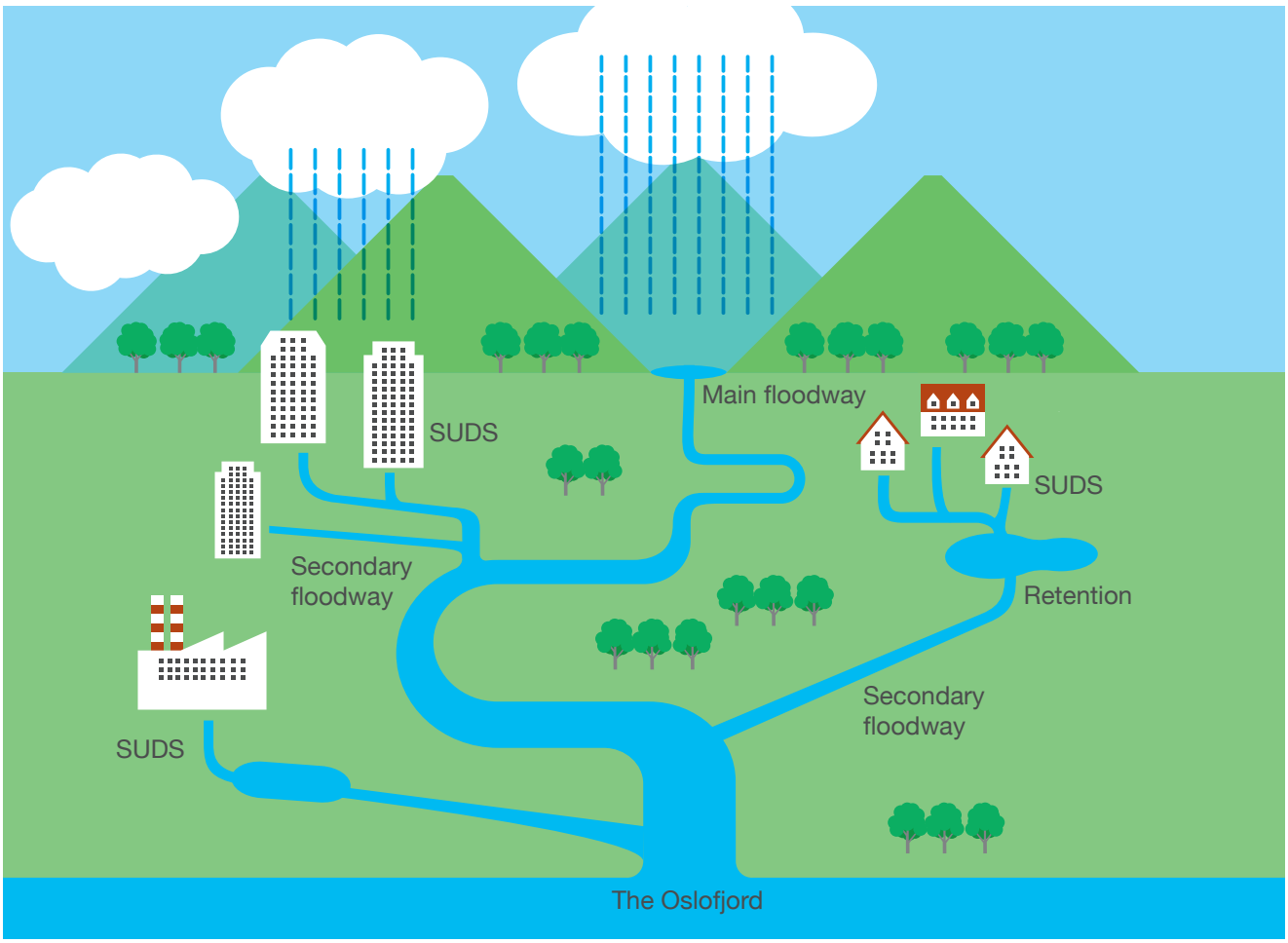
With open systems, we can make use of natural purification methods to clean contaminated stormwater.

Developing an open floodway and retention network that is an integral part of our sewer systems will contribute to a more robust city better equipped to handle rain. Such a system would involve both major floodways and allotted retention areas that can handle heavy rainfall, and minor floodways that can transport stormwater safely from a small area to the major floodways. Local measures like rain gardens, green roofs etc. will limit the amount of stormwater in runoff systems and reduce instances of overflow. Multi-functional solutions will be absolutely essential if we are to compete for space for these measures. The municipal master plan, which sets out guidelines for land use in the city, will be a critical tool in the construction of this system.

