Interreg Baltic Sea Region

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SUSTAINABLE WATERS City Blues

MAINTAINING NATURE-BASED SOLUTIONS FOR STORMWATER MANAGEMENT

Monitoring findings and maintenance guidance for municipalities

D2.2 Maintenance guidance for nature-based solutions (NBS)

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Summary

Nature-based solutions (NBS) only deliver their stormwater benefits if they are maintained. Yet the City Blues partner cities reported that maintenance is often planned too late, responsibilities between departments are unclear and failures are rarely documented. In addition, staff and budgets are limited. Many small NBS are scattered across the city, which makes them hard to equip with sensors and to inspect regularly. This report responds to that gap. It is meant as **decision support** rather than another classic maintenance manual, of which many already exist: it helps a municipality decide how to find out what condition its NBS are in and how to turn that information into maintenance.

Part A reports what the Berlin Centre of Competence for Water (KWB) did and learned in City Blues together with the partner cities. A questionnaire and interviews in 2024 established how the partner cities maintain and monitor their NBS today. A systematic review, published as Kaur et al. (2025), identified 36 failure modes across the NBS life cycle, eight of which occur in operation and maintenance. Building on this, four complementary monitoring approaches were tested: digital manual inspection forms, low-cost LoRaWAN sensors in Aarhus, unmanned aerial vehicles (drones) in Malmö and citizen science in Tampere, complemented by campaigns on green roofs and infiltration swales in Berlin. The data of all four approaches come together in the **BGI Inspector**, a web application developed by KWB that serves as the data foundation of a maintenance support system for NBS.

Part B translates these findings into guidance. It distinguishes reactive maintenance, triggered by a failure that has already been noticed, from planned maintenance, scheduled either by calendar or by the observed condition of the asset. A decision table links each operation and maintenance failure mode to the symptoms that reveal it, the monitoring approach that detects it, the recommended maintenance strategy and typical actions. Recommendations are given for cities at different stages of NBS maturity. The guidance is summarised on the City Blues NBS model website, which is the project's main output.

In the partner cities, the campaigns were shaped by practical constraints such as sensor outages, changes in staff and limited participation of residents. Their quantitative results are therefore limited. They nevertheless delivered the training data for the automated drone analysis and the design principles for the citizen science campaign that KWB has run since July 2026 in cooperation with Berliner Wasserbetriebe and the Berliner Regenwasseragentur.

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1 Introduction

1.1 Why maintenance of NBS needs support

Over the last decade, cities in the Baltic Sea Region have built a growing number of nature-based solutions for stormwater management: swales, infiltration basins, rain gardens, green roofs, retention ponds, wetlands and flood meadows. Their planning and construction have received much attention. Their operation and maintenance have not. NBS are living, changing systems: vegetation establishes or dies back, sediment accumulates, surfaces clog and erode. The catchment around them changes as well. Without adequate maintenance they gradually lose the retention, infiltration and treatment capacity they were designed for, often without anyone noticing until a flood or a complaint reveals the problem.

At the start of City Blues, the partner cities were asked about their main challenges in monitoring and maintaining NBS (chapter 2). Four bottlenecks stood out:

- limited financial and human resources for operation and maintenance;
- NBS that are already built are difficult to retrofit with monitoring devices;
- many small solutions are scattered across the city, which makes high-tech monitoring of every asset impractical;
- there is no standard way to document condition, failures and maintenance.

These findings agree with international reviews of asset management for NBS (Langeveld et al., 2022). They also show that cities do not lack generic maintenance checklists. What they lack is a practical, affordable way to know **which** of their many NBS need attention, when and why.

1.2 Purpose and scope of this report

Deliverable D2.2 evaluates and compares maintenance strategies for NBS based on the findings from the partner cities, classifies them in a way that allows NBS to be taken into account in long-term strategic planning and (sewer) asset management. It also feeds into part C of the City Blues operational model (Output O1.4), the NBS model website. The report is therefore written as **decision support**: it does not repeat existing maintenance manuals, but helps a municipality choose how to monitor its NBS and how to plan maintenance from the information it collects.

The work behind this report followed three criteria for monitoring approaches that cities can realistically adopt. Approaches should be:

- **minimally invasive**, so that existing NBS can be assessed without construction work;
- **cost-effective**, so that municipalities can afford them beyond a research project;
- **able to cover large areas quickly**, so that a whole city's stock of NBS can be kept in view.

The focus is on NBS whose primary purpose is stormwater management and on their hydraulic functions: infiltration, retention, detention and evapotranspiration. Other objectives such as biodiversity, urban heat or social use are covered by the monitoring guidance on the NBS model website (City Blues, 2026a) and are only touched on here.

The City Blues application foresees monitoring and maintenance strategies for the NBS in the pilot areas of the partner cities. The pilots were completed late in the project or are still under construction. One pilot is a catchment plan. None of them could be monitored in operation over a period long enough to derive site-specific strategies. As anticipated in the questionnaire to the cities in 2024, the monitoring campaigns were therefore carried out on existing NBS with similar characteristics in the partner cities (chapter 6). Building on these campaigns, this report provides a generic monitoring and maintenance strategy that the partner cities can apply to their pilots once they are in operation. The decision table in chapter 9 links each failure mode to its symptoms, the monitoring approaches that detect it and typical maintenance actions. Chapter 10 gives the steps for cities at different stages of maturity. The monitoring guidance per NBS objective on the NBS model website complements this with parameters, frequencies and action triggers (City Blues, 2026a).

1.3 How to read this report

Part A – What we did and learned (chapters 2–7) documents the evidence base: current practice in the partner cities (chapter 2), the failure modes of NBS (chapter 3), the monitoring framework (chapter 4), the BGI Inspector (chapter 5), the monitoring campaigns (chapter 6) and a comparison of the approaches (chapter 7).

Part B – Maintenance guidance (chapters 8–10) is written for municipal maintenance and asset managers. Readers who want practical advice can start there and return to Part A for the background.

Throughout this report, **maintenance** means all activities that keep an NBS performing as intended, from routine care such as mowing and litter removal to repairs and renewal. **Monitoring** means collecting information (data) on the performance or condition of an NBS. A **failure mode** is the way in which an NBS stops performing as intended, for example clogging of an infiltration surface.

Part A – What we did and learned

Part A documents the evidence collected by KWB and the City Blues partner cities between 2024 and 2026.

2 Monitoring and maintenance practice in the partner cities

2.1 Approach

To design monitoring campaigns that fit the cities' needs, KWB first collected an overview of current practice. In summer 2024, the partner cities filled in a questionnaire on (1) existing NBS and available data, (2) maintenance and failure modes as well as (3) monitoring and technical infrastructure. Follow-up interviews were held with four partner cities in August and September 2024. The results are presented in combined form and are not attributed to individual cities.

2.2 Current practice in the partner cities

Table 1 summarises the range of practices reported by the partner cities. To keep the focus on common patterns, the results are combined across cities.

Table 1 Maintenance and monitoring practice in the partner cities, 2024 (combined questionnaire and interview results)

Topic	Practice reported by the partner cities
NBS data and register	Ranges from city-wide GIS data on NBS, partly published by the water utility, to no central register at all with information stored per project. In between, larger NBS are known to the utility or the technical department or are mapped in a non-public GIS.
Who maintains	NBS are usually maintained together with the surrounding park, street or public space by municipal staff, municipally owned companies or subcontractors. Where responsibilities are split, the split follows function: for example the utility for hydraulic function, the municipality for road drainage or cloudbursts, homeowner associations for appearance. In one city the water utility is not responsible for NBS at all.
Maintenance guidance	One city follows a national guideline. Another uses site-specific maintenance cards for its retention ponds. The other cities have no specific guideline for NBS maintenance.
Documentation	From standardised forms and checklists kept in semi-digital form over logbooks that are becoming digital to no systematic documentation.
Failure modes recorded	Only one city records failures systematically. Elsewhere failures are acted on when they become visible or are reported, or they are recorded only when the function is clearly not achieved.
Monitoring	Existing monitoring serves water quality, biodiversity or flow reporting rather than maintenance: biological monitoring of stormwater ponds, stream flow, online water quality sensors, manhole inflow sensors and earlier research on green roofs. LoRaWAN networks exist or have existed in three cities. Drones, satellite data or crowdsourced data collection are used occasionally. Visual checks often follow complaints.

2.3 Key findings

- **NBS are rarely maintained as assets of their own.** In most cities they are looked after together with the park or street they are part of. This works for appearance, but hydraulic functions such as infiltration capacity or outlet performance are not checked explicitly.

- **Responsibility is split.** Utilities, municipal departments, subsidiaries, contractors and private owners each maintain part of the stock. Where the boundaries are clear, cooperation works well. Elsewhere it is unclear who should act when an NBS underperforms.
- **Failures are seldom documented.** Only one city records function, failures and maintenance systematically, even there in a semi-digital form. Without such records, cities cannot see patterns, plan ahead or justify maintenance budgets.
- **Data are fragmented.** Most cities have no complete register of their NBS. Information sits in project folders, utility systems or the memory of individual staff members.
- **Monitoring focuses on water bodies, not on NBS condition.** Where monitoring exists, it serves water quality or biodiversity reporting rather than maintenance decisions. Sensor experience exists in some cities. However, reliability problems (missing or implausible data) were reported.
- **Cities were interested in all four approaches.** Suggestions ranged from cameras with image recognition for ponds and the use of existing LoRaWAN networks to mapping NBS from the air and involving residents through citizen science.

