



Managing Adaptive REsponses to changing flood risk

Bergen. Haukås Watercourse

List of stakeholders

The stakeholders should be listed in the standard list. However the terms in the standard list should be used within the case study in order to enable readers to understand more easily.

Ref. No.	Stakeholder	Developers		Long term ownership		Interest																				
						Regulators										Planning bodies					Knowledge development					
						Wildlife	Heritage	Environment	Water quality	Water quantity	Emergency planning	Strategy planners	Development control	Building control	Road/Transport	Initiators	Create state of the art knowledge	Maintain knowledge								
		A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D			
	Public authorities and water utility organisations																									
1	National Government											1		1												
	- Cultural Heritage							x	x																	
2	Provincial Government (County Hordaland)											3		X												
	- Environmental department					x				x	X			x												
	- Food safety authority									X	X	X	X							x	x		x	X		
3	KLIF (Climate and pollution Directorate)									x	x				x	x	x	x			x	X		x	x	
4	Norway’s Water and Energy Directorate (NVE)									x		X		x		x		x						x	X	
5	City of Bergen (divided by departments)																									
	- Fire department																									
	- Directorate for Civil Protection and Emergency Planning													X	X											
	- Department of Climate, Environment and Urban Development													x	x	x	x		x					x		
	- Water and sewage department / Bergen Water	x	x	x	x							x	x	x	x	x		x		x			x		x	X
	- Department for Green Areas	x	x	x		x	x										x	x						x	X	
	- Planning / Building department														x	x	x	x	x	x	x				x	X
	- Transport /roads (state- /county- and city level)	x	x	x	x									x		x		x							x	X

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1 Introduction

The Haukås watercourse is a small watercourse in the Municipality of Bergen with a catchment of 8.9 km². Human activities affect both water quality and runoff conditions to nearby lakes and streams. Existing activities include farming, a horseracing track, a motor sports centre, a rock quarry and roads.

Storm water management within a large area usually involves several parties. The challenge is to ensure that personnel and organisations at every level are involved in planning, designing and maintaining facilities. Work and responsibilities must be coordinated between the various parties, including the municipality, municipal agencies, builders, developers, planners and contractors.

1.1 Aims and objectives

The goals of this demonstration project is to ensure that runoff from the watershed does not increase beyond today's flow rate, in order to prevent future flooding, and to ensure that the Haukås watercourse is in a good ecological condition, and to maintain

and improve the water quality in the watercourse.

Sustainable urban drainage systems are required to meet these aims and objectives and these must be based on:

- Open watercourses and drainage systems
- Infiltration of runoff
- Slowing down runoff
- Floodways

1.2 Background

Large areas in the Haukås watershed have been designated as future development areas for housing and industry in the city's master plan. Plans for these extensive housing and industrial developments require plans for how to deal with storm water. It is also important that areas are secured for recreation, biodiversity and education.

The Haukås watercourse is the only known watercourse in the municipality of Bergen where the freshwater pearl mussel can still be found. The population was believed to be extinct, but it was rediscovered in 2002. The deterioration and destruction of habitat is the greatest threat to the freshwater pearl mussel in the Haukås watercourse. Eutrophication,

erosion of land and forestry areas, canalisation of rivers, stream closures, clear-cutting, and the drainage of swamps and other outlying areas are also important factors. Pearl fishing was once a serious threat, but is now prohibited.

The freshwater pearl mussel mainly lives in running water. It can be found anywhere in nutrient-poor sites with gravel and sand bottoms that are stabilized by small and large stones and boulders. When mussel larvae are released by the mother, they have to make contact with a fish gill or they will die very quickly. This stage on a fish is absolutely essential if the larvae are to reach maturity and start life as benthic mussels in the river. The only suitable host fish species is the Atlantic salmon or trout, and this parasitic stage usually lasts 9–11 months. When the larvae leave the fish they have to find a suitable substrate, and if they do not they will die. In the early years (up to a length of 15–30 mm), mussels live buried in the substrate at the bottom of the river. This is a critical phase with a high mortality rate (95% of mussels die within the first 5–8 years). Under normal conditions, life expectancy may be 140–250 years in Scandinavia.

Norway has almost a third of the known remaining freshwater pearl mussel sites and more than half the mussels in Europe. However, it is believed that about one-third of the locations in Norway are suffering from recruitment failure. This means that in these populations, the freshwater pearl mussel is still present, but there are only old individuals left in the stock. This is the case for the population of freshwater pearl mussels in the Haukås watercourse. The entire population, with some exceptions, is more than 50 years old. This implies that there has been little or no recruitment to the population in the last 50 years. The reason for this is that the mussel's requirements for water quality have not been fulfilled. In the past, the main problems were agricultural runoff and sewage which led to eutrophication. In recent years, the main problems in the watercourse have been runoff from the horseracing track, roads and urban development. This has led to high turbidity which has most likely been fatal for the young mussels living in the substrate.

1.3 Regulations, procedures and standards

The city's master plan

The total area of the Haukås watercourse is 8.9 km². Land use is currently distributed between 5.9 km² of natural area, 1.4 km² of agriculture and 1.2 km² developed areas. The master plan proposes increasing the developed areas by about 2 km². This will reduce the agricultural land and natural areas by the same amount. This increase in developed areas could have large implications for the Haukås watercourse if it is not handled with care.

