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Sustainable Drainage Consultants + Landscape Architects

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SuDS Feasibility Report for Wild Park, Brighton

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Introduction

Robert Bray Associates were commissioned to undertake a feasibility study for the introduction of retrofit Sustainable Drainage System (SuDS) techniques to prevent polluted highway runoff infiltrating directly into the underlying chalk aquifers. The areas identified as potential locations for SuDS interventions are an existing highway drainage balancing pond and a public parkland area.

Location

The project is based to the north-east of Brighton, between Falmer and Moulsecoomb.

The drained highway comprises the junction area of the A27 and A270 just west of the Falmer station. In this report it will be referred to as 'the highway catchment'.

Runoff drains to an existing balancing pond just to the south of the A27/A270 junction off Woollards Way and to the north-east of The Keep records centre. This has been identified as having the potential to better manage pollution and, barring features within the highway catchments themselves, is the first opportunity to begin managing water quality and flow rates. In this report it will be referred to as 'The Keep balancing pond' or 'the balancing pond'.

The parkland area that has been identified as an opportunity to install new SuDS features is the eastern grass strip of Wild Park, adjacent to Lewes Road approximately 950m west-south-west of the balancing pond and A27/A270 junction. The narrow strip of parkland lies between woodland and the Lewes Road, running approximately north-north-east to south-south-west, and is approximately

55m wide at the northern end narrowing to 20m at the southern end. In this report it will be referred to as 'the Wild Park area'.

A location plan showing The Keep balancing pond and Wild Park site areas.

Protecting Groundwater

This project is designed to protect groundwater from a significant source of pollution in the Chalk Downs area : highway runoff.

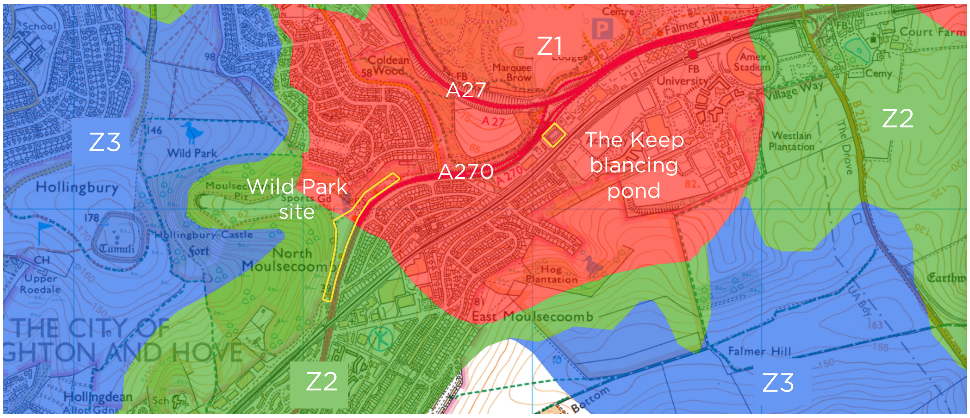
Although polluted with a cocktail of heavy metals, hydrocarbons and other pollutants, this runoff is typically taken to soakaways where it is allowed to infiltrate into the chalk geology and the aquifers therein.

This pollution then impacts the quality of both extracted water for potable use and stream and river water quality.

Groundwater context - SPZs

The highway catchment and The Keep pond lay within a Zone 1 (inner protection zone) groundwater Source Protection Zone whilst the existing soakaways are located within Zone 2 (outer protection zone).

Site location in relation to Source Protection Zones (SPZs)



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The Current Hydraulic & Pollution Condition

In the case of this highway catchment, the polluted runoff currently is collected via gullies in the highway and then piped to the Keep balancing pond. At the balancing pond a penstock valve limits the rate of discharge from the pond. This allows surges of runoff to be attenuated in the pond in an attempt to reduce flooding and so as not to surcharge the soakaways that are the final discharge location.

The discharge from the pond is piped alongside the Lewes Road to the southern end of the Wild Park area where a number of connected soakaways allow infiltration into the ground. When these are exceeded it is likely that they surcharge via their chamber covers and onto Lewes Road.

Due to the lack of features to effectively remove pollutants, runoff that reaches the soakaways contains relatively high levels.

Sump gullies – the prevalent conventional drainage mechanisms for highways - only effectively collect heavy oil and larger silt particles, allowing much of the pollution to bypass the device. Gross pollutants are collected in a water-filled sump where, due to the presence of nutrients in runoff, anaerobic conditions quickly develop and the contents develop a high Biological Oxygen Demand (BOD).

> *Often referred to as the "foul flush", highly polluted liquor is discharged during the initial stages of a storm event.*
>
> *Design Manual for Roads & Bridges 2004 – Part 3 describing sump gullies*

Pollutants are then allowed to infiltrate into the underlying geology via the soakaways.

Project Objectives

The main priority of the project is to dramatically reduce the amount of runoff pollution being discharged into groundwater and reduce the highway's contribution to flooding in a manner that is not detrimental, and is ideally beneficial, to community experience and biodiversity of the areas utilised.

