Maidstone Borough Council

Mote Park Lake Reservoir Engineering Services

Options Appraisal Report

April 2018

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Mote Park Lake Reservoir Engineering Services

Options Appraisal Report

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OPTIONS APPRAISAL REPORT

1. EXECUTIVE SUMMARY

1.1 ALARP Feasibility Report

In 2014 an inspection of Mote Park Lake Reservoir was carried out under the Reservoirs Act 1975. The resulting Section 10 report concluded that the reservoir does not meet the standards for safety identified in Floods and Reservoir Safety 4th Edition (ICE, 2015). The report included a mandatory recommendation in the interests of safety that the capacity of the spillway is increased to reduce the risk of failure due to overtopping "As low as reasonably practicable" (ALARP).

The 2017 ALARP feasibility report outlined a range of options and their costs to assess which option best reduces risk against an ALARP and whether the cost of works would be proportionate to the corresponding reduction in risk. It concluded that to satisfy the Reservoirs Act 1975 "matters in the interests of safety" to reduce the risk of failure due to overtopping, one of these options (table 1-1) should be selected and implemented.

Table 1-1: Long list of options for increasing the capacity of the spillway identified in ALARP report

Option	Work Involved
A1-40	40m wide auxiliary spillway, on embankment with 1.2m freeboard – formed with grass covered articulated concrete blocks (ArmorFlex or similar)
A2-40	40m wide auxiliary spillway, on embankment with 1.7m freeboard – formed with reinforced concrete
B	Strengthening of embankment crest to inhibit breach
C1-50	50m wide auxiliary spillway, on abutment with 1.2m freeboard – formed with grass covered articulated concrete blocks (ArmorFlex or similar)
C2-50	50m wide auxiliary spillway, on abutment with 1.7m freeboard – formed with reinforced concrete
A2-40 + C2-50	Both concrete options

The ALARP report noted that overall the spillway should be updated to meet current engineering standards (1 in 10,000 design standard, PMF for safety check flood), unless there are compelling reasons why this is not reasonably practicable.

"Other considerations" in the 2017 report notes that:

> "It is recognised that land issues mean that Option A is unlikely to be acceptable to the owner of the downstream face of the dam, and that only Options B or C are likely to be acceptable to him.
>
> "Option B is not recommended unless there are compelling reason why option C cannot be adopted.
>
> This leaves Option C which will include the following impacts
>
> a) Loss of paths along west side of West Drive (and bridge over stream)
> b) Reprofile/lower land east of West Drive to remove obstruction to flow in extreme floods
> c) Creation of sections of wall as part of forming non-overflow crest
> d) Loss of trees

> "None of these is considered disproportionate in the context of reducing the risk to life from dam failure, such that Option C is considered proportionate with the only choice being between a concrete chute or grasscrete, the choice affecting both appearance and the height of the non-overflow embankment remote from the auxiliary spillway".

The timescale to complete the physical works is by 6 June 2020.

The ALARP budget project cost for the Option C scheme varied between £1.4M and £1.9m.

1.2 Development of Preferred Options

In November 2017 Maidstone Borough Council (MBC), the owner of the Mote Park Lake Reservoir commissioned Black & Veatch (BVL) to develop a preferred option with the council.

As part of this development, BVL reviewed the long list of options (Table 1-1) for increasing the capacity of the spillway to develop a short list of options. The options BVL identified were generally based on the options outlined in the long list of options identified in the ALARP report. The BVL-selected options with budget cost estimates for the selected options which are considered viable are listed in Table 1-2.

Table 1-2: Summary Costed Options

Option		Description	Total (£m)
1	**C1 (50m)**	50m wide auxiliary spillway, on abutment formed with grass covered articulated concrete blocks (ArmorFlex or similar)	1.58
1A	**C1 (65m)**	65m m wide auxiliary spillway, on abutment formed with grass covered articulated concrete blocks (ArmorFlex or similar)	1.75
2	**C2 (50m)**	50m wide auxiliary spillway formed with reinforced in-situ concrete	2.59
2A	**C2 (65m)**	65m wide auxiliary spillway formed with reinforced in-situ concrete	3.03
3	**A2 (40m) + C2 (50m)**	40m wide auxiliary spillway, and 50m wide auxiliary spillway, on abutment – both formed with reinforced in-situ concrete	4.19

Note: A circa 58m wide auxiliary spillway (Option 1/1A) is considered practical with a budget cost estimate of £1.66m.

All options were considered viable and meet the standards approach.

Option 1/1A - 50m-65m auxiliary spillway formed with grass covered articulated concrete blocks (ArmorFlex or similar) is the preferred options due to.

- Lowest capital cost
- Lowest visual impact as spillway grassed

Option 2/2A - 50m-65m auxiliary spillway formed with reinforced in-situ concrete is not preferred giving consideration to:

- Scour protection will be required at the downstream end of the spillway where the spillway is constructed with reinforced concrete

- Higher capital cost than Option 1/1A
- Higher visual impact of concrete spillway compared to grassed spillway

Option 3 - 40m wide auxiliary spillway, and 50m wide auxiliary spillway on abutment (both formed with reinforced in-situ concrete) is not preferred giving consideration to:

- Highest capital cost
- Extensive vegetation clearance (loss of visual backdrop and continuity of woodland habitat)
- Ownership of the downstream face of the dam. MBC does not own the downstream face of the dam and the landowner is likely to be resistant to options which would remove the existing tree backdrop to Turkey Mill Pond, used as a wedding venue by the downstream landowner.
- Temporary haul road through Turkey Mill to facilitate construction of spillway A2. All access to Turkey Mill will be from Mote Park.
- Scour protection will be required at the downstream end of the spillway where the spillway is constructed with reinforced concrete
- The water level in Turkey Mill would have to be lowered during the works
- Visual impact of concrete spillways and in particular spillway A2
- Potential effects on badgers

1.3 Recommendation

It is recommended that an auxiliary spillway circa 58m wide on the abutment, formed with grass-covered articulated concrete blocks, is selected and progressed to outline design at an estimated construction cost of £1.66m.

Scope of works includes:

- Auxiliary spillway 58m wide;
- Area of ground lowered;
- Wavewall / raised embankment to retain flood level and wave run-up;
- HV cables diverted;
- Modifications to bridge parapet;
- Specimen trees retained where possible; and
- Environmental mitigation.

2. INTRODUCTION

2.1 Overview

In 2014 an inspection of Mote Park Lake Reservoir was carried out under the Reservoirs Act 1975. The resulting Section 10 report concluded that the reservoir does not meet the standards for safety identified in Floods and Reservoir Safety 4th Edition (ICE, 2015). The report included a mandatory recommendation in the 'interests of safety' that the capacity of the spillway is increased to reduce the risk of failure due to overtopping "As low as reasonably practicable" (ALARP). This should be carried out as a study to identify options and to define and agree what works would be proportionate in cost to the reduction in risk achieved, followed by the works.

The 2017 ALARP feasibility report outlined a range of options and their costs to assess which option best reduces risk against an ALARP and whether the cost of works would be proportionate to the corresponding reduction in risk. It concluded that to satisfy the Reservoirs Act 1975 "matters in the interests of safety" to reduce the risk of failure due to overtopping, one of these options (table 2-1) should be selected and implemented.

Table 2-1: Long list of options for increasing the capacity of the spillway identified in ALARP report

Option	Work Involved
A1-40	40m wide auxiliary spillway, on embankment with 1.2m freeboard – formed with grass covered articulated concrete blocks (ArmorFlex or similar)
A2-40	40m wide auxiliary spillway, on embankment with 1.7m freeboard – formed with reinforced concrete
B	Strengthening of embankment crest to inhibit breach
C1-50	50m wide auxiliary spillway, on abutment with 1.2m freeboard – formed with grass covered articulated concrete blocks (ArmorFlex or similar)
C2-50	50m wide auxiliary spillway, on abutment with 1.7m freeboard – formed with reinforced concrete
A2-40 + C2-50	Both concrete options

The ALARP report notes that overall the spillway should be updated to meet current engineering standards (1 in 10,000 design standard, PMF for safety check flood), unless there are compelling reasons why this is not reasonably practicable.

"Other considerations" in the 2017 report notes that:

> "It is recognised that land issues mean that Option A is unlikely to be acceptable to the owner of the downstream face of the dam, and that only Options B or C are likely to be acceptable to him.
>
> "Option B is not recommended unless there are compelling reason why option C cannot be adopted.
>
> This leaves Option C which will include the following impacts
>
> e) Loss of paths along west side of West Drive (and bridge over stream)
> f) Reprofile/lower land east of West Drive to remove obstruction to flow in extreme floods
> g) Creation of sections of wall as part of forming non-overflow crest

h) Loss of trees

"None of these is considered disproportionate in the context of reducing the risk to life from dam failure, such that Option C is considered proportionate with the only choice being between a concrete chute or grasscrete, the choice affecting both appearance and the height of the non-overflow embankment remote from the auxiliary spillway".

The timescale to complete the physical works is by 6 June 2020.

2.2 Scope

Maidstone Borough Council (MBC), the owner of the lake, has commissioned Black & Veatch (BVL) to develop a preferred option with the council and proceed to further develop that option up to and including the submission and grant of planning permission.

The scope of this report is to provide sufficiently outline designs and costings for proposals that meet the ALARP criteria to enable recommendation of a preferred option taking account of design aesthetics, cost, risk, practicality, disruption to users and ongoing maintenance costs.

A staged approach is being undertaken to develop a suitable proposal for the works. The stages will be completed as follows:

(i) Appraisal of options for works; and
(ii) Develop preferred option for works and submit a planning application.

This report covers stage (i) the options appraisal for works at Mote Park.

2.3 Confirmation of Scope of Work

In line with BVLs "proposed methodology" in "Mote Park Lake Reservoir Engineering Services Proposal", a start-up meeting was held with MBC on 14-Nov 2017 to:

a) Obtain data, surveys, study reports etc. and confirm scope of work".
b) Review the available data and reports to confirm issues for each of the revised short listed options (B, C1-50 and C2-50).

BV considers that option "B" (strengthen crest to inhibit breach) is unlikely to provide an acceptable standard of protection and proposed that option A (A2 + C2) is looked at instead as an option that would provide a very high standard of protection.

At the start-up meeting MBC agreed that options A, C1 and "C" are looked at, and option "B" is discounted.

A key assumption / limitation identified was that the scheme should not increase the risk of flooding downstream. This sets the minimum level of the auxiliary spillway at circa 21.8m OD (above the current lowest point on the dam).

2.4 Short List of Options Considered

As part of this study, BVL reviewed the long list of options (Table 2-1) for increasing the capacity of the spillway to develop a short list of options. The options BVL identified were generally based on the options outlined in the long list of options identified in the ALARP

report. The BVL-selected options, presented to and agreed with MBC at the Project Start-up Meeting are listed in Table 2-2.

Table 2-2: Summary of Short List Options Considered

Option		Work Involved
1/1A	**C1**	50 to 65m m wide auxiliary spillway, on abutment (freeboard TBC) – formed with grass covered articulated concrete blocks (ArmorFlex or similar)
2/2A	**C2**	50 to 65m wide auxiliary spillway, on abutment (freeboard TBC) – formed with reinforced concrete
3	**A2 + C2**	40m wide auxiliary spillway, on embankment (freeboard TBC); and 50m wide auxiliary spillway, on abutment (freeboard TBC) – both formed with reinforced concrete

Notes:
1. Based on the available topographical survey data there was judged to be sufficient space to expand the proposed width of the option C auxiliary spillway from 50m up to 65m.

3. BACKGROUND

3.1 Site Overview

Mote Park Lake is located in Mote Park approximately 1km from the centre of the Maidstone (in Kent), OS coordinates TQ777551. Mote Park is a 1.8km² multi-use public country park and is Grade II listed. The park is maintained by Maidstone Borough Council (MBC), who also act as the undertaker for the reservoir. The lake is used for fishing, sailing boats and model boats.

The lake was formed between 1793 and 1800 when the River Len, a tributary of the River Medway, was dammed. The lake was then enlarged by the second Earl of Romney in 1839, the lake being enlarged by excavation.

The dam forming the lake consists of a raised embankment with a spillway located at the northern end of the lake. A smaller lake, Turkey Mill Pond, is located along the northern/downstream edge of the embankment. The River Len flows northwest from Turkey Mill Pond into Maidstone town centre.

