Fleet Pond SSSI

Fleet Pond Restoration Project PA2 Feasibility Report

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1 INTRODUCTION

1.1 BACKGROUND

Fleet Pond is Hampshire's largest freshwater lake (21 hectares [ha]) and the lake forms a key component of the Fleet Pond Site of Special Scientific Interest (SSSI) and Local Nature Reserve (LNR), which includes other habitats such as woodland and heathland etc. Fleet Pond is classed as a Heavily Modified Water Body under the Water Framework Directive, it is classed as a Reservoir under the Reservoirs Act and the water body is also classified as Main River by the Environment Agency. Fleet Pond is located on the eastern fringe of the town of Fleet at National Grid Reference (NGR) SU 820 549 and forms an extremely valuable historical, social, recreational and biodiversity resource for the local and wider community.

Over the years, the ecological and physical condition of Fleet Pond has deteriorated due to a number of reasons that include sediment deposition and reduction in lake depth, the presence of turbid water and nutrient inputs from urban runoff and wildfowl. The lake part of the SSSI was previously categorized as Unfavourable Declining by Natural England. A partnership of organisations including Hart District Council, Natural England, the Environment Agency, Fleet Pond Society, MoD and Johns Associates, together with organisations such as the Hampshire and Isle of Wight Wildlife Trust, Fleet Town Council, Hampshire Ornithological Society, the local community and community groups have been working hard to initiate, deliver and maintain lake restoration initiatives. The works has resulted in the SSSI now being classed as Unfavourable Recovering.

There is now a need to secure further funding to enable further and targeted key restoration and management activities to ensure the ongoing recovery of the lake and building in resilience in terms of future pressures from e.g. changes in catchment management, growth in population, pollution and climate change.

1.2 OVERVIEW

Johns Associates has been appointed by Hart District Council to carry out a feasibility study for the next stage of restoration works at Fleet Pond, referred to as the PA2 Project, that is focusing on a series of agreed core objectives. This new work will build on significant actions already undertaken between 2010 and 2017 (a review of this and recommendations can be found in Appendix A). This phase of restoration works would be managed by Hart District Council and funded through a successful application in 2020 to the Higher Tier of the Countryside Stewardship Scheme (CS) and potentially through other funding opportunities if they become available. CS is a scheme that provides financial incentives for land managers/farmers to look after their environment via several different methods such as: flood risk management, woodland creation and management, conserving and restoring wildlife habitats, encouraging educational access, reducing widespread water pollution from agriculture, keeping the character of the countryside and preserving historical features in the landscape. There are four main elements to the scheme and for the Fleet Pond Restoration Project the relevant scheme is Higher Tier – this covers environmentally significant sites, commons and woodlands.

The purpose of this document is to present the preferred options for the proposed 2020 CS application to achieve the agreed restoration and management objectives, supported by a range of detailed technical background work. The supporting technical work are documented in a series of technical notes located at the back of this document in a series of Appendices as follows:

Appendix A: Technical Note 1: Technical Review of Phase 1 Fleet Pond Restoration Project;

Appendix B: Technical Note 2: Fleet Pond PA2 Objectives;

Appendix C: Technical Note 3: Countryside Stewardship Funding Options;

Appendix D: Technical Note 4: Gelvert Stream, Coldstream Marsh and Fugelmere Marsh;

Appendix E: Technical Note 5: Accelerated Lake Macrophyte Re-establishment;

Appendix F: Technical Note 6: Water Quality Investigations.

1.3 ABOUT THIS DOCUMENT

The remainder of this document is a compliant CS Feasibility Study for a successful 2020 application for CS funding. The remaining sections present:

- Section 2: Project Location
- Section 3: Details of Tenderer
- Section 4: Aims and Objectives
- Section 5: Site Survey
- Section 6: Project Proposal
- Section 7: Higher Tier Countryside Stewardship Feasibility
- Section 8: Countryside Stewardship Options
- Section 9: Project Implementation and Timetable
- Section 10: Communications Plan
- Section 11: Estimated Costs
- Section 12: Maintenance Description
- Appendices (see Section 1.2 for description)

2 PROJECT LOCATION

2.1 APPLICANT, FARM BUSINESS AND SITE IDENTIFICATION DETAILS

Applicant: Hart District Council – Local Authority and landowner. Fleet Pond is owned by Hart District Council and managed by Hart District Council Countryside Services.

Site Identification: Fleet Pond Site of Special Scientific Interest

Grid reference	SU 820550 (centre of lake)
Site Name	Fleet Pond
Site Status	The total reserve area is designated as a Local Nature Reserve; of this 48 hectares is designated as a Site of Specials Scientific Interest (SSSI)
SSSI Name	Fleet Pond
Date Notified	1954 (under the 1949 Act)
Date Renotified	1984 (under the Wildlife and Countryside Act 1981
District	Hart
County	Hampshire
Local Planning Authority	Hart District Council
Total Area	The Nature reserve covers 57 hectares of which 48 hectares is designated SSSI. The Pond accounts for 21 hectares.
Legal Right of Access	There are no legal rights of access to the site. But the site is registered open access.
Byelaws	Fleet Pond Local Nature reserve has byelaws in operation. They were updated ibn 2008. The revised and the original version, drawn up in 1976, are held by Hart District Council at the Civic Office, Fleet.
Applicant Details	CS - SBI number 108442957 Vendor number 536977 CPH number 15/206/8001 Customer number 1103339702.

2.2 SITE MAP

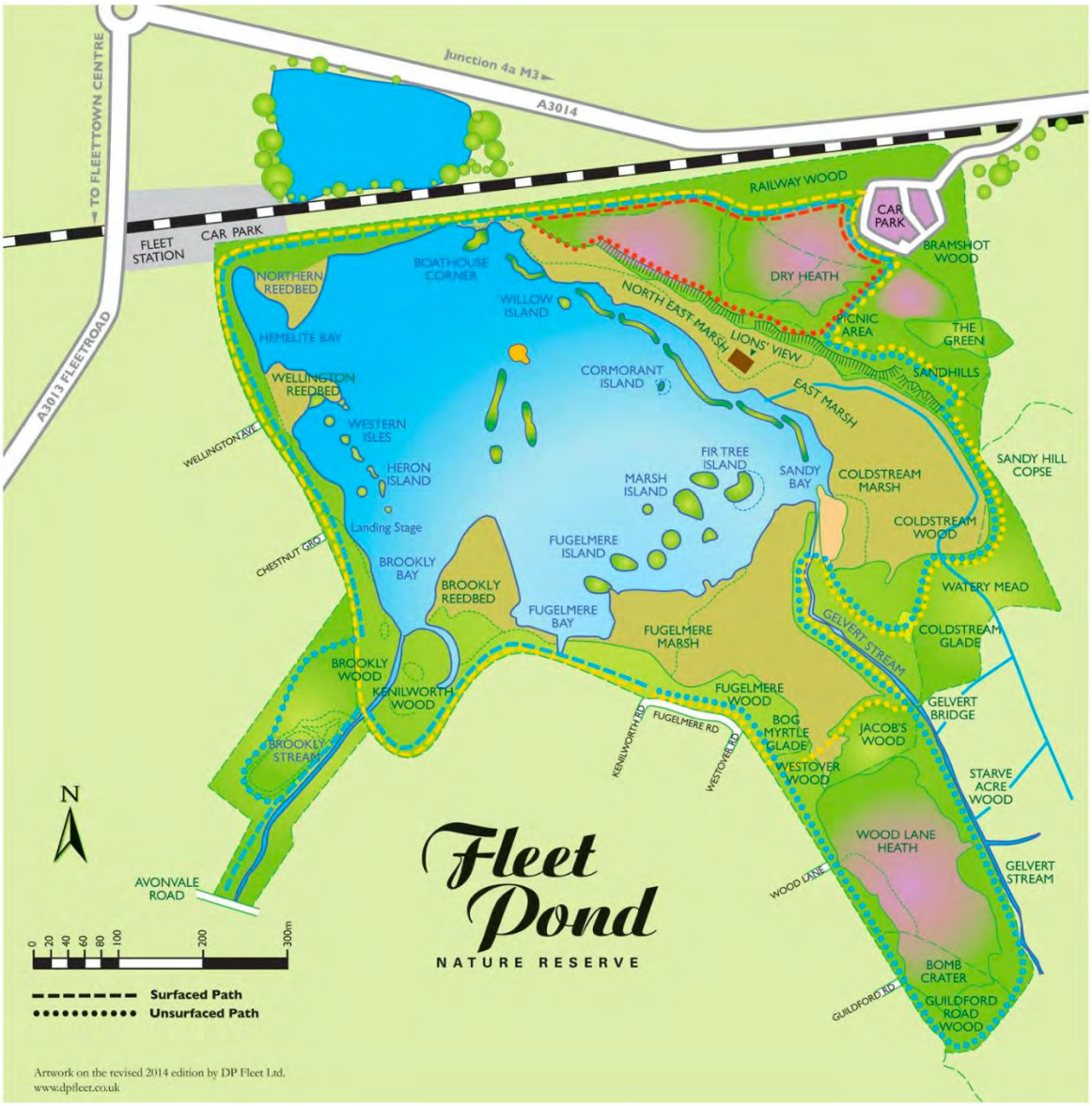

Figure 1. Site Map for Fleet Pond

3 DETAILS OF TENDERER

3.1 NAME AND CONTACT DETAILS

Organisation: Hart District Council.

Lead Individual: Steven Lyons BSc Hon MACMA.

Countryside Operations Manager

steven.lyons@hart.gov.uk

01252 774224

Contact Details: Hart District Council

Civic Centre, Harlington Way

Fleet

Hampshire

GU51 4AE

3.2 SUITABILITY FOR ROLE

3.2.1 Land Tenure

The application site is owned by Hart District Council. This is a Freehold landholding, with its acquisition dating to 1972. All tenure documents are held by the Legal Unit of Hart District Council at the Civic Offices: Civic Centre, Harlington Way, Fleet, Hampshire, GU51 4AE.

3.2.2 Management Infrastructure and Resources

Fleet Pond is managed as a Local Nature Reserve and Site of Special Scientific Interest by Hart District Council Countryside Services, as the owners of the land with overriding responsibility for the site. There is generous volunteer support from the Fleet Pond Society. Ultimately, any management decisions over the land will be made by Hart District Council as the legal owners of the land, however its tries to accommodate the views and opinions of its various stakeholders where possible or appropriate.

The HDC Head of Service for Technical Services has overall responsibility for the Countryside Service. The Countryside & Ecology Services Manager has responsibility for the delivery of the service. The responsibility of site management falls to the Countryside Operations Manager, Senior Countryside Ranger and the Ranger for Fleet Pond. The Hart Countryside Ranger is responsible for operating and co-ordinating the implementation of the Management Plan for the site. The Ranger is also required to assist the other Ranger(s) of the Countryside Service in work at other sites within the District.

Within the Countryside team there are five other full time Countryside Rangers with site responsibilities and / specialisms, a Countryside Visitor Services Manager, Education & Marketing Rangers, three Tree Officers, a Landscapes Manager and a Biodiversity Officer.

A range of tools and equipment are available to the Rangers, including:

- 40 – 50 hp 4x4 tractor with front end loader with third service and various attachments.
- Small Kubota tractor for easy use on site
- Tipping trailer with mesh sides
- Cut and Collect equipment, mower, baler, rake
- Ride on mower unit and / or mower unit for main tractor
- Pedestrian tractors with sickle bar mower, flail mower and rake for work in wet / soft areas that a full sized tractor can not access
- Chipper unit
- Chainsaws, brush cutters, blowers
- 75 hp tractor with front loader and various attachments
- John Deere Gator ATV buggy
- Tirfor Winches
- Pesticide safe mostly containing Roundup, application equipment and appropriate
- PPE
- Various workshop tools required to maintain the above, inc. COSHH safe & fuel safe
- Various hand tools required for the staff and volunteers to use

Countryside Rangers are qualified in the use of chainsaws, pesticide application, tractor driving, off-road driving, use of pedestrian mowers and use of brushwood chippers. Appropriate PPE is provided for all machinery and tasks as part of the standard uniform provision.

4 RECOMMENDATIONS AND PA2 OBJECTIVES

Please refer to Appendix A and B for full details.

4.1 SUMMARY OF PREVIOUS FINDINGS

In summary, the key work carried out between 2010 and 2017 included:

- Dredging of the lake bed, and using some of the sediment to create a number of islands across the lake
- Creation of two overflow channels linking the lower right-hand bank of the Gelvert Stream to a restored boundary ditch and into Coldstream Marsh;
- Provisions of replacement culvert and bridge adjacent to Coldstream Marsh;
- Establishment of new reedbeds;
- Provision of channel bank features to reduce erosion in vulnerable areas;
- Clearance of scrub from Coldstream Marsh;
- Creation of submerged geotextile fences to increase sediment deposition;
- Dredging parts of the Brookly Stream;
- Creation of a series of side channels and overflow points in the lower Gelvert and Brookly Streams;
- Restoration of Brookly Pond;
- Creation of a twin pipe overflow/siphon system to divert higher flows from the Brookly Stream into the newly created Brookly Pond; and
- Creation of a new wetland feature (Avondale Pond) to retain sewage in the event of an emergency, provision of an information board at this location.

Following the initial round of works and recent site visits there have been several key indicators of improvements within Fleet Pond, including:

- The removal of nutrient rich sediment from the lake bed to form new vegetated islands and marginal areas, potentially exposing older sediment with a rich seedbank. Recent site surveys carried out in 2019 found vegetation to be present on the lake bed in certain locations;
- The nutrient rich sediment used to construct islands, where establishing marginal vegetation will utilise nutrients from the sediment, thereby removing them from the lake (especially if harvested);
- Recorded improvements in oxygen concentrations;
- Reduction in recorded turbidity levels and water transparency. Recent site visits found the lake bed to be visible across the lake. This is likely a combination of managing sediment input sources such as at the Long Valley MoD Training Area and a more stable in-lake environment with less resus-pension of fine sediment;
- Sediment deposition was found in the stream diversion and marginal areas constructed at part of the previous phase of restoration works;
- Positive feedback from recreational users of the lake.

4.2 RECOMMENDATIONS

Recommendations from the conclusion report for the previous phase of restoration works include:

- Ongoing catchment monitoring and intervention as set out in the Diffuse Water Pollution Plan
- Continued engagement with the wider FPRP partners and catchment managers to help maintain improving conditions in terms of inflow into the lake
- Use of data loggers and sensors to obtain long-term data to monitor further improvements in water quality and provide triggers for a remedial action
- Further works to establish common reed on the islands
- Use of existing vegetation to create anchored plant islands and/or submerged planted areas, to help with re-establishment of lake macrophytes and zooplankton populations
- Installation of natural measures to help reduce bird grazing on islands
- Maintenance activities on installed features
- Further routine monitoring of all these features to determine their ongoing efficacy, together with targeted investigations into the phytoplankton, zooplankton and fish communities; their dynamics, influences and options for optimising their long-term influence on Fleet Pond SSSI
- Small scale suction dredging as part of maintenance to remove on-going build-up of sediment behind curtains

Technical Note 1 provides a technical review of the previously carried out works around Fleet Pond, it also makes a series of recommendations based on the work that has been previously carried out. Some of the recommendations include:

- A wider catchment scale approach to future works, such as; further investigations at Long Valley MoD, investigations into urban runoff directly into the watercourses that feed the pond.
- Collection of sediment data from diversion channels and pond to assess the effectiveness of the diversion channels. Establishment of when high sediment loads occurs.
- Considerations should be given to any further works on the Gelvert that could encourage deposition of silt prior to reaching the lake. Suggested measures included re-meandering the channel, installation of natural 'check dams'.
- Reinstating a trash screen on the Brookly Stream to ensure upstream flood risk is minimised, and debris flowing into the lake is reduced.
- Further discussions with Thames Water relating to the sewage pumping overflow. Potential studies into reducing the overflow.
- Assess why the remaining connections between Fleet Pond and Little Pond are closed off, as the current single opening acts as a significant constraint during flooding and sediment passage. Consider whether the invert level of the connection can be lowered.
- A 2D hydrological model of the pond should be created to assess velocities under a variety of flow conditions, outputs could also inform where the optimum locations are for any future dredging.

4.3 OBJECTIVES

Technical Note 2 provides a review of all the previous restoration and management objectives and indicates which are relevant for the PA2 project, those that are potentially relevant, and those that are not relevant but still need consideration outside of this specific project.

In summary, the objectives set out in Appendix B and considered relevant to this project are:

- A1: Prevention of silt and debris entering Fleet Pond through the Gelvert Stream
- C2: Increase the diversity and extent of submerged and emergent habitats through the body of the lake for plants, plankton and macro-invertebrates
- C3: Maximise the local native biodiversity associated with the lake
- D1: Minimise the input of sediment material from the rural catchment including the MoD training estate, Tweaseldown Racecourse, road drainage and other locations
- D2: Restore a natural planform to increase channel length and capacity and provide opportunities for sediment and debris deposition before discharging into Fleet Pond

A series of S.M.A.R.T. objectives have then been developed in Appendix B for the PA2 project. These are Specific, Measurable, Agreed, Attainable and Achievable, Realistic and Resourced, and Timebound.

The 3 key objectives are:

- **Objective 1:** To ensure the existing Gelvert Stream diversion channels function effectively to manage sediment input to Fleet Pond and enhance wetland functionality including Coldstream Marsh.

- **Objective 2:** To increase the wetness of Fugelmere Marsh and increasing heterogeneity, restore natural function, increase the diversity of wetland habitats and biodiversity.

- **Objective 3:** To increase the diversity and abundance of lake aquatic macrophytes, invertebrates and zooplankton through the use of a range of techniques and features (including protection from grazing fish and birds).

In addition to these main objectives, a series of wider objectives (have been established. These consider wider aspects around the lake, such as managing the Brookly Stream, managing nutrient levels, and ensure future resilience from climate change.

5 SITE SURVEY

5.1 OVERVIEW

General and specific surveys of the Fleet Pond site were conducted by Johns Associates between September and December 2019. This provided a general update on many aspects of the condition of the lake and associated features, but specifically was targeted to inform identified objectives and likely actions associated with the PA2 funding application. These included:

- Visual inspections of the previous works areas to record condition and function to inform the development of objectives for the PA2 funding application;
- Hydrological and geomorphological inspections of the Gelvert Stream and stream diversions including observation on flow, flow path, sediment transport and connectivity (see Technical Note 4);
- Updated topographic surveys of the Gelvert Stream and diversion channel corridors, Fugelmere Marsh, and Coldstream Marsh (see Technical Note 4);
- Ecological walkover inspection of the Gelvert Stream channel and diversion corridors to confirm whether any notable changes had occurred and whether protected species issues need to be taken into account when considering future restoration proposals (see Technical Note 4);
- Phase 1 habitat survey of Fugelmere Marsh to inform the scoping, function and siting of restoration measures and consideration of protected species and sensitive habitat issues (see Technical Note 4);
- Assessment of water quality in the Gelvert Stream, Brookly Stream, associated diversion features and across Fleet Pond (see Technical Note 5) to include:
    - Depth;
    - Transparency;
    - Turbidity;
    - Dissolved oxygen;
    - pH;
    - Electrical conductivity;
    - Evidence of plants.
- Walkover assessment of the condition, function and status of a wide range of sediment management measures associated with Long Valley that discharges water and sediment into the Gelvert Stream, including consideration of turbidity of water through this system.

5.2 PHASE 1 HABITAT SURVEY OF FUGELMERE MARSH

A Phase 1 Habitat Survey was carried out as a part of this feasibility study, focusing on Fugelmere Marsh as this was the principal area likely to be modified through the proposals. Specific details about the survey and its findings can be found in Technical Note 4. The main habitats present were marsh/marshy grassland, wet heath/acid grassland mosaic, and areas of scrub and bramble. Figure 2 below shows the Phase 1 Habitat Map for this area which gives a good indication of the location of the habitats and the amount of coverage for each one. During the survey the edge of the marsh beyond the fence was very wet so was inaccessible during the survey, however it could be seen that it was dominated by common reed. The restoration proposals for the area would be micro-sited during implementation to minimise disturbance of establishing more valued habitats

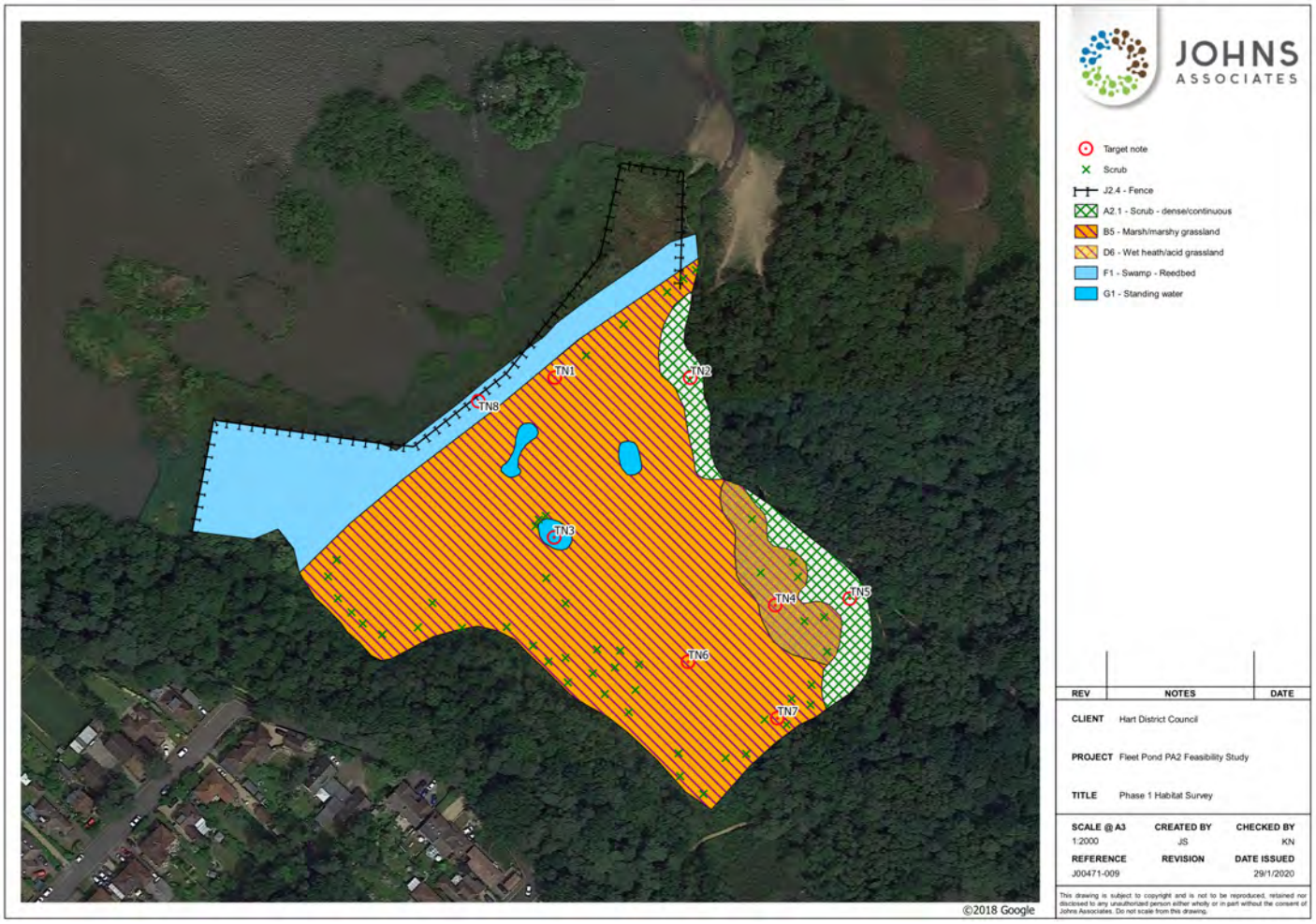

Figure 2 – Phase 1 Habitat Survey Map fo Fugelmere Marsh

5.3 TOPOGRAPHICAL SURVEY OF THE GELVERT STREAM SYSTEM, COLD STREAM MARSH AND FUGELMERE MARSH

A topographic survey was carried out of the Gelvert Stream and the existing diversion channels, but also included new areas such as Fugelmere Marsh and larger portions of Coldstream Marsh. Some areas of Fugelmere Marsh were inaccessible due to the water levels so they were not included in the physical survey but informed by Lidar data provided by the Environment Agency.

The elevation points have been turned into a Digital Elevation Model which can be seen in Figure 3. This was used in conjunction with ground truthing exercises to establish potential locations for testing the feasibility of creating new diversion channels from the Gelvert Stream, proposals to increase the effectiveness of the Gelvert Stream and associated diversion channels, and to support the development of proposed restoration features associated with rewetting and restoring lake marginal habitats in Fugelmere Marsh.

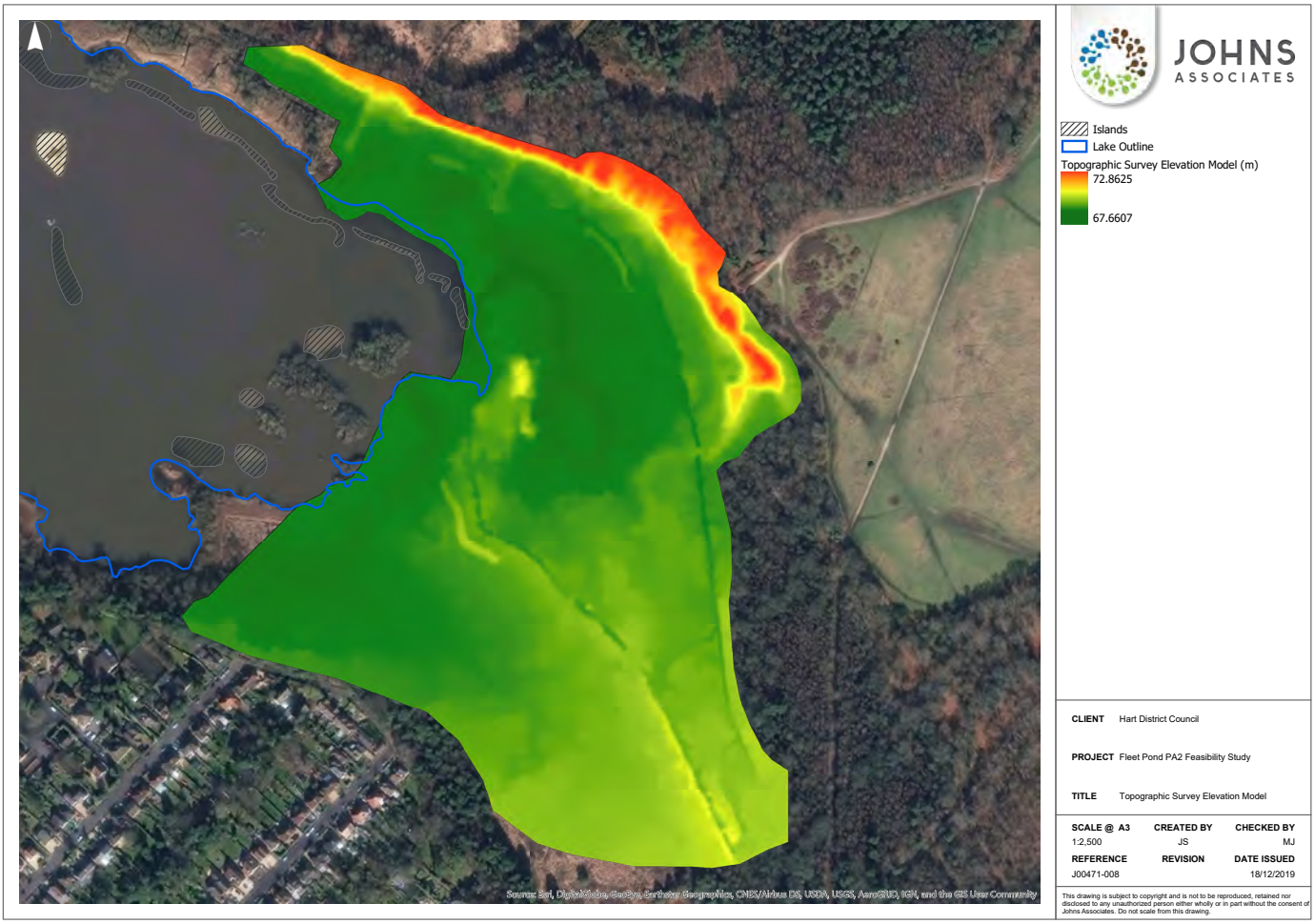

Figure 3 – Topographic Survey Elevation Model

6 PROJECT PROPOSAL

6.1 OBJECTIVE 1: TO ENSURE THE EXISTING GELVERT STREAM DIVERSION CHANNELS FUNCTION EFFECTIVELY TO MANAGE SEDIMENT INPUT TO FLEET POND AND ENHANCE WETLAND FUNCTIONALITY INCLUDING COLDSTREAM MARSH

Appendix D (Technical Note 4) sets out a series of options relating to improving the function of the diversion channels. Recent site visits by Johns Associates in 2019 found that an informal 'leaky dam' is present at the upper diversion channel. This was helping to push high flows down the upper diversion channel, particularly with the help of a backlog of leaf litter behind and within the leaky dam.

The diverted flow was clearly observed continuing all the way along the existing diversion channel and around the perimeter of Coldstream Marsh and into the lake where some flow was still visible. Sandy sediment similar to that which is found on the bed of the Gelvert and in Sandy Bay was found on the bed and banks of the diversion channel suggesting that it has the capacity and function to divert the transport of fine sediment into the diversion channel and away from the main body of the lake.

Based on this clear demonstration that the existing diversion channel can function effectively, the recommended proposals for this objective are to install more formal leaky woody dams at both of the diversion channels in the Gelvert Stream so that flows can be pushed down them more frequently, helping to reduce the amount of sandy deposits in the main channel and lake, also support the wetland functionality of this part of the site and Coldstream Marsh. It is understood that during normal and low flow conditions there will likely not be any water in the diversion channels.

This proposal could be funded by using the RP32 CS option, which is for small leaky woody dams, alongside WN2 and WN7.

Small areas of wetland scrapes and gutters can be created to allow a greater amount of water to be held in the woodland area increasing the areas of wetland habitat, water and sediment storage, but also ensuring areas of differing water chemistry do not mix.

Figure 4 shows a design proposal for the small leaky wooden dams. The design for leaky dam would see them constructed on the downstream side of the diversion channels, they would be set approximately 10cm below bank-top to allow flows to pass over the top during bank-full conditions. There will be small gaps between each of the logs to allow small amounts of water to continue flowing through during high water conditions, this will ensure that the stream does not become too backed up, whilst also ensuring that water still gets pushed down the diversion channels. During normal flow conditions when the diversion channels are not needed the gap underneath the leaky dam will allow flow to continue down its normal route unimpeded.

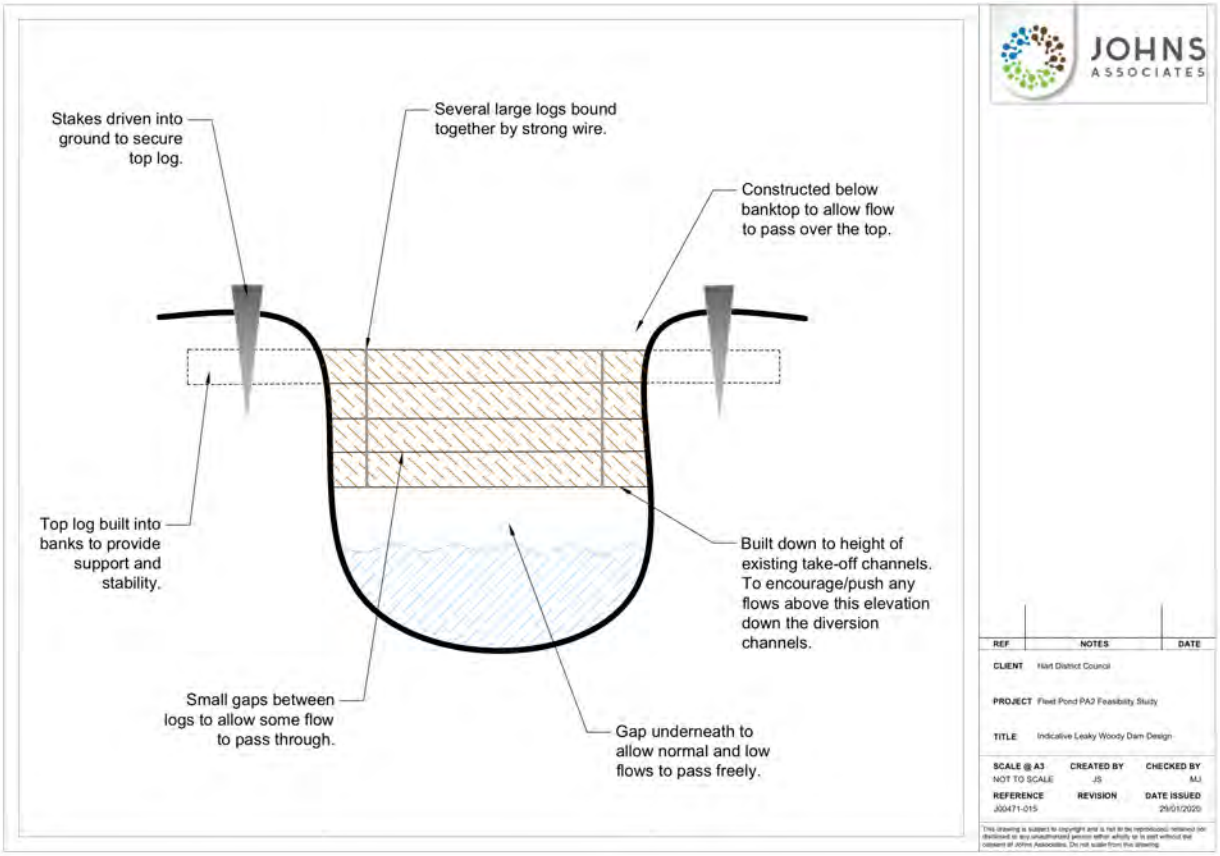

Figure 4. Design specification for individual small leaky dam (RP32 CS option)

Figure 5 shows the proposed location for the two small leaky wooded dams associated with the existing diversion channels.

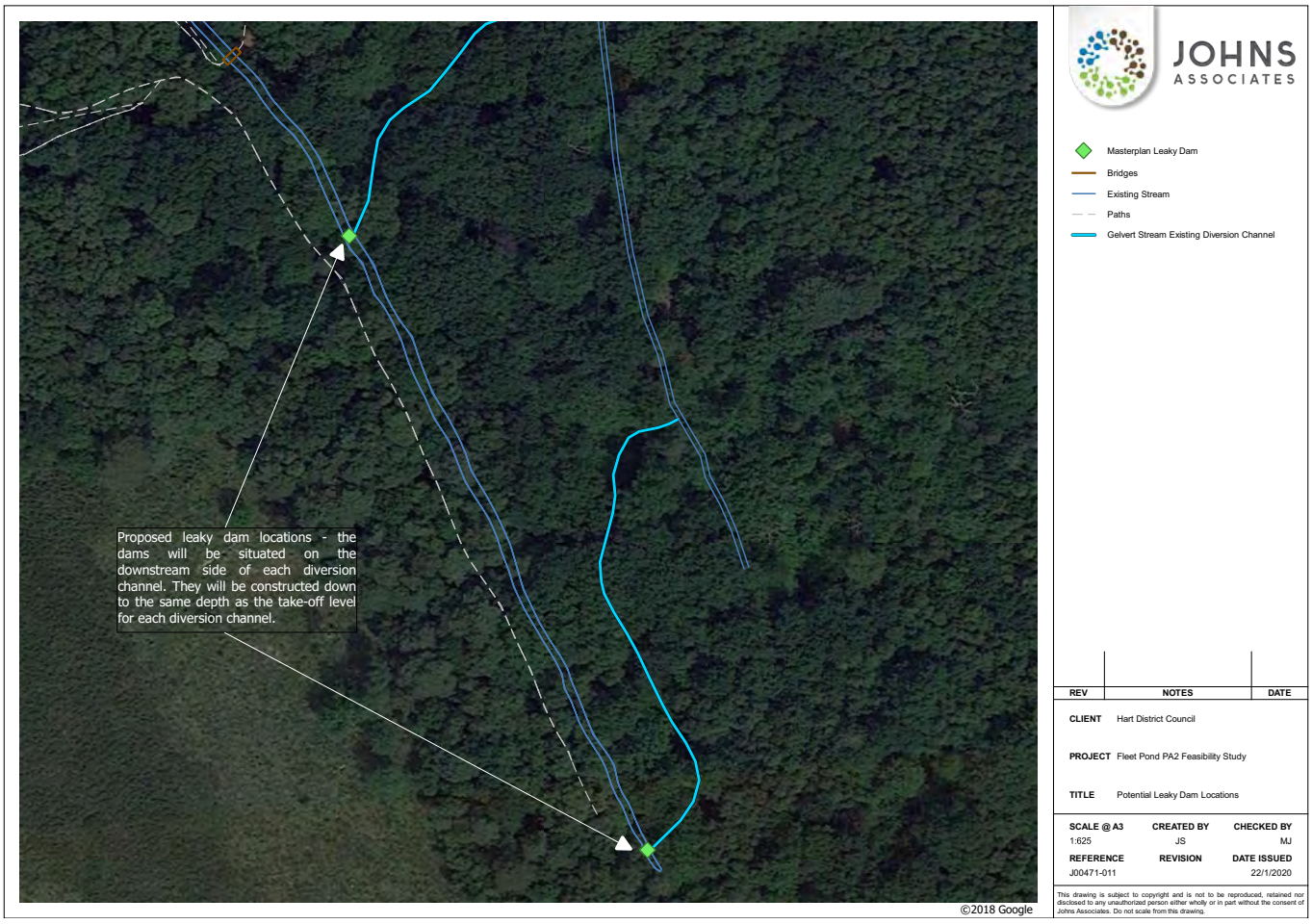

Figure 5 – Proposed locations of individual small leaky dams (RP32 CS option)

Objective 2 focuses on increasing the wetness of Fugelmere Marsh with the aims of restoring natural function and increasing biodiversity and habitat heterogeneity. Appendix D (Technical Note 4) explores several potential options for rewetting Fugelmere Marsh, including creating new diversion channels from the Gelvert Stream that would flow through the marsh, or completely realigning the Gelvert so that it flows through the marsh and Wood Lane Heath/Starve Acre Wood. Most of these are significantly limited by topographical constraints and would also compromise the proven effective function of the existing Gelvert Stream diversion channels, when operated alongside small leaky wooden dams.