When we build open systems, it will also mean improving how we use our watercourses and opening even more closed streams. Some roads must also act as floodways where there is a considerable distance to the nearest watercourse. Stormwater is a resource that should be exploited, but the water quality can be poor and pollute watercourses and sewer systems. With open systems, we can make use of natural purification methods to clean contaminated stormwater.

This is a comprehensive task that requires structured and targeted work and cooperation between municipal agencies, and between the City of Oslo, sectoral professionals and city residents.

Figure 2 How a functioning floodway and retention network could look in practice.



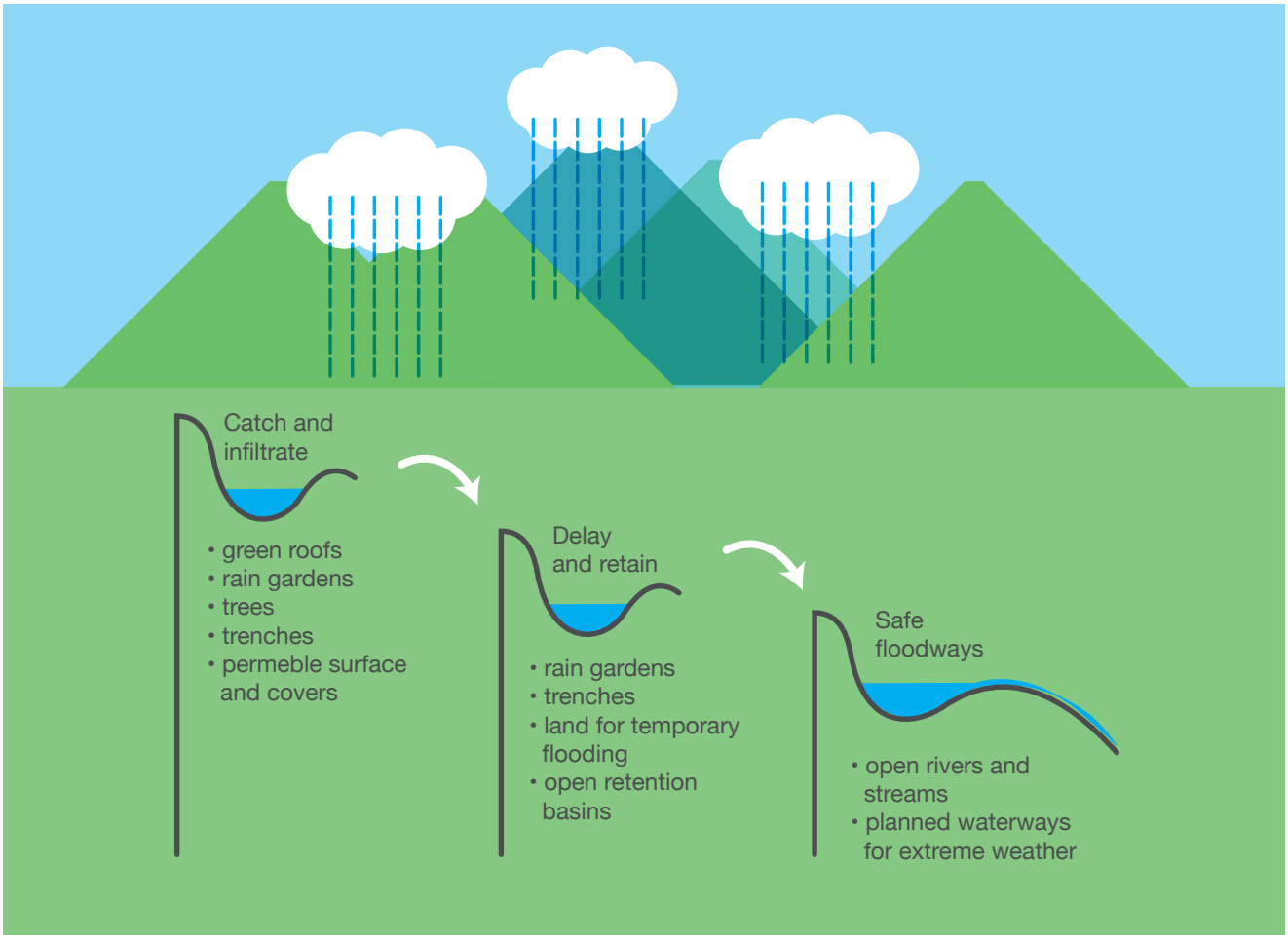
How we will reach our goals

A three-step strategy must be implemented in practice. This means infiltration after light rain, retention after a moderate rainfall and safe runoff to a recipient (floodways) after heavy rain. If this strategy is implemented in all land use, theoretically we should be able to handle most rainfall levels and intensities with minimal damage. In addition, the city will benefit from more blue-green areas. However, most of the city is already built-up and we will mainly be able to implement the entire three-step strategy in new areas and during major reconstruction/maintenance.