A number of features of significant cultural heritage are located around the dam. The features are largely related to a Grade II listed house located within the park. The features include, but are not limited to, the following:

- *Old Ashford Road, constructed in 1794, which runs across the crest of the dam embankment;*
- *A Boathouse located on the northern bank of Mote Park Lake, constructed 1836-39;*
- *The overflow from Mote Park Lake to Turkey Mill, constructed in 1838; and*
- *Poll Mill believed to be built in 1585. The mill lies within Mote Park Lake; it was bought by Lord Romsey in 1838 to accommodate construction of the north end of the lake.*

Turkey Mill Business Park is located to the north of the lake at the downstream end of the dam. The business park is constructed around Turkey Mill Pond and the River Len, it consists of a number of buildings which are occupied by different businesses. The business park is owned by a private landowner, Turkey Mill Investments. The Turkey Mill Investments landownership boundary extends to the southern (downstream) face of the dam embankment.

An overview of the site is shown below in Figure 3-1.

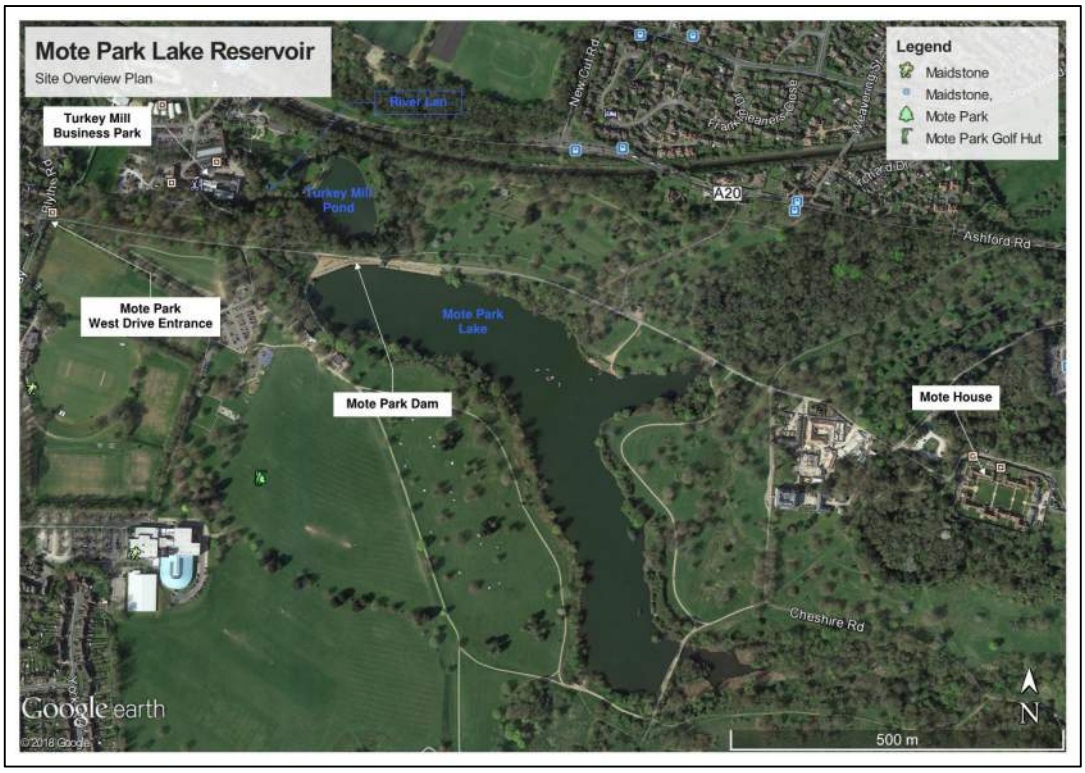

Figure 3-1: Site Overview Plan

3.2 Reservoir Details

3.2.1 Reservoir

Mote Park Lake is a reservoir retained by an embankment dam. The reservoir is formed by damming the River Len which flows downstream from the reservoir towards Maidstone town centre. The reservoir covers an area of 120,000m² and has a capacity of 200,000m³. The top water level is 19.29m OD (the lowest invert level of the spillway culverts).

3.2.2 Dam

The dam retaining the reservoir is formed with a raised earth embankment with a spillway in natural ground to the west. Failure of the dam would result in flooding of Turkey Mill Business Park and several areas of housing along the River Len. A risk-based approach, undertaken for the 2017 ALARP Report, identified that the consequences of the dam failing (triggering the release of impounded water) were that three people would be killed and approximately £5 million of property damage would occur[1]. Therefore the dam at Mote Park is assessed as Flood Category A, where consequences of failure of the dam are major and would "threaten lives in a community".

An overview of the reservoir dam is shown below in Figure 3-2.

[1] It was identified that the fluvial flood itself would have caused damage even without dam failure, so the proportion due to dam failure is likely to be around half these figures.

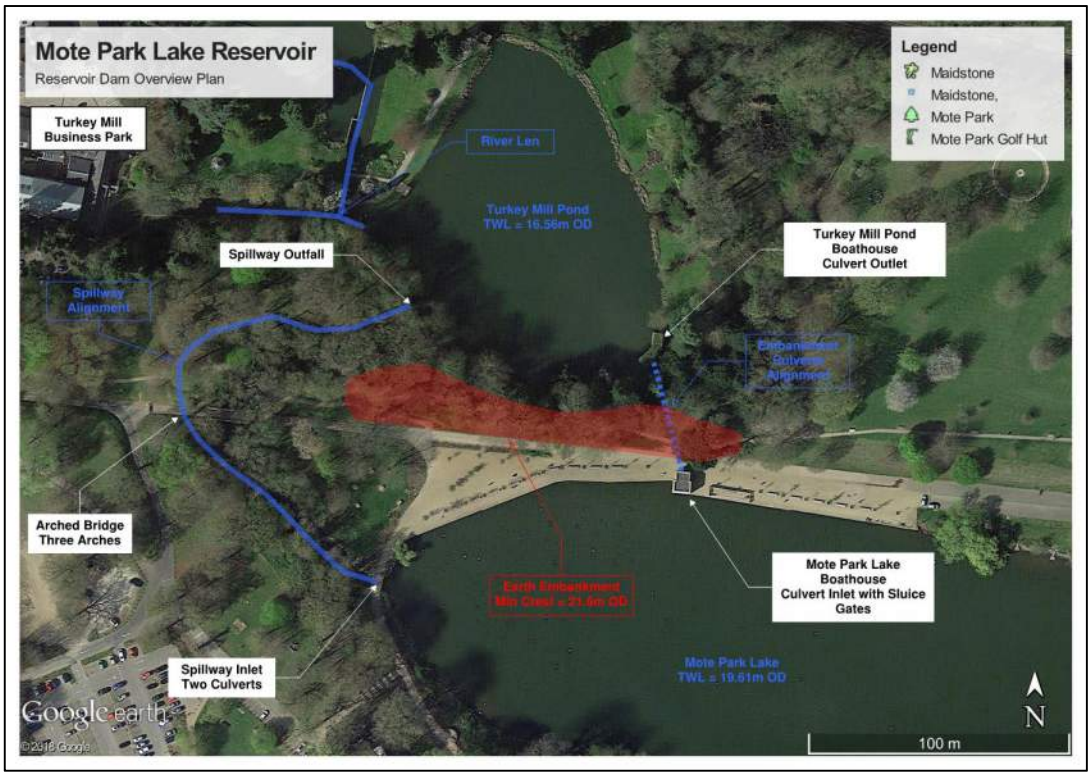

Figure 3-2: Reservoir Dam Overview Plan

Embankment

The embankment is located at the northern end of Mote Park Lake, OS coordinates TQ774553. It is approximately 140m long and separates Mote Park Lake, to the south (upstream), and Turkey Mill Pond, to the north (downstream). A footpath, spans across the top of the embankment between the lakes. The path spans from West Drive, a historic entrance to the park, towards Mote House the Grade II listed house located within the park to the east. The embankment crest level is 21.7m OD (the lowest point on the dam crest). The overall height to the lowest embankment foundation is around 10m. The composition of the embankment is sandy, silty, gravelly clay based on the ground investigation carried out in 2018.

The impounded water level of Mote Park Lake is 19.29m OD giving an approximate freeboard of 2.3m along the upstream edge of the embankment. The water level of Turkey Mill Pond is 16.56m OD leaving about 5m height of the downstream face of the Mote Park Lake embankment exposed above the Turkey Mill Pond water level.

Embankment Culvert

A culvert through the dam is located at the eastern end of the embankment. The culvert spans from the boathouse on Mote Park Lake to the boathouse on Turkey Mill Pond. Flow through the culvert is controlled by sluice gates in the boathouse on Mote Park Lake. The sluice gates control the flow through four 0.6m wide openings. Two gates (approximate invert levels 17.4mOD and 15.6mOD) controlling openings at each level. The gates are operated manually from the upstream boathouse on Mote Park Lake. It is believed that the gates were installed to control the flow of water between Mote Park Lake and Turkey Mill Pond, a head pond for a mill located at Turkey Mill. One gate can lower the water level in the reservoir by about 1m per day (limit using culvert sluice restricted by the inlet in the boathouse).

The gates have not been appropriately maintained and at present only one upper gate is operable, although its condition is considered poor. It is believed that this has been the case since around 1977 when Turkey Mill was acquired by Peter Young. There are no formal operating rules for the functioning sluice gate.

Spillway

The spillway is located beyond the western end of the embankment. It conveys flood water from Mote Park Lake downstream to Turkey Mill Pond.

Two culverts, invert levels 19.29m OD and 19.63m OD, are located under a footpath on the northwest bank of Mote Park Lake. The culverts discharge into an earth channel lined with gabion mattress. The channel conveys flow under the West Drive footpath via a three arched bridge, invert level 19.21m OD. The now unlined channel conveys flow northwest in a curving route towards Turkey Mill Pond where it spills from the west bank.

3.3 Previous Reports

3.3.1 Stillwater Associates Ltd, 2014 – Section 10 Report

A Section 10 Inspection of Mote Park Lake was carried out in 2014 by Alan John Brown, a member of the All Reservoirs Panel. The report concluded that the reservoir does not meet the standards for safety identified in Floods and Reservoir Safety 4th Edition (ICE, 2015).

The report included the following mandatory requirement, to be carried out 'in the interests of safety':

"The spillway capacity is increased to reduce risk on failure due to overtopping as low as reasonably practicable (ALARP). This should be carried out as a study to identify options and define / agree what works would be proportionate in cost to the reduction in risk achieved, followed by the works."

3.3.2 Stillwater Associates Ltd, 2017 – ALARP Report

In response to the mandatory requirements set out in the 2014 Section 10 Report, the "Assessment of whether the risk of failure of the dam during flood events is "As low as reasonably practicable" (ALARP)" report was completed in 2017. As recommended in the Section 10 Report, the report identified a range of options for increasing the capacity of the spillway. It also included an economic assessment to facilitate the identification of options which best reduces risk against the ALARP criteria.

A summary of the identified options with budget project costs and the annual chance of dam failure are given below in Table 3-1.

Table 3-1: Summary of Options Identified

Option	Works Involved	Budget Project Cost £(m)	Annual Chance of Dam Failure with Release of Reservoir Contents	Cost to save a life £(m) (Note 1)
	Existing situation		110	n/a
A1-40	40m wide grasscrete auxiliary spillway, on embankment with 1.2m freeboard	1.2	2,000	3.3
A2-40	40m wide reinforced concrete auxiliary spillway on embankment with 1.7m freeboard	1.7	8,000	4.5
B	Strengthen crest to inhibit breach	0.7	1,500	1.9
C1-50	50m wide grasscrete auxiliary spillway, on abutment with 1.2m freeboard	1.4	4,000	3.6
C2-50	50m wide concrete auxiliary spillway, on abutment with 1.7m freeboard	1.9	20,000	5.1
A2-40 C2-50	Both concrete options	3.6	80,000	9.3
Notes: 1. *Cost becomes grossly disproportionate when cost to save a life exceeds £8.5m*				

The report concluded that upgrading works were required. It also concluded that in order avoid enforcement proceedings from the Environment Agency against MBC the following actions were required:

- *A decision as to which option / works will be implemented by 6th June 2017, to be confirmed in writing by the Council to the All Reservoirs Panel Engineer (and thus to the Environment Agency)*
- *Completion of the works within three years i.e. by 6th June 2020.*

3.3.3 Stillwater Associates Ltd, 2017 – Flood Study

A flood study report was prepared to assess the inflow hydrograph and flood routing for a range of floods from 1:10 year to PMF.

