MUNICIPALITY OF REYKJANESBÆR

DETAILED PLAN FOR STORM WATER MANAGEMENT – ASBRÙ

RESIDENTIAL PLOTS, SCHOOL, PUBLIC PARK, GRÆNÁSBRAUT AND SKÓGARBRAUT

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CONTENTS

1 Introduction

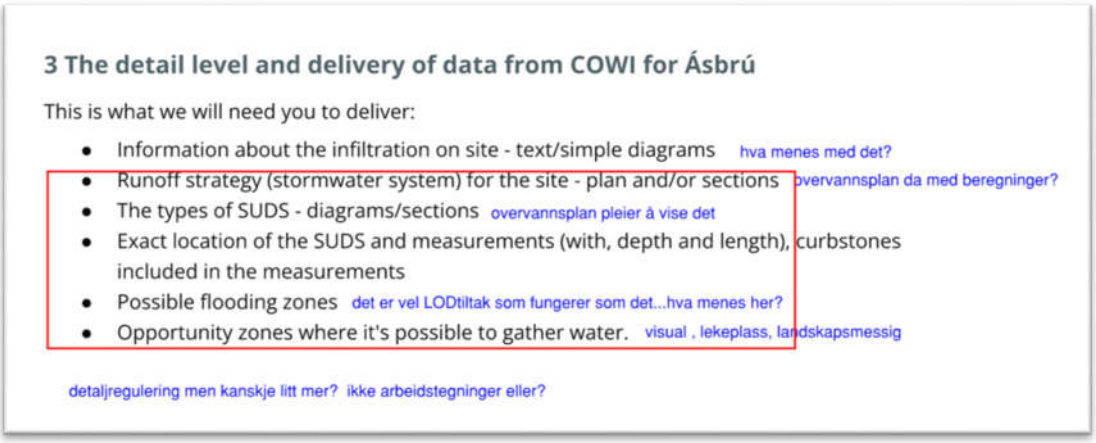
In 2019 Alta has elaborated a masterplan for a residential neighborhood in Ásbrú (Municipality of Reykjanesbær). In that occasion COWI was asked to participate to this development by elaborating a sustainable stormwater strategy and main solutions (COWI, 2019).

The masterplan has now moved on to the next phase and COWI was asked to elaborate detailed stormwater plan for several areas of interest.
A more detailed stormwater strategi has therefore been applied to these specific sites/object:

- 3 residential plots
- the school plot and public park
- Grænásbraut and Skógarbraut (the main road system).

This report describes xxx.

Many analyses, research, mapping and stormwater principles have already been elaborated during the previous phase of the development plan for Ásbrú. These have built up a knowledge that is essential to understand the whole picture of the site, but also give the right tools to move into a detailed plan. This is the reason why some of that knowledge is again reported in this document.



2 The development plan

Alta has elaborated a proposal for local planning for these areas of interest, which is showed in Figure 1 and Figure 2. The main features for each sites/object can be summarized as follow:

- *Residential plots*
  These plots will be developed with several residential blocks with garage basements. Outdoor areas will include green areas, but also paved areas for both parking and car access.
- *School and park plot*
  The school plot will include a main building (ca. 23 700 m²) located on the lowest part of the plot and along the north side, but also a secondary building (ca. 4 300 m²) on the highest part of the plot, towards Grænásbraut.

Development and design of this plot will be defined via an architectural competition. The buildings shown in the figure below are therefore only illustrative.

- *Grænásbraut and Skógarbraut*
  Roads are designed with walking and bicycle path on both sides of the road, where green structure divides pedestrians' and cyclists' path from trafficked areas.

New buildings are in the illustrations below showed with flat and green roofs. It is not yet certain whether this is applicable for the area, but roof design will affect the way roof runoff is handled. General assessments are described in chapter 4.2.