In built-up areas, we should try to implement the first step of the three-step strategy where possible. We must ensure that municipal spaces such as parks, pedestrian and cycle paths, etc. can be part of an open runoff system. A combination of open and closed systems will be required where the city is densest, but planning should be based on a long-term perspective and a vision of open solutions in these areas as well.

Natural drainage lines must be maintained. As a guiding principle in all planning and construction, whether it is major urban development projects, smaller building projects or sector projects, natural drainage lines must be maintained. The points where stormwater flows into and out of a building plot should not be changed because associated problems are known and therefore predictable. When drainage lines are changed, the challenges associated with water runoff could change and become more difficult to address.

Figure 3 The above figure illustrates the three-step strategy and typical stormwater measures within the three steps.



We will develop and improve our body of knowledge

A solid knowledge base is necessary to facilitate functional open and local stormwater management. We want the three-step strategy to be implemented in practice, but we still know too little about how much water it should be possible to handle at each of the three steps. Local conditions vary too much for it to be feasible to determine a specific amount of water that should be retained. Nevertheless, we want to determine possible requirements.

We also need to keep better track of soil mechanics in the city and how great the potential is to infiltrate stormwater. To get a complete overview of the runoff in an area, we will also need a far larger set of data on rainfall and rainfall events, so we can base our analyses on an even better quality assured dataset in the future.

ID	Strategy and action	Responsible	Partners	Working years
1	**Assess water quantities in the three-step strategy** • Water quantities in the three-step strategy will be evaluated based on the types of buildings and natural conditions. Step 2 has top priority. • Evaluate the ability of watercourses to withstand an increased flow of stormwater. • Assess and adopt acceptable tolerance levels for flooding.	VAV	BYM, NVE, SVRØ, Norwegian Environment Agency	2016–2017
2	**Assess and map the potential for infiltration** • Digitise existing data on soils and soil mechanics. • Map soil data, proportion of impervious surfaces and proportion of permeable surfaces. • Prepare fact sheets about infiltration in clay.	PBE	VAV	2016–2021
3	**Develop a coordinated database for rainfall events.** • Develop a database where rainfall events, notices of damage and flooding are recorded. • Facilitate further cooperation with the insurance industry in terms of the dissemination of information related to claims.	VAV	BER, BRE, BYM, FNO, MET	2018–2019

We will prevent the consequences of stormwater astray

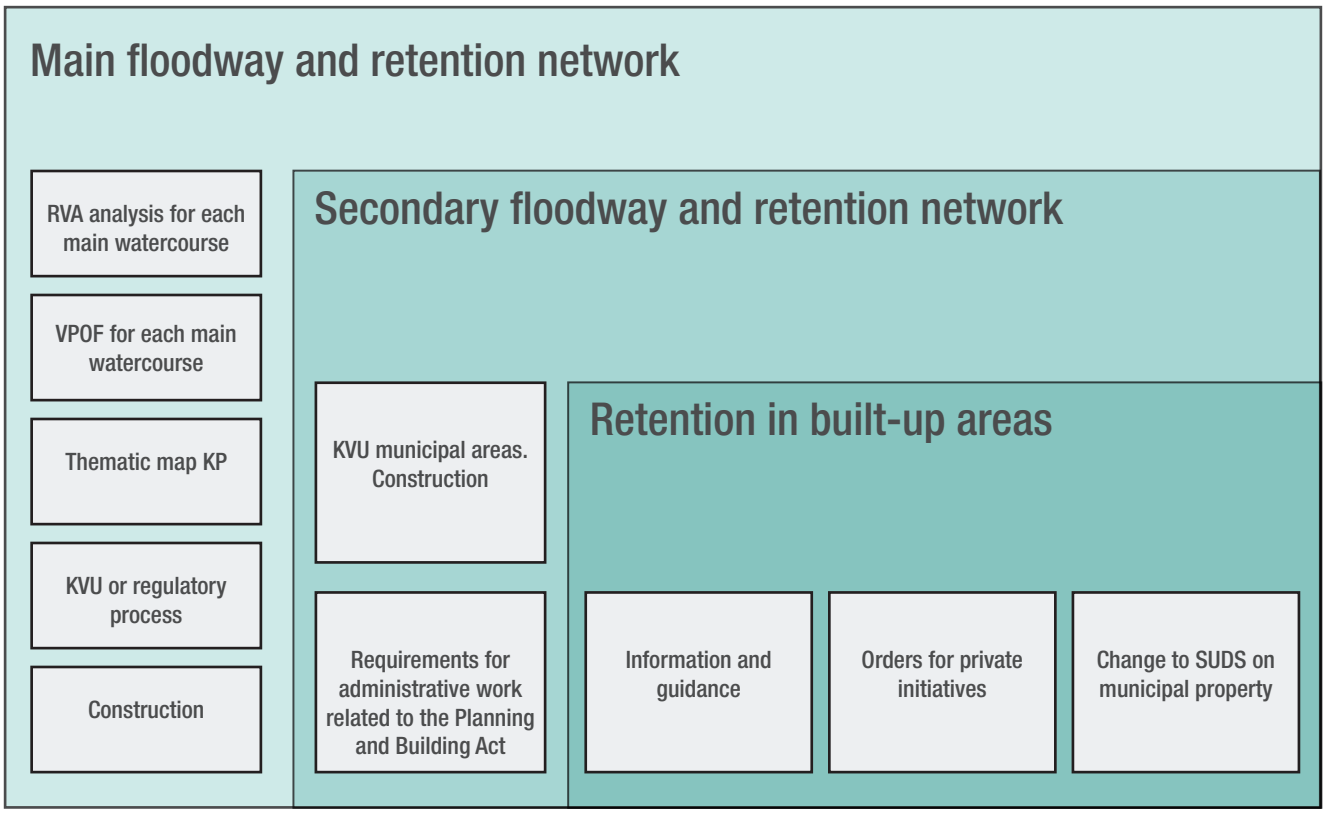
When new areas are planned and developed it will be absolutely necessary to have effective tools so we can limit the consequences of stormwater. Such tools will also give us the necessary basis for assessing the need for risk mitigation measures in built-up areas where no new construction is planned. Stormwater retention on private property will also be absolutely necessary to reduce the risk of flooding in streets, the sewage system and neighbouring properties. In addition, we need to further develop our emergency systems to reduce the consequences of extreme rainfall events.