4. OPTIONS CONSIDERED

4.1 Floods & Waves Protection Standard

There are two methods of approach to reservoir safety with regard to floods: a 'standards-based' approach, where the required level of protection is arrived at based on a broad categorisation of downstream damage, including the potential to endanger life, (as detailed in the previous version of Floods and Reservoir Safety, 3rd Ed, ICE, 1996) and the 'risk-based' approach (as set out in the current Floods and Reservoir Safety, 4th Ed, ICE, 2015), where the risk of failure of the dam due to floods is assessed together with downstream damage including the likely loss of life, and the tolerability of that risk evaluated to arrive at the required level of protection as described in *Environment Agency "Guide to risk assessment for reservoir safety management" (RARS) (2013)*

The 'standards approach' required the dam to pass the flood with adequate freeboard – with an explicit statement regarding the need to correct any deficiency.

In the 'risk-based' approach, the dam is assessed with regard to reducing the risk of failure due to floods to 'as low as reasonably practicable' (ALARP). The ALARP principle is met when it is deemed grossly disproportionate in terms of expending resources to gain any further reduction in risk.

4.2 Short List of Options Considered

BVL further assessed the long list to develop a short list of options to be appraised in this report. The options identified were generally based on the options outlined in the long list (above). However, the options were either dropped or modified. The selected options were presented to MBC at the Project Start-up Meeting and the list was agreed.
The following short list of options was identified:

Table 4-1: Summary of Short List Options Considered

Option		Work Involved
1/1A	**C1**	50 to 65m m wide auxiliary spillway, on abutment (freeboard TBC) – formed with grass covered articulated concrete blocks (ArmorFlex or similar)
2/2A	**C2**	50 to 65m wide auxiliary spillway, on abutment (freeboard TBC) – formed with reinforced concrete
3	**A2 + C2**	40m wide auxiliary spillway, on embankment (freeboard TBC); and 50m wide auxiliary spillway, on abutment (freeboard TBC) – both formed with reinforced concrete

Notes:
2. Based on the available topographical survey data there was judged to be sufficient space to expand the proposed width of the option C auxiliary spillway from 50m up to 65m.

An overview plan of each option considered is given in Appendix A.

4.3 Scope Common to All Options:

(i) Diversion of HV cables to avoid cables being affected by works including running beneath non-overflow crest wall.
(ii) West Drive Bridge. Remove and replace part of parapet wall to form open balustrades and coping.
(iii) New access stairs from footbridge down to West Drive.
(iv) Abandon cast iron pipes (subject to tapping during construction).
(v) Ground lowering to enable spillway and approach channel construction.
(vi) Protection to selected specimen trees.
(vii) Removal of trees and vegetation.
(viii) Local ground raising to form new earth embankment (infilling of gully, which provides access to Mote Park boat club's storage container).
(ix) Wave wall formed from Redi-Rock precast concrete blocks.

4.4 Option 1/1A (C1)

(i) Spillway length of 50-65m acceptable (58m length seems achievable).
(ii) Articulated concrete cable tied blocks for "C1" spillway or. Spillway gradient 1:4
(iii) Grass cover to articulated concrete cable tied blocks.
(iv) Spillway retaining walls formed using Redi-Rock precast concrete blocks.

4.5 Option 2/2A (C2)

(i) Spillway length of 50-65m acceptable (58m length seems achievable).
(ii) Reinforced concrete in-situ cast steps for "C2" spillway. A gradient of between 1:3 and 1:4 is acceptable for the spillway.
(iii) Spillway retaining walls formed using Redi-Rock precast concrete blocks.

4.6 Option 3 (A2+C2

(i) Reinforced concrete in-situ cast steps for "A" spillway laid to 1 in 3 gradient.
(ii) Reinforced concrete in-situ cast steps for "C2" spillway. A gradient of between 1:3 and 1:4 is acceptable for the spillway.
(iii) Scour protection at downstream end of spillway.
(iv) Spillway retaining walls for "A2" formed using reinforced concrete.
(v) Spillway retaining walls for "C2" formed using reinforced.
(vi) Spillway length A2 (40m) + C2 (50m).
(vii) Temporary haul road through Turkey Mill to facilitate construction of spillway A2. All access to Turkey Mill will be from Mote Park.
(viii) Extensive vegetation clearance (loss of visual backdrop).
(ix) Reinstate 1.8m high mesh security fence.

5. HYDRAULIC DESIGN

5.1 Introduction

The three short listed options were considered for the hydraulic design as follows:

- Option 3 - A2 (40m) + C2 (50m)
- Options 1/1A & 2/2A - C (50m)
- Options 1/1A & 2/2A – C (65m)

Note: Hydraulic assessment was carried out to cover possible range of widths of C spillway

The following material types, as discussed in Section 7 were considered for construction of the spillway:

- Reinforced concrete steps cast in-situ
- Grass covered articulated concrete blocks

The "A" spillway is located on the main dam discharging directly into Turkey Mill Pond. The required gradient of the spillway is 1:3. Only reinforced concrete is suitable to construct the spillway.

The "C" spillway discharges into the existing spillway channel, to the west of the dam, before discharging into Turkey Mill Pond. A gradient of between 1:3 and 1:4 is acceptable for the spillway.

5.2 Limiting Velocities

The following limiting (maximum) velocities are considered appropriate for the design materials used to construct the spillway:

- Reinforced concrete,
  Velocity > 10 m/s, up to 20 m/s and more
- Grass covered articulated concrete blocks,
  Velocity = 8m/s (10m/s for limited damage)

5.3 Flood Assessment

A flood assessment was carried out by Stillwater Associates (in 2017). This has not been repeated, although the flood hydrographs have been re-routed through the reservoir to derive the peak water levels under flood conditions. This has included water levels within the existing spillway channel and in Turkey Mill Pond during various return period floods.

5.4 Wave and Freeboard

Waves, wave run-up and dam freeboard have been assessed using the method outlined in Floods and Reservoir Safety 4th Ed. and EurOtop Manual.

The following minimum freeboard has been assessed:

- Minimum Design Freeboard = 350mm (No overtopping)
- Minimum Safety Check Freeboard = 200mm (Limited overtopping)

Table 5-1 summarises the stillwater and stillwater plus minimum freeboard levels for the design and safety check floods.

Table 5-1: Mote Park Lake – Flood Water Levels

Flood Event	Spillway A (40m) + C (50m)		Spillway C (50m)		Spillway C (65m)	
	Stillwater (mOD)	Stillwater + Min. Freeboard (mOD)	Stillwater (mOD)	Stillwater + Min. Freeboard (mOD)	Stillwater (mOD)	Stillwater + Min. Freeboard (mOD)
1:1,000yr	22.31	22.66	22.53	22.88	22.44	22.79
Design Flood 1:10,000yr	22.74	23.09	23.15	23.50	22.99	23.34
Safety Check Flood (PMF)	23.37	23.57	24.01	24.21	23.85	24.05

5.5 Spillway Hydraulic Assessment

Design of spillway gradient and material type can be limited by maximum velocity. Table 5-2 summarises calculations of velocity on the auxiliary spillway for the various configurations considered. During large floods the water levels within the existing spillway channel limit the drop on the spillway chute, particularly for spillway C. This results in lower chute velocities compared to longer chute lengths where the flow would tend towards normal depth.

In summary:

- Spillway "A" requires a concrete spillway
- Spillway "C" for the flows and slopes assessed can be concrete or grass covered concrete cable tied blocks
- For Spillway "C1" slope at right end of spillway needs to be approx. 1:4. This can be steepened to 1:3 20m higher up the existing spillway channel, if required.

Table 5-2: Mote Park Spillway – Hydraulic Summary

	Spillway A (40m) + C (50m)			**Spillway C (50m)**			**Spillway C (65m)**		
	PMF	1:10,000yr	1:1,000yr	PMF	1:10,000yr	1:1,000yr	PMF	1:10,000yr	1:1,000yr
Flow Rate (m^3/s)	132 + 166 (298)	62 + 77 (139)	25 +31 (56)	277	132	52	315	142	56
Unit Flow Rate ($m^3/s/m$)	3.31	1.54	0.62	5.54	2.64	1.04	4.85	2.18	0.86
Head over Weir (m)	1.57	0.94	0.51	2.21	1.35	0.73	2.05	1.19	0.64
Max. Velocity on Chute (m/s) [Normal Depth]	15.6 Smooth conc. 1:3 slope	11.6 Smooth conc. 1:3 slope	8.1 Smooth conc. 1:3 slope	17.6 Smooth conc. 1:4 slope	9.3 Grass 1:4 slope	6.4 Grass 1:4 slope	16.7 Smooth conc. 1:4 slope	8.65 Grass 1:4 slope	5.8 Grass 1:4 slope
Max. Velocity on Chute (m/s) [Calculated] Spillway 80	7.4 Grass 1:4 slope	6.8 Grass 1:4 slope	5.2 Grass 1:4 slope	7.1 Grass 1:4 slope	7.4 Grass 1:4 slope	6.2 Grass 1:4 slope	6.3 Grass 1:4 slope	7.4 Grass 1:4 slope	5.6 Grass 1:4 slope
Max. Velocity on Chute (m/s) [Calculated] Spillway 60	5.5 Grass 1:3 slope	6.2 Grass 1:3 slope	5.4 Grass 1:3 slope	Drown. Grass 1:3 slope	5.9 Grass 1:3 slope	6.0 Grass 1:3 slope	Drown. Grass 1:3 slope	5.7 Grass 1:3 slope	6.0 Grass 1:3 slope

Notes:

1. Auxiliary weir crest level = 21.80mOD.
2. Manning's 'n': Concrete = 0.013; Grass = 0.023.
3. Spillway 80 is section at right end of C weir. Spillway 60 is 20m up the channel.

Velocities for concrete spillway have been assessed for a smooth spillway. Velocities on a stepped spillway will be lower.

6. GEOTECHNICAL DESIGN

6.1 Geology

An overview of the geology in the area is given in the BGS Geology of Britain Viewer and BGS GeoIndex. The viewer and index provide a summary of the geology in a particular area based on observations during historic ground investigations and resulting inferences. There are no historic boreholes near the dam at Mote Park.

The geology forms a banded sequence of strata. It is categorised into superficial deposits and bedrock. Superficial deposits are 'young' geological deposits that form the upper bands (approximately 1 to 6m) of strata. The deposits lie, near the surface, on top of bedrock. They are typically made up of unconsolidated sediments. The Bedrock is made up of older geological deposits either formed with rock or consolidated deposits. Bedrock is typically covered either by younger superficial deposits or water.

Superficial Deposits

Superficial deposits are shown in an isolated area around Mote Park Lake along the southern edge of the dam. The stratum shown on the viewer includes the following:
Alluvium – The stratum is shown on the viewer around Mote Park Lake on the upstream side of the dam. It is a normally soft to firm consolidated silty clay. Typically it is formed with layers of silt, sand, peat and gravel. It is a fluvial deposit and it is likely that it deposited by the River Len.

Bedrock

Three different bedrock strata are shown on the viewer around the dam at Mote Park. The strata include the following:

Hythe Formation – The stratum is shown to the east and west of the dam covering much of the park area. It typically has a thickness of 18 to 100m. It comprises alternating sandy limestones ("Ragstone") and sandy mudstones ("Hassock"). The stratum typically overlies Atherfield Clay.

Atherfield Clay Formation – The stratum forms two vertical strips through the east and west sides of the dam. Around Maidstone the thickness of the stratum is approximately 10m. It consists of mudstone with some pebble, vertebrate bones, gritty sandstone or shelly sandy mudstone.

Weald Clay Formation – The stratum forms a single strip, separating the strips of Atherfield Clay, through the centre of the dam. It is around 240m thick south of Maidstone. It is formed with thinly-bedded mudstone ("shales"), mudstone with subordinate siltstones, fine to medium- grained sandstones, shelly limestones and clay ironstones. It typically underlies the Atherfield Clay Formation.

6.2 2018 Ground Investigation

Ian Farmer Associates were commissioned by MBC to carry out Ground Investigation at Mote Park in January 2018. The ground investigation has been completed but the subsequent testing and factual report has not yet been received.

