



MULTIDIMENSIONAL ANALYSIS OF NATURE-BASED SOLUTIONS 1/2



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Interreg



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the European Union

Central Baltic Programme

MUSTBE

International Workshop Aspects of Multidimensional Stormwater Solutions of nature-based solutions for urban runoff management and treatment and pilots in Tallinn, Viimsi, Pori, Riga and Soderhamn.

02.10.2024 Pori

MULTIDIMENSIONAL ANALYSIS OF NATURE-BASED SOLUTIONS

2/2

- Why we need Nature-based solutions and multidimensional analysis?
- Used methodology for multidimensional analysis.
- Multidimensional analysis results of MUSTBE project pilot areas.
- What is the impact of a smart element in NBS solution?

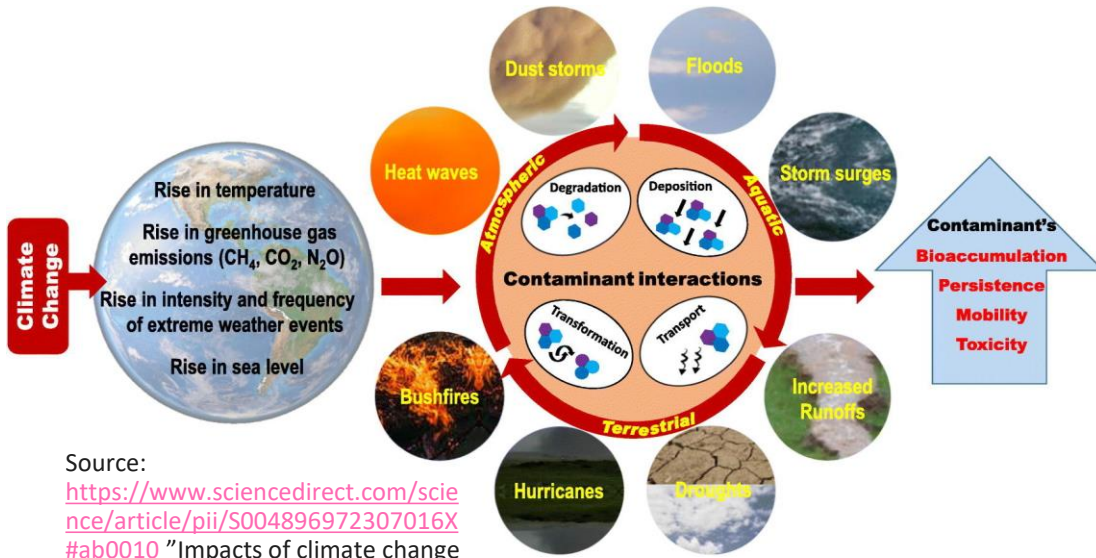


Activity 1.3 Multi-objective analysis of the technical solutions for stormwater treatment

D.1.3.1 Analysis report and preliminary design

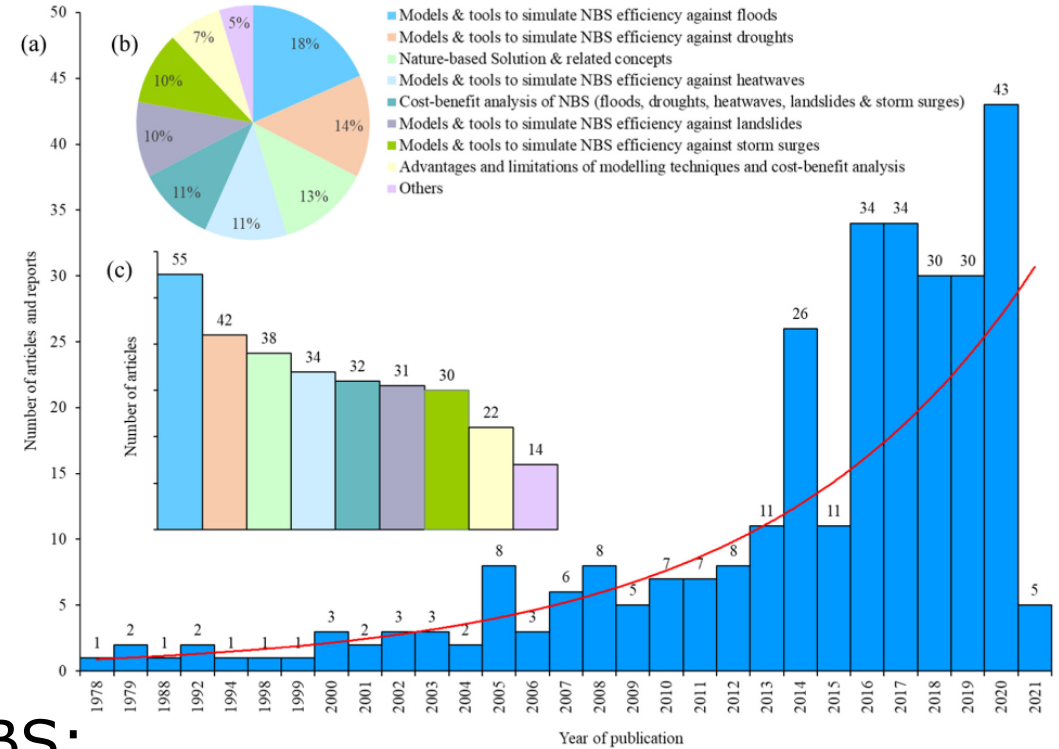
MULTIDIMENSIONAL ANALYSIS

The Bottom Problem:



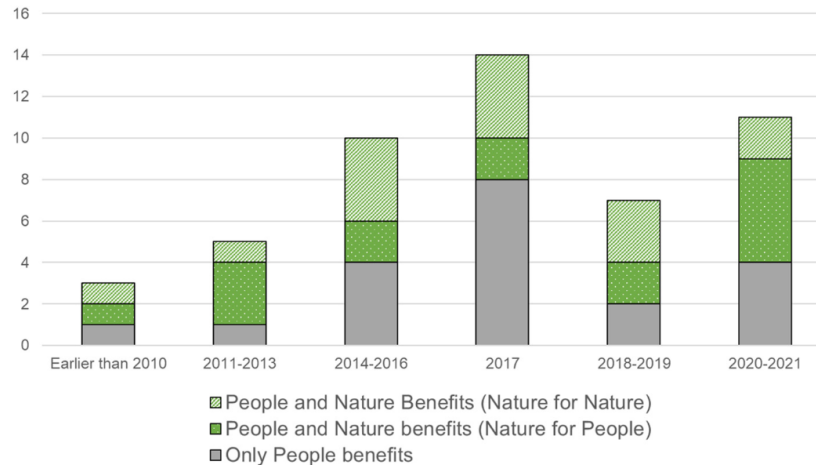
Source: <https://www.sciencedirect.com/science/article/pii/S004896972307016X#ab0010> "Impacts of climate change on the fate of contaminants through extreme weather events"

NBS focus:



Source: [Nature-based solutions efficiency evaluation against natural hazards: Modelling methods, advantages and limitations - ScienceDirect](#)

Lack of knowledge of NBS:

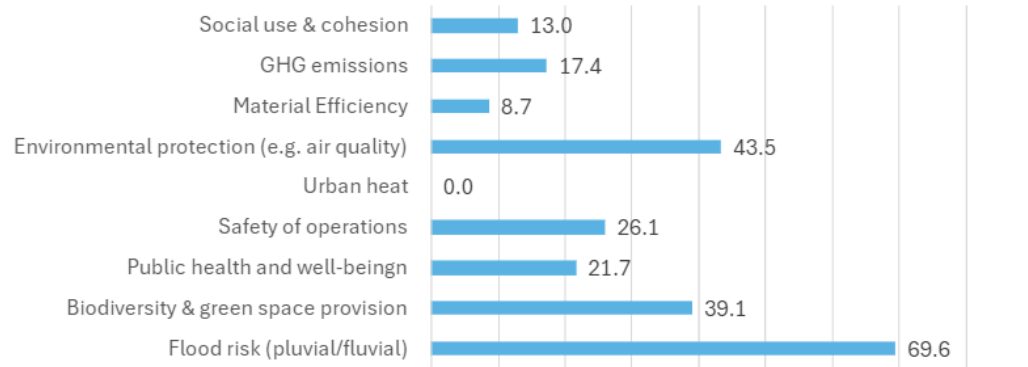


Source: "Knowledge gaps and future research needs for assessing the non-market benefits of Nature-Based Solutions and Nature-Based Solution-like strategies - ScienceDirect"

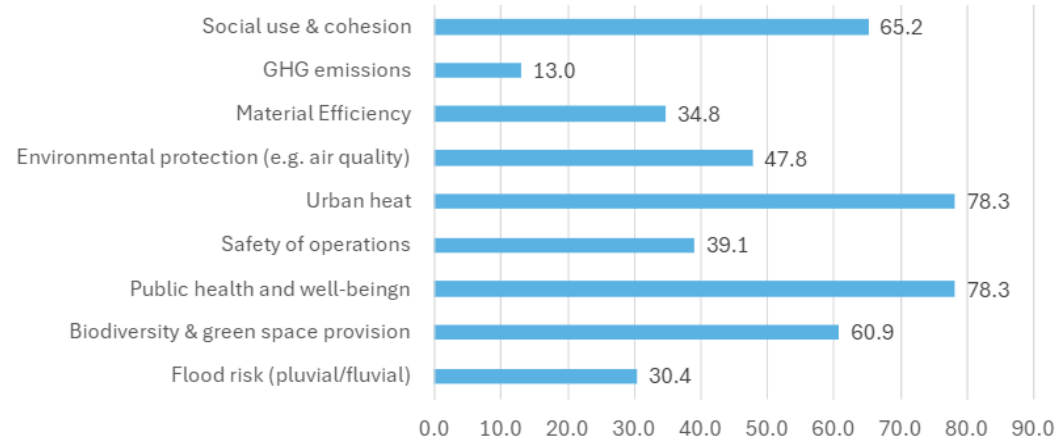
NBS BENEFITS

OBJECTIVES OF PREVIOUS PROJECTS:

Primary objectives of NBS lighthouse projects [%]

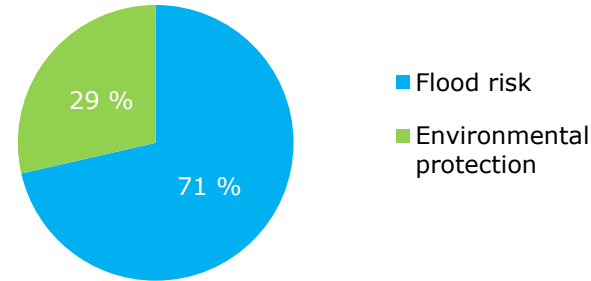


Secondary objectives of NBS lighthouse projects [%]

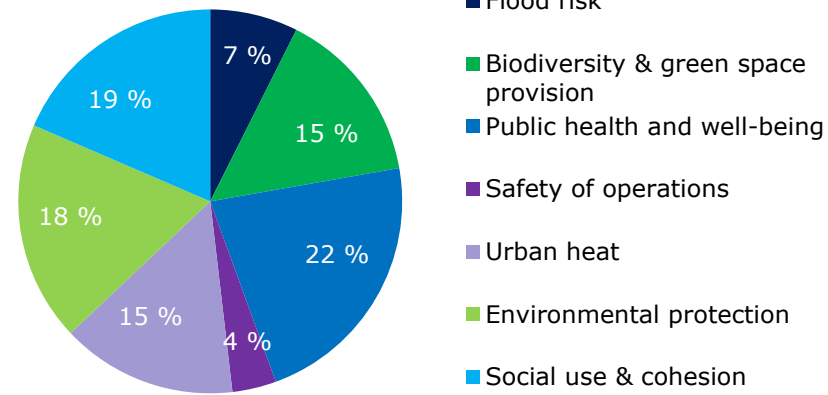


OBJECTIVES OF MUSTBE PROJECT:

Primary benefit



Co-Benefit



PARAMETERS TO BE ANALYZED:

Flood mitigation



Water quality



UHI mitigation



Well-being



Source:
<https://bgd.org.uk/wp-content/uploads/2017/04/Benefits-of-NBS.png>

Source: City Blues project, 2024

NBS BENEFITS ANALYZING METHOD

Score division:

- 1 (0 – 0.3)**
representing no or very low impact
- 2 (0.3 – 0.6)**
representing medium impact
- 4 (0.6 – 1.0)**
representing high impact

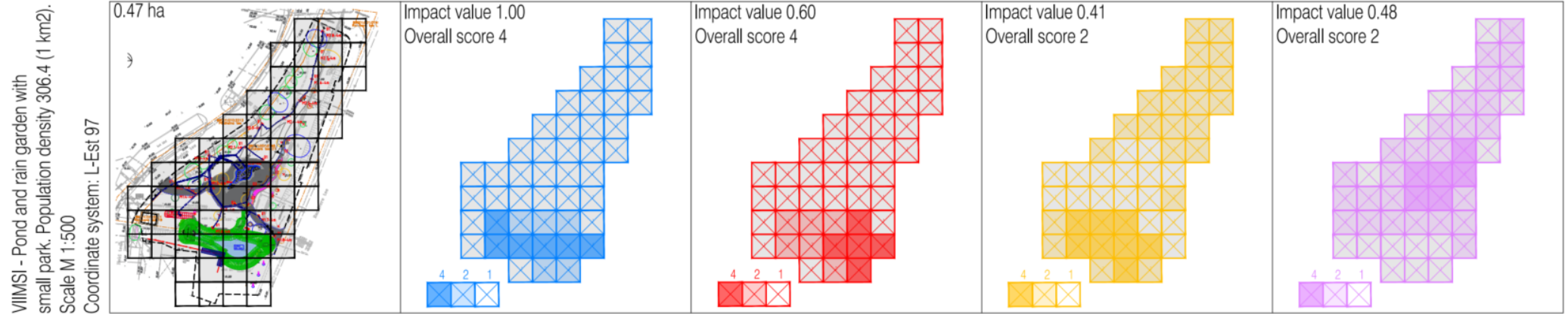
Grid 10x10 m based on National grid system.