These findings shaped both the monitoring campaigns (chapter 6) and the design of the BGI Inspector (chapter 5).

3 Failure modes of NBS across the life cycle

3.1 Why failure modes matter for maintenance

Maintenance is, in essence, the prevention and correction of failures. To plan it, a city needs to know which failures typically occur, how serious they are, where in the life cycle they originate and whether they can be prevented. City Blues partners TalTech, KWB and the University of Stavanger therefore carried out a systematic literature review of failure modes of nature-based stormwater solutions, published in *Blue-Green Systems* (Kaur et al., 2025). This chapter summarises the results that are relevant for maintenance.

3.2 Approach and main results

The review followed the PRISMA methodology and analysed 76 studies. Each failure mode was assigned to a life cycle stage (planning, design, operation and maintenance) and classified along three dimensions:

- **severity**: critical failure or underperformance, judged by whether the NBS still fulfils its hydraulic function (runoff control, retention, infiltration);
- **origin**: intrinsic (flaws within the system, such as design assumptions or materials), extrinsic (external pressures such as climate variability or urban densification) or induced (human action after implementation, such as improper maintenance);
- **preventability**: preventable, complexity-related or intelligent (failures from deliberate experimentation).

In total, **36 failure modes** were identified: 14 in planning, 14 in design and 8 in operation and maintenance (Figure 1). Preventable and intrinsic failures dominate the planning and design stages, while induced failures dominate operation and maintenance. Early-stage weaknesses cascade: insufficient stakeholder input in planning can lead to unsuitable vegetation in design and then to die-off or vandalism in operation. Planning at catchment scale reduces the probability and severity of failures in later stages.

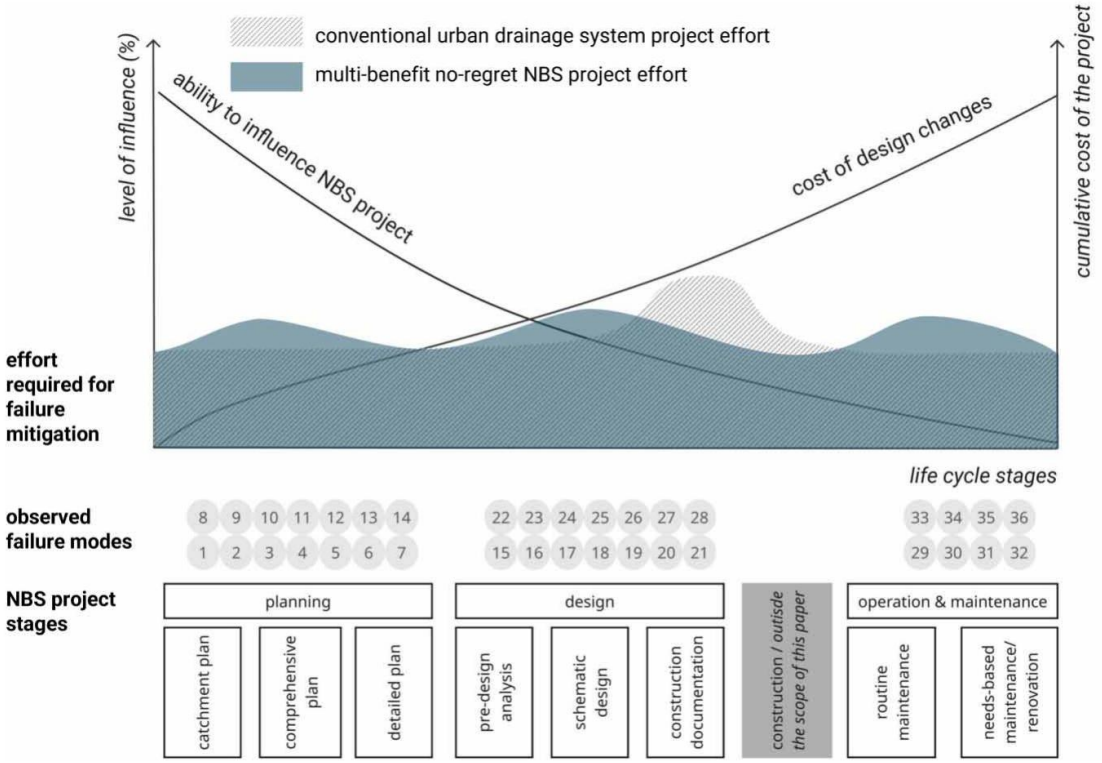


Figure 1 Failure modes observed across the NBS life cycle and the ability to influence an NBS project over time (graphical abstract of Kaur et al., 2025)

3.3 Failure modes in operation and maintenance

Table 2 lists the eight failure modes of the operation and maintenance stage. Six of the eight are induced and preventable: they result from insufficient or unsuitable maintenance and can be avoided with systematic maintenance planning and oversight. These failure modes form the backbone of the guidance in Part B.

Table 2 Failure modes in the operation and maintenance stage (after Kaur et al., 2025, Table 4)

No.	Failure domain	Failure mode	O&M stage	Severity	Origin	Preventability
29	Infiltration	Clogging due to sediment accumulation, particle size, media breakdown and ageing	Routine; needs-based	Critical	Induced	Preventable
30	Infiltration	Winter conditions reduce infiltration in swales (ice lenses, frost, snow)	Routine	Underperformance	Extrinsic	Complexity-related
31	Infiltration	Surface clogging of porous pavements due to debris build-up	Routine	Underperformance	Induced	Preventable
32	Retention, detention, evaporation	Soil erosion	Routine	Critical	Induced	Preventable
33	Retention, detention, evaporation	Degradation of vegetation (deteriorated plant health) causing loss of evapotranspiration	Needs-based	Underperformance	Induced	Preventable
34	Retention, detention, evaporation	Sediments not removed; accumulation limits storage	Routine	Critical	Induced	Preventable

No.	Failure domain	Failure mode	O&M stage	Severity	Origin	Preventability
35	Retention, detention, evaporation	Outlet structure malfunctions due to insufficient maintenance	Routine	Critical	Induced	Preventable
36	O&M capacity	Poor operational oversight and lack of performance monitoring	Routine; needs-based	Underperformance	Intrinsic	Preventable

3.4 What this means for maintenance

- **Most O&M failures are preventable.** Clogging, erosion, sediment build-up, outlet malfunction and vegetation loss can be avoided or limited by timely maintenance, provided someone notices them early.
- **Failures announce themselves.** Many failure modes show visible symptoms before they turn into hydraulic failure: standing water after rain, bare patches, deposits at the inlet, vegetation over a drain. Monitoring can target these symptoms rather than measuring performance directly.
- **Lack of oversight is itself a failure mode.** Failure mode 36, poor operational oversight and lack of performance monitoring, is the organisational root of many others. A register of NBS and a routine to record their condition are therefore the first maintenance measure.
- **Design decisions shape maintenance.** Failures such as missing maintenance access or designs without maintenance guidance (failure mode 18) originate in planning and design but surface in operation. Maintenance teams should be involved before an NBS is built.

4 Monitoring framework

4.1 What to monitor: performance, failure modes and influencing factors

The objectives of an NBS, such as flood prevention, are described by **performance parameters**: runoff reduction, peak attenuation, infiltration rate or drawdown time. In practice, performance is reduced by **failure modes** and influenced by **external and internal factors** such as rainfall, temperature, initial soil moisture, design and age (City Blues, 2024a). All three can be monitored. Measuring performance directly gives the clearest answer but is expensive and oftentimes only feasible for NBS with clearly defined boundaries, such as green roofs. Observing failure modes and their symptoms is cheaper and works for any NBS, but is less exact. Influencing factors, above all rainfall, are needed to interpret both: standing water two days after a heavy storm means something different from standing water after a dry week.

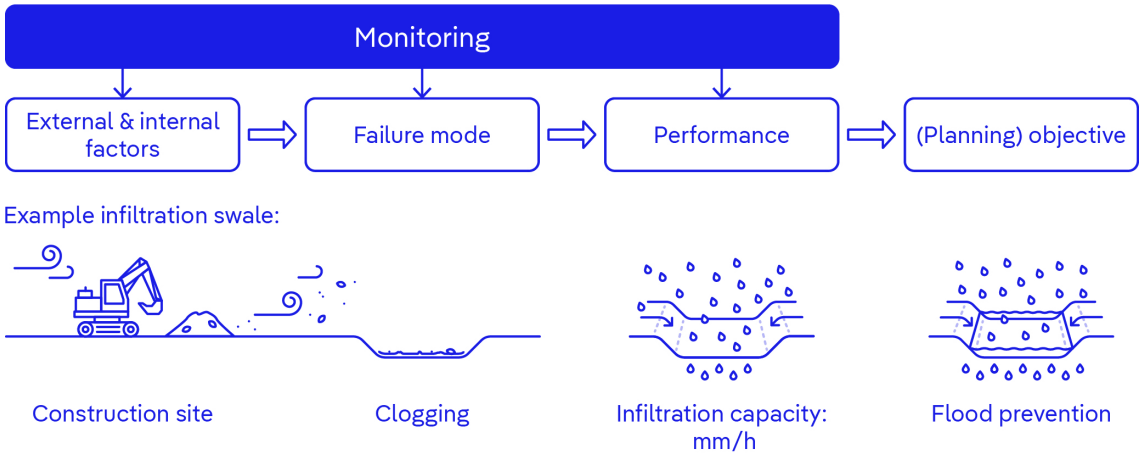


Figure 2 Structure of NBS using the example of an infiltration swale: external and internal factors cause failure modes, which reduce performance and thus the (planning) objective. Monitoring can address each step (adapted from KWB, 2024)

4.2 Four complementary monitoring approaches

Based on the cities' needs and the three criteria in section 1.2, City Blues tested four complementary approaches (Table 3). Digital manual inspection is the **reference**: a low-tech method that any city can use and against which the other approaches are compared.