The investigation provides information on the composition of the embankment and the underlying ground conditions. The investigation is being undertaken to gain a further understanding of the geotechnical design requirements and inform the design of the new auxiliary spillway.

The ground investigation consisted of a series of exploratory holes located along the dam between Mote Park Lake and Turkey Mill Lake, four cable percussive boreholes and four windowless samples. The exploratory holes are as follows:

Exploratory Hole	Easting	Northing	Ground level (mOD)	Depth (mbgl)
BH1	tbc	tbc	tbc	7.0
BH2	577476.4	155326.4	21.66	8.5
BH3A	577452.1	155337.3	21.95	10.0
BH4	tbc	tbc	tbc	10.0
WS1	tbc	tbc	tbc	4.45
WS2	tbc	tbc	tbc	4.45
WS3	tbc	tbc	tbc	4.45
WS4	tbc	tbc	tbc	4.0

The cable percussive boreholes were located at the eastern and western ends of the existing embankment (two at each end). The window samples were located on a berm just above water level, along the bank of Turkey Mill.

The investigation included geotechnical laboratory and in-situ lab testing in order to determine the design parameters of the soil.

In addition to the scheduled holes a large trench was excavated along the embankment as part of a cable repair activity. This trench acted as a large trial pit along the stretch. It should be noted that the backfilling of this trench and the placing of sand around the cable that passes through it may not comply with the standards required for dam construction. It is proposed to possibly realign the cables along the embankment as part of the works. It can be confirmed that they are approximately 1.0m bgl and are well mapped by UKPN records.

The exploratory holes sunk as part of the investigation encountered a variety of material. In general the materials were of natural origin, but placed in-situ to form the dam.

The exploratory holes sunk along the upstream indicated a distinction between the eastern and western geology.

<u>Western</u>
To the west the boreholes were sunk alongside the existing spillway. The geology in this area was varied. It is possible that this is the natural geology of the area consisting of the Hythe Formation with bands of limestone present.
Water strikes were encountered in this area at 5.5m – 6.5m bgl.

Eastern

To the centre and east of the dam the strata encountered followed the following sequence.

- Topsoil – soft dark brown.
- A soft cream yellow slightly gravelly, sandy clay becoming dark grey/brown with depth.
- Soft to firm dark grey sandy clay.

No water strikes were encountered in these exploratory holes.

The trench dug along the centre of the embankment indicated superficial Made Ground of sandy clay.

The window samples sunk on the downstream edge of the dam encountered topsoil over very soft to soft slightly gravelly, sandy clay, over slightly silt, sandy clay. Water strikes in all exploratory holes in this area were encountered close to ground surface, as expected due to the proximity of Turkey Mill Lake.

6.3 Engineering Considerations

Preliminary engineering considerations include the following:

- The embankment composition is varied and often granular in nature. This presents a risk to its permeability and its effectiveness as a dam; however any inundation will be short term and is unlikely to have an impact on stability.
- The soft nature of the clay strata will require attention when designing foundations for structures such as the wave wall.
- The variability of strata to the west of the embankment and the presence of bands of limestone will need to be considered for the construction of the new auxiliary spillway through this area.

7. CIVIL DESIGN

7.1 Auxiliary Spillway Design

The civil design associated with each option includes the construction of a new auxiliary spillway. The spillway may either be designed with grass covered articulated concrete blocks or with reinforced concrete. The suitability of design is dependent on a number of factors these include hydraulic design requirements and environmental constraints. An overview of the various design options is given below.

7.1.1 Grass Covered Articulated Concrete Block Spillway

The existing slope along the downstream side of the dam will be regraded to form a typically 1 vertical to 4 horizontal (1in 4) slope. Whilst a steeper gradient is feasible a 1 in 4 gradient is preferred to aid maintenance of the grass and limit peak velocities in operation.

Where required the dam will be lined with a subgrade.

Dry-cast interlocking concrete blocks of uniform size and shape will be tied with a matrix of cables to form large mats of blocks, similar to Armorflex by Armortec. The mats will be laid across the embankment in rows. Soil dowels will be provided to resist uplift of the mats. The voids are infilled with a gravel/soil mix. The blocks will then be topsoiled and seeded as required to encourage the growth of grass along the slope. The blocks will provide reinforcement of the slope whilst facilitating a natural appearance.

An example of the use of grass covered articulated concrete blocks to reinforce a spillway is shown in Figure 7-1.

Figure 7-1: Grass Covered Articulated Concrete Block Slope Reinforcement, During Construction (left), Post Construction (right)

An anchor block will be provided at the top of the slope. The block will act as the crest to the weir that the dam will effectively form during a design flood event. The concrete blocks forming the slope reinforcement will be tied to the anchor block. The blocks will be continued across the existing spillway channel to provide scour protection.

Side walls along each side of the new auxiliary spillway will be constructed. These walls will contain flow within the spillway.

Various construction options are possible including reinforced concrete, masonry or precast concrete blocks with a textured finish to look like dressed masonry. It is proposed that the walls will be formed using Redi-Rock precast concrete blocks with a Limestone Blockwork finish, or similar. The finish will be confirmed through stakeholder consultation.

The wall will be backfilled with clay placed and compacted in layers to provide a low permeability cut off behind the wall.

Figure 7-2: Redi-Rock wing wall and Armorflex (photo reproduced with permission of CPM Group)

7.1.2 Reinforced Concrete Spillway

Two sub-options for a reinforced concrete spillway were considered. These included a stepped structure and a sloped structure. The stepped structure is preferred in this location, due to its energy dissipation characteristics avoiding the need for a stilling basin, and a reduced health and safety risk.

The construction of the stepped spillway was considered further, with the options to construct the structure with either cast in-situ units, or precast block units. Given the gradient of the slope and the potential velocities cast in-situ construction was preferred.

The existing slope along the downstream side of the dam will be regraded. The slope will be 1 vertical to 3 horizontal. The graded slope will be lined with blinding to provide an even and stable surface for the sections of spillway to be constructed. Side walls along either end of the new section of spillway will also be constructed to contain flow within the spillway. Key trenches will be cut into the slope to form concrete shear keys to anchor the spillway. The stepped spillway will be formed in reinforced concrete.

The toe of the slope will be formed with a row of sheet piles aligned perpendicular to the slope. The sheet piles will help support the spillway slab from slipping and prevent undermining of the slope occurring through scour. Scour protection, such as rip rap stone will be downstream of the toe within Turkey Mill Pond. Placing of the scour protection may need the use of floating plant on the pond.

7.2 Wave Wall

A wave wall will be provided along the crest of the embankment to protect the non-spillway sections of embankment from overtopping. The wall will be between 1m and 2m high. It will prevent overtopping of the embankment from waves during design flood events and also retain a shallow depth of water during very extreme flood events.

Various construction options are possible including reinforced concrete, masonry or precast concrete blocks with a textured finish to look like dressed masonry. It is proposed that the walls will be formed using Redi-Rock precast concrete blocks with a Limestone Blockwork finish, or similar. The finish will be confirmed through stakeholder consultation. If blocks are used the joints will be sealed. The wall will be supported on a concrete base slab, below finished ground level. Due to the possibly disturbed and sandy nature of the ground under the proposed wall alignment a shallow cut-off may be required

to minimise seepage under the wall during extreme flood events. This could be formed from piling, or a clay, or cement/bentonite, or concrete, filled trench.

Figure 7-3: Redi-Rock wave wall at Walshaw Dean Reservoir (photo reproduced with permission of CPM Group)

In order to access the wall from both sides it will be required to remove the existing fencing aligned across the top of the embankment. New fencing will be required. Removal and replacement of the fence will be required to take place in coordination with Turkey Mill.

7.3 Local Ground Raising / Earth Embankment

The ground will be raised by approximately 1m to 2m at the right end of the dam to form an earth embankment in continuity with the wave wall. The crest of the new embankment will tie into the top of the wave wall. The embankment will have a trapezoidal section with a crest width of 2m; the slopes will be formed with a maximum gradient of 1 in 3 although can be shallower to fit with the existing landform. This is primarily to infill the gully.

Figure 7-4: Low spot (gully) providing access to Mote Park boat club's storage container

Existing topsoil will be striped, the sub-soil excavated to a firm foundation. A key trench will be provided to prevent seepage under the embankment. The ground raising embankment will be constructed using imported clay to form an impermeable core with shoulders formed with material excavated to form the spillway. Once the ground is raised to the required level it will be topsoiled and landscaped as required.

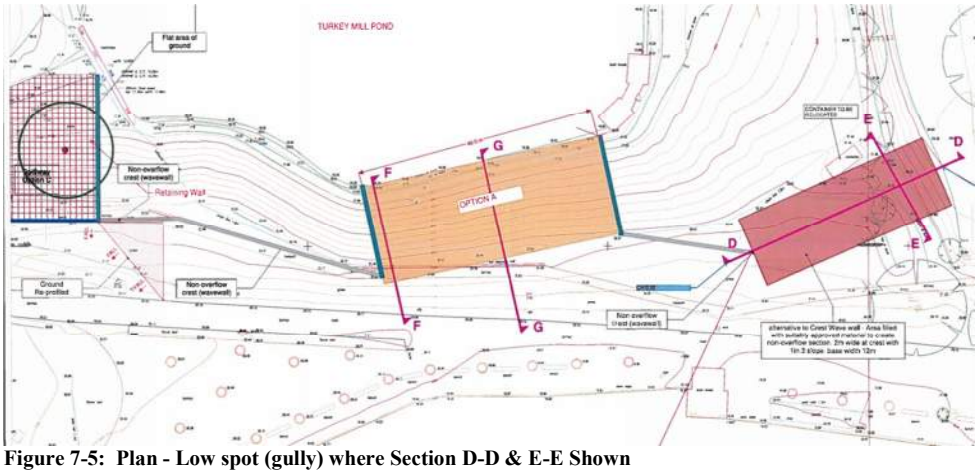

Figure 7-5: Plan - Low spot (gully) where Section D-D & E-E Shown

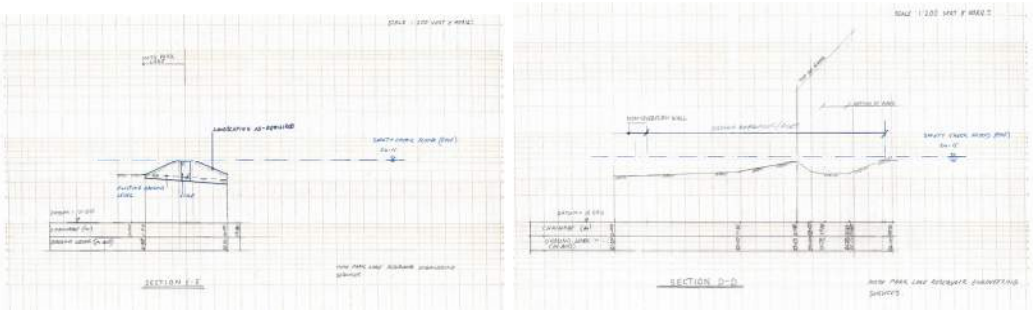

Figure 7-6: Section D-D & E-E through low spot (gully)- crest width 2m

Mote Park Boat Club's container will no longer be accessible and will need to be relocated prior to commencement of this element of the works.

7.4 West Drive Bridge

West Drive is one of the historic main entrances to the Grade II* mansion. There were some improvements to the channel upstream of West Drive Bridge in early 2016, but these did not include any enlargement of the culverts under West Drive Bridge.

During significant flood events the bridge provides a hydraulic restriction leading to the bridge becoming surcharged. The bridge parapets provide a restriction to flood flows.

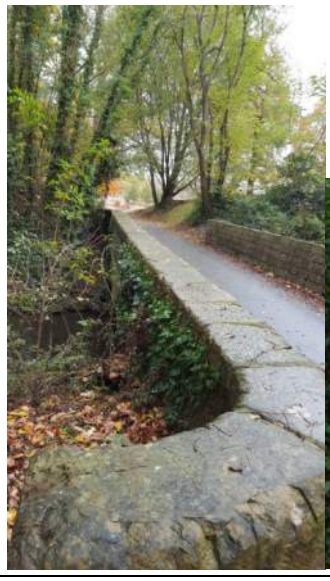

Figure 7-7: West Drive Bridge showing existing parapet arrangement

It is proposed that the linear sections of the parapet wall (approx 15m x 2) is removed and replaced with bespoke heritage type cast stone (or suitably approved equivalent) open balustrades and coping. This will give a small increase in flow, during extreme flood events when the bridge overtops, and should retain an aesthetically pleasing appearance. The curved end sections of West Drive Bridge's parapet wall will be retained. Balustrades will be supplied pre-drilled to accept stainless steel location dowels. A structural assessment of West Drive Bridge, to accommodate the changes will be required.