The master plan has two provisions that will be crucial in handling the runoff and storm water that will be generated by large development projects.

Water, drainage and storm water treatment
A plan for water, drainage and storm water treatment is to be included in all plans. The framework plan should show principal solutions for the area, the context of the overall primary system and storm water

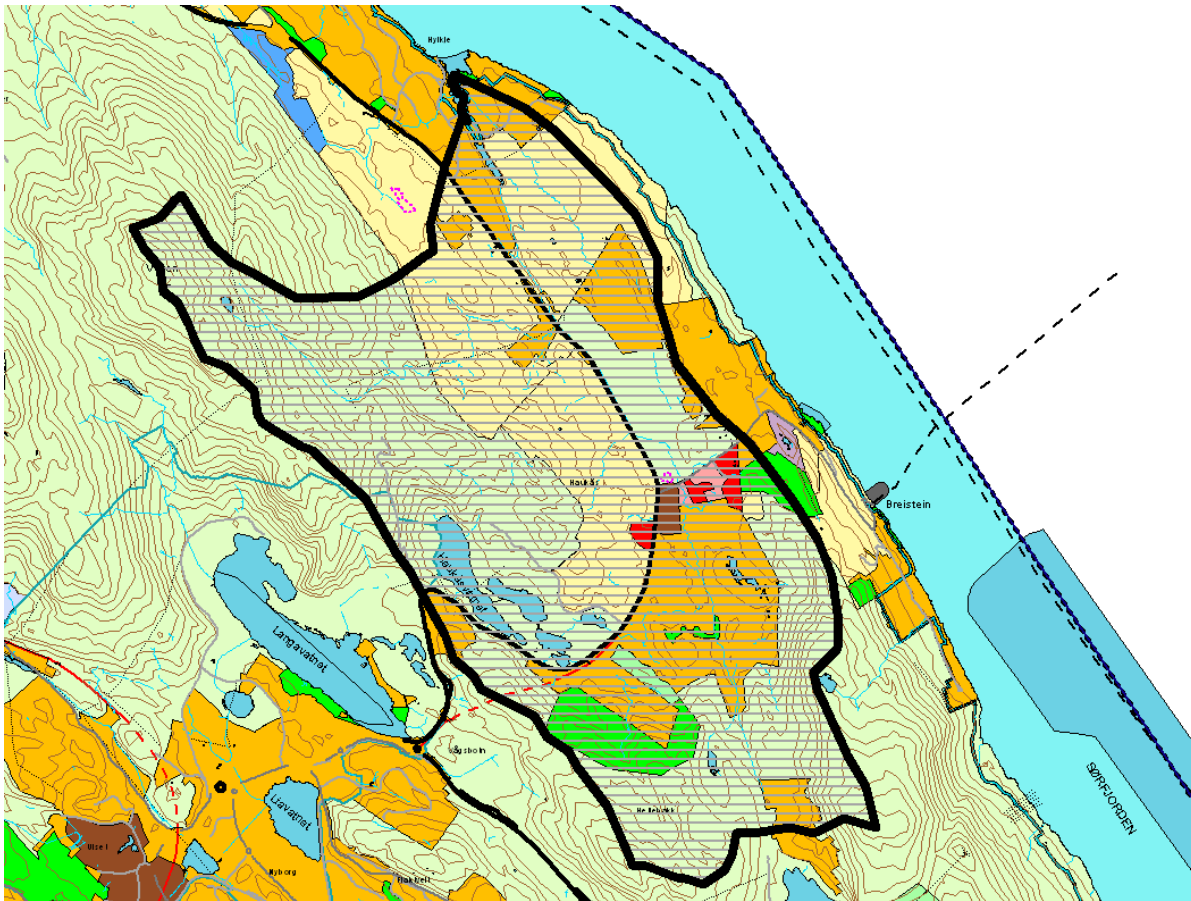
management. Precipitation should preferably be given runoff through infiltration into the ground and into open waterways. The plan shall identify and secure land for storm water management.

Waterways

Blasting, landfilling and excavation are prohibited within certain distances of watercourses. This varies according to the different zones:

- a 10-metre distance along waterways in city centres,
- a 20-metre distance along waterways in areas designated as building areas
- a 50-metre distance along waterways in areas designated for agriculture, nature and outdoor activities

Exceptions: Nature-friendly arrangements that safeguard the public interest and leisure agriculture, and which are subject to rules providing crossing points and access to waterways.



Nature Diversity Act

The Nature Diversity Act aims to preserve biological diversity, ecological processes and nature's production capability. It regulates the management and protection of areas and provides regulations regarding alien species. The Act requires that the precautionary principle be applied to decisions that affect nature and ecosystems, and that assessments are based on a comprehensive analysis of the combined effects to which the ecosystems will be exposed. The law also allows areas to be protected if they are critical to ensuring the continued survival of endangered species.