Table 3 Monitoring approaches tested in City Blues

Approach	What it observes	Typical use	Tested in
Digital manual inspection forms	Visible condition and symptoms of failure modes, maintenance needs, photos	Routine inspections of any NBS type; reference for the other approaches	All campaign cities, Berlin
Low-cost LoRaWAN sensors	Water levels, soil moisture, local weather, continuously and remotely	Key assets where hydraulic performance must be tracked over time	Aarhus
Unmanned aerial vehicles (drones) with RGB and multispectral cameras	Vegetation cover and vitality, structural defects, trash, standing water, over large areas	Green roofs and large or inaccessible NBS; city-scale surveys	Malmö, Berlin
Citizen science	Problems noticed by residents: blockages, standing water, damage	NBS in public space with regular passers-by; early warning between inspections	Tampere, Berlin

4.3 Research questions

For each approach, KWB and the cities agreed on research questions and indicators before the campaigns started (Table 4). A fifth line of work asked how the data from all approaches can be brought together in one data model; this became the BGI Inspector (chapter 5).

Table 4 Research questions of the City Blues monitoring work

	Research question	Indicators
A Manual inspection forms	How can a digital inspection form be designed to document failure modes and maintenance needs? Is it suitable for daily municipal routines?	Completion and usability; feedback and adoption by municipalities

	Research question	Indicators
B LoRaWAN sensors	How effective are low-cost sensors in detecting failure modes, such as clogging of infiltration measures and of inlets and outlets, compared to manual inspection? Can results from one monitored NBS be transferred to similar NBS nearby?	Detected clogging events; reduced sensor needs
C Drones (UAV)	Can drones detect failure modes of green roofs, infiltration measures and wetlands more accurately and efficiently than manual inspection and can they make maintenance more efficient?	Detected failure modes; time of inspection; maintenance resources
D Citizen science	What is the potential of citizen reports for detecting NBS failure modes? How should a campaign be set up to get useful reports?	Number and quality of reports compared to inspections
E Smart data model	How can data from different approaches, NBS types and planning objectives be integrated in one interoperable data model?	Applicability and integration

5 The BGI Inspector: digital support for NBS maintenance

The BGI Inspector is the data foundation of the maintenance support system that KWB set out to develop in City Blues. It brings the four monitoring approaches together in one place and turns observations into maintenance findings. Today it records condition; the decision layer that recommends what to do is the next development stage (section 5.9). Part B of this report is a first, manual version of that decision layer.

5.1 What it is and who uses it

The BGI Inspector is a web application developed by KWB in the City Blues project. It gives a municipality or a utility one place for the condition of its NBS: a register of assets such as green roofs, infiltration swales and bioretention areas, four ways of collecting their condition and a review workflow that turns observations into maintenance findings. The web application runs in a normal browser. The field forms run on any phone or tablet without an app. Every organisation works in its own workspace and the whole tool is bilingual, German and English.

In Berlin two organisations test it today. One KWB used workspace holds green roofs and swales and is the testbed for the drone workflow. Berliner Wasserbetriebe (BWB), the Berlin water utility, monitors about 70 infiltration swales with manual inspections and citizen reports from QR codes on the assets (section 6.4). The functions below are described in the order a maintenance team meets them: register the assets, collect condition data, review and act, adapt the tool to the organisation.

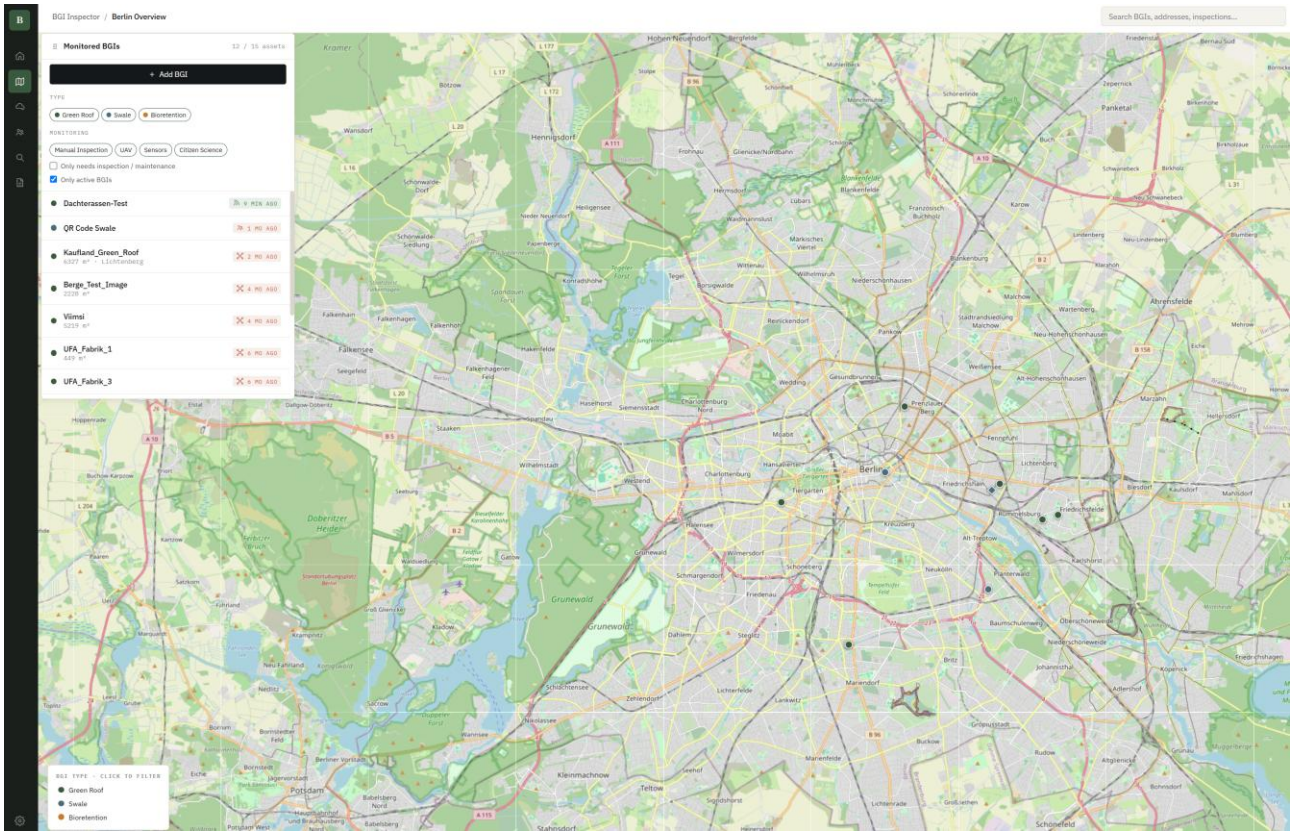


Figure 3 Dashboard map with all assets of a workspace, status chips showing the newest data per asset and the filters for type, monitoring approach and "only needs inspection / maintenance"

5.2 The asset register

Every asset is a record with a type, a position on the map, address, size, district and the monitoring approaches that are active for it: manual inspection, citizen reporting, sensors, drone. The three built-in types are green roof, swale and bioretention; a workspace can add its own types. The map is the daily entry point: each asset carries a chip with its newest data point and the source it came from and the list can be reduced to the assets that currently need inspection or maintenance.

Each asset has a detail page with one tab per approach: Overview, Manual inspection, UAV (drone), Sensors, Citizen Science, Maintenance & reports and Downloads. The Overview tab also provides the asset's QR codes. One code opens the manual inspection form for the field team, the other opens the public citizen form. For citizen reporting the tool generates a printable sign in the organisation's design, as PDF or PNG, so the code can go onto the asset itself.