The recommended proposal that is being put forward for PA2 CS funding is to create a series of backwaters from Fleet Pond into Fugelmere Marsh to restore a series of linear sources of open water, plant nursery habitats and linking through a network of smaller channels and rewetting of wider and more inland parts of the Marsh. The proposed locations of these can be seen in Figure 6.

The proposed backwater channels are to be around 0.75m deep, 2m wide on the bed and 6m wide at the top to ensure that they do not become silted up and too overgrown with vegetation, and require excessive management. Similar features located on Coldstream Marsh and the Gelvert diversions are now noted as supporting a diverse aquatic plant community. Each channel will be around 100m long and assuming the dimensions proposed, this will result in around 300m^3 of material being removed from each one using a mechanical excavator.

Figure 7 shows potential locations for this removed material to be placed (but may be more dispersed to ensure placement in one mechanical movement to avoid the need for any Environmental Permits). The suggested locations are within the Marsh – being microlocated to avoid existing wet/more valuable habitat, with existing reedbed and other valuable macrophytes being re-located to island habitat to promote further plant recolonization in the lake. Alternatively, these could be located on the fringes of the marsh/lake where they could be used to extend the wetland habitat potentially creating new valuable reedbed or marginal inundation habitats for aquatic plants. A small amount of the material could also be used to extend the existing bund in the eastern part of the marsh so that is provides more protection for the footpath from any potential high-water levels in the marsh. Material will also be used to create two new otter holts, providing support for this key species that is known to be in the wider catchment area. The successful colonization by otter will significantly support efforts to manage invasive crayfish populations and introduce further predation pressure on the fish population.

A residual high flow diversion link to Fugelmere Marsh, combined with a leaky dam, is proposed to enable exceptional high flows that overtop the upper leaky dams to be part-diverted to the south eastern part of Fugelmere Marsh. This would be constructed from twin polypipes (at least 25cm diameter each) located in the Gelvert channel left hand bank (facing downstream), passing below the footpath (reinstated over the diversion) and exiting in the Marsh. Diverted flows would be allowed to flow freely within the Marsh with water finding lower lying areas.

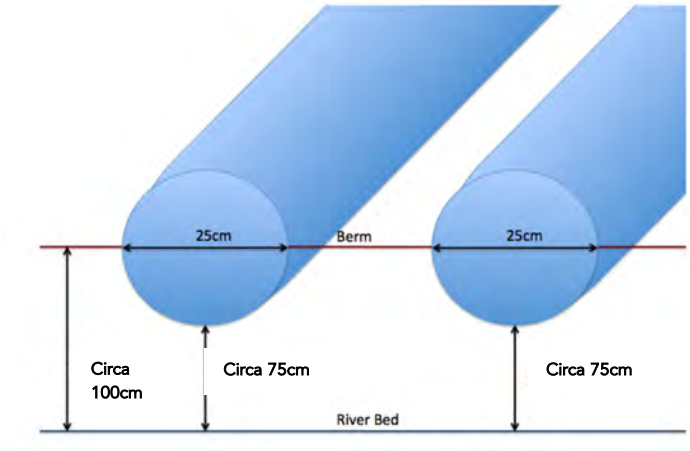

Figure 6. Cross Section of Twin Diversion Pipes

This proposed PA2 CS solution was chosen over the other proposals in Technical Note 4 as it is more feasible given the available funding options, it would also not significantly interfere with the existing Gelvert Streams function and diversion channels which could have had negative impacts on Coldstream Marsh. The backwaters can also potentially create new habitats for macrophytes, invertebrates and zooplankton away from potential predation as they will be more sheltered than the open lake and its fringes.

WN2, WN4, WN7, RP6 and RP32 are the potential CS funding codes that could be used for this proposal.

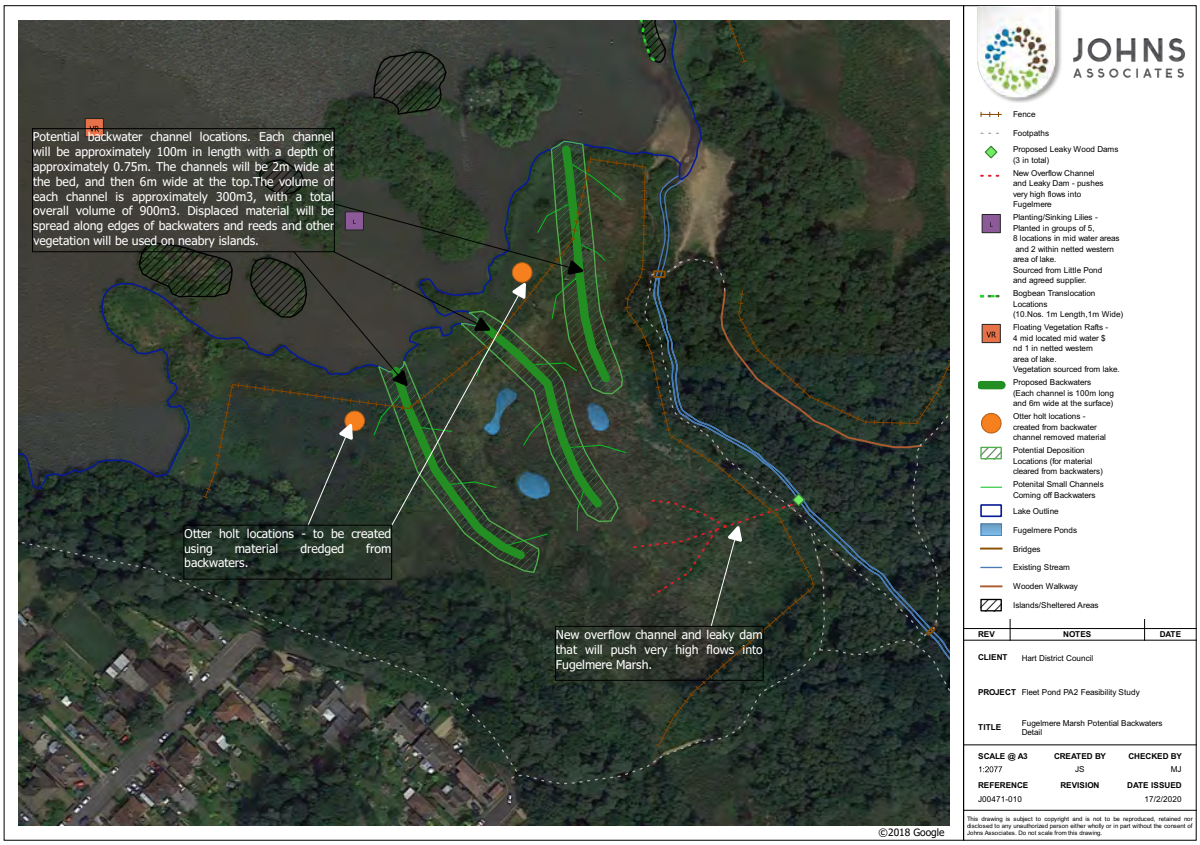

Figure 7 – Potential locations of new features in Fugelmere Marsh

6.2 OBJECTIVE 3: TO INCREASE THE DIVERSITY AND ABUNDANCE OF LAKE AQUATIC MACROPHYTES, INVERTEBRATES AND ZOOPLANKTON THROUGH THE USE OF A RANGE OF TECHNIQUES AND FEATURES (INCLUDING PROTECTIONS FROM GRAZING FISH AND BIRDS)

Objective 3 relates to increasing the diversity of macrophytes, invertebrates and zooplankton in the lake through the implementation of a range of proposals to accelerate the re-establishment of lake macroinvertebrates.

A range of potential options are available for the accelerated increase in aquatic macrophyte re-establishment and these have been assessed in more detail within Appendix E. The key proposals for implementation under the PA2 are set out below and located on Figure 8.

6.2.1 Bogbean Translocation

Existing areas of established bogbean will be cut by hand into 1 x 1 m sections and floated / placed onto pontoons to be towed and deposited at the margins of 5no. islands within Fleet Pond (Figure 1. At the end of this Technical Note).

A total of 2 m2 bogbean translocation will occur for each of the 5 islands (10 m2 in total) will be monitored annually to assess how it establishes and spreads around the islands. Should establishment be successful further bogbean will be translocated to new areas and islands within the site.

6.2.2 Planting/Sinking Lilies

Ten groups of 5no. water lilies will be planted in Fleet Pond. Two groups of water lilies will be planted within the more sheltered and netted area on the western boundary of the Pond and the other eight will be planted within mid-

water areas as per the PA2 Feasibility Masterplan. Native white *Nymphaea alba* and yellow water lilies *Nuphar lutea* and water fringe *Nymphoides peltata* species will be planted. All planted will be harvested from the Little Pond, where lilies are growing adjacent to the lake bank (with owner permission) and/or sourced locally with proven provenance and genetic suitability and agreed in advance with Natural England.

6.2.3 Floating Vegetated Rafts

6.2.4 Five floating islands will be installed with 4no. located within the open water of Fleet Pond and away from the islands in order to break up the open water areas and 1no. located within the netted sheltered area on the western boundary of Fleet Pond. The floating islands will be a minimum size of 4 x 4 m and be planted with established harvested native wetland plants from within Fleet Pond SSSI. The islands are low maintenance, simple to install, mimic natural wetland habitat, encourage the formation of biofilms and improve the water quality.

6.2.5 Island Perimeter Biohaven

The floating biohaven type solution can also be secured to and enhance the habitats associated with the mid-water fixed islands, providing significant increased habitat diversity. In addition to the islands, biodegradeable submerged natural fibre habitats can be suspended to maximise refuge opportunities for zooplankton and macroinvertebrates. The internal length of the four main mid-lake islands will be enhanced in this way with a total length of 180m as shown on the Masterplan at the end of this document. These will be installed in conjunction with deadwood reefs sunk along the inner perimeter of the islands to provide further protection to the island edge, habitat for invertebrates and fish as well as reduce the depth of open water below the island perimeter.

6.2.6 Reed Habitat Expansion and Management

Planting of a further 100 reed plugs in suitable island/marginal habitat locations. Management of scrub on an ongoing basis to promote the expansion of reed (and other macrophytes). Use of reed harvested from Fugelmere Marsh when creating the backwaters.

6.2.7 Protective Cages

A trial to demonstrate the value of fixed and submerged plant nursery enclosure would be carried out. This would support the re-establishment of planted macrophytes, initially commencing with water lilies (see above). This would comprise a rectangular frame (1.5m high, 4m long x 4m wide) fitted to the bed of the lake within the sheltered western area and supporting a 0.5cm mesh screen to prevent birds, fish and crayfish entry. An equivalent lid would be added enabling inspection of the plant growth to be completed.

6.2.8 Woody Debris Reef

Bundles of coarse woody debris bundles will be located to form a deadwood reef along the net lines that form the boundary to the sheltered western part of the lake to provide added protection from fish accessing the area. The deadwood has the added benefit of providing habitat shelter to smaller fish, macro-invertebrates, zooplankton and the sheltered area as a whole. The northern most opening to the sheltered area will not have wood deposited in order that access to the area for boats continues to be provided by temporarily dropping the net. This would cover a length of approximately 40m long x 1m wide x 1m high.

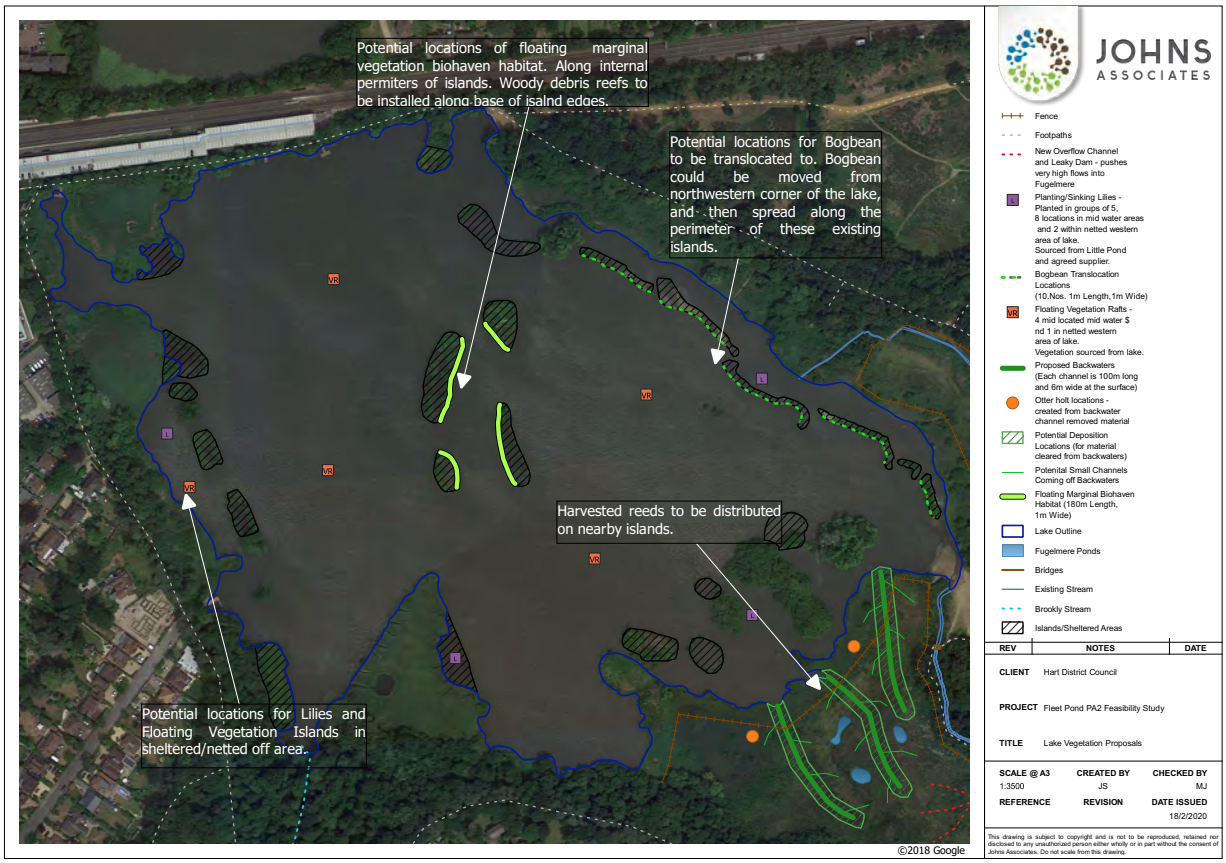

Figure 8 – Location, Type and Numbers of Aquatic Plant Proposals

6.2.9 Brookly Pond Nutrient and Emergency Sewage Management

As recently as January 2020 the recently restored sewage pumping station balancing pond and associated canal and Brookly pond were used to part delay the release of sewage to Fleet Pond, arising after very heavy rain. Under the current management regime, the Brookly Pond is typically full of water with limited capacity to attenuate sewage releases. The current control is a simple weir with weir boards. A considerable improvement can be made if the outflow is lowered in height to meet the level of the Brookly Stream, allowing the pond to drain in drier months and promote the revegetation by emergence plants. The installation of a suitable control structure funded by CS will allow the drained pond to better attenuate any further accidental releases that may occur in the future. These works are also key to reducing the input of excessive nutrients to the northern parts of Fleet Pond which in turn is influencing plant growth. Management of scrub on the steep banks and surroundings of the pond and canal will also help reduce nutrient inputs from leaf litter and increase the potential for establishment of a healthy and diverse ground flora, stabilizing the banks and supporting an increase in biodiversity. This work can be funded under CS Code WN7, SB2, and WN8.

Brookly Bay Sediment/debris removal and re-use

Sediment and nutrient rich leaf litter has built up in Brookly Bay and is limiting the successful establishment of macrophytes and becoming sub-aerially exposed in drier periods as the lake level drops. It is proposed that this area is dredged and arisings placed on the Brookly Bay Island within a new terrace formed from Nicospan Geotextile and wooden posts. This would require the harvesting of alder and willow scrub for off-site re-use, prior to the placing of the dredged sediment in the same manner as before. This can be seen in Figure 9. The perimeter length of containing geotextile is approximately 100m and the volume contained would equate to 300m^3. This can be done from the lake in one mechanical movement under an Environment Agency waste exemption.

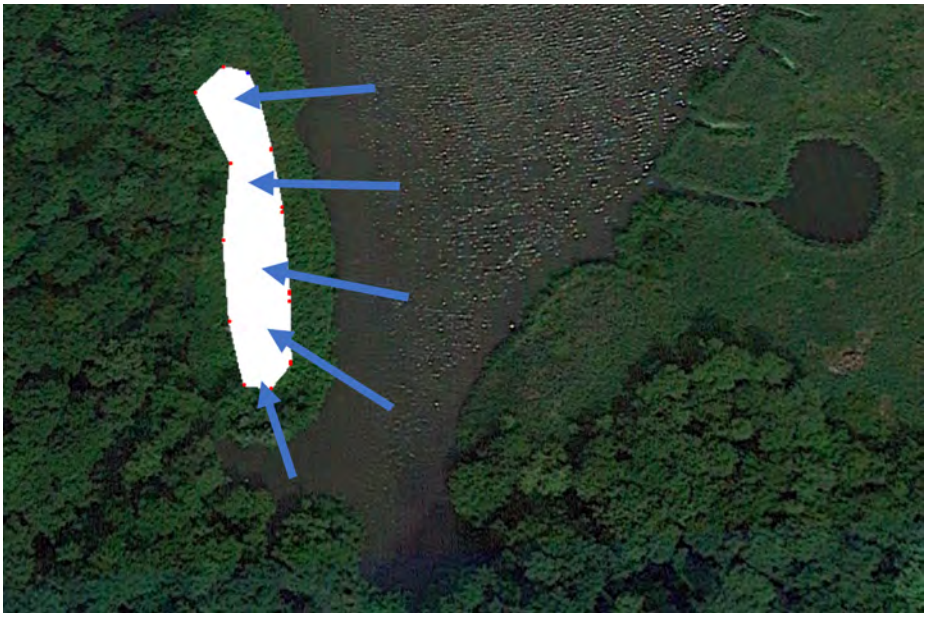

Figure 9. Dredging location and receptor

This would be funded through CS code WN7.

6.3 ONGOING MANAGEMENT

The experience gained from the completion of the Phase 1 Fleet Pond Restoration Project has confirmed the essential need to continue certain regular lake and habitat management activities. Whilst some activities are undertaken by the Hart Countryside Services and Fleet Pond Society Volunteers, the further expansion of habitat restoration activities means that funding for wider management activities is essential and should form part of the PA2 funding application if at all possible. Management and Maintenance is specified in Section 12 of this document.

6.4 ONGOING MONITORING

The experience gained from the completion of the Phase 1 Fleet Pond Restoration Project has confirmed the essential need to continue certain regular lake and habitat monitoring activities. Whilst some activities are undertaken by the Hart Countryside Services and Fleet Pond Society Volunteers, the further expansion of habitat restoration activities means that funding for wider monitoring activities is essential and should form part of the PA2 funding application if at all possible. Monitoring is specified in Section 14 of this document.

7 HIGHER TIER COUNTRYSIDE STEWARDSHIP FEASIBILITY

7.1 OVERVIEW

This phase of the restoration works would be funded through a successful application to the Higher Tier of the Countryside Stewardship (CS) Scheme. CS is a scheme that provides financial incentives for land managers/farmers to look after their environment. The scheme is open to all eligible farmers, woodland owners, foresters and other land managers, it is suitable for many types of land use, for example conventional and organic farmland, coastal areas, uplands and woodlands. It is competitive with applications being scored against local priority targets to maximise environmental benefit. There are four main elements to the scheme: Mid-Tier, Wildlife Offers, Higher Tier, and Capital Grants. This application will be for the Higher Tier which covers the more environmentally significant sites, commons and woodlands. The options available here are more complex than those found in the Mid-Tier due to the needs of these sites.

7.2 ELIGIBILITY

The priority of the CS Higher Tier is to protect and enhance the natural environment, in particular: biodiversity and water quality. The proposed selected for ongoing restoration and management of Fleet Pond as set out in Section 5 of this document are eligible for the Higher Tier Scheme as Fleet Pond is a Site of Special Scientific Interest which is one of the requirements set out in the Higher Tier Manual.

There are specific requirements for SSSI sites:

- If land is designated as a SSSI it must be appropriately managed, and paid multi-year options or capital options must not cause damage. This has been proven through the successful and ongoing management of Fleet Pond by the Hart District Council Countryside Team and with the notable support from the Fleet Pond Society, and previously by the Phase 1 Fleet Pond Restoration Project and its repeat funding from Natural England, Environment Agency, Hart District Council, Fleet Pond Society and being independently recognised and awarded the Environment and Sustainability Award by the Institute of Civil Engineers in 2013.

- Where the site is not currently in good condition, options and/or capital items to improve its condition must be chosen, for sites already in good condition grants that maintain this condition should be chosen. Fleet Pond SSSI has been classified by Natural England as Unfavourable Recovering. As such the proposals reflect restoration and management measures to further support the recovery of the SSSI.

8 COUNTRYSIDE STEWARDSHIP OPTIONS

8.1 AVAILABLE OPTIONS

Appendix C (Technical Note 3) provides a detailed review of the potential available options for the PA2 funded phase of the Fleet Pond Restoration Project. Specific likely eligible options for funding have been chosen as they are suitable for the Site and would help to enable the achievement of objectives set out in Technical Note 2. The following CS Options are deemed viable:

- WN7 Restoration of large water bodies – this will pay up to 100% of the actual costs of the works. This is only available on SSSIs with ecologically degraded water bodies of 1 hectare or more, and if other land management options are included in the agreement.
- WT6 Management of reedbed – this option will pay £78 per hectare. This is available for whole and part-parcel sections, it can only be used on priority reedbed in good condition which is more than 2ha, or degraded reedbed more than 2ha in area with the potential for restoration.
- RP32 Small leaky woody dams – this option will pay £461.39 for each dam. This is available only in catchments that have been targeted for flood risk measures, for dams that will be in streams between 1m and 2.99m wide, and where it has been approved by the Environment Agency or Lead Local Flood Authority.
- WN2 Creation of scrapes and gutters – this option pays £2.80 per square meter. This can only be used in locations agreed with a Natural England advisor, scrapes provide areas of bare ground that may be designed to hold water in wet habitats, Gutters provide shallow channels that can hold/transport water through wet habitats and provide feeding areas for waders.
- WN8 Timber Sluice – £315 will be paid per sluice for this. This provides a simple mechanism for water level control, this will support raised water levels for restoring or creating habitats.
- WN4 Ditch, dike and rhine creation – this pays £8.40 per meter. The aim of this is to establish raised water levels to help restore or create habitats.
- SB2 Scrub control on difficult sites – up to 80% of the costs will be paid by the option. This is only for sites that need either specialist operations or machinery with costs that cannot be covered by the schemes fixed-rate scrub control payments – this includes sensitive habitats and areas with difficult or hazardous working conditions such as steep slopes, bogs and islands.
- RP6 Installation of piped culverts in ditches – this option will pay £340 per culvert. It available in combination with options for the management and restoration of habitats or features with the support of a Natural England advisor.

Figure 8 highlights the areas of Fleet Pond SSSI where eligible CS funding can be applied, together with a summary of the relevant codes and associated areas/potential funding available.

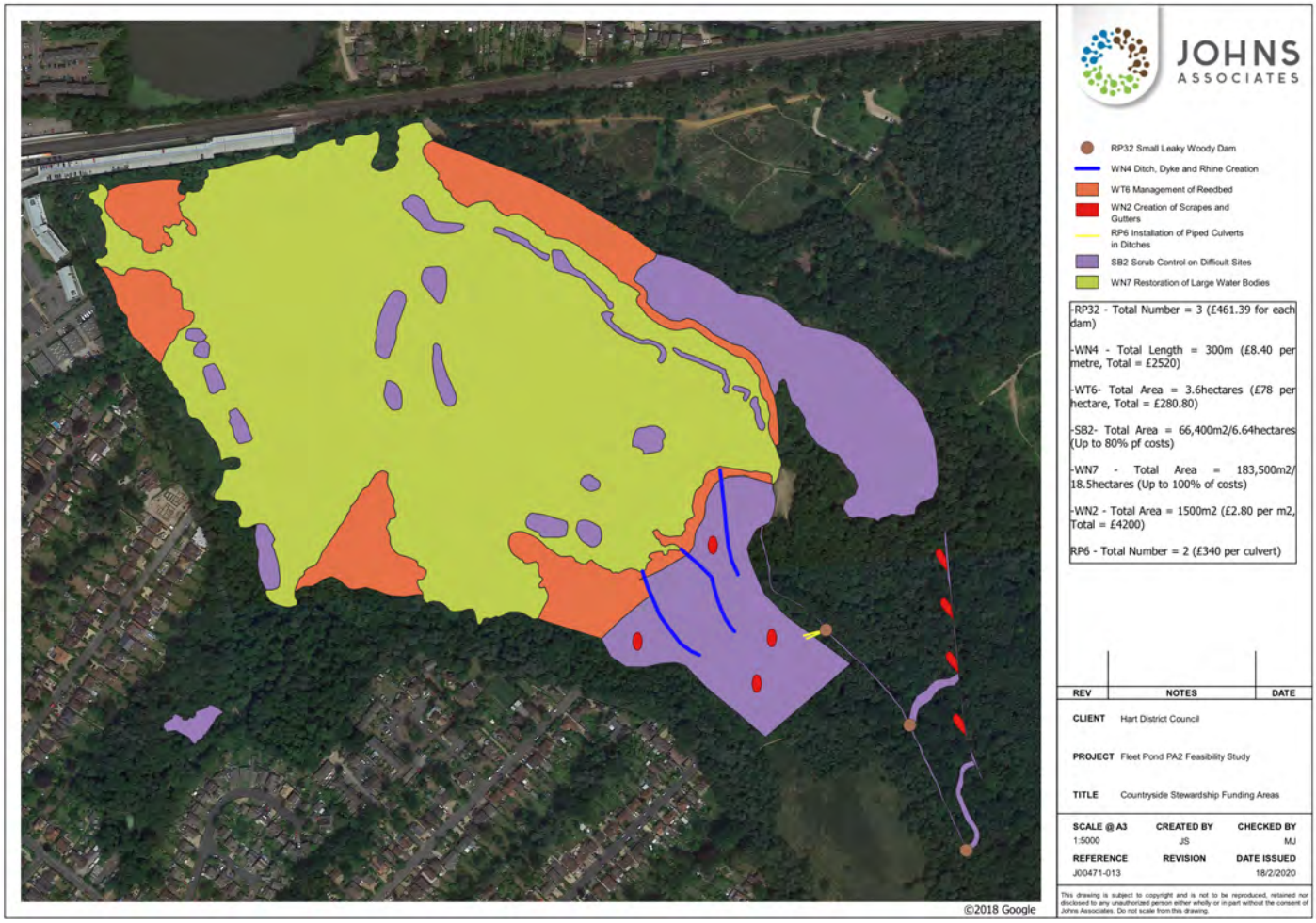

Figure 10. Countryside Stewardship Funding Areas

Table 8.1 provides a summary of the potential funding made available to HDC from a successful CS application.

CS Option	Funding Amount	5 Year Scheme	10 Year Scheme
RP32 – Small Leaky Dam	£461.39 per dam. 3 dams = £1384.17 Replaced at 5 years and 10 years	£2768.34	£4152.51
WN4 – Ditch, Dyke and Rhine Creation	WN4 - £8.40 per metre. 300m = £2,520 Created once	£2,520	£2,520
WT6 – Management of Reedbed	£78 per hectare. 3.6Ha = £280.80	£1404	£2808
WN2 – Creation of scrapes and gutters	£2.80 per m2. 1500m2 = £4200, rescraped between 5- 10 years	£4200	£8400
SB2 – Scrub Control on Difficult Sites	80% of actual costs. Estimated at £5000 ex VAT outside of islands and Brookly Pond as part of restoration proposals (Objective 3)	£4000	£8000
WN7 – Restoration of Large Waterbodies	Up to 100% of actual costs See breakdown in Section 11.	100% of actual costs	100% of actual costs

Table 8.1. Countryside Stewardship Funding Summary

Figure 11 is a PA2 Masterplan showing the location of the individual project components, lengths, areas, numbers and relationship to the CA funding codes.

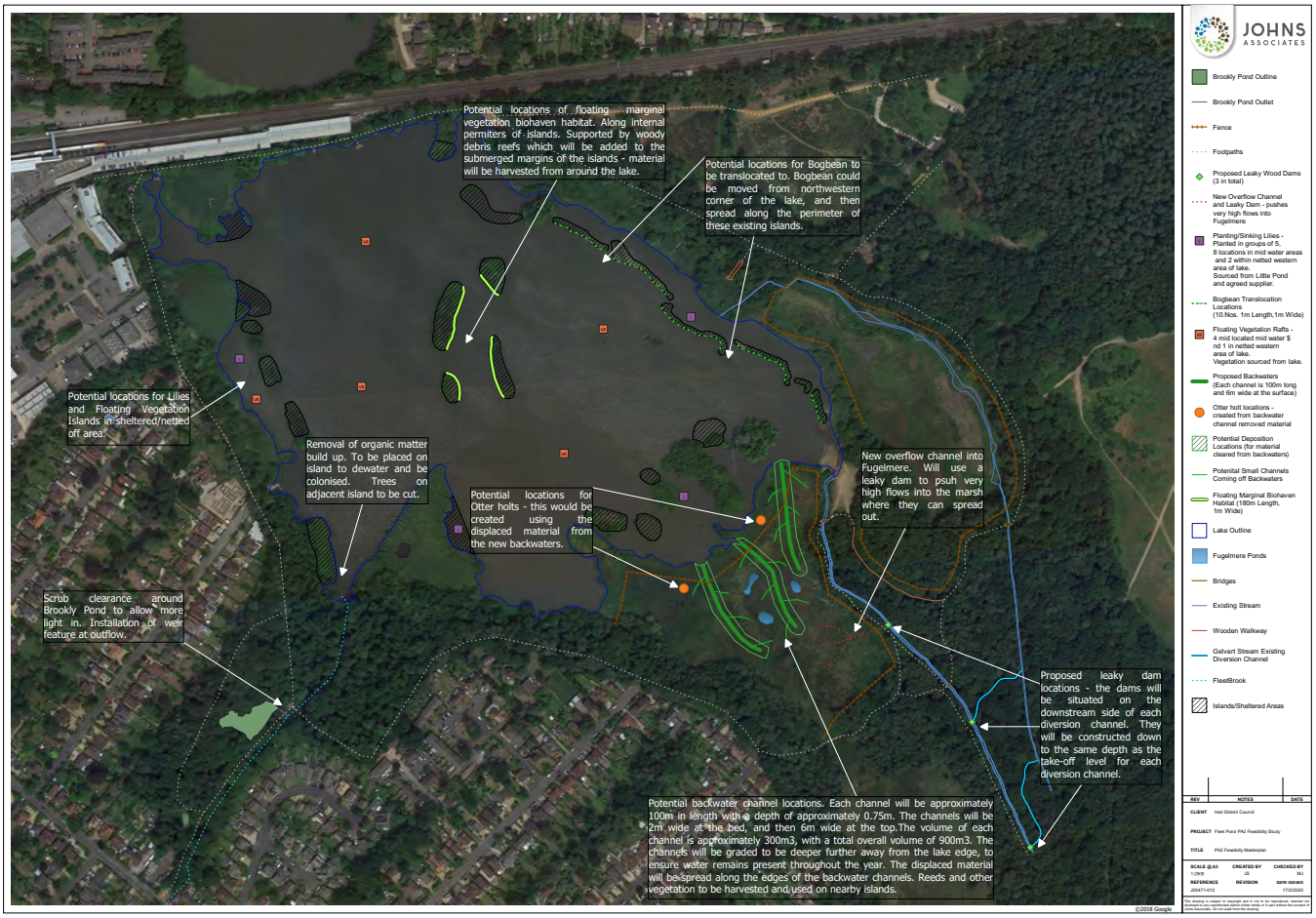

Figure 11. PA2 Countryside Stewardship Masterplan

9 PROJECT IMPLEMENTATION AND TIMETABLE

9.1 PROJECT IMPLEMENTATION

It is projected, that if a successful CA application is made in the first quarter of 2020, funding will be made available, subject to approval from the Rural Payments Agency (RPA) to implement the initial phase of works set out in this document in the first month of 2021. Ongoing management and monitoring would then occur over a further 4-year period within a 5-year CS funded project duration.

The proposals (as per Section 6) have been specified in line with the eligible CS Options identified in Section 8 and to promote existing features and management successes and accelerate the recovery and restoration of key designated features of interest associated with the lake and wetland components of the SSSI (aquatic and wetland macrophytes [that in turn support zooplankton, macroinvertebrates and birds], and ongoing protection of the lake from fine sediment and reduced water quality).

The proposals also take into account more prohibitive, costly and/or regulatory limiting solutions (e.g. hydrological and topographical constraints, avoiding the need for planning permission, footpath diversions, avoiding sensitive habitats, unnecessary additional infrastructure costs or Environmental Permits associated with potential waste arisings.

The project would be led and coordinated by Hart District Council with support from its appointed environmental consultants, principal contractor for the works and any associated sub-contractors.

10 COMMUNICATIONS PLAN

10.1 OVERVIEW

Fleet Pond is owned by Hart District Council (HDC) and managed by Hart District Council Countryside Services. The Fleet Pond Society (FPS), founded in 1976, is a voluntary organisation with charity status (No. 290637) dedicated to the retention and enhancement of the Local Nature Reserve. The Fleet Pond Society work in partnership with the Hart Countryside Service Rangers in the management of the pond through volunteer work parties, projects and fundraising.

The relationship between Hart District Council and the FPS is a positive long standing partnership to make the best decisions for the management of the Nature Reserve and public relations. Formal communication includes the HDC countryside ranger responsible for the management of Fleet Pond attending the FPS quarterly Executive Committee Meetings and attending the Societies AGM. In addition, there are also HDC and FPS Partnership Meetings as and when necessary, but mainly three times a year. A HDC Countryside Ranger also manages the monthly FPS Sunday volunteer days and supervises when possible the off-shoot specialist groups and working parties.

Other regular communication with active FPS members includes e-mails and newsletters, updates on work planned and proposed ideas. HDC's Marketing and Education Ranger liaises with FPS's press officer on all publicity and press releases. Weekly face to face communication is common with some members of the FPS and general information is communicated where appropriate. HDC and the FPS have Facebook and Twitter accounts, have healthy followers, allowing good social media exposure.