A new term was introduced in the Nature Diversity Act: “priority species”. Species can be prioritized if:

- the species has shown a great decline in population
- Norway has a special responsibility to take care of it (liability sensitive)
- the species is listed in international conventions

The Nature Diversity Act outlines three measures that can be taken to improve conditions for priority species:

- A ban on harvesting
- The protection of important, smaller-scale ecological functions
- It may be necessary to clarify the result of planned interventions on ecological functions.

Action plans will be prepared for priority species, including measures to ensure the protection of habitats. The action plans shall be developed in close cooperation with any interested parties affected. The Nature Diversity Act makes it easier for cross-sector policy instruments to be used, which are tailored more closely to each species. The freshwater mussel is one of the species in Norway that has been proposed as a priority species.

EU Water Framework Directive

Norway is in the process of implementing the EU Water Framework Directive. Norway is obliged to adhere to the directive because of

the EEA Agreement. Its implementation in Norway is authorized through the Water Regulation, which entered into force on 1 January 2007. This regulation aims to maintain the ecological and chemical state at a high quality, or to improve the quality of all fresh water, groundwater and coastal waters within one nautical mile of the baseline. This will be implemented by designing regional management plans and having special programmes for regional measures.

The Haukås watercourse is a part of the Voss-Osterfjorden Water Area, which is one of five water areas in the Hordaland Water Region. By the end of 2015 the management plan for the Hordaland Water Region should be finished, and measures to improve the biological and chemical state should be proposed. By the end of 2021 all the measures should be implemented. This will hopefully be an important contribution towards safeguarding the freshwater pearl mussel and improving the water quality in the Haukås watercourse.

1.4 Timeline

November 2001 - municipal Bergen commune period 2000-2011 is adopted. Major areas are

to be developed for residential and industrial purposes.

2002 - The red-listed freshwater pearl mussel is rediscovered in the Haukås watershed.

2005 - Guidelines for stormwater management in the City of Bergen were adopted.

May 2005 - Planning of Haukås Wetland Park starts. Plan aims to improve conditions for the freshwater pearl mussel, ensure good stormwater management and develop areas for outdoor activities.

September and November 2005 – two major flood events occurred.

January 2006 - The report "Haukås watershed - Future development and comprehensive stormwater management" is finished. The report will provide guidance on how the development and construction in the watershed to watershed Haukås designed to ensure good stormwater management.

September 2008 - First transitional political consideration Haukås Wetland Park plan.

February 2009 - MARE project launched.

2010 - The rescue operation for the freshwater pearl mussel starts. The main focus of this operation is farming of freshwater pearl mussel. The project will continue for several years and the first mussels are expected to be released in 2014 or 2015. It is crucial to improve the water quality the Haukås watershed to ensure survival of the released freshwater pearl mussels.

2012 – Installation of turbidity monitor in the Haukås watershed to monitor the water quality permanent.

March 2013 - Preliminary plan for an overview plan of the Haukås area.

2 Details

2.1 Analysis and assessment

The Haukås Wetland Park

The planned area of the Haukås Wetland Park is 410 acres, and the area lies northeast of the city of Bergen. An analysis of the area's natural state and what it is currently used for has been used as a basis for planning the park. The purpose of the plan is to secure the area for biodiversity, recreation and outdoor

activities in the form of a local park. Large areas in the Haukås watershed have been designated future development areas for housing and industry in the city's master plan. It is thus important that the rich biological diversity and the landscape of Haukås' waterways and adjacent wetlands are preserved. The plan should also ensure that the area is available for recreation and physical activity. The Haukås Wetland Park should also handle storm water and prevent flooding in areas close to the Haukås River, which will hopefully help to reduce the runoff of fine sediments.

The Åsane district used to have the largest continuous wetland complex in the Bergen area. Today this habitat type is relatively rare because large areas of marsh and wetland have been lost as a result of urban development. Restoration of the river and the vegetation along the river will not only make the landscape more beautiful, but will also help to restore some of the green areas.

Wetlands – which constitute the central part of the planning area – will be wet or covered with water for most of the year. This provides a habitat for a wide variety of plant and

animal species. There are some important natural resources in the planning area, such as nesting areas for the northern lapwing (*Vanellus vanellus*), and the Haukås river is the only known location for the freshwater pearl mussel (*Margaritifera margaritifera*) in the Bergen municipality. The freshwater pearl mussel is protected and listed on the national Red List of endangered species. But the area is also a potentially exciting landscape for adventure, learning and recreation activities. The intention is for the area to safeguard and enhance biological diversity and have a versatile range of uses. The restoration of the natural landscape includes:

- Reconstructing parts of the old, meandering river
- Creating sedimentation ponds and pools beside the river
- Establishing local species of vegetation
- Improving the water environment of the river

The area is easily accessible and has a topography which also is suitable for a multi-purpose design. By establishing areas that wheelchair users can access for fishing, raised boardwalks through the wet area, railings and

benches, large parts of the site will be accessible to all users. This will result in a canalization of the traffic, so that parts of the wetland will lie undisturbed. Information about facilities and activities must be made available.