Figure 7-8: Scarborough parapet balustrading reproduced with permission of Procter Cast Stone

7.5 Services / Utilities

A desk based utility services search was carried out by Zetica in January 2018 for the area surrounding Mote Park Lake Reservoir Dam. The resulting services maps indicated the presence of the following services:

- One underground 11kV (HV) cable operated by UK Power Networks
- One underground 33kV (eHV) cable operated by UK Power Networks

The two electricity cables are aligned (individually) southwest to northeast across the dam area. Both cables cross the southern portion of the spillway (in separate locations) via ducts. The cables are then aligned east along the embankment.

To accommodate the works associated with any of the options diversion of the existing HV cables will be required to avoid the proposed works. This should be carried out in advance of any excavation works.

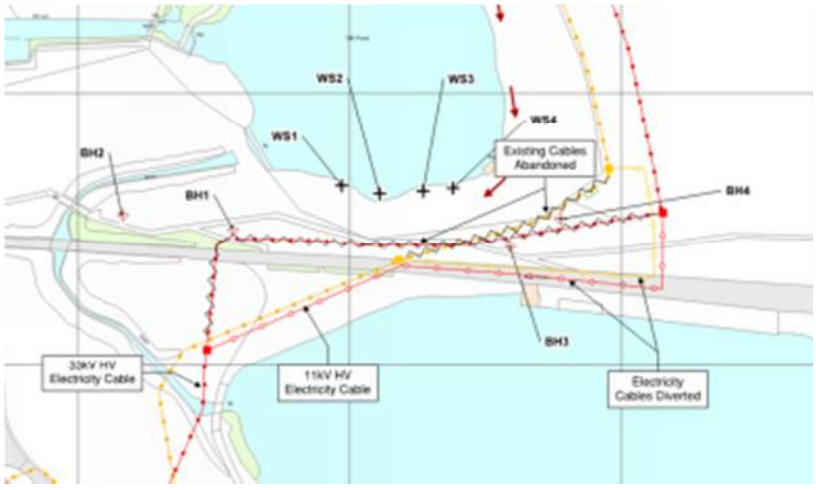

Figure 7-9: HV Cable Diversion

A 300mm diameter cast iron pipe crosses the existing dam spillway in two places. A services map included in the 'Mote Park Conservation Plan' (MBC, 2008) indicates that this service is an 'old' water pipe that was new in 1955. The pipe, believed to be an abandoned water main, is aligned south to north across the study area. It crosses the spillway once to the south of the embankment, then again to the north of the embankment. However, its status would need to be confirmed before any works to abandon the pipe could commence.

7.6 UXO

A desk based UXO survey was carried out by Zetica in January 2018 for the area surrounding Mote Park Lake dam. It indicates a low risk of UXO in the dam area.

8. CONSTRUCTION ISSUES

The following construction issues have been considered during the development of the options; including key works activities, access and operational constraints.

8.1 Earthworks

Earthworks are required to form the auxiliary spillway channels and reprofile the ground to retain extreme floods and facilitate water flow.

Excavation will generally be from the top of the embankment. For spillway A the existing embankment would be regraded to form a 1 in 3 slope. For spillway C the existing ground will be regraded to form a 1 in 4 slope. Areas of infill will need to be benched into the slope, compacted and then re-graded. Temporary access to spillway A will be via Mote Park. Excavated spoil will be stockpiled locally where it can then be re-used within the works or hauled away for disposal. Lowering of Turkey Mill Pond may be required to complete excavation and re-grading of the lower portion of the slope of spillway A.

8.2 Spillway Construction

The spillway will then be constructed in sections. The method of construction will vary depending on the spillway design (see section 7.1).

For option C1 the spillway retaining walls will be constructed before the cable tied blocks are laid. The crest beam will be constructed and the cable tied panels working down from the crest. The cable tied blocks will extend across the spillway channel to provide scour protection. Existing stone blocks from the channel can be re-placed on top of the scour protection.

For the reinforced concrete options C2 and A the spillway will be formed working up the slope. The toe restraint will be a row of sheet piles for option A and a shear key for option C2.

Spillway construction will be carried out in coordination with Turkey Mill and MBC Park Staff to avoid disruption.

8.3 Water Management During Construction

Construction work to be carried out in the channel (highlighted yellow) associated with option C should have minimal effect on water users of Mote Park Lake, as water levels can be controlled near normal levels. Work within the channel is likely to take between 4-6 weeks.

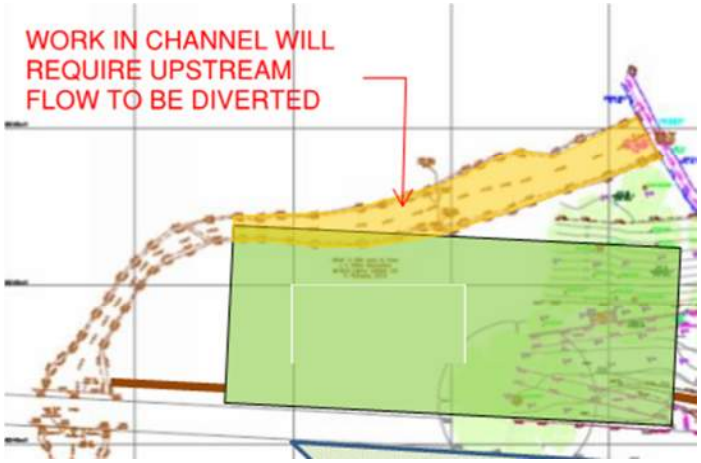

Figure 8-1: Work undertaken in the channel

In order to undertake this work, flow out of the lake will need to be temporarily diverted. This can be achieved by constructing a temporary low dam at the outlet culvert to the spillway. The sluice gate will need to be operated to divert all flows coming into the lake directly into Turkey Mill. This will need the sluice to be in good working order over its full range. Alternatively the incoming flow to the lake will need to be overpumped. This is likely to be expensive and disruptive.

Spring water enters the spillway channel via a pipe located upstream of the bridge. This flow will need to be temporarily diverted either into the lake or past the spillway excavation.

For option A, the water level in Turkey Mill would have to be lowered to construct the spillway.

9. ASSESSMENT OF ENVIRONMENTAL EFFECTS

9.1 Baseline Environmental Context

The project will not encroach on any 'sensitive areas'[2] as defined under the Town and Country Planning (Environmental Impact Assessment) Regulations 2017. The nearest sensitive site is a Scheduled Monument (The College of All Saints) some 1.3km away from the proposed works. Spot Lane Site of Special Scientific Interest (SSSI) is also considered a sensitive site, which is approximately 2.3km away from the proposed works (see Appendix F for Designated Sites Plan).

Locally designated features in proximity to the Project include:

- Two Local Nature Reserves, namely River Len, and Vinters Park, approximately 420m and 550m distance from the works, respectively;
- Mote Park itself is Grade II Listed under Registered Parks and Gardens (England);
- Several Grade II Listed buildings (60+) within a 1km buffer of the proposed works, including Mote House, Stables to Mote House, Raigersfeld, and The Old Brewhouse; and
- Spot Lane Quarry SSSI approximately 2.3km away.

Potential detrimental effects of the Project identified for consideration were:

- Effects on natural resources from the physical changes to the topography of the area, including the potential production of solid waste (however this will be minimised through good practice employed during detailed design and construction);
- Noise and vibration effects on users of Mote Park and Turkey Mill;
- Potential risks of water contamination from construction work affecting Mote Park Lake, Turkey Mill Pond and the River Len;
- Potential effects on air quality and Maidstone Air Quality Management Area (AQMA) from construction work;
- Potential direct effects on Historic England Registered Parks and Gardens Grade II Listed Mote Park;
- Potential indirect effects on other heritage assets: The College of All Saints (Scheduled Monument) and listed buildings as noted above;
- Potential effects on biodiversity, including indirect effects on nationally designated nature reserves at River Len and Vinters Park;
- Effects on landscape character and visual effects on people; and
- Temporary effects on local road network, affecting community services and facilities.

Effects on natural resources, noise and vibration, water contamination, air quality, local roads, community services and facilities will be minimised through good practice employed during detailed design and construction. A number of specialist studies were commissioned to determine the potential effects on biodiversity and protected species, aquatic ecology, heritage, landscape character, and visual effects on people. To inform these assessments, a Tree Survey and Tree Constraints Plan were completed.

The findings of these specialist studies are outlined below.

[2] The following are considered as 'Sensitive Areas': SSSIs, National Parks, AONBs, the Broads, properties appearing on the World Heritage List, Scheduled Monuments, European Sites (e.g. SACs, SPAs)

9.2 Tree Survey and Tree Constraints Plan

A Tree Survey has been carried out to BS 5837:2012, and a Tree Survey Report, Tree Constraints Plan and Tree Survey Schedule is included in Appendix D.

The scheme proposals for each option will inevitably result in significant loss of tree cover, as the proposals will be carried out in an enclosed part of the site where there are a significant number of existing trees.

Whilst Option 3 (A2+C2) would have the greatest effect on trees, the most significant effects will be the loss of trees assessed as Grade 'A', and this will be broadly similar for all options.

An Arboricultural Impact Assessment and Arboricultural Method Statement will be prepared to protect trees to be retained, based on the preferred option. However, it is recommended that additional impact assessment be carried out as part of the ongoing design process to inform mitigation proposals.

Grade A trees that will be significantly affected by all options are Turkey Oaks T468 and T778 (affected by the new spillway on abutment proposals) and the Holm Oak T484 (affected by the raising of ground levels alternative to crest wave wall). It is noted that the Root Protection Area of T484 has already been compromised by excavations associated with repair of a high voltage electricity cable.

The construction of the crest wave wall is likely to affect additional trees both within Mote Park and on neighbouring property at Turkey Mill Pond. The former include London plane T480 (Grade B) and beech T474 (Grade B), while the latter include ash T3004 (Grade B), yews T3014 and T3012 (both Grade B) and beech T3011 (Grade B).

All options would further require removal of a large swathe of group G3021 (collectively Grade A) on Turkey Mill Pond land, and Option 3 would require removal of most or all of group G773 on the south bank of the existing stream between Mote Park Lake and Turkey Mill Pond. Whilst group G773 consists mostly of young, low quality Grade C individuals, it is collectively assessed as Grade B.

Other trees that will be affected by the lowering of ground levels and use of the picnic area (temporary construction effect) to the south of the West Drive include the goat willow T464, oaks T462 and T463, all assessed as Grade B.

9.3 Biodiversity and Protected Species

A preliminary ecological appraisal has been carried out by BVL, informed by a desk study and extended Phase 1 habitat survey (P1HS) on the 6th February 2018. The information provided in the report *Mote Park Lake Reservoir Design Preliminary Ecological Appraisal,* Black & Veatch, (March 2018) forms the basis for any further ecological surveys and impact assessments; and can be used to inform design development. A P1HS map and target notes are included in Appendix E.

The Scheme is located partially within Mote Park and River Len (a local wildlife site) and Turkey Mill estate. The habitats present on site are common and widespread. Of most interest are the two notable habitats (Section 41: Deciduous woodland and Wood Pasture and Parkland) and veteran trees. Removal of veteran trees should be minimised and any retained trees protected. Location of veteran trees should be identified by a qualified Arboriculturist.

From a combination of a desk study and P1HS the presence of the following has been highlighted within the Scheme; badger, nesting birds and potentially veteran trees. Species not confirmed to be present in the Scheme area but known to be present within 1km include dormouse, reptile, water vole, otter and Desmoulin's snail. No invasive species were recorded within the Scheme but the survey was carried out at a sub-optimum time of year.

To confirm further mitigation requirements the following surveys are recommended: water vole survey, bat roost assessment, invasive species survey and potentially dormouse surveys. Consultation on the survey requirements for Desmoulin's Whorl Snail and any specific mitigation for fish is also recommended.

To prevent impacts to badger it is recommended that any works remain 30m away from this sett where possible. If this cannot be achieved then a licence may be needed within 30m of the sett as there is potential to disturb badgers, although the sett should be checked to confirm the status (active/inactive) to help inform any decision-making/licensing that may be required. If the sett is categorised as active then this cannot be disturbed between December-June inclusive.