SuDS principles should be adopted for the design of an enhanced treatment and infiltration system. These can be summarised as follows :

- **Remove gross pollutants and silts as close to source as**

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possible/practicable

- **Keep water management at the surface as far as possible**
- **Employ robust and easily maintained nature-based techniques to manage water**
- **Provide progressive cleaning through a variety of techniques**
- **Protect against contamination of watercourses or groundwater by avoiding discharge until water is sufficiently cleaned**
- **Limit discharge rates throughout the system to provide volumetric attenuation and slow the flow**
- **Exploit the opportunities inherent in landforming and planting to provide amenity benefits and enhanced biodiversity**

The proposals will seek to limit maintenance requirements to routine landscape maintenance operations wherever possible and minimise specialist maintenance.

In addition they will explore opportunities to rationalise maintenance of the existing balancing pond at the same time as proposing methods of adapting it to provide better initial pollution removal.

Concept ideas

Following the flowpath of runoff from the A270, the concept proposals identify opportunities at The Keep balancing pond followed by those within part of Wild Park adjacent to Lewes Road upstream of the existing failing soakaways.

The Keep Balancing Pond

The Keep balancing pond taken near to the large chamber containing a weir and penstock valve.

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Here the proposals show modifications to the balancing pond to create a hierarchy of treatment seeking to maximise pollution removal before discharge to the publically accessible Wild Park treatment and infiltration basins. The concept plan shows the following features:

- **A dedicated forebay area within the existing pond defined by a berm or gabion structure. Planted with vigorous reed species, this area will still the inflow of water promoting silts and associated pollution to settle out in this defined area. This focusses the de-silting maintenance primarily to this easily accessible area and protects the remaining pond area from siltation.**
- **A simple berm arrangement will direct flows along a circuitous route through the basin in order to maximise 'residency' time and pollution removal/treatment.**
- **Robust wetland planting throughout the pond as well as floating wetland baffles provide water quality treatment of day-to-day flows when the water level in the pond is lower. In more intense or prolonged storms, as the water level in the pond rises, the root matrices of floating wetland baffles arranged transversely to the general flow will continue to provide a significant degree of pollution treatment as well as reducing preferential flowpaths through the pond.**

The existing inlet(s), outlet and liner should be inspected and cleared/renovated as required. Ideally the pond should be desilted prior to amendments and pond works should be carried out, allowed to settle and ideally allowed to vegetate prior to connection to the Wild Park basins. This could be achieved through the construction of a two-way valve chamber at the sewer interception point adjacent to Wild Park.

Floating wetlands like this installation by Biomatrix can have a dramatic effect on water quality and can be designed to rise up and down with changing water levels.

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We partnered with Biomatrix on this park in Hastings where the floating wetlands delivered a 74% reduction in nitrate, 71% reduction in E. Coli, and a 69% reduction in Enterococci.

The outlet should be modified as required to ensure a designed nominal water level is maintained in the pond to sustain wetland vegetation.

The existing penstock should be adjusted to achieve a designed discharge rate to be agreed with AOne following more detailed modelling and a permanent explanatory sign erected at the entrance to enable successful maintenance of the system into the future.

Wild Park

A view of the long strip of grassland forming part of Wild Park adjacent to the Lewes Road (A270) stood at the park road entrance looking south.

The proposals show the existing surface water pipe being intercepted as it crosses from the south-eastern side of Lewes Road to the north-western side. From this point, a new pipe is shown laid at a gradient of 1:150 in order to bring the water flow up onto the surface as soon as

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practicable and reduce the excavation required to form new basins within Wild Park. Depending upon the surveyed levels of both the pipe/chamber inverts and topography, the water flow may be able to be 'daylighted' in a swale to the north side of the Wild Park vehicular entrance. This would be lined to prevent infiltration of residual pollution present in the flow and planted with wetland planting to provide significant water quality treatment. A two-way valve chamber at this interception point would allow a trickle or occasional flow into the new basin system to promote plant establishment until the basins are sufficiently vegetated to allow full diversion of flows.

The swale flow would require some form of crossing beneath the Wild Park access road – either by bridge, pipe culvert or channel depending upon swale invert and budget constraints.

Once conveyed beneath the access road, the water flow will pass into the first treatment basin (basin 1). This is a simple elongated basin with a defined deeper forebay area to collect residual silts in an easily accessible location close to the site entrance and thus protect the rest of the system from siltation. This basin and the subsequent treatment basin (basin 2) are lined to prevent infiltration of residual pollution and to maintain a wetland habitat for enhanced treatment of pollution. Each will have standing water of between 100 and 300mm (450mm for the forebay) with gentle side slopes and a series of designed level 'benches' (terraces) for ease of access and egress - safety by design. A storage depth of around an additional 300mm will be available during rainfall events with a simple flow control at each outlet holding flow back in the basins to maximise treatment time and provide flood protection. The basins will be linked by simple swale channels.

Once the flow has passed through the two treatment basins, subsequent basins are focused on promoting infiltration. Each basin will be unlined and their shape and arrangement in a series of cascading landforms maximises the surface area exploited for infiltration whilst allowing access through the park. Flow controls at outlets points of each basin holds flow back in each basin for a prolonged time to allow infiltration to occur. The soils in the base of the basins shall be enhanced topsoil to make it free-draining with a healthy sward of meadow vegetation and associated invertebrates and soil fauna ensuring maximum infiltration. Soil depth shall be a minimum of 300mm depth to provide further filtration and bioremediation of flows before they reach groundwater.