Flood reduction
SWMM modelling

Water quality improvement
Calculated based on the NBS solution design and purification ratio by comparing the measured of total suspended solids (TSS) concentration prior the intervention to the expected TSS value after the NBS implementation

Urban heat reduction
Using reduction rates based on the land use type

Public health and well-being
Calculated based on the changes of land use type according to intendents of human use



MUSTBE PILOT AREAS

Pilot locations:



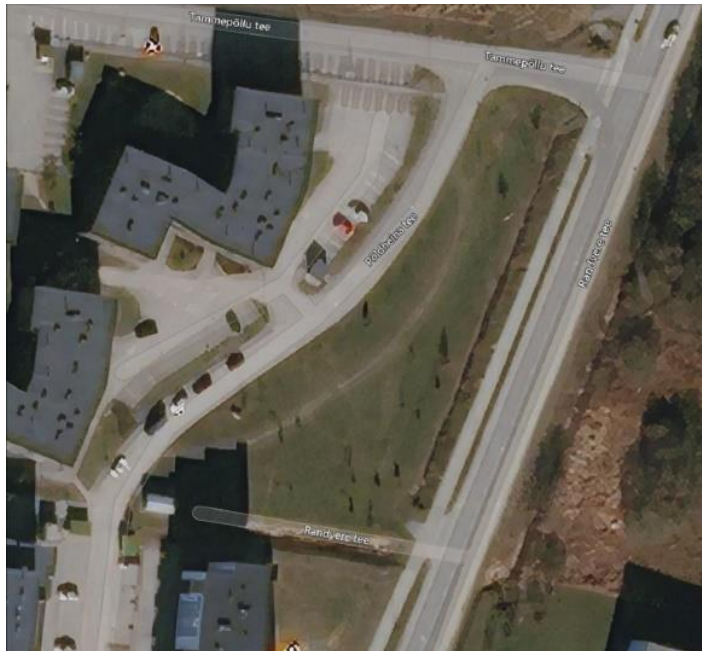
Pilot location	NBS solution
Viimsi, Estonia	Pond and rain garden with small park.
Tallinn, Estonia	Water flow regulation and sediment ponds with small park.
Porten, Sweden	Sediment and stormwater retention pond.
Broberg, Sweden	Sediment and stormwater retention pond with park.
Keskusaukio, Finland	Stormwater tree-solution in parking lot <u>and also permeable pavement.</u>
Kempinte, Finland	Stormwater treatment and retention pond-ditch system with small park.
Riga, Latvia	Sediment pond and treatment wetland with park area.

VIIMSI, ESTONIA: POND AND RAIN GARDEN WITH SMALL PARK 1/2

Primary benefit: flood risk reduction.

Co-benefits: biodiversity and greenspace provision, public health and well-being, water quality improvement, social use and cohesion.

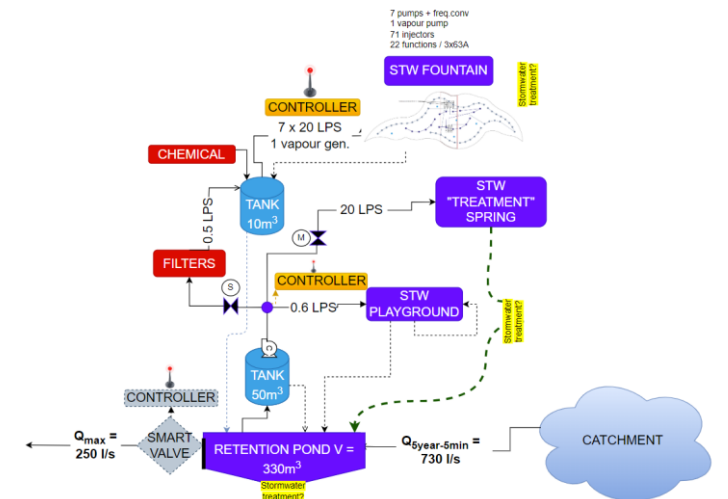
Existing situation



NBS layout concept

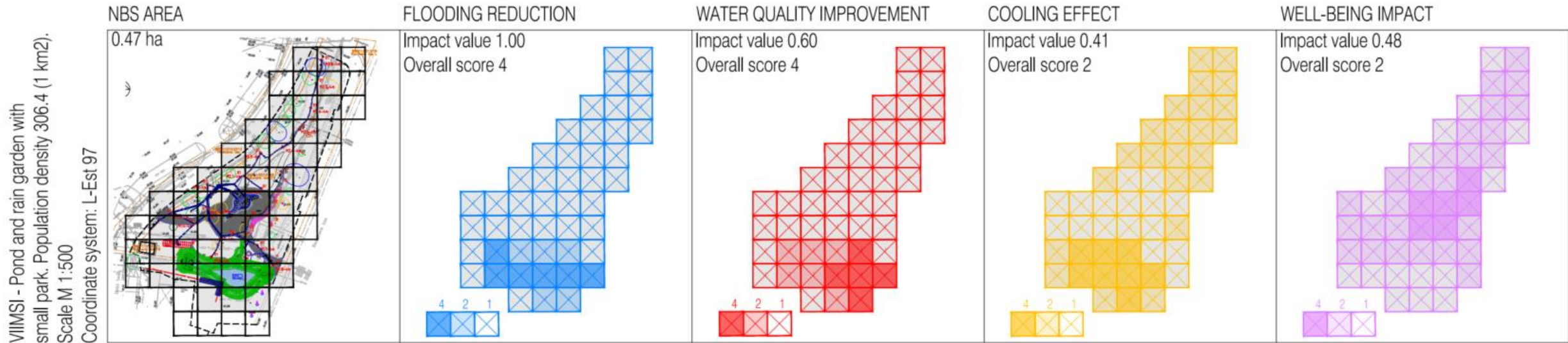


Water flow technical solution

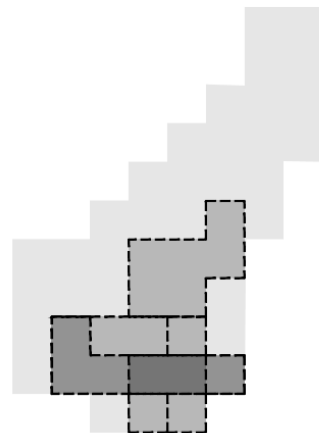


VIIMSI, ESTONIA: POND AND RAIN GARDEN WITH SMALL PARK 2/2

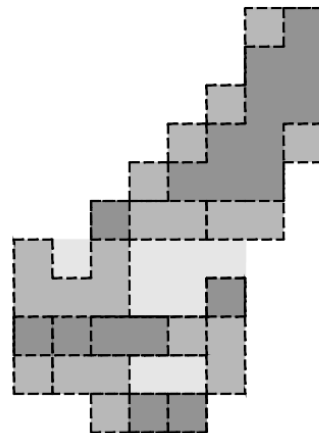
Analysed benefits: flooding reduction, water quality improvement, cooling effect, well-being impact.



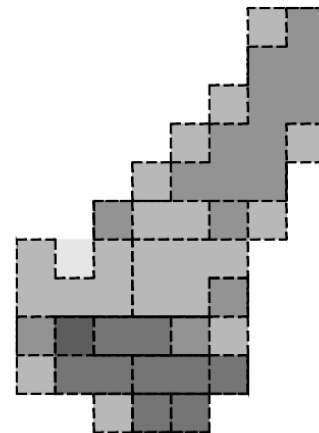
BENEFITS WITH
SCORE 4



BENEFITS WITH
SCORE 2



BENEFITS WITH
SCORE 4 & 2



TALLINN, ESTONIA: WATER FLOW REGULATION AND SEDIMENT PONDS WITH SMALL PARK 1/2

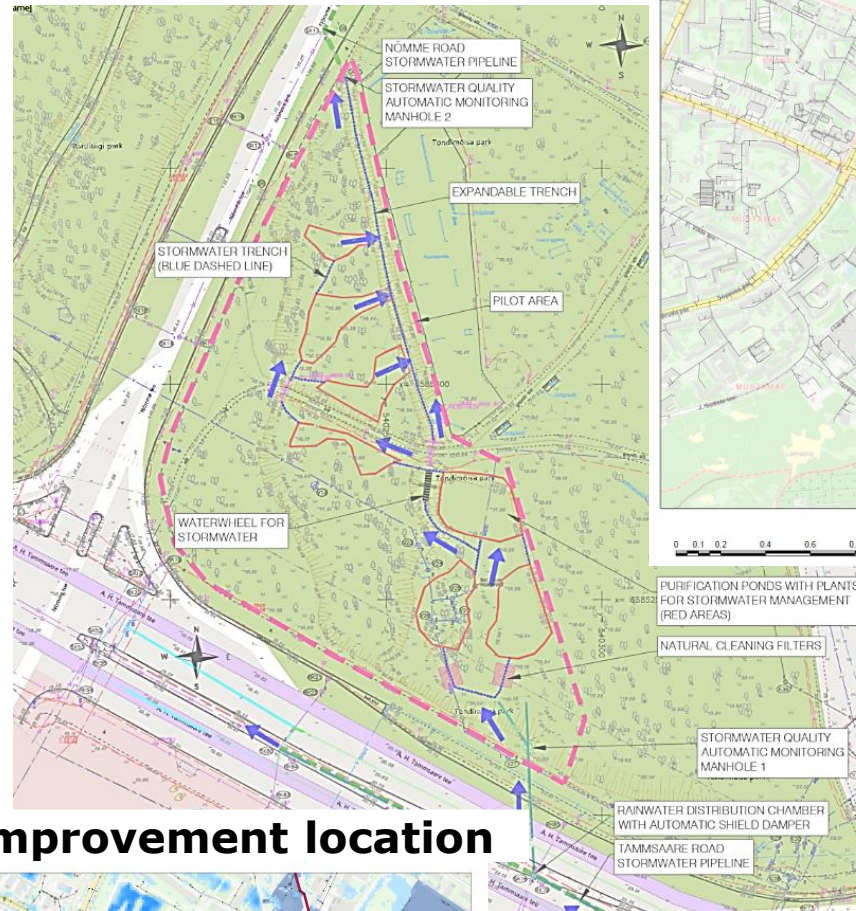
Primary benefit: environmental protection.

Co-benefits: flood risk, public health and well-being, social use and cohesion.