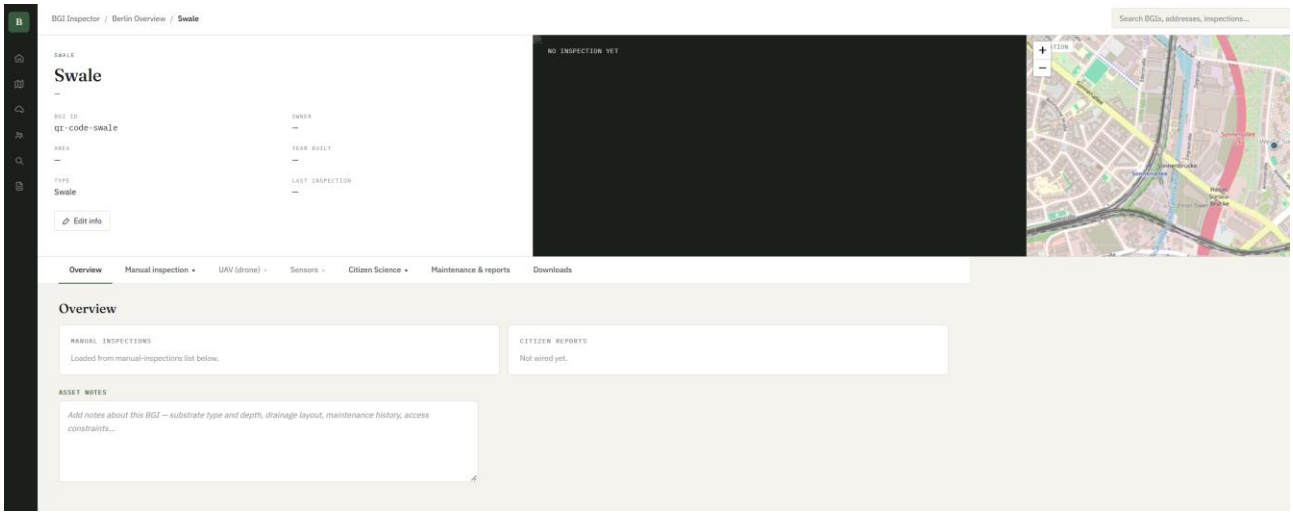


Figure 4 Asset detail page, Overview tab, of a swale: basic data, active monitoring approaches, map position and the QR codes for the field form and the citizen form

5.3 Manual inspection on a tablet

The inspector scans the asset's QR code or opens the form from the asset page. The form has a general part (facility, address, date and time, weather, date of the last inspection, inspector), a site-context part (rain in the last 48 hours, site plan available; for green roofs also irrigation and soil test) and the checklist. The built-in checklists for green roofs and swales are adapted from established municipal inspection checklists and grouped into sections such as vegetation, inlet and overflow, main treatment area and the draining property. Each item is answered yes, no or not applicable, with an optional comment and an "action needed" flag. Items can carry their own camera button, so a photo documents the exact question it belongs to; a general photo card at the end remains available. Notes and a "wet-weather inspection needed" flag close the form.

Submitted inspections appear on the asset page with the number of positive findings and flagged actions. Opening one shows every answer, comment and photo under its question. The form keeps the wording the inspector actually saw, so a later change of the checklist never alters past records.

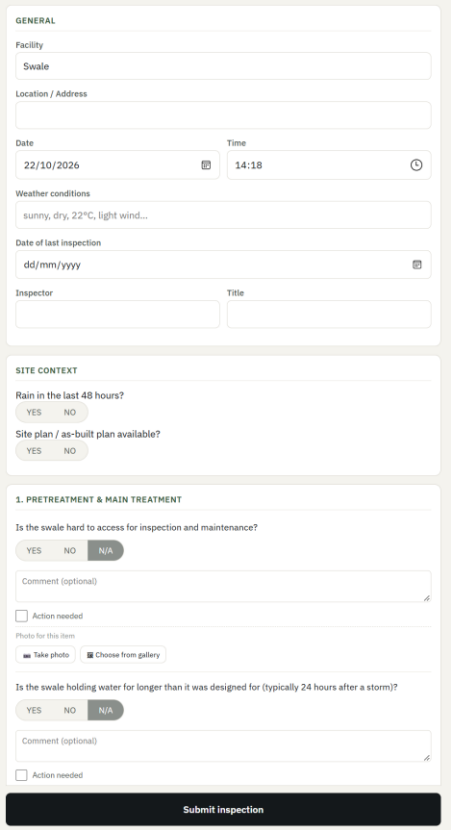


Figure 5 Manual inspection form on a phone: the general part, the site context and the first checklist section with a photo row on one item

5.4 Citizen reporting with QR signs

A weatherproof sign on the asset invites passers-by to report what they see. Scanning the code opens a short questionnaire, anonymous and without any app or account: for swales, standing water for several days, deposits, erosion, damage, a free-text field and photos. The report lands in the organisation's review queue with the status "new". The team verifies it on site and sets it to reviewed, actioned or dismissed. After sending, the reporter sees how many reports the fleet received in the last 30 days, which keeps the sign credible.

Two counters make the campaign measurable. An anonymous scan counter records how often each sign was scanned, by day, without IP addresses or cookies, so the organisation can see how many scans turn into reports. The sign register records the date each sign went into the field and the date it was taken down, which gives the honest denominator for the reporting yield.

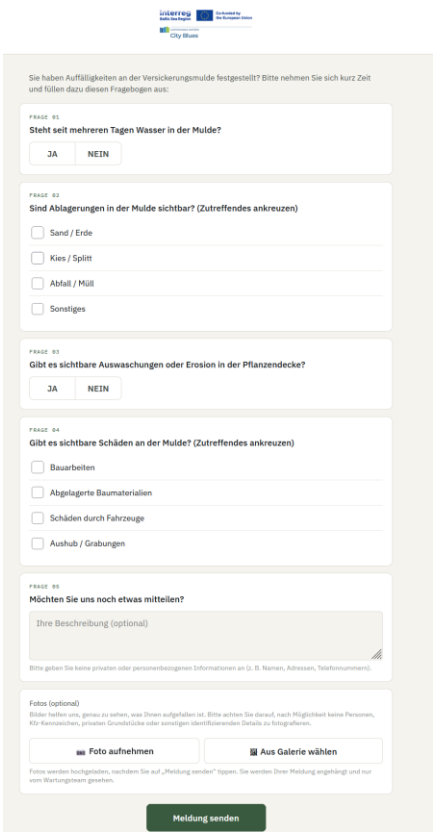


Figure 6 Citizen form on a phone: the five questions for a swale, the photo option and the privacy note

5.5 Sensors

Sensors on or near an asset are connected through LoRaWAN interface. The platform polls each device every five minutes, a decoder, editable in the settings, translates the device payload into named measurements and the readings are stored as a time series. A sensor is either linked to one asset or global, for example a weather station serving the whole workspace. Thresholds per measurement raise an alert on the asset. The Sensors tab shows the time series with a selectable range. The Downloads tab exports it as CSV.

In Berlin a weather station and a climate sensor deliver temperature, humidity, air pressure, solar radiation and rainfall. They provide the weather context for reading inspections: standing water two days after heavy rain means something different from standing water after a dry week.

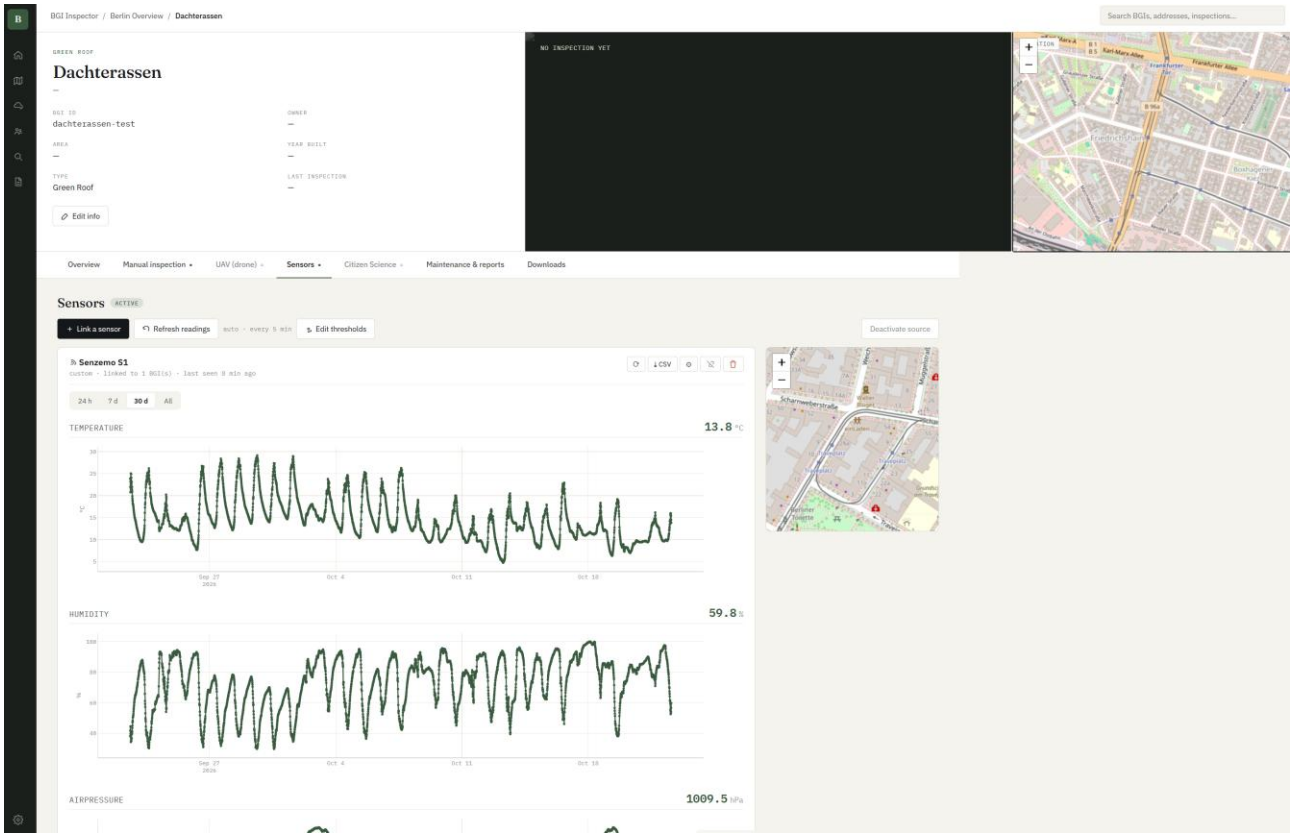


Figure 7 Sensors tab of an asset with a linked weather station: the measurement chart with range selection and the threshold settings

5.6 Drone inspection (research grade, in development)

The drone workflow turns a flight over a green roof into a condition and defect assessment. It is used on Berlin test roofs and is still being validated; it is described here because it shows where automated condition assessment is heading, not as a finished product. It builds on the workflow presented by Schütz et al. (2026). A flight delivers an RGB orthomosaic and an NDVI raster, the standard vegetation index from multispectral imagery. The workflow has four steps:

- **Mission data:** upload the two rasters; the tool records the weather and the rainfall of the preceding 48 hours automatically.
- **Roof mapping, once per roof:** the roof areas are delineated automatically. The operator marks keep-clear zones (fire strips, gravel margins, paving) and drains. Everything is stored georeferenced, so later flights reuse the mapping.
- **Condition assessment:** vegetation cover and bare patches, vitality and the trend against the previous flight.
- **Defect detection:** trash, vegetation over drains, standing water as well as vegetation encroaching into keep-clear zones.