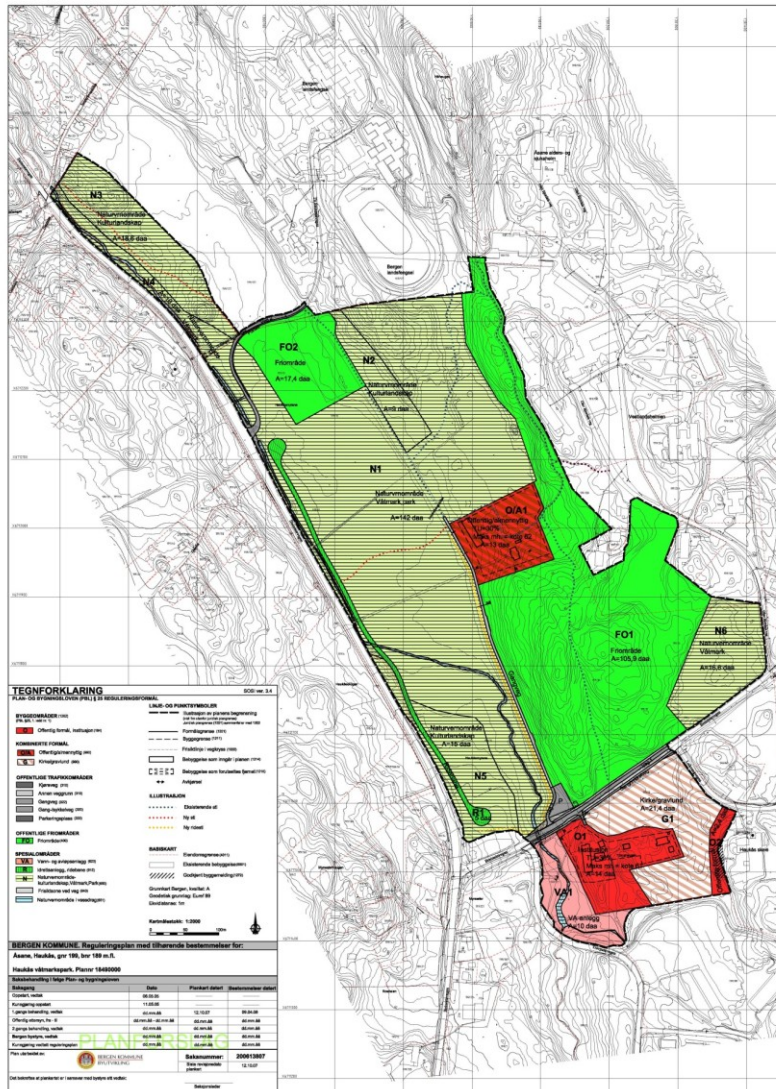
The 2006 plan outlines a development of the Haukås Wetland Park over a 5-7 year period and an investment of NOK 10–15 million (1–1.5 million Euro) has been proposed.



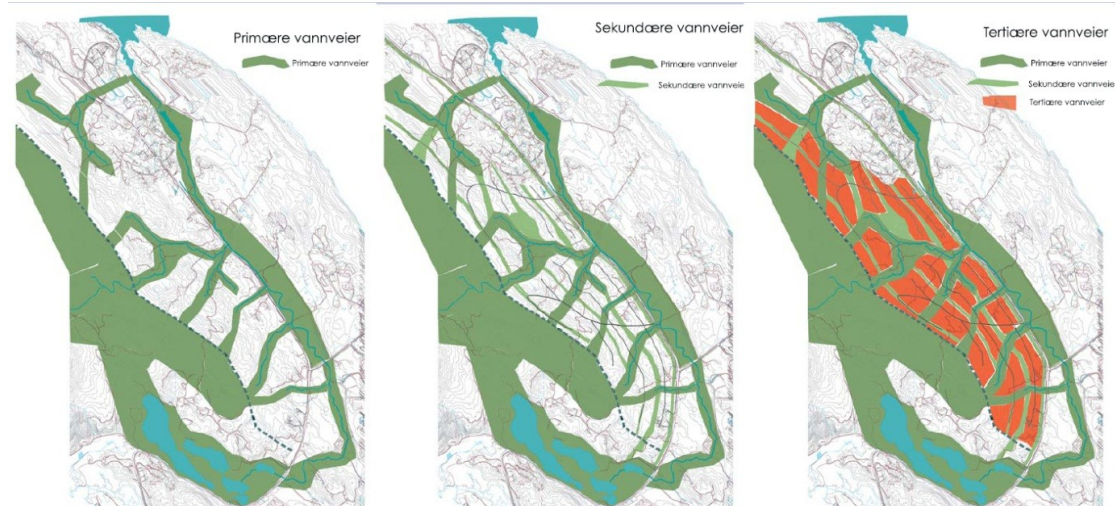
An overview of the planned Haukås Wetland Park area. Above: The current situation (2005). Below: Future situation after the wetland park has been established.