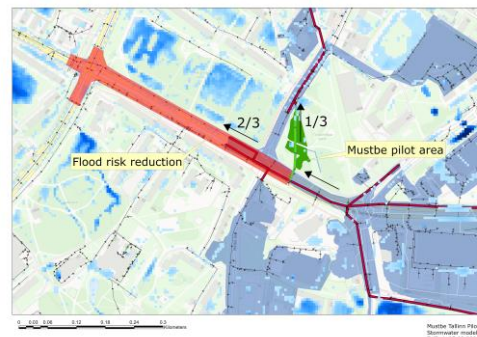
Existing situation



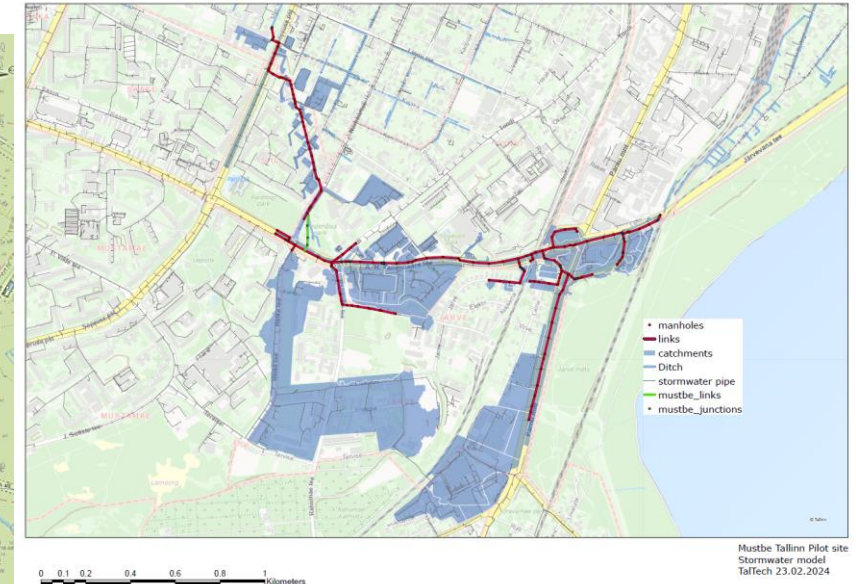
NBS water flow scheme



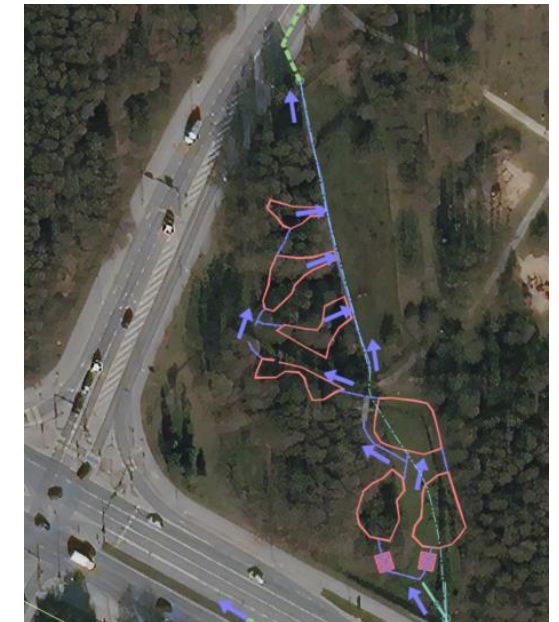
Flooding improvement location



SWMM water flow modelling



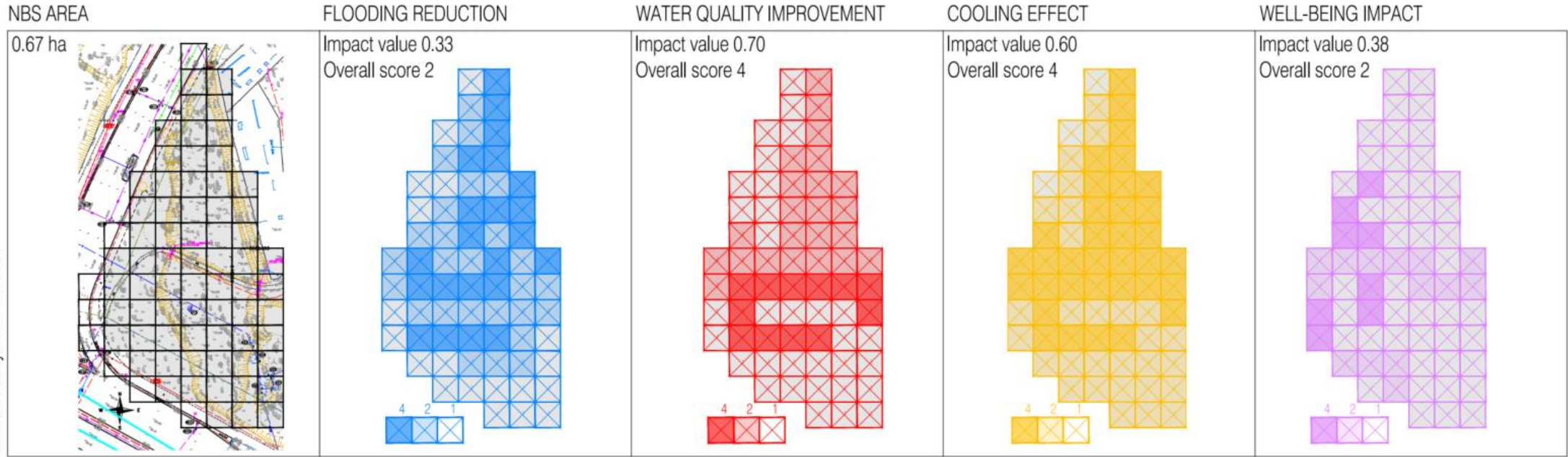
Mustbe Tallinn Pilot site
Stormwater model
TalTech 23.02.2024



TALLINN, ESTONIA: WATER FLOW REGULATION AND SEDIMENT PONDS WITH SMALL PARK 2/2

Analysed benefits: flooding reduction, water quality improvement, cooling effect, well-being impact.

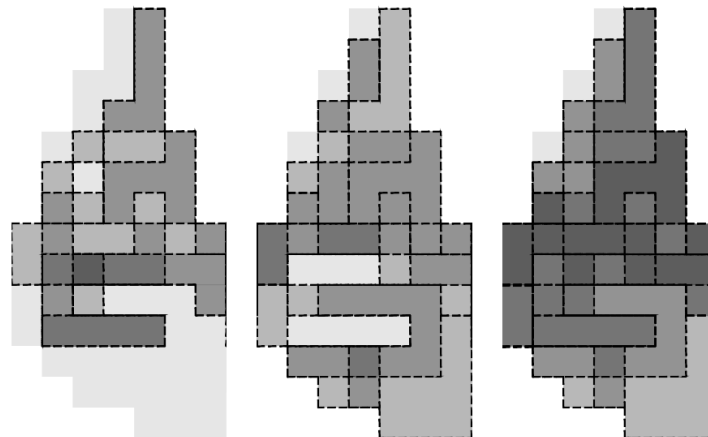
TALLINN - Water flow regulation and sediment wetland area. Population density 2847.3 (1 km²).
Scale M 1:500
Coordinate system: L-Est 97



BENEFITS WITH SCORE 4

BENEFITS WITH SCORE 2

BENEFITS WITH SCORE 4 & 2



PORTEN, SWEDEN: SEDIMENT AND STORMWATER RETENTION POND 1/2

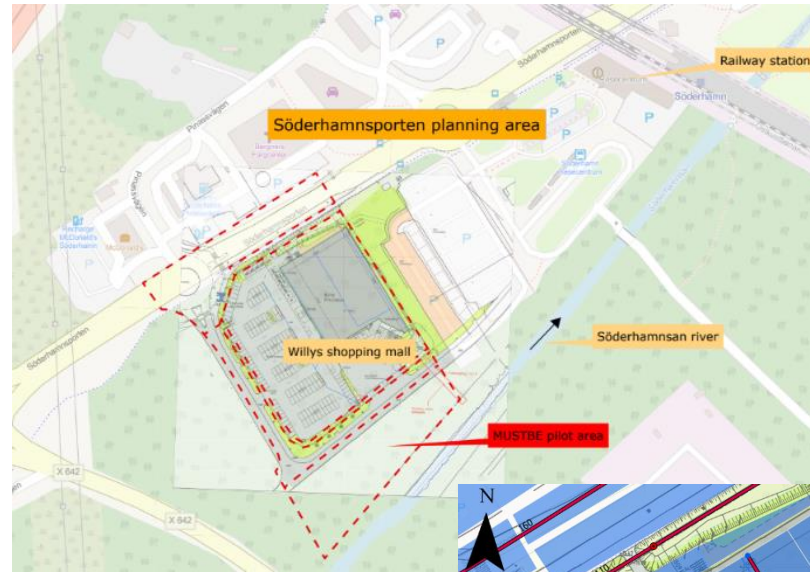
Primary benefit: flood risk.

Co-benefits: biodiversity and green space provision, public health and well-being, urban heat, environmental protection.

Existing situation

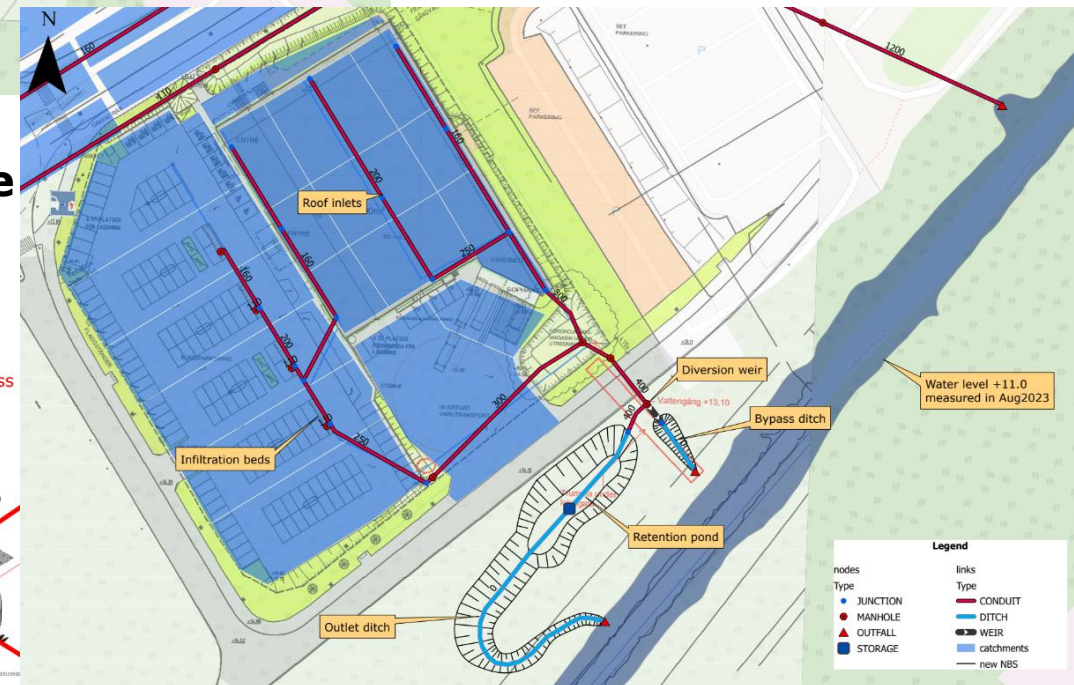
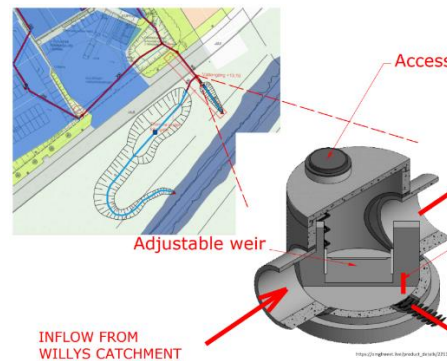