Figure 4 Flooding at Jernbanetorget 26 June 2014. (Photo: Agency for Water and Sewerage Works)

ID	Strategy and action	Responsible	Partners	Working years
4	**Create the thematic map "Stormwater and urban flooding"** • Carry out a risk and vulnerability analysis (RVA) for stormwater and flooding for each of the catchment areas for the major rivers and the Oslo Fjord and assess the suitability of the theoretical drainage lines as floodways. • Develop a planning guide for stormwater and urban flooding for catchment areas, based on RVA analyses. Plans should show the desired floodways and retention network, vulnerable areas and the need for further planning processes, zones requiring special consideration, regulations and concept studies. • Create the thematic map for stormwater and urban flooding based on the planning guides. The thematic map should be linked to the land-use element of the municipal master plan and clarify routes and zones requiring special consideration.	VAV (RVA, VPOF) PBE (VPOF, thematic maps)	PBE, VAV, BYM, EBY.	2016–2021
5	**Plan for, and construction of the main floodway and retention network** • Develop plans for and build/facilitate the defined main floodway and retention network based on the RVA analysis and planning guides. • Clarify needs, responsibilites, and costs for operating and maintaining the systems through concept evaluations and design.	BYM	VAV, PBE, EBY City districts	2018–2021
6	**Establish coordinated operational emergency response** • Develop an emergency response analysis for stormwater based on the "Overarching RVA for the City of Oslo". The analysis should provide the basis for planning emergency response drills for extreme weather. • Develop a coordinated emergency response plan to ensure that critical points are manned. This should include an emergency response map with alternative driving routes when floodways are in use. The emergency response map should include vulnerable objects. • Evaluate and develop forecast warnings focused on local urban flooding.	BER	BYM, VAV, BRE, MET, FNO, NVE OPD	2017–2019
7	**Ensure local stormwater retention in built-up areas** • Establish open and local retention at multiple municipal properties (see also action point 9). • Provide information and guidance on appropriate measures for built-up areas. • Establish management activities that include issuing orders for private initiatives as necessary, in the event of complaints.	VAV	PBE, EBY, OBY, UBF, BBY	2017–2018

Stormwater retention on private property will also be absolutely necessary to reduce the risk of flooding in streets, the sewage system and neighbouring properties.

Figure 5 The figure illustrates the plan for development of an effective floodway and retention network.



All municipal projects should be model projects

The City of Oslo is a major developer and must lead by example. We must spearhead initiatives to obtain knowledge about stormwater solutions and the city's hydrology. Our best opportunity is to develop a number of municipal projects as pilots and model projects. To do so, we will need a common work method for planning and implementing projects, and we must be a demanding customer when projects are put to tender.

Squares, meeting places, parks and green corridors are important areas that we must use for stormwater retention. The same applies to roundabouts and road shoulders. The concept of multi-functionality must permeate our mindset when we choose solutions and the development of pedestrian and cycle paths should be coordinated with the development of the network of floodways.