To prevent impact to bats, it is recommended that bat roost assessments (internal/external) of all potentially impacted trees/buildings (including the Turkey Mill boat house) should be undertaken to highlight any further constraints to the Scheme. This can be conducted at any time of year. In addition to this, further details should be sought from Maidstone Borough Council regarding bat roost(s) within the tunnel to aid decision making regarding licensing and any further survey requirements. In addition to this, the Scheme should aim to prevent severance of any woodland/groups of trees as these can be used as commuting corridors for bats. If severance is unavoidable then bat activity surveys should be conducted along the feature to gain an understanding of how bats will be impacted by any change to commuting habitat. Surveys should be undertaken between April-October and would involve one activity survey per month during April-October and static detector deployment (two per transect) once a month for five days per month (April-October).

To prevent the impact to water vole it is recommended that a water vole survey is undertaken before the start of works on the stream southern end of Turkey Mill Lake and spillway to ensure that any burrow locations are identified. This should be conducted at an optimum time during the survey period (April-October).

To prevent impact to Desmoulin's whorl snail it is considered that further discussion with Natural England should be sought to confirm requirement for any mitigation.

To prevent impact to dormouse it is recommended that if trees or scrub are to be removed from woodland then provision will need to be made for dormouse. This could include reasonable avoidance measures if small areas of woodland or scrub are removed or dormouse surveys if large sections of woodland will be removed.

To prevent impact to fish it is recommended that the Environmental Agency is consulted to confirm whether any specific mitigation measures are required during the works which would exceed standard controls for silt.

There is potential for the Scheme area to support otters owing to its hydrological connectivity with wider habitats (such as the River Len) and the Scheme does contain waterbodies with the potential for large fish stocks, therefore during construction it is recommended that any excavations are either covered overnight or a means of escape for badger/otter is provided.

Prior to construction suitable habitat for reptiles such as grassland on banks should be made unsuitable for the species prior to construction to encourage displacement. Grassland should be strimmed in a two-staged approach during the active period (March-October), under supervision of an Ecologist, to allow reptiles to vacate the area as long as there is also suitable adjacent habitat for any reptiles to relocate to. If there is no suitable adjacent habitat, the Ecologist will translocate the reptile to a suitable area which will be identified before works commence.

Prior to construction a check for invasive and non-native species should be undertaken at a suitable time of year (April-September) to determine presence/absence.

In summary, further survey work will be required to assess the detailed effects of the preferred option on bats, water vole and potentially dormouse. Advice needs to be sought from Natural England on the approach to assess and mitigate the effects of the preferred option on Desmoulin's whorl snail. Mitigation measures are likely to be required to manage and limit effects on badger, bats, birds, dormouse, reptiles water vole and otter, with licences potentially being required for badger and bats. It will also be necessary to carry out a further survey to identify or discount the presence of invasive species, and if present, a strategy for removal will need to be designed and implemented. Further consideration will need to be given to the effects of habitat fragmentation, and potential mitigation measures that can be included in the detail design proposals.

At this stage, the effects on biodiversity and protected species appear to be broadly similar for all scheme options, with the slight exception of effects on badger, which would be less of a concern if the preferred option avoids the spillway on embankment (A2).

9.4 Aquatic Ecology

Invertebrates

A species level survey of the River Len was carried out in May and November 2005, and revealed there to be a varied array of invertebrates in the river, with species communities tending to change continually along the river as the chemistry and habitat type changed. Specifically below Mote Park, cold spring water provides habitat for the uncommon cased caddis. The survey also highlighted the strong influence of springs on the flow of the River Len. The three sites situated in the Study Area are: Spot Lane, D/S Mote Park Lake, and Square Hill road (Sites 1, 2 and 3, respectively; see Figure G3 in Appendix G).

The stretch of river which included Site 1 (see Figure G3 in Appendix G) was found to generally have very good biological quality. It mainly runs through unpopulated arable farmland but reaches a more urban area at Site 1, when the biological scores notably dropped in the November samples. This is due to sewage debris during the autumn, highlighting that the site is subject to storm water flow from residential sewers and urban run-off. Several sensitive species of caddis and mayfly were found, as well as a high number of the amphipod *Gammarus pulex*, and number of species with a preference to rapid flow conditions at the site.

Site 2 was situated just downstream of Mote Park Lake, and was found to have extremely clear water and restricted invertebrate fauna when compared to other sites. The clear water is underground spring water directly from within Mote Park Lake via an outflow pipe, which explains the unexpected fauna at this site. Some headwater species were found including the caseless caddis larvar (*Lype reducta* and *Plectrocnemia conspersa*). The cased caddis (*Apatania muliebris*) is an uncommon, glacial species, which likes cold,

spring water, and very few records are found in Kent. The flat worm *Polycelis feline* was also present at this site, which also has a preference for cold water.

Site 3, which is downstream of Square Hill road, was found to have good biological quality; however it has fewer of the more sensitive species which were found at Site 2. The site is downstream of Mote Lake Park and Turkey Mill and the water has been static, resulting in a decline in the water quality. This was the only site in the River Len to have the cased caddis *Ceraclea*, which is usually associated with lakes. After Site 3, the River Len flows into Maidstone Town Centre, and is culverted under the town's main shopping centre.

The full aquatic invertebrate data for the three sites can be found in Appendix G.

Vertebrates

A Medway fisheries survey was carried out in August 2017, as part of the Environment Agency's National Monitoring Programme, which aims to establish the current structure of fish communities in England and Wales. The site in this survey and within the Study Area is called Turkey Mill. The survey length was 100m and was carried out by the electric fishing method.

Common species at the site included Common Bream (*Abramis brama*), European eel (*Anguilla Anguilla*), Gudgeon (*Gobio gobio*), Perch (*Perca fluviatilis*), Pike (*Esox Lucius*), and Roach (*Rutilus rutilus*).

It is important to note that the European eel is of conservation importance, currently on the IUCN redlist as 'critically endangered', a Species of Principal Importance (SPI), on the OSPAR list of threatened and/or endangered species, and is protected on the Eels Regulations (2009).

The Water Framework Directive (WFD) is required to establish a framework for the protection of inland surface waters (rivers and lakes), transitional waters (estuaries), coastal waters and groundwater; ensuring that all aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands are to meet or keep to a 'good status' by 2015 and thereafter. The fisheries report highlighted that the River Len waterbody status is 'Poor'.

The full survey report can be found in Appendix G.

9.5 Archaeology and Cultural Heritage

A preliminary archaeological assessment of the proposed options has been carried out by Trent & Peak Archaeology; a division of York Archaeological Trust (*Historic Environment Desk-Based Assessment: Flood Alleviation Works at Mote Park, Maidstone,* Trent & Peak Archaeology February, 2018).

The objective was to identify the nature and extent of the recorded archaeological resource within the area affected by the proposed options and its immediate environs, and to undertake an assessment of any impacts that the proposed development may have on the historic environment resource.

The assessment has indicated that the proposed development may result in moderate indirect adverse impacts to Mote Park Grade II Registered Park and Garden, specifically to the designed vistas along Mote Avenue to and from Mote House. Furthermore the

assessment has shown that the site may contain remnants of post-medieval fabric relating to the original dam or other landscape and building works within this area of the park, which may be subject to direct adverse impacts.

To mitigate the potential for direct adverse impacts on currently unknown archaeological remains, implemented mitigation measures entailing appropriate recording actions would preserve sites by record before partial loss or destruction thereby reducing the significance of any adverse effect.

Impacts to the character and therefore the significance of the park may arise from the use of inappropriate materials; it is advised that the advice of the Local Authority Conservation Officer and/or the Gardens Trust is sought in this respect. The detailed design should be sympathetic to the character within the park area.

The proposed development will however provide defences against the water level of Mote Park Lake rising during an extreme flood event and causing damage. The proposed development will therefore be a preventative measure against damage being caused to the settings of designated heritage assets including, but not limited to Mote Park Grade II Registered Park and Garden and the Turkey Mill complex. The proposed development will therefore have a positive impact by making a positive contribution to the significance of these assets.

The assessment has indicated that there may be a minor indirect adverse impact upon the Turkey Mill Complex and a negligible indirect adverse impact upon Mote House Grade II* Listed Building and Mote House Stables.

The significance of effects is assessed as being the same for all options and it is noted that there may be scope for mitigation through further archaeological works. Continued dialogue with relevant heritage personnel within Maidstone Borough Council and the Gardens Trust is advised throughout the design stages of the proposed development.

It is noted that the 2017 ALARP report concluded that the economic assessment of all options are proportionate with a cost to save a life and that a major upgrade along these lines is unavoidable, and will be enforced by the Environment Agency.

Cultural Heritage figures can be found in Appendix I.

9.6 Landscape and Visual Effects

A desk based study was carried out to inform a site visit which was carried out on 6 March 2018. The weather during the visit was mostly cloudy and visibility was good.

Photographic images were collected during the visit, and are included in this report at Appendix H. These aim to illustrate the nature of the landscape setting and visual environment likely to be affected by the development options.

A photographic view location plan is included at the front of Appendix H. The images were taken in accordance with recommendations outlined in Landscape Institute Advice Note 01/11: *Photography and photomontage in landscape and visual impact assessment.* Landscape Institute (March 2011), London.

The desk based study included a review of the Mote Park, Maidstone Conservation Plan (Draft 2, June 2008): ACTA, the Sensory Trust, and Enplan.

The Mote Park, Maidstone Conservation Plan identifies 17 distinct Landscape Character Areas within the park. The area likely to be affected by the proposed options falls entirely within Landscape Character Area 1: Park Entrance which includes a sub-character area 1A: North Edge. The sub-character area is identified for its atypical visual connectivity with neighbouring land uses outside Mote Park; specifically the Turkey Mill complex to the north, and the prominence of the park wall along the top of the dam.

The site visit confirmed the beech avenue at the main entrance to the park from Mote Avenue being a strong and distinctive feature of the park. The linearity of the avenue is enhanced where it passes through cutting immediately on approach to the lake. The complex topography belies the functional character of the dam.

The Mote Park, Maidstone Conservation Plan describes the park's regional significance being by virtue of:

- the setting of Mote House;
- the setting of a complete suite of park buildings and structures either by Daniel Asher Alexander or closely following his style;
- a late eighteenth/early nineteenth-century English landscape park on a very broad, simplistic scale at odds with contemporary trends;
- a collection of parkland trees;
- a landscape of considerable time depth where successive phases can easily be traced;
- the site of substantial remains of a seventeenth-century formal landscape;
- the site of an extensive and well preserved deserted medieval settlement containing standing medieval buildings;
- a recreational resource combining the assets of a country park with an urban setting and urban park facilities.

The site survey aimed to identify ways in which the proposed options might impact on these areas of significance. The following issues were identified (see Appendix H for relevant images):

- Loss of trees and changes in topography that could adversely affect the setting of Mote House, and the late eighteenth/ early nineteenth century English landscape park. It is noted that the simple setting of the house is based on the westward axis along the full length of the lake (towards the boat house and main entrance) and the south-westward axis to the pavilion. This suggests a high value is attached to the view from the house towards the area which would be affected by the proposed options. The relocation of the boat club's container may also have an effect on the setting of the house and park;
- Loss of the Park Wall and replacement with a new structure (wave wall) will directly and adversely affect the complete suite of park buildings and structures either by Daniel Asher Alexander or closely following his style; the use of local ragstone and the simplicity of buildings and other features constitute a unique set of structures, contrasting with the style of other English landscape parks of the same period;
- The introduction of cast stone balustrade to West Drive Bridge will also directly and adversely affect the suite of buildings and structures. It is recommended that advice be sought from relevant heritage personnel at Maidstone Borough Council, and in consultation with the Gardens Trust, bearing in mind the engineering requirements of the proposal. It is possible that an alternative detail may be utilised to minimise the adverse effects and still meet functional requirements.
- Loss of trees causing potential adverse effects on the valued collection of parkland trees. The older trees are of interest as markers of routes through the pre-park

landscape. However it is noted that no particularly notable species (Black Walnut, Tulip, Field Maple) will be affected by either option; and

- Loss of trees causing potential beneficial effects on sequential views for pedestrian visitors from Mote Avenue entrance (effect on recreational resource).