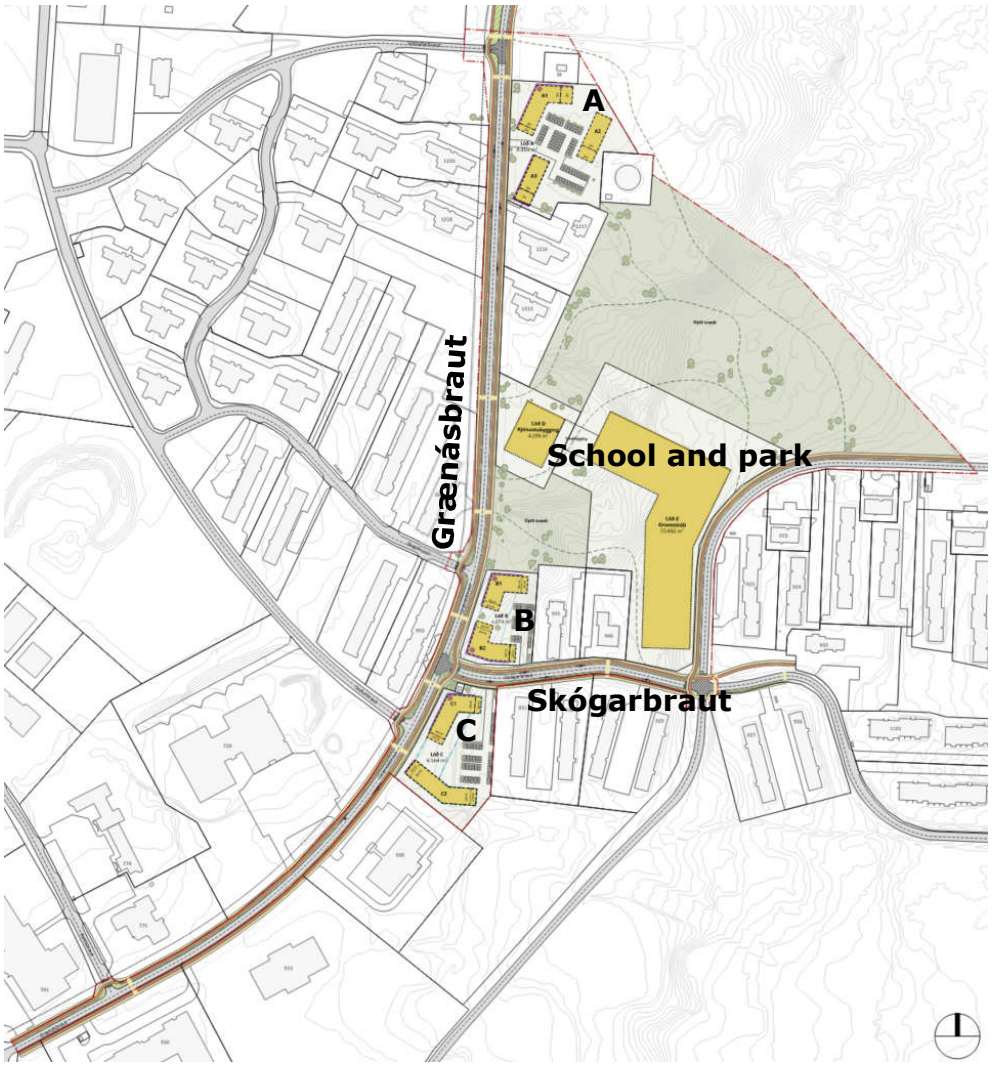


Figure 1: Above: overview of the plan proposal. Bottom left: residential site A. Bottom middle: residential site B. Bottom right: residential site C. (Alta, 2022)

Figure 2: Perspective of the site plan. (Alta, 2022)

The overall goals of the detail plan are:

- Create a place where people of all ages and backgrounds can gather (public park and school) and hopefully it will also be an attraction for the rest of the town.
- The school with its playground is meant to represent a multi-use area to build up a stronger community in Ásbrú, but it also represents a unique attraction area for the town. The public park will create a unique outdoor place by among others introducing stormwater management as an opportunity to play with water, create wind shelter and good walking paths.
- The goal for the streets is to increase tra c safety, give access to everyone (pedestrians, cyclists, and drivers), create more attractive intersections and street experience, create good connections to the surrounding area, but also contribute to stormwater management.

3 Grunnlag/knowledges

3.1 Guidelines for stormwater management

Since Reykjanesbær municipality haved not developed own guidelines on stormwater management, COWI has in 2019 elaborated a general strategy for stormwater management for Ásbrú neighbourhood (COWI, 2019).
That strategy emphasised the importance to change approach concerning stormwater management: from traditional and underground systems to climate-adapted and sustainable systems. This follows the principles described by Norsk Vann, where the 3-step strategy has the main focus:

- Step 1: infiltrate minor rainfall by diverting runoff from impervious surfaces to green areas.
- Step 2: delay and retain greater rainfall by establishing retention basins/solutions by shaping the terrain.
- Step 3: ensure safe floodways for extreme rainfall.