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A newt-breeding wetland installed as part of our SuDS design at Hazeley Academy school.

For peace of mind, an outlet from the final basin could be connected to the existing soakaways. Although these offer far less infiltration potential compared to the basins, if the modified flow route is connected back to this existing destination, it would avoid the possibility of being accused of making the drainage situation worse.

Order of construction

If a two-way valve is installed at the head of the Wild Park interventions, construction of The Keep and Wild Park works can occur consecutively (in either order) or concurrently as the valve can ensure flows continue to the existing soakaways during construction.

In terms of commissioning, ideally The Keep balancing pond works would be complete before flows are diverted into the Wild Park installation so that the Wild Park system benefits from the preliminary cleaning that the proposals in the balancing pond would deliver.

Wild Park could be operational before The Keep works have been carried out if need be. In this case, the water entering Wild Park would not have the benefit of preliminary cleaning, however heavy silts should have dropped out in the balancing pond, along with a modest reduction in other pollutants, leaving Wild Park to manage the rest.

If The Keep works are to be carried out after Wild Park then the two-way valve should be activated to divert flows away from Wild Park to prevent it receiving construction silts. These will then be collected in the existing soakaways – unless another form of management is used – and the soakaways can be emptied at the end of the works.

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Hydraulic performance

The hydraulic performance of each option can be summarised as the total volume that the proposed basins and wetlands can temporarily store and discharge – either through flow controls (in the case of wetlands) or infiltration into the ground.

More accurate hydraulic performance could be assessed at detailed design stage once actual infiltration rates have been determined on site, however we have carried out calculations based on the concept designs and modelled different infiltration rates to determine the system's performance in relation to rainfall events.

The Keep balancing pond – hydraulic performance

The attenuation capacity of the balancing pond is unknown due to the lack of detailed plans however the proposals will not add additional attenuation potential as this is set by the weir chamber and penstock valve.

Wild Park wetlands – hydraulic performance

Based on the basins in Wild Park having 300mm depth storage capacity, the available volume would be as follows:

- **Option 1 : 1700m^3**
- **Option 2 : 1800m^3**

The actual area of catchment that this can accommodate will depend upon the infiltration rate available on site. Based on slightly conservative infiltration rate of 36mm/hr ($1x10^{-5}$ms), each option would be able to attenuate and infiltrate all runoff for a 1-in-30 rainfall generated by the following approximate catchment areas :

- **Option 1 : 50,000m^2 road catchment**
- **Option 2 : 52,900m^2 road catchment**

It is quite likely that there will be better infiltration than this. For comparison, if the infiltration rate is 5 times higher at 180mm/hr ($5x10^{-5}$ms) then the catchment accommodated would increase to the following :

- **Option 1 : 77,300m^2 road catchment**
- **Option 2 : 81,800m^2 road catchment**

These figures should be compared against the approximate highway catchment area and the design reviewed accordingly at detailed design stage when a more accurate infiltration rate can be used in modelling calculations.

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Monitoring of performance

There are two aspects of the project that may be desirable to monitor to demonstrate its efficacy : hydraulic performance (impact on flood reduction) and water quality.

These could be carried out at both sites to determine the impact of the different techniques employed at each.

Hydraulic monitoring

Baseline rainfall

Baseline rainfall data could be collected from local Environment Agency rain gauges.

The Keep balancing pond

Weather station data combined with a detailed analysis of the highway catchment that drains into the balancing pond would give a reasonable idea of the inputs to the balancing pond.

- **A pressure or other level sensor in the penstock/weir chamber at the pond's outlet point, on the pond side of the weir, would provide information about the water level in the pond. This information could be interpolated to provide the flow rate through the penstock valve as well as an approximate rate of flow over the weir when exceeded.**

This information, along with the overall storage capacity of the pond, would allow analysis of the attenuation performance of the pond.

Wild Park System

Sensors at the balancing pond will be providing data on the flow inputs to the Wild Park system.

To evaluate the Wild Park system's hydraulic performance there are various options delivering different levels of detail of performance.

- **At the most basic we should know whether water gets to the end of the system and ideally at what rate it leaves the end of the system if it does. This could be achieved by a pressure sensor in a simple orifice flow control chamber between the last basin's outlet and the existing soakaways. The sensor's data would allow interrogation of the water level in the basin, the flow rate through the chamber's orifice, over its weir and when the basin and soakaways are surcharged and flooding occurs. By subtracting the measured output from the known input (from the balancing pond outlet), the overall performance in different rainfall events can be determined.**

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- **To add more detail to this picture, further monitoring devices could be installed such as level/flow monitors after each component (eg. Between swale and Basin 1; between Basin 1 and Basin 2, etc...). These could be within chambers or beneath bridge/culvert connections between basins. This would establish the performance of each component, particularly different types of components (conveyance swale, lined wetland basins and un-lined infiltration basins). This level of detail could be used to inform future projects, predicting performance where more or less space is available to install SuDS.**

Water quality monitoring

In order to establish the efficacy of the designed system, a comparison between the levels of the different pollutants in runoff as it enters the balancing pond and points along the system would be required.