Roads generate a lot of stormwater. At the same time, this stormwater can contribute to the pollution of the surrounding area. Some roads will also be included in the floodway and retention network. This means we must take a new approach to designing, operating and maintaining roads.

A pilot project in Deichmanns gate will explore the use of open stormwater solutions as a means to achieve sustainable urban drainage systems (SUDS). Here, the groundwater level will be important for preserving the old buildings and Møllergata school, which is listed. Several types of rain gardens will be built and tested, which will provide valuable knowledge about the functionality and suitability of rain gardens in dense urban areas, both summer and winter.

Figure 6 Illustrative image of Deichmanns gate with blue-green solutions. (Source: The Agency for Urban Environment)

The concept of multi-functionality must permeate our mindset when we choose solutions and the development of pedestrian and cycle paths should be coordinated with the development of the network of floodways.

ID	Strategy and action	Responsible	Partners	Working years
8	**Develop a "Guide for Planning and Implementation of Municipal Projects"** • A common guide that includes principles for the planning, involvement, implementation and operation of municipal projects. All types of projects should be included, including stormwater management in road projects. • Consider the possibility of a common map access solution. • Expand the existing project developer forum as driving force in the work.	FIN	VAV, BYM, EBY, PBE, OBY, UBF, Sporv.[1]	2016–2019
9	**Retaining stormwater on municipal property**[2] Public spaces • Conduct concept evaluations for municipal land that can be utilised for storm-water retention. The studies should aim to identify the quantities that can be handled and which nearby areas stormwater is running off from. Section for Planning of Schools, Kindergartens and other municipal property • Develop plans for upgrading to open and local stormwater management on existing municipal properties. The Hovinbyen district should be prioritized for model projects.	EBY/OBY/ UBF/ BBY/Oslo Port Authority	VAV, BYM, PBE	2017–2021
10	**Develop a road and street norm for Oslo.** • Evaluate built road water solutions. • Include technical specifications and design of roads as part of the floodway and retention network, and reduce the risk of the spread of pollution. • New procedures for clearing sand traps and road sweeping. Frequency should be based on pollution risk and reliability of road and sewer systems. • Develop principles to determine when road water is considered polluted.	BYM	VAV, PBE, SVRØ Bicycle Agency	2016–2017

[1] Sporveien / Ruter
[2] Municipal undertakings such as Hafslund, Sporveiene, etc. are also landowners and should be involved in this work.

We will establish closer working relationships

Water, green structures and functional outdoor spaces must be planned in line with a unified concept, in order to allow the city to adapt to climate changes. Urban densification and varying soil mechanics means that we also need coordinated stormwater solutions both above and below ground. Acceptable investment levels, while also maintaining the aesthetically desired expression for the area, must be included in early assessments so that a decision can be made based on the proper criteria. It also means that we must see investment processes and planning tools in better context.

Coordination between sectors and disciplines in the City of Oslo is under constant improvement and development, but we still need better lines of communication between agencies and everyone must have access to the same tools. To ensure uniformity and breadth in the City of Oslo's stormwater initiatives, we must develop these tools jointly to a greater extent.

ID	Strategy and action	Responsible	Partners	Working years
11	**Further develop investment processes into the Oslo model** • Consider the possibility of better coordination of the investment process and the Oslo model for land-use planning. • Cooperate to further develop the use of planning guides for public spaces and coordinate this better with the preparation of a technical master plan for area development	KVU: FIN/BYU/ MOS VPOR/tek: VAV	PBE, BYM, EBY	2017–2018
12	**Develop procedures and tools for administrative work related to the Planning and Building Act** • Assess whether and possibly how internal clarification between the Agency for Planning and Building Services and specialist agencies can replace the prior statement scheme. • Assess whether all stormwater statements can be collected in one place and possibly introduce a new scheme.	PBE	VAV, BYM	2016–2018
13	**Coordinate complaint processing** • Develop principles for processing complaints about stormwater in built-up areas. • Establish management with the use of relevant legislation that follows up principles. • Create a database to identify various issues and collate experiences. The database should be coordinated with the database for rainfall events in action point 3.	VAV	BYM, EBY	2016–2017
14	**Further develop the dig coordination system** • Consider the potential for implementing upgrades to floodways when digging activities are to take place. • Develop guidelines for the use of cable trenches.	BYM	PBE, VAV, Systems developer	2016–2017

We will provide better guidance and information

Information and guidance on stormwater is an important step to ensure that housing construction and industrial development are adapted to climate challenges, with effective and open stormwater management. Effective dialogue and readily available information will help to increase knowledge and awareness of climate change and stormwater management among both private individuals and professionals.