The 3-step strategy is also showed in Figure 3.

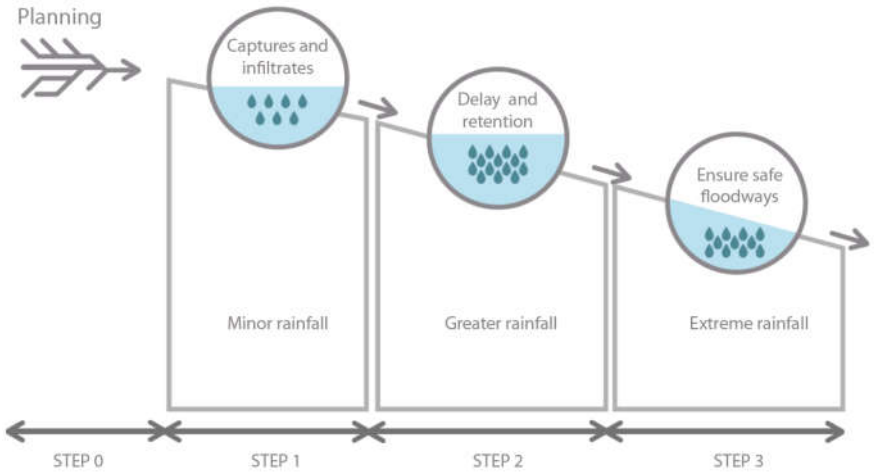


Figure 3: The 3-step strategy for a sustainable stormwater management according to Norsk Vann.

Guidelines for stormwater management for several Norwegian municipalities have required until now 20-year or more as the dimensioning return period for retention (step 2). Oslo municipality, which is one of the most future-oriented municipality concerned stormwater management, has now implemented its strategy by reducing the dimensioning return period for retention to 5-year.

Formulering her er avhengig av hva Erik finner ut av beregninger (trenger vi fordrøyning på tomtene?)

3.2 Infiltration

In November 2021 the municipality of Reykjanesbær has carried out an infiltration test in different areas of the development sites to investigate and document the hydraulic conductivity of the soil. Hydraulic conductivity is the

sinking rate of the soil that determinate how fast the water infiltrate into the soil.
Infiltration test has been carried out according to the procedure described in Attachment 1.

The results of the infiltration test are shown in Table 1 and Figure 4. Red[SOÅ1] dots and cells indicate no infiltration, blue indicate a medium infiltration rate, light blue a high infiltration rate and green very high infiltration rate.
Here it is possible to see that most of the points do not drain. This is presumably because the bedrock is just 50 cm under the top soil.
The very high permeability in point nr. 2 is due to a manmade stony landfill. This landfill drains supposedly the runoff further to an existing floodway on the other side of the road.

Table 1: Results from the infiltration test.

Point nr.	Measured time to infiltrate 30 cm of water based on a predefined pit (30x30 cm and H=30cm)	Infiltration rate
1	It does not drain	0
2	It drains all water (10 cm in 29 sec.)	Very high
3	It does not drain	0
4	It does not drain	0
5	It does not drain	0
6	29 min. and 39 sec.	High
7	It does not drain	0
8	1 hour	Medium

Figure 4: Results and locations for the infiltration test.

Om det kun blir transport, vil infiltrasjon ikke påvirke beregniner ?? vi må kunne si noe her om hvordan vi bruker infiltrasjon videre.[SR2]

3.3 Today's waterways

In the previous phase, a registration of the existing stormwater system was carried out. Registration included all those elements, either existing or that had to be improved to assure continuity in the runoff system. Continuity was indeed described in the previous phase as a prerequisite to assure a safe and well working system.

That previous mapping is shown in Figure 5~~Figure 4~~, but some more registration has been conducted by the sites for the detailed plan to have a more accurate overview of the existing stormwater system.

Some of those registered stormwater elements were for example swales, terrain depression, cross drains, overflow, etc..

Mapping of existing swales and terrain depression show basically where the waterways lie and flow in the terrain today. Those are therefore important as they give an indication of where new buildings and infrastructure should be located/placed in the plot to avoid water damages.

In Figure 5~~Figure 4~~ it's for example possible to see that bigger waterways from upper catchments, are collecting along Grænásbraut. All the plots investigated for the detailed plan lie along this road, on the downstream side. This means that future road system has to either maintain or provide safe floodways to safeguard property on the downstream side of the that road.