10.2 SPECIFIC MEASURES AND INITIATIVES

There are a number of information boards at Fleet Pond which will be used to communicate the project and work specifications, location and specifications, together with communication routes to Hart District Council if there are any queries.

There will be regular communication and consultation on progress and opportunities to provide further benefits and resole any issues arising, though a Fleet Pond Restoration Project Steering Group. This buildings on many years of strong relationships between Hart District Council, the Fleet Pond Society, Natural England, Environment Agency, MoD, Johns Associates and others e.g. Thames Water, Hampshire and Isle of Wight Wildlife Trust and Hampshire Ornithological Society. The Steering Group would meet quarterly throughout the duration of the project.

11 ESTIMATED COSTS FOR OBJECTIVES

11.1 OBJECTIVE 1: TO ENSURE THE EXISTING GELVERT STREAM DIVERSION CHANNELS FUNCTION EFFECTIVELY TO MANAGE SEDIMENT INPUT TO FLEET POND AND ENHANCE WETLAND FUNCTIONALITY INCLUDING COLDSTREAM MARSH

11.1.1 Key Components of Project and CS Funding Codes

The key components of delivering Objective 1 are:

- RP32 CS Option Installation of two leaky dams including small amounts of bank and bed protection
- WN2 CS Option Creation of scrapes and gutters to allow a greater amount of water to be held in the woodland area increasing the areas of wetland habitat, water and sediment storage
- WN7 Option Restoration of large water bodies to ensure ongoing functioning of diversion channels and sediment and nutrient control areas

11.1.2 Budget Breakdown

Table 11.1 provides a breakdown of the preliminary budget estimate for the proposals, showing funding from CS, contractor and consultancy support costs from organisations with significant experience of working at Fleet Pond.

Table 11.1 Objective 1 Budget Estimate

Objective 1: Gelvert Stream and Coldstream Marsh

Item	Description	CS Code	CS Funding £	Preliminary Iex VAT	Shortfall made up from WN7 or other funding £	Observations
1	Installation of two leaky dams (and bed/bank protection)	RP32	922.78	3500		Mobilisation of hire of small plant and operatives for 3 days
2	Creation of scrapes and gutters total 750m2	WN2	2100	3500		Assumes plant access
3	Restoration of large waterbody	WN7				Potential for 100% funding to make up the difference
4	Permitting and consultancy support. Excl. monitoring			3000		Assumes this is not avilable from WN7
	TOTAL		**3022.78**	**10000**	**6977.22**	

This task can be independent from those associated with Objectives 2 and 3.

11.2 OBJECTIVE 2: TO INCREASE THE WETNESS OF FUGELMERE MARSH AND INCREASE HETEROGENEITY, RESTORE NATURAL FUNCTION AND INCREASE THE DIVERSITY OF WETLAND HABITATS AND BIODIVERSITY

11.2.3 Key Components of Project and CS Funding Codes

The key components of delivering Objective 2 are:

- RP32 CS Option — Installation of one leaky dam including small amounts of bank and bed protection
- WN4 CS Option — Creation of three rhines within Fugelmere Marsh
- WN2 Option — Creation of scrapes and gutters in Fuglemere Marsh to support re-wetting
- RP6 Option — Installation of two piped culvert linking the upper Gelvert Stream Channel to Fugelmere Marsh
- WN7 Option — Ensuring ongoing functioning of diversion channels and sediment and nutrient control areas to continue the restoration of large water body

11.2.4 Budget Breakdown

Table 11.2 provides a breakdown of the preliminary budget estimate for the proposals, showing funding from CS, contractor and consultancy support costs from organisations with significant experience of working at Fleet Pond.

Table 11.2 Objective 2 Budget Estimate

Objective 2: Fugelmere Marsh

Item	Description	CS Code	CS Funding £	Preliminary	Shortfall made up from WN7 or other funding	Observations
1	Installation of one leaky dam (and bed/bank protection)	RP32	461.39	1500		Mobilisation of hire of small plant and operatives for 1 day
2	Creation of 750m2 scrapes and gutters	WN2	2100	750		By machine
3	Installation of two culverts linking Gelvert Stream to Fugelmere Marsh	RP6	680	3500		2 pipes, excavate path and reinstate over
4	Creation of 3 x rhines in Fugelmere Marsh	WN4	2520	49750		Assuming objective 3 is also delivered at the same time to avoid additional mob/demob and preliminaries costs
5	Restoration of large waterbody	WN7				Potential for 100% funding to make up the difference
4	Permitting and consultancy support. Excl monitoring			5000		Assumes this is not avilable from WN7
	TOTAL		**5761.39**	**60500**	**54738.61**	

This task has to be delivered alongside those associated with Objective 3 to avoid duplicate mobilisation/demobilisation/preliminaries welfare etc costs.

11.3 OBJECTIVE 3: TO INCREASE THE DIVERSITY AND ABUNDANCE OF LAKE AQUATIC MACROPHYTES, INVERTEBRATES AND ZOOPLANKTON THROUGH THE USE OF A RANGE OF TECHNIQUES AND FEATURES (INCLUDING PROTECTIONS FROM GRAZING FISH AND BIRDS)

11.3.5 Key Components of Project and CS Funding Codes

The key components of delivering Objective 3 are:

- WN7 Option Restoration of large water body through the translocation of bogbean, provision of new areas of water lily colonies, provision of floating vegetated rafts, provision of planted island perimeters, reed habitat expansion through plug planting and harvesting of materials from Fugelmere Marsh, provision of a protective cage for plant recolonization and provision of woody debris reefs along island margins, dredging and removal of organic rich accumulated sediment from Brookly Bay and placement on adjacent island for future recolonization by plants.
- SB2 Control of scrub at difficult locations focused on the lake islands and Brookly Pond to promote wetland macrophyte recovery
- WN8 Option Provision of new timber sluice to manage emergency storage/release of nutrient rich waters

11.3.6 Budget Breakdown

Table 11.3 provides a breakdown of the preliminary budget estimate for the proposals, showing funding from CS, contractor and consultancy support costs from organisations with significant experience of working at Fleet Pond.

This task has to be delivered alongside those associated with Objective 2 to avoid duplicate mobilisation/demobilisation/preliminaries welfare etc costs.

Table 11.3 Objective 3 Budget Estimate

Objective 3: Aquatic Macrophytes and Wider Lake Restoration

Item	Description	CS Code	CS Funding £	Preliminary I	Shortfall made up from WN7 or other	Observations
1	Bogbean translocation	WN7	1500	1500		10 m2 removed by hand and transferred/sunk by boat/pontoon
2	Lilies	WN7	2000	2000		50 x lilies in biodegradeable bags, planted by hand and by boat
3	Floating planted islands	WN7	4000	4000		5 x 4x4m2 floating/anchored islands installed by hand and from boat/pontoon, planted from lake plant and planted up by hand
4	Island biohaven	WN7	2000	2000		180m installed by hand/boat/pontoon and planted from lake plant and planted up by hand
5	Reed plugs	WN7	3000	3000		Harvested and planted by hand
6	Plant nursery cage	WN7	3000	3000		1.5mx4mx4m with lid and metal mesh
7	Woody debris reef	WN7	1500	1500		130m long x 1 m x 1m can be added incrementally as timber harvested
8	Brookly Pond dewatering and new flow control	WN8	3250	3250		Timber control structure requries smal machine - link to Objective 1
9	Brookly Pond Canal scrub management	SB2	5000	5000		Reuse of timber in lake unless unsuitable species
10	Brookly Bay sediment removal and placement on Island	WN7	25000	25000		In lake dredging requried - large pontoon and excavator etc, 100m nicospan and posts
11	Harvesting and translocation of 120m of reed from Fugelmere to islands	WN7	3000	3000		Using equipment from above
12	Preliminaries and demobilisation	WN7	9000	9000		Assuming objective 2 is also delivered at the same time to avoid additional mob/demob and preliminaries costs
13	Restoration of large waterbody	WN8				Potential for 100% funding to make up the difference
14	Permitting and consultancy support. Excl monitoring			12000		Assumes this is not avilable from WN7
	TOTAL		**62250**	**74250**	**12000**	

11.4 BUDGET SUMMARY

A summary of the key budget estimate totals for the delivery of all three PA2 restoration objectives is shown below:

- Total core funding from CS for new restoration work to deliver the three identified objectives: £62,250 ex VAT
- Total additional funding from CS or other sources to deliver the three identified objectives: £73,715.83 ex VAT
- Total additional CS funding for wider SSSI management SB2 and WT6: 80% of estimated £5000 ex VAT additional scrub management costs and £280.80 ex VAT for reedbed management

12 MAINTENANCE DESCRIPTION

12.1 OVERVIEW

The Fleet Pond Management Plan prepared by Hart District Council (2015-2020) confirms a number of existing aims, management requirements and performance indicators that are reproduced here and added to where appropriate.

In order to enhance and maintain the features of the site that will be restored through the PA2 project, a number of key maintenance aims have been identified.

1. To optimise the restoration and spatial extent of biodiverse lake, wetland, woodland, heathland and grassland habitats.
2. To safe-guard all rare and notable species.
3. To reduce and control non-native plant species.
4. To maintain the water level and saturation of wetland at a level which is of maximum

benefit to wildlife but which meet both statutory requirements and non-statutory

obligations.

5. To maintain the accessibility and safety of the site for public use, promoting health

and wellbeing, without compromising the nature conservation interests.

6. To provide interpretative facilities that will develop an awareness and understanding

of the natural history of the site and educate users.

7. To meet all legal and other obligations.

12.2 LAKE ISLANDS

12.2.1 Vision

The islands are a safe haven for breeding birds with Common Terns nesting on site and birdlife such as Little Ringed Plovers, Oystercatchers, Lapwing, Common Redshank and over wintering Bittern. They are free from scrub and invasive plants and help to reduce the wave motion over the surface of the pond. They create pockets of refuge for young fish and other aquatic species. The islands support a healthy cover of Common Reed and other native wetland plant species. They are easy to maintain, with appropriate vegetation supporting the edges and growing in the varying depths and water levels achieved.

12.2.2 Performance Indicators

These performance indicators give an indication as to the status of the feature. When the factors and attributes of the feature as listed below are found to be within the upper and lower limits, the feature is said to be in favourable conservation status.

% of Common Reed over whole of feature

- Upper limit = 80%
  Lower limit = 60%

Common Reed stems per m2 within area of dominant reed Upper limit = none set

- Lower limit = 150 stems

Height of Common Reed prior to cutting

- Upper limit = none set
- Lower limit = 100cm

Cover of scrub (over whole of feature)

- Upper limit = 10%
- Lower limit = 0%

Reedbed should be covered by surface water November – March

- Upper limit = 95% coverage, 100cm deep
- Lower limit = 50% coverage, 30cm deep

Area of reedbed allowed to remain dry during November – March

- Upper limit = 10%
- Lower limit = 5%

Cover of invasive species over whole of feature

- Upper limit = 5%
- Lower limit = none set

12.2.3 Management

Management Options	Notes on Management Tasks	Time and Resources
Scrub control	Annually remove woody species from edges of the new islands.	Sept- Mar Rangers/vols/contractor from boat
Invasive Species Control	Please see Feature 10.	Rangers/contractor
Maintain goose fencing	To be revised – may be replaced with more effective method such as faggots	Rangers/Contractors
Planting Reeds	Reeds can be cut and extracted by the roots from the Flash and other areas agreed by Natural England and re-planted on appropriate islands. Some reeds may have to be obtained from outside sources. When the criteria for reed reaches the desired density and height a rotational cutting and removing reed plan should be implemented.	Sept - Oct Rangers/Vols/Contractors
Maintain gravel base	On Clearwater Island for nesting Terns. Top up AW. Would expect to see at least 6 breeding pairs as a minimum.	Rangers/Vols/Contractors
Bare Ground retention	Small areas of bare ground creation with hand tools	Sep – Feb Volunteers
Island enhancement	The island edges are in need of long term stabilization and protection from erosion and	Sep – Feb Contractors
	invasive plants and scrub. The possibility of installing Coir bunds around the edges of the new Islands and reedbed extensions will be explored. These could be planted with Common Reed seeds and/or reed plugs as well as with reeds transplanted from the existing established reed beds. This is subject to discussion and consent from NE and EA.	As and when funding available & consents achieved.

12.3 STREAMS AND DITCHES

12.3.4 Vision

The streams and ditches around the site are open and free from debris, blockages and silt. Ditches are dug out to maintain their water carrying capacity and to prevent nearby roads and footpaths becoming flooded during heavy rainfall and they are free from invasive species.

The paths alongside streams provide a peaceful walk, where birds such as Herons and Kingfishers can be glimpsed.

12.3.5 Performance Indicators

These performance indicators give an indication as to the status of the feature. When the factors and attributes of the feature as listed below are found to be within the upper and lower limits, the feature is said to be in favourable conservation status.

Amount of ditch/stream kept clear as percentage of total

- Upper limit = none set
- Lower limit = 2%

Number of culverts kept clear

- Upper limit = none set
- Lower limit = 0

Level of bank erosion

- Upper Limit = 10%
- Lower limit = none set

Presence of invasive species (including Crassula helmsii)

- Upper limit = 10%
- Lower limit = none set

Depth of channel

- Upper limit = none set
- Lower limit = 30% decrease in depth

12.3.6 Management

Management Options	Notes on Management Tasks	Time and Resources
Undesirable species control	Please see Feature 10.	As and when Rangers / Volunteers
Clearance of debris and blockages	Any major debris or blockages from streams and ditches should be removed. Checks for blockages are especially important after heavy rainfall. Ditches are to be dug out as and when necessary to maximise the capacity.	As and when Rangers / Volunteers
Ditch clearance	Ditches should be kept open and their carrying capacity maintained by using a mini digger.	As and when. Rangers
Insert Dog Steps	Where bank erosion (Gelvert Stream) is most evident through dogs entering and exiting the water insert dog steps	As and When Rangers/Volunteers

12.4 REEDBEDS

12.4.7 Vision

The reedbeds are dominated by Common reed, with other desirable reedbed species such as Yellow Loosestrife and Bulrush found amongst the tall stems. New greens shoots of reed begin emerging in spring and by summer the reedbeds are alive with the sound of Reed Warblers, Sedge Warblers and Reed Buntings. The reeds provide shelter for many other animals such as Harvest Mice, Grass Snakes, frogs, toads and many species of invertebrates. The edges of the reedbeds are protected from grazing animals such as Geese by Bog Bean, which also supports a rich diversity of life.

12.4.8 Performance Indicators

These performance indicators give an indication as to the status of the feature. When the factors and attributes of the feature as listed below are found to be within the upper and lower limits, the feature is said to be in favourable conservation status.

Cover of undesirable species

- Upper limit = 5%
- Lower limit = none set

Vegetation should include Common Reed

- Upper limit = none set
- Lower limit = 60%

Common Reed stems per m2 within area of dominant reed

- Upper limit = none set
- Lower limit = 150 stems

Height of Common Reed prior to cutting

- Upper limit = none set
- Lower limit = 100cm

Cover of scrub (over whole of feature)

- Upper limit = 10%
- Lower limit = 0%

Litter layer coverage

- Upper limit = none set
- Lower limit = 10%

Litter layer depth

- Upper limit = 20cm
- Lower limit = none set

Reedbed should be covered by surface water November – March

- Upper limit = 95% coverage, 100cm deep
- Lower limit = 50% coverage, 30cm deep

Areas of Reedbed should remain dry

- Upper limit = 10%
- Lower limit = 5%

12.4.9 Management

Management Options	Notes on Management Tasks	Time and Resources
Scrub control	Scrub in the middle and around the edges of the reedbeds should be reduced and controlled. Stumps need to be cut low and treated to prevent regrowth. Surrounding woodland also needs to be controlled and potentially coppiced to prevent encroachment and shading. Any encroaching woodland should be cut down and treated with approved herbicide. The bulk of the brash produced will be chipped on to the woodland edge off the reedbed where appropriate and refuges created using stacked core wood.	Sept – Feb Rangers / Volunteers
Mowing	Mowing of the reedbeds must take place at the driest possible time during the winter period, which is usually around September once the birds have finished breeding. Mowing can be carried out either with a brushcutter or with a BCS pedestrian mower. Depending on ground conditions, mowing can be time consuming, i.e. when there are lots of stumps to avoid or there are wet patches of ground. This should be carried out on rotation with the other reedbeds on site with reedbeds being cut every 5 – 6 years.	Sep– Feb Rangers / Volunteers
Burning	Burning may take place as part of the 5 – 7 year rotational reed bed management to remove the excess of cut reeds. Burning is used as an appropriate tool which is carried out under controlled methods by rangers, either burnt in rows after raking or on raised fire platforms.	Sept- Feb Rangers/Volunteers
Bogbean Management	The Bogbean has been further extended around the reedbeds to reduce grazing pressure from Geese and other wildfowl and may possibly benefit from further extension to other areas of the Pond including The Flash. The Bogbean also provides a valuable habitat for aquatic invertebrates. It can be pulled up from abundant areas and transplanted. However we need to maintain a balance between areas of bog bean edges to that of open water habitat.	Rangers/Volunteers
Chemical management	Stumps should be treated with herbicide; however any stumps next to open water can not be treated unless the operator has the correct qualification.	Stump treating As and When.

12.5 MARSHES AND FENS

12.5.10 Vision

Both areas of marsh (Fugelmere and Coldstream) are covered by swards of wetland plant species, graduating into reedbed towards the Pond itself. The marshes remain wet all year round and become flooded in the winter months. Wildfowl often take advantage of these secluded wet areas in the winter and in

the summer the wet marsh areas are alive with dragonflies and damselflies as they hunt and search for mates. A large number of insect species are also recorded here, several of which are nationally rare. Cows graze these areas in the summer, keeping tallervegetation and grasses short to allow the wetland plants to flourish. Grass Snakes and Common Lizards can be seen basking in the sun on top of the grassy tussocks, while Roe Deer are seen grazing the marshes or just keeping to the shade of the surrounding woodland. Scrub is kept to a minimum by the grazing animals and willing volunteers, while undesirable species are also kept at bay.

12.5.11 Performance Indicators

Based on HLS indicators of success, these performance indicators give an indication as to the status of the feature. When the factors and attributes of the feature as listed below are found to be within the upper and lower limits, the feature is said to be in favourable conservation status.

Cover of undesirable species

- Upper limit = 5%
- Lower limit = none set

Cover of scrub (over whole of feature)

- Upper limit = 10%
- Lower limit = 0%

Bog-moss (Sphagnum) should be at least frequent across the area of fen

- Upper limit = found in 60% of stops
  Lower limit = found in 35% of stops

At least 2 desirable species should be at least occasional across the area of fen. Including the species; Bogbean (*Menyanthes trifoliate*),Bog mosses (*Sphagnum* spp.), Branched Bur-reed (*Sparganium erectum*), Cottongrass (*Eriophorum angustifolium*), Common Butterwort (*Pinguicula vulgaris*), Common Skullcap (*Scutellaria galericulata*),Common Reed (*Phragmites australis*), Common Valerian (*Valeriana officinalis*), Gypsywort (*Lycopus europaeus*), Hemp-agrimony (*Eupatorium cannabinum*), Lesser Spearwort (*Ranunculus flammula*), Marsh Arrowgrass (*Triglochin palustre*), Marsh Bedstraw (*Galium palustre*), Marsh Cinquefoil (*Potentilla palustris*), Marsh- marigold (*Caltha palustris*), Marsh Pennywort (*Hydrocotyle vulgaris*), Marsh Valerian (*Valeriana dioica*), Meadowsweet (*Filipendula ulmaria*), Purple-loosestrife (*Lythrum salicaria*), Ragged Robin (*Lychnis flos-cuculi*), Reed Canary-grass (*Phalaris arundinacea*), Reedmace (*Typha latifolia*), Reed Sweet-grass (*Glyceria maxima*), Sedges, Water Forget-me-not (*Myosotis scorpioides*), Water Horsetail (*Equisetum fluviatile*), Water Mint (*Mentha aquatica*), Wild Angelica (*Angelica sylvestris*), Yellow Flag (*Iris pseudacorus*) and Yellow Loosestrife (*Lysimachia vulgaris*).

- Upper limit = none set
- Lower limit = 2

Average height of vegetation across the Fen

- Upper limit = 50cm
- Lower limit = none set

Cover of surface water (The whole surface should be wet from October to May. The surface should receive at least one flood per year and remain damp. Seepage should be visible all year round and the soil should be damp.)

- Upper limit = 100%
- Lower limit = 5%

For wetland grazing

Vegetation cover should be in tussocks or in patches over 50cm high

- Upper limit = 35%
- Lower limit = 25%

The vegetation should include a mosaic of shorter and / or taller plant species.

12.5.12 Management

Management Options	Notes on Management Tasks	Time and Resources
Scrub control	The scrub in both marshes needs to be controlled to avoid it becoming established. Stumps should be treated with an approved herbicide, and any roots should be pulled up where possible. The bulk	Sept – March Rangers / Volunteers / Contractors
	of the brash produced will be chipped on to the woodland edge, off the reedbed, where appropriate and refuges created using stacked core wood.	
Turf cutting & stripping	Scrapes and/or shallow pools to be carried out in certain sections in Fugelmere and Coldstream to reduce scrub and grass tussocks and benefit inverts and birds, subject to botanical surveys.	Dec – March Contractors
Grazing	Coldstream, East marsh, Fugelmere and Gelvert will continue to be grazed.	April – Sept
Chemical treatment	Spraying should be done in the summer months with appropriate herbicide. Stumps, if they are not able to be pulled up, should be treated with appropriate herbicide.	Spraying April - Sept Stump treating As and When.

12.6 MONITORING DESCRIPTION

12.6.13 Lake Islands

- Condition Assessments
- Annual botanical surveying
- Breeding bird survey annually

12.6.14 Streams and Ditches

- Water quality monitoring annually
- Botanical surveying every year

12.6.15 Reedbeds

- Condition assessments annually
- Botanical surveying every year
- Invertebrate surveying every 5 years (Yr 2)
- Ornithological surveying annually
- Ariel photography to monitor the size of the reedbeds as and when

12.6.16 Marshes and Fens

- Condition assessments annually
- Botanical surveying every years
- Invertebrate surveying every 5 years (Yr 2)
- Ornithological surveying annually

Appendix A: Technical Note 1: Technical Review of Phase 1 Fleet Pond Restoration Project;

AW Water Engineering

Short Technical Report

PROJECT	Fleet Pond Restoration – Technical Review
CLIENT	Johns Associates
REFERENCE	047/010
DATE	5th October 2019

Revision	Description	Issued by	Date	Approved
01	FINAL	AW	05/10/19	Andy Wallis

1 Introduction

This note has been produced to form part of an internal review of the work completed to date on the Fleet Pond Restoration project, and to provide independent recommendations on potential further work that could be undertaken to provide further improvements at the pond. This review focuses on the hydraulic, hydrological and geomorphological elements of this work. A substantial amount of work has been undertaken at the pond and it is not possible to review all elements of this, but the focus has been on the key items of work as discussed below.

This review has been based on a review of the documentation that has been produced for the project as well as a workshop with staff from Johns Associates on 3rd October 2019. This note is divided up based on particular elements of the project, with recommendations presented in each section.

2 Physical changes over a longer time period

It would be beneficial to understand the key physical changes that have happened to the pond over time, to help establish how much both natural and man-made issues have affected the pond over time. For example it is quoted that the pond was held to a greater depth previously, but was that due to a higher retained water level or a lower bed level? How has the lower pond changed over time, and especially the outlet structure from this pond? Has this structure been modified over time? At what stage were the railway culverts first constructed and then gradually filled in?

This information would be useful to understand alongside the data that has been collected on the pond itself and the upstream catchments.

3 Catchment approach

Whilst some of the issues that have impacted on the environmental status of Fleet Pond originate within the pond, it is important to recognise that a lot of the issues originate in the upstream catchments, especially sediment supply. Within the early stages of the previous work, focus was placed on reducing the sediment runoff from the MOD land within the Gelvert Stream catchment. This has been effective, but more could be done with this.

The main restoration works, by necessity, focussed on the pond and its immediate environs, and were very successful. As part of any future works there should be further work to look at any opportunities within the catchment to make positive interventions that could benefit the pond, as well as other areas. These should include:

- Further investigations at the MOD land to better understand the effectiveness of the previous interventions, and any potential further works. These should include the existing settlement ponds, opportunities for planting, potential to install natural check dams within the drainage channels or filling in of gullies to reduce velocities and encourage deposition of silt, and routing of runoff into vegetated areas rather than drains.
- Investigations into urban runoff directly into the watercourses that feed the pond. If there are any outfalls from highway drainage or the surface water sewer system that directly enter the

watercourses, consideration should be given to diverting these to go through a natural filter system (e.g. swale or reed bed) prior to entering the watercourses.

Any funding application for further improvement works in this area will be enhanced by ensuring a whole catchment approach is being followed.

4 Survey/gauge data

As part of the restoration project data was collected on the depth of water within the pond and the amount of siltation. This was used to inform the dredging works within the pond. It is unfortunate that limited data has been collected after the works were complete and after the system had had time to stabilise. This data would have been very useful to assess the effectiveness of any works and the potential for further works.

It is recognised that installing and maintaining gauges is expensive and budgets would have been limited. It would have been very beneficial to have had some gauging on the watercourses that feed the pond, especially on the Gelvert Stream. If information on water levels and ideally turbidity had been collected this would have been very useful in informing any future work.

It is understood that the Fleet Pond Society record lake depths on a regular basis - this information will be useful to evaluate changes prior to, during and after the dredging works and future phases.

5 Gelvert Stream inflow

As part of the restoration works, improvement works were undertaken to Gelvert Stream. These consisted of the formation of a diversion channel on the right (eastern) bank to take high flows through wetland areas, with the intention that some of the sediment load would be deposited in these areas, and the remainder deposited in controlled areas of the pond.

The principal for undertaking these works is very sound, and is likely to have been effective. To determine how effective it would be beneficial to collect sediment data from this diversion channel as well as the pond. It would appear that a large amount of silt was still deposited in Sandy Bay from the main channel, so this may indicate that further work could be done to reduce the silt loads entering the pond. It would also be useful to establish whether there has been much sediment entering the pond from the diversion channel.

The diversion channel will only come into use once flows are relatively high, and due to the level and orientation of the overflow weir there will always be a substantial flow continuing down the main channel. The majority of sediment is likely to be therefore still continuing down this main channel.

Ideally, it would be of benefit to establish when the highest sediment loads enter the upstream channel. Are there quite high sediment loads even under low flows? After heavy rainfall is there a sudden increase in sediment that then tails off or is it fairly consistent for longer periods of time. With this sort of upstream catchment there is often a ‘first flush’ effect where the sediment is initially very high. If this was the case, then the overflow channel may not be coming into use until after the sediment loads have decreased.

To increase the effectiveness of the diversion channel it may be possible to provide a throttle on the main channel downstream of the diversion channel. This would need to be designed to not impact on low flows, but would then force more flow into the diversion channel and therefore increase the sediment loads passing into this channel.

Consideration should also be given to any further works on the Gelvert Stream that could encourage deposition of silt prior to reaching the ponds. At present the watercourse is artificially straight for a significant reach, and as a result is quite incised and will have artificially high velocities. Through the introduction of meanders within the channel this will increase the overall channel length and reduce velocities, with the additional benefit of forcing more water into the adjacent floodplain during low flows where deposition of sediment is more likely. This would also reduce any erosion within the channel, which will be contributing to the sediment supply.

An alternative to this (or in addition) would be to include a number of natural ‘check dams’ within the watercourse. This would do something similar to the sheet piling that is currently in parts of the channel, in that it would act to trap upstream sediment. These would also act to increase the flow passing into the adjacent floodplain. These dams could be constructed from woody debris, but may require some wooden stakes in certain locations to hold them in place.

With any of these measures it is important that flood risk to adjacent areas is considered. However, these interventions are only likely to impact on more regular flood levels, when there is unlikely to be any risk to adjacent areas. In more extreme events the majority of flow will be in the floodplain and therefore unaffected by these works.

All of these works though are unlikely to be as effective in reducing sediment loads as works in the upstream catchment as described earlier.

6 Brookly Stream

Brookly Stream is a more urban watercourse than Gelvert Stream, and is also influenced by the canal overflow. Whilst there are some siltation issues originating from Brookly Stream, the bigger issue is to do with water quality.

Historically there was a grill in the downstream reach of the stream, which would have trapped debris where it could have been removed from the channel. This grill was removed by the Environment Agency due to concerns on upstream flood risk and difficulties in accessing the structure. Whilst there is some evidence of upstream flooding within property boundaries, this is thought to be as much due to local drainage issues as the stream itself. This should be further investigated, ideally with a short modelling study of this stream.

The grill is likely to have been effective at trapping certain types of debris and it may be worthwhile reinstating a trash screen on this watercourse. A new screen could be constructed to ensure the upstream flood risk is minimised, whilst also making it easier to access and maintain.

Works have been undertaken to reinstate overflow watercourses adjacent to Brookly Stream, which connect into settlement ponds with adjustable outfall structures. It would be useful to know how well these have worked, how often they have operated and what material has been deposited within the ponds.

One of the principal sources of pollution comes from the Thames Water sewer overflow, which has been reported to operate twice a year on average. Further discussions should be held with Thames Water to determine what improvements they have already undertaken in this area, and whether any future works are planned. Studies could look at any joint opportunities to reduce this overflow further by looking at aspects such as reducing connections from the stormwater or highway drainage systems to the combined sewer, or localised works within the urban catchment to reduce runoff.

The Basingstoke Canal Authority may also know more about the overflow from the canal, and whether there are any opportunities to reduce the amount of floodwater entering the canal in the first place, or reducing the overflow in this location.

With the canal overflow and also any direct urban connections to the stream it may be possible to revise, or reroute these connections so that the runoff has to pass through more ‘natural’ treatment prior to entering the stream, e.g. by the use of reed beds.

Any further work on Brookly Stream will have to fully consider the potential flood risk impacts to third parties.

7 Fleet Pond

Significant works have been undertaken within Fleet Pond itself, mainly involving dredging silt from within the pond to create a number of islands. This was to increase the depth of the pond, create valuable habitat, reduce the reach length within the pond (i.e. reduce the size of wind driven waves and currents), and to create different regions within the pond to try to encourage siltation within certain areas.

It will be very interesting to collect water and sediment depth information from the pond to determine how effective these works have been and how much resiltation there has been. However, the anecdotal evidence suggests these works have been very successful.

Limited budget was available at the time of the original works to undertake any more detailed studies. However, if there is the opportunity to do any further studies it would be useful to investigate the following:

- Within the previous work it is not clear what consideration was given to the invert level of the culvert under the railway that connects the two ponds, the bed levels of the downstream pond and the levels of the weir used to control discharge from the downstream pond. This would have been useful to help inform optimum depths to dredge the pond to. At present it would appear the railway culvert opening only has an invert level of 67.4m, which will only be 300-400m below normal water levels. Over time the pond will always be liable to resilt to this level.
- It appears that there used to be a number of connections through the railway line between the two ponds, but only one is now in use. It would be good to look at why the other connections are no longer active, and also what levels these were all historically at. The single current opening is acting as a significant constraint both in terms of flood levels and the passage of sediment. During flood conditions there is significant afflux across this structure (200-600mm) which will be impacting on upstream flood risk as well as reducing the velocities within the main pond.
- In addition, the high invert level of the railway connection will be limiting the flow of sediment between the ponds at low flows and encouraging siltation upstream. Consideration should be given to whether this can be lowered, but this is only likely to be viable if the bed of this opening does not form part of the railway structure. This would also need to consider the impacts on the downstream pond.
- Either on its own, or in combination with looking at the railway openings, it would be good to look further at the outfall structure from the lower pond. If this is a large fixed crest weir then it will always be limiting the velocities within the pond in flood conditions. If there was any opportunity to introduce a lower controlled opening (e.g. a small sluice gate), then this would encourage erosion of silt at a lower level within the pond. Any works such as this would need to consider the impacts on the downstream channel.
- The islands that have been created on the eastern side of the pond act to constrict some of the flow path from Gelvert Stream to one part of the pond, but it is not clear where these are in relation to the opening through the railway. Ideally this should be orientated to direct flow straight through the opening to keep material in suspension for longer.
- Lastly, if budget is available it would be beneficial to create a 2D hydrological model of the pond. This could be then used to look at velocities through the pond under a variety of flow conditions. The outputs from this can then inform where the optimum locations are to undertake further dredging or create islands, to minimise locations of low velocities. This would be relatively simple to do if bathymetry data is available.

Appendix B: Technical Note 2: Fleet Pond PA2 Objectives;

HART DISTICT COUNCIL

Fleet Pond PA2 Feasibility Study

Technical Note 2: Objectives

1 INTRODUCTION

Johns Associates has been appointed to carry out a feasibility study for the next stage of restoration works at Fleet Pond that builds on significant work already undertaken between 2010 and 2017.

The next phase of restoration would be funded through a successful application to the Higher Tier of the Countryside Stewardship Scheme (CS) and potentially though other funding opportunities if they become available.

This document sets out a series of objectives that will guide the development and deliver of further restoration, monitoring and management activities funded through a successful Countryside Stewardship PA2 funding application.

2 BACKGROUND

2.1 FLEET POND SSSI

Fleet Pond is Hampshire's largest freshwater lake (21 hectares [ha]) and forms a key component of the Fleet Pond Site of Special Scientific Interest (SSSI) and Local Nature Reserve (LNR), which includes other habitats such as woodland and heathland etc. Fleet Pond is also a Heavily Modified Water Body under the Water Framework Directive, is a Reservoir under the Reservoirs Act and the water body is also classified as Main River by the Environment Agency. Fleet Pond is located on the eastern fringe of the town of Fleet at National Grid Reference (NGR) SU 820 549 and forms an extremely valuable historical, social, recreational and biodiversity resource for the local and wider community. A map showing the location of Fleet Pond and the surrounding area is provided as Figure 1.

Over the years, the ecological and physical condition of Fleet Pond has deteriorated due to a number of reasons that include sediment deposition and reduction in lake depth, the presence of turbid waters and nutrient inputs from urban runoff and wildfowl.The lake part of the SSSI was previously categorised as Unfavourable Declining by Natural England, reflecting it poor state. A partnership of organisations including

Hart District Council, Natural England, the Environment Agency, Fleet Pond Society, MoD and Johns Associates, together with organisations such as the Hampshire and Isle of Wight Wildlife Trust, Fleet Town Council, Hampshire Ornithological Society, the local community and community groups have been working hard to initiate, deliver and maintain lake restoration initiatives.

There is a critical requirement to revisit key elements of the work completed under the Fleet Pond Restoration Project (2010-2017) to understand which elements were critical to observed improvements in Fleet Pond such as increased records of aquatic macrophytes, improved transparency, a reduction in turbid/sediment laden flows entering the lake and establishment of reeds on certain new lake islands. This forms part of the the current Fleet Pond PA2 Project and is reported on separately In Technical Note 1 produced by Johns Associates (2019).

The outcome of this review, together with project consultation, further site assessments and consideration of potential funding opportunities through Countryside Stewardship (carried out in the latter part of 2019) will support a successful funding application in 2020 to enable further and targeted key restoration and management activities to ensure the ongoing recovery of the lake and building in resilience in terms of future pressures from e.g. changes in catchment management, growth in population, pollution and climate change.

2.1 PREVIOUS OBJECTIVES

The Fleet Pond Restoration Project (2010-2017) was supported by a Masterplan (Johns Associates, 2012) that evolved as the project developed, in particular in response to funding requirements. The 2012 Masterplan had a series of objectives, which are reproduced here to support the establishment of objectives for the Fleet Pond PA2 project (these are set out in Section 3).

Table 2.1 sets out a review of the previous objectives, together with commentary on whether these were achieved (or not) and an indication if these remain suitable for consideration as part of the focused scope of the PA2 Project (shown as green-yes, amber-potentially, red-not relevant to the PA2 Project but considered to remain a relevant objective in general terms).

Table 1. Review of Fleet Pond Masterplan (2012) Objectives

Objective	Delivered as part of FPRP(2010-2017)	Relevance to PA2 Project
A. Site of Special Scientific Interest		
A1 Prevention of silt and debris entering Fleet Pond through Gelvert Stream	Two flow offtake channels and a new link channel to the lake were created to allow part of the Gelvert Stream flow to be diverted to a new longer flow path to the lake including numerous opportunities for sediment to be deposited.	Making these features (or similar) fully effective is a key task associated with the PA2 project.