Neighbourhood area conception



Stormwater management solution

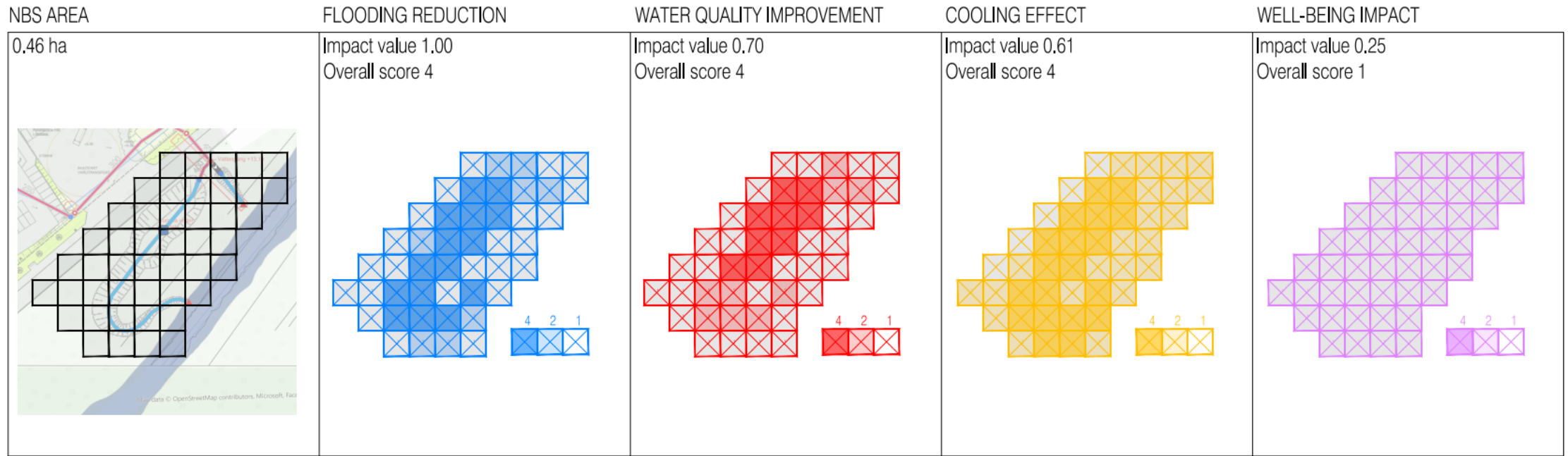
Diversion manhole location and work principle



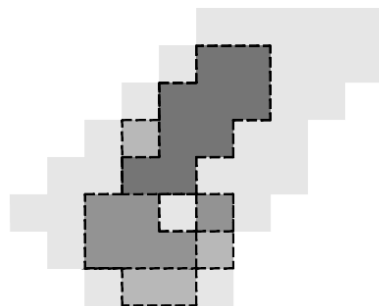
PORTEN, SWEDEN: SEDIMENT AND STORMWATER RETENTION POND 2/2

Analysed benefits: flooding reduction, water quality improvement, cooling effect, well-being impact.

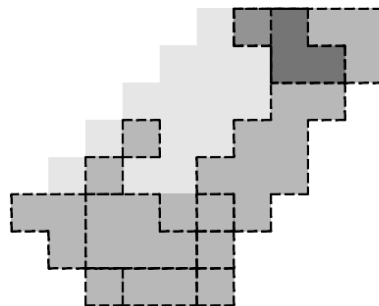
PORTEN - Sediment and stormwater retention pond.
 Population density 1117.0 (1 km²).
 Scale M 1:500
 Coordinate system: SWEREF 99



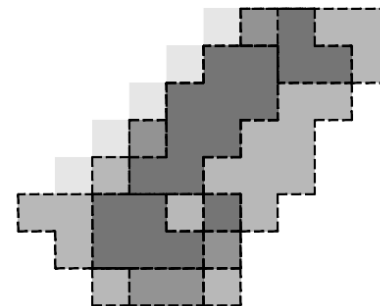
BENEFITS AREAS
WITH SCORE 4



BENEFITS AREAS
WITH SCORE 2



BENEFITS AREAS
WITH SCORE 4 & 2



BROBERG, SWEDEN: SEDIMENT AND STORMWATER RETENTION POND WITH PARK 1/3

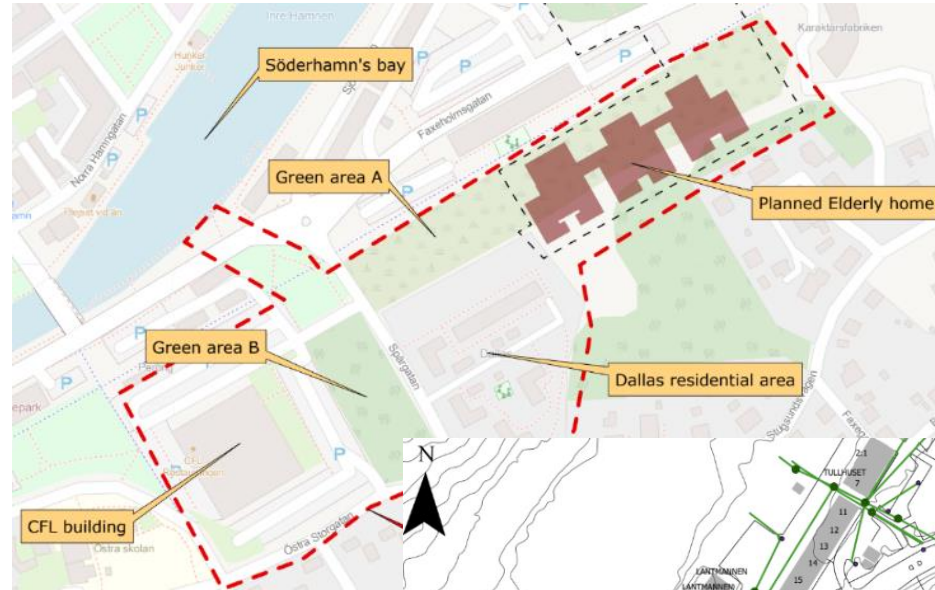
Primary benefit: flood risk.

Co-benefits: biodiversity and green space provision, public health and well-being, safety operations, environmental protection, social use and cohesion.

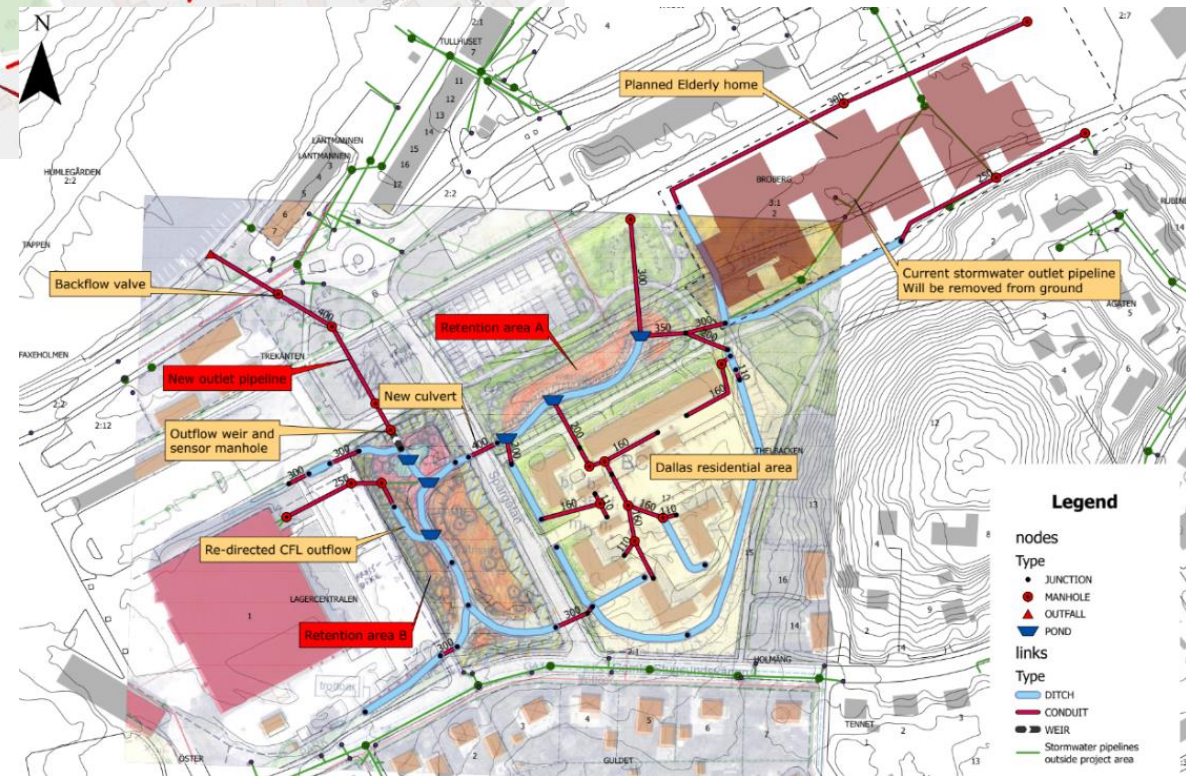
Existing situation



Neighbourhood area conception



Stormwater management solution



BROBERG, SWEDEN: SEDIMENT AND STORMWATER RETENTION POND WITH PARK 2/3

Neighbourhood area conception



Primary benefit: flood risk.

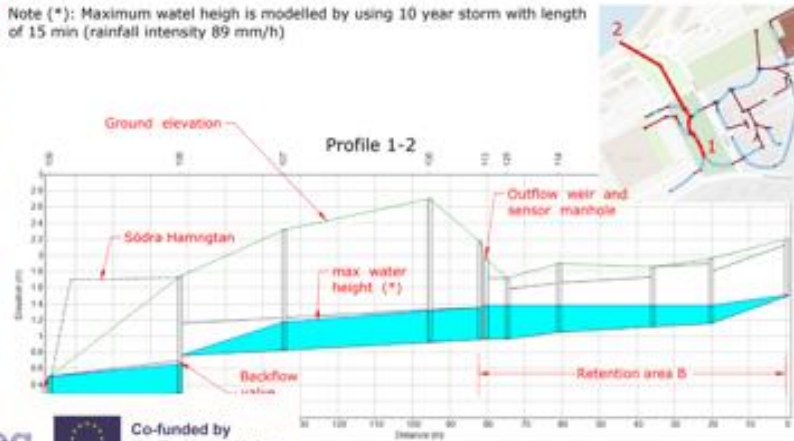
Co-benefits: biodiversity and green space provision, public health and well-being, safety operations, environmental protection, social use and cohesion.

Existing situation

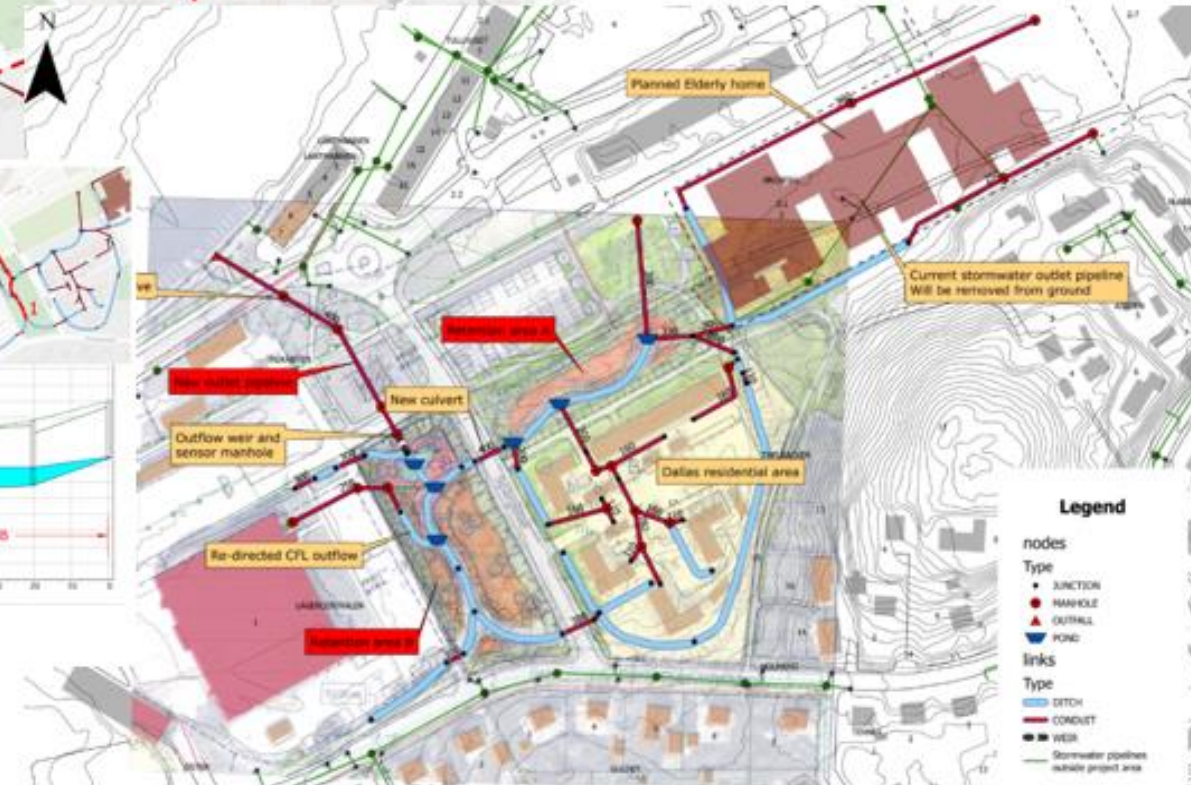


Technical outflow solution

Note (*): Maximum water height is modelled by using 10 year storm with length of 15 min (rainfall intensity 89 mm/h)