Future developments in the Haukås watershed and comprehensive measures for storm water management

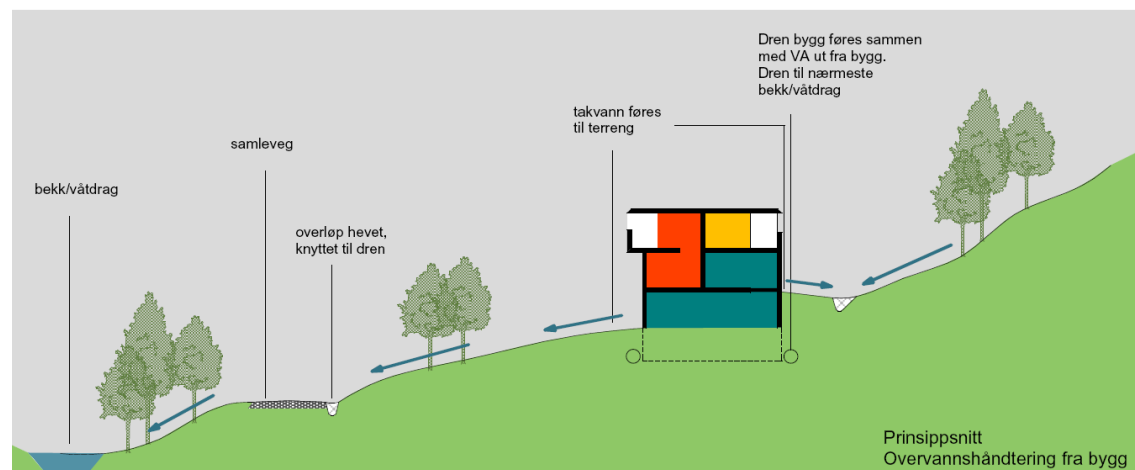
The challenge for the new development areas is to safeguard the natural waterways and exploit the natural conditions for open local water handling. Planning must also address the need for high flood safety and ensure floodways through inhabited areas. Important criteria for the location of buildings will be terrain heights, fall conditions, natural waterways, wetlands and natural terrain depressions, etc. Waterways branch off in different ways from the main river, in tributaries known as primary, secondary and tertiary waterways. This waterway structure must be maintained in the development areas, in order to ensure that the water is handled safely and properly.



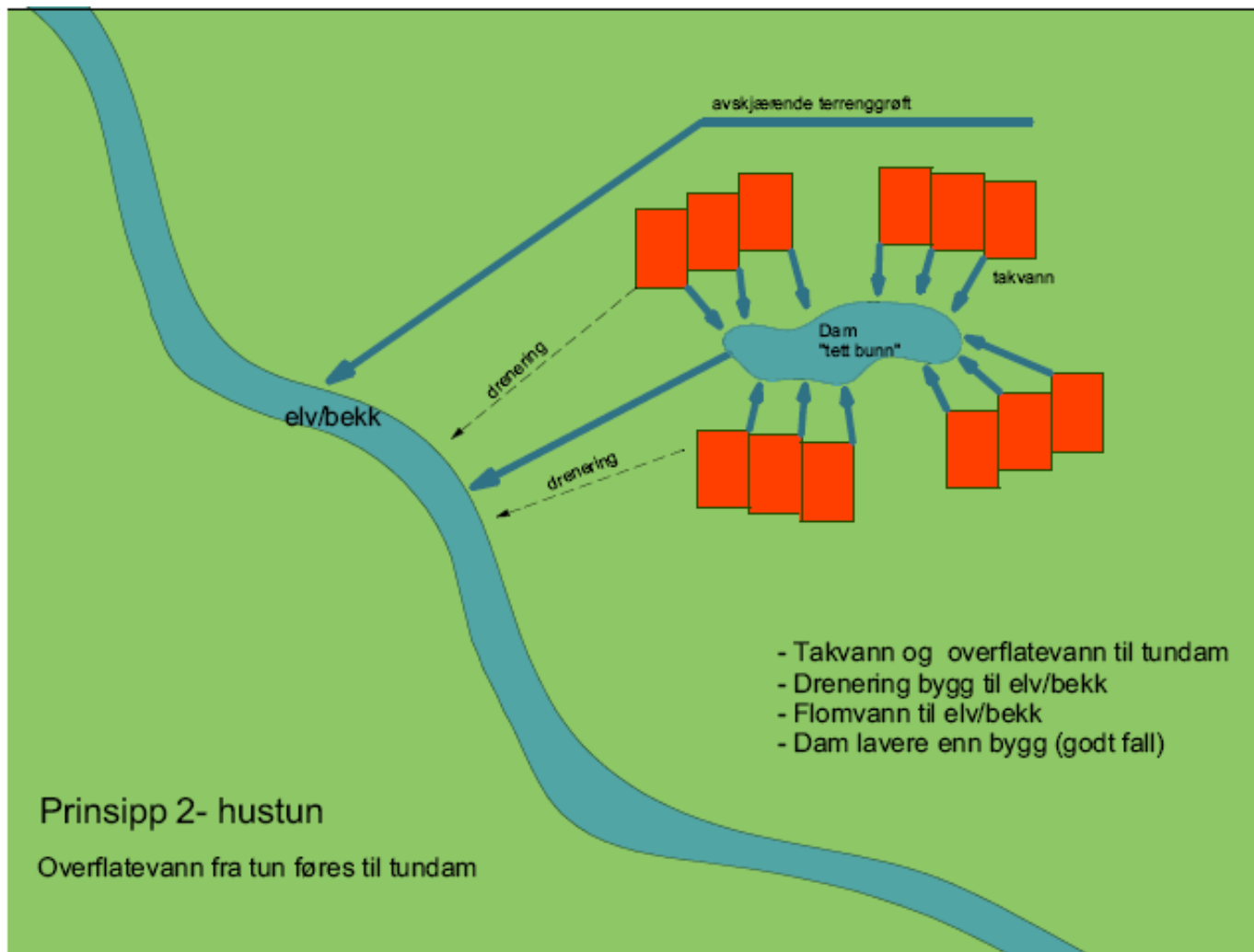
In urban areas, surface water should be dealt with at source as much as possible. This helps to maintain natural groundwater levels, ensuring infiltration and slow runoff and keeping waterways open. The percentage of impermeable surface areas should be kept to a minimum. Contaminated storm water, which it is prohibited to release into a particular recipient, must either be treated locally, released into a less sensitive recipient or routed to municipal wastewater treatment plants.