Similarly residential plot B and C lies upstream others existing residential plots. Plot B and C need therefore to be developed in a way that runoff from those plots do not affect the properties below.

Må også si noe om drenslinje gjennom skole: I dag renner forbi bolig, burde kanskje gjøres om til en sikrere måte (se overvannsplan)

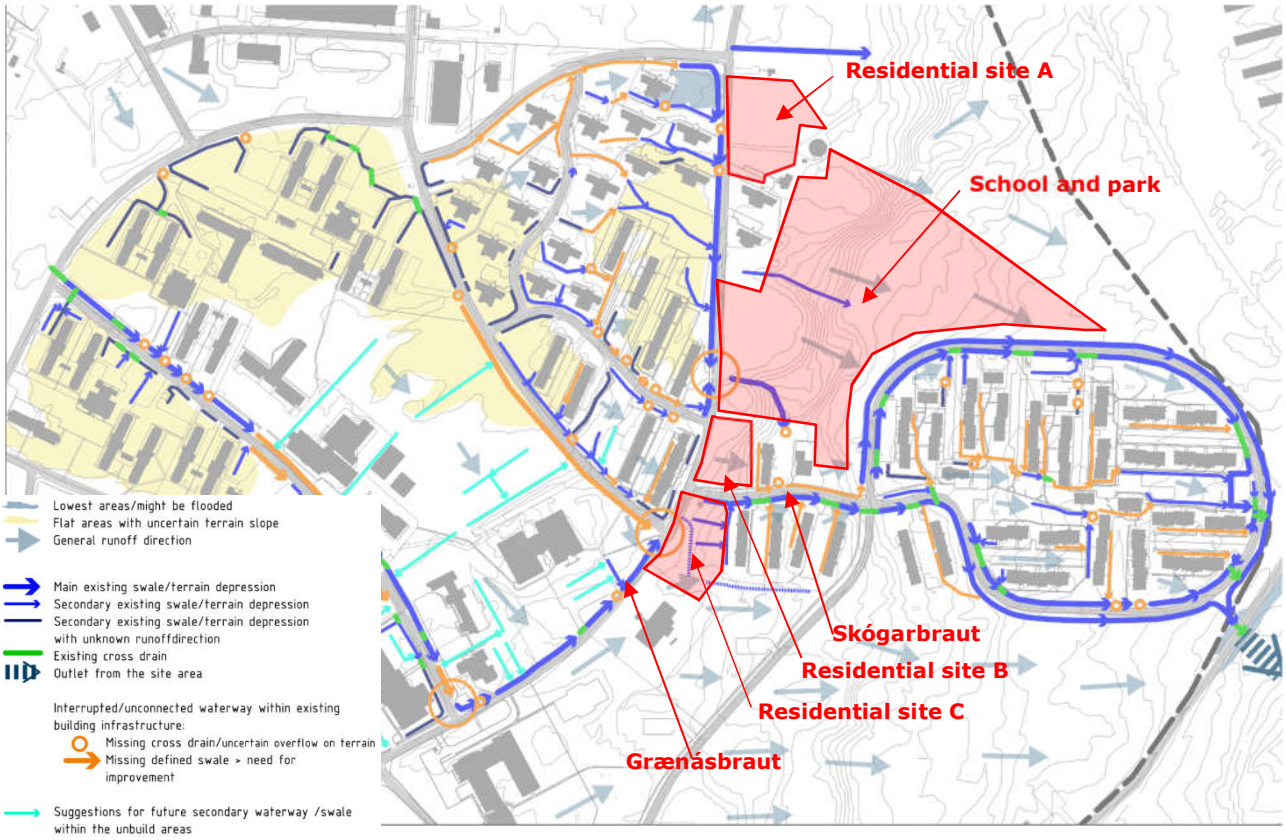


Figure 5: Previous registration of those stormwater elements, either existing or that had to be improved to assure continuity in the runoff system. (COWI, 2019) Actual sites/object for this detailed phase are indicated with red lines.

4 Stormwater management detailed plan

4.1 Main principles

The future development in the Ásbrú area should rely on the main principles described in the sustainable stormwater strategy (COWI, 2019).
Understanding of those principles in this detailed phase is essential to plan the plots in a sustainable and appropriate way that takes care of the natural elements in the landscape (slopes, sunken area, waterways, etc.,), the context, the environment, and last, but not least safeguards the investment costs.