Stormwater management solution



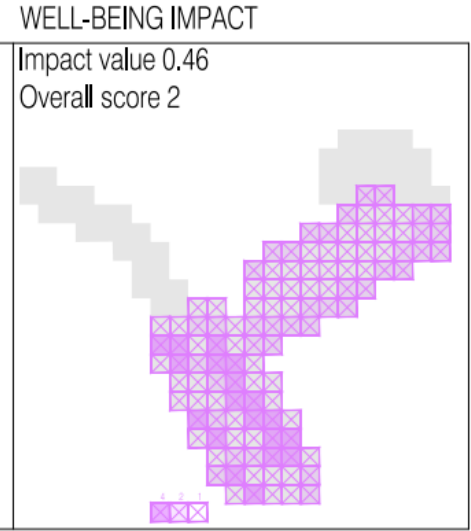
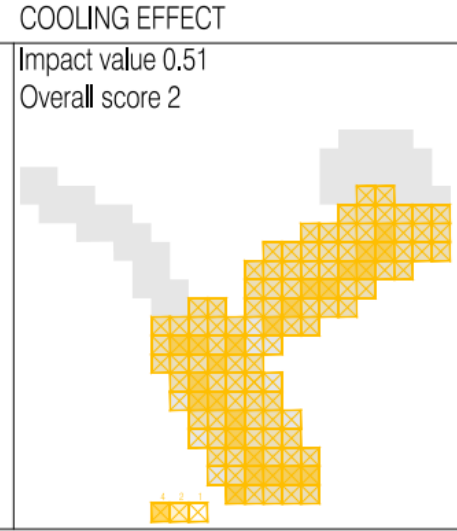
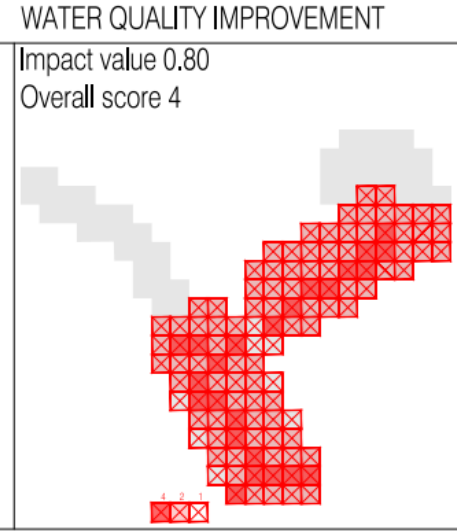
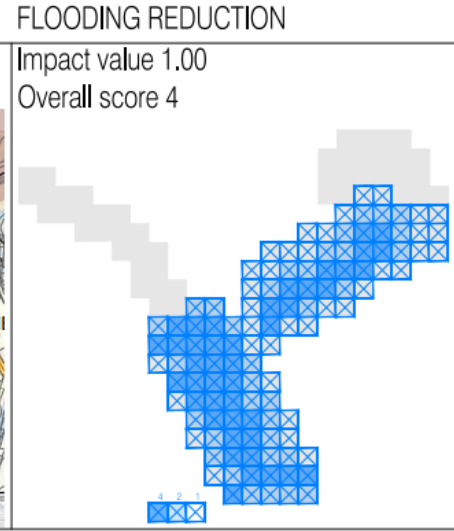
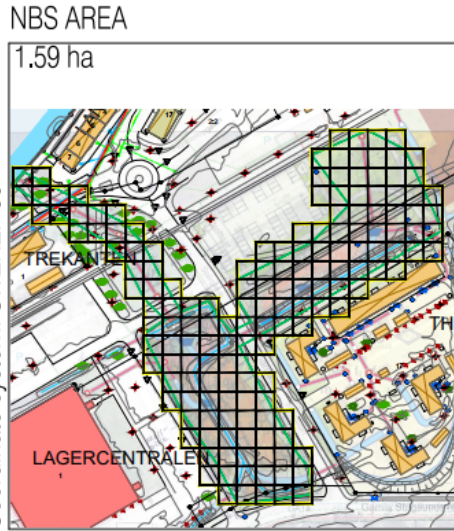
BROBERG, SWEDEN: SEDIMENT AND STORMWATER RETENTION POND 3/3

Analysed benefits: flooding reduction, water quality improvement, cooling effect, well-being impact.

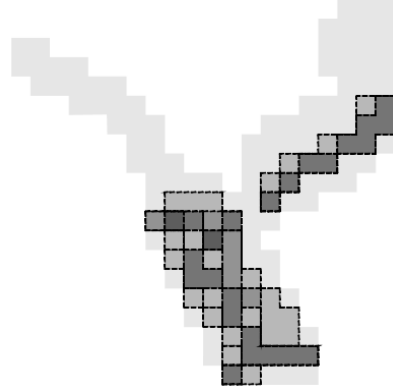
BROBERG - Sediment and stormwater retention pond. Population density 1117.0 (1 km²).

Scale M 1:1000

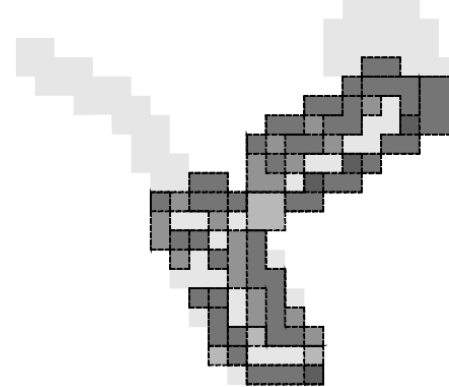
Coordinate system: SWEREF 99



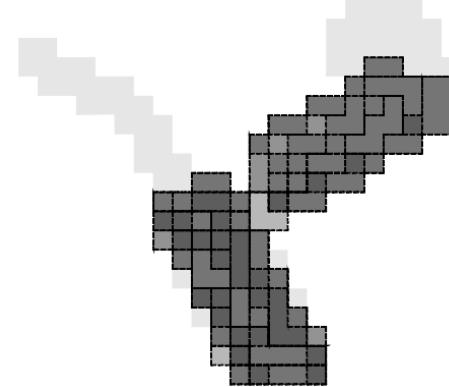
BENEFITS AREAS WITH SCORE 4



BENEFITS AREAS WITH SCORE 2



BENEFITS AREAS WITH SCORE 4 & 2



KESKUSAUKIO, FINLAND: STORMWATER TREE-SOLUTION IN PARKING LOT AND ALSO PERMEABLE PAVEMENT 1/2

Primary benefit: flood risk.

Co-benefits: urban heat, environmental protection, social use and cohesion.

Existing situation

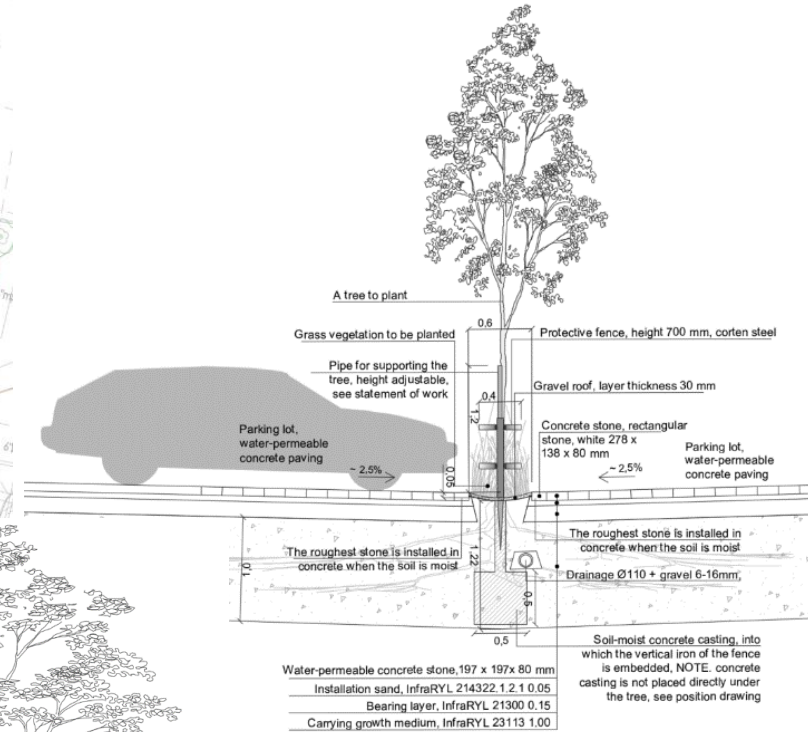


NBS solution



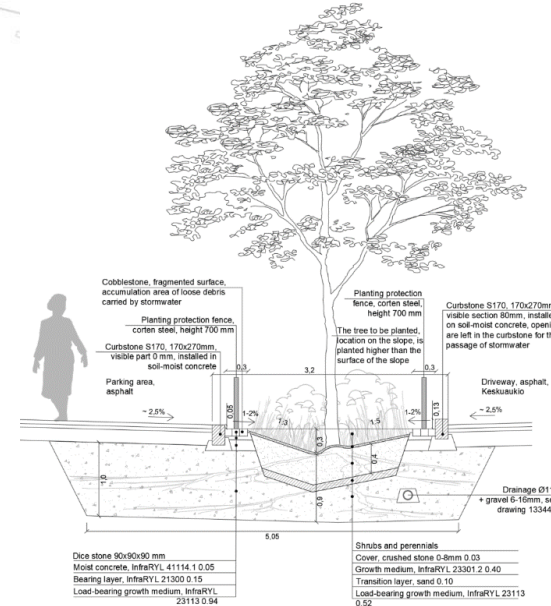
Cross section A-A:

Treetank and permeable



Cross section B-B:

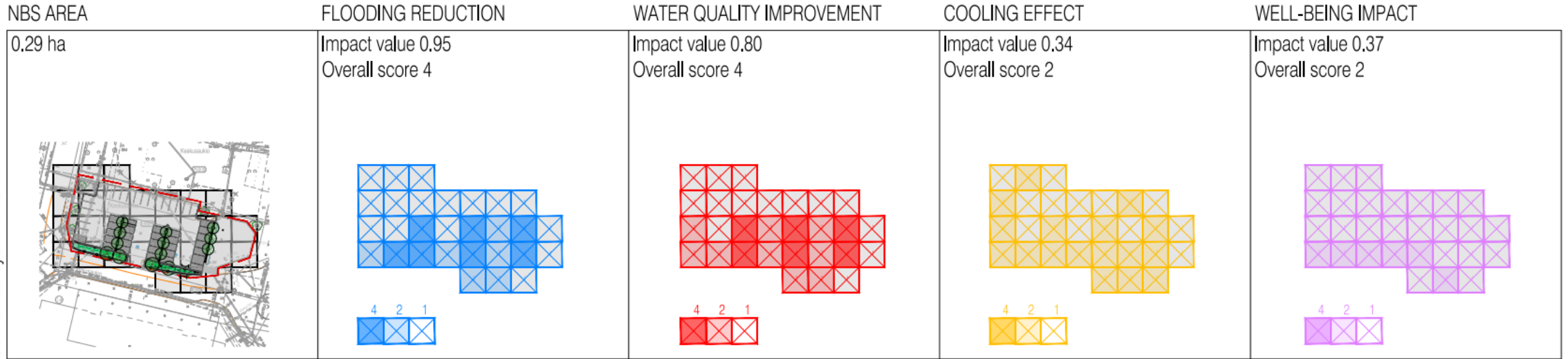
Permeable ditch with trees



KESKUSAUKIO, FINLAND: STORMWATER TREE-SOLUTION IN PARKING LOT AND ALSO PERMEABLE PAVEMENT 2/2

Analysed benefits: flooding reduction, water quality improvement, cooling effect, well-being impact.