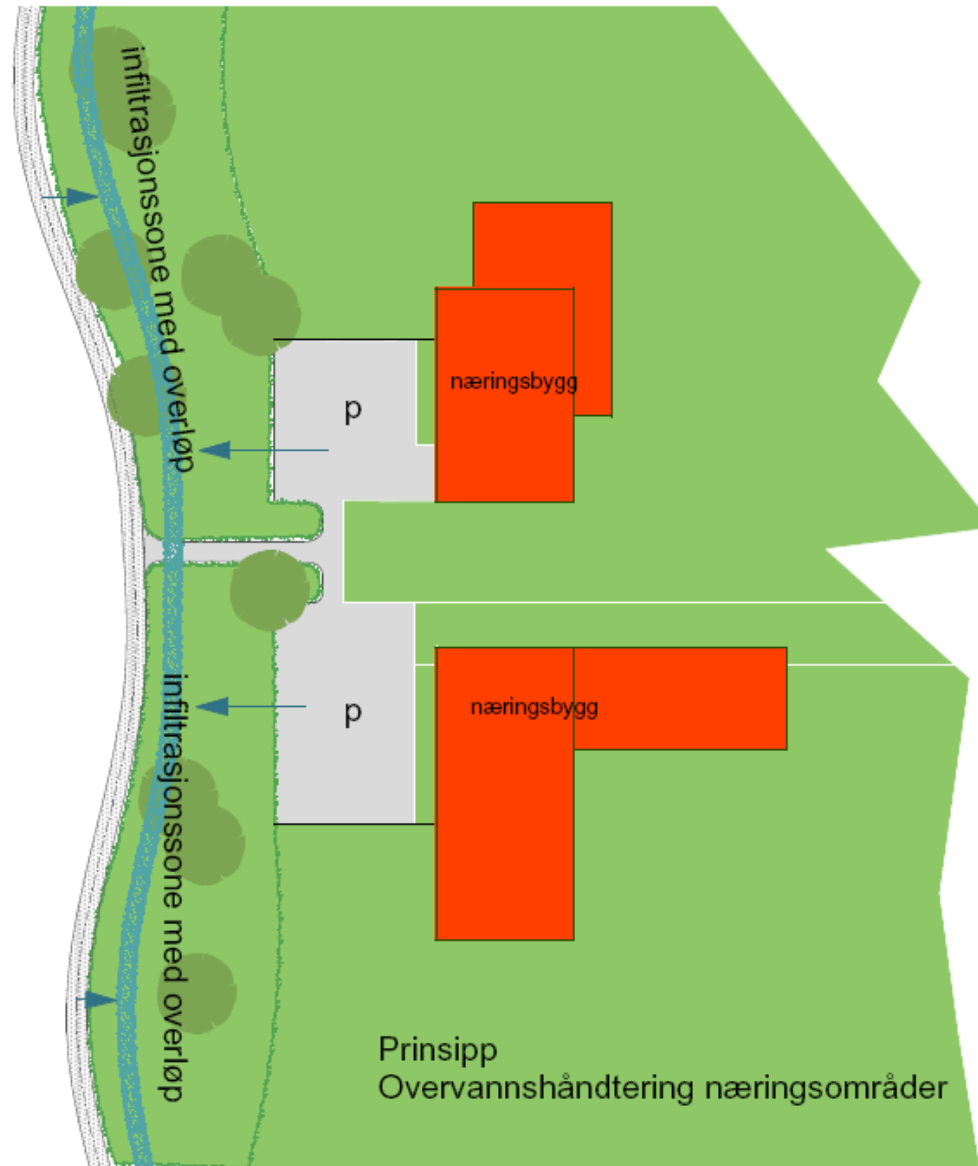
The report describes different types of waterways; primary (dark green), secondary (light green) and tertiary (red) waterways.



Principle for the management of surface water from buildings.



Principle for the management of surface water from a housing area. The water runs in an open system from the houses to a dam and on to the main river system. This helps maintain the natural groundwater level, ensuring infiltration and slowing runoff to prevent flooding.