Methods of monitoring

There are different options for monitoring pollution levels :

- **Multi-parameter Sondes capable of monitoring a wide range of pollutants or pollution indicators including : Temperature; Polargraphic (Clark) DO; Optical DO; Conductivity (SC); Salinity; TDS; Turbidity; ORP; pH; Depth; Level; Ammonium; Nitrate; Chloride; TDG; Chlorophyll a; Rhodamine; and Blue Green Algae. These remain within the system in chambers or pipes and can provide live data via GPRS, GSM or radio or collect data on a data card that needs to be manually downloaded at intervals.**
- **Sampling and lab testing requires manual collection of water samples which are then taken to a laboratory for analysis to determine the pollution levels.**

Clearly the former does not require a response to a rainfall event in order to collect data and will also collect data at multiple points throughout a rainfall event. This means that a much more detailed picture can be formed of the fate of pollutants in the system during different rainfall events. Due to the length of the proposed system and the likely long residency time of water passing through the system, with a manual sampling approach, there is a high risk of unreliable results.

For example, imagine a rainfall event occurs. For the initial period of time, the ‘first flush’ of pollutants may be washing off the roads and into the balancing pond. If a sample is taken at the pond inlet after this time, due to reasonable response times, the runoff may now be carrying significantly less pollutants and the sampling generate modest levels. If then a sample is taken further down the system, this may

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coincide with the first flush volume that is making its way down the system, rather than the more diluted volume that was tested in the balancing pond. Thus, although significant pollution may have been removed from the first flush, the comparison between samples would not be reliable or representative.

Monitoring locations

Ideally water quality would be monitored before groups of treatment features and also between different feature types for example :

- **at the inlet and outlet points of The Keep pond**
- **in a chamber before the swale**
- **between the swale and the first wetland basin (Basin 1)**
- **between the second wetland basin (Basin 2) and the first infiltrating basin (basin 3)**
- **At the connection between the final basin and the existing soakaways.**

This would allow evaluation of the efficacy of the different stages of treatment and show progressive cleaning and polishing.

A second level of detail in water quality monitoring would be achieved by adding intermediate monitoring points between each wetland basin and each infiltration basin.

After the wetland basins, runoff will be allowed to infiltrate through the base of subsequent basins. Although it is understood that the soil strata that lie above the chalk geology is highly effective at pollution removal, a monitoring device could be installed beneath one of more infiltration basins to confirm the difference in pollution levels entering the basin and those making their way through the soil. Ideally these should be a minimum of 300mm below the basin surface level. Devices could be placed at different depths in the same location to measure the performance over depth of soil. The results from such monitoring could be an important consideration for future SuDS projects in the area.

The device would require a perforated chamber that will allow infiltrating water to migrate into the chamber where the monitoring apparatus is located.

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Impacts on park use

Each concept option aims to create a more visually interesting landscape with a range of natural habitats in order to attract more public use and enhance biodiversity.

Parks that move away from expansive amenity grass and develop more wildlife friendly and visually diverse landscapes tend to attract a broader variety of users.

We have also seized the opportunity to include an alternative linear route, away from the busy Lewes Road, for pedestrians and cyclists with connections at each end of the space as well as a connection with the bus stop located part way along.

Flowering meadows, interesting topography and features such as balance beams and stepping stones attract both people and wildlife.

Option 1

Option 1 includes a single sinuous path route which meanders into the park and back to the Lewes Road to connect with the bus stop area before meandering back into the park, between the two wetland basins and back to the main park entrance. This design offers more interaction between the path route and the biodiversity features, particularly using a boardwalk through one basin (Basin 4) and by running between the two wetland basins (Basins 1 & 2).

Although we have shown a seating area between Basins 1 and 2, this could easily be reorientated or extended to become a dipping platform for educational purposes (as per Option 2).

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Option 2

Option 2 presents a longer footpath route into the park allowing users to remain further away from the road, with a separate path link from the bus stop area. By pushing the path to the outside of the basins, there is less interaction between them however it does free up space allowing larger basins to be constructed.

A dipping platform/seating area has been shown although this could be reorientated to become simply a seating area or a combined seating and dipping platform area. In both options we have shown this over the second wetland basin as it is likely that this will be the most biodiverse due to the reduction in incoming pollution having passed through Basin 1.

Educational potential

The wetlands and meadow habitat within basins offer the opportunity for school visits to dip for aquatic life or search for invertebrates amongst the native grasses and flowering perennials.

Interpretative information could also inform children and adults alike, of the issues around conventional drainage and how this project is demonstrating an effective alternative.

Play potential

The designs could also incorporate informal play elements such as balance beams and stepping stones across basin areas or creating circuitous swale mazes between basins.

This swale maze at Red Hill School is part of our SuDS treatment train – children can play along it in dry weather and hurdle over the timber bridges; when it rains, water flows along the maze and children can still explore via the brdges.