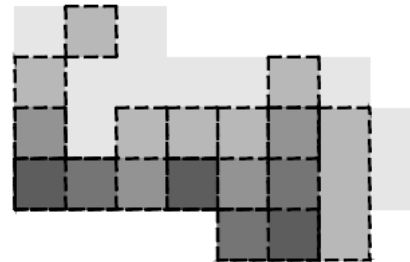
PORI - Stormwater tree-solution in parkinglot.
 Population density 71.89 (1 km²).
 Scale M 1:500
 Coordinate system: EUREF-FIN



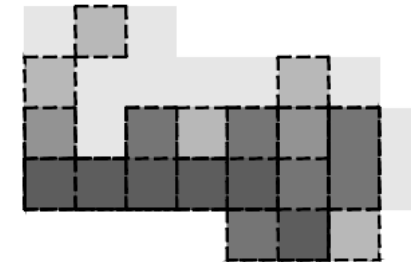
BENEFITS AREAS WITH SCORE 4



BENEFITS AREAS WITH SCORE 2



BENEFITS AREAS WITH SCORE 4 & 2



KEMPINTE, FINLAND: STORMWATER TREATMENT AND RETENTION POND-DITCH SYSTEM WITH SMALL PARK 1/3

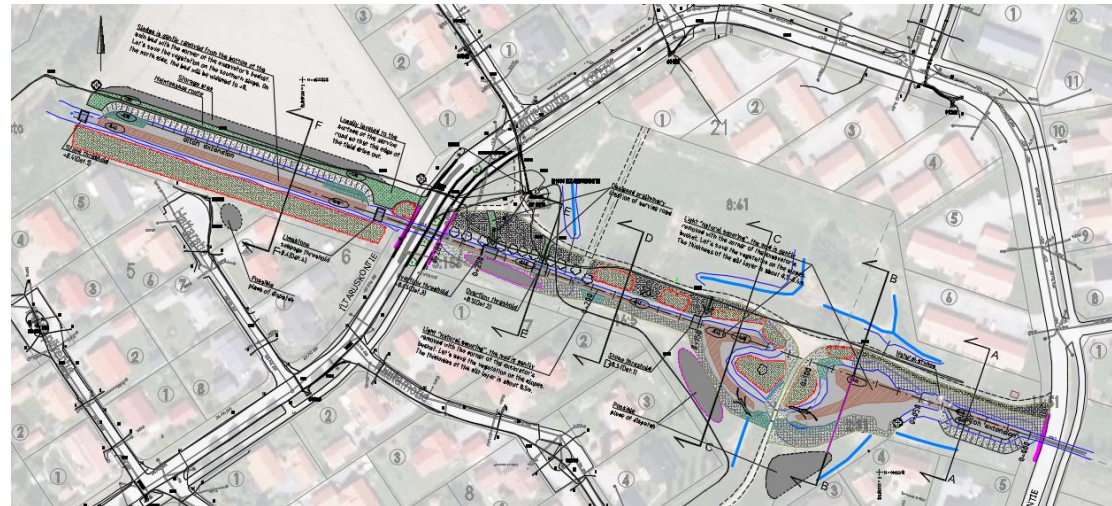
Primary benefit: flood risk.

Co-benefits: urban heat, environmental protection, social use and cohesion.

Existing situation

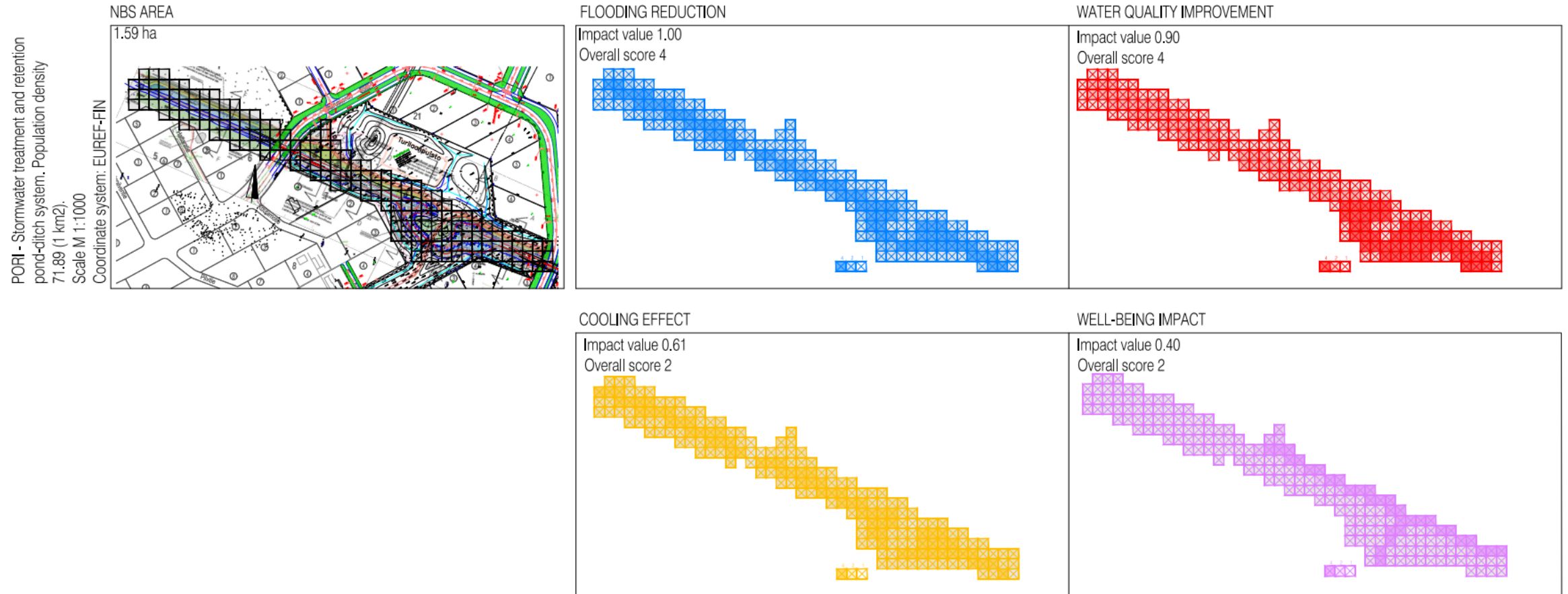


NBS solution



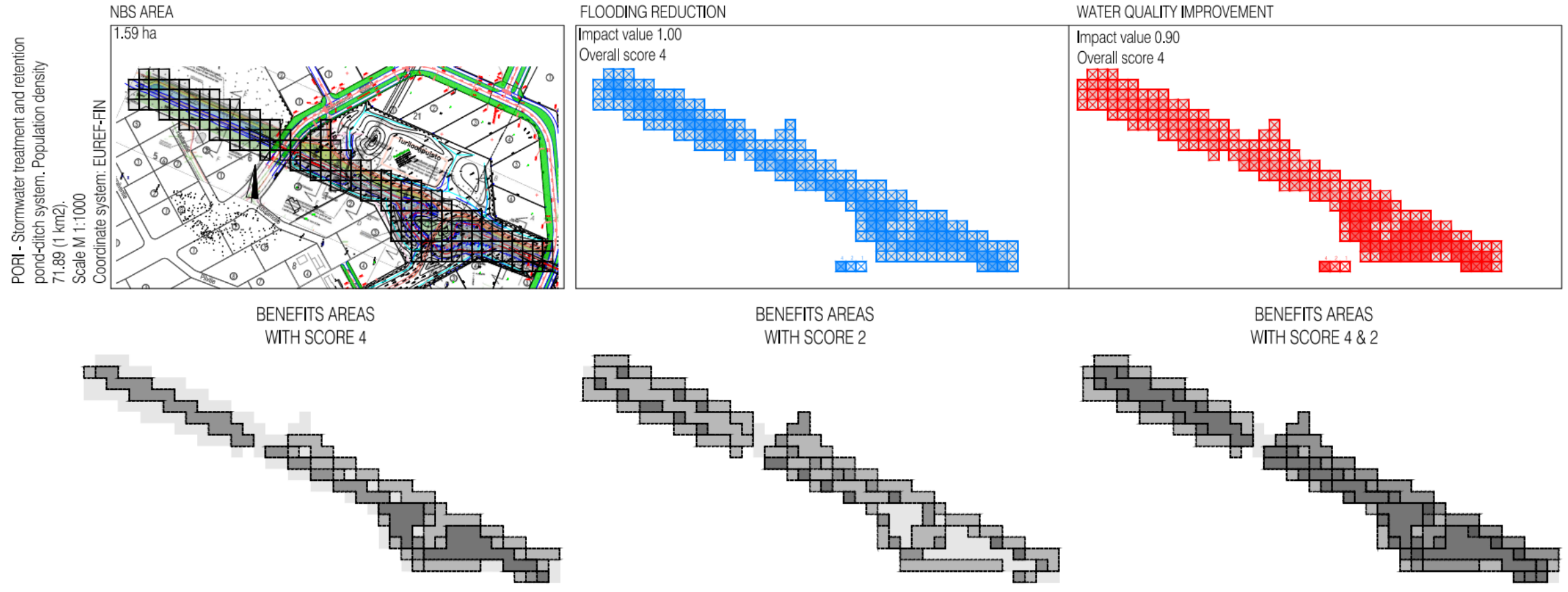
KEMPINTE, FINLAND: STORMWATER TREATMENT AND RETENTION POND-DITCH SYSTEM WITH SMALL PARK 2/3

Analysed benefits: flooding reduction, water quality improvement, cooling effect, well-being impact.



KEMPINTE, FINLAND: STORMWATER TREATMENT AND RETENTION POND-DITCH SYSTEM WITH SMALL PARK 3/3

Analysed benefits: flooding reduction, water quality improvement, cooling effect, well-being impact.



RIGA, LATVIA: SEDIMENT POND AND TREATMENT WETLAND WITH PARK AREA 1/2

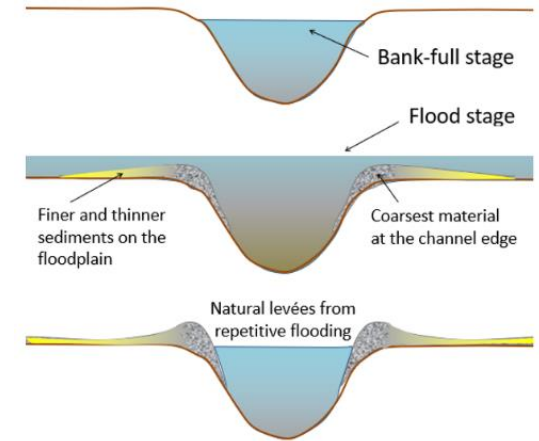
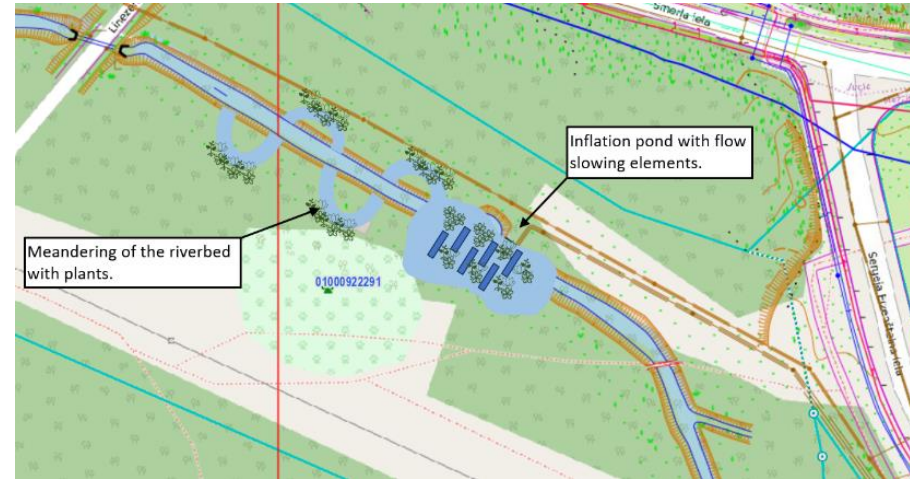
Primary benefit: environmental protection.

Co-benefits: flood risk, public health and well-being, social use and cohesion.