Spatial planning of the plots has therefore to be carried out according to a sequence of preliminary runoff requirements[SR3] first.
The runoff requirements to be followed are:

1 Existing waterways have to be investigated as they define where the floodwater is lead in and out of the plot. Inlet points are important as nothing should be planned here that blocks waterflow. Blocked waterways can lead to unpredictable new waterways and therefore to eventually water damages.
Same principle has to be applied for the outlet points: exceeding waterflow from the plot has to be lead outside the plot on a safe and freeway. Again, to ensure a safe discharge of exceeding waterflow from the plot.

2 Existing waterways also define where the buildings and main infrastructure are more suitable to be placed in the plot. For example, it is recommended to place buildings on sag curves or higher area in the plot. This to avoid eventually water damages and reduce risk of flooding.

3 Understanding of the main slope direction of the terrain gives an indication of where the water will naturally flow to since the runoff follows the terrain elevation gradient. This helps to understand where SUDS have to be placed in the plot. For example, SUDs will have no function if located on sag curves or on the highest area of the plot. It is therefore suggested to establish SUDs on the lowest parts of the property. In this case the SUDs catch a greater runoff, and consequently reduce the risk of damages downstream.

4 Existing sunken areas indicate where the runoff naturally would flow to and be collected. These areas can for example be maintained as collection and retention areas for runoff also after development. It is in general recommended to avoid locating an impervious area/building in a sunken area compared to the main terrain as this would be a "trapped" area for runoff. This situation increases the risk of flooding and possible water damage as runoff cannot be directed out of the area. Floodways have always to be secured.

5 New or adapted terrain has to secure a continue slope through and along the whole stormwater system. Interruptions or deviations of this slope principle, such as wrong fall direction or wrong elevation, can increase flooding and water damages.

These principles mainly explain that site's topography is fundamental to secure a sustainable and climate/stormwater management oriented spatial planning.

After[SOÅ4] those preliminary principles, the stormwater system can be planned according to the following:

- "Nature alike": open and local;
- SUDs are established as close to the runoff source as possible (such as impervious surfaces: roofs, parking lots, etc.);
- Runoff from impervious surfaces should be diverted and delayed on terrain;
- Sag curves on pervious surfaces: impervious surfaces, like asphalt or concrete, can't infiltrate. Sag curves should be established within the green structure;
- Crest curves on green surfaces: pervious surfaces have a high infiltration capacity. Crest curves should be established on impervious surfaces;
- The stormwater system should be established as a continuous system, where all the stormwater elements are connected either by a cross drain or an overflow on the surface (assured by a sag curve). This to guarantee a well working and safe system for both extreme rainfall and/or winter season when hydraulic conductivity is significantly reduced as a consequence of frozen soil cover;

- Cross drain in between two SUDs on the bottom of the SUD: to ensure infiltration and retention, the cross drain should be established higher than the bottom of the SUD.
- New terrain design should ensure safe discharge of floodwater in extreme weather and/or winter season;
- Runoff from the development plan should not cause flooding problems downstream;
- Runoff from the development site should not worsen the groundwater condition;
- A coherent swale system consisted by a continuous slope gradient, should be established along the roads to assure a controlled and safe transportation of the exceeding runoff[1];
- Curbs along roadways: curbs hinder the road runoff to flow freely into the swales. It is therefore recommended to either avoid curbs or where the use of curbs is needed, to create openings/passages through the curbs to direct runoff to swales;
- Polluted runoff, i.e. from the road system, has to infiltrate through a green/vegetated surface to archive pollutant removal;
  Man-holes can be implemented, but these should be installed higher than the maximum water level in the SUDs. Infiltration through the soil cover and retention are the main principles. "Man-holes" should represent just an "emergency" overflow in case of extreme rainfall.

Applications of preliminary requirements and stormwater principles are given in the figures below. Figure 6 is applicable for residential areas, while Figure 7 for road system.

[1] *Exceeding runoff: is the water that is not infiltrated and/or retained because the precipitation intensity is greater than the hydraulic conductivity (extreme rainfall), which means risk for overflowing.*