A2 Small scale rotational dredging	Targeted small scale dredging of parts of Fleet Pond was a key component of the FPRP(201-12017). This focused on known shallow and problematic areas, with most sediment being reused to form islands to be colonized by plants including common reed, limit wind/wave transport of bed sediment, create marginal habitats, and expose the potentially buried lake plant seedbank. A smaller volume of sediment circa 1000m3 was dewatered and removed from the lake and reused as clean naturally occurring material under the CL:aire Code of Practice.	This area/issues needs further consideration and action but falls outside of the PA2 Project actions.
A3 Monitoring the effect of bottom feeding fish to establish whether or not they have a deleterious effect	Natural England commissioned Johns Associates (2013) to undertake a nutrient study and a nutrient model of Fleet Pond was developed. This identified that the lake was acting as a depositional environment where nutrients accumulate contributing to eutrophication and affecting water quality and ecological function. Phosphorous (in particular was investigated further). The study highlighted that reducing the re-suspension of lake sediments by removal or depletion of foraging fish and crayfish to help reduce the internal loading of phosphorous and facilitate the establishment of plant communities and turbulent mixing in shallow water areas.	This area/issues needs further consideration and action but falls outside of the PA2 Project actions.
A4 Protection of reedbed margins from geese grazing	Some of the new islands, especially where reeds were planted, were protected by marginal wire fencing. Some of these were removed due to concern about bird entanglement. The preferred method of protecting the reedbed edge was through the establishment of fringing bogbean beds (*Menyanthese trifoliata*) which have now established well in many parts of the lake.	The successful establishment of robust plant beds is a key task associated with the PA2 project.
Water Framework Directive		
B1 "Failing Waterbody" Improve water quality in the lake to maximise measurable improvements and the opportunity to reach "Good Ecological Potential"	Water quality improvements were sought through the delivery of the combined elements of the FPRP(2010-17) although most influencing factors are associated with the upstream catchments. A Diffuse Water Pollution Plan Supporting Study was	Useful evidence base to inform certain objectives for PA2 project.

	completed by Johns Associates (2015) to identify likely causes, evidence of impacts on the SSSI from diffuse pollution, and to identify knowledge gaps, and identify potential remedies.	
Wider Objectives in the Lake		
C1 Maximise the area of dredged lake and restored bathymetry (to a maximum of 2m depth)	The 2010-17 works included localized dredging over a number of years that has restored some water depth in those locations where dredging occurred.	This area/issues needs further consideration and action but falls outside of the PA2 Project actions.
C2 Increase the diversity and extent of submerged and emergent habitats through the body of the lake for plants, plankton and macro-invertebrates	The 2010-17 works included measures to promote habitat diversification and plant re-establishment including exposure of older lake bed sediments and potentially a seedbank, creation of shallow island berms and island habitats (with varying depths of water cover), alongside temporary zooplankton refugia.	Further measures to speed up the successful re-establishment of habitats for plants, plankton and macro-invertebrates is a key task for the PA2 Project.
C3 Maximise the local native biodiversity associated with the lake	See above	See above.
C4 Maintain the high quality of the local landscape	The 2010-17 works was supported by an initial planning application/permission that included consideration of changes on the local landscape and incorporated measures that ensured no significant effects arose.	This area/issues needs further consideration and action but falls outside of the PA2 Project actions as no significant landscape impacts are predicted.
C5 Enhance the angling opportunities	Hart District Council undertook a visitor needs assessment, that was outside of the scope of the 2010-17 works. It has since implemented a number of SSSI compatible measures to enhance angling opportunities at Fleet Pond.	This area/issues needs further consideration and action but falls outside of the PA2 Project actions.
C6 Enhance the wider recreational opportunities associated with the lake (walking/running/other fitness; meeting places/seating; ornithology/natural history; educational opportunities; conservation volunteering)	Part of Thames Water funded works within the 2010-17 works included improving footpaths and provision of an information board. Hart District Council undertook a visitor needs assessment, that was outside of the scope of the 2010-17 works. It, together with the Fleet Pond Society have since implemented a number of measures to enhance wider opportunities at Fleet Pond.	This area/issues needs further consideration and action but falls outside of the PA2 Project actions.

C7 Manage the restored lake environment for future generations	The FPRP(2010-17) did not include on-going management. Such activities are carried out by Hart District Council and the Fleet Pond Society and its conservation volunteers.	Not a specific action associated with the PA2Project but ongoing management is critical to the ongoing restoration and recovery of Fleet Pond SSSI.
Wider Objectives Out of Lake – Gelvert Stream		
D1 Minimise the input of sediment material from the rural catchment including the MoD training estate, Tweseldown Racecourse, road drainage and other locations	Two flow offtake channels and a new link channel to the lake were created to allow part of the Gelvert Stream flow to be diverted to a new longer flow path to the lake including numerous opportunities for sediment to be deposited.	Making these features (or similar) fully effective is a key task associated with the PA2 project.
D2 Restore a natural planform to increase channel length and capacity and provide opportunities for sediment and debris deposition before discharging into Fleet Pond	The two offtake channels adopted a more natural planform, linking to a restored ditch and new sinuous channel in Coldsream Marsh linking to the lake, If made fully effective these will provide opportunities for sediment and debris deposition before discharging into Fleet Pond. Restoring a natural planform to the Gelvert Stream remains a long-term objective.	Making these features (or similar) fully effective is a key task associated with the PA2 project.
D3 Increase stream channel biodiversity	The new channels created (see above) provided additional ephemeral stream channel habitat opportunities in areas previously dominated by holly and birch scrub.	This is a benefit arising from the PA2 Project actions.
D4 Increase educational and amenity benefits	Hart District Council undertook a visitor needs assessment, that was outside of the scope of the 2010-17 works. It, together with the Fleet Pond Society have since implemented a number of measures to enhance wider opportunities at Fleet Pond.	This area/issues needs further consideration and action but falls outside of the PA2 Project actions.
D5 Reduce flood risk	The provision of the new channels and flow paths and the retention of the existing channels have supported the management of flood risk.	This is a benefit arising from the PA2 Project actions.
Wider Objectives Out of Lake – Brookly Stream		
E1 Minimise the input of organic material from overhanging trees and garden waste	Publicity about the FPRP(2010-17) included guidance to riparian homeowners about green waste. Some tree removal occurred to facilitate the FPRP works but no specific	Further work in this area would be of benefit and this is still considered a relevant objective, but is beyond the scope of the PA2 project.

	strategy or actions associated with this objective were suitable for available funding.	
E2 Minimise the input of sediment from road drainage, eroding banks and other sources	A Diffuse Water Pollution Plan Supporting Study was completed by Johns Associates (2015) to identify likely causes, evidence of impacts on the SSSI from diffuse pollution, and to identify knowledge gaps, and identify potential remedies.	Useful evidence base to inform certain objectives for PA2 project but falls outside of the PA2 Project. Still considered relevant in general terms.
E3 Reduce the input of nutrients	See above. Works were undertaken on behalf of Thames Water to provide some attenuation of leakages / overflows from the sewage pumping station adjacent to the Brookly Stream, with separate works to restore a pond to further add to this capacity – adding further opportunity to resolve the problem before flows entered Fleet Pond.	Not a specific action associated with the PA2 Project but ongoing investigation and management is critical to the ongoing restoration and recovery of Fleet Pond SSSI.
E4 Restore a natural planform to increase channel length and capacity and provide opportunities for sediment and debris deposition before discharging into Fleet Pond	Works were undertaken to create/restore a series of ponds associated with Brookly Woods including an old canal. These areas are affected by inputs of organic matter and lack of water flow leading to anoxic conditions being prevalent. An overflow connection to the pond from the water course was provided but rarely operates. Being outside of the SSSI, funding opportunities to implement measures in this location were limited.	This area/issues needs further consideration and action but falls outside of the PA2 Project actions.
E5 Increase stream channel biodiversity	In-channel works to restore depth and remove sediment, in conjunction with the restoration of a former canal and ponds were completed. Localised biodiversity benefits are limited in the larger pond due to development of organic rich anoxic conditions, with the potential for unmanaged areas to decline. Opportunities for woodland ground flora to diversify have been created due to clearance of scrub.	This is a benefit arising from the PA2 Project actions.
E6 Increase educational and amenity benefits	A new information board was provided in 2017, with improvements to pathways through Brookly Wood also delivered.	This area/issues needs further consideration and action but falls outside of the PA2 Project actions.
E7 Reduce flood risk	The additional capacity of the restored ponds/channels provide a minor benefit to flood risk management.	This area/issues needs further consideration and action but falls outside of the PA2 Project actions.

F Wider Objectives Lake Environs		
F1 Increased educational opportunities	Hart District Council undertook a visitor needs assessment, that was outside of the scope of the 2010-17 works. It, together with the Fleet Pond Society have since implemented a number of measures to enhance wider opportunities at Fleet Pond.	This area/issues needs further consideration and action but falls outside of the PA2 Project actions.
F2 Increased recreational and well-being opportunities	Hart District Council undertook a visitor needs assessment, that was outside of the scope of the 2010-17 works. It, together with the Fleet Pond Society have since implemented a number of measures to enhance wider opportunities at Fleet Pond.	This area/issues needs further consideration and action but falls outside of the PA2 Project actions.

In summary, the following Fleet Pond Restoration Project Masterplan Objectives appear to be directly relevant to the Fleet Pond PA2 Project, with other objectives helping to inform the adopted PA2 Objectives:

- A1 Prevention of silt and debris entering Fleet Pond through Gelvert Stream
- C2 Increase the diversity and extent of submerged and emergent habitats through the body of the lake for plants, plankton and macro-invertebrates
- C3 Maximise the local native biodiversity associated with the lake
- D1 Minimise the input of sediment material entering Fleet Pond via the Gelvert Stream from the rural catchment including the MoD training estate, Tweseldown Racecourse, road drainage and other locations
- D2 Restore a natural planform to the Gelvert Stream to increase channel length and capacity and provide opportunities for sediment and debris deposition before discharging into Fleet Pond

3 PA2 PROJECT OBJECTIVES

1.1 OVERVIEW

A series of SMART objectives have been developed for the PA2 project that draw on the review of the FPRP2010-17 Masterplan Objectives and informed by the scope of work proposed for the PA2 Feasibility Study, in particular the review of the success of the previous works and current status and likely relevant Countryside Stewardship funding (Technical Notes 1 and 2 prepared by Johns Associates, 2019).

SMART Objectives are:

1. Specific. Will everyone be able to understand it? ...
2. Measurable. ...
3. Agreed, attainable and achievable. ...

4. Realistic and resourced. ...
5. Timebound.

1.2 PA2 OBJECTIVES

1.2.1 PA2 Objective 1: To Ensure the Existing Gelvert Stream Diversion Channels Function Effectively to Manage Sediment Input to Fleet Pond and Enhance Wetland Functionality Including Coldstream Marsh.

Observations made on a number of occasions between September to December 2019 (inclusive) have shown that a simple 'leaky dam' (that has been present in the channel of the Gelvert Stream for more than a year) has become effective in diverting a significant proportion of the main channel flow into the upper diversion link and into the main diversion channel through Coldstream Marsh and then into Fleet Pond. This became more efficient at diverting flows through the accumulation of leaf litter. The diversion channel functions very well at conveying flow with a reduction in energy when the confluence with a restored military ditch is reached providing a high-quality depositional environment. Flow was observed (in October and November 2019) throughout this new channel right up to the confluence with the lake. A further low energy environment is also present in Coldstream Marsh, which itself became wetter during the study period including from flows being diverted. The effect of this process is to reduce downstream flows, although these remained present during the study period. This does influence sediment transport downstream, with evidence of recent sand deposition in the bed of the channel towards the confluence with Fleet Pond, likely to be a result of reduced stream power with lower flows below the diversion. The lower stream diversion was not observed to be operating during the study period as it requires a flow exceeding 0.5m to function and this was also influenced by the majority of the flow being diverted in the upper channel link.

These observations are highly valuable as they clearly demonstrate the effectiveness of the work implemented during FPRP2010-17 with the additional influence from a suitably sized and placed leaky dam.

Delivering PA2 Objective 1 will ensure the correct and optimal functioning of the Gelvert Stream diversion channels though "Natural Flood Management" (NFM) and the use of the existing diversion features to reconnect the flow with the floodplain and to reduce sediment input into Fleet Pond from the upstream catchment. It will also enhance wetland functionality. This will be of wider benefit to the biodiversity of both the Gelvert Stream and the new diversion channels, adjacent wet woodland and Coldstream Marsh.

This objective is in part being delivered now, but the PA2 project will enable the specific structure to be modified to be more resilient, enabling its removal/adjustment/replacement if required. Some additional local bed and bank protection will be required to protect against scour and bank erosion. A further structure would be placed downstream of the lower diversion link channel to maximise its function and value and the flexibility of the system,

S: Use of NFM and specifically 'leaky dams' to promote elevated flows and sediment transport to prioritise through the diversion channels, reconnecting with the adjacent floodplain, promoting sediment deposition (and colonisation when not in use) before flowing into Fleet Pond. A residual flow in the existing channel would be maintained.

M: Measured through the use of visual observation of the functioning of the diversion channels though weekly observations made by the HDC Rangers or Fleet Pond Society Volunteers or consultants. Evidence of sediment deposition can be made by recording bedload at fixed points when not flowing and turbidity when in operation.

A: This objective is being achieved already through the existing woody debris/leaf litter feature demonstrating the effectiveness of the proposals, delivering what was previously agreed through FPRP2010-17

R: The existing informal structure is effective at diverting flows, but a better design would provide greater flexibility required and greater longevity. Funding can be secured through Countryside Stewardship and maintenance (low level input).

T: The benefits of the existing informal leaky dam have already been observed and can continue to be realised until a replacement is required/provided.

1.2.2 PA2 Objective 2: To Increase the Wetness of Fugelmere Marsh and Increasing Heterogeneity, Restore Natural Function, Increase the Diversity of Wetland Habitats and Biodiversity.

Fugelmere Marsh has been enhanced in recent years through the removal of significant scrub cover, the creation of some pools and introduction of specialized grazing. This has resulted in the re-establishment of wetland habitat characterised as a marsh with areas of slightly raised land and drier habitat, trending from dry to wet on an east to west and south to north axis with reedbed and open lake water lying beyond the northern boundary. There is a clear need to rewet this habitat – formerly open lake, and preserve and enhance/extend the more valuable habitats present.

S: Achieve re-wetting of Fugelmere Marsh in combination with other wetland habitat management and natural functioning of the lake and Gelvert Stream and avoid prioritizing flow away from other sensitive habitats.

M: Measured through the use of visual observation of the functioning of the diversion channels though weekly observations made by the HDC Rangers or Fleet Pond Society Volunteers or consultants and repeat Phase 1 habitat mapping and botanical surveys.

A: This objective has been demonstrated by re-creation of wetland habitats in the Coldstream Marsh through FPRP2010-17

R: Successful work has already been achieved and proposals can be based on tried and tested measures. Funding can be secured through Countryside Stewardship and maintenance (low level input).

T: Rewetting opportunities can be delivered within a 12 to 24-month period with ongoing management required on a less frequent basis (e.g. every 3-5 years)

1.2.3 PA2 Objective 3: To Increase the Diversity and Abundance of Lake Aquatic Macrophytes, Invertebrates and Zooplankton Through the Use of a Range of Techniques and Features (including protection from grazing fish and birds)

The previous work carried out during the FPRP201-17 to accelerate plant recovery through fish exclusion is considered to not have been successful – especially to a level that warrants prioritising funding to further extend this. An increase in water transparency has been recorded and a qualitative increase in zooplankton numbers have been recorded along with an increase in lake bed macrophytes and marginal plants associated with wetter islands. The focus needs to be associated with accelerated macrophyte assemblage recovery as this will re-introduce a significant and key part of the ecosystem associated with Fleet Pond today and restore a key element of its primary importance when notified as a SSSI. Robust macrophyte assemblages will assist with:

- providing habitat for zooplankton, invertebrates and fish will;
- stabilise bed sediment and help process and store nutrients;
- potentially help shade out and manage algal populations;
- contribute to an oxygenated water column.

This can be achieved through the creation of plant nurseries where plants harvested from the lake and be protected from grazing fish and birds, translocation of existing plants to provide further protection to the island habitats and the provision of pre-planted floating/lake bed habitats (using suitable native species of a proven local provenance) to provide immediate benefit and act as accelerated incubators for further recolonization.

S: Focus on restoring a robust, diverse native macrophyte assemblage in the lake rather than on fish exclusion

M: Measured through the use of repeat botanical surveys.

A: This objective has been demonstrated to a limited extent by natural establishment of plants in the lake

R: Proposals can be based on tried and tested measures. Funding can be secured through Countryside Stewardship and maintenance (low level input).

T: Pre-planted macrophyte features can be delivered within a 12 to 24-month period with minimal ongoing management required.

1.3 WIDER OBJECTIVES

1.3.4 Residual FPRP2010-17 Objectives

Please refer to Table 1 for the full list of original objectives that are still considered to be relevant at the time of writing.

1.3.5 WO1 Implement a Range of Catchment Management and Diffuse/Pollution Management Measures to Control the Input of Nutrients and Other Deleterious Substances at Source

1.3.6 WO2 Ensure the ongoing Maintenance and Monitoring of Sediment Management Measures in Long Valley and Bourley Valley CDU TSS

1.3.7 WO3 Re-naturalise the Brookly Stream Planform and Function and Relationship with its Floodplain, Maximise Ecosystem Service Provision and Remove Anoxic Standing Waters and Reduce Litter Inputs to Fleet Pond

1.3.8 WO4 Manage Nutrient Levels and Controls in Fleet Pond – Particularly the Reduction of Phosphorous

1.3.9 WO5 Ensure Future Resilience from Climate Change and Growth in Local Population and Urban Impacts

1.3.10 WO6 Maximise Opportunities for Re-wilding, Delivery of Ecosystem Services, Natural Flood (and other environmental) Management Techniques

1.3.11 WO7 Ensure Regular Appropriate Management and Monitoring is Funded and Delivered as Part of Short to Long Term Budget and Resource Planning

1.3.12 WO8 Ensure Compatibility and Avoidance of Duplication Between Fleet Pond Restoration Project Objectives and Wider Initiatives Associated with EA Flood Risk Management, Hartland Park Mitigation and Enhancement, Neighbourhood Plan Delivery, Thames Water Asset and Operational Plans

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Appendix C: Technical Note 3: Countryside Stewardship Funding Options;

HART DISTICT COUNCIL

Fleet Pond PA2 Feasibility Study

TECHNICAL NOTE 3: Countryside Stewardship Funding Options Review

1 INTRODUCTION

Johns Associates has been appointed to carry out a feasibility study for the next stage of restoration works at Fleet Pond referred to at the PA2 Project, that is focusing on a series of core objectives as set out in Technical Note 2. The priority PA2 objectives are:

- PA2 Objective 1: To Ensure the Existing Gelvert Stream Diversion Channels Function Effectively to Manage Sediment Input to Fleet Pond and Enhance Wetland Functionality Including Coldstream Marsh.
- PA2 Objective 2: To Increase the Wetness of Fugelmere Marsh and Increasing Heterogeneity, Restore Natural Function, Increase the Diversity of Wetland Habitats and Biodiversity.
- PA2 Objective 3: To Increase the Diversity and Abundance of Lake Aquatic Macrophytes, Invertebrates and Zooplankton Through the Use of a Range of Techniques and Features (including protection from grazing fish and birds).

The next phase of restoration would be funded through a successful application to the Higher Tier of the Countryside Stewardship Scheme (CS) and potentially though other funding opportunities if they become available.

Countryside Stewardship is a scheme that provides financial incentives for land managers/farmers to look after their environment via several different methods such as: flood risk management, woodland creation and management, conserving and restoring wildlife habitats, encouraging educational access, reducing widespread water pollution from agriculture, keeping the character of the countryside and preserving historical features in the landscape. There are four main elements to the scheme and for the Fleet Pond Restoration Project the relevant scheme is Higher Tier – this covers environmentally significant sites, commons and woodlands.

The purpose of this document is to review relevant Countryside Stewardship funding options and to shortlist those considered relevant to the delivery of the next phase of the restoration and management of Fleet Pond.

Further to review and approval by the project Steering Group and in particular, Natural England, the key project output (the application for CS) would be aligned to the options to ensure its compatibility and success.

2 POTENTIAL FUNDING OPTIONS

2.1 AVAILABLE FUNDING OPTIONS

2.1.1 WN7 – Restoration of large water bodies

This funding option will pay up to 100% of the actual costs of the works. It is intended to restore the wildlife value of large water bodies that have become degraded. It is only available for Higher Tier applications on Sites of Special Scientific Interest (SSSI) with ecologically degraded water bodies of 1 hectare or more, and if other land management options are included in the agreement. This item can be used to support the implementation of lake restoration plans. It can also cover: water management, scrub management, management of invasive non-native species, fish removal, bird control and desilting.

There are several requirements for this item, such as: a specification for the works must be agreed with Natural England. The works must then be completed as set out in the approved specification and within the agreed timescale. The agreement holders will also need to keep several records, and supply them on request: any consents or permissions connected with the work, photos of site before the works start, item specification if required, receipted invoices or bank statements where a receipted invoice is not available, photographs of the completed work.

It is also recommended that before applying applicants should contact the Environment Agency for advice and any permits that may be necessary. This will not need to be provided with the application but any consents will need to be submitted with the payment claim.

2.1.2 WT6 - Management of reedbed

This option will pay £78 per hectare. It is available for Higher Tier applications for whole and part-parcel sections. It can only be used on priority reedbed in good condition which is more than 2ha in area, or degraded reedbed more than 2ha in area with the potential for restoration. Areas of open water up to 1ha can also be included in this option if they are part of the land. This item is for managing, maintaining and restoring priority reedbed habitat. If it is successful there will be predominantly open, reed-dominated vegetation with occasional scrub and open water features along ditch lines and ponded areas. Open water features can be sustained all year round by high water levels. Well maintained or recovering reedbeds will support healthy populations of target reedbed species.

There are several requirements for this item, with agreement holders likely needing to: manage water levels and supply, manage distribution and flow of water through the site, maintain any culverts, sluices, tidal flaps or bunds, manage scrub and vegetation to maintain a predominantly open reedbed, dispose cut material appropriately and manage any open water features. It is likely that the agreement holder will not be allowed to apply fertilisers or manures and use pesticides or herbicides other than for the control of weeds/non-native

invasive species. The agreement holder will also need to keep records of field operations at the parcel level, including any associated invoices.

2.1.3 RP32 – Small leaky woody dams

For this option £461.39 will be provided for each dam. It is available for Higher Tier applications, only in catchments that have been targeted for flood risk measures, for dams that will be in streams between 1m and 2.99m wide, and where it has been approved by the Environment Agency or Lead Local Flood Authority. Leaky woody dams help slow the movement of water and push flows onto the floodplain during floods. This increases temporary storage of flood waters within water channels and out on the floodplain. They will also help delay the passage of flood water downstream, allow sediment to settle out and reduce downstream flood risk.

There are several requirements for this item that agreement holders will need to do, such as: follow indicative drawings that are in Annex 2c of the Higher Tier manual, the dam should be constructed from logs that are large enough to span the water channel and out onto the floodplain so that they provide a stable and long-lasting structure, the dam should also be secured in line with the requirements of the Environment Agency or Lead Local Flood Authority. Dams should be aligned at right angles to the channel bank to reduce scouring, and they should allow low flow to pass unimpeded at all times, they should be located on slow flowing reaches of the water course that have on average 2m of floodplain on either side, and built to a height sufficient to encourage water to spread onto the floodplain upstream of the dam. Dams should be built in series (minimum 3 dams) at a spacing between dams of about 5 to 7 times the width of the channel, dams should not be installed directly upstream of pinch points such as bridges or culverts that can back up flows and swamp the dam. Dams will need to be checked and maintained to ensure the structure remains effective, and requirements set out in any Feasibility Study or CSF Design Plan.

Agreement holders need to keep and supply the following records upon request: consents or permissions connected with the work, receipted invoices or bank statement, photos of the site before work starts, a copy of the Feasibility Study, woodland management plan or CSF design plan where applicable. The following records will need to be supplied with the claim: photographs of the site during the different stages of construction, contracts, invoices or other documents confirming the technical specification for the works, photos of the completed works. Applicants must seek advice from the Environment Agency and Lead Local Flood Authority (where relevant) to check if consent is required to carry out the work – any consents or permissions will need to be submitted with the payment claim.

The design of leaky woody dams can vary, and the siting of dams in natural water courses will be dictated by local circumstances and availability of/easy access to import suitable materials to site. Dams will need to be checked and potentially de-silted regularly to prevent it collecting large amounts of silt.

2.1.4 WN2 – Creation of scrapes and gutters

This option will pay £2.80 per square metre, it is available for Higher Tier applications and only in locations agreed with a Natural England adviser. It cannot be used on historic or archaeological features. Scrapes provide areas of bare ground, these may be designed to hold water in wet habitats or provide early

successional areas in dry habitats. Gutter provide shallow channels that can hold/transport water through wet habitats and provide feeding areas for waders.

There are several requirements for this option that agreement holders are likely to need to do, such as: agree a detailed specification with Natural England for creating scrapes or gutters, create the scrapes of gutters in accordance with this specification, and follow the implementation plan and complete it. There are specific requirements for creating scrapes for waders and wildfowl, with agreement holders needing to: locate any scrapes at least 100m away from hedges or tall trees (in the location shown in the specification), carry out the work between July and November, scrapes should have an irregular shape to maximise the length of its edge, the sides should be graded to a gently slop from the shallow margins down the a maximum depth of 40 to 50cm at the centre. The surface of the scrape should be rough. There are also requirements for the creation of gutters: they should be created in the places shown in the specification, work should be carried out between July and November, make sure gutters are at least 30cm deep and 1.5m wide, with gently sloping edges and shallow margins that are 3 to 5cm deep. The gutters should be connected to ditches with high water levels, and be periodically isolated from ditches where water levels cannot be held high, they should also be kept wet using gravity feed, water control structures or pumps. Agreement holders will not be allowed to use spoil to fill hollows or low areas within the field or to form a bund or bank around the scrape or gutter, place spoil on areas with high soil erosion or runoff potential, create islands within scrapes, carry out works when ground nesting birds are present, fence the scrapes and gutters.

Agreement holders need to keep and supply the following records on request: consents or permissions connected with the work, receipted invoices or bank statements, specification of agreed works, photos of the site before work starts. The following will need to be supplied will the claim: photos of the completed works, implementation plan or feasibility study if required. It is recommended that before applying to this, applicants should obtain any consents required from Natural England or the Local authority if on historic or archaeological features.

The specification for this will identify the purpose of the scrapes and gutters, and will be tailored accordingly – it should consider site hydrology, soil type, botanical interest, archaeological and historic features, and landscape character. The shape, size, depth, location, methods, timing of the work, spoil disposal and ongoing management requirements should all be specified. Consent may be needed from the local land drainage authority; a waste exemption licence may also be required.

2.1.5 WN8 – Timber sluice

£315 will be paid per sluice for this option. It is available for Higher Tier applications, but only with one of the following management options: GS7/8/9/10/11/12/13/14, HS7, WT6/7/8/9. It provides a simple mechanism for water level control, this will support raised water levels for restoring or creating habitats.

For this option there are several requirements, such as: the sluice must be constructed to the size and height agreed with Natural England, use precut tongue and groove or chamfered boards that fit tightly together and can be easily reused/replaced, drive the boards into the ditch sides and bed so the bottoms are at least 300mm into impermeable soil, make sure the boards are long enough to raise the water to the desired level.

A first board should be installed central to the ditch, subsequent boards should be driven in on either side of the central board, the final boards should be well keyed into the ditch banks.

Alternate requirements for seepage barriers include: constructing the barrier using wooden slats, making sure slats are formed either vertically or horizontally, leave a small gap of 2mm between each slat, use posts to support and secure the slats, vertical slats should be braced by horizontal timbers to ensure they stay in place. Once vertical boards are in place, an appropriately sized opening should be cut out and metal channelling screwed to each vertical edge to accept the sluice boards, a plank bridge should also be installed across the bank of the board tops on the downstream side, this should be firmly into the ditch banks.

The following records will need to be kept and supplied on request: consents/permissions connected with the work, receipted invoices or bank statements, photos before the work starts. Photos during and after construction, along with documents confirming the technical specification should be supplied with the claim.

2.1.6 WN4 – Ditch, dike and rhine creation

This option pays £8.40 per metre, it is available for Higher Tier applications, but only in combination with one of the following management options: WT6/7/8/9, GS7/8/9/10/11/12/13/14, HS7. It cannot be used to create ditches that will lead to waterlogged land being drained or archaeological features being dried out. The aim of this item is to establish raised water levels to help restore or create habitats.

The requirements for this option, mean the agreement holders are likely to need to: create a channel 70-100cm deep, with a variety of depth in it grading to a shallow, wet marginal fringe, make sure bank slope profile varies along the length of the ditch (30-45 degrees), create berms along the sides of the ditch, excavated material is to be placed on top of the bank or next to it – not filling hollows or low areas, or on historic or archaeological features. Spoil should also be thinly spread to prevent a spoil bank from forming.

The following records will need to be kept and supplied on request: consents or permissions connected with the work, receipted invoices or bank statements, photos of the site before work. Photos after the work has been completed should be supplied with the claim. Advice on any necessary consents can be sought from the Environment Agency and should be submitted with the claim.

2.1.7 SB2 – Scrub control – difficult sites

This option will pay up to 80% of the actual costs, it is available for Higher Tier applications, only on sites that either need specialist operations or machinery, with costs that cannot be covered by the schemes fixed-rate scrub control payments – this includes sensitive habitats and areas with difficult or hazardous working conditions such as steep slopes, bogs and islands. Or have it as a requirement of an approved Forestry Commission woodland management plan. This option cannot be used to control dwarf and western gorse, as these are key parts of heathland, or to manage scrub by grazing.

There are several requirements for this option, including: sending at least 3 written quotations for completing the work to Natural England or the Forestry Commission (quote must identify associated costs), carry out scrub control during the autumn and winter, follow guidance on what to do with any stumps and how to dispose of cut material, control re-growth.

Agreement holders need to keep and supply on request the following records: consents or permissions connected with the work, records of when scrub control was carried out, records of any pesticide or herbicide treatments including dates and locations, a Forestry Commission approved Woodland Management Plan or a Natural England approved implementation plan (if relevant), photos before work starts, item specification (if required). Receipted invoices or bank statements and photos of the completed works need to be submitted with the claim. The three quotes for completion of the work will also be sent with the application. If the work is set out in either a Forestry Commission Woodland Management Plan approval letter, or a Natural England approved implementation plan then it will need to be sent with the application.

It is advised that scrub is only to be cut to ground level, roots should not be disturbed, and protruding stems should not be left.

2.1.8 RP6 – Installation of piped culverts in ditches

For this option £340 per culvert will be paid, it is available for Mid-Tier and Higher Tier applications, only in areas targeted to reduce water pollution from agriculture, or in combination with options for the management and restoration of habitats or features with the support of a Natural England adviser. It cannot be used; to replace an existing culvert; where it may damage an environmental, historical or archaeological feature identified on the Farm Environment Record, the Environmental Information Map or the HEFER; where it will restrict the movement of migratory fish or eels; without relevant advice or consents from the Environment Agency or flood defence consenting authority.

There are several requirements for this option, such as: install a concrete pipe at least 450mm in diameter following the manufacturer's instructions, ensure that pipes have a positive joint to preserve alignment, make sure the pipes give a useable width at ground level that is appropriate for the traffic using the crossing. The pipes should be set on a firm bed and in true alignment, the gradient should approximate to that of the ditch bed, the pipe invert should be fractionally below the bottom of the true ditch bed, the downstream ditch should be graded if any deepening is needed to accommodate the culvert. The culvert should be maintained by removing any build-up of debris, all work must meet the relevant British Standards, and comply with the culvert design and operation guide.

Agreement holders need to keep and supply on request the following records: any consents/permissions connected with the work, receipted invoices or bank statements, photos of site before the work. Photos of the site after during and after work, along with documents confirming the technical specification should be supplied with the claim.

Several recommendations include avoiding active river areas – particularly meanders, avoid depositional areas, make the crossing perpendicular to the river, consider floodplain crossings, reduce the risk of pollution to protected species and their habitats, where necessary erosion should be minimised by installing protection measures downstream of the culvert and on the sides of the ditch. It is also suggested that a stone-free filling should be packed tightly at the sides of the pipe and at least 300mm above it, the layers should be up to 150mm thick and thoroughly consolidated before adding the next layer. The manufacturers guidance on how deep to cover backfill should be followed, and the backfill surface should be crowned above surrounding levels.

2.2 SUMMARY OF FUNDING OPTIONS NOT AVAILABLE FOR FLEET POND

2.2.1 WT7 - Creation of reedbed

This option lasts for 10 years, and will pay £323per ha. It is available for Higher Tier applications for whole and part-parcel land. It is only available on: arable land, temporary grassland, improved grassland, wetland habitat in poor condition if approved by a specialist, or land with a very shallow gradient and a reliable, sufficient water supply that maintains an adequate flow and water table during the summer. This option cannot be used on existing semi-natural habitat, unless any existing wetland is in poor condition and work is agreed by a specialist, on historic or archaeological features, when it could flood someone else's land, if it is associated with poor water quality, or on areas of open water 1ha or more in area.

2.2.2 SW12 – Making space for water

This option pays £640 per ha, it lasts for 20 years, instead of the standard 5 years for the grant scheme. It is available for Higher Tier applications and for SSSI sites in a relevant strategic river restoration plan or river basin management plan. Applicants must also meet one of the following conditions: be following a recommended fertilizer management system to plan nutrient inputs across the farm, plan to adopt a recommended fertilizer management system within 18 months of the start of the agreement, qualify as a low intensity farmer.

2.2.3 RP11 – Swales

This option pays £5.95 per square meter, it is available for Mid-Tier and Higher Tier applications, but it is only available in areas targeted for the reduction of water pollution from agriculture.

2.2.4 RP10 – Silt filtration dams or seepage barriers

This funding option pays £75 per unit, it is available for Mid and Higher Tier applications, however only for ditches in areas targeted for the reduction of water pollution from agriculture and for the reduction of flood risk, in conjunction with a Feasibility Study, an Implementation Plan or a Catchment Sensitive Farming commissioned designed plan agreed with Natural England.

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Appendix D: Technical Note 4: Gelvert Stream, Coldstream Marsh and Fugelmere Marsh;

Fleet Pond – PA2 Feasibility Study

Gelvert Stream Realignment

1 INTRODUCTION

1.1 BACKGROUND

Previous Works at Fleet Pond carried out between 2010 and 2017 included the creation of a diversion channel and two diversion links to take higher flows from the main Gelvert Stream Channel and to allow this flow to be influenced by a series of features designed to remove energy from the flow of water and force deposition of fine sediment (sand and silt) that is entrained in the diverted flow, potentially using establishing vegetation to attenuate some of the colloidal load prior to discharging into Fleet Pond. This can be seen in Figure 1.

Figure 1. Alignment of the Gelvert Stream Diversion Channel and Links

The diversion channel and links are intended to provide benefit to the main body of the lake from a reduction in sediment deposition and turbid water arising from future erosion and runoff from the upstream Long Valley and Bourley Valley SSSI (and potentially overflows from the Basingstoke Canal) which includes a critical military vehicle test track and features within this part MoD Aldershot Training Estate. Whilst significant improvements in the control of sediment erosion and transport and in the quality of runoff from this part of the training estate have been recorded, opportunities to protect Fleet Pond SSSI lake habitats from future impacts were seen as a critical habitat management action.

The location, design and function of the works was strongly influenced on the specific funding mechanisms (and their limitations) available at the time and planning/regulatory controls. It was determined that to maximise the benefits of the available funding, the diversion should take advantage of an existing right hand bank breach (lower or first diversion channel) and defunct former military boundary ditch and elements of Coldstream Marsh. Works to remove scrub were initiated and a new diversion channel created, including renovation of the military ditch, provision of a large box culvert under part of the Fleet Pond perimeter path and new channels and ponds within Coldstream Marsh. Hydraulic modelling was completed in support of the design and a suitable offtake level and control structure were agreed and consented by the Environment Agency. The first diversion link takes a proportion of the flow above 0.5m depth in the main Gelvert Channel. A second diversion link was constructed to take flows above 0.3m in the main Gelvert Channel. Subsequent elevated flows are partly diverted into these channels, and deposited sediment has been recorded, but it has become clear that insufficient flows enter the diversion. This is due to the need for further control structures in the main channel promoting the diversion.