Open and local stormwater solutions can purify contaminated stormwater and be used for stormwater retention. Multiple solutions together can constitute a larger network for stormwater management and can also have other uses when it is not raining. As of today, we have 15 fact sheets to help stimulate creativity and spread knowledge of SUDS. This collection will be expanded in the years ahead.

Figure 7 Example of a fact sheet.

ID	Strategy and action	Responsible	Partners	Working years
15	**Further develop our database of fact sheets** • Construction coordinators must prepare fact sheets for new stormwater measures/systems being built. Fact sheet for Deichmanns gate and the use of drainage lines and risk maps should be prioritised. • Construction coordinators must also evaluate and improve existing fact sheets. • Coordinate fact sheet database with the blue-green factor tool.	VAV	BYM, PBE, Project owners	2017–2021
16	**Revise stormwater planning guide** • The municipal master plan for Oslo towards 2030 and new requirements and guidelines for stormwater management should be the basis for upgrades. • The planning guide should include information on stormwater in planning and building projects and built-up areas.	VAV	BYM, PBE	2016–2017
17	**Develop a communication strategy** • Should contain tools to communicate with the public about floodways, stormwater measures and extreme weather. • Continue to develop meeting places and training programmes aimed at executive officers, planners and others. • Develop a guided tour programme for stormwater measures/systems for interested parties, municipalities, schools, etc.	VAV	BYM, PBE, EBY, OBY, UBF, BBY, University, College	2016–2017
18	**Funding schemes for stormwater initiatives will be established** • Investigate and establish funding schemes for establishing stormwater measures.	VAV	BYM, PBE, FIN (City Hall)	2017–2018

Our priorities

In conjunction with this action plan, a number of map tools have been developed to help prioritize the implementation of measures to reduce the risk of flooding due to stormwater in the future. The maps show where we are experiencing the most damage and flooding, where damage costs the most in terms of compensation payments, and the theoretical risk of flooding and/or erosion associated with drainage lines in the city. These maps will serve as important background material when actions and projects are prioritized, based on this action plan, in sector planning by the various agencies and in administrative work related to the Planning and Building Act.

1. Has there been a lot of damage and have there been high insurance claims recorded in the area?

The results of climate change manifest themselves in different ways. The same will be true for costs.

Analyzing insurance data gives us an overview of both the dispersion and accumulation of claims related to stormwater damage, as well as the size of compensation payments related to such claims. Costs are illustrated in the figure below. The redder the field, the higher the compensation payments have been. Altogether there were 30 instances of damage in the most costly catchment area (Båntjern), amounting to NOK 8.16 million. This is due to both the number of instances of damage and the fact that a number of properties experienced repeated damage.

The cost distribution in the catchment areas and number of repeat instances of damage are important factors when it comes to prioritization.

FACTS

The torrential rain on 26 June 2014 can be categorised as extreme, but because it affected only a small part of the city, the damage was limited. The total cost of this single event was approximately NOK 10.7 million. Of this amount, approximately NOK 6.7 million was related to buildings and NOK 0.5 million was for infrastructure and call-outs. Traffic delays are estimated at approximately NOK 3.4 million, but that figure is very uncertain.

During the period 1st January 2008–28th October 2014, there were a total of 2,396 insurance claims related to damage from stormwater. Together, this amounted to NOK 97,389,243 million in compensation payments, ranging from a minimum of NOK 40,646 to a maximum of NOK 2,291,096.