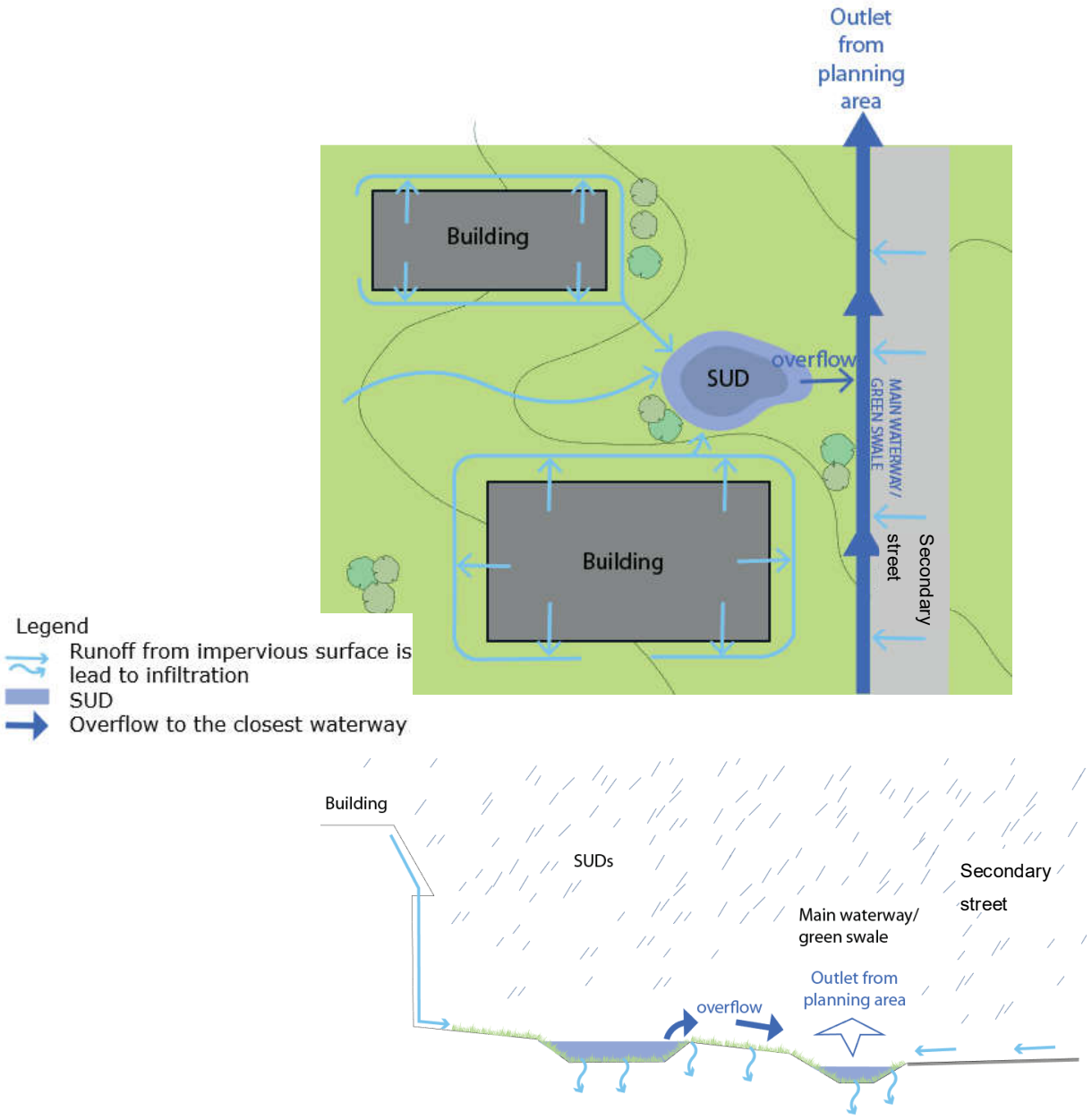


Figure 6: Topography's / elevation's hierarchy principles for a sustainable and climate/stormwater management oriented spatial planning. Applied on a residential area.

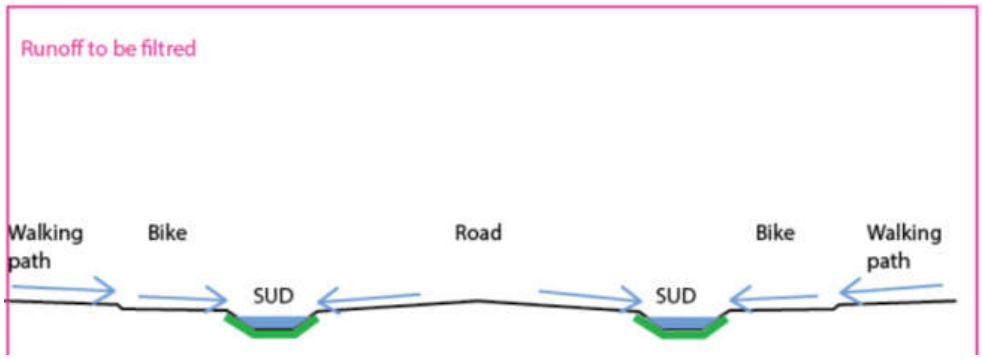


Figure 7: FIGUREN MÅ OPPDATERES!!! Elevation's hierarchy for road system f to safeguard sustainable stormwater management and ensure floodways.