An informal 'leaky dam' is currently present below the upper diversion link and has been shown to be highly effective at prioritising flow through the diversion channel.

1.2 SCOPE OF TECHNICAL NOTE 4

Johns Associates has been appointed to carry out a feasibility study for the next stage of restoration works at Fleet Pond (referred to as the PA2 Project) that builds on significant work already undertaken between 2010 and 2017. Key objectives of the PA2 Project include 'ensuring the Gelvert Stream diversion channels function effectively to manage sediment input to Fleet Pond and enhance wetland functionality including Coldstream Marsh' (see Technical Note 2, Johns Associates).

A key element of the scope of Technical Note 4, as defined by the initial 2019 brief set by Hart District Council and Natural England is to "*assess the possibility of realigning the Gelvert Stream to increase the wetness of Fugelmere Marsh, to increase heterogeneity and restore natural function, and to increase the diversity of wetland habitats for biodiversity. This section of the study will also provide suggestions to increasing the flow and effectiveness of the existing diversion channels to Coldstream Marsh*".

Currently, Fugelmere Marsh gets its water supply from upslope flow entering from the adjacent Wood Lane Heath, the levels of the lake and groundwater rising, rainfall pooling and being stored in a number of scrapes/ponds that are present in the marsh, and runoff entering the marsh from the surrounding areas. This likely means that during the summer when water levels are lower, and rainfall is less frequent that the available water is decreased and some wet areas may dry up. To help counter this and allow the area to be wet

throughout the year, it has been suggested that the Gelvert Stream could be diverted into Fugelmere to allow flows to pass through the marsh creating new wet areas and habitats and supporting habitat diversification. The existing channel of the Gelvert Stream flows just to the east/northeast of Fugelmere with the two being separated by a footpath, before the Gelvert Stream flows into Sandy Bay.

The Johns Associates team has identified a number of mechanisms that could help achieve this re-wetting. There are several ways that the previously mentioned objectives could be achieved and these have been examined in this Technical Note, with preferred options highlighted. These works would be funded through a successful application to the Higher Tier of the Countryside Stewardship Scheme and potential other funding opportunities if they become available. Potentially viable Countryside Stewardship funding options are reviewed in Technical Note 3.

This work has been informed by an updated topographic survey and walkover surveys completed in October and November 2019 and ground truthing conducted by the Johns Associates team.

2 GELVERT STREAM – EXISTING DIVERSION CHANNELS

2.1 CURRENT DESIGN CRITERIA

Johns Associates commissioned HR Wallingford to undertake hydrological and hydraulic modelling of the Gelvert Stream and Fleet Pond system for the purposes of assessing the feasibility of a proposed diversion channel for high flows in the Gelvert stream. The diversion channel (with two linking connections at 230m and 430m upstream of the Gelverts confluence with the lake) ultimately outfalls into Fleet Pond.

The Gelvert Stream has a catchment of 7.4km2 and a critical storm duration of 8 hours. Peak flows at this duration for the 1, 10 and 100 year returns are 1.3, 2.6 and 4.4m3/sec respectively. The Fleet Pond system has a catchment of 12.4km^2 and a critical storm duration of 24-36 hours. Peak flows at this duration for the 1, 10 and 100 year return periods are 2.4, 4.9 and 8.2 m^3/sec respectively. Peak flood levels within the pond for these events are 68.03, 68.25 and 68.46 mAOD respectively. The bankfull capacity of the Gelvert stream without the diversion channel has been assessed as being 1.5m^3/sec which equates to slightly greater than a one year return period design flow. On this basis overbank flow would be expected around once each year, probably during the winter months. This estimate of bankfull assumes a banktop off-take level of 69.0 m AOD with no overflow occurring elsewhere upstream.

The flow split between the Gelvert and the Phase 1 and Phase 2 diversion channel (lower and upper diversion links) have been assessed for 1.5m^3/sec and 0.9m^3/sec flow using weir levels of 68.25, 68.4 and 68.8 mAOD, as well as a box culvert of 1m x 1.5m. This gives a range of flow splits to operate the potential use of diversion channel weir boards at the lower diversion link. In reality the boards have never been used because maximum flow has been desired.

Velocities in the diversion channels are lower than in the main Gelvert channel and whilst sufficient to transport/mobilise sand grains in the upper parts, the velocities will fall with distance promoting deposition due to the sinuosity of the channel and oversized dimensions including pools, scrapes and backwaters.

The diversion scheme is not thought to cause any change in the flood levels of Fleet pond for the following reasons:

- The diversion channels do not change the catchment runoff characteristics and will therefore not change the flood flow volumes passing into the pond; and
- The buffering effect of storage in the Pond and the dominance of floodplain flow during high return period events mean that the diversion channels will not significantly alter the rate that flood flows are conveyed to the pond.

2.2 POSITIVE EFFECT OF A TEMPORARY LEAKY DAM

Recent site visits carried out within the PA2 study period (September to December 2019) have confirmed that the water flowing down the Gelvert Stream is clear (very low turbidity) with the channel bed being visible and water transparency within the lake itself is similar e.g. during a survey in November 2019 the lake bed was visible across the lake.

The PA2 Project site visits identified traces of sandy sediments along the lengths of the diversion channels, including underneath leaf litter, confirming that they have been functioning and depositing sediment from the main Gelvert channel. This can be seen in Plates 1 and 2.

Plates 1 and 2. Sand deposits below leaf litter within the lower diversion link and sand deposits on the bed of the upper diversion link.

An informal leaky woody dam was present immediately downstream of the upper diversion link, with the aim of forming a level of impoundment above the woody structure and maintaining a residual flow below it. It has the effect of promoting flows down the diversion channel. Two recent site visits following rainfall events have found the leaky dam to be very effective with large amounts of water being pushed down the diversion

channel, and flowing through the woodland before settling out into Coldstream Marsh. Sandy sediment that is typical of the type washed down from the upper catchment and MoD site was seen on the banks and bed of the diversion channel through the woodland – confirming that the leaky dam is further helping the diversion channel to effectively complete its planned function. There was a large amount of leaf litter in the channel that had been pushed against the dam and was helping divert flows along the diversion channel, however this had also clogged up the gaps in the dam meaning that only a small amount of flow was able to continue down the main channel. Removal of these leaves could reduce the amount of water flowing down the diversion channel, but the leaky dam would still ensure that if levels are high enough then water would still be pushed down the diversion channel. This is illustrated by Plates 3 and 4.

Plates 3 and 4. Leaky woody dam and flow passing below the structure but majority of flow passing down the diversion channel.

Installation of a similar feature at the lower diversion channel link would also help to encourage high flows to pass down this channel, as during the site visit the levels were too low for any water to enter the lower diversion.

Maintenance of leaky dams will be required to ensure that excessive leaf litter is not allowed to build up during high flow conditions as this could result in the banks being overtopped too frequently if not enough flow is allowed to pass through the dams. The dams should also be designed so that during normal conditions low flows are able to pass underneath without interference, the current design of the informal dam that is in place may need to be reviewed to ensure that it is allowing this to happen. More formal dams could be installed that are permanent features, or removable features so that they can be taken out of the channel during bankfull conditions to allow flow to pass unimpeded down the main channel and the diversion channels.

It is also likely that some form of soft bank protection may be required to minimise scour/erosion around the location of the feature especially in higher flows. These works will be able to be minimised by the placement and orientation of the leaky dam.

During more extreme flood conditions the dam is likely to be washed away. This will help ensure that there is a minimal change in upstream water levels during a flood event. However, due to the limited flow there would be in the channel compared to the floodplain, and the available width of the floodplain, there would only be a minimal impact on upstream water levels even if the dam was to remain in place. There should not be any concern therefore about any increase in upstream flood risk as a result of these dams. Any maintenance plan will need to include the requirement to repair and/or replace the dam following flood events.

3 POTENTIAL OPTIONS TO REWET FUGELMERE MARSH

3.1 FUGELMERE MARSH

It is assumed that the northern parts of Fugelmere Marsh were once the open water part of Fleet Pond and that over time, through natural vegetation transition and potentially influenced by water levels being lowered, the area transitioned from open water to scrub. In recent years, the removal of significant scrub and tree cover, the addition of several pools and introduction of specialised grazing has seen this area evolve/be restored to form an area of marshland and other associated wetland habitats as well as areas of wet heath, and drier areas of scrub and trees. The area trends from dry to wet on an east to west and south to north axis, with reedbeds and the open lake lying to the north. There is a need to rewet this habitat further to preserve, enhance and extend the valuable habitats that are currently present.

The PA2 Project aims to increase the wetness of Fugelmere Marsh, to increase heterogeneity and restore natural function, and to increase the diversity of wetland habitats for biodiversity.

This section of Technical Note 4 examines a range of potential options to achieve this objective. It has been informed by an updated topographic survey, Extended Phase 1 Habitat Survey and walkover surveys completed in October and November 2019 and ground truthing conducted by the Johns Associates team.

3.2 OPTION 1 - CONSTRUCTION OF A NEW DIVERSION CHANNEL DOWNSTREAM OF EXISTING DIVERSION CHANNELS

Option 1 would see the creation of a new diversion channel into Fugelmere Marsh in between the existing lower diversion channel and the footbridge near Sandy Bay. During a site walkover a section of the left-hand bank that has been eroded was identified as a potential location for the new offtake channel. The channel could take two forms, either a culvert or pipes under the existing footpath that then flows into a newly constructed channel in Fugelmere, the alternate would be to create a diversion channel similar to the existing ones upstream – this would require the construction of a bridge so that the footpath can pass over the top of the channel. Once in Fugelmere Marsh there are a number of different locations the channel could go and these are discussed below. As there are a number of pools present in Fugelmere the routes have been chosen to allow potential integration of the diversion channel into these ponds, helping to ensure they sustain water throughout the year to help support rewetting the marsh.

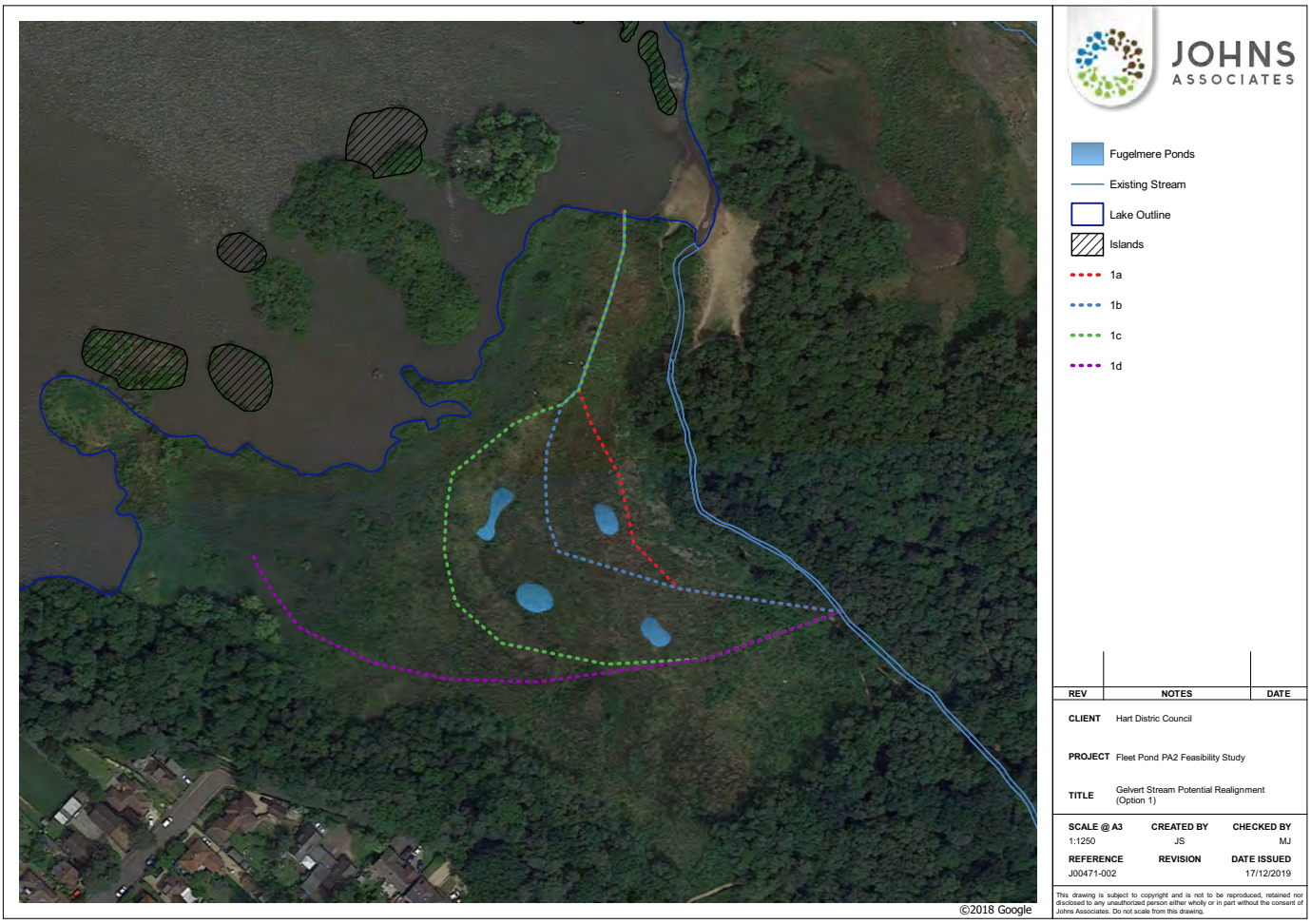

Figure 1 – Option 1 Potential diversion channel routes through Fugelmere Marsh

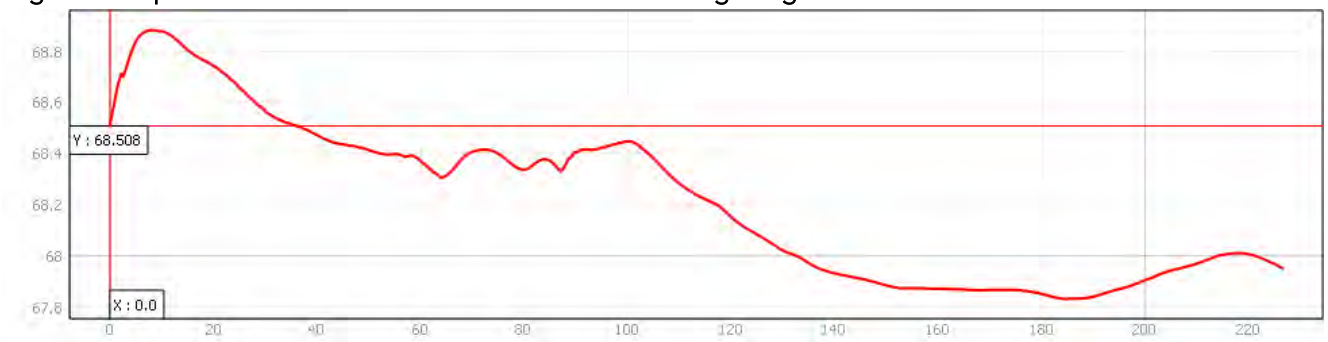

Figure 2 – Option 1a Elevation Profile from Gelvert Stream bed down to the lake (based on Topographic Survey)

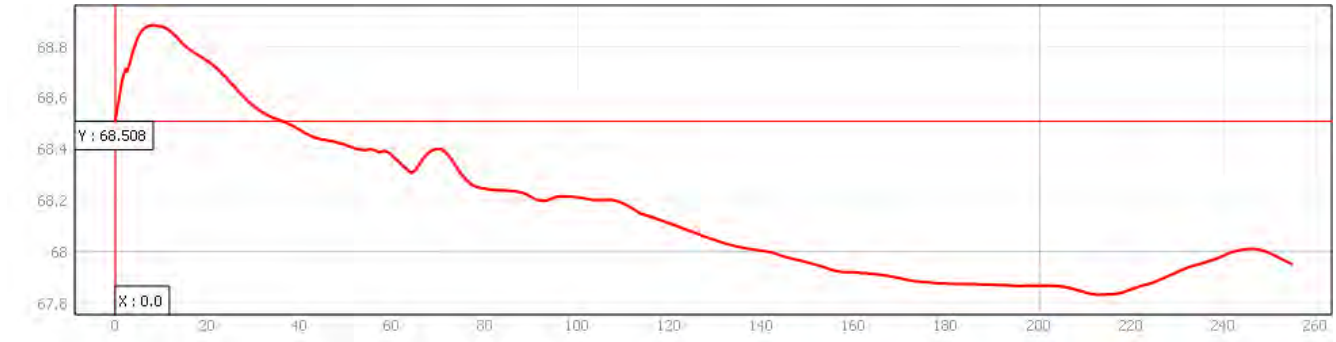

Figure 3 – Option 1b Elevation Profile from Gelvert Stream bed down to the lake (based on Topographic Survey)

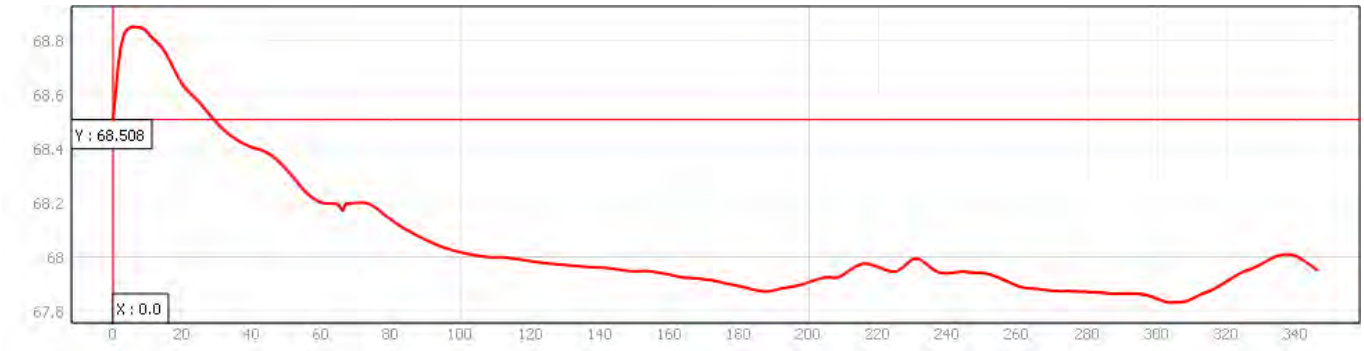

Figure 4 – Option 1c Elevation Profile from Gelvert Stream bed down to the lake (based on Topographic Survey)

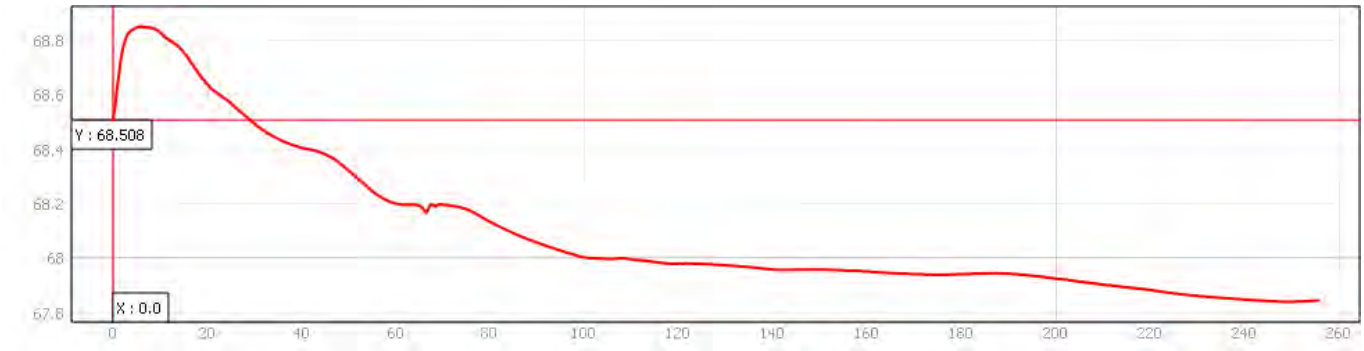

Figure 5 – Option 1d Elevation Profile from Gelvert Stream bed down to the lake (based on Topographic Survey)

Figures 2-5 above show the elevation profiles for the potential routes based on the recent topographic survey of the site that was carried out, and the Environment Agency 1m DSM LiDAR data that is available freely online. The profiles start from within the channel so that the level of the existing bank is visible – in the suggested location the bank is around 1m higher than the existing channel bed, but due to the erosion that has occurred there is a section that is lower than this and would be a suitable location for the new channel to begin. The existing bed level is at approximately 68mAOD. During low flows water levels are therefore unlikely to be much higher than 68.2mAOD in the Gelvert Stream. In order to pass flow into Fugelmere Marsh, irrespective of which option is chosen, the water level will need to be at least ?????mAOD in Gelvert Stream. The elevation profiles show that once out of the channel the elevation generally tends to decrease as you move along the profile, the profiles shows the elevation fluctuates along the profile but any increases are relatively small. As it would be necessary to dig down slightly to create the new channel this increase in elevation would be removed via that process. In order to re-wet the marsh, it may be beneficial for any new channel to be quite wide and with a shallow depth/low bank height so that flows can come out of the channel and go further into the marsh. If the new channel were to have high banks then it will retain any flows – preventing other areas of the marsh from being rewetted other than the channel itself. Creation of several scrapes and gutters within the marsh would provide pathways for the water to flow through to reach different areas of the marsh that are selected for rewetting.

Option 1a – This option would see a channel created that runs along the east/northeast side of the marsh, it would be possible to use the bund that is located here as a natural bank for the new channel which would help prevent high flows from going out onto the pathway, and push them outwards further into the marsh.

Option 1b – This potential route has the channel running through the middle of the small ponds that are present in Fugelmere, this would allow potential high flows in the channel to spill into the ponds allowing them to retain their water levels which could then contribute to wetting the marsh during summer if they retain the water.

Option 1c – For this option the channel flows around the south/southwestern side of the existing ponds before heading north towards Sandy Bay. Selecting this option in combination with either Option 1a/b would focus the rewetting on the areas that were found to be drier during recent site visits, as the western side of the marsh was seen to already have quite a large amount of surface water during recent site visits.

Option 1d – This final option sees the channel flow down to the south/southwestern side of the marsh before heading to the lake, the elevation on this side of the marsh is lower than the rest, and a recent site visit after heavy rainfall found the ground to be quite wet underfoot here. This could be due to the lower elevation, meaning that when the lakes water levels are higher some of the water reaches the marsh area, or there could be natural scrapes/dips that allow water to pool after rainfall events. Therefore, it might not be necessary to select this option due to this side of the marsh already appearing to be wet.

Rewetting Fugelmere Marsh would be made more feasible by using a combination of options 1a, b, c and d so that the coverage of water is at its maximum. Choosing these options as well as creating additional smaller connecting scrapes and gutters would allow water to spread much further over the marsh, increasing the potential for new wet habitat creation. However, this would all be dependent on the level of flow in the Gelvert stream, and the design of the start of the off-take channel, which could take several forms. One option is that the new diversion channel would have a similar function to the existing diversion channels – in that it takes off high flows from the main channel and diverts them elsewhere to reduce deposition in the lake, and help reduce the potential for the Gelvert stream banks downstream to be overtopped. The effectiveness of this could be improved by installing a leaky woody dam similar to that found at the existing upstream diversion, this would create a build-up of water during high flows that would then be pushed down the new diversion channel. This will only be effective during very high flows, as during any low to moderate flows the water levels are never likely to get high enough to result in water entering the diversion channel.

An alternate option for the offtake channel (if having some flow in the diversion channel throughout the year is seen as critical), would be to create the new channel/culvert at a level similar to the current channel bed. However, this would result in the flow being continually split between two channels, and whilst flows are low this may have negative effects on downstream locations such as Sandy Bay as deposition of sand is likely to occur in the channel rather than the bay which could result in Sandy Bay decreasing in size over time. To avoid this from happening, and provide control over the flows in the channel, a feature such as a stop-dam could be constructed on both the main channel and the new diversion channel. This type of structure would provide flexibility so that when flow is low, a board could be put in place temporarily on the main channel to divert the flow down the diversion channel to Fugelmere Marsh, and then when required the board can be taken out of the main channel and inserted into the diversion channel to have the flow continue on its normal path down the Gelvert. This allows control over the flows in the channels, but consideration would need to be made to ensure that the boards are not in place during a high flow event so as to prevent the banks from being overtopped. The temporary environmental impacts of stopping flow passing down one of the channels would also need to be assessed.

3.3 OPTION 2 – NEW DIVERSION CHANNEL OPPOSITE EXISTING UPSTREAM DIVERSION THAT FLOWS THROUGH WOOD LANE HEATH, INTO FUGELMERE MARSH

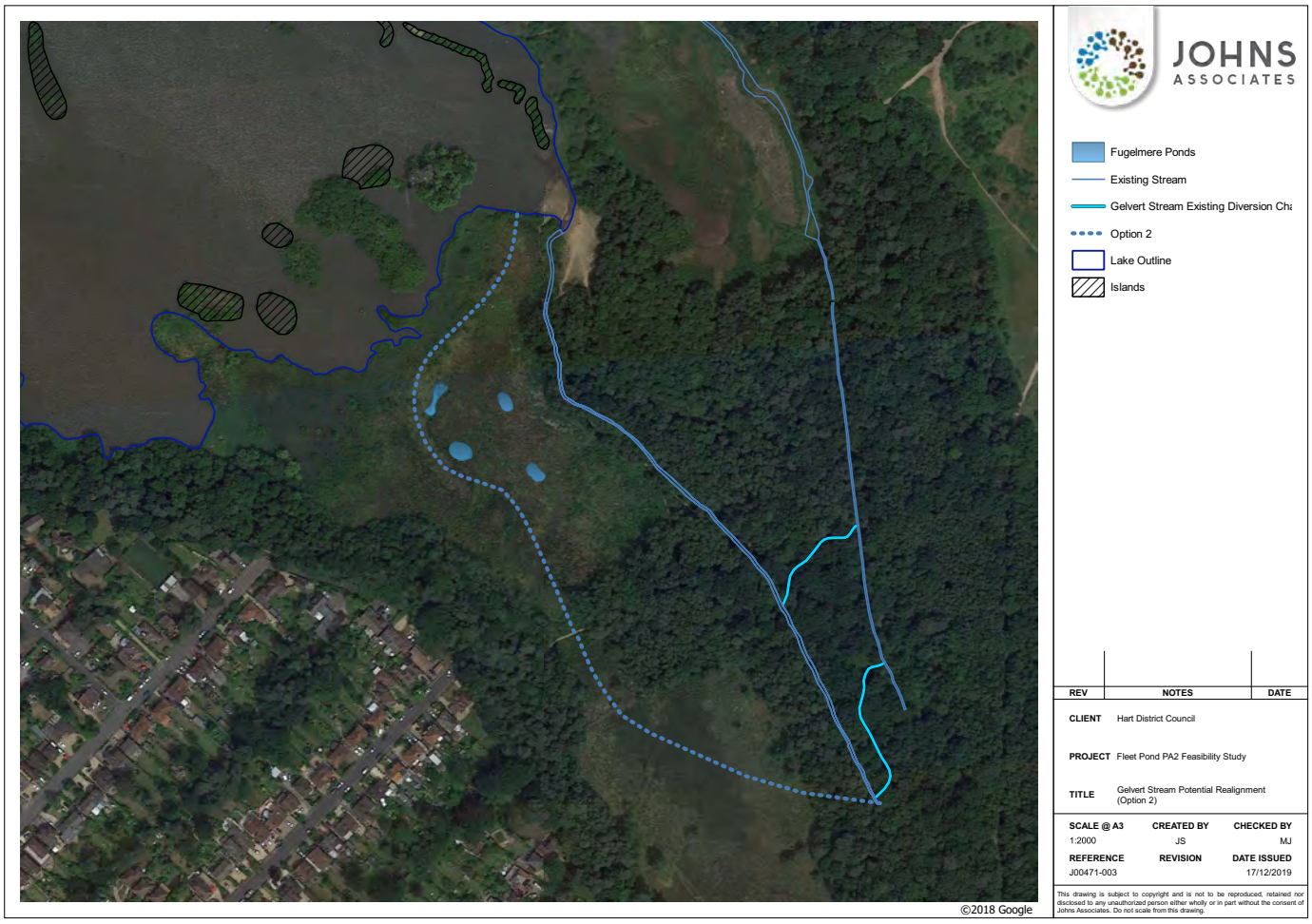

Figure 6 – Option 2 Potential diversion channel through Wood Lane Heath and Fugelmere Marsh

Figure 7 – Option 2 Elevation Profile from Gelvert Stream bed down to the lake (based on Topographic Survey)

Option 2 sees the construction of a new and longer diversion channel opposite the existing upper Gelvert Stream diversion channel. A new diversion channel created on the left hand bank would see high flows split between 3 potential routes: the main channel, the existing diversion and the new diversion. In order for all channels to operate correctly, the existing leaky dam that is in place would need to be altered so that it does

not prioritise one channel over the other, changing the angle so that it is at right angles to both channels would allow this. The new channel would flow through Wood Lane Heath which is a low-lying area with a downhill profile towards the lake (the northwestern edge of Wood Lane Heath next to Fugelmere was seen to be very wet already on a recent site visit – suggesting that there are number of flow paths on the heathland already that cause surface water to pool in this area). Construction of several pipes/culverts under the footpath between Fugelmere and Wood Lane Heath would be required to allow surface water, and new flows from the diversion channel to flow under the footpath and out into Fugelmere Marsh.

It may be suitable for this option to create several scrapes and gutters in both Wood Lane Heath and Fugelmere Marsh that spread out from the initial diversion channel, allowing the water to spread out, rewetting a larger area, and also to collect larger amounts of surface water that can add to the flow. The pooling of surface water that was observed during a recent site visit suggests that there are already existing natural flow channels through both Wood Lane Heath and Fugelmere. Identifying any features such as this would be beneficial at it could reduce construction costs and times to use pre-existing natural flow paths. The route shown in Figure 6 could be the main channel, and then having several sub-channels coming off of this one would help to spread the water further over Fugelmere Marsh.

Having the new diversion channel further upstream than Option 1 would mean that there is a greater amount of available water at high flows for the new diversion channel, as for Option 1 the flow would have already been diverted down the 2 existing diversion channels before reaching the new one, meaning that flows are lower so it might not be as effective. Whereas at this upstream location the high flows would be split between the existing diversion and the new diversion at the same location. This could reduce the effectiveness of the existing downstream diversion channel, but this could be increased by the installation of a leaky woody dam at this location to push remaining high flows down this channel as well.

A similar problem to that of Option 1 is also likely to occur for Option 2 in that during periods of low flow, there will not be enough water in the main channel to have any flow in the diversion channels. This could be solved by installing pipes/a culvert at the offtake for the new diversion channel that are at the same level as the main channel bed. However, this would mean that the flow would be continually split between two channels and given how low the flow already is in the main channel at times, this may cause one of the channels to dry up. Installation of stop dams on both the main channel and new diversion channel could help with this as then the flow could be switched between the two channels by removing/adding a board to the necessary dam. An alternative option would be setting the pipes/culvert of the diversion channel slightly higher than the existing bed but lower than the existing diversion channel, meaning that flows will need to reach a certain height before they are diverted. This would mean that there would not be a continual flow in the diversion channel meaning that areas that are being rewetted may dry up if there is a long period of time between flows being high enough to go into the diversion channel. Having pipes at the entrance to the offtake channel that are adjustable would be a potential solution to this as they could be adjusted relevant to the level of water in the channel to ensure that there is some flow always available for the diversion channel.

A potential problem with this option is that Wood Lane Heath appears to be a stable Priority Habitat that functions effectively, and affecting this by diverting flows through the area could have a negative impact on the species and extent of Priority Habitat that are present in the area. Also, similar to Option 1, this will only be effective in moderate to high flows, with no increased wetting during lower flow conditions.

3.4 OPTION 3 – CONSTRUCTION OF BACKWATERS FROM FLEET POND INTO FUGELMERE MARSH

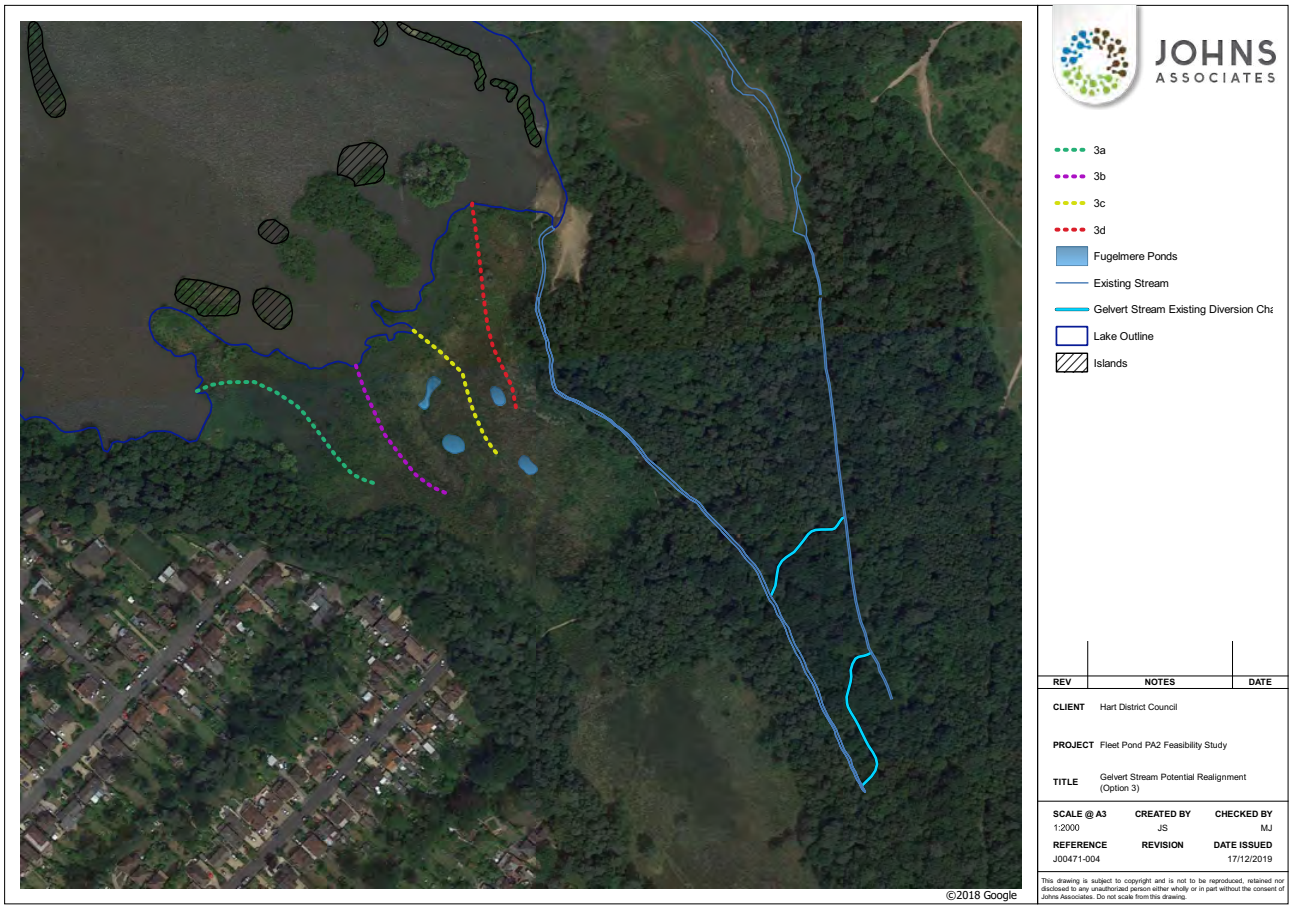

Figure 8 – Option 3 Potential new backwaters from Fleet Pond flowing into Fugelmere Marsh

Option 3 would see the construction of several backwater channels from Fleet Pond into Fugelmere Marsh, these backwaters would allow the nearby areas of marsh to be rewetted when lake levels rise. Alternatively, they could be dug down to a depth so that they are continually wet throughout the year, smaller channels could then be dug extending from the main ones that fill with water when lake levels rise to increase the coverage of water.

Figure 8 shows 4 potential locations for the backwaters, and the elevation profiles for these are included in Figures 9-12. Options 3a and 3b only have a range of around 30cm over the profiles, whereas options 3c and 3d have ranges over 50cm. The sediment that would need to be removed in order to create the channels could be used to form the banks in certain areas where rewetting is to be avoided. This option may prove to be a more simple and effective method of providing a permanent source of water to the marsh that can rewet the area. This option also means that the existing diversion channels on the Gelvert would not lose any of their effectiveness due to the water being taken off at a 3rd location – which may have had implications for Coldstream Marsh if the supply of water coming from the diversion channels were to decrease.

