Public report on the 1st MUSTBE international event and five concepts for NBS pilots improved

Riga, Latvia

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CONTENT

1. INTRODUCTION

MUSTBE is an EU and Central Baltic Programme funded project with the aim to develop multidimensional storm water treatment solutions in urban areas for cleaner Baltic Sea. The project involves seven pilot sites in four countries. In MUSTBE altogether eight partners from Estonia, Finland, Latvia, and Sweden collaborate to tackle the common territorial challenge on reducing harmful substances from reaching the Baltic Sea.

The preliminary ideas of the seven NBS[1] pilot concepts were further developed and improved at an event held in Riga late-October 2023. The 2-days international workshop, ”*Best practices of nature-based solutions for urban runoff management and treatment and pilots in Tallinn, Viimsi, Pori, Riga, and Söderhamn*”, was organized by Riga Technical University in cooperation with the other project partners.

The event served as a fruitful platform for sharing the expertise of the MUSTBE consortium members and international experts on the best practices of NBSs. Furthermore, the workshops gave good input into and insight into the process of further developing the pilot concepts e.g. for feasibility studies and technical design, conceptualization of site specific NBSs, SuDS[2] design considering the quantity and quality of runoff, improvement of site biodiversity – and other priority areas.

More than 50 participants from Latvia, Estonia, Finland, Sweden, and the Netherlands participated in the workshops. Approximately 46% of the participants represented different sectoral departments of municipalities, including several representatives from each project partner municipality, 30% universities, 14% infrastructure providers, 8% companies involved in water management, and one participant represented Latvia water and wastewater works association.

At the first workshop day four international experts not involved in project partnership and two experts from the project partner universities presented their accumulated knowledge on NBS for urban runoff management and treatment: *Kelsey Flanagan*, Associate Senior Lecturer at the Lulea University of Technology Urban Water engineering group, made presentation on organic contaminants in stormwater green infrastructures including treatment performance, fate, and implications for multifunctionality. *Floris Cornelis Boogaard*, Professor at the Hanze University of Applied Sciences presented several examples of recently implemented NBSs in Europe and web sources of such solutions. *Olof Jonasson*, stormwater specialist, consultant at Tyréns Sverige AB, and Research Fellow at the University of Technology Sydney presented his extensive experience on tradeoffs among areas to be considered in development, implementation, and maintenance of NBS stormwater systems. *Nils Kändler*, Researcher at Urban Water Systems research group of TalTech presented knowledge areas, catchment scale analysis, modelling tool for analysis, multidimensional approach, overall environmental impact, and smartening of NBS solutions. *Margit Kõiv-Vainik*, associate professor at the University of Tartu presented insights for several stormwater management projects she has been involved. *Jurijs Kondratenko*, Research Assistant at the Riga Technical University presented Latvian experience with development and implementation of NBSs. After each of the presentation questions, answers and discussions took place.

[1] NBS = nature-based solution
[2] SuDS = sustainable drainage system

In addition to the expert presentations, the two-day event included mini workshops focusing on each of the pilot site. Participants were split up into four open experience-sharing co-creation groups to improve the concepts one by one: each working group was led by one international expert outside the MUSTBE partnership and moderated by the representative of the pilot site. After the ideation session the ideas were presented to the whole audience.

The following chapters provide a summary of the concepts and the resulted ideas for concept improvements gathered during the Riga event.

2. Viimsi site concept

In Viimsi, Haabneeme parish is situated next off to a cliff, which is known to emit large amounts of groundwater. The emitted water is directed to stormwater pipeline and conveyed to the Baltic Sea. Because of the large volume of groundwater, the SW systems are constantly surcharged. This in turn means that during heavy rainfall or snowmelt the area is highly threatened by flooding.

During flood events hazardous substances are flushed from the street area to the SW system. Lubja cliff is adjacent to Randvere street which has heavy traffic and pollutants coming from vehicles. Water from the catchment area in question flows directly to the Baltic Sea.