It was noted during the survey that the areas to be directly affected by the proposed options (the main entrance from Moat Avenue, the lakeside seating area and picnic area, and the dam abutments and embankment) together function as one of the main hubs of activity within the park, and were busy with visitors despite it being a cold winter's day during the working week. Users of the park were identified as the main visual receptor group likely to be affected by the proposed options. As recreational users, their susceptibility to change is likely to be high.

The survey visit confirmed the only other landscape or visual receptor group that could be affected by the proposed options is users of Turkey Mill Pond. These users will be people attending a wedding reception, again with a high susceptibility to change.

Some aspects of the civil engineering design proposals will affect valued landscape and visual characteristics of the park, and will be broadly similar for all options. Highly sensitive visual receptors at Turkey Mill Lake will be significantly more affected by Option 3 (A2 + C2) than the other 2 options, with Option 1/1A (C1) offering the least significant visual effects. It was also noted on site that there may be opportunities for reinforcement planting of trees and shrubs, possibly including a proportion of evergreen species, that would over time mitigate loss of screening, and possibly enhance screening of activities within Mote Park for users of Turkey Mill Lake.

10. STAKEHOLDER LIAISON

10.1 Turkey Mill Investments

A liaison meeting was held on 5 February 2018, attended by John Hopkins (JH) (BVL), Dougie Lawson (DL) (Turkey Mill), Deborah Turner (DT) (MBC) and Andrew Williams (AW) (MBC).

JH explained the background to the works and described the short list of options being considered. The likely preferred option (Option 1/1A (C1)) of cable tied blocks discharging into the existing spillway channel was also explained. DL noted that if all the works were carried out within Mote Park that the impact on Turkey Mill would be low. One issue noted was to limit construction noise during weddings; primarily 2-3pm on wedding days.

10.2 Stakeholder List

BVL has supported MBC in defining a comprehensive project stakeholder list and stakeholder engagement strategy/process for each of these stakeholders. Stakeholders listed in Table 10-1 have been contacted either by MBC or BVL. MBC has sent stakeholders a letter informing them of the scheme to increase the spillway capacity to reduce risk of failure due to overtopping ALARP.

Table 10-1: Stakeholders

Contact	Organisation	*e-mail*
Egg	Mote Park Fellowship.	secretary@moteparkfellowship.org.uk
Stuart Clarke	Mote Park Water sports centre	moteparkwatersportscentre@live.co.uk
Chris Diaper	Model Boat club	chrisdiaper58@gmail.com
Maurice Knott	Maidstone Model Engineering Society	knott.m@sky.com
John Shrimpton	Maidstone victory angling society	j.ands@mypostoffice.co.uk
Neil Coombs	Kent Wildlife Trust	Neil.Coombs@kentwildlife.org.uk
	Kent Bat Group	info@kentbatgroup.org.uk
John Sweet	Audley homes	johnsweet@audleyretirement.co.uk
Dougie Lawson	Turkey Mill	dougie@turkeymill.co.uk
Sarah Garcia	Historic England	e-seast@historicengland.org.uk
Margie Hoffnung	The Gardens Trust	margiehoffnung@thegardenstrust.org

10.3 Historic England

Historic England were contacted to confirm if their consent is required and whether there are any issues they wish to be considered. Sarah Garcia, Historic England's Business Officer South East has confirmed that planning permission would need to be determined by Maidstone Borough Council and that MBC should be able to confirm this. Should planning permission be required, Historic England would not be consulted on the application as it does not fall into the relevant criteria to do so (being in a Grade II Park).

10.4 Presentation to Councillors

A presentation was given to MBC Councillors on 5 March 2018 by BVL to brief the members on the scheme with a site visit on 6 March 2018.

11. RISKS AND MITIGATION

Table 11-1: Summary of Risk & Mitigation

Risk Ref	Category	Risk/Description/Likelihood (L/M/H)	Likelihood (L/M/H)	Consequence(s)	Mitigation	Status	Risk Owner	Additional Mitigation required
1	Client	Sluice valve: Inability to control water in Mote Park Lake when spillway needs to be constructed.	H	Delay to construction programme if sluice fails to operate. Additional cost to client for contractor delay, standing time and overpumping. All area will be out of bound to the public if pumps are used.	Ensure sluice is in working order.	Outstanding Risk	Client	MBC to consider replacement/refurbishment of sluice for start of works on the spillway
2	Client	Bat roost in sluice boathouse:	H	Delay to construction programme Unlimited fine Could be sent to prison for up to 6 months	Undertake Bat survey in advance of construction phase i.e. during design.	Outstanding Risk	Client	Licence from Natural England required.
3	Client	Qualified Civil Engineer (QCE) (AR Panel Engineer) may not agree with solution proposed.	M	Redesign. Physical works not completed within the Inspecting Engineer's recommended timescale. Negative publicity and enforcement action by Environment Agency.	Design proposals reviewed by an AR Panel Engineer.	Outstanding Risk	Client	MBC to appoint a QCE.
4	Client	Physical works not completed within the Inspecting Engineer's recommended timescale (by 6 June 2020).	M	Environment Agency enforcement action.	Client to ensure they can demonstrate that scheme is progressing.		Client	Agree alternative timescale.
5	Information	Delay in receiving existing site/design information	H	Programme delay.		Outstanding Risk	Client	
6	Contractor	Uncertainty over contractor's contract T&Cs	L	Lack of clarity impacting programme	Early agreement with client on form of		Client	

Risk Ref	Category	Risk/Description/Likelihood (L/M/H)	Likelihood (L/M/H)	Consequence(s)	Mitigation	Status	Risk Owner	Additional Mitigation required
					contract required			
7	Client	Failure to appoint Principal Designer	H	Client will have to undertake Principal Designer. Client may not be aware of what role entails.	Advised of duty		Client	
8	Client	Planning	H	Failure to clarify in advance required documents to support planning application leading to delay to Planning Approval and delay to commencement and completion of Physical works	Contact Planning Department in advance of application to confirm required additional documentation. Contact Planning Department to make them aware of scheme.	Outstanding Risk	Client	
9	Client	Specimen trees. Opposition to its removal	H	Extent of protection required to retain tree affects spillway hydraulics. Public Relations	Look at options for working around the tree to avoid its removal.	Outstanding Risk	Client	MBC able to monitor tree and remove it if necessary
10	Client	West Drive Bridge weight limit restriction		Limit on size of plant contractor can use, rate of progress and duration of the works. Failure of bridge Drowning / loss of life Public Relations	Structural survey of bridge to assess weight limit. Contract documents to contain weight limit restrictions. Consider alternative access to site (Ashford Road)	Outstanding Risk	Client	Condition survey in advance of construction works.
11	Client	Nature and extent of recorded archaeological resource within the area affected by options.	H	Partial loss or destruction of post-medieval fabric relating to the original dam or other landscape and building works. .	Implement mitigation measures entailing appropriate recording actions through further archaeological works	Outstanding Risk	Client	Continued dialogue with relevant heritage personnel within MBC and Gardens Trust.

11.1 H&S Risk Assessment

A Design Risk Management Register, to document how we have identified hazards during this option appraisal process has been prepared. A 'SHE' box, containing 'significant health and safety risk' identified in the risk management register has been placed on sketches. It will be placed on all drawings and will show identified significant residual health and safety risks.

A 'significant health and safety risk' is a risk that is not likely to be obvious to a competent contractor or other designers, an unusual risk or a risk that is likely to be difficult to manage effectively. Table 15-1 summarises the significant residual risks identified during the appraisal.

Table 11-2: Summary of Significant Residual Risks

Ref	Activity	Hazard	Control
S.1	Archaeological impacts	Partial loss or destruction of post-medieval fabric relating to the original dam or other landscape and building works.	Implement mitigation measures entailing appropriate recording actions through further archaeological works

11.2 Construction (Design and Management) Regulations 2015 (CDM 2015)

Regulations 4 and 5 of CDM 2015 sets out the client's duty to make suitable arrangements for managing a project and maintaining and reviewing these arrangements throughout, so the project is carried out in a way that manages the health and safety risks. For projects involving more than one contractor, these regulations require the client to appoint a principal designer and a principal contractor and make sure they carry out their duties.

Regulation 5 Appointment of the principal designer and the principal contractor

(1) Where there is more than one contractor, or if it is reasonably foreseeable that more than one contractor will be working on a project at any time, the client must appoint in writing—

(a) a designer with control over the pre-construction phase as principal designer; and

(b) a contractor as principal contractor.

(2) The appointments must be made as soon as is practicable, and in any event, before the construction phase begins.

(3) If the client fails to appoint a principal designer, the client must fulfil the duties of the principal designer in regulations 11 and 12.

(4) If the client fails to appoint a principal contractor, the client must fulfil the duties of the principal contractor in regulations 12 to 14.

12. OPTION COSTING

High level estimated budget cost for options which are considered viable are given in Appendix B and are summarised in Table 12-1.

These costs are CAPEX costs only and include a 10% addition for contractor contingency/ risk, 5% for minor items, 30% for Contractors prelims / supervision and 15% for Contractors overhead and profit.

A 20% contingency based on project cost has been allowed.

There are no allowances for MBC staff costs, and it is suggested that MBC budgets allow for these and other costs not shown as included in Appendix B.

Costs associated with Environmental mitigation to support planning application have not been determined during this "appraisal of options" stage and will be assessed during "Environmental studies- Stage 2". Consultations with Planning, MBC, interested parties and specialist will be required before a final estimate can be arrived at. A provisional budget estimate of £100k has been allowed.

Table 12-1: Summary Costed Options

Option		Description	Total (£m)
1	**C1 (50m)**	50m wide auxiliary spillway, on abutment formed with grass covered articulated concrete blocks (ArmorFlex or similar)	1.58
1A	**C1 (65m)**	65m m wide auxiliary spillway, on abutment formed with grass covered articulated concrete blocks (ArmorFlex or similar)	1.75
2	**C1 (50m)**	50m wide auxiliary spillway formed with reinforced in-situ concrete	2.59
2A	**C1 (65m)**	65m wide auxiliary spillway formed with reinforced in-situ concrete	3.03
3	**A2 (40m) + C2 (50m)**	40m wide auxiliary spillway, and 50m wide auxiliary spillway, on abutment – both formed with reinforced in-situ concrete	4.19

Cost base Q1 2018.

13. APPRAISAL SUMMARY TABLE

Appraisal Summary Table (AST) is presented in Appendix C. The aim of the AST is to identify the preferred approach to reduce the risk.

Key risk are identified as

Ideal
Desirable, but not ideal
Neutral
Not desirable, but not unacceptable
Unacceptable

Key issues identified:

Table 13-1: Key AST issues

Option		Buildability	Civil Design	Maintenance Cost	Access Arrangements	Archaeology and Cultural Heritage
1/1A	**C1**	The use of modular sections of articulated concrete blocks combined with the location of much of the works along the existing spillway makes construction relatively straightforward.)	'Relatively simple civil design	Low maintenance costs - maintenance limited to grass cutting and regular inspections.	Minor reinstatement to West Drive road due to construction plant movement.	Proposed development may result in moderate indirect adverse impacts to Mote Park Grade II Registered Park and Garden, specifically to the designed vistas along Mote Avenue to and from Mote House. Site may contain remnants of post-medieval fabric relating to the original dam or other landscape and building works within this area of the park. 'To mitigate the potential for direct adverse impacts on currently unknown archaeological remains, implemented mitigation measures entailing appropriate recording actions would preserve sites by record before partial loss or destruction thereby reducing the significance of any adverse effect.
2/2A	**C2**	Constructability relatively straightforward with all works carried out on dryland (to existing spillway). Slight increase in complexity than Option 1/1A with use of reinforced concrete	Relatively simple civil design however use of concrete adds complexity particularly where in-situ concrete is used.	Neutral maintenance costs - maintenance of concrete required (including face of spillway)	Minor reinstatement to West Drive road due to construction plant movement.	As option 1/1A
3	**A2 + C2**	"Option difficult to construct due to works associated with spillway A (i.e. space constraints, requirement to construct spillway with steeper gradient, requirement to complete works on water, etc), Permanent removal of aesthetic backdrop for Turkey Mill. Potential financial loss to Turkey Mill (weddings)."	Additional complexity with requirement to construct spillway at steeper gradient with restricted space. With additional likely requirement to carry out portion of works from Turkey Mill Pond.	Neutral maintenance costs - maintenance of concrete required (including face of spillway)	Extensive temporary haul road required. Access to Turkey Mill will have to be provided from Mote Park.	As option 1/1A

14. SUMMARY & RECOMMENDATIONS

14.1 ALARP Feasibility Report

The 2017 ALARP feasibility report outlined a range of options and their costs to assess which option best reduces risk against an ALARP and whether the cost of works would be proportionate to the corresponding reduction in risk. It concluded that to satisfy the Reservoirs Act (1975) "matters in the interests of safety" to reduce the risk of failure due to overtopping, one of these options (table 15-1) should be selected and implemented.