Another potential benefit of creating backwaters is that they can also act as habitats for fish, macrophytes and invertebrates that may be present in the lake and looking for sheltered areas that are safer from predators. Considerations will need to be made for the existing vegetation present in the areas that the backwaters are to be created – any reeds that are present could be translocated to the banks of the backwaters to encourage more to grow and spread to the new areas.

Design of these backwaters will need to consider the volume of water required to pass up them, and the requirements for animals or people to be able to access the channels. They are likely to be relatively wide where they meet the pond, reducing in width and depth as the go upstream. This will ensure that during high rainfall conditions the likelihood of sediment within the channels being naturally eroded from runoff is maximised. However, over time these channels may still be prone to siltation and an irregular programme of desilting may be required.

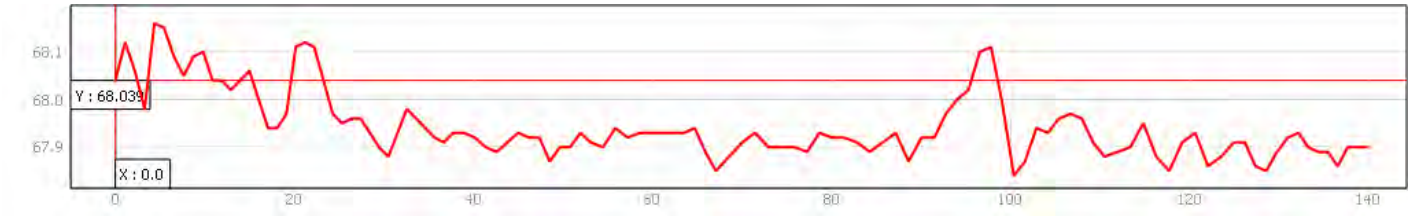

Figure 9 – Option 3a Elevation Profile from lake into Fugelmere Marsh (Red line is EA 1m DSM LiDAR)

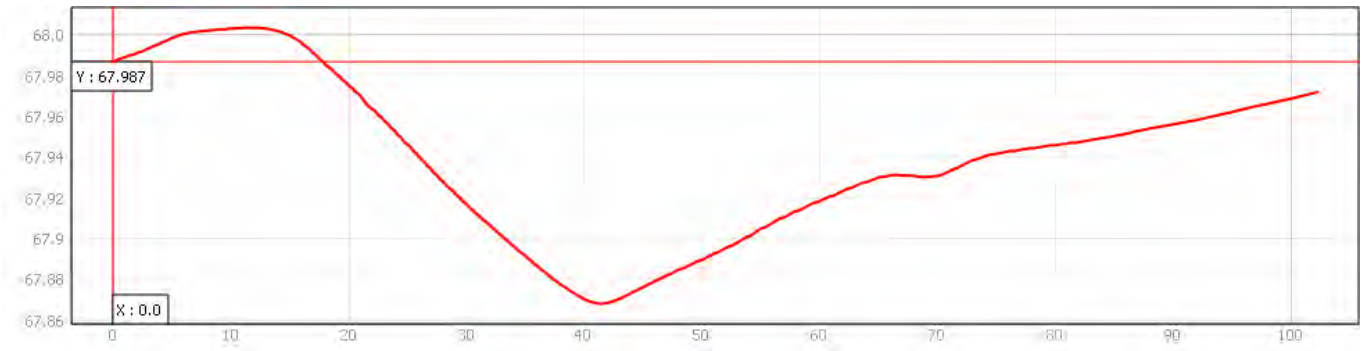

Figure 10 – Option 3b Elevation Profile from lake into Fugelmere Marsh (Red line is Topographic Survey)

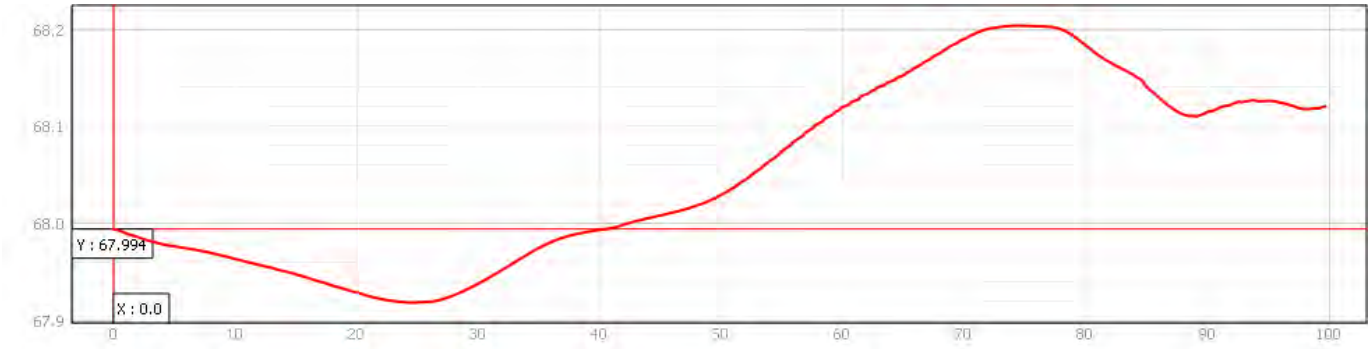

Figure 11 – Option 3c Elevation Profile from lake into Fugelmere Marsh (Red line is Topographic Survey)

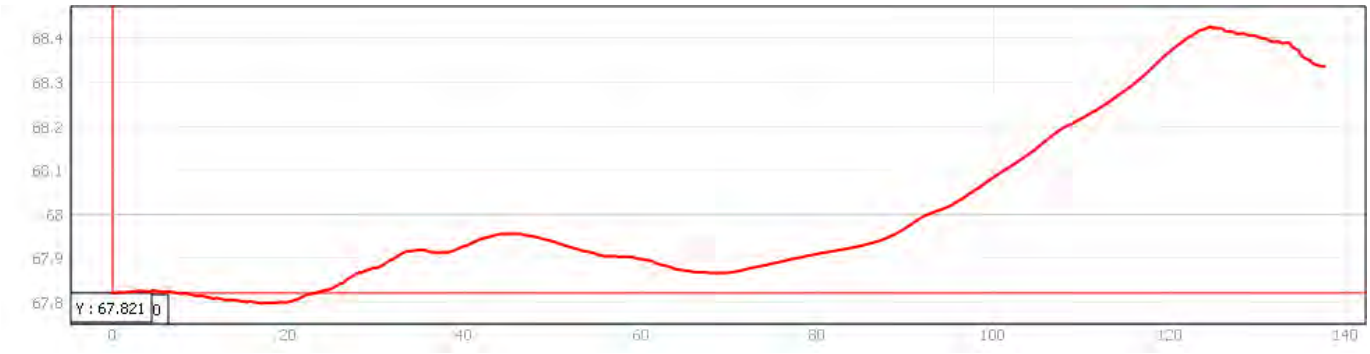

Figure 12 – Option 3d Elevation Profile from lake into Fugelmere Marsh (Red line is Topographic Survey)

3.5 OPTION 4 – COMPLETE REALIGNMENT OF THE GELVERT STREAM

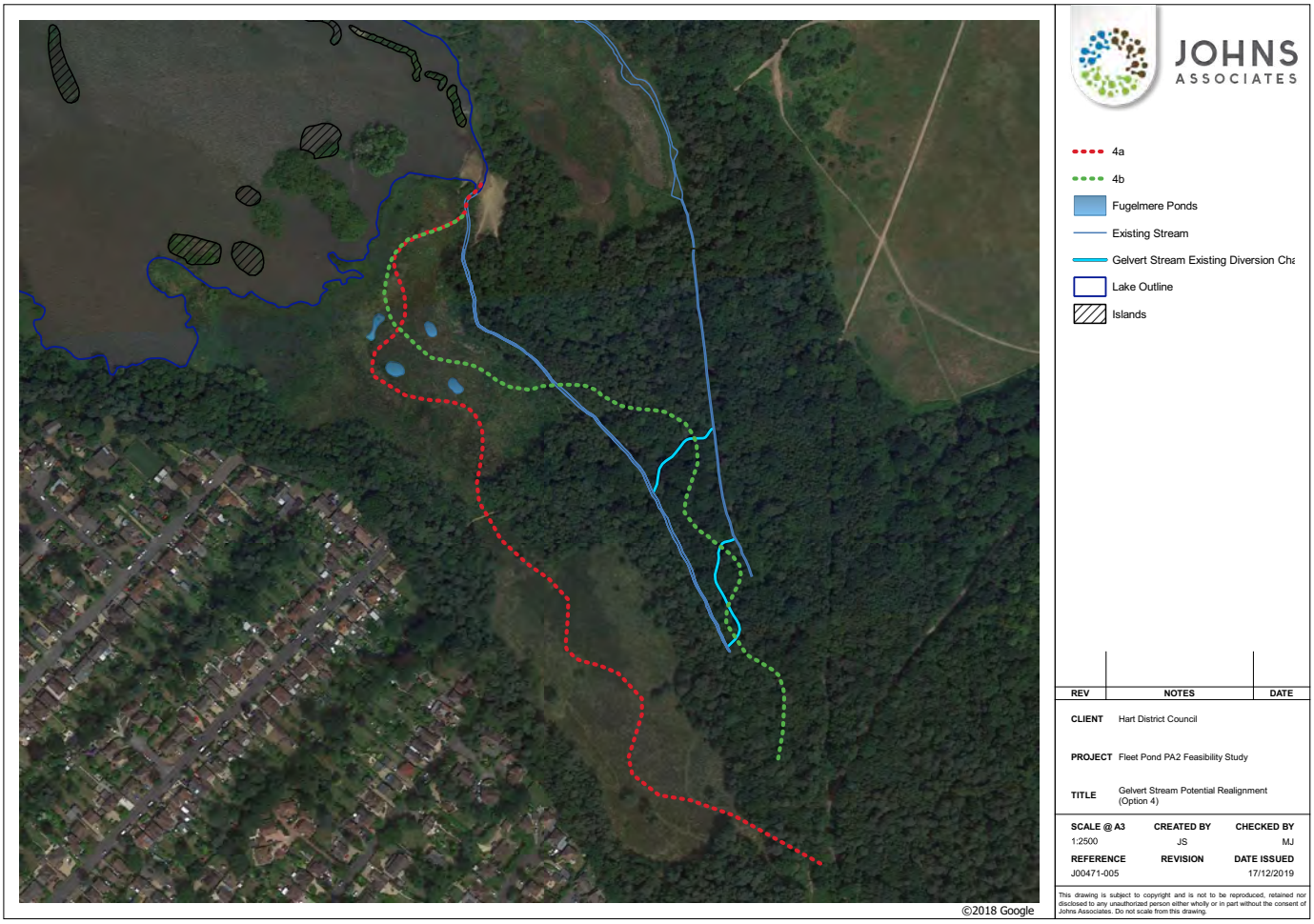

Figure 13 – Option 4 Potential locations for complete realignment of the Gelvert Stream

Option 4 would require a significant amount of work, and funding. However, it would allow the Gelvert to return to a more natural channel shape and planform that could prove beneficial due to an increased capacity to deal with higher flow conditions, and more natural opportunity for sediment deposition. This option suggests completely moving the Gelvert to a different location, where it can be re-meandered and left to form a natural channel shape and pathway. Figure 13 presents two potential locations for the Gelvert to be

relocated to – option 4a suggests moving the stream so that it flows through Wood Lane Heath and Fugelmere Marsh before coming back to its original route to flow into Sandy Bay. For this option, having the channel flow through Wood Lane Heath would provide a wide area with space for meanders, and that is relatively free of trees which would reduce the amount of leaf litter that gets picked up in the stream. Flowing through Fugelmere would allow this area to be rewetted as a number of small offtake channels could be created here that spread water throughout the marsh. Directing the flow to then join back up to the original channel so that it continues to flow into Sandy Bay would enable this important amenity asset to remain as deposition of sandy material from the Gelvert would still be deposited here.

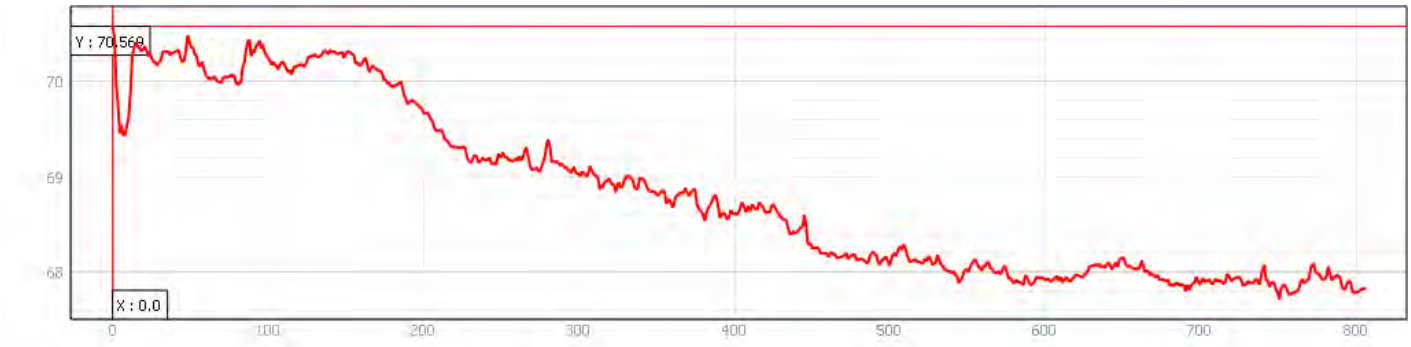

Figure 14 – Option 4a Elevation Profile (Red line is EA 1m DSM LiDAR)

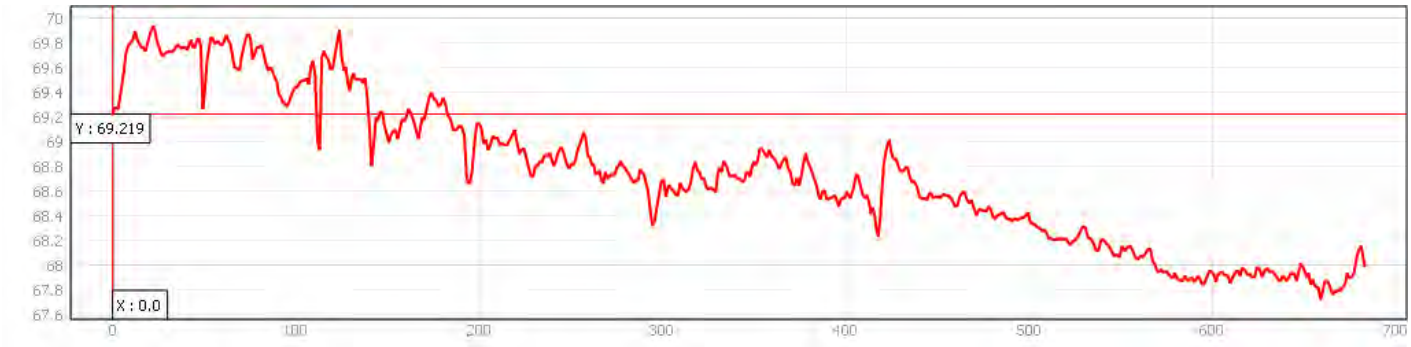

Figure 15 – Option 4b Elevation Profile (Red line is EA 1m DSM LiDAR)

Option 4b sees the channel being relocated and re-meandered through Starve Acre Wood before crossing the original channel and flowing into Fugelmere Marsh where it then loops round and joins the original channel flowing into Sandy Bay. It also means that it could be connected to the existing diversion channels providing extra capacity for flood events. This could also lead to the production of wet woodland habitats. This option sees the stream flowing into Fugelmere Marsh which would help to meet the aim of rewetting this area, and again joining up with the original channel to flow into Sandy Bay.

Both options would require a significant amount of work such as: creating the new channel, potentially moving the path to follow the new stream route to retain amenity value, vegetation clearance, creating connections to the existing diversion channels. This amount of work would require significant funding to be able to carry

it out effectively and is highly likely to require planning permission and all supporting studies. A potential problem with this option is that moving the channel away from the existing diversion channels would mean that the supply of water to Coldstream Marsh would be reduced which could have negative consequences for the habitats found there. The existing channel could be left in place and used as a diversion channel for high flows, its high banks mean that it would have a high capacity to carry a large amount of flood water, the connections to the existing diversion channels could also remain so that during a bankfull event the flow has several channels over which it can spread, this could also provide more areas for sediment to be deposited.

4 RECOMMENDATIONS

4.1 EXISTING GELVERT STREAM DIVERSIONS/COLDSTREAM MARSH

Observations made on a number of occasions between September to December 2019 (inclusive) have shown that a simple 'leaky dam' (that has been present in the channel of the Gelvert Stream for more than a year) has become effective in diverting a significant proportion of the main channel flow into the upper diversion link and into the main diversion channel through Coldstream Marsh and then into Fleet Pond. This has become more efficient at diverting flows through the accumulation of leaf litter. The diversion channel functions very well at conveying flow with a reduction in energy when the confluence with a restored military ditch is reached providing a high-quality depositional environment. Flow was observed (in October and November 2019) throughout this new channel right up to the confluence with the lake. A further low energy environment is also present in Coldstream Marsh, which itself became wetter during the study period including from flows being diverted. The effect of this process of storing water is to reduce downstream flows, although these remained present during the study period. This does influence sediment transport downstream, with evidence of recent sand deposition in the bed of the channel towards the confluence with Fleet Pond, likely to be a result of reduced stream power with lower flows below the diversion. The lower stream diversion was not observed to be operating during the study period as it requires the water levels to exceed 0.5m in Gelvert Stream to function and this was also influenced by the majority of the flow being diverted in the upper channel link.

These observations are highly valuable as they clearly demonstrate the effectiveness of the work implemented during FPRP2010-17 with the additional influence from a suitably sized and placed leaky dam.

Delivering PA2 Objective 1 will ensure the correct and optimal functioning of the Gelvert Stream diversion channels though "Natural Flood Management" (NFM) and the use of the existing diversion features to reconnect the flow with the floodplain and to reduce sediment input into Fleet Pond from the upstream catchment. It will also enhance wetland functionality. This will be of wider benefit to the biodiversity of both the Gelvert Stream and the new diversion channels, adjacent wet woodland and Coldstream Marsh.

This objective is in part being delivered now, but the PA2 project will enable the specific structures to be modified to be more resilient, enabling its removal/adjustment/replacement if required. Some additional local bed and bank protection will be required to protect against scour and bank erosion. A further structure would be placed downstream of the lower diversion link channel to maximise its function and value and the flexibility of the system.

It is recommended that the existing leaky dam in place at the upper diversion is modified or recreated to present a similar design to that as shown in Annex 2c of The Countryside Stewardship Higher Tier Manual – see Figure 16 below. As the leaky dam design shown in Figure 16 seems to be designed to force water out of the channel, subtle variations to design will need to be included so that prioritises forcing flow down the diversion channel. This could be done by installing the dam at a level that has the crest below banktop, this would allow high flows to pass over the top of the dam, as well as being pushed down the diversion channel. The banks around the diversion channels, and leaky dams may need to be reinforced to ensure that the risk of the banks being eroded is reduced as this could affect the integrity of any feature put in place. This could be achieved using natural materials.

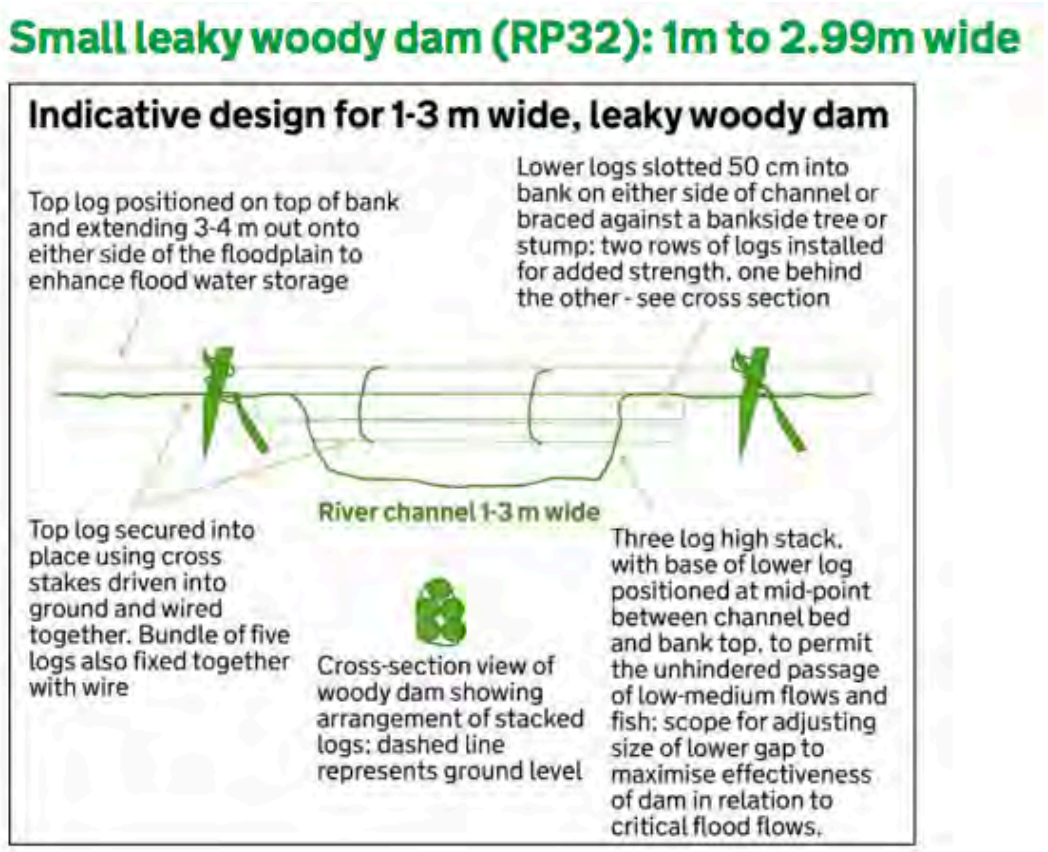

Figure 16 – Indicative design on leaky woody dam (Countryside Stewardship Higher Tier Manual, 2019)

4.2 REWETTING FUGELMERE MARSH

Four potential options have been suggested for this section of the works:

- Option 1 – Creation of a new diversion channel in-between the existing lower diversion channel, and the footbridge at Sandy Bay. The channel would flow into Fugelmere Marsh where it could take a number of potential routes in order to re-wet the habitat
- Option 2 – Creation of a new diversion channel opposite the existing upstream diversion. This new channel would flow through Wood Lane Heath before entering into Fugelmere Marsh where it could then spread out to allow a sufficient amount of re-wetting
- Option 3 – Creation of backwaters flowing into Fugelmere from Fleet Pond allowing the marsh to be rewetted as the lake levels rise
- Option 4 – Complete realignment of the Gelvert Stream so that it follows a meandering route through Wood Lane Heath and Fugelmere Marsh, or through Starve Acre Wood before flowing into Sandy Bay

Each option provides many advantages, but there are also limitations and potential negative consequences that will need to be considered for each of them. There are several limitations of creating new diversion channels for Options 1 and 2, the key issue for the creation of a new diversion channel comes from the level of water that is available in the Gelvert. If the new diversion channels are intended to serve a function similar to that of the existing channels in that they only offtake high flows from the main channel, then it has to be assumed that they will only have water in them during or after high flow events. This has implications for the aim of wanting to maximize the value and function of the diversion channels to protect Fleet Pond from elevated sediment transport/turbid flows and rewet Fugelmere Marsh, as the supply of water allowing this to happen would be entirely weather dependent – meaning that during the drier summer months when rainfall is limited there would be little if any available water to keep the habitats wet in Fugelmere. This could cause the habitats to degrade or cause certain species to die off due to the area being too dry.

A potential solution for this would be to create the new diversion channel at a lower level than the existing ones, for example the new diversion channel could be at half the height of the existing ones (e.g. 15cm above bed level) meaning that flows would also only need to be half that height in order for water to enter the diversion channel. However, this still means that flow down the diversion channels is dependent on the weather, so again there may not be enough water available during summer to sustain wet habitats. The channel could then be designed so that it is at the same level as the existing channel bed, meaning that there is always water available throughout the year providing that there is some water in the Gelvert. However, this could also lead to problems downstream due to the small amount of flow that is in the Gelvert during dry periods, as permanently splitting the flow between two channels would see the levels drop in the main channel past the diversion point. If flows are already low enough then there may not be enough flow to sustain both channels potentially causing one or both to dry up. This could then result in wet habitats in Fugelmere Marsh drying up, and also have implications for Sandy Bay as the supply of sediment would be interrupted. To counter this, installing removable stop dams on the main channel and the diversion channel, would allow the flow to be switched between the two. This would provide a lot of control as to when water is supplied to Fugelmere through the diversion channel. Inserting a stop board on the main channel to push all of the flow down the diversion channel would result in the main channel drying up, potentially resulting in harm to any fish, or other living creatures that may be in the stream at the time. Therefore, it may only be suitable to install a stop dam on the diversion channel so that flows can be split temporarily and then switched back to just the main channel as necessary. Whilst these methods could provide suitable solutions to enable these options to

function effectively, they would make the river system more unnatural than it currently is, which could be seen as a negative by many. So, it may be more suitable to choose an option that would leave a more natural feel to the Gelvert Stream and surrounding area.

Option 4 presents an outcome that would allow the Gelvert to re-naturalise, by designing a more natural meandering channel, and then leaving enough space around it so that the natural processes in the river can help form and shape the channel to something that could be expected of one this size and in this location. Whilst there would be many benefits to having a new channel that is allowed to function naturally, assuming it is allowed the time and space to develop, it could also have negative consequences as the present water course and diversions that are in place seem to be functioning well and carrying out their job effectively. As confirmed by recent site visits the upper diversion channel was in use – pushing high flows through the woodland and out to Coldstream Marsh. The lake bed was also visible across the lake, confirming that turbid flow levels are currently lower, traces of the sandy material typically washed down from the MoD site were found on the banks of the diversion channel in the woodland. Therefore, it may not be necessary to create an entirely new channel, as it would not only take a significant amount of work, but also a long amount of time for the new channel to function correctly, and provide the same benefits that the existing one and its diversions are providing.

It is recommended that Option 3 is pursued as this presents an option that would not interfere with the current functions of the existing channel, it would instead allow proportionate improvements to be made, rather than fully altering or realigning the channel, which would not only result in positive benefits, but also minimse potential negative effects. The creation of several backwaters into Fugelmere Marsh would allow a continual supply of water to the marsh to create new wet habitats. As the backwaters would be reliant on the level of water in the lake they would be designed to a depth to ensure that there is water in the channels throughout the year – smaller scrapes and gutters could be created coming off the backwaters at slightly higher elevations so that they only fill with water when lake levels are higher. Having extra channels would allow water to spread further into the marsh when the lake levels are higher, providing more opportunities to rewet a larger area.

Considerations would need to be made to avoid any important species that may be present in locations where the backwaters are to be created. It would be possible to translocate vegetation such as reeds and other marginals to the edges of the new backwater channels, this would help to encourage the population to spread and colonise the banks. The new backwaters have the potential to provide another benefit that could help meet another aim of the project, as they would provide a sheltered area of water away from the main lake that could be used as a nursery area for macrophytes and macroinvertebrates.

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Appendix A Extended Phase 1 Habitat Survey

JOHNS ASSOCIATES

- Target note
- Scrub
- J2.4 - Fence
- A2.1 - Scrub - dense/continuous
- B5 - Marsh/marshy grassland
- D6 - Wet heath/acid grassland
- F1 - Swamp - Reedbed
- G1 - Standing water

REV	NOTES	DATE

CLIENT Hart District Council

PROJECT Fleet Pond PA2 Feasibility Study

TITLE Phase 1 Habitat Survey

SCALE @ A3	CREATED BY	CHECKED BY
1:2000	JS	KN
REFERENCE	**REVISION**	**DATE ISSUED**
J00471-009		29/1/2020

Appendix B Topographic Survey

Contour Lines

Pathways

Scrub/Foliage

Stream/Lake Edge

Fence

Approx Height = 68.00

0m 100m

Appendix E: Technical Note 5: Accelerated Lake Macrophyte Re-establishment;

HART DISTICT COUNCIL

Fleet Pond PA2 Feasibility Study

TECHNICAL NOTE 5: Accelerated Lake Macrophyte Re-establishment

1 INTRODUCTION

Johns Associates has been appointed to carry out a feasibility study for the next stage of restoration works at Fleet Pond, (referred to as the PA2 Project), that is focusing on a series of core objectives as set out in Technical Note 2. One of the priority PA2 objectives is:

- PA2 Objective 3: To Increase the Diversity and Abundance of Lake Aquatic Macrophytes, Invertebrates and Zooplankton Through the Use of a Range of Techniques and Features (including protection from grazing fish and birds).

The next phase of restoration would be funded through a successful application to the Higher Tier of the Countryside Stewardship Scheme (CSS) and potentially though other funding opportunities if they become available.

The purpose of this document is to review the relevant methods available to accelerate the establishment of greater diversity and abundance of lake aquatic macrophytes, and by achieving this, increase the macroinvertebrate diversity and zooplankton abundance in the lake.

2 CURRENT/PREVIOUS METHODS USED FOR MACROPHYTE RE-ESTABLISHMENT

The citation for Fleet Pond Site of Special Scientific Interest (SSSI) (last revision dated 1979) describes that "*Fleet Pond is an extensive, shallow lake, whose waters are generally neutral in reaction. It is flanked successively by extensive reed Phragmites beds, alder Alnus carr, and acid woodland dominated by oak Quercus and birch Betula. Though suffering from recent silting, Fleet Pond supports a rich aquatic flora, including a number of locally distributed or rare species*."

At the inception of the Phase1 Fleet Pond Restoration Project, surveys had identified that whilst marginal and lakeshore aquatic macrophytes were established (e.g. common reed *Phragmites australis*) together with areas of marginal trees and shrubs, there were virtually no recorded open water submergered, emergent or floating macrophytes present. This was a significant area of concern and solutions to improve the condition of the lake for macrophytes focused on reducing sediment inputs, improvements in water transparency, exposure of buried seedbank, creation of shallow water and sheltered areas, creation of mid-water islands, reedbed management and creation including open water

areas, and an understanding of the influence of nutrient levels, fish and grazing birds on macrophyte establishment and success.

2.1 ISLAND HABITATS

Island habitats were created as part of Phase 1 FPRP using Nicospan wall and timber posts back filled with dredged sediment. These features were created for a number of reasons:

- To act as new locations to place dredged materials from the lake bed;
- To provide suitable locations for establishing reedbed and other habitats;
- To provide shelter for wild birds and waterfowl;
- To provide valuable edge habitat and to increase the habitat complexity within the open water area of the lake, thereby reducing the impacts of wind influenced waves and sediment ripple migration;
- To vary the elevation of the surface of the islands so therefore varying wetness (this Influences the vegetation establishment - some are wetter so marginal vegetation will establish, some drier so scrub and ruderals have established requiring management effort); and
- Establishment of new reedbeds on some islands.

2.2 NEW MARGINAL HABITATS

New marginal lake habitats were established in a similar manner to the islands: using Nicospan and timber posts back filled with dredged sediment to create an extension of the lake shore. These areas are now typically lower and wetter and support marginal macrophyte species including.

2.3 FISH EXCLUSION

The aim of fish exclusion was to minimise the grazing impact on the potentially recovering historic seed bank below the dredged profile within an area enclosed by the lake shore and islands. This was to be achieved through the use of 1 cm mesh size seine netting, with float and weight line and fixed to Islands. However, this proved to be extremely difficult to maintain and became permeable to fish. This method (fish exclusion) has now been discounted although there remains the potential to continue to use the netting (still *in situ*) supplemented by coarse woody debris created an area of marginal shelter to help support = success in = establishing macrophytes in different conditions than found in the open water environment of the lake.

2.4 TRANSLOCATION OF BOGBEAN

This species has previously been shown to be successful at buffering the lake margin thereby allowing the reedbeds to become established. As a rooted macrophyte species, sections can be cut and towed to other areas of the lake for re-establishment. Bogbean is currently being grown on and is very successful at protecting reeds from grazing wildfowl, although it has to be cut back at times due to excessive growth.

2.5 POTENTIAL EXPOSURE OF BURIED SEEDBANK

Historically, Fleet Pond was notable for its macrophytes and clear water; indeed, this was partly the reason for notification as a SSSI in 1984 (although it was initially designated in 1951 under terms of The National Parks and Access

to the Countryside Act 1949). Dredging of the lake bed could re-expose the potentially viable historic seed back which may germinate with exposure and improved transparency arising from the works. However, to date no coring has been competed to determine the quality/viability of the seed bank.

2.6 REED TRANSLOCATION

Reeds were translocated by machine, taking 1 m_2 scoops of existing reedbed and translocating this onto the newly-created islands. Historically, the Fleet Pond Society also conserved reed seed heads and spread seed and cut reed brash to promote the establishment of reedbed on the islands and elsewhere in Fleet Pond.

2.7 DISPERSAL FROM WATERCOURSES

Fleet Pond has a hydrological connection from the Basingstoke Canal through overflows into the Gelvert Stream and the Brookly Stream. This should act as a rich source for macrophyte re-establishment. It is also a potential source of Invasive Non-Native Species (INNS) of plant.

2.8 PLANTED COIR ROLLS

Funds were previously secured and approved by Natural England for the purchase of pre-planted coir rolls (comprising local reed stock). These were installed on the islands by hand from a boat, which was both difficult and time-consuming. These coir rolls had limited success, but the rhizomes may have contributed over time to the establishment of reeds on the islands and may continue to do so.

2.9 MANAGEMENT ACTIVITIES

The Fleet Pond Society carries out a range of management activities in and around the lake. Management activities include:

- Scrub control on a number of the newly created islands that remain wet throughout the year and which are considered to offer the best opportunities for aquatic macrophyte nursery establishment or development into significant *Phragmites* reedbeds. These management works involve the removal of alder and willow scrub habitat. All cut scrub is removed.
- Removal of some wire netting which was installed around the islands to prevent grazing of the young reeds during early establishment but which was obstructing scrub management activities.

In addition, the Hart District Council Ranger service also carries out regular management works to habitats and facilities in and around the lake on a regular basis.

Continued scrub removal on the wet islands is necessary to control these species, support the expansion of reed and prevent dominance by scrub.

2.10 Invasive Non-Native Species (INNS) Plants

A number of INNS plants have been identified both from within Fleet Pond and in surrounding watercourses/habitats:

- *Crassula* has been identified by the Fleet Pond Society on all of the wet islands with reeds within the lake;
- Skunk cabbage *Symplocarpus foetidus* has been noted in Brookly Stream woodland and along the margins of the lake itself;
- There have been recent reports of floating pennywort *Hydrocotyle ranunculoides* in Brookly Stream.; and

- *Lemna* dominates the Brookly ponds.

3 OTHER OPPORTUNITIES FOR ACCELERATED MACROPHYTE RE-ESTABLISHMENT

3.1 CURRENT CONDITIONS

Increased light levels to beds are now occurring as a result of increased water transparency and decreased turbidity. Deeper sediment layers have been exposed and these may have helped support the germination of buried plant seed.

3.2 EXISTING MACROPHYTES

An aquatic macrophyte survey of Fleet Pond was under taken in August 2019 ("*Aquatic Macrophyte Survey of Fleet Pond*" Dr Giles Groome, August 2019). This survey acknowledged the recent paucity of macrophyte records from Fleet Pond: however, the survey results were encouraging, with over half of the 106 recorded samples yielding at least one macrophyte species. Twelve species of macrophyte (13 including a sample supporting submerged juvenile *Typha* sp.) were recorded: seven from the open water of Fleet Pond; nine (or 10) from open water within islands; two from the silted over stand; and three from The Flash. The survey recorded several species for the first time in several decades, which suggests the recent works have been successful and the lake is re-gaining ecological diversity.

The report makes a number of recommendations both for management and monitoring of Fleet Pond habitats, which have been considered in the production of this Technical Note.

3.3 TRANSLOCATION OF BOGBEAN

Bogbean *Menyanthese trifoliate* is a creeping plant which flowers from April to May. Existing areas of established bogbean will be cut by hand into 1 x 1 m sections and floated / placed onto pontoons to be towed and deposited at the margins of 5no. islands within Fleet Pond (Figure 1. At the end of this Technical Note).