To meet the MUSTBE challenges, a smart nature-based SW retention and treatment solution will be built into Randvere tee 21 plot owned by the municipality (size: 0.35 ha). The main SW collector of the catchment crosses the area. Therefore, it is the best location to reduce flooding problem and to clean groundwater/stormwater by building a smart nature-based SW system in key place(s) in the catchment. Smart nature-based SW systems can slow down flowrates which in turn would mean that during heavy rain or snowmelt period water would be gathered up in NBS to minimize peak flowrates that threaten existing stormwater systems capacity. Nature-based solution can also clean water, this in turn would prevent hazardous substances reaching the Baltic Sea.

Accordingly, the planned solution will contain bonds and rain gardens for slowing down, treating and reducing downstream flow volumes. Also, to demonstrate how stormwater could be re-used up in urban environment a rainwater-based fountain will be built. Eventually, the area will be turned into a small SW park that will contain different rainwater-based attractions to raise awareness of urban SW runoff and quality. Outflows from NBS will be controlled in real time, automatic water quality sensors will be installed to ensure efficient SW treatment.

In the workshops of the meeting in Riga, the focus was on the complexity of the system to be built in the Viimsi pilot area and how to improve the SW quality in the ditch. During the discussions it was pointed out when designing storm water system solutions, it is important to pay attention to the maintenance cost of the facility. It is reasonable to assess the complexity of the system in the design phase and consider how much system maintenance will cost and whether it is reasonable. Over-engineering must be avoided. Also, it is important to assess and plan the preservation of the system over the winter.

When reusing storm water for other purposes, attention must be paid to the quality of the water and the treatment system. The use of nature-based solutions is complicated by the unsuitability of conventional systems for storm water with a low level of purification.

3. Tallinn site concept

The concept of the city of Tallinn involves a plan to build a pilot NBS and real-time monitoring/regulating system to Tondimõisa park. The catchment area covers an area of about 37 ha and it includes dense urban areas with rooftops, streets, industrial, and commercial areas, for example. It is also the area of the highest traffic load in Tallinn.

Initial plan demonstrated in the workshop was:

- Online regulated valve system on Tammsaare Street to regulate flows
- Online monitoring system for water quality parameters
- Sand-oil trap
- NBS – first area
- Culverts between two areas
- NBS – second area
- Online monitored water quality system
- Ouflow to Nõmme street stormwater sewerage

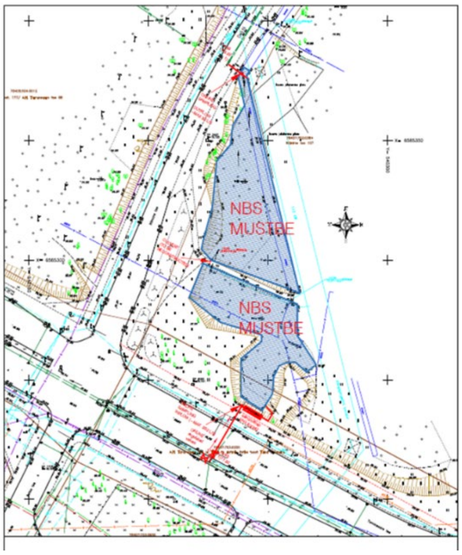

Figure 1. Map of the Tallinn pilot site.

Challenges and restrictions related to the concept:

1. The first part of NBS is about 1 meter higher than the second part.
2. Small diameter of the stormwater pipeline in Nõmme Street (De315)
3. Environmental issues:
    - To ensure the preservation of high greenery of value classes I and II and, if possible, the preservation of high greenery of value class III.
    - Nesting place of goshawk (protected bird).
    - Tree felling and the planned construction work must be carried out during the non-nesting time of birds, including barn owls, from August 1 to January 31.

- The NBS is needed for buffering runoffs as well as for purification.