4.1.1 Pollution[SR5]

During the last years there has been a growing interest about stormwater management. Not just in terms of amount of stormwater (water quantity), but also in terms of pollutants in the surface water (water quality).
This is because in urban areas the surface water is often contaminated. Roads, industry and other human activities are often the sources of this pollution that is transported with the surface water. Typical pollutants include a wide range of dissolved and particulate compounds such as heavy metals, organic pollutants, microplastics, oil, salt, etc.
Based on Norwegian standard the need to clean the discharge of stormwater depends on the amount of traffic and the recipient's vulnerability. Some Studies[SR6][SOÅ7] have also demonstrate that in smaller urban contexts, by leading polluted/road runoff to permeable green surfaces (stage 1 of the 3-step strategy) it was achieved a sufficient level of water purification.

The sites chosen for the detailed stormwater plan include three residential plots, the school and park lot and two roads. The main source of pollutant will then be related to the road system and parking lots.
According to the stormwater strategy, runoff from impervious area has to be leaded to green area for infiltration. The new road system and the new parking lots have then to be planned so that runoff flows to a green structure, as showed in the principle in **Error! Reference source not found.**~~Figure 6~~.
According to xxx the green structure needs then to be designed to handle step 1. In this way, a satisfactory cleaning level will be achieved.

Fra referater:

- Risk of pollution in water that is collected around school or in the park
- Safaty concerns

4.2 Detailed plan for each area of interest

Litt avhengig av hva Erik finner ut med beregninger, men her skal det forklares at det er lagt opp til transport!

Må si noe om grønne tak!

Based on that and the principles described in chapter 4.1 and 4.1.1, it has been elaborated a detailed plan for sustainable stormwater management for each site/object.

Residential site A-B and C

Figure 8: Detailed stormwater plan for residential site A.

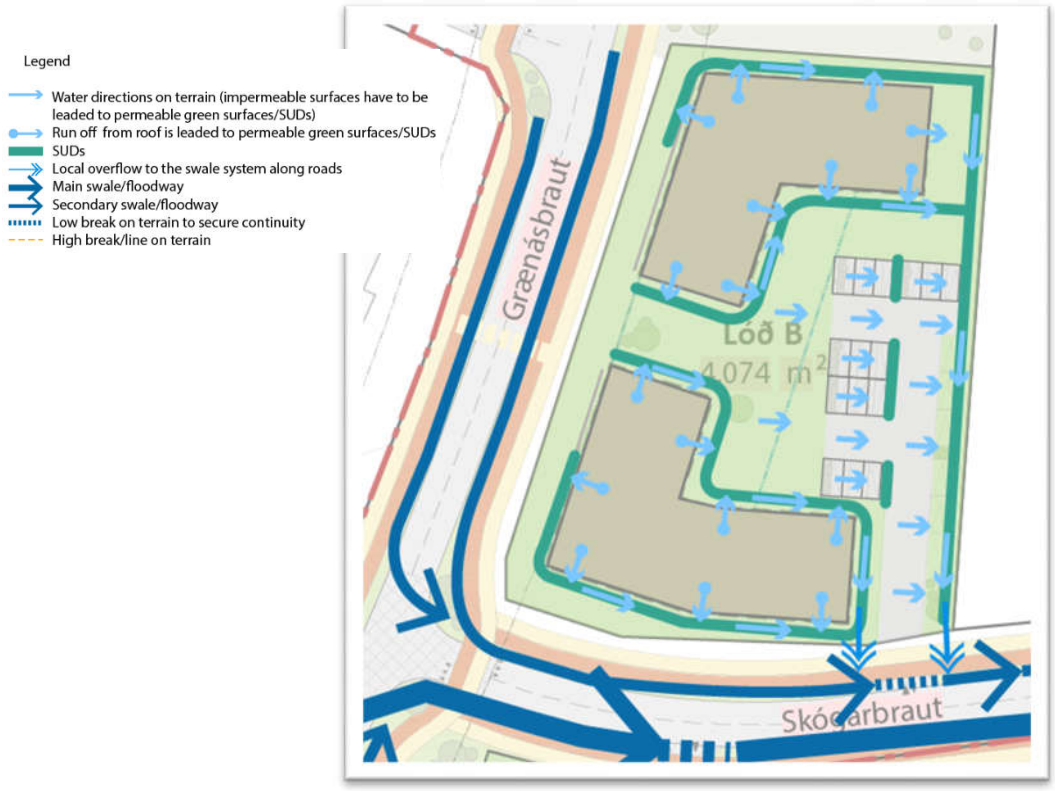


Figure 9: Detailed stormwater plan for residential site B.