Existing situation



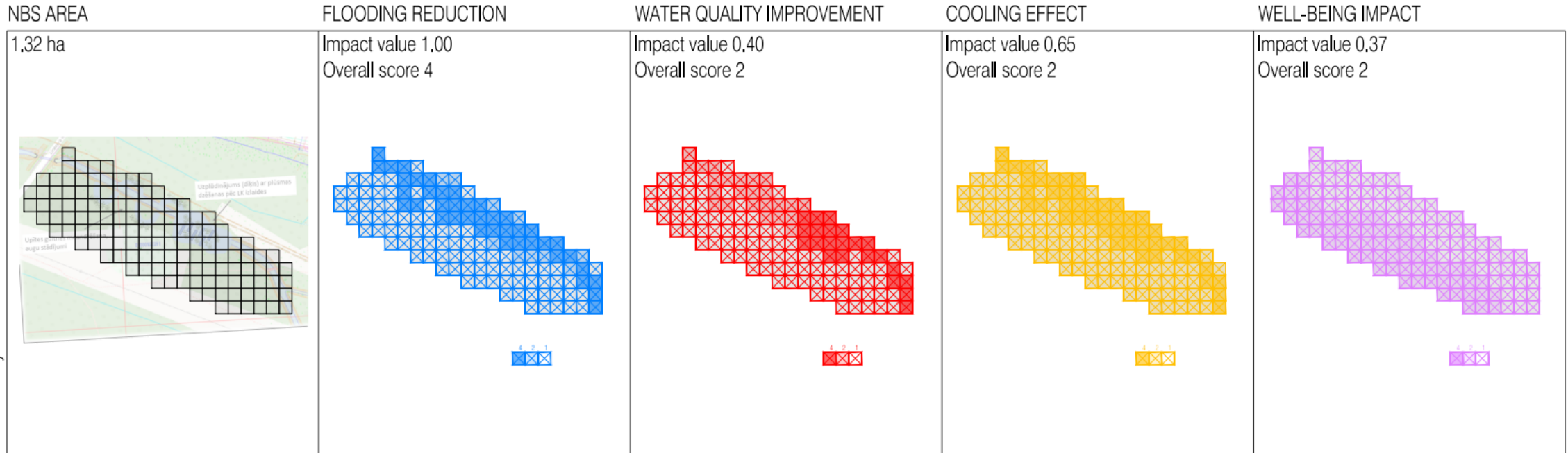
NBS solution



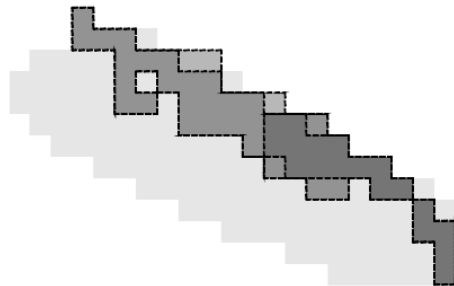
RIGA, LATVIA: SEDIMENT POND AND TREATMENT WETLAND WITH PARK AREA 2/2

Analysed benefits: flooding reduction, water quality improvement, cooling effect, well-being impact.

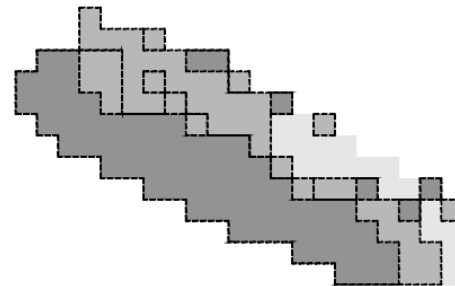
RIGA - Sediment ponds and treatment wetland.
 Population density 2000.0 (1 km²).
 Scale M 1:1000
 Coordinate system: TKS-93



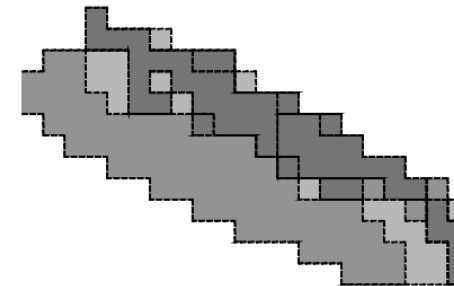
BENEFITS AREAS WITH SCORE 4



BENEFITS AREAS WITH SCORE 2



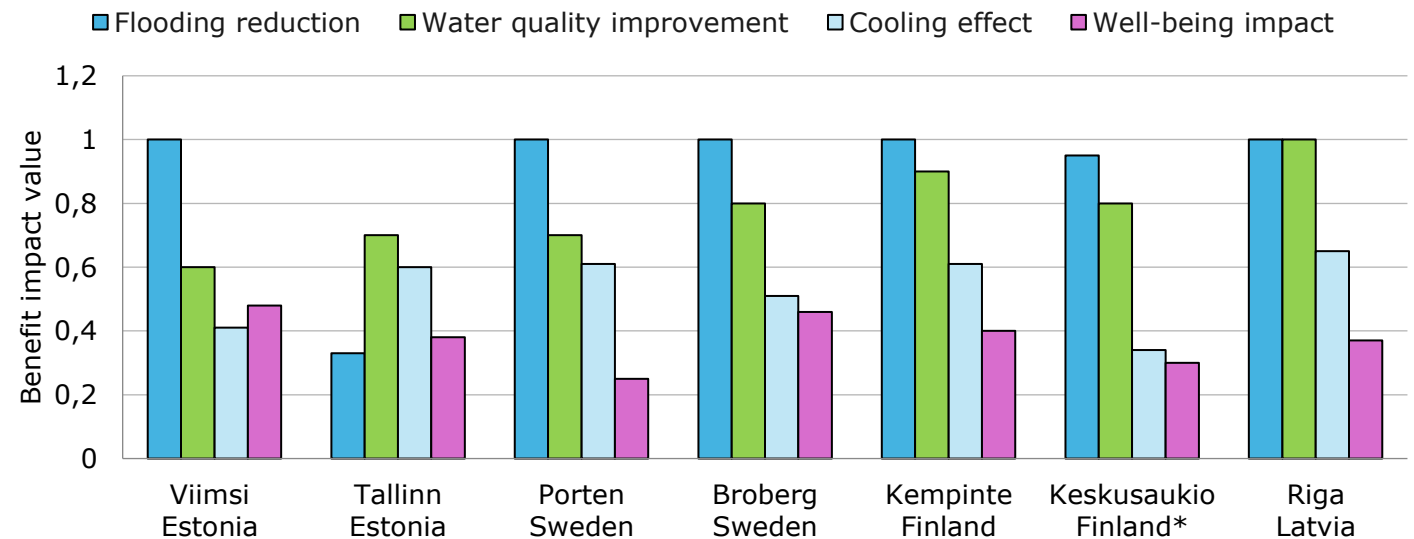
BENEFITS AREAS WITH SCORE 4 & 2



NBS BENEFIT IMPACT RESULTS

Pilot location	NBS solution
Viimsi, Estonia	Pond and rain garden with small park.
Tallinn, Estonia	Water flow regulation and sediment ponds with small park.
Porten, Sweden	Sediment and stormwater retention pond.
Broberg, Sweden	Sediment and stormwater retention pond with park.
Keskusaukio, Finland	Stormwater tree-solution in parking lot <u>and also</u> permeable pavement.
Kempinte, Finland	Stormwater treatment and retention pond-ditch system with small park.
Riga, Latvia	Sediment pond and treatment wetland with park area.

Benefit impact

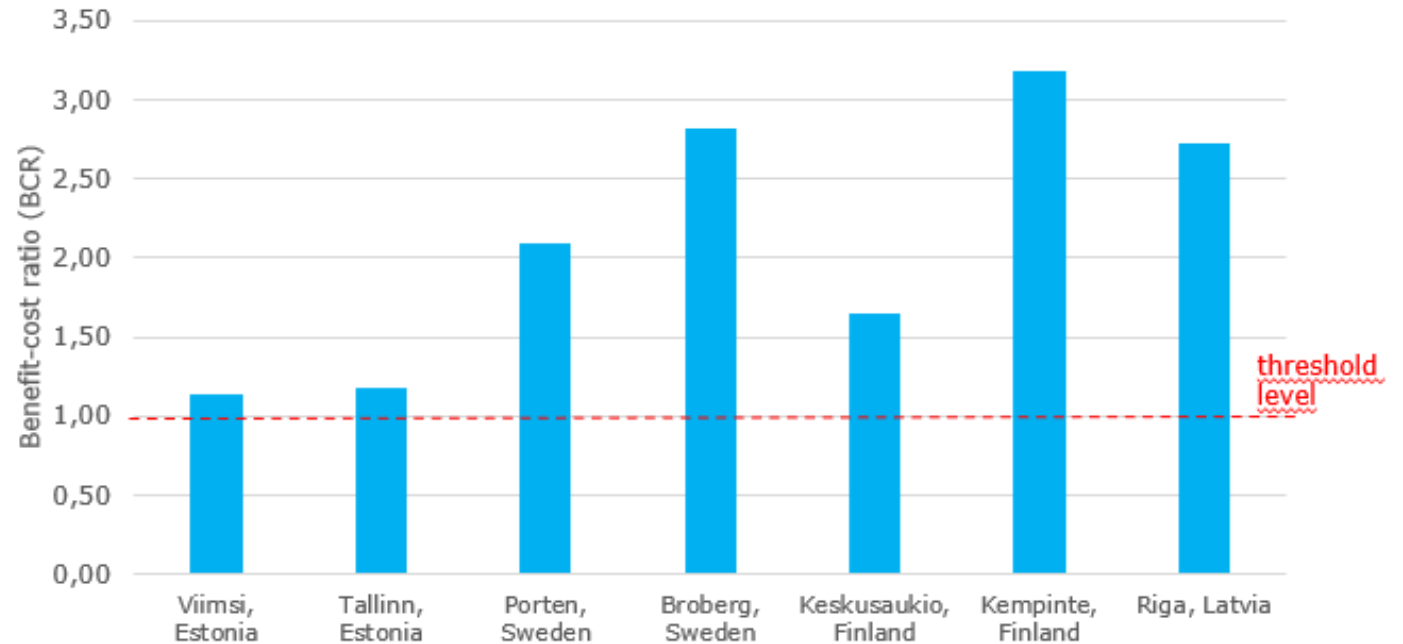


BENEFIT-COST ANALYSIS OF MULTIDIMENSIONAL NBS 1/2

Used Unit Prices

Benefit	Sub-cost	Cost (€)	Unit
Flooding reduction	Protection from flood risk (A. Biasin, 2023)	13.86	m2
Water quality improvement	Nitrogen reduction (J. Cetkovic, 2022)	44.35	kg
	Suspended solids reduction (J. Cetkovic, 2022)	0.01	kg
Cooling effect	Energy saving (A. Biasin, 2023)	0.76	m2
Well-being impact	Active open-green spaces (O. Güngör, 2022)	16.86	m2

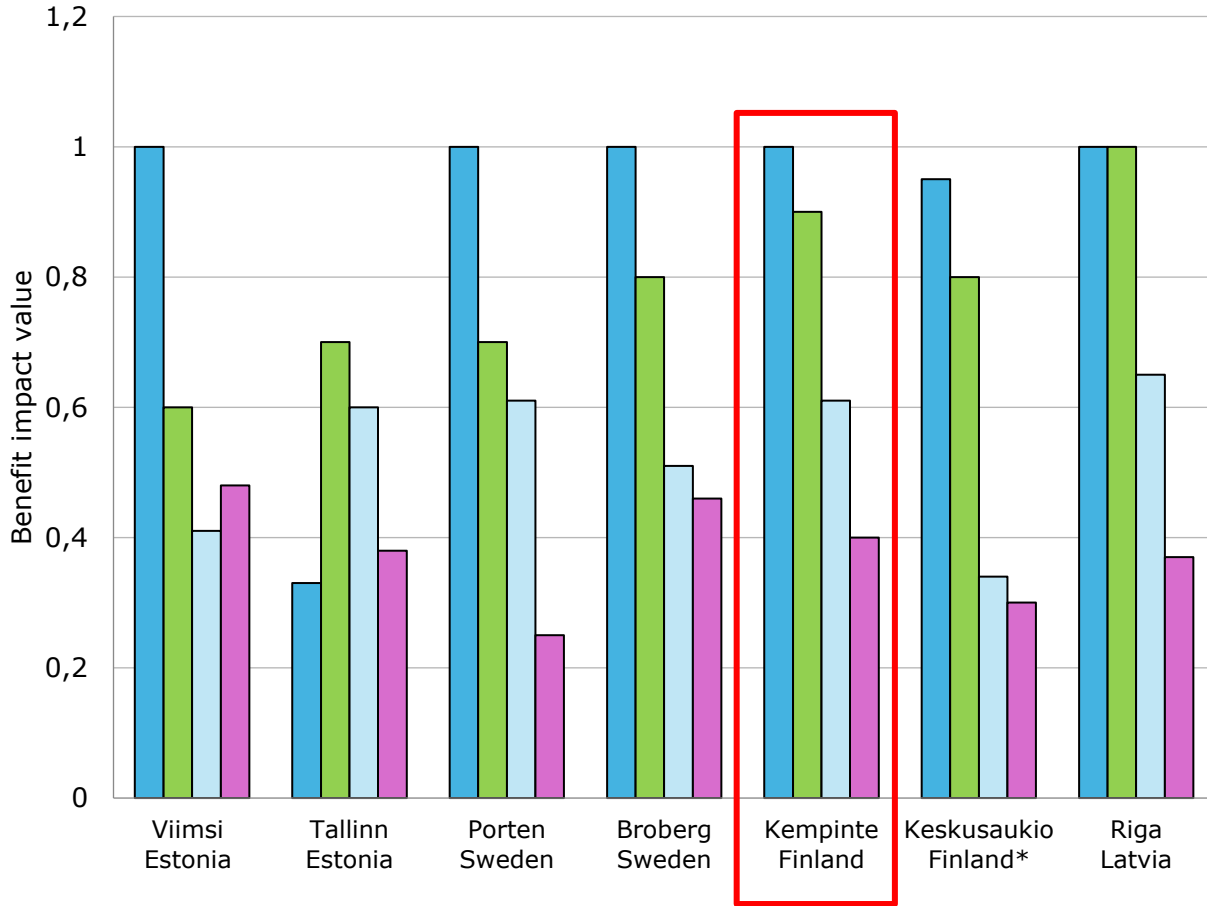
Benefit-cost ratio (CBR):