Questions for experts and brainstormers

- Aim is to direct the first runoff of stormwater from road to NBS. The NBS is needed for buffering street runoff as well as for purification.
    - Do we need sand oil trap before NBS for high street runoff?
    - Best practices to achieve both goals?
- What water quality parameters should be online monitored that give the best understanding of water quality?
- What plants are the best for our conditions and requirements (help purification)?

Ideas developed in the workshop

- There is no need for oil-sand trap before NBS, but the first section of NBS should be designed for sedimentation and be easy to clean and accessible with machinery.
- There are three water quality parameters that can easily be monitored online and give good information of water quality: temperature, conductivity, and TSS.
- Alders (that already grow at the site) are great for water cleaning and tolerate flooding. Also reed was recommended.
- As one crucial aspect is the time that water spends in the NBS, there might be a need for online-flow regulation in inflow and also in outflow.
- High greenery (alders) have to be preserved and therefore the area cannot be deepened, but nice flow delaying ditches can be created.
- Fun element for local inhabitants could be “smart flower“ opening up only when water in NBS outlet is clean.

4. Pori site concepts

4.1 Urban Treetank, Central square (Keskusaukio)

Currently, storm water runoff from the paved area and the street is discharged directly into wells, from where it is routed to the storm water drainage system. The catchment area is small, but storm water from a busy street and a popular parking lot is likely to carry pollutants.

The pilot project will replace the asphalt surface of the car park, while changing the surface levelling. In addition, tree planting will be replaced, and the levelling will be used to direct storm water runoff to the planting areas.

Figure 2 Air view of the Pori Central Square

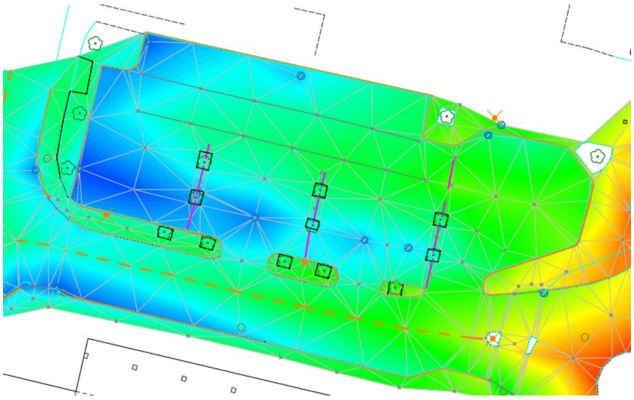

Figure 3 Figure 2 Map of the Pori Central Square and placement of the tree tanks.

Ideas developed in the workshop

- The asphalt paving of the parking lot should be regraded to direct stormwater runoff to tree planting areas.
- The risks of using biochar were warned. There is little research on the benefits of biochar for stormwater treatment. Some other growing medium and stormwater filtration material should be considered.
- Infiltration of stormwater with drainage gravel or sand of equivalent coarseness (filter sand?).
- The use of coarse crushed stone used in log tree foundations should be considered and analysed, if it would work.
- Cassette solution might provide more storage volume.
- The site could be used to test the success of different tree species in the face of stormwater challenges. Challenges include long dry periods and flooding periods when there is a lot of water. In addition, pollutants from asphalt surfaces and car tyres can be harmful to trees.

- A particularly stunning, cool stormwater structure would be a good eye-catcher.
- For example, an artificial tree (metal frame with a vine growing along it?) or something similar.
- Tree planting areas should be established well below the parking lot (about 10 cm) to allow for efficient water diversion.
- Measurement based on individual analyses and flow measurements from which load reductions for stormwater leaving the site can be calculated.
- the underlying soils allow for the absorption of stormwater, this should be further confirmed by soil investigations.
- A survey of the height of the water table will help to investigate the possibility of absorption.
- The composition of the solids in the rainwater leaving and entering the structure should be analysed to get an idea of the amount of pollutants retained in the structure.