Safety by design

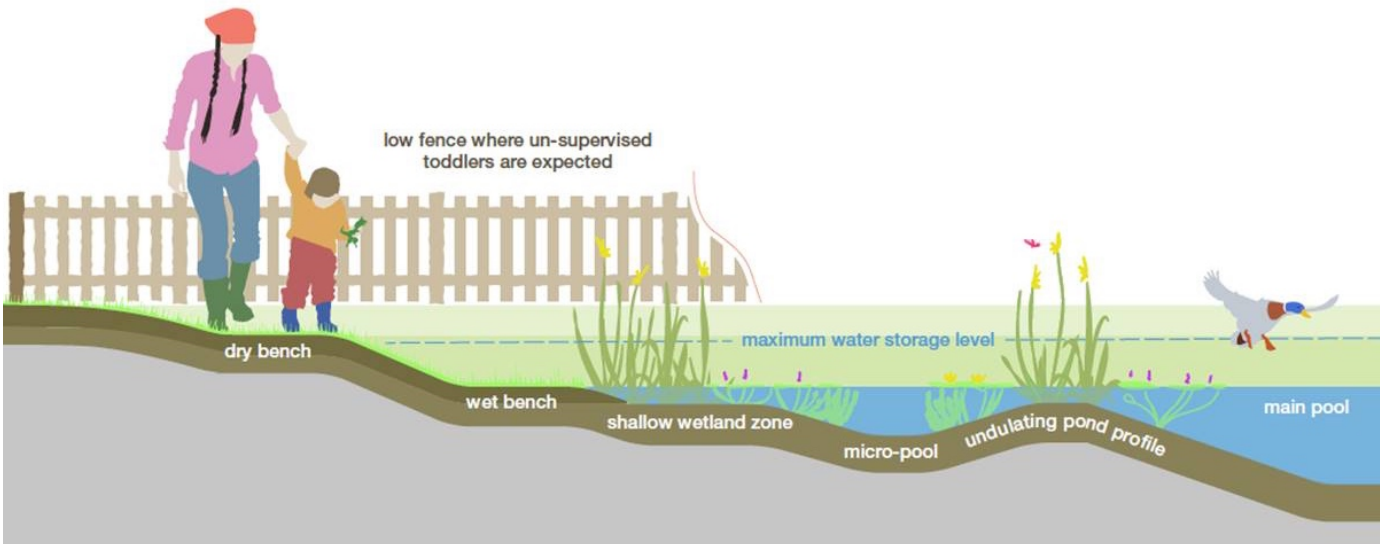
In a parkland setting such as this it is appropriate to design for the assumption that toddlers will be supervised. Running onto the road is likely to present a greater risk here than the introduction of wetlands and predominantly dry meadow basins.

As such the design should not intend to keep toddlers away from the wetland through the use of a fence. In such a situation it is quite reasonable to use a strategy of safe access and egress appropriate for children and adults above toddler age.

Best practice in such a location would be to ensure :

- **that side slopes, above and below the water surface) are at or shallower than 1:3 to allow ease of and controlled access and egress.**
- **a level 'dry bench' (a min.1m wide level strip around the feature) is included above the maximum water line to allow surveillance and awareness without being physically being drawn into the wetland.**
- **a level 'damp bench' is included at the permanent designed water level. At this point, the vegetation type will change to marginal planting. Anyone standing on this bench will have both visual and tactile cues as to the presence of a water body and can choose to egress via the gentle side slopes up to the dry bench and beyond.**
- **A level 'wet bench' be provided at 100-150mm below the water surface. Again, there are further physical cues, including wet feet and thicker aquatic vegetation, to warn against travelling further into the wetland.**

Graphic depicting a safe-by-design approach to wetland edges.



If these design measures are carried out, access into the wetland will be through concerted effort. Any attempt to prevent concerted entry risks actually creating greater

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danger by preventing natural surveillance of the wetland and preventing rescue access in case of a person becoming in distress. A far better approach where toddlers are expected to be supervised is to provide safe and controlled access and egress.

This approach is supported by RoSPA and we have employed it on a number of our SuDS projects.

Approximate cost estimates

Cost estimates at feasibility stage are approximate guides only. Much can change through detailed design and quotation for engineering work can vary widely.

The Keep balancing pond

The cost of installing gabion and soil berms as well as a floating wetland system capable of adapting to changing water levels would be in the region of £250,000 -£300,000.

Wild Park

We estimate that the cost of intercepting the existing surface water pipe, installing new valve chamber, inlet, swale, culvert and constructing two lined wetland and several unlined infiltration basins, based on a no-cart-off cut and fill design, paths, boardwalks and seating, to be in the region of £200,000 - £300,000.

Appraisal of concept ideas

Although Option 1 provides slightly less basin area, I feel that it offers a more immersive experience for visitors with the new path meandering between and through basins. It also allows more opportunity to divert into the park.

Additional path routes could be added linking to park paths to the north.

Essentially each follows a sensible water management rationale offering very similar benefits and could be adapted at detail design stage to incorporate qualities of the other.

Analysis of the catchment area and likely runoff volumes at outline/detailed design stage may help inform the level of demand for storage volume and help choose between one option and the other.

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Summary

This project offers a rare opportunity to intercept large volumes of polluted runoff before it infiltrates into the sensitive chalk geology and manage it more sustainably at the same time as enhancing an underused and underwhelming grass area in a prominent public place.

Combined with The Keep balancing pond, the entire system would demonstrate a good range of practical, robust and cost-effective alternatives to conventional practices, acting as a model for future projects.

Both opportunities - to adapt existing balancing ponds to better treat pollution and exploit underused landscape areas as treatment and infiltration systems – are easily repeatable.

Kevin Barton

Meadow basins as part of retrofit SuDS, like this one at our Renfrew Close project in London, can bring a natural beauty to previously underwhelming and under-used greenspace .