Every automated finding is reviewed: the operator confirms or dismisses it. All thresholds are parameters per roof, stored in versions, so a changed threshold can never masquerade as a change on the roof. The picture of each step, with exactly the layers switched on, can be downloaded as an image for reports and meetings.

HOW IT DECIDES: VEGETATION COVER AND BARE PATCHES
Every pixel of the roof area, minus zones and built-in structures, is classified as living vegetation or not from the NDVI value. Cover is the share of vegetated pixels, counted rather than averaged, so one thriving patch cannot hide a dead one. The target follows the FLL green-roof guideline: 90 % cover is fine, below 80 % is a failure. Bare patches larger than half a square metre are listed individually.

HOW IT DECIDES: VITALITY AND TREND
Vitality looks only at the vegetated pixels and reports how healthy they are, independent of how much vegetation there is; falling vitality at stable cover is the early warning for drought stress. The trend compares cover with the previous flight of the same roof, in percentage points. It does so only when both were measured with the same parameters.

HOW IT DECIDES: TRASH
A trained detector scans the roof image in tiles and marks objects it recognises as trash, each with a confidence value. Boxes that are mostly living vegetation are hidden, because healthy sedum is the detector's typical mistake. The operator confirms or dismisses the rest.

HOW IT DECIDES: DRAINS AND STANDING WATER
For each mapped drain the tool measures how much of the grate is covered by vegetation, the visible precursor of a blocked outlet. Standing water is found where the NDVI shows no plant signal, the surface is smooth and dark and the area is at least one square metre; water next to a drain is rated critical.

HOW IT DECIDES: KEEP-CLEAR ZONES
Each zone type has a tolerance for vegetation: practically none on fire strips, some on gravel margins, following the BuGG guidance. The tool measures the vegetated share per zone and marks encroachment above the tolerance, with the affected patches drawn on the image.

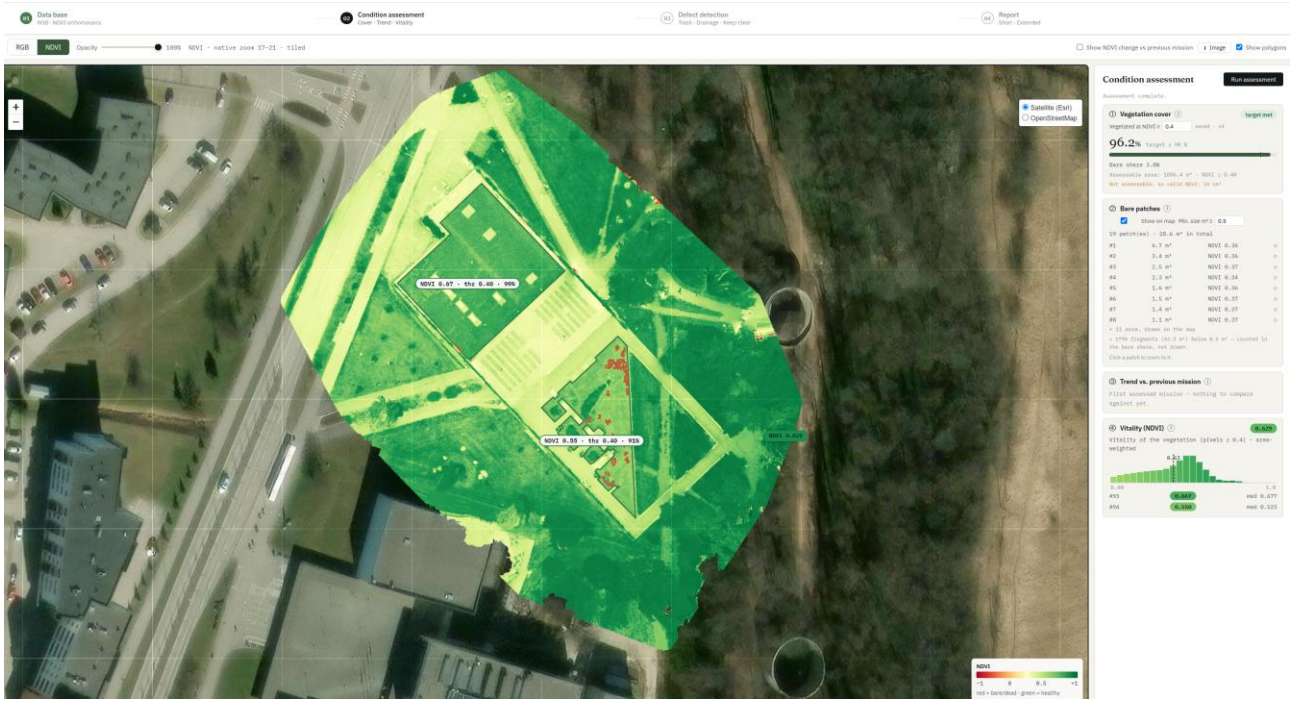


Figure 8 Condition assessment step of a drone mission: the sidebar with cover, bare patches, vitality and trend together with the map with the bare patches drawn on the roof

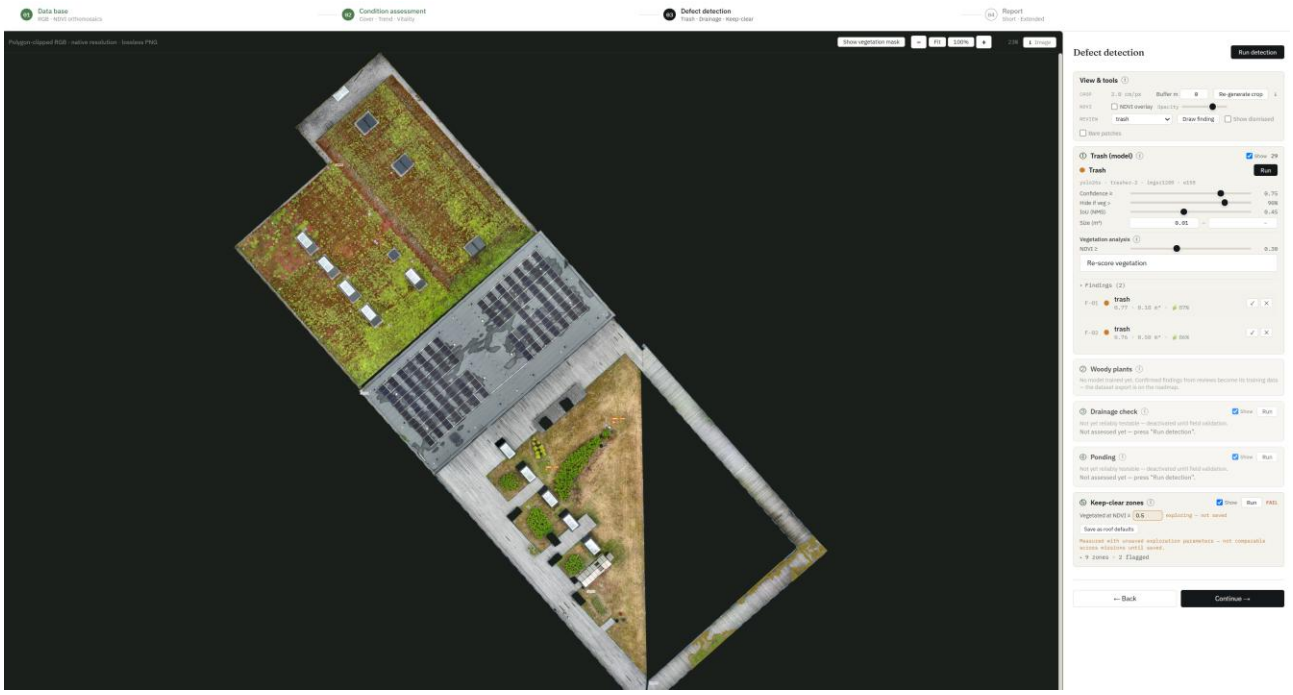


Figure 9 Defect detection step: the roof image with trash detections, zone outlines and encroachment together with the block list with the review buttons

5.7 Reviewing findings and acting

All four sources end in the same place: a finding or an inspection record with a status. Citizen reports move from new to reviewed to actioned or dismissed. Manual inspections carry their action flags. Drone findings are confirmed or dismissed. The map filter "only needs inspection / maintenance" lists the assets with open items. The status chips show at a glance which source last reported.