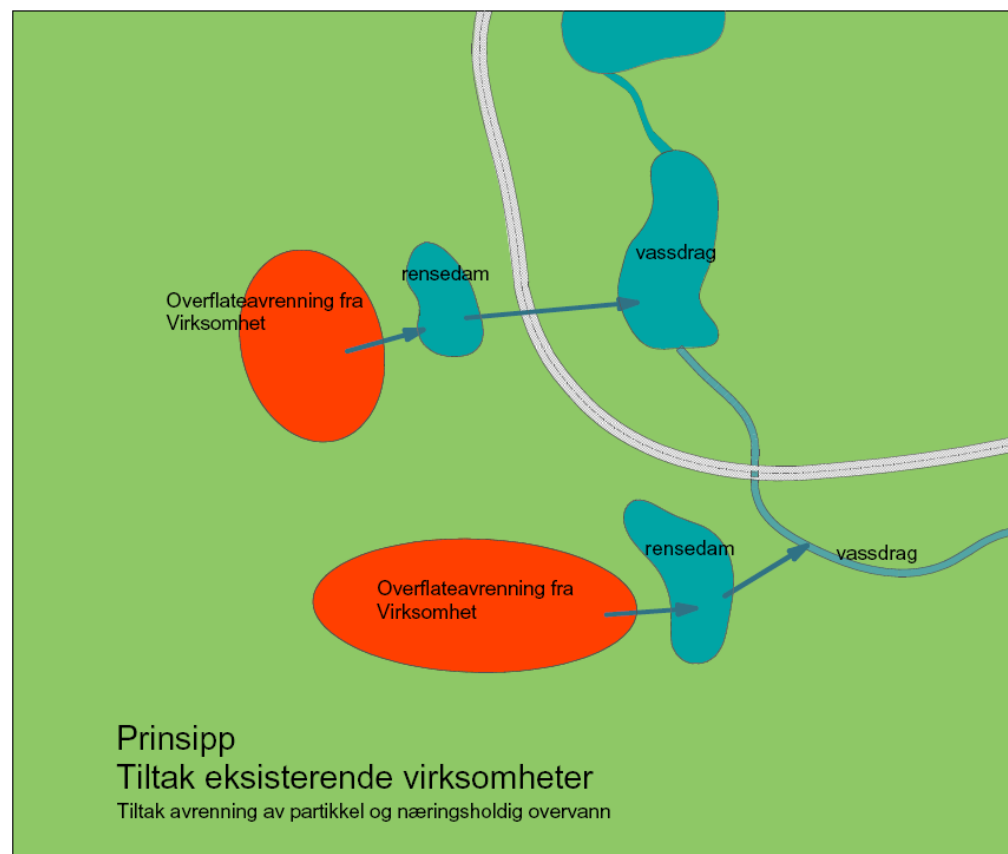


Principle for the management of surface water from an industrial area with impermeable surfaces. It is important that an infiltration zone is provided between the impermeable surfaces and the waterways. This improves the water quality and reduces the flood risk.

There are a lot of existing activities in the catchment that currently influence water quality. In order to achieve the good ecological and chemical state required by the Water Framework Directive, these ongoing activities have to be dealt with. The main facilities currently in the catchment area are:

- Quarry
- Motorsport Centre
- Horseracing track
- Roads (E39)
- Agriculture (small scale)
- Waste water plants
- Gas station

Activities from these contribute to the emission of particles, nutrients, oil and bacteria. Storm water discharges from each activity can be significantly reduced by using simple natural solutions. Such solutions would involve separating clean storm water runoff from contaminated runoff and establishing treatment systems in the form of cleaning ponds or wetlands. The design and location of these measures must be based on a detailed review of each activity.



Principle for the management of surface water from current facilities in the catchment area of the Haukås River.

2.2 Problem definition

A major challenge will be to ensure that construction work complies with comprehensive storm water plans and relevant regulations throughout the planning, municipal approval and construction phases. This is a challenge for the city's administration, planners, developers and contractors.

The water quality is not satisfactory today and has to be improved in order to ensure that the freshwater pearl mussel will be able to survive in the watercourse. This is also a prerequisite if the requirements of the EU Water Framework Directive are to be met.

2.3 Options considered

Two options were considered and both have been selected (see section 2.4).

2.4 Selected option

To prevent future flooding and improve conditions for biodiversity, the following options were selected:

- It is mandatory for all new planning projects to have a plan for storm water management.

A plan for storm water management plan ensures that new plans will not increase runoff from the site and ensure clean runoff to watercourses.

- Planning of Haukås wetland park. This planning process aimed at restoring a former wetland to ensure biodiversity, slowing runoff from Haukås watershed and provide new recreational areas for people.

2.5 Implementation

Guidelines for storm water management in the Municipality of Bergen

The master plan for the Municipality of Bergen states that it is mandatory for all plans covering a certain area to make a water and sewerage plan that includes storm water management. This plan has to be approved by the Water and Sewage Agency in the Municipality of Bergen before it is given general permission. This ensures that all plans in Bergen are quality-assured in terms of taking storm water management into account.