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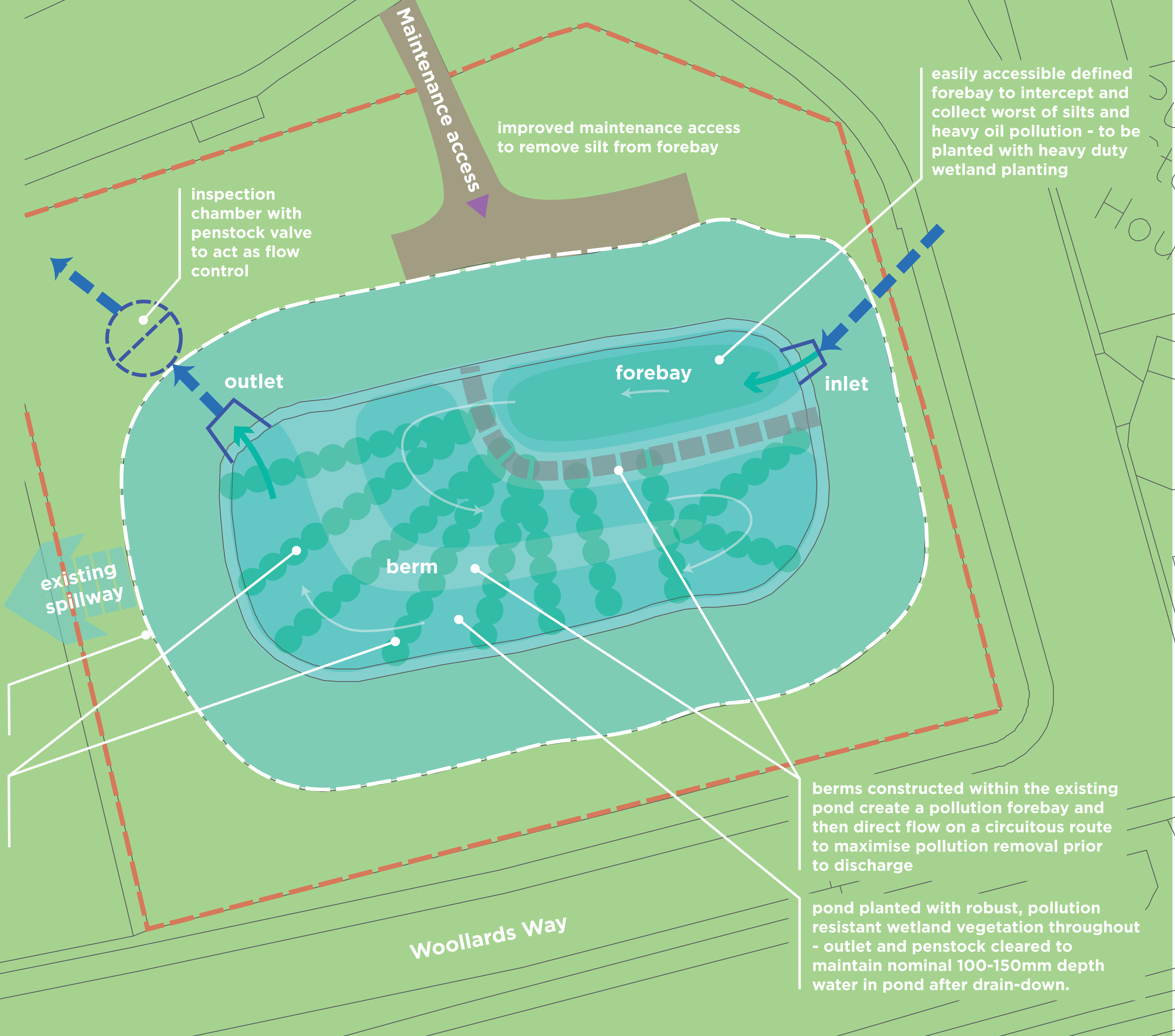
SuDS Concepts: Woollards Way Balancing Pond