4.2 Wetland, Turilaanpuisto

The wetland in Turilaanpuisto was built in the early 2000s and has not been maintained since then. The wetland basins have become quite saturated and a lot of vegetation has grown in the area.
The catchment area of the wetland is almost entirely acid sulphate soils. Due to the nature of the area, it occasionally drains acidic water which also contains heavy metals dissolved from the soil.
The wetland is to be upgraded so that it can retain solids. The aim is also to reduce the acidity of the water leaving the wetland.

Figure 4 The other Pori pilot site is located in Turilaanpuisto.

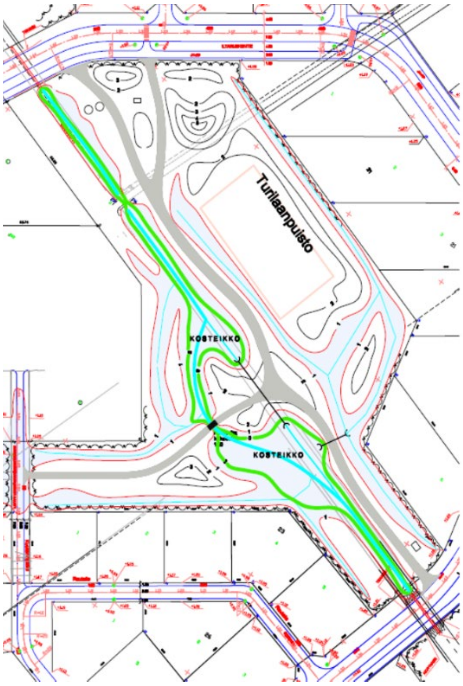

Figure 5 Area map of the wetland in Turilaanpuisto.

Ideas and considerations from the workshop

- Removal of loose sediment/cleaning of the wetland and subsequent reconsideration of measures.
- The composition of the bottom sediment should be investigated in order to know how the sludge should be treated and where it can be disposed of.
- Ensure water quality based on analyses and reduce overall pollution.
- Consideration has been given to installing a well to collect solids from the water before the wetland. Functionality of the well? Difficult to maintain?
- Need to find out where in the wetland the pH drops.
- Bottom dam to increase retention and pre-draining pond? Also exploring the possibility of using a constructed detention basin after the wetland to make it easier to collect sediment.

5. Riga site concept

Positioned downstream of the Pļavnieki and Dreiliņi catchments, the NBS design could be intricately tailored to cater to the distinct storm water quantities and qualities. The mixed land use catchment located upstream might further introduce unique stormwater quality challenges. The site planning might have to accommodate for overhead powerlines, potentially limiting construction space and posing the possibility of an expensive rerouting. However, the flat terrain could offer a promising avenue for efficient water rerouting via terraforming. A potential directive for the design could emphasize the separation of stormwater and Šmerļupīte water until the former undergoes partial treatment.

For water management, several innovative solutions could be adopted. The gravity sewer pipe's Real-time Control (RTC) might be instrumental in managing the inflow into the NBS, especially during peak events. There could be a provision for a permanent ponding area by the stormwater pipe outfall, its size possibly constrained by the surface elevations. Before its confluence with the Šmerļupīte creek, the stormwater might benefit from a sedimentation pretreatment in a well-designed flow labyrinth. Enhanced with baffles, this structure could aim to optimize the hydraulic retention time (HRT). The tail end of this system could host a vegetative zone with reeds, offering further purification. Addressing nitrogen concerns, a biofilter embedded with woodchips could be employed.

One of the notable aspects of the project could be the NBS's role in the re-naturalization activities, particularly in revitalizing the Šmerļupīte creek. This not only emphasizes ecological restoration but also showcases the potential of NBS in sustainable urban water management.

In addition to the core water management functionalities, there's potential to amplify the site's aesthetic appeal. A musical installation inspired by Dresden's Singing Drain Pipes might be incorporated, using the drafts in the sewer pipes to produce melodies. Enriching the experience further, walking paths and recreational zones could be woven around the NBS, encouraging community engagement, and spotlighting the significance of sustainable water practices.