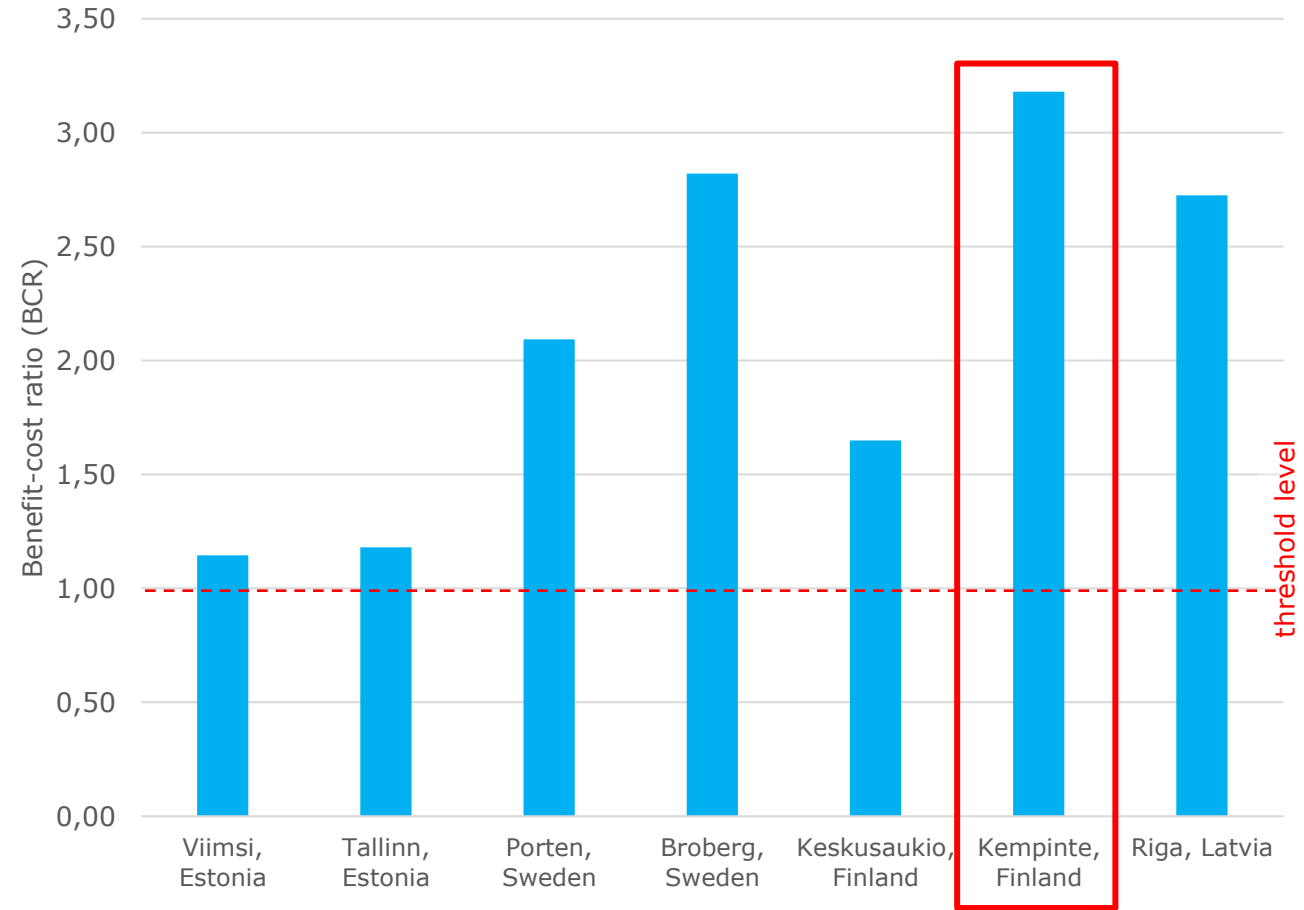
Pilot area	Investment	Cost NPV	Benefits NPV	Benefit-cost ratio (BCR)
Viimsi, Estonia	488,237.06 €	526,060.76 €	602,138.85 €	1.14
Tallinn, Estonia	394,157.30 €	428,808.08 €	505,978.45 €	1.18
Porten, Sweden	61,488.49 €	89,729.12 €	187,860.94 €	2.09
Broberg, Sweden	384,465.47 €	412,282.22 €	1,162,605.18 €	2.82
Keskusaukio, Finland	64,412.72 €	90,752.52 €	149,696.41 €	1.65
Kempinte, Finland	257,650.88 €	295,104.13 €	938,677.60 €	3.18
Riga, Latvia	368,989.10 €	406,442.35 €	1,107,810.38 €	2.73

BENEFIT-COST ANALYSIS OF MULTIDIMENSIONAL NBS 2/2

- Flooding reduction
- Water quality improvement
- Cooling effect
- Well-being impact

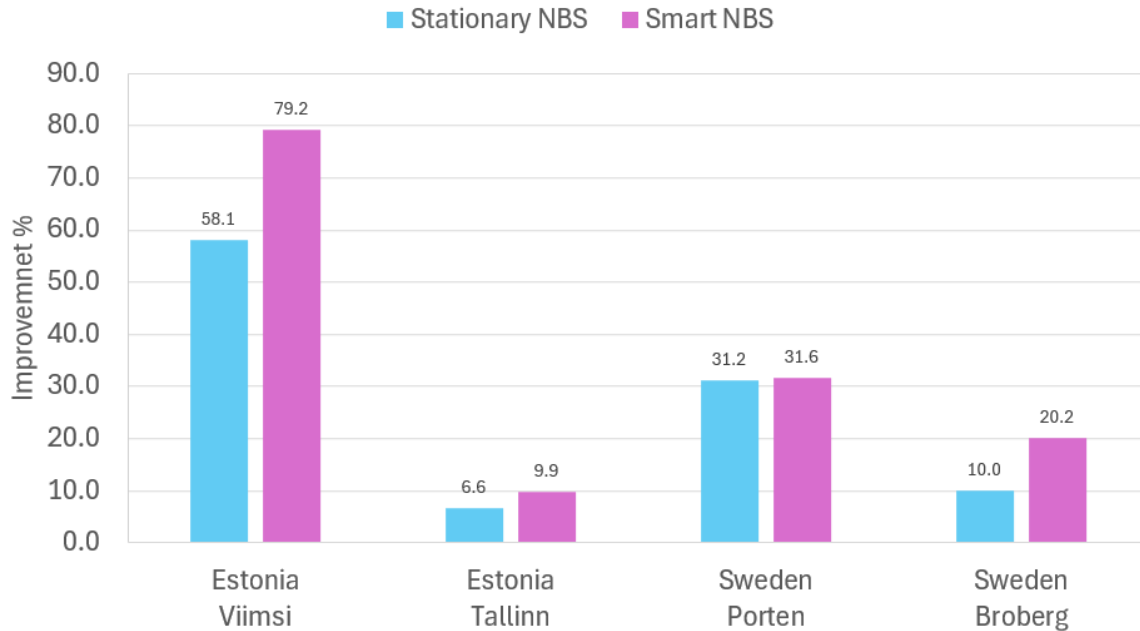


Benefit-cost ratio (BCR):

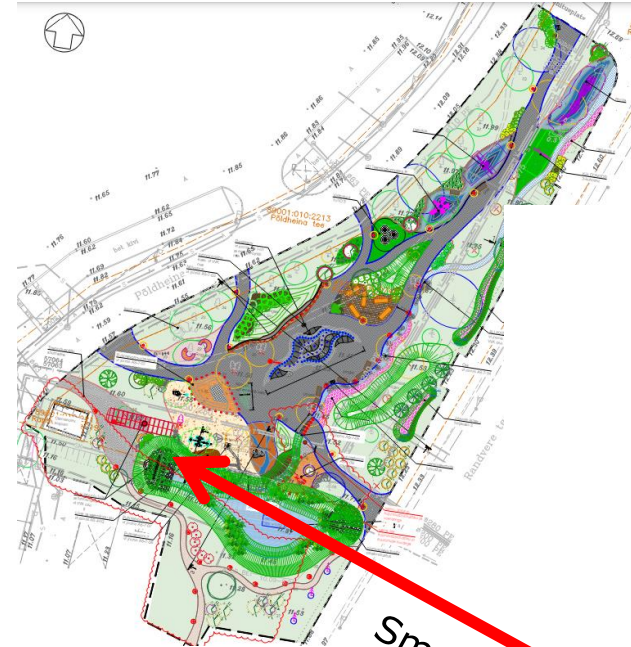


SMART MULTIDIMENSIONAL NBS

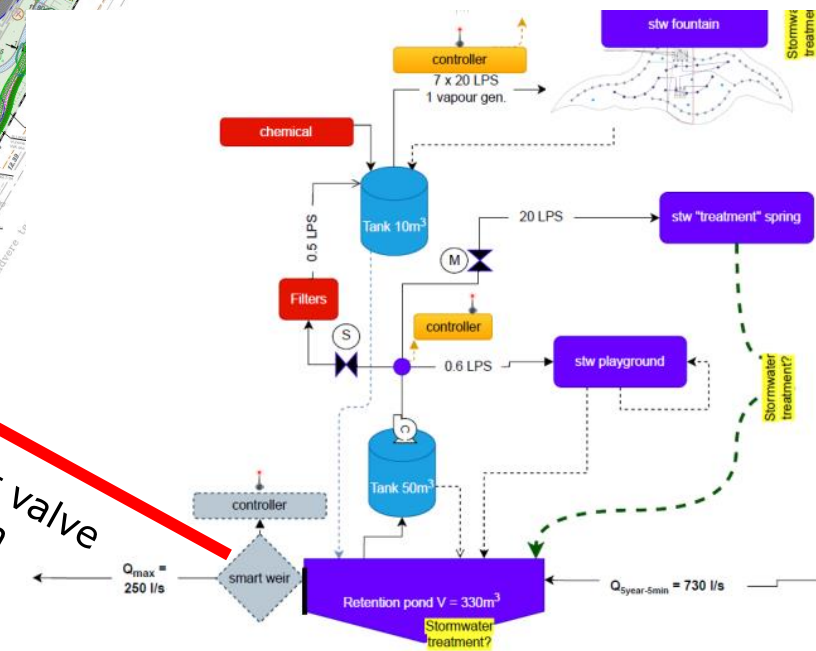
Flooding improvement based on SWMM flow volume



Viimsi layout plan



Viimsi technical water flow scheme



MULTIDIMENSIONAL ANALYSIS - CONCLUSION

- As the urban areas have limited space for NBS solutions it is important to understand the purpose of the solution and apply as many different benefits as possible
- An elaborated preliminary design makes NBS more profitable
- Smart elements in NBS can make urban areas more resistant for extreme weather events



Thank you! Questions?

'We are the first generation to feel the impact of climate change and the last generation that can do something about it'

~ Barack Obama