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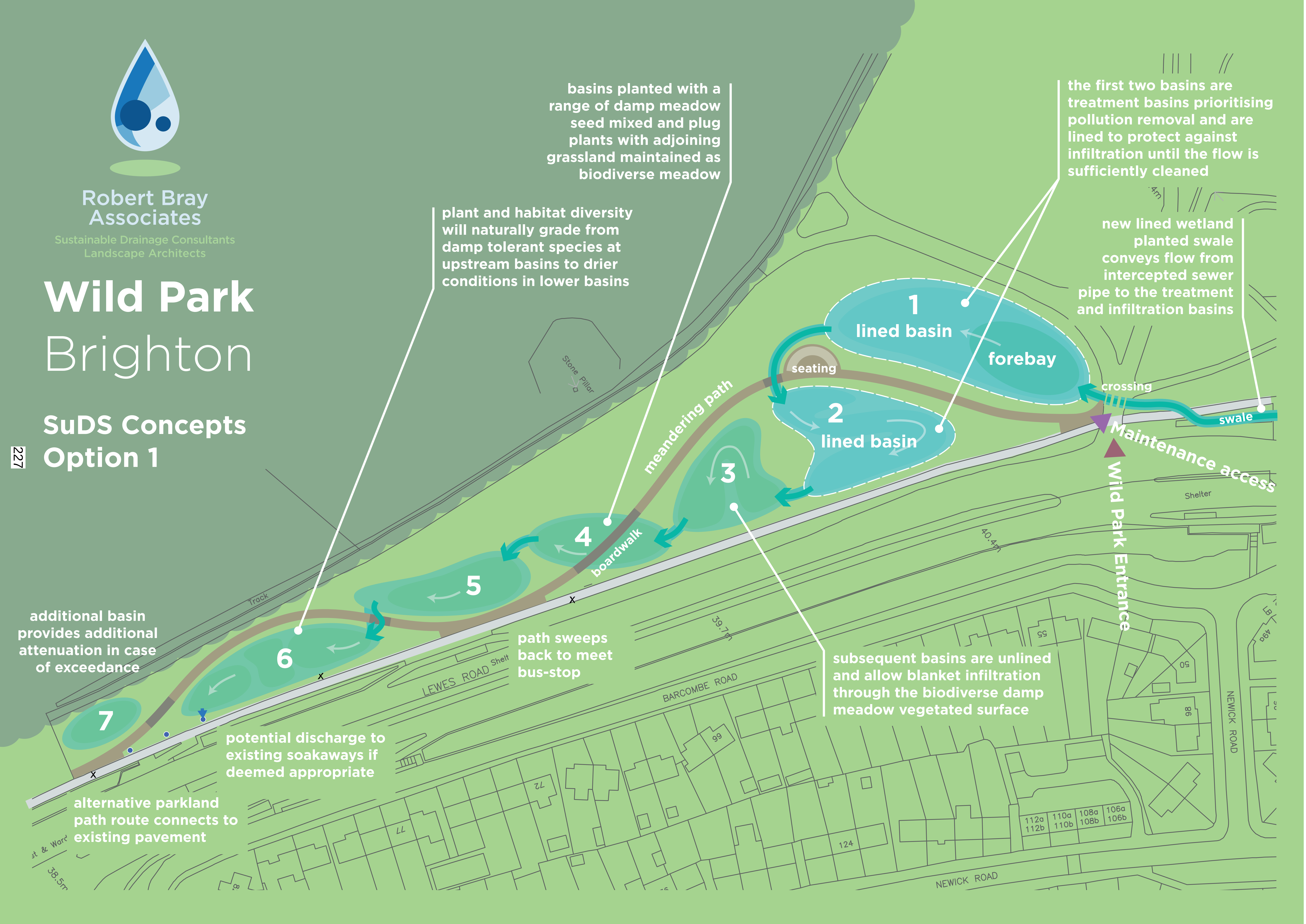
SuDS Concepts
Option 1



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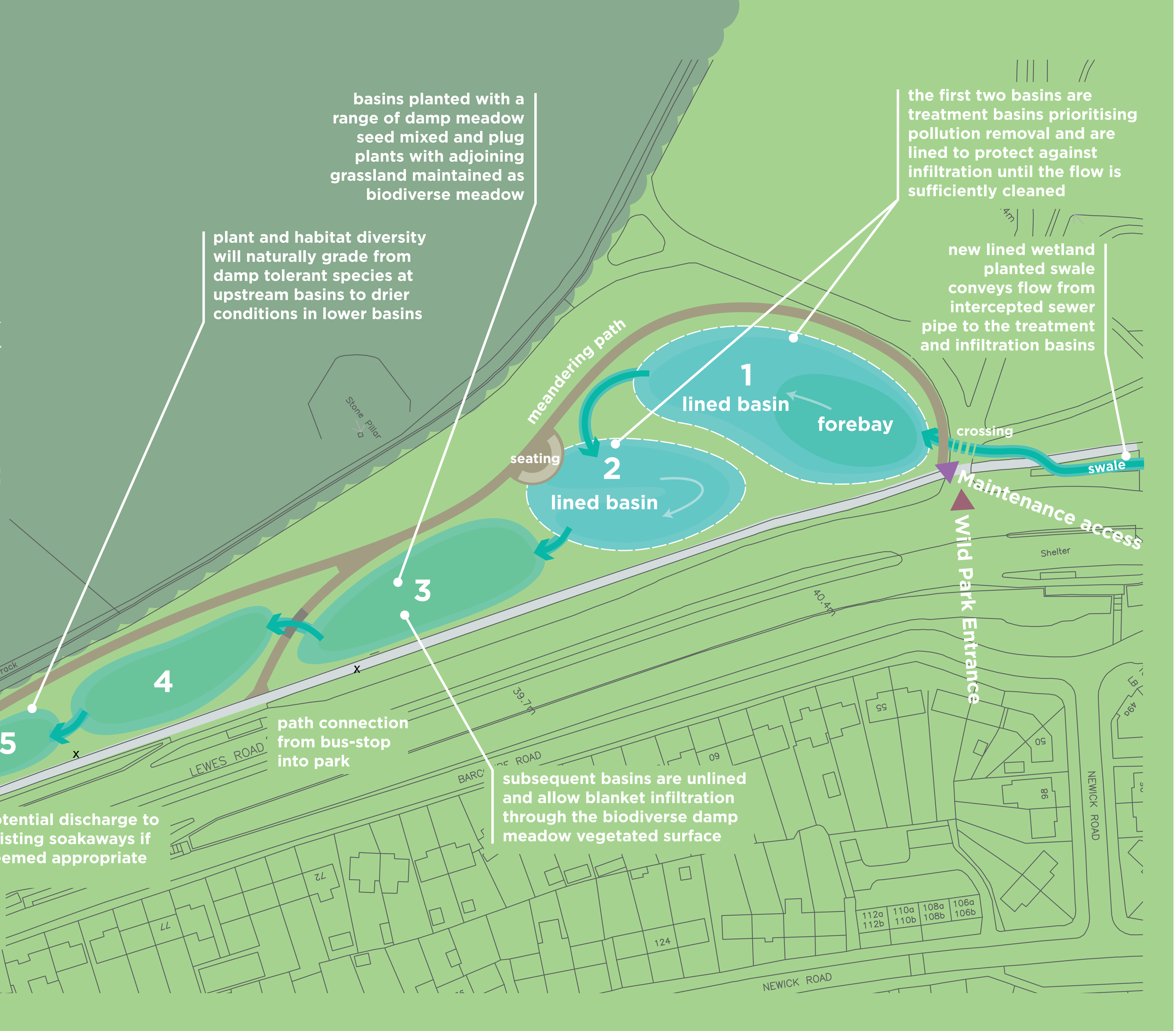
SuDS Concepts: Option 2