The document, "Guidelines for storm water management in the Municipality of Bergen", states the following:

Storm water plan

A schematic plan for storm water management should be made for all land use plans. This plan forms the basis for any further design of storm water management in the individual construction project. The schematic plan should address the requirements and priorities stated in the overall plans and the water and wastewater norm. The following should be recorded and evaluated in schematic plans:

- Topography*
- Ground conditions and vegetation*
- Areas with vegetation that are vulnerable to groundwater changes*
- Areas and recipients that are vulnerable to pollution*
- Areas that are suitable for infiltration, slowing runoff, storm water ponds, etc.*
- Natural drainage patterns*
- Existing floodways*
- Municipal sewage and storm water system*

Schematic plan must include specifications of changes in drainage patterns, floodways, an assessment of pollution levels in surface water, an assessment of the recipient, water quality, required solutions for storm water management at project level and location of

any “common areas” for storm water measures.

Regulation of the Haukås Wetland Park

The plan for the Haukås Wetland Park has not yet been implemented, because it is still under political discussion. The Directorate for Nature Management is currently considering the Haukås marshes as one of 15 locations for restoration. After a hearing, 10 of the sites will be selected for restoration. They will receive substantial financial support. If the Haukås Wetland Park is selected as a potential restoration site, this will hopefully accelerate the political process.

The Water Framework Directive and the Nature Diversity Act

The provisions of the EU Water Framework Directive and the Nature Diversity Act are currently being implemented in Norway.

2.6 Performance and effects of selected options

The city’s master plan and its regulations for watercourses and water supply, sewerage and

storm water management have been in use for many years. Guidelines for storm water management in the Municipality of Bergen provide further details of water supply, sewerage and storm water management. If these rules and guidelines are followed, this will largely ensure biodiversity and sustainable storm water management in the watercourse.

If the Haukås Wetland Park becomes a reality, its restoration will help to ensure sustainable storm water management and an improved habitat for the endangered freshwater pearl mussel in the river.

The provisions of the EU Water Framework Directive and the Nature Diversity Act are currently being implemented in Norway. The results of these measures are not yet apparent. Hopefully they will provide the municipality with the right apparatus with which to improve water quality sufficiently to ensure the biological diversity of the Haukås watershed in general, and the survival of the freshwater pearl mussel in particular.

2.7 Difficulties encountered

Many plans have been made for the catchment area of the Haukås watercourse. If

all these plans had been put into practice and the intentions followed up, the results for storm water treatment and biological diversity would have been satisfactory. The problem has been that the approved plans have not always been followed during the implementation phase of projects. One of the results of this has been the destruction of the 20 metre buffer zone along the river in some development projects.



This was originally an area regulated as a nature conservation area. A land reclamation site was located right beside the small river and this resulted in the destruction of the buffer zone along the waterway.

Regulation of the Haukås wetland park was submitted for public review in 2009. The plan has been under political discussion since 2009. Because of disputes over what the Haukås marshes area should be used for, there has not yet been any political decision. Hopefully the nomination by the Directorate for Nature Management of the Haukås marshes as a potential restoration site will speed up the process again.

There are currently many activities in the catchment area of the Haukås watershed that contribute to the pollution of the river, especially particulate pollution. It is difficult to find laws and regulations that make it possible to address and correct the runoff from these activities. The municipality of Bergen is still working to find solutions to these problems to ensure a satisfactory water quality.

3 Review

3.1 Discussion

Many excellent plans and reports have been prepared for the Haukås watershed, including:

- Preparations for the Haukås Wetland Park
- The Haukås watershed - Future development and storm water management
- Population status of the freshwater pearl mussel in the Haukås watershed

If adopted plans, regulations and recommendations had been followed up, this would have safeguarded biodiversity and sustainable storm water management in the Haukås watercourse. Although the catchment area of the Haukås watershed is small, there have been a number of major development projects in recent years. The projects have been carried out at high speed, which has made it difficult to supervise the projects. The result of this has been that some of the major development projects have not followed the approved plans, which in turn has led to the destruction of buffer zones and an adverse effect on storm water management.

3.2 Learning points

Good planning is essential if the desired effects of storm water management and biodiversity are to be achieved. But if the plans are not followed in the implementation phase, a good plan has little or no value.

3.3 Conclusions

Recent building activities in the Haukås watershed illustrate the fact that developers and contractors have to be closely monitored and supervised to ensure that the approved plans are followed.

Planning of Wetland Park has taken a long time. In cities where scarcity of land begins to emerge, there are many different interests that must be considered before a final decision of the use of the land is determined. This has delayed the process and postponed the final decision. A new overall municipal plan is now being prepared and will probably determine what the area will be used for.

3.4 Recommendations

The key to success is to have good plans, and for these to be followed up by the responsible authority throughout every stage, from planning to project completion. This will

ensure that due care is taken to safeguard storm water management and biodiversity.

Sources

The Haukås watershed. Future development and storm water management (2006).
Guidelines for surface water management, The City of Bergen
Regulation of the Haukås Wetland Park (2009).
The freshwater pearl mussel in the Haukås River. Population status, reproduction and water quality (2004).
Contaminants in the Haukås watershed 2005–2006 (2006)