Figure 10: Detailed stormwater plan for residential site C.

School and public park

Figure 11: Detailed stormwater plan for school plot and public park.

Grænásbraut and Skógarbraut

4.2.1 Possible SUDs

THORA vil ikke ha et "foredrag" om SUDs, men hun ønsker at det skal gis info om størrelse

Tenker da at her nevnes det bare kort om de ulike mulighetene, mens minimum størrelse kan gis I dimensjoneringskapittel, men må nok avvente hva Erik finner ut.

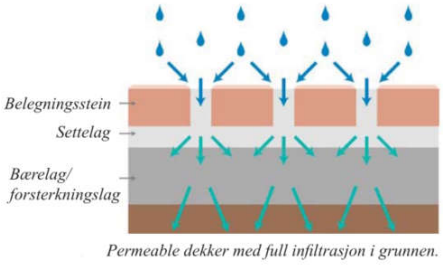
In the previous phase, by visiting the site, it was registered that stormwater solutions were already established in the Ásbrú area. These SUDs were mainly based on a "nature like approach": runoff from hard surfaces such as roofs and paved areas, is directed to green and lower levels areas for infiltration. In case of heavier rain, the runoff was led further to green swales along the road infrastructure and transported further outside the Ásbrú area.
Typology of SUDs was though quite limited by just green sunken areas.
The development of the Ásbrú area gives then the opportunity to introduce more differentiated, climate- and biodiversity-oriented solutions.

Possible SUDs to apply in Ásbrú could then be:

- Permeable surfaces, such as gravel, sand, paving stones, reinforced grass, etc., but also simply grassed areas as used today;
- Green roof, both extensive (with sedum/light construction) and intensive (rood garden/tick soil layer);
- Infiltration and retention areas, such as rain garden, multifunctional playground, etc.,;
- Swales and ditches;
-

Construction layers for each type of SUDs and inspiration pictures from existing project are shown in table xx.

Table 2: [SR8][SOÅ9]

		Construction layers*	**Example in an existing project**	**Function**
Permeable surfaces	Gravel Sand Paving stones	 *Permeable dekker med full infiltrasjon i grunnen.* Bases on just infiltration into the ground. *(Illustration: Vann- og avløpsetaten og Bymiljøetaten, Oslo municipality.)*	 Example of paving stone and gravel/sand by Sandaker plass, Oslo, Norway. (*Foto: Simona Robba)*	- Infiltrating runoff into groundwater - Controlling and reducing of the total runoff during heavier rainfall (retention effect)
	Reinforced grass			
	Grass			

**Be aware that construction layer might be adjusted according to local conditions.*

These SUDs typology all contribute to stormwater management by:

- Infiltrating runoff into groundwater;
- Controlling and reducing of the total runoff during heavier rainfall (retention effect);
- Reducing risk for damages due to exceeding runoff during extreme rainfall.

5 Calculations (ERIK)

Si noe om det er samme data som før, eller ny. I så fall hvilken.

5.1 Meteriological data

5.2 Dimensioning

Usikker litt på dette kap. Må se på det etter beregninger. Vi burde I alle fall si noe om dybde på grøftene

Fra referatet:
Alpmg the roads the delivery will be more detalied.

- Min. width and depth of SUDs along roads, incl. curbstones
- Types of SUDS that can be used. General diagrams showing principles, not detailed design.

6 Summarizing

7 References and Attachments

7.1 References

Alta. (2022). *Tillaga að deiliskipulagi - Skóla- og samkomusvæði á Ásbrú.*
COWI. (2019). *SUDs - Asbru. Sustainable stormwater strategy.* Oslo.

7.2 Attachments

6 Infiltration test for blue/green stormwater management. Alta&COWI, 2021.

7 Ásbrú - Stormwater Detailed plan. COWI, 2022.

8