For a drone mission the tool generates a report, short or extended, with the annotated roof map, the numbered findings with photos, a prioritised list of actions and, where a previous flight exists, the comparison. A report is a frozen snapshot: later re-analysis never changes it. An optional AI-written summary can be added; it works from the structured results only, never from the imagery. The report is complete without it. The Downloads tab exports what a city needs for its own systems: drone rasters, polygon geometry, sensor time series and citizen reports as CSV. A maintenance task list that fills itself from inspections and keeps a completed history is planned for the next iteration.

5.8 Adapting the tool to an organisation

Both forms, the citizen questionnaire and the manual checklist, are edited per asset type by the workspace administrator in the settings, in both languages at once. Questions can be yes/no, single choice, text, number, date or a checklist row; sections can be added and reordered; the general part of the manual form can be renamed and fields can be hidden; and each item can be given a photo button. Every save creates a new version. Earlier answers keep rendering against the version they were given with. The QR links on printed signs never change.

Workspaces keep organisations strictly apart. Within a workspace an administrator manages users and their role, administrator or member, assigns the default language and maintains the asset types and sensor decoders. The platform operator holds a separate administrator role across workspaces for setup and support.

5.9 Outlook: from condition record to decision support

The BGI Inspector today records condition; it does not yet recommend what to do. The next development stage turns the record into decision support: a maintenance-need score per asset, inspection and intervention scheduling informed by rainfall, sensor alerts, citizen reports and imagery as well as explicit rules that link observed symptoms to causes and actions, so that maintenance can move from fixed calendars to the actual state of the asset. The decision table in chapter 9 is a first, manual version of these rules. Biodiversity-aware rules, which tolerate spontaneous vegetation where it does no hydraulic or safety harm, are part of that direction.

6 Monitoring campaigns

Table 5 gives an overview of the campaigns. Each campaign is described with the same structure: objective, site and set-up, outcomes and lessons learned.

Table 5 Overview of the City Blues monitoring campaigns

Campaign	NBS	Approaches	Period
Aarhus	Two infiltration-retention filters in Trige	LoRaWAN sensors, weather station, digital manual inspection	From May 2025 – August 2026
Malmö	Green roof (Risberga school), urban wetland (Toftanäs), large swale – Risberga catchment	Drone (RGB and multispectral), manual inspection	Flights from May 2025 – August 2025
Tampere	Retention basin (Kuminapolku), bottom dam of the Varsanpuisto flood meadows	Citizen science (information signs)	From autumn 2025 - today
Berlin	Green roofs (drone testbed); about 70 infiltration swales in Karlshorst and Adlershof (with BWB and RWA)	Drone, weather sensors, manual inspection, citizen science (QR codes, signs, flyers, information walk)	From July 2026 - ongoing

6.1 Aarhus: low-cost LoRaWAN sensors on infiltration basins

Objective

Clogging is one of the most common and most critical failure modes of infiltration measures (failure mode 29). It develops slowly and is usually discovered only when water stands in the basin for days. The Aarhus campaign tested whether low-cost LoRaWAN sensors can detect decreasing infiltration capacity early enough to trigger maintenance before the problem becomes visible. It also tested whether they can monitor infiltration basins more efficiently than manual inspection (research questions B.1 and B.2).

Site and set-up

The infiltration and retention systems in Aarhus are operated by the City of Aarhus and the utility Aarhus Vand to manage stormwater and protect the receiving streams. Two infiltration-retention filters in Trige were equipped as pilot sites. At each site, soil moisture sensors were installed at two depths (10 and 30 cm) and water level sensors in the manholes to measure inflow. A weather station records local climate conditions. All devices transmit via LoRaWAN, which allows long-range, low-energy communication suitable for distributed NBS. The campaign started in May 2025.

Digital manual inspections were carried out in parallel as the reference against which the sensor data were to be evaluated.

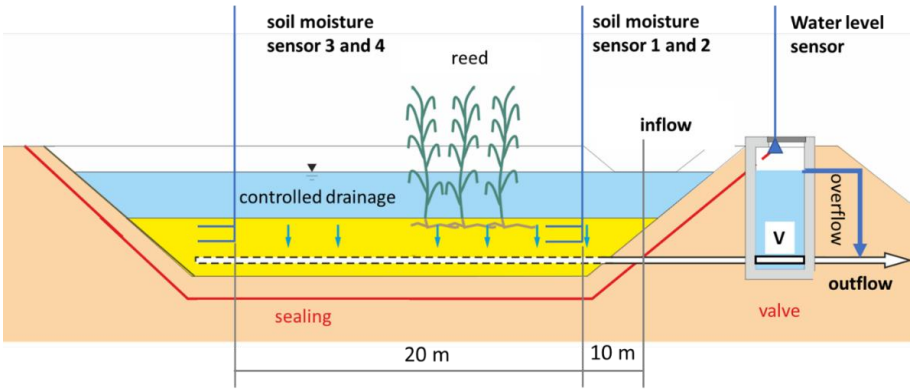


Figure 10 Measurement concept for the Aarhus infiltration basins: soil moisture at two depths, water level in the inflow manhole and weather station

Outcomes and lessons learned

The installation in May 2025 showed that low-cost LoRaWAN sensors can be fitted to existing infiltration-retention filters and their manholes with little effort. Over the campaign period up to August 2026, however, the data basis remained too fragmented for the planned evaluation. Individual sensors failed or delivered implausible values. Changes in staff interrupted the joint routines for checking the devices and carrying out the reference inspections. A continuous record that would allow planned and actual infiltration capacity to be compared over several rain events could therefore not be established. The same applies to the comparison of sensor data with manual inspections.

The campaign nevertheless delivered practical lessons for cities that want to use sensors on NBS:

- **Sensors need maintenance too.** Batteries, data transmission and the plausibility of values have to be checked regularly. Otherwise gaps remain unnoticed until the data are analysed.
- **Responsibilities must be agreed before installation.** Who owns the devices and the data, who checks them and who reacts to alerts should be fixed in writing so that the arrangement survives changes in staff.
- **Sensors suit a few key assets.** The effort per site confirms that continuous sensing is worthwhile for representative or critical NBS rather than for every swale or basin.
- **Manual inspection remains the reference.** Without regular inspections, sensor signals can neither be interpreted nor validated.

6.2 Malmö: drones for condition assessment

Objective

The Malmö campaign explored whether drones can provide faster and more precise condition assessments than manual inspections and whether they can make maintenance more efficient (research questions C.1 and C.2). The aim was a largely automated workflow in which objects are detected, failure modes are classified and a written evaluation report is generated.

Site and set-up

The campaign took place in the catchment of the Risberga stream, the City Blues pilot area of Malmö. Three NBS types were monitored: a green roof on Risberga school, an urban wetland and a large swale. Flights were carried out with a DJI Mavic 3M carrying a 20 MP RGB camera and a 5 MP multispectral sensor, which allows both visible structural issues and vegetation health (NDVI) to be assessed. Images were processed into orthomosaics with the open-source software WebODM and analysed with a Mask R-CNN object detection model (Detectron2) and NDVI-based vegetation indicators; a language model compiles the structured findings into a report (Schütz et al., 2026). Monitoring began in May 2025. Analysis of the images required approval from the Swedish authorities, which delayed the evaluation; a first demonstration of the workflow was therefore built with drone data from Brandenburg, Germany.

in 

Figure 11 Drone-based condition assessment: example of UAV image

Outcomes and lessons learned

All flights were completed between May and August 2025. When the images were processed, it became clear that the flight settings had not been applied consistently across all missions. The image series was therefore not suitable for a systematic comparison with manual inspections or for tracking changes between flights. Together with the time needed for the data authorisation, this meant that the research questions on detection accuracy and inspection time could not be answered with the Malmö data.

The images were nevertheless valuable. They were annotated and used to train the Mask R-CNN object detection model that now forms part of the drone workflow of the BGI Inspector (section 5.6). The experience also shaped the procedure for the drone flights over green roofs in Berlin (section 6.4).

Lessons for municipalities:

- **Fix a flight protocol before the first flight.** Altitude, image overlap, time of day and camera settings should be defined once and documented with every mission so that flights can be compared.
- **Clarify data permissions early.** Approval for collecting and using aerial images can take months. It should be requested together with the flight permits.
- **Plan for training data.** Automated detection needs annotated images. Early flights are valuable for building this data set even before they can be used for condition assessment.

6.3 Tampere: citizen science with information signs

Objective

Tampere receives feedback from residents mostly as e-mails with an address and a short description of a problem, for example that a forest is flooding. The campaign tested how citizen science can systematically support the monitoring of NBS: can residents help detect visible failure modes and provide reliable input for maintenance planning? How should such a campaign be set up to obtain useful reports (research question D)?

Site and set-up

Two information signs were installed at NBS in autumn 2025 (Figures 12 and 13; sign texts in Annex A):

- **Kuminapolku stormwater basin.** The basin retains and treats rain and meltwater and protects Lake Kaukajärvi from eroded soil. The sign explains that the basin does not work properly if, for example, the grated overflow well near Kuminapolku is blocked, shows a photo of a blocked and a cleaned well. It asks residents to fill in a short survey via a QR code.
- **Bottom dam of the Varsanpuisto flood meadows.** The dam, part of the City Blues pilot, raises water onto the flood meadows during heavy rain and snowmelt and leaves an opening for fish such as the endangered brown trout. The sign shows the normal situation and the situation after heavy rain. It asks residents to contact the city service point by e-mail or phone if debris or ice block the opening and the water has not dropped within a few days.