Considering that there is uncertainty about the water quality and potential cross-contamination from the storm sewers discharging into the pilot area, it is instrumental, within the MUSTBE project, to create effective online water quality monitoring system in the storm sewer discharge as well as in the Šmerļupīte creek, that would provide data on 1) character and timing of contamination in the storm sewer providing insights into potential presence and possible sources of cross-contamination; 2) effect of MUSTBE pilot site on water quality; 3) needed additional measures upstream/downstream of the pilot site.

6. Söderhamn site concept

As a part of the MUSTBE project, the municipality of Söderhamn has taken the initiative to establish two pilot sites, Broberg and Söderhamnsporten, each of which having different challenges. These sites will test the effectiveness of retrofitting urban streams with nature-based treatment systems, with the primary objective being to prevent the deterioration of water quality in the Baltic Sea and to manage stormwater effectively.

6.1 Broberg Dallas

The Broberg area is reserved for the new municipal elderly home. The district is situated at Söderhamns bay and is highly affected by sea-level rise, and the area is a low-point. Stormwater runoff systems developed must be profoundly analysed beforehand to avoid the acceleration of flood and water quality deterioration risks. Any failure of the system will also negatively impact the Baltic Sea. The soil in this area is polluted by “kisaska”, PAH’s, heavy metals and also consists of sulphide clay at a depth of about one meter. Additionally, there is a cultural heritage-listed railway that cuts through the area. The following text is a summary of the ideas from the co-creation workshop.

Option: Ditch (Figure 6)

- Outflow ditch should be curved instead of a straight structure (A) to foster storm water (sw) treatment.
- Add pipeline (culvert) to the ditch to cross the old railway (due to the potential heritage zone restrictions) (B).
- WaStop inline check valve etc. backflow measure could be installed at the outlet (C) – although a high sea level will not affect the runoff as far as the upstream water level is higher than at the downstream (which is the case in Broberg).

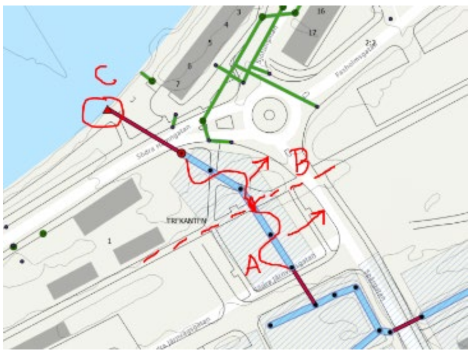

Figure 6 Three options (A, B, and C) each related to ditching solutions.

Option: Pipeline (Figure 7)

- Pipeline (A) has advantages in terms of environmental safety as this method avoids the leaching of contaminants from the soil to the sea. This will be clarified in the environmental impact assessment.

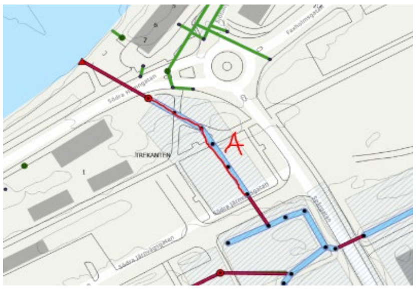

Figure 7 Shows option A, related to pipeline solutions.

Existing ditches (Figure 8):

- Extend existing ditches (A) to create sufficient detention area (buffer capacity) to handle larger stormwater volumes.
- Plan dedicated capacity (B) for the sedimentation.
- Retrofit ditches (A) into grassed swales.
- NBS should be isolated from the soil (potential pollution) by liner/clay layer. Soil excavation must be done in minimum volumes.