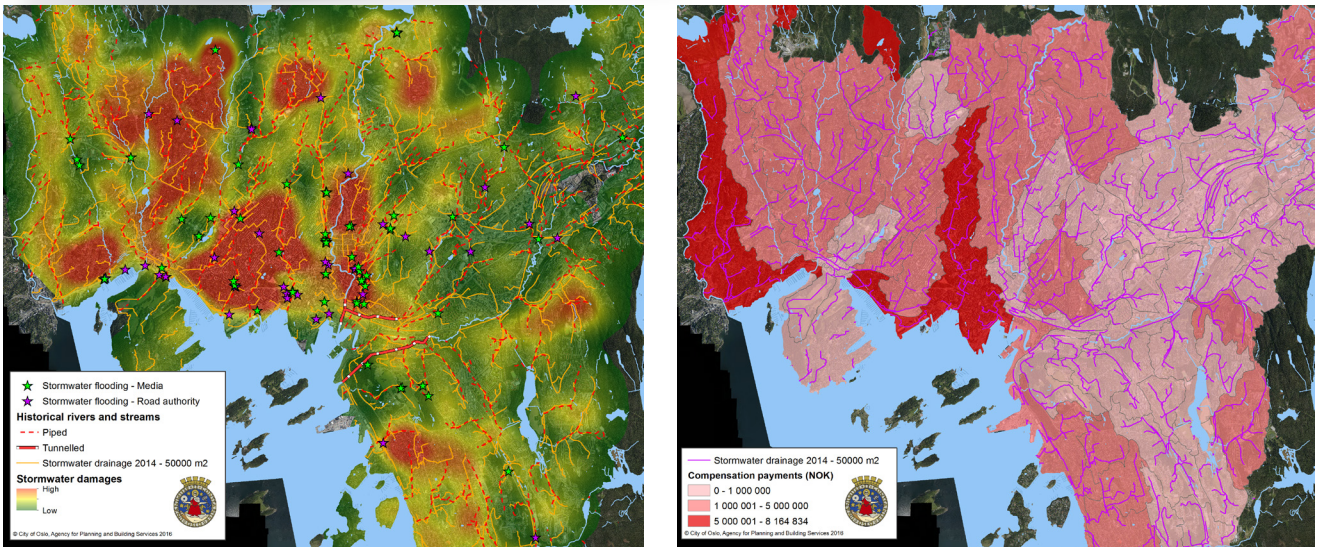


Figure 8 The figure on the left shows areas with an accumulation of damage resulting from stormwater and flooding that coincide with mapped drainage lines. The figure to the right shows the distribution of costs per catchment area for the main watercourses. (Source: Agency for Planning and Building Services)

2. Where is the highest risk of flooding and erosion?

Drainage lines are classified by the probability of flood and erosion (i.e. a combination of terrain slope and catchment area for drainage lines). Thus, information about vulnerable functions and objects as well as recorded damage contribute important prioritization criteria to the map of flooding and erosion risk "Risk Map" for Oslo's building zone.

A separate set of criteria for assessing risk and vulnerability has also been drawn up to contribute to uniform assessments and conclusions in risk and vulnerability analyses.