The two signs thus test two reporting channels: a structured online survey and the city's existing service point.



Figure 12 Information sign at the Kuminapolku stormwater basin, Tampere, with QR code to the reporting survey (photo: City of Tampere)



Figure 13 Information sign at the bottom dam of the Varsanpuisto flood meadows, Tampere (photo: City of Tampere)

Outcomes and lessons learned

The signs have been in place since autumn 2025. No malfunction of the basin or the dam occurred during the campaign that would have required a report. The campaign therefore produced no data set from which the reliability of citizen reports could be assessed.

A quiet sign is not necessarily a failed sign: if an NBS works, there is nothing to report. To tell the two situations apart, a campaign needs to know how often a sign is noticed at all. These insights, together with the Malmö drone campaign, formed the basis for the Berlin campaigns (section 6.4). These place a QR code on each asset, count every scan anonymously and accompany the signs with flyers, information boards and a guided walk.

Lessons for municipalities:

- **Measure attention, not only reports.** A scan counter shows whether residents notice a sign even when they have nothing to report.
- **One code per asset.** A QR code on each NBS locates a report precisely and lowers the effort for residents.
- **Combine signs with outreach.** Flyers, information boards and guided walks explain why NBS matter. This makes reporting more likely.
- **Use existing channels.** Reports should reach the unit that can act, ideally through the city's existing service or feedback system.

6.4 Berlin: complementary transfer and validation campaigns

Berlin is not a City Blues pilot city, but as KWB's home city it served as a test and validation site for the approaches before and alongside the partner-city campaigns. Equipment was tested in Berlin before installation in the partner cities. The experience from Malmö and Tampere was transferred into two Berlin campaigns that run on the BGI Inspector: a drone campaign on green roofs and a citizen science campaign on infiltration swales in cooperation with Berliner Wasserbetriebe (BWB) and the Berliner Regenwasseragentur (RWA).

Drone campaign on green roofs

Berlin green roofs serve as the testbed for the drone workflow described in section 5.6. The Mask R-CNN model trained with the Malmö images is applied and further validated here.

Citizen science campaign on infiltration swales

In the past, the companies maintaining the infiltration swales in two Berlin neighbourhoods reported an increasing number of damage cases. Together with BWB and RWA, KWB therefore set up a citizen science campaign in 2026 with four aims: to explore citizen science as a monitoring method for NBS, to inform residents about the function of the swales, to reduce damage and to have damage reported faster. The campaign addresses three research questions:

- Is citizen science a suitable method for the condition assessment of NBS? How many people react and scan the QR code? Which groups report?
- Can damage and maintenance needs of swales be identified more effectively through citizen reports?
- Can information and awareness campaigns reduce the operation and maintenance costs of NBS by changing behaviour?

The two areas were chosen because they differ in use and in the people who pass by (Table 6).

Table 6 Characteristics of the two Berlin campaign areas

	Karlshorst (Carlsgarten)	Adlershof
Area	Residential area east of the Karlshorst trotting track	Science and business park north of Rudower Chaussee
Use	Detached and terraced houses; street drainage via infiltration swales	Research institutes, retail, administration, university; street drainage via infiltration swales
Typical problems	Unauthorised construction work, litter, grit, leaves, unsuitable planting, soil deposits	Parked cars, people stepping into swales when leaving their cars, footpaths across swales, litter, grit, soil erosion, unauthorised construction work
Target groups	Residents (homogeneous)	Employees, students, residents, shoppers (very diverse)
Outreach	Large banner at a central place; QR codes on lamp posts at the swales; flyers for residents; information walk led by BWB and RWA	Information boards; QR codes on lamp posts at the swales; poster and flyer in the university library canteen; flyers on parked cars

Every QR code is georeferenced and generated separately for each area and outreach method. Scanning it opens the citizen form of the BGI Inspector for the respective swale (section 5.4). Reports therefore arrive with their exact location. They can be attributed to the area and to the channel that prompted them, while the anonymous scan counter shows how often each code is used. The flyer and the banner explain how a swale works. They list the problems residents should report (parking, litter, construction sites, standing water, damage) and invite them to an information walk on 2 September 2026 (Figure 14). All monitored swales and incoming reports can be viewed in the BGI Inspector.



Figure 14 Flyer for residents in Karlshorst, front and back (in German): function of the infiltration swales, issues to report and invitation to the information walk

The campaign is evaluated with three indicators: the number of damage cases reported by the maintenance companies compared with the records of 2025 provided by BWB, the number of citizen reports per area and the number of reports per outreach method. In addition, KWB assesses the condition of the swales during regular site walks. BWB obtained the permits and provided the signs. KWB designed the material, distributed it and carries out the site walks and the analysis. RWA leads the information walk together with KWB. The campaign started in July 2026 and runs until the end of the project in October 2026. Its results will be evaluated after the campaign has ended.

First lessons learned

The campaign is still running. One lesson has already emerged:

- **Citizen reports need moderation.** Posts and photos must be checked manually before the data are used. Incorrect entries and inappropriate photos can then be removed.

7 Comparison of the monitoring approaches

Table 7 compares the four approaches on four criteria: cost and staff effort, reliability of the data compared with manual inspection, scalability to a whole city and the operation and maintenance failure modes (Table 2) they

can reveal. The assessment combines the campaign experience with the literature reviewed in City Blues (City Blues, 2024a; Kaur et al., 2025).

Table 7 Comparison of the monitoring approaches (preliminary)

	Manual inspection (reference)	LoRaWAN sensors	Drones	Citizen science
Cost and staff effort	Low equipment cost (tablet, forms); high staff time per asset and visit	Medium to high per asset (sensors, gateway, installation, upkeep); little staff time once running	Medium (drone, pilot licence, processing); low time per asset; permits needed	Very low (signs); staff time to review and verify reports
Reliability compared with manual inspection	Reference; depends on inspector and weather at the time of visit	Continuous and objective, but data gaps, calibration drift and implausible values occur	Objective and repeatable for vegetation and visible defects; detection accuracy still being validated	Variable; reports must be verified on site; strong for obvious problems
Scalability to a whole city	Limited by staff capacity	Low to medium: suited for key assets, not for every small NBS	High for roofs and large areas; limited by airspace rules	High where many people pass by; low in remote locations
Failure modes revealed (Table 2)	Most visible symptoms: 29 (ponding), 31, 32, 33, 34, 35; supports 36	Hydraulic effect of 29, 30 and 34 (slow drawdown, overflow); not the cause	33 (vegetation), 35 (vegetation over drains), standing water as symptom of 29; trash; 32 partly	Symptoms of 29, 34 and 35 (standing water, deposits, blocked outlets), damage

The approaches are **complementary rather than competing**. Manual inspection remains the backbone and the reference. Citizen reports and drone surveys extend coverage at low cost per asset and tell a city where to inspect. Sensors are worth their cost on a few key assets where hydraulic performance must be tracked continuously and their data can help interpret the other approaches. Bringing all sources together in one register, as the BGI Inspector does, is what turns individual observations into a usable picture of the whole NBS stock.

Part B – Maintenance guidance

Part B is written for municipal staff who are responsible for keeping NBS working: maintenance and asset managers, stormwater specialists and the contractors working for them. It builds on Part A, but can be read on its own.

8 Reactive and planned maintenance of NBS

Every maintenance activity is either a reaction to a problem that has already been noticed or part of a plan made in advance. Both have their place. The question for a city is which share of its maintenance should be planned and on what information the plan should be based.

8.1 Reactive maintenance

Reactive maintenance is carried out after a failure has occurred and been noticed: a resident reports a flooded path, an inspector finds a blocked outlet, a storm leaves debris in a swale. It is the dominant mode in most partner cities today, where NBS are maintained together with the surrounding park and failures are acted on when they become visible (chapter 2).

Reactive maintenance is acceptable when:

- the failure develops quickly and cannot be foreseen, for example storm damage or vandalism;
- the consequences are minor and repair is cheap, for example litter in a rain garden;
- the failure is easy to notice and reliably reported, for example a blocked dam opening next to a busy path.

It becomes a problem when failures develop slowly and stay invisible until they are severe. Clogging of infiltration surfaces (failure mode 29), sediment accumulation in ponds (34) and vegetation degradation on green roofs (33) are typical examples: by the time they are noticed, restoring the function often requires replacing the filter media or replanting, at much higher cost.

Reactive maintenance can be improved by making failures visible earlier. Citizen science signs (sections 5.4 and 6.3) and sensor alerts turn residents and devices into an early warning system. A clear reporting channel ensures that reports reach the unit that can act.

8.2 Planned maintenance

Planned maintenance is scheduled before a failure occurs. It can be based on two kinds of information:

- **Calendar-based:** activities are carried out at fixed intervals, such as mowing several times a year, clearing inlets in spring and autumn, or desilting a forebay every few years. This is how most maintenance programmes and the site-specific maintenance cards used by one of the partner cities work. Calendar-based plans are simple to organise and budget, but they treat every asset the same, regardless of its actual state: some assets are maintained too often, others too late.
- **Condition-based:** activities are scheduled according to the observed condition of each asset. Inspections, drone surveys, sensor data and citizen reports indicate which assets need attention.