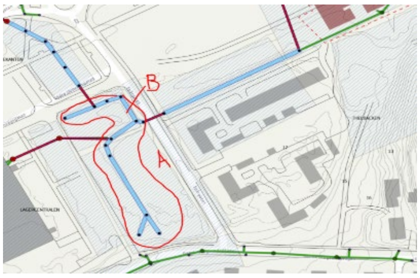

Figure 8 Displays option A and B in terms of existing ditching solutions.

Regarding the planned elderly home, implementing stormwater re-use can reduce runoff volumes.

6.2 Söderhamnsporten

Söderhamnsporten is a transportation hub that brings together railways, highways, and connections to the town center. The area is already heavily developed, but there are plans for further expansion. Söderhamnsån, a river that runs through the district, presents a challenge when planning storm water systems. Increased storm water runoff will have a direct impact on the water quality in the Baltic Sea, so careful decisions are required. The following text is a summary of the ideas from the co-creation workshop.

Planned Porten District:

- A master plan for the future storm water system should be set for the whole area.
- The plan should contain both pipelines (grey) and NBS (green) solutions.
- 10–15% of the impermeable surfaces (currently grey areas) should be dedicated to nature-based solutions.
- Plan green roofs and reduce stormwater loads with plot-based nature-based solutions.
- The master plan should show where it is most feasible to build MUSTBE demonstration site (pilot investment).

Inflow from the forest catchment (creek) (Figure 9)

- Preserve the existing inflow creek (A) - do not enclose it into the pipeline.
- Create detention area (B) to accumulate extreme flows (i.e., springtime snowmelt).

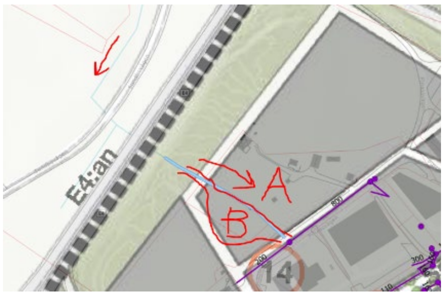

Figure 9 Options A and B in the inflow from the forest catchment.

The Main Stormwater Collector (Figure 10)

- Remove the pipeline (A) and create a curved ditch/creek for the improvement of the water quality.
- Preserve the existing open section (ditch) (B).

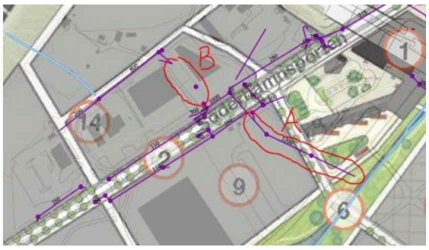

Figure 10 Options A and B related to the pipeline that is the main stormwater collector.

Pilot Investment (Figures 11–13)

- Option A is a parking area as a cloud-burst detention solution to accumulate excess stormwater. Water depth should be safe for the parked vehicles. It is a smart solution to notify residents about the area's status, see Figure 11.
- Option B is a pilot rain garden at the parking lot (A) or green stripe (B). The outflow can be connected to the existing 1.2m collector, see Figure 12 and 13.
- Option C is to Install on-line water quality monitoring station (A) with construction of the detention area (for water treatment) (B) on Söderhamnsån.

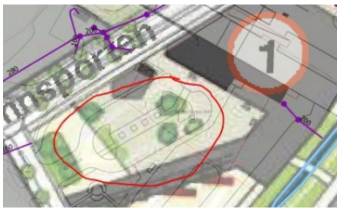

Figure 11 The option A area.

Figure 12 Options A and B in parking lot/green stripe suggestion.

Figure 13 Options A and B in both parking lot/green stripe and on-line water quality monitoring station (A) with construction of the detention area (for water treatment) (B).

7. CONCLUTIONS

In a result of experience-sharing and brainstorming sessions of the workshop, several possible solutions for all pilot concepts have been analyzed and all pilot concepts have been further developed. For some solutions there are several options with descriptions developed. Decisions on the final concepts of all seven pilot sites will be taken during the second project period after discussing options left open after the workshop.