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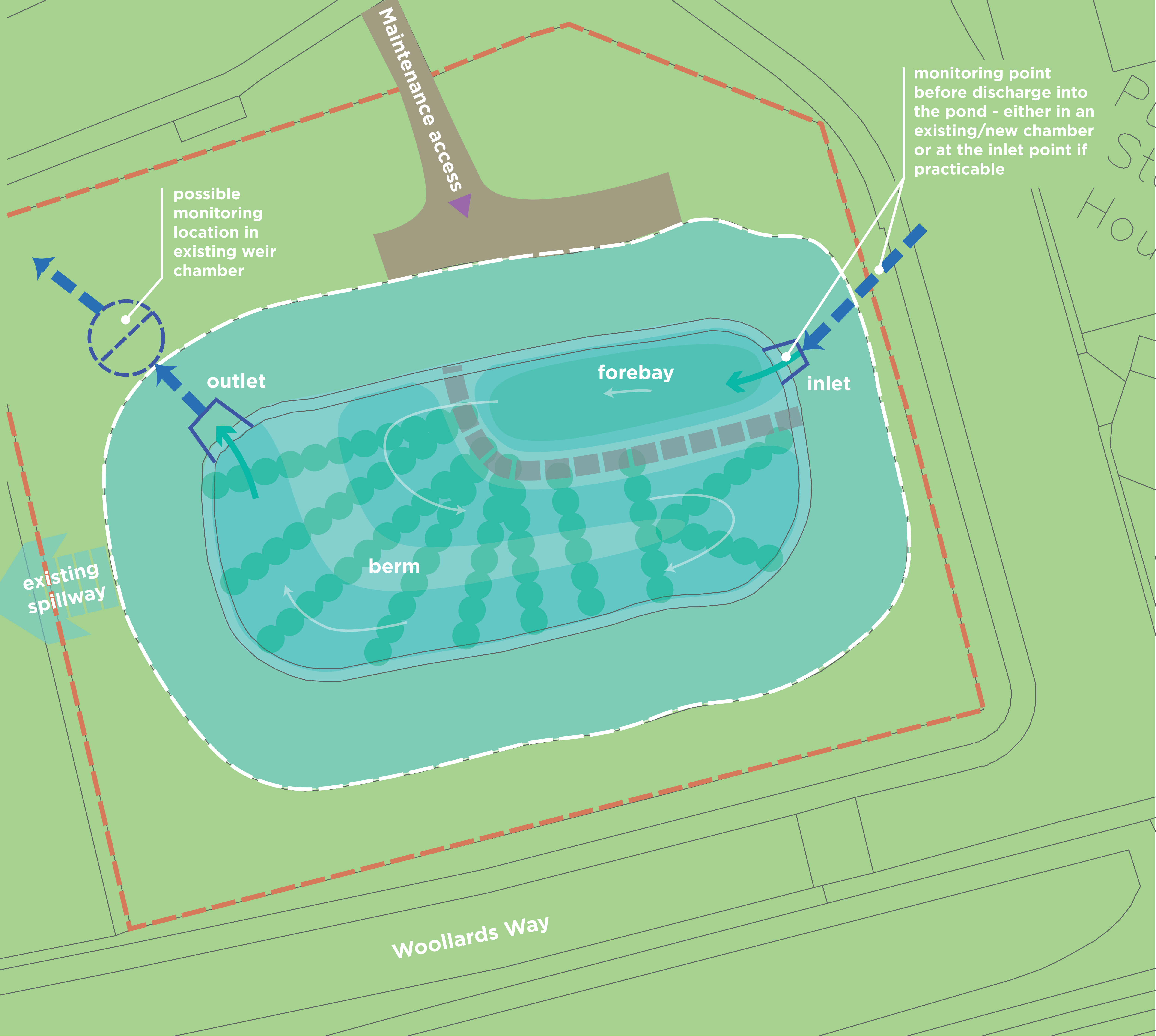
SuDS Concepts: Monitoring locations 1 of 2



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SuDS Concepts: Monitoring locations 2 of 2

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