A total of 2 m_2 bogbean translocation will occur for each of the 5 islands (10 m_2 in total) will be monitored annually to assess how it establishes and spreads around the islands. Should establishment be successful further bogbean will be translocated to new areas and islands within the site.

3.4 PLANTING/SINKING LILIES

Ten groups of 5no. water lilies will be planted in Fleet Pond. Two groups of water lilies will be planted within the more sheltered and netted area on the western boundary of the Pond and the other eight will be planted within mid-water areas as per the PA2 Feasibility Masterplan. Native white *Nymphaea alba* and yellow water lilies *Nuphar lutea* and water fringe *Nymphoides peltata* species will be planted. All planted will be sourced locally (including the potential to harvest from the adjacent Little Pond) with proven provenance and genetic suitability and agreed in advance with Natural England.

To avoid the use of plastic aquatic planting baskets and reduce plastic pollution within Fleet Pond the water lilies will be planted within biodegradable plant nursery bags which will have stones placed in the bottom to weight the lilies down the pond bed and will also have holes cut within the bag to allow the lily rots to penetrate the pond bed. The bags can be sourced at a minimal cost.

3.5 FLOATING PLANTED VEGETATED RAFTS

Five planted floating islands will be installed with 4no. located within the open water of Fleet Pond and away from the islands in order to break up the open water areas and 1no. located within the netted sheltered area on the western boundary of Fleet Pond. The floating islands will be a minimum size of 4 x 4 m and come planted with established native wetland plants harvested from Fleet Pond. The islands are low maintenance, simple to install, mimic natural wetland habitat, encourage the formation of biofilms and improve the water quality.

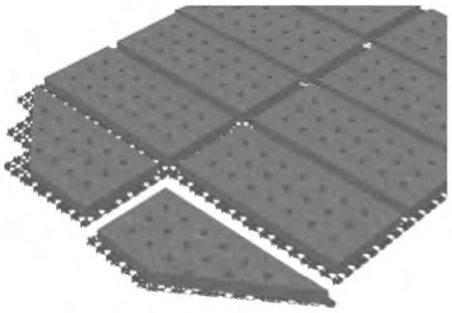
Macrophyte species which were recorded present during a survey conducted in 2019 should be included within the planting mix of the floating islands but other species will also be appropriate if present in Fleet pond. The species include various-leaved water-starwort *Callitriche platycarpa*, common water star-wort *Callitriche helmsii*, smooth stonewort, small pondweed *Potamogeton berchtoldii*, curled pondweed *Potamogeton crispus*, blunt leaved pondweed *Potamogeton obtusifolius*, lesser pondweed *Potamogeton pusillus*, fennel pondweed *Stuckenia pectinate*, and horned pondweed *Zannichellia palustris*. Final species selection and sourcing needs to be agreed with Natural England.

Floating ponds can be sourced from British Flora, Salix and Floating Islands West and many other suppliers.

3.6 ISLAND PERIMETER BIOHAVEN

The floating biohaven type solution can also be secured to and enhance the habitats associated with the mid-water fixed islands, providing significant increased habitat diversity. In addition to the islands, biodegradeable submerged natural fibre habitats can be suspended to maximise refuge opportunities for zooplankton and macroinvertebrates.

The internal length of the four main mid-lake islands will be enhanced in this way with a total length of 180m as shown on the Figure at the end of this document.



BioHaven Standard

A high specification module with integral connection system allowing quick and easy installation

Module size: 2 x 1m²

Connection system: HPDE connection grid system

Installation: designed for self installation (design & build also available)

Applcations: lake, pond and river regeneration projects. Habitat gain and water treatment in urban and rural water bodies

Example of Biohaven Island (courtesy of British Flora)

3.7 REED HABITAT

Following a process of scrub management on the islands it would be beneficial to encourage further reed habitat to establish, which in addition to providing high value habitat will have the added benefit to helping to reduce scrub from re-establishing. There are several different planting methods for reedbeds which are outlined further below:

- Rhizome Reed Plugs: 30 cm_2 of rhizome is dug up later in the year and then spilt into 10 pieces preferably with the roots still attached. The plugs are grown on in root trainers in full sun and with the water level kept topped up. Reed plugs are ready for planting in June when the shoots are 30 – 45 cm tall.
- Seed Reed Plugs: Seeds are collected from mature reeds and hung in a bag (non-plastic) in a greenhouse over the spring. The seedlings are scarified/snipped up with scissors and planted in root trainers following the method above.
- Reed Cages: The most effective method; reed plugs are planted within wire cages which protect the reeds from browsing. The cages are constructed from 2.5 m x 1 m sections and made into a cylinder which is staked around the plugs.
- Reed Cuttings: Stems of existing reed beds are cut down the stem as close to the base as possible. Stems are pushed into the ground to approximately 50 – 60 cm burying several nodes and leaving 10 – 15 cm or 1 – 3 leaves above grounds. Several hundred stems need to be planted per island. The planted area must be protected from geese with brush wood. The cuttings die over approximately 5 weeks and shortly afterwards new shoots grow.

3.8 PROTECTION FROM GRAZING FISH AND BIRDS

Wire mesh has been installed on the existing island edges to protect reed but this is seen as not being very effective against geese/swans. The project steering group has recommended removing this to prevent the potential for injury to smaller birds. The Fleet Pond Society has previously added coarse woody debris onto islands as a way of limiting larger

bird access to establishing reeds. The floating bogbean perimeter has been recognised by the project steering group as a successful way of minimising grazing of plants by birds from the water.

3.9 PROTECTIVE CAGES

A trial to demonstrate the value of fixed and submerged plant nursery enclosure would be carried out. This would support the re-establishment of planted macrophytes, initially commencing with water lilies (see above). This would comprise a rectangular frame (1.5m high, 4m long x 4m wide) fitted to the bed of the lake within the sheltered western area and supporting a 0.5cm mesh screen to prevent birds, fish and crayfish entry. An equivalent lid would be added enabling inspection of the plant growth to be completed.

3.10 WOODY DEBRIS REEF

Bundles of coarse woody debris bundles will be located to form a deadwood reef along the net lines that form the boundary to the sheltered western part of the lake to provide added protection from fish accessing the area. The deadwood has the added benefit of providing habitat shelter to smaller fish, macro-invertebrates, zooplankton and the sheltered area as a whole. The northern most opening to the sheltered area will not have wood deposited in order that access to the area for boats continues to be provided by temporarily dropping the net. This would cover a length of approximately 40m long x 1m wide x 1m high.

3.11 MARGINAL NURSERY

It is possible, to use the shallow existing marginal areas (including new marginal habitat) as a stock/source for macrophytes to plant elsewhere in Fleet Pond.

3.12 FUGELMERE MARSH

New backwaters are proposed to be created in Fugelmere Marsh to rewet habitats and to provide further rich macrophyte beds and potential future plant nursery areas as part of the PA2 project (see Technical Note 4).

4 AQUATIC MACROPHYTE PROPOSALS

Figure 1 illustrates the location, number, type of aquatic plant re-establishment proposals that would be considered as the key components of the part of the PA2 CA funding bid.

Figure 1 Lake Vegetation Proposals

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January 2020

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Appendix F: Water Quality Investigations.

HART DISTRICT COUNCIL

Fleet Pond PA2 Feasibility Study

TN5 Water Quality Monitoring

1 INTRODUCTION

1.1 BACKGROUND

During previous works at Fleet Pond between 2010 and 2017, water quality monitoring was carried out at a number of sample locations across the lake, Gelvert Stream, Brookly Stream, and the Little Pond. A range of parameters were sampled in order to establish a pre-works baseline and in particular to identify any potential adverse impacts arising from the ongoing works and potential inputs of nutrient rish or contaminated water from a number of catchment sources. The majority of the parameters were measured using a Hanna HI9828 Multiparameter Water Quality Meter, in addition to this an Oakton T – 100 Turbidimeter, and a Secchi disk were also used. Laboratory analysis were carried out for nutrients and contaminants. The results and analysis from this sampling, along with the sample locations map can be seen in the Fleet Pond Restoration Project Summary 2010-2017 Johns Associates Report (June, 2017).

1.2 SCOPE OF TECHNICAL NOTE

Johns Associates has been appointed to carry out a feasibility study for the next stage of restoration works at Fleet Pond (referred to as the PA2 Project) that builds of significant work already undertaken between 2010 and 2017. As a part of this an updated water quality survey can help to form a knowledge base, to inform decisions about future works on the site. It can also provide an update to the existing data from previous surveys to provide information about how the condition has progressed since the last round of works finished.

A Hanna HI9829 Multiparameter Water Quality Meter was used to record a number of parameters including: pH, Dissolved Oxygen, Electrical Conductivity, Turbidity, Pressure and Total Dissolved Solids. This was supported by the use of a Secchi disk to assess the clarity of the water. The 2019 autumn/winter survey selected a range of locations covering Fleet Pond, the Gelvert Stream and Brookly Stream and associated ponds and drainage channels, as well as the Little Pond. A separate survey was also carried out at Long Valley – the MoD training estate upstream of the Gelvert. This more extensive coverage will show a broader picture of the quality of the water coming into, and leaving the lake, as well as that that could remain in the lake.

Three surveys were carried out and the locations of the samples taken during those can be seen below in Figures 1, 2 and 3, for Fleet Pond and Long Valley respectively.

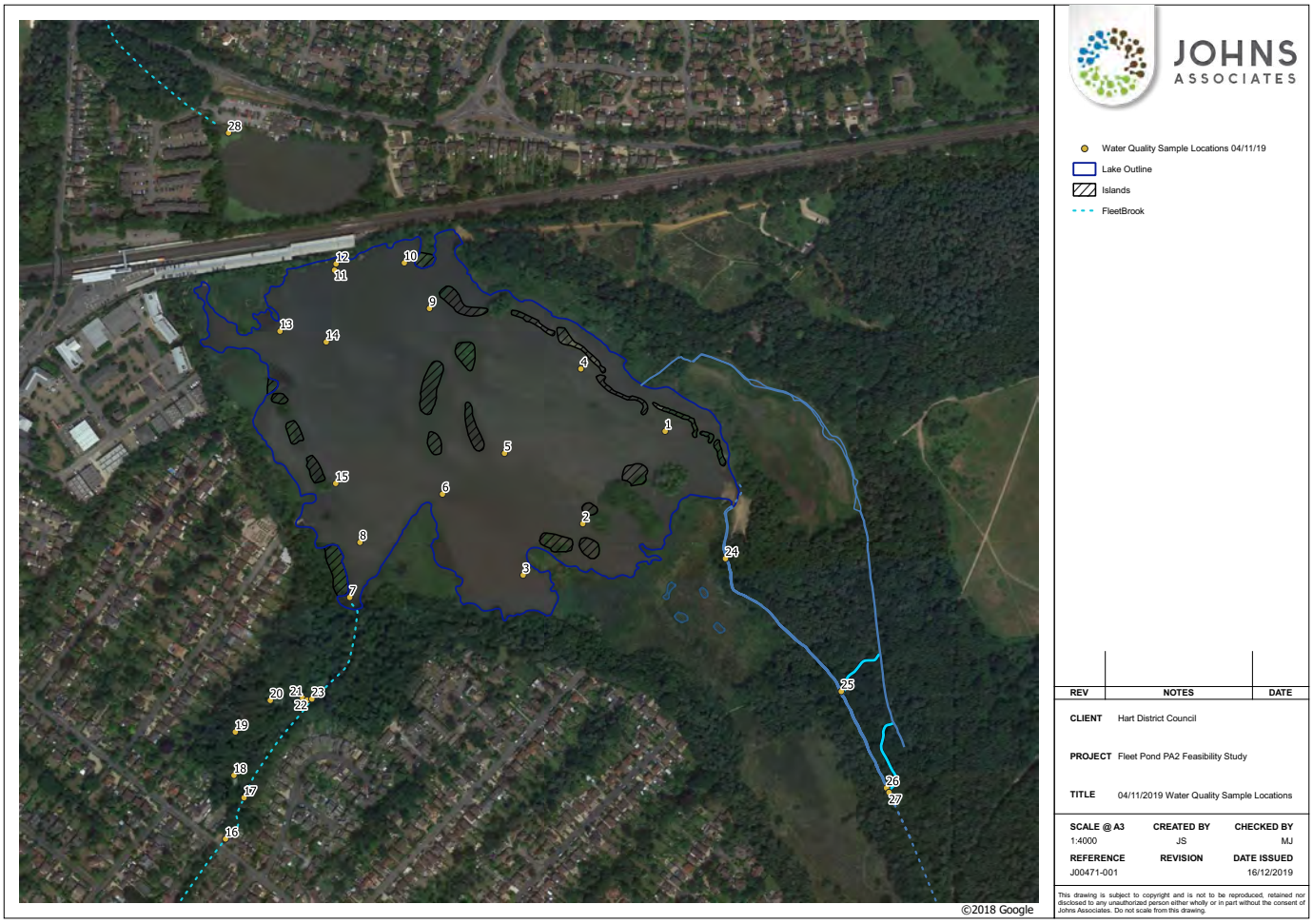


Figure 1 – Water Quality Sample Locations – Fleet Pond Survey 04/11/19

Figure 1 shows the location of the samples that were taken during an extensive survey that covered the lake, the Gelvert Stream, Brookly Stream and the smaller ponds and channels around the Brookly. This survey was carried out via foot, and a boat to collect the data from within the lake. The sample locations were updated from the historic survey locations so that there was a more complete coverage of the lake and its surroundings, with a particular focus on what is coming into the lake via the Gelvert and Brookly streams.

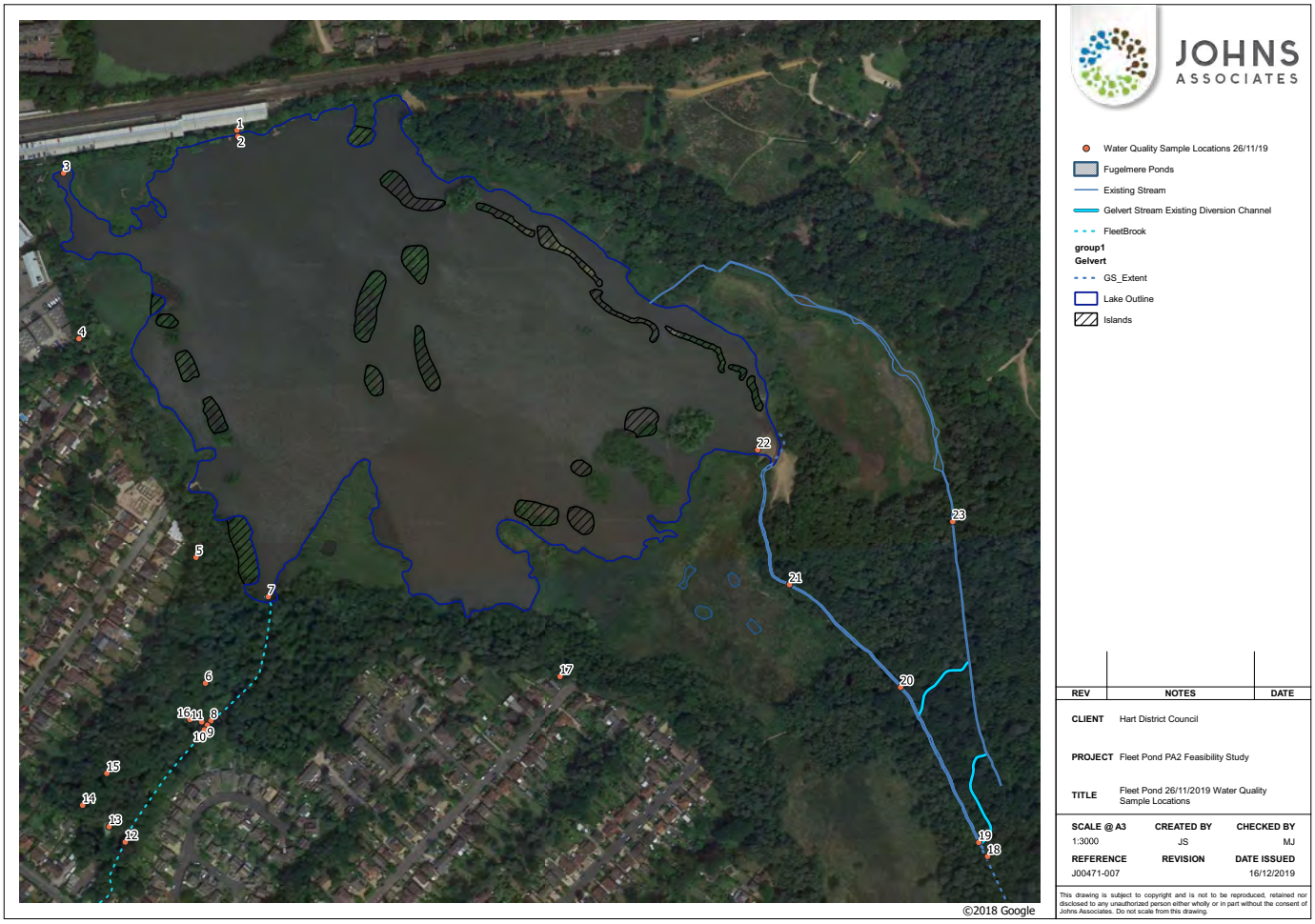


Figure 2 – Water Quality Sample Locations – Fleet Pond Survey 26/11/19

Figure 2 shows water quality sampling locations carried out on foot, and which revisited many of the points outside of the lake that were sampled during the previous survey and well as water inflow and exit from the lake. This repeat survey was influenced by a considerable amount of rainfall between the two surveys, and taking samples from within the stream and diversion channels would help give an idea of what was being washed downstream during rainfall events and if this was having any adverse effects on the water quality.

Figure 3 – Long Valley Water Quality Sample Locations – 11/12/19

Figure 3 shows the location of water sampling locations carried out across the Long Valley MOD Training Area upstream of the Gelvert. Long Valley drains to the Gelvert Stream so this survey was designed to show the condition of the water that could enter the Gelvert and potentially cause problems with elevated levels of sand and colloidal loading. The survey also gave the opportunity to inspect the majority of the sediment and flow control features that were previously installed in Long Valley in the past – using turbidity as an indicator of the current level of effectiveness and status of the water flowing towards and entering the Gelvert Stream.

1.3 PARAMETERS SAMPLES

1.3.1 Dissolved Oxygen

Understanding the levels of dissolved oxygen in a standing water body is essential and fish and other aquatic organisms require oxygen to survive. The levels of dissolved oxygen must be in high enough concentrations to sustain aquatic life, particularly of less-tolerant species. Oxygen is also required for respiration by most algal species and by aquatic and semi-aquatic macrophytes. There are several reasons why there might be a natural variation in DO levels within the water column, for example – oxygen is produced during photosynthesis and consumed during respiration and decomposition, as photosynthesis requires light it can

only occur during the day, whereas respiration and decomposition can occur through a 24-hour period. The can lead to reduced DO levels during the night when photosynthesis cannot counter-balance the loss of oxygen. This often results in DO levels being at their lowest just before dawn, when photosynthesis is able to resume. Oxygen can be added to the water via other means such as air, inflowing streams and artificial oxygenators.

1.3.2 pH

The pH scale ranges from 0 to 14, a measurement of 7 is considered to be neutral, with substances up to 7 acidic, and over 7 to be alkaline. Typical lake water ranges between pH 6.5 and pH 8.5, lower values can occur in dilute waters high in organic content, and higher values in eutrophic water, groundwater brines and salt lakes. The pH sample is a measure of the concentration of hydrogen ions.

1.3.3 Turbidity

Turbidity is an indication of how clear the water is – the greater the amount of total suspended solids (or sediments) in the water, the cloudier it appears and the higher the measured turbidity. Common suspended solids in lakes and other standing waterbodies include clay, silt, and sand from soils, phytoplankton, particles of decaying vegetation, industrial waste and sewage. Usually turbidity is measured with a Turbidimeter, however for this survey the multiparameter probe that was used is able to measure turbidity. High turbidity and suspended solids in streams and lakes may be caused by a number of factors, such as:

- Soil erosion
- Domestic and industrial wastewater discharge
- Urban run-off from roads, car parks and other impermeable surfaces
- Flooding and increased flow rates
- Algal growth arising from nutrient enrichment
- Dredging or de-silting operations
- Removal of riparian vegetation and other bank disturbances
- An excess of bottom-feeding fish (such as carp) that stir up sediment

NTU stands for Nephelometric Turbidity Unit and signifies that the instrument is measuring scattered light from the sample at a 90-degree angle from the incident light. NTU is most often used when referencing the USEPA Method 180.1 or Standard Methods For the Examination of Water and Wastewater.

FNU stands for Formazin Nephelometric Units and also signifies that the instrument is measuring scattered light from the sample at a 90-degree angle from the incident light. FNU is most often used when referencing the ISO 7027 (European) turbidity method.

1.3.4 Electrical Conductivity

Conductivity is a measure of the ability of water to conduct an electric current. It is sensitive to variations in dissolved solids – the degree to which these dissociate into ions, the amount of electrical charge on each ion, ion mobility and the temperature all have an influence on conductivity. Conductivity of freshwaters can range from 10 to 1000 µS cm^{-1}, however in polluted water or those that receive large amounts of land run-off the measurement may exceed 1000 µS cm^{-1}. As water moves through a catchment it picks up a variety of dissolved and particulate materials from the substrate, rocks and soils. The dissolved, or soluble fraction of the waters total solid load is referred to as total dissolved solids (TDS). The electrical conductivity provides a simple measure of TDS. Conductivity is a measure of the waters ability to conduct and is directly related to the total dissolved salt content of the water. It is temperature sensitive and increases with temperature. Variations in conductivity may indicate sources of pollution such as: wastewater from sewage works, industrial discharges, urban runoff from roads, and agricultural runoff.

2 SAMPLING RESULTS

2.1 HOW TO INTERPRET THE DATA

All the data collected are point samples only, therefore they do not give an accurate representation of water quality within Fleet Pond and its surroundings over time. The values shown on the following graphs may have been influenced by specific short-term factors (e.g. heavy rainfall bringing increased water into the lake from the catchment), or may be part of a longer-term trend, or a combination of the two.

2.2 DISSOLVED OXYGEN

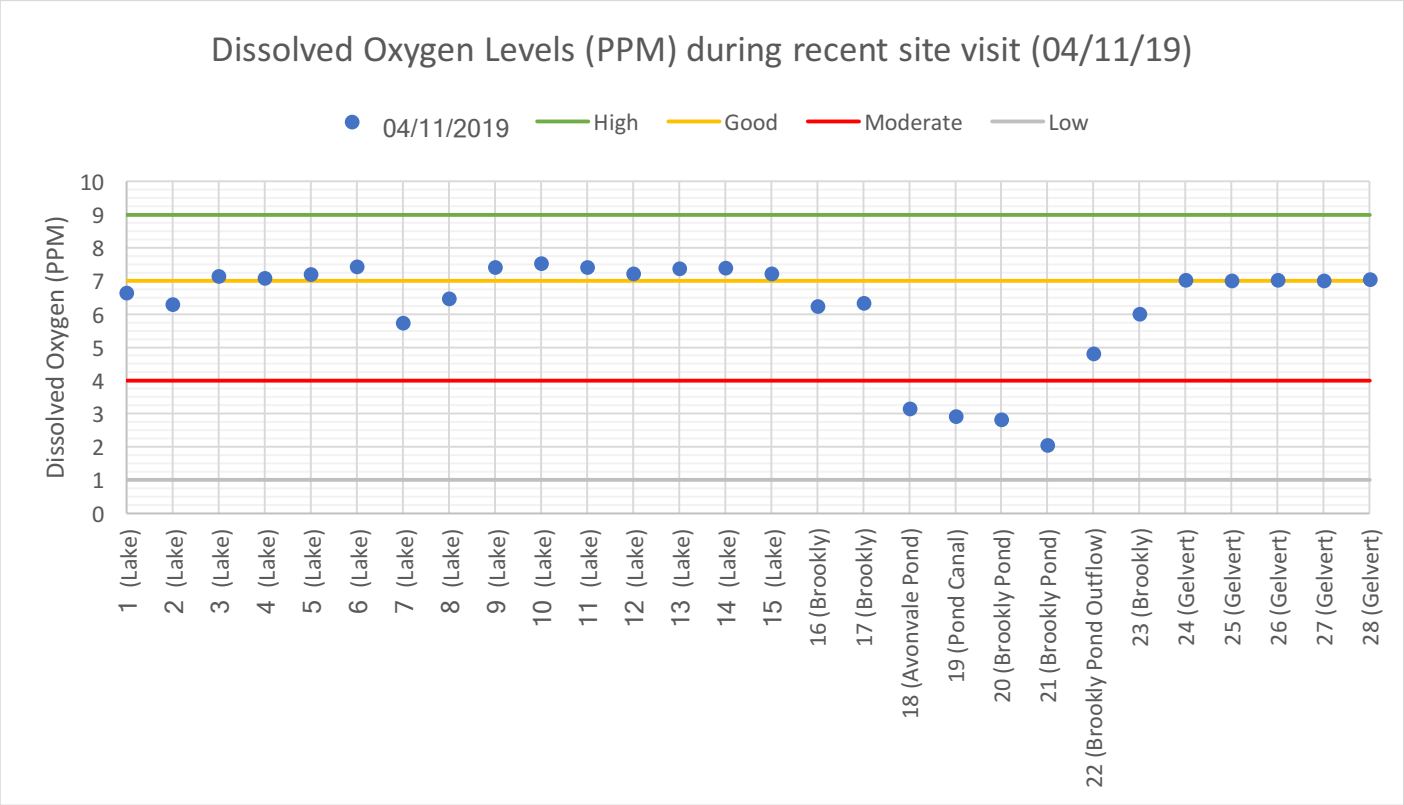


Figure 4 – Recorded Dissolved Oxygen Levels (ppm) 04/11/19

Figure 4 shows the DO levels recorded across 28 sample locations during the survey on the 4th November 2019. The graph shows that the majority are around the Water Framework Directive 'Good' level. The areas that show a significant change in DO levels are mainly limited to the Brookly Stream and its associated smaller ponds. The lower readings for the ponds were expected given that there is very little flow through the water to help maintain oxygen levels and avoid anoxic conditions, and that considerable leafy and other organic matter was observed, together with the odour of hydrogen sulphide – an indicator of anoxic conditions.

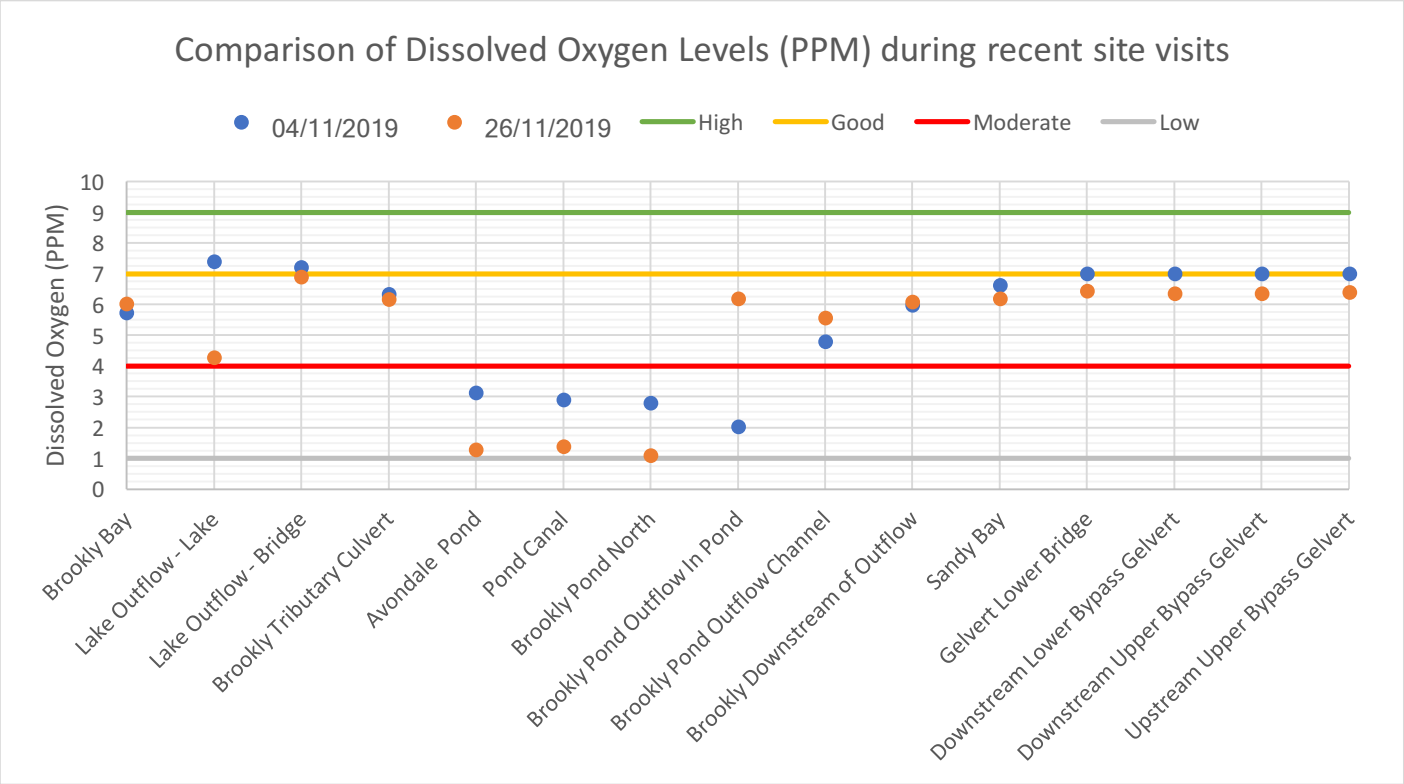


Figure 5 – Comparison of DO levels at specific sample points on the 4th and 26th of November 2019

Figure 5 is a comparison of DO levels at several locations across the lake and Gelvert/Brookly Streams. This shows that the results are similar across both surveys with the majority of readings being between Moderate and Good. The lowest readings for both surveys were around the Brookly and its associated ponds. This highlights that a solution needs to be agreed for the Brookly Ponds.

2.3 PH LEVELS

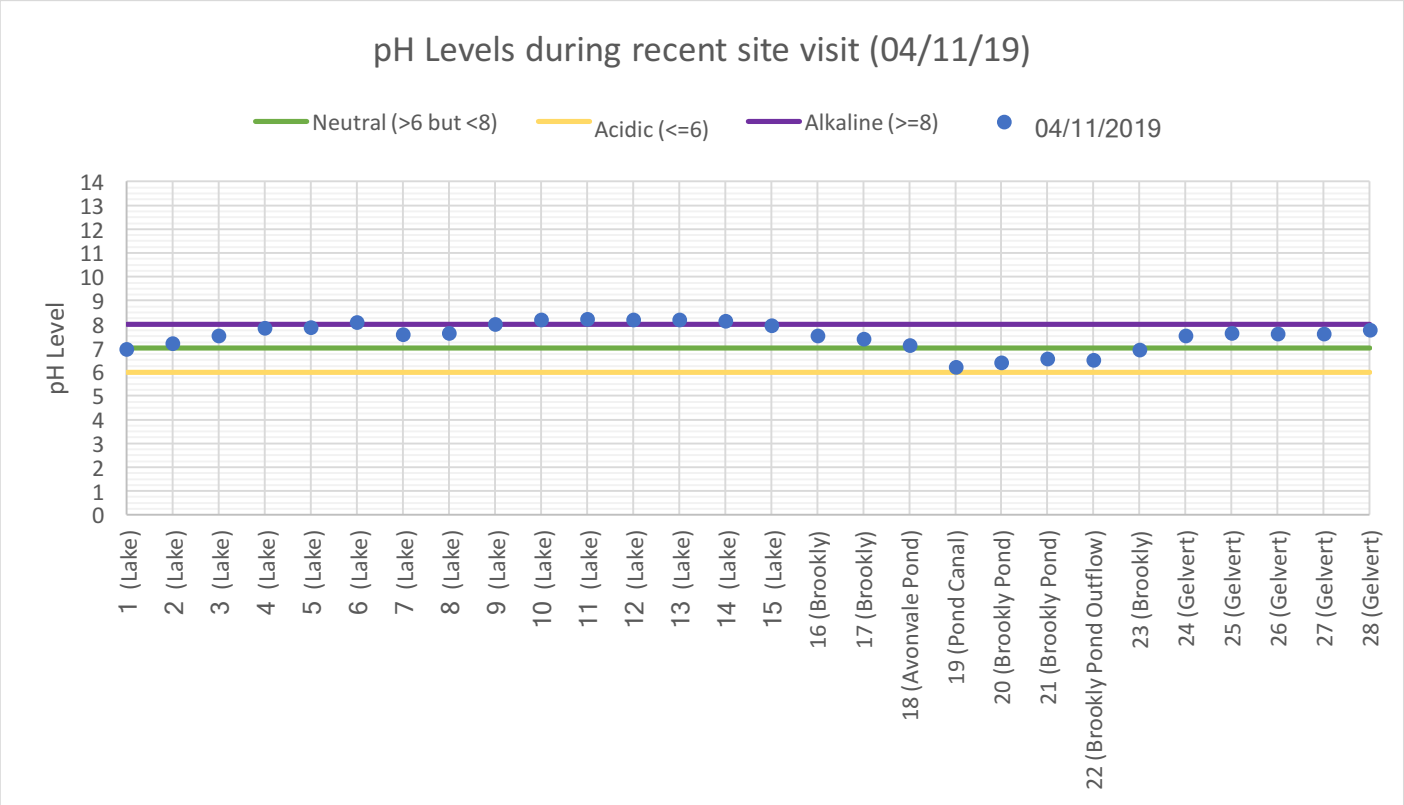


Figure 6 – pH Levels measured during survey on the 04/11/19

Figure 6 above shows the pH Levels across the lake and Brookly and Gelvert Streams. This shows that the pH for the lake is relatively consistent – ranging between pH 6.93 and pH 8.21. This is within the range considered to be normal for a freshwater body. The Gelvert and main channel of the Brookly have similar pH readings to the lake, however the ponds around the Brookly have the readings that differ the most from the rest. For these points the readings are below pH 6.5 which is moderately more acidic than the rest of the samples, most likely as a result of the influence of baseflow from the local soil/groundwater that is dominating the water composition and little opportunity for dilution and dispersion of the pond water.

Figure 7 below shows a comparison at several points across two survey dates, illustrating very little variation in pH levels over time. The only locations seeing obvious changes in pH were: Brookly Bay, the lake outflows, the outflow of Brookly Pond, and Sandy Bay. Variation could be expected in these locations as they are focal points for water flowing into the lake.