Maintenance is then directed there. Condition-based planning uses limited resources where they matter most, but requires a register of assets and a routine to record their condition.

In practice, a robust maintenance plan combines both: calendar-based routine care for activities that are cheap and always needed combined with condition-based decisions for activities that are expensive or only sometimes needed, such as desilting, media replacement or replanting. Table 8 summarises the differences.

Table 8 Reactive and planned maintenance of NBS

	Reactive	Planned: calendar-based	Planned: condition-based
Trigger	Failure noticed or reported	Fixed interval	Observed condition reaches a threshold
Information needed	Reporting channel	Asset list and maintenance programme	Asset register, condition records, thresholds
Typical activities	Emergency clearance, repairs after storms or vandalism	Mowing, litter removal, inlet and outlet clearing, inspection rounds	Desilting, filter media renewal, replanting, erosion repair
Strengths	No planning effort; responds to real problems	Easy to organise and budget	Resources go where they are needed; failures caught early
Weaknesses	Slow failures found late and repaired at high cost; no overview	Ignores the actual state of each asset	Requires data, a register and trained staff
Supported by	Citizen science, sensor alerts	Manual inspection forms, maintenance cards	All four approaches combined in a register such as the BGI Inspector

8.3 Link to asset management of grey infrastructure

The same distinction between reactive and planned maintenance underlies asset management of sewers and other grey infrastructure. There, maintenance types are standardised as corrective and preventive maintenance (CEN, 2017). Condition data from regular inspections are stored per asset in a register and used in deterioration models to predict when assets reach a critical condition and to plan rehabilitation over the long term (Ana and Bauwens, 2010; Caradot et al., 2018; Tscheikner-Gratl et al., 2019). NBS can enter the same asset management systems if they are treated in the same way: as registered assets with recorded condition, defined failure modes and documented maintenance (Langeveld et al., 2022). The asset register, condition records and failure modes used in this report follow this logic. Deterioration models for NBS remain a research need (Langeveld et al., 2022; Girot et al., 2026), because the condition records needed to calibrate them are only now being collected.

9 Decision support: from symptom to maintenance action

Table 9 links the operation and maintenance failure modes from chapter 3 to the symptoms that reveal them, the monitoring approaches that detect them, the recommended maintenance strategy and typical actions. It is a first, manual version of the rules that the BGI Inspector is to apply automatically in future (section 5.9). The maintenance actions follow the monitoring and maintenance guidance on the NBS model website (City Blues, 2026a).

Table 9 Decision table: from symptom to maintenance action

Failure mode (Table 2)	NBS types	Symptoms	Detected by	Strategy	Typical action
29 Clogging of infiltration surfaces	Swales, rain gardens, infiltration basins, bioretention	Standing water beyond the design drawdown time; fine deposits on the surface	Sensors (drawdown), citizen reports (standing water for days), manual inspection after rain	Condition-based; inspect after heavy rain	Check inlet and outlet first; remove fines, scarify the surface; test infiltration; renew filter media if needed
30 Reduced winter infiltration	Swales	Ponding, ice, snow storage in the swale	Sensors, seasonal inspection	Accept seasonally; planned spring check	Avoid snow storage on infiltration surfaces; check function in spring
31 Surface clogging of porous pavements	Porous and permeable pavements	Puddles on the pavement after moderate rain	Manual inspection, infiltration test	Calendar-based cleaning	Vacuum sweeping or pressure washing; remove clogged top layer
32 Soil erosion	Swales, basins, green roofs, stream banks	Gullies, bare soil, exposed media, deposits downstream	Manual inspection, drones (bare patches), citizen reports	Condition-based; check after storms	Stabilise and replant; repair inlets and scour protection
33 Vegetation degradation	Green roofs, rain gardens, bioretention	Bare patches, falling vitality, invasive or unwanted species	Drones (cover, NDVI vitality, trend), manual inspection	Condition-based; green roof cover target 90 %, action below 80 %	Diagnose cause (drought, nutrients, weeds); replant; adjust irrigation or substrate
34 Sediment accumulation	Ponds, forebays, wetlands, basins	Deposits at inlets, reduced open water, shallower forebay	Manual inspection (sediment depth), citizen reports (deposits), sensors (reduced storage)	Calendar-based check, condition-based removal	Desilt forebay; trace and reduce the sediment source
35 Outlet malfunction	All NBS with inlets, outlets, overflows and drains	Blocked grate or dam opening, vegetation over drains, repeated overflow	Manual inspection, drones (drains on green roofs), citizen reports (blocked opening)	Planned check plus fast reactive clearance	Clear immediately; trace debris source; repeated blockage prompts design review
36 Poor oversight	All	No register, no records, unclear responsibility	–	Organisational	Set up an asset register and condition records; assign responsibilities per asset

Three rules of thumb follow from the table:

- **Check the cheap things first.** Many hydraulic failures are caused by a blocked inlet or outlet. Clearing it is quick and should come before expensive tests or media replacement.
- **Read symptoms together with the weather.** Standing water or overflow only indicates a failure if it occurs after rainfall the NBS was designed for. A local rain gauge or weather station makes symptoms interpretable.
- **Repeated failures point to design.** If the same failure returns after maintenance, the cause is likely in the design or the catchment. The case should then be fed back to planners and designers.

10 Recommendations for cities

10.1 Where to start, depending on your city's maturity

Cities are at different stages of mainstreaming NBS. The City Blues operational model describes four transition stages, from the sewered city to the water sensitive city (City Blues, 2024b). Table 10 suggests monitoring and maintenance steps for each stage. For the City Blues pilots, these steps are the starting point for their monitoring and maintenance once they are in operation.

Table 10 Monitoring and maintenance steps by transition stage

Stage	Situation	Recommended next steps
Sewered city	First NBS pilots; no routines for their maintenance	Agree who maintains each pilot and how Write a maintenance card per site Inspect with a simple digital form; put a citizen sign on visible assets
Drained city	NBS in strategies and new developments; maintenance mostly reactive and bundled with parks	Build a register of all NBS with location, type and responsible party Introduce standard inspection forms and record failures and actions Combine calendar-based routine care with condition-based checks after heavy rain
Water cycle city	Many NBS; maintenance budgets and programmes in place	Shift expensive activities (desilting, media renewal, replanting) to condition-based planning Equip a few representative key assets with sensors; use drones for green roofs and large NBS Report maintenance KPIs, such as share of NBS maintained according to plan (City Blues, 2024b)
Water sensitive city	NBS fully integrated in city planning and asset management	Integrate NBS condition data into the asset management of grey infrastructure Use condition records to develop deterioration models and long-term renewal plans Feed maintenance experience back into design standards

10.2 General recommendations

- **Plan maintenance before construction.** Define maintenance needs, access, responsibilities and budget in the design stage. Involve the maintenance team in design reviews.
- **Treat NBS as assets.** Register every NBS with its location, type, responsible party and design function, so that its condition can be followed over time.
- **Standardise documentation.** Use the same inspection form and failure mode terms across departments and contractors, so that records can be compared and analysed.
- **Combine approaches.** Use manual inspection as the backbone, citizen reports and drones to extend coverage and sensors where continuous data are worth the cost.
- **Close the loop.** Use maintenance records to adjust maintenance intervals and to feed lessons back into planning and design.

10.3 Integration into the NBS model

The City Blues NBS model website (https://nbsmodel.tampere.fi) is the main output of the project. Its section "Monitoring and maintenance" in the Catalogue of Practices, written by KWB, gives monitoring and maintenance guidance per NBS objective, including monitoring parameters, frequencies, action triggers and decision rules (City Blues, 2026a). This report provides the evidence base and the decision support behind that guidance.

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Annex A – Citizen science signs

The Tampere signs were produced in Finnish. English summaries of their content are given below; the original posters are reproduced in Figure 15.

KUMINAPOLKU STORMWATER BASIN (KUMINAPOLUN HULEVESIALLAS)

The stormwater basin retains and treats rain and meltwater. It fills during heavy rain and snowmelt; the water then infiltrates into the ground and evaporates. This reduces erosion of the ditch and prevents soil from being carried into Lake Kaukajärvi.

Do you notice problems with the basin? The basin does not work normally if, for example, the overflow well with the grated cover near Kuminapolku is blocked. If you notice a malfunction, please report it by filling in a short survey via the QR code below; it takes about one minute. Thank you for helping us keep the stormwater basin working.

Contact: Tampere service point, tampereenpalvelupiste@tampere.fi, 041 730 8168.

BOTTOM DAM OF THE FLOOD MEADOW (TULVANIITYN POHJAPATO)

The bottom dam is part of the Varsanpuisto and Huhmarpelto flood meadows, which prevent flooding in the lower reaches of the Vuohenoja stream. During heavy rain and snowmelt the dam raises water onto the flood meadows in a controlled way and slows down the flow. An opening has been left in the dam so that aquatic animals, such as the critically endangered brown trout, can move along the stream.

Do you notice problems with the dam? If debris or ice have blocked the opening and the water has not dropped within a few days, please inform the City of Tampere service point (tampereenpalvelupiste@tampere.fi, 041 7308 168). Thank you for helping us keep the bottom dam working.

The planning and construction of the flood meadows were funded by the EU Interreg Baltic Sea Region programme as part of the City Blues project.



Figure 15 Signs for the Kuminapolku stormwater basin (left) and the bottom dam of the Varsanpuisto flood meadows (right), Tampere (originals in Finnish)