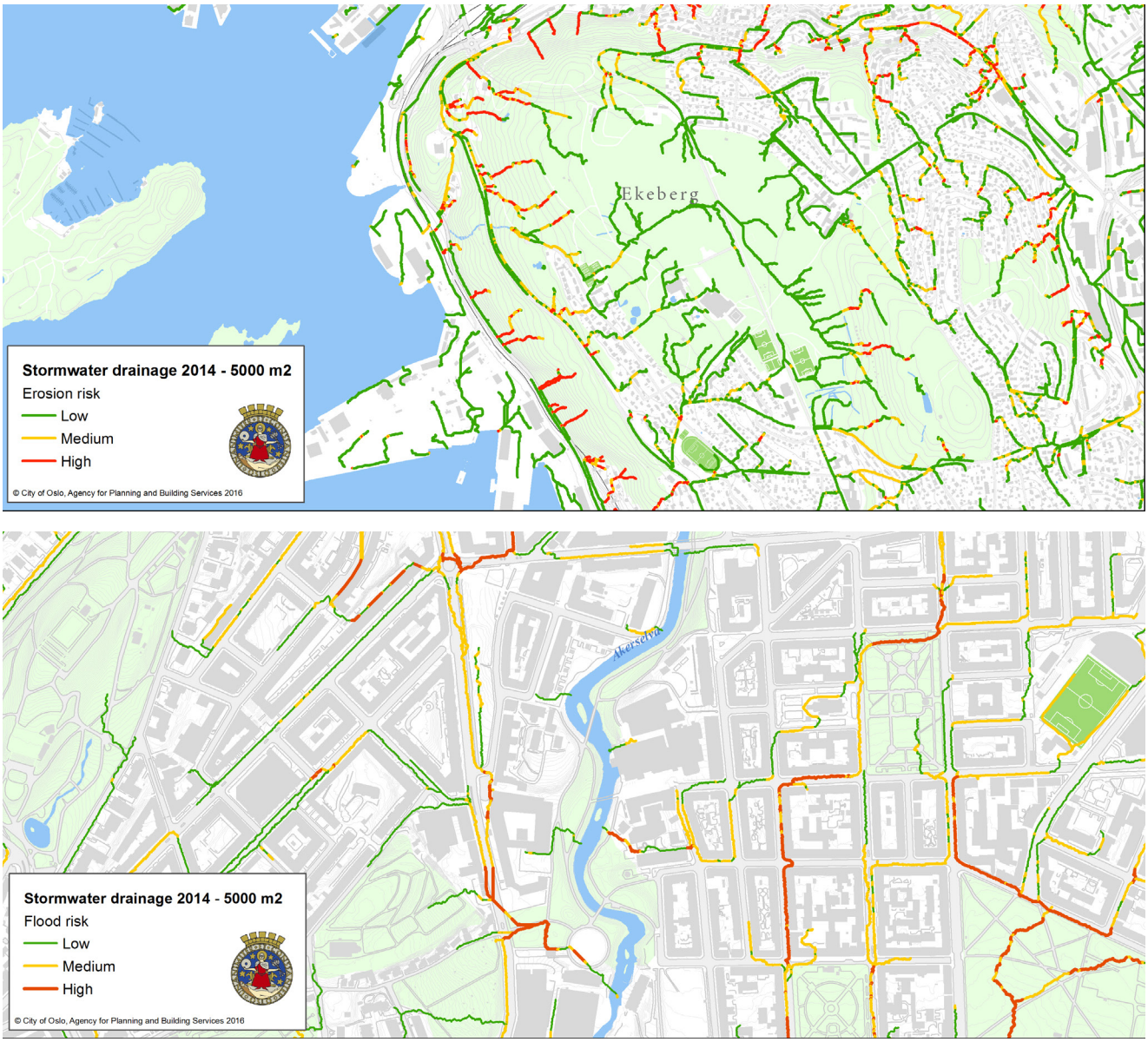


Figure 9 The map at the bottom shows the risk of flooding for drainage lines based on depressions in the terrain and where the terrain is flat. The map at the top shows erosion risk, i.e. risk of high water velocity in drainage lines due to terrain slope. Both are divided using the traffic light principle, where green lines are low risk, yellow represents medium risk and high risk is in red.

Terms and abbreviations

Term	Explanation
Blue-green factor	A tool to ensure adequate amounts of vegetation for open stormwater management on each plot. This method has great potential in administration and planning work, and must be further developed. In minor cases, the calculation tool is simplified so that stormwater retention on a property is also ensured. Using this or an equivalent method that meets the current requirements for vegetation and stormwater management will simplify both municipal administrative work and the developer's planning.
Built-up areas	This means populated areas where there are no plans for transformation or development and which are thus not included in planning work. These are primarily areas where there are no applications for building projects under the Planning and Building Act, and which are not included in the processing of applications for building permits. "Built-up areas" can also be developed areas where applications have been made for smaller building projects, where the zoning plan is old and the area is now covered by the new municipal master plan.
Dimensioned rain	What quantity of rain must be planned for, on the basis of intensity, duration and frequency curves (IDF curve).
Flood	When the water flow in a river or stream exceeds a certain water level.
Floodwater flow	Water flow in a river, stream or floodway exceeding a certain water level.
Floodway	A desired and adapted route where heavy precipitation should run off.
Retention	Larger or smaller areas that are adapted for the retention/detention of a certain amount of stormwater so that water runoff slows down and the amount of stormwater that is released at one time is reduced.
Main floodway	River or specially adapted road or large channel that constitutes the main artery in the runoff system.
SUDS	Sustainable urban drainage systems. Local stormwater management.
Flood	An excess of stormwater on terrain or a surface that is normally dry.
Recipient	Common name for a stream, river, lake, ocean, marsh or other water source.
Secondary floodway	Smaller stream, constructed channel or the like that transports stormwater from a smaller area to a main floodway or main retention basin.
Three-step strategy	Infiltration after light rain (step 1), retention after moderate rainfall (step 2) and safe runoff to a recipient after heavy rain (step 3).
Urban flooding	Flooding due to heavy rainfall that is not due to high water levels in rivers or streams, but rather to e.g. impervious surfaces.
Water occurrence	A water occurrence is a defined and significant amount of stormwater, i.e. in a coastal area, lake or stretch of river, or a defined volume of groundwater.
VPOF	Planning guide for stormwater and urban flooding.
Urban drainage lines	A theoretically calculated line where stormwater is likely to run off, based on how the terrain is shaped and sloped. Rule of thumb: water will constantly seek the lowest point in the terrain and runs downwards.

Abbreviation	Explanation	Abbreviation	Explanation
BBY	Municipal Undertaking for Social Housing	NVE	The Norwegian Water Resources and Energy Directorate
BER	Emergency Planning Agency	MET	The Norwegian Meteorological Institute
BYM	The Agency for Urban Environment	MOS	Department of Environment and Transport
BYU	Department of Urban Development	OBY	Municipal Undertaking for Social Service Buildings
BRE	Agency for Fire and Rescue Services	OPB	Oslo Police District
EBY	Agency for Real Estate and Urban Renewal	PBE	Agency for Planning and Building Services
FIN	Department of Finance	RVA	Risk and vulnerability assessment
FNO	Finance Norway	SVRØ	Norwegian Public Roads Administration, Eastern Region
IDF	Intensity, duration and frequency	UBF	The Municipal Undertaking for Educational Buildings and Property
KF	Municipal undertaking	VPOF	Planning guide for stormwater and urban flooding
KP	Municipal Master Plan	VPOR	Planning Guide for Public Space
KVU	Concept evaluation	NOU	Norway's public reports
VAV	The Agency for Water and Wastewater Services		

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