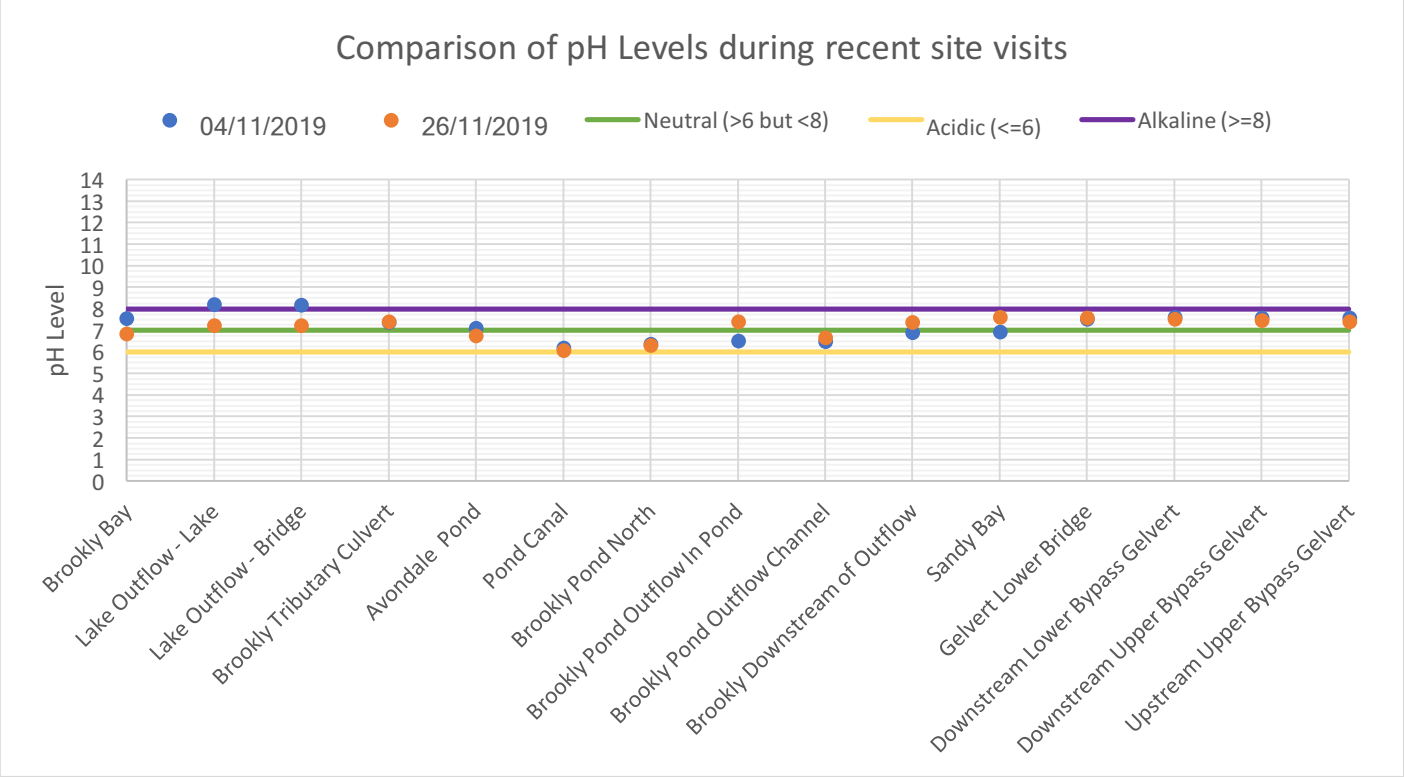


Figure 7 – Comparison of pH Levels at specific sample points on the 4th and 26th November 2019

2.4 TURBIDITY

Figure 8 below shows the recorded turbidity levels across the lake and Gelvert/Brookly Streams during a survey on the 4th November 2019. The levels recorded across the lake are all below 20 FNU which matches with visual observations of being able to see the lake bed across the lake. The highest results were in Brookly Pond and Avondale Pond and the associated outflows and canals. The ponds themselves had a significant coverage of pond weed which would have an effect of the amount of available light, however the water itself was very dark in colour due to the amount of suspended sediment and decaying organic material.

Figure 9 below shows a comparison between the 4th and 26th November 2019. Most of the turbidity measurements are relatively similar, however there are a few noticeable differences – Avondale Pond and the outflow from Brookly Pond have much lower readings on the 26th than the 4th.

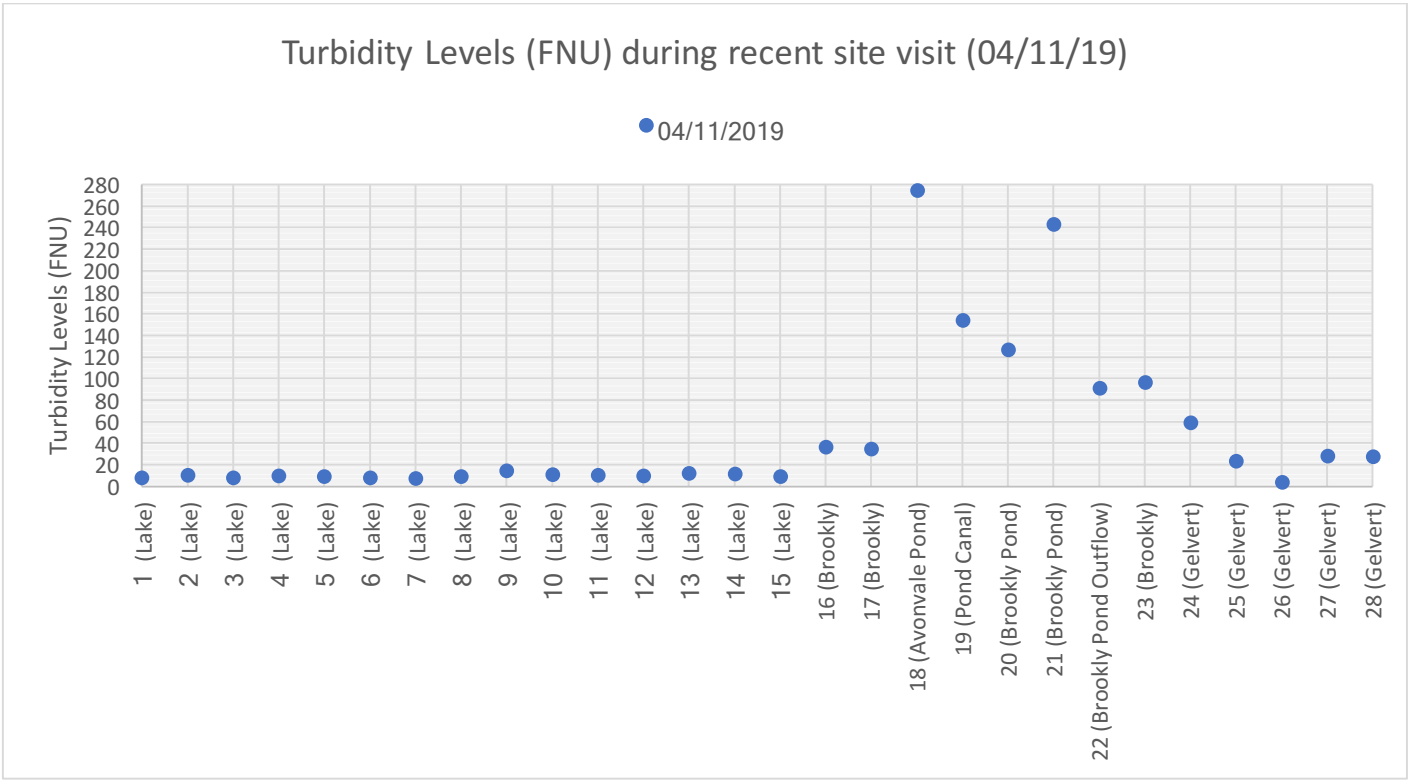


Figure 8 – Turbidity levels recorded during survey on 04/11/19

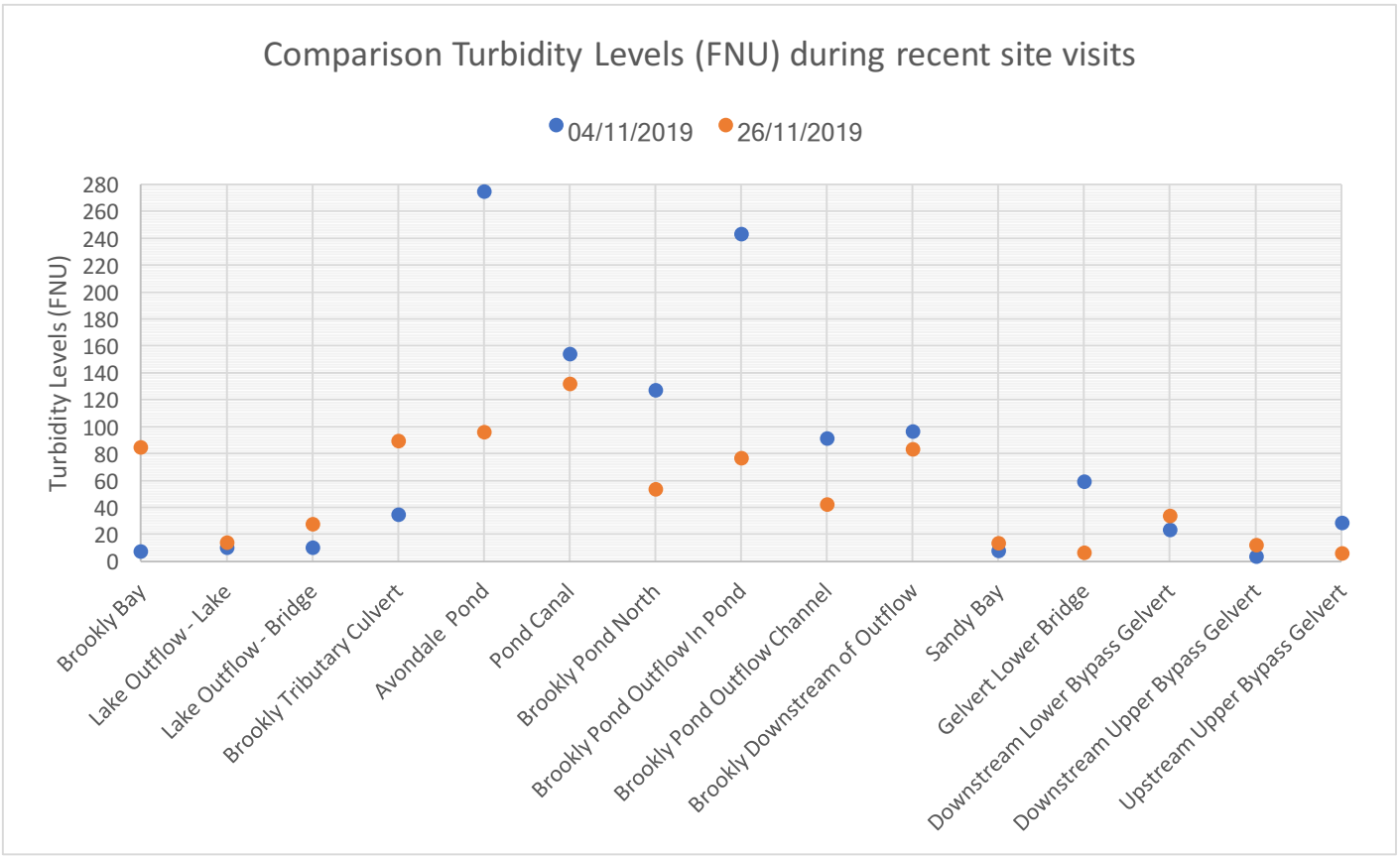


Figure 9 – Comparison of Turbidity levels at specific points on 4th and 26th November 2019

2.5 ELECTRICAL CONDUCTIVITY

Figure 10 shows the Conductivity levels recorded during the 4th November survey, all of the readings are within the expected range of freshwater bodies. However, there are some noticeably higher measurements – in particular the Brookly Pond and its associated canal and outflow. This increased level of conductivity could result from inflow of urban runoff due to the rainfall that occurred during November, it could also highlight the presence of other pollutants and concentration of organic matter in these locations – further analysis would be required to determine the specifics of any pollutants.

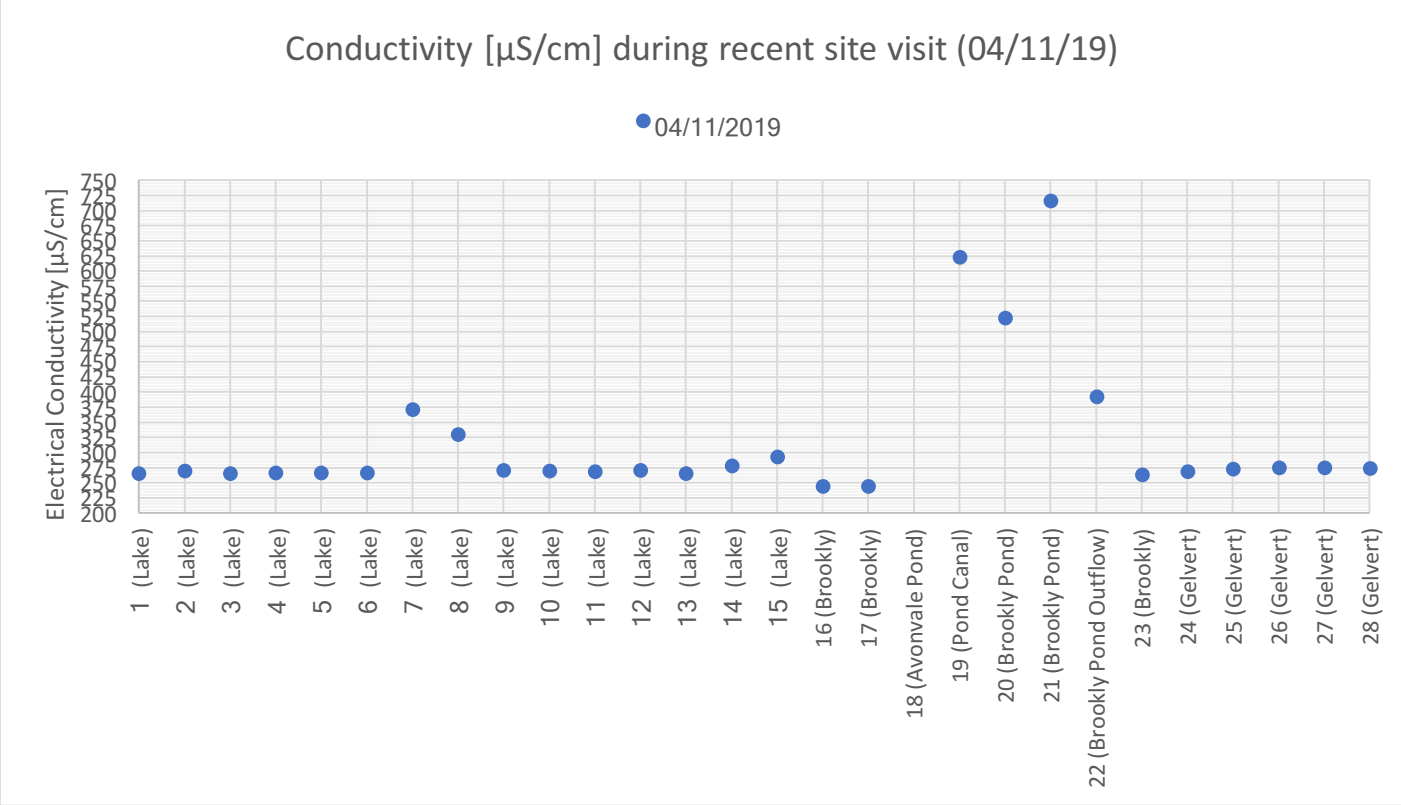


Figure 10 – Conductivity recorded during survey on 04/11/19

Figure 11 below shows a comparison of conductivity between the 4th and 26th of November. Many of the levels are similar across the two dates, however there are significant differences between the dates at several locations includings – Brookly Bay, Fleet Pond outflow, and the outflow from Brookly Pond. The outflow of Brookly Pond had much higher readings on the 4th than the 26th.

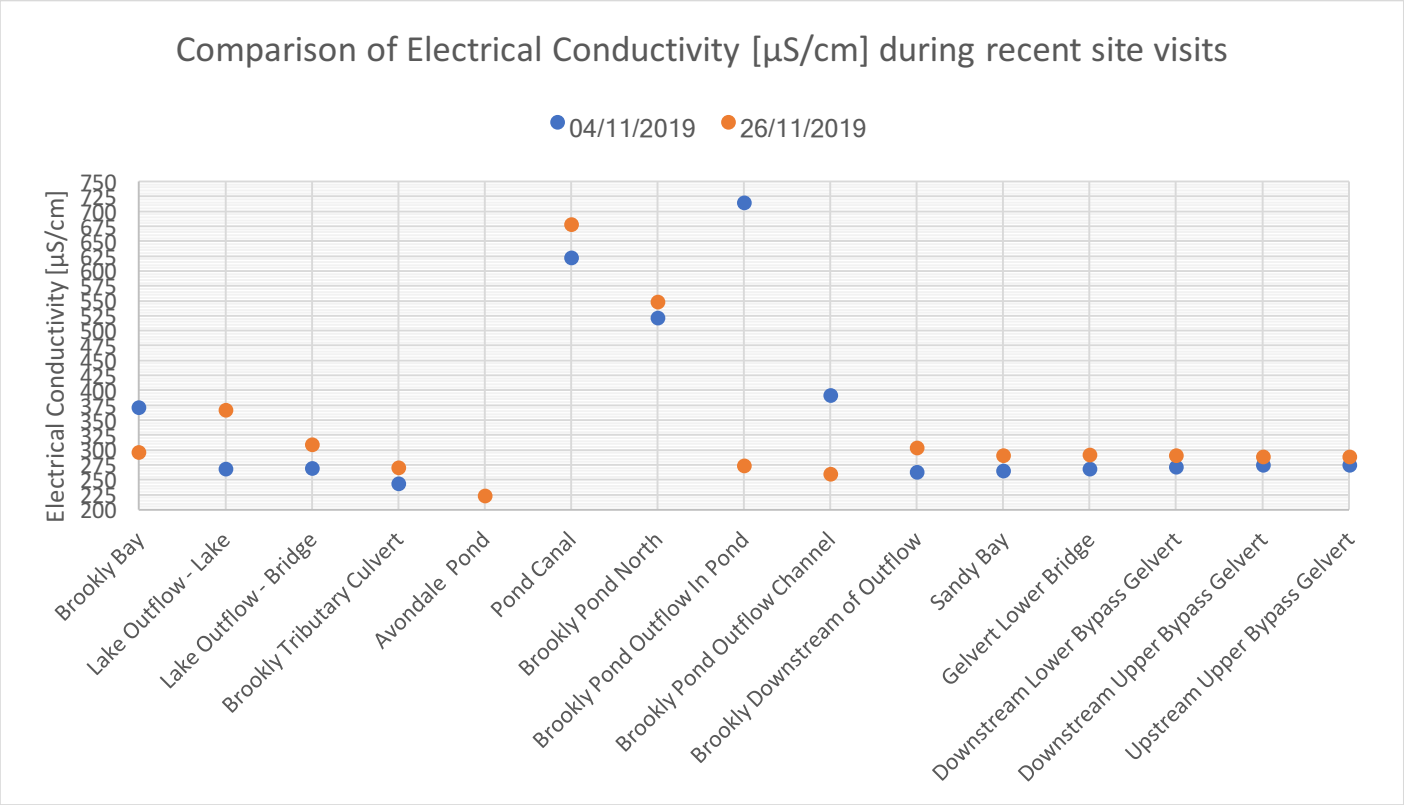


Figure 11 – Comparison of conductivity at specific points for the 4th and 26th November 2019

2.6 SECCHI DISK COMPARISON

During the site survey on the 04/11/19 a Secchi Disk was used to assess the visual clarity of the lake. In all but 2 locations across the survey points on the lake the Secchi disk remained visible down to the bed of the lake. The average Secchi disk depth recorded across the lake during this survey was 64.7cm, with an average lake depth at the sampling locations of 67.4cm. Previous surveys carried out in February 2015, September 2014 and February 2011 also used a Secchi disk – the averages of these are shown below in Table 1, along with the 2019 results.

November 2011 Average Water Depth (cm)	November 2011 Average Secchi Depth (cm)	September 2014 Average Water Depth (cm)	September 2014 Average Secchi Depth (cm)	February 2015 Average Water Depth (cm)	February 2015 Average Secchi Depth (cm)	November 2019 Average Water Depth (cm)	November 2019 Average Secchi Depth (cm)
52.6	40.9	78.3	38.8	85.4	32.8	67.4	64.7

Table 1 – Average water and secchi depth across 4 different survey dates

From Table 1 it can be seen that the actual maximum depth that the Secchi disk was visible to, is at its highest level during the 2019 in comparison to earlier surveys. A significant improvement over the 2015 average Secchi

depth of 32.8cm, the most recent survey gave an average depth of 64.7cm. This suggests that the clarity of water has greatly improved since 2015.

3 LONG VALLEY RESULTS

3.1 OBSERVATIONS

The upper parts of Long Valley dominated by stable heath and woodland habitats showed little signs of erosion or sediment transport.

The outer tracks show evidence of surface e water flow and sediment transport although this continues to be diverted across the track into an adjacent setline/management pond.

This management pond continues to function with a decrease in turbidity downstream of the impoundment.

This part of the sandy tracks demonstrate rutting from heavy vehicle movement through wet/fluidised sand and the ongoing presence of large standing water bodies with the potential to erode/transport sediment downslope.

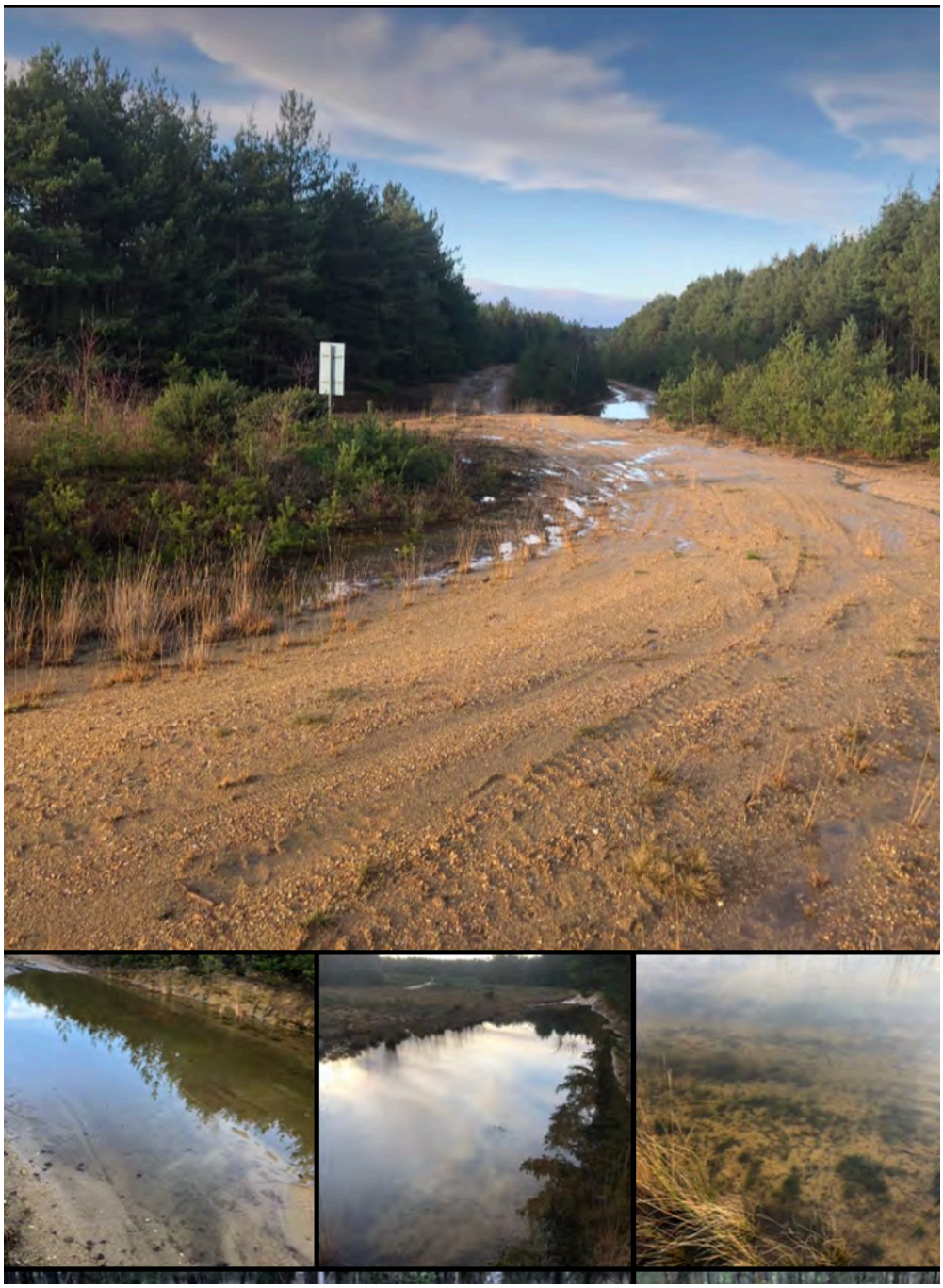
Significant ruts across sandy tracks showing turbid water displaced into adjacent areas.

Significant turbid water associated with deeper areas of standing water and vehicle/pedestrian passage

Significant turbid water associated with deeper areas of standing water with clay exposures and vehicle/pedestrian passage. Transparent water located adjacent to but off-track.

Functioning sediment and runoff management areas off-track with established vegetation showing a marked decrease in turbdity

Relatively stable track surfaces and transparent water from limited useage.



Relatively stable track surfaces and transparent water from limited useage.

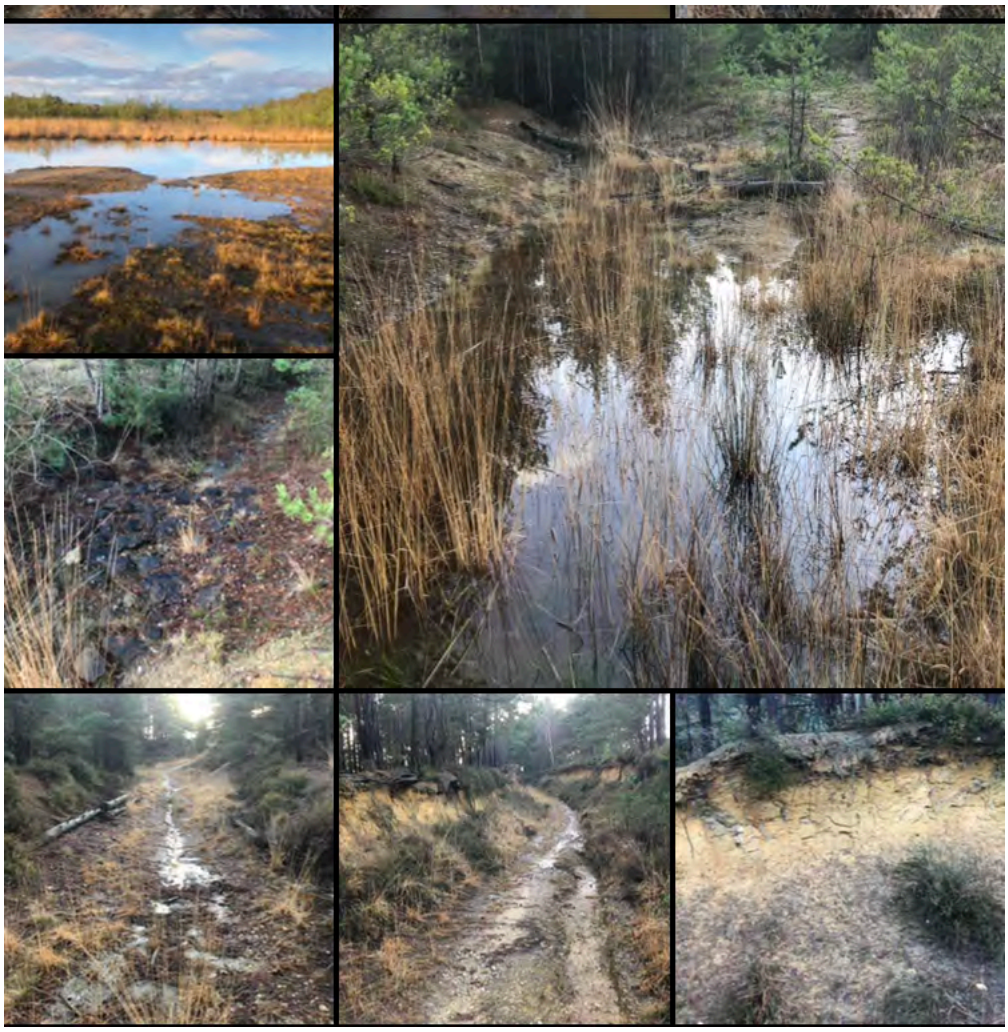
Vegetated pathways through woodland adjacent to tracks.

Surface water flows down the main central track showing varied pathways and marginal stable vegetated areas.

Functioning sediment traps with vegetation showing flow of turbid water downslope

Stable gully tracks with new runoff channel and some sandy erosion

Continued functioning of diversion feature pushing turbid and sandy flow into marginal habitats and channel



Relatively stable gully and vegetated features.

Relatively stable tracks and vegetated features.

Continued functioning features by upper balancing / holding lagoon with low turbidity

Stable and vegetated features by upper holding lagoon, also some eroding tracks in the vicinity

Evidence of turbid/sandy runoff from track but good functioning of check dam with lower turbidity downstream

Eroding tracks and channels close to the lower balancing/holding lagoon and adjacent heath management works. Improved turbdity below lagoon.

Well vegetated area south of the lower balancing lagoon with diffuse flow paths

Final stages of the Long Valley flow path leading to the confluence with the Gelvert Stream, showing improved / good turbidity levels.

3.2 TURBIDITY

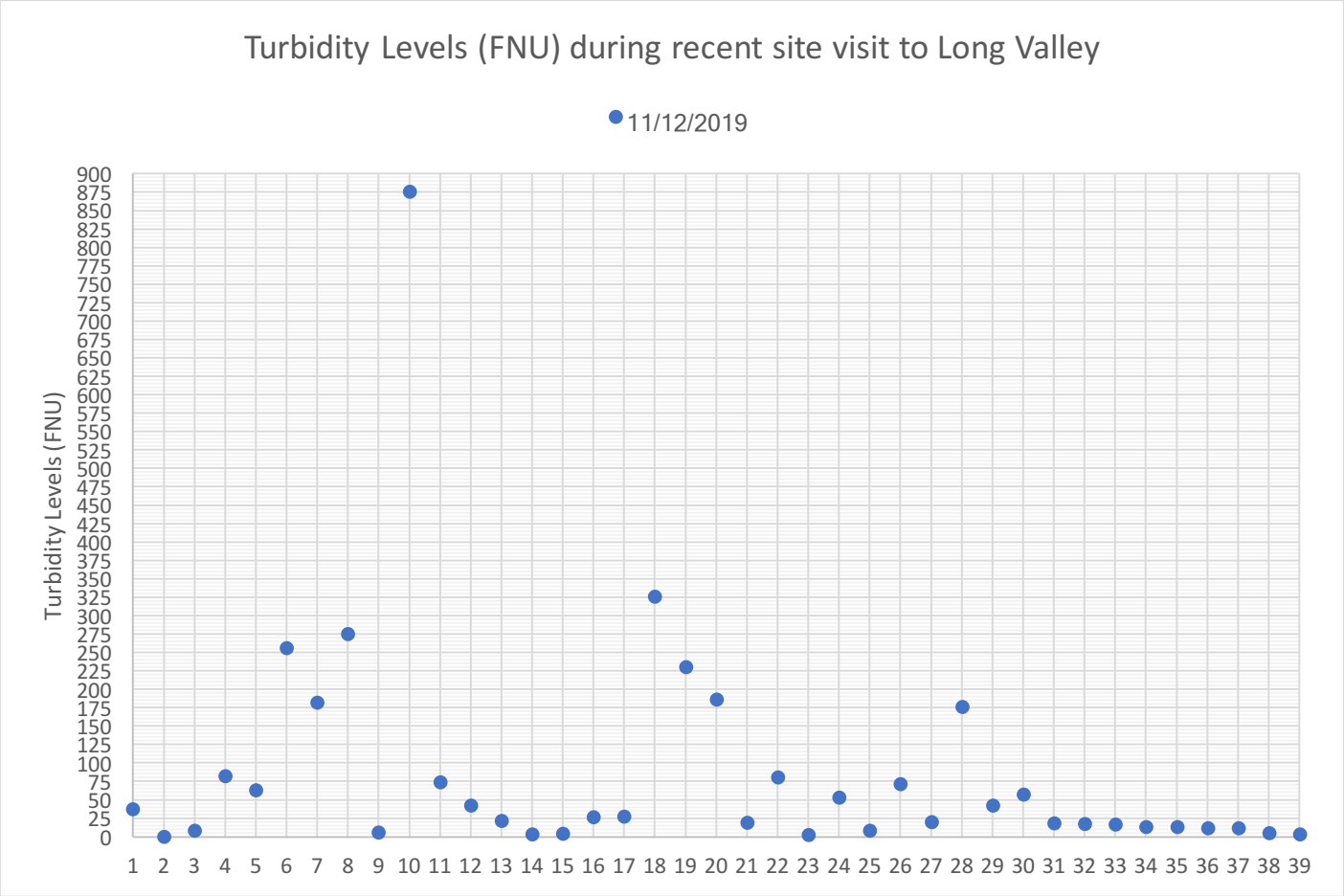


Figure 12 – Turbidity levels recorded across Long Valley on 12/12/19

Figure 12 shows that although there is some variation between higher/lower levels of turbidity (reflecting more active/less active locations), the key trend of interest is the overall reducing/lower levels of turbidity from left to right, representative of top to bottom of Long Valley.

3.3 CONDUCTIVITY

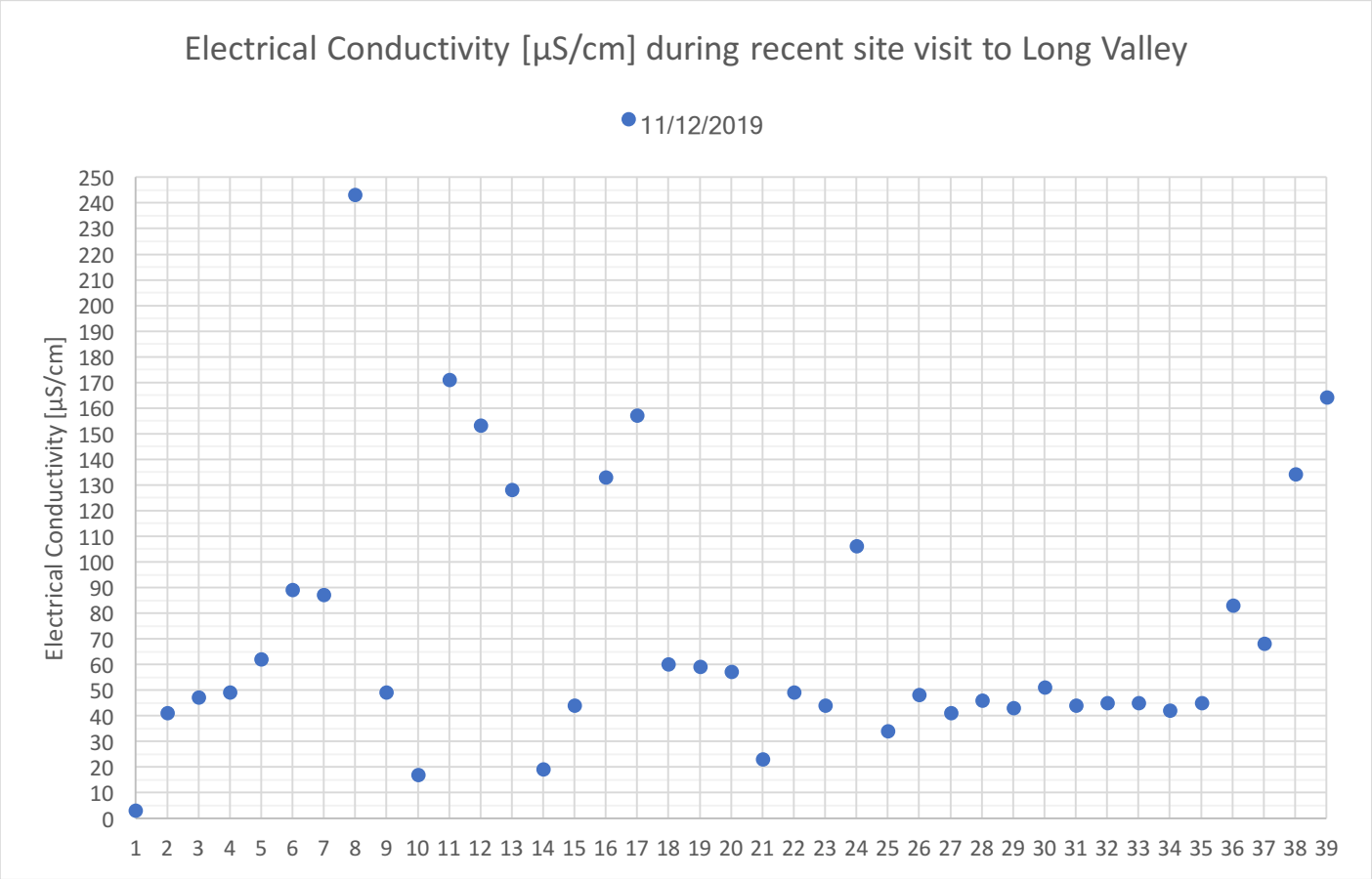


Figure 13 – Conductivity levels recorded across Long Valley on 11/12/19

Figure 13 shows that the majority of the sample locations had a conductivity of less than 100 µS/cm, with the minority of points being above this. This demonstrates a general low solute load in the sources of runoff feeding into the Gelvert Stream. In some cases, the spikes in conductivity coincide with more turbid/active locations. The downslope spikes may represent an influx of more organic rich water from woodland that dominates the location close to the confluence with the Gelvert Stream.

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