Table 14-1: Long list of options for increasing the capacity of the spillway identified in ALARP report

Option	Work Involved	Total (£m)
A1-40	40m wide auxiliary spillway, on embankment with 1.2m freeboard – formed with grass covered articulated concrete blocks (ArmorFlex or similar)	1.2
A2-40	40m wide auxiliary spillway, on embankment with 1.7m freeboard – formed with reinforced concrete	1.7
B	Strengthening of embankment crest to inhibit breach	0.7
C1-50	50m wide auxiliary spillway, on abutment with 1.2m freeboard – formed with grass covered articulated concrete blocks (ArmorFlex or similar)	1.4
C2-50	50m wide auxiliary spillway, on abutment with 1.7m freeboard – formed with reinforced concrete	1.9
A2-40 + C2-50	Both concrete options	3.6

Evaluation of risk reduction options by assessing the cost of the options and whether these are proportionate to the reduction in risk to avoid enforcement action was carried out as part of the 2017 report.
The decision on what works should be carried out was to be based on considerations including:

a) Compliance with engineering standards
b) Acceptability of damage to dam
c) Economic calculation of costs for each option and their benefit in terms of reduced risk of failure to the public downstream (release of the reservoir)
d) Other considerations, including impacts of each option.

"Other considerations" recognised that land issues mean that Option A is unlikely to be acceptable to the owner of the downstream face of the dam, and that only Options B or C are likely to be acceptable to the owner. Option B was not recommended unless there are compelling reason why option C cannot be adopted, which have not been presented in discussions on the draft report.

14.2 Hydraulics

The spillway needs to be updated to meet current engineering standards (1 in 10,000 design standard, PMF for safety check flood).

For a 1:10,000yr design flood event (table 5-1), stillwater plus minimum freeboard level varies from 23.09mOD for (Spillway A (40m) + C (50m)), to 23.50mOD for Spillway C (50m). The corresponding flow rates are 139 m^3/s and 142 m^3/s.

For a Safety Check Flood (PMF), stillwater plus minimum freeboard level varies from 23.57mOD for (Spillway A (40m) + C (50m)) to 24.21mOD (Spillway C (50m)). The corresponding flow rate is 298m³/s and 277m³/s. The maximum PMF flow rate of 315m³/s occurs for spillway C (65m).

For Spillway C, the maximum flow rate for the 1:10,000yr design flood event and maximum PMF will vary depending on the width of the channel. The final width will be confirmed at outline design however a width of 58m is considered most likely.

Spillway gradient and material type can be limited by maximum velocity. In summary:

- Spillway "A" requires a concrete spillway
- Spillway "C" for the flows and slopes assessed can be concrete or grass covered concrete cable tied blocks
- For Spillway "C1" slope at right end of spillway needs to be approx. 1:4. This can be steepened to 1:3 20m higher up the existing spillway channel, if required.

14.3 Geotechnical

The ground investigation has been completed but the subsequent testing and factual report not yet received.

Preliminary engineering considerations include the following:

- The embankment composition is varied and often granular in nature. This presents a risk to its permeability and its effectiveness as a dam; however any inundation will be short term and is unlikely to have an impact on stability.
- The soft nature of the clay strata will require attention when designing foundations for structures such as the wave wall.
- The variability of strata to the west of the embankment and the presence of bands of limestone will need to be considered for the construction of the new auxiliary spillway through this area.

14.4 Auxiliary Spillway

The spillway may either be designed with grass covered articulated concrete blocks or with reinforced concrete. The suitability of design is dependent on a number of factors these include hydraulic design requirements and environmental constraints.

Two sub-options for a reinforced concrete spillway were considered. These included a stepped structure and a sloped structure. Of the two sub-options, the stepped structure is preferred due to its energy dissipation characteristics avoiding the need for a stilling basin, and a reduced health & safety risk.

14.5 Wave Wall

A wave wall will be provided along the crest of the embankment to protect the non-spillway sections of embankment from overtopping. The wall will be between 1m and 2m high. It will prevent overtopping of the embankment from waves during design flood events and also retain a shallow depth of water during very extreme flood events.

Various construction options are possible including reinforced concrete, masonry or precast concrete blocks with a textured finish to look like dressed masonry. It is proposed

that the walls will be formed using Redi-Rock precast concrete blocks with a Limestone Blockwork finish, or similar.

14.6 West Drive Bridge

During significant flood events the bridge provides a hydraulic restriction leading to the bridge becoming surcharged. The bridge parapets provide a restriction to flood flows.

It is proposed that the linear sections of the parapet wall (approx 15m x 2) is removed and replaced with bespoke heritage type cast stone (or suitably approved equivalent) open balustrades and coping. The curved end sections of West Drive Bridge's parapet wall will be retained.

A structural assessment of West Drive Bridge, to accommodate the changes will be required.

14.7 Services / Utilities

To accommodate the works associated with any of the options, diversion of the existing HV cables will be required to avoid the proposed works. This should be carried out in advance of any excavation works.

The resulting services maps indicated the presence of the following services:

- One underground 11kV (HV) cable operated by UK Power Networks
- One underground 33kV (eHV) cable operated by UK Power Networks

14.8 Preferred Options identified by BVL

All options were considered viable and meet the standards approach.

The options identified by BVL were generally based on the options outlined in the long list of options identified in the ALARP report. BVL selected options are listed in Table 14-2.

Table 14-2: Summary of Short List Options Considered

Option		Description	Total (£m)
1	**C1 (50m)**	50m wide auxiliary spillway, on abutment formed with grass covered articulated concrete blocks (ArmorFlex or similar)	1.58
1A	**C1 (65m)**	65m m wide auxiliary spillway, on abutment formed with grass covered articulated concrete blocks (ArmorFlex or similar)	1.75
2	**C1 (50m)**	50m wide auxiliary spillway formed with reinforced in-situ concrete	2.59
2A	**C1 (65m)**	65m wide auxiliary spillway formed with reinforced in-situ concrete	3.05
3	**A2 (40m) + C2 (50m)**	40m wide auxiliary spillway, and 50m wide auxiliary spillway, on abutment – both formed with reinforced in-situ concrete	4.19

Option 1/1A - 50m-65m auxiliary spillway formed with grass covered articulated concrete blocks (ArmorFlex or similar) is the preferred options due to.

- Lowest capital cost
- Lowest visual impact as spillway grassed

Option 2/2A - 50m-65m auxiliary spillway formed with reinforced in-situ concrete is not preferred giving consideration to:

- Scour protection will be required at the downstream end of the spillway where the spillway is constructed with reinforced concrete
- Higher capital cost than Option 1/1A
- Higher visual impact of concrete spillway compared to grassed spillway

Option 3 - 40m wide auxiliary spillway, and 50m wide auxiliary spillway on abutment (both formed with reinforced in-situ concrete) is not preferred giving consideration to:

- Highest capital cost
- Extensive vegetation clearance (loss of visual backdrop and continuity of woodland habitat)
- Ownership of the downstream face of the dam. MBC does not own the downstream face of the dam and the landowner is likely to be resistant to options which would remove the existing tree backdrop to Turkey Mill Pond, used as a wedding venue by the downstream landowner.
- Temporary haul road through Turkey Mill to facilitate construction of spillway A2. All access to Turkey Mill will be from Mote Park.
- Scour protection will be required at the downstream end of the spillway where the spillway is constructed with reinforced concrete
- The water level in Turkey Mill would have to be lowered during the works
- Visual impact of concrete spillways and in particular spillway A2
- Potential effects on badgers

Note: For detailed assessment of impacts, positive and negative of the three options please see Appendix C – Appraisal Summary Table.

14.9 Environmental Considerations

There is a preference against Option 3, which would require the felling of more trees, and would have a greater effect on severance of habitat, badger, and visual effects on users of Turkey Mill Pond.

Loss of some trees is inevitable. Development of the design of the preferred option will be informed by arboricultural impact assessment work. An Arboricultural Method Statement will form part of the contract documentation to govern the protection of trees through the implementation of the works.

Further ecological surveys will need to be undertaken to inform mitigation measures to be employed as part of enabling works and the implementation of the scheme.

An archaeological mitigation strategy will need to be prepared as part of the ongoing design work, to minimise adverse effects on built heritage and archaeological interests on the site.

Consultation with Maidstone Borough Council Conservation Officer and The Gardens Trust will be required to advise on the detailed design of replacement elements of structures designed by, or in the style of, Daniel Asher Alexander.

14.10 Recommendation

It is recommended that an auxiliary spillway circa 58m wide on the abutment, formed with grass-covered articulated concrete blocks, is selected and progressed to outline design at an estimated construction cost of £1.66m.

Scope of works includes:

- Auxiliary spillway 58m wide;
- Area of ground lowered;
- Wavewall / raised embankment to retain flood level and wave run-up;
- HV cables diverted;
- Modifications to bridge parapet;
- Specimen trees retained where possible; and
- Environmental mitigation as outlined above.

15. LIST OF STUDIES

Table 15-1 lists the studies commissioned by Maidstone Borough Council as part of this options appraisal. Table 15-2 lists the studies commissioned by BVL under MBC Purchase Order 444622.

Table 15-1: Studies commissioned by MBC

Name	Study Type
Harry Skinner Surveys	Topographical Survey
Zetica	Type D desktop assessment for Buried Services
Zetica	UXO desktop study
Ian Farmer Associates (1998) Ltd	Geotechnical site investigation survey

Table 15-2: Studies commissioned by BVL

Name	Study Type
Trent & Peak Archaeology	Preliminary archaeological assessment
SJA Trees	Tree Survey and Tree Constraints Plan
BVL	Preliminary Ecology Assessment
BVL	Preliminary landscape assessment and walkover survey
BVL	Environmental Screening and Scoping Report

BIBLIOGRAPHY

	Description
1.	Mote Park Section 10(6) Cert 2012 Final
2.	Mote Park Sluice Gate Survey Report
3.	Sluice Gate Operation
4.	Report on an Inspection under Section 10 of the Reservoirs Act 1975
5.	170302 Mote Park Lake Operators Manual_v1.4 LT amends 15 05 17
6.	170418 Notes of meeting at Turkey mill
7.	Assessment of whether the risk of failure of the dam during flood events is “As low as reasonably practicable” (ALARP)
8.	Partial Certificate under Section 10(6) as to the carrying out of safety recommendations
9.	170904 MPL Stillwater approach
10.	Mote Park Conservation Plan - Draft 2 June 2008
11.	170127 Mote Park Lake Flood Study
12.	Appendix 1 - (22.06.05 Register of Special Historic Interest)
13.	Appendix 3 - Mote Park Stakeholders
14.	Appendix 4 - Mote Park Questionnaire
15.	Appendix 7
16.	Appendix 8 - Notes of Visit to Mote Park (14/02/08)
17.	IS1600169- issue sheet - J.C. White
18.	Mote park extracts from 2010 GI (small) - Ian Farmer Associates
19.	Mote Park Flood Assessment - May 10 - Scott Wilson
20.	Mote Park Lake Sup Eng Report September09
21.	MP-Draft Spillway Design-13048-01
22.	MPL CAT Arch Report (March 11)
23.	R18145 2008 Report
24.	Utilities Map
25.	Stakeholder Analysis table October 2016
26.	Mote Park Fellowship (contacts)
27.	Mote Park Tree Survey
28.	Conservation Plan - Figures
29.	Conservation Plan - Full Report (with access Plan)
30.	Mote Park - Maintenance Report (2008)
31.	Historic Buildings Appraisal (1997)
32.	UXO Report
33.	Mote Park Lake Reservoir Engineering Services Proposal
34.	Lidar data downloaded from Environment Agency data portal

APPENDICES

APPENDIX A: OVERVIEW PLANS

- Plan & Sections Option C
- Plan & Sections Option C+A

Option	Work Involved
C1	50 to 65m m wide auxiliary spillway, on abutment – formed with grass covered articulated concrete blocks (ArmorFlex or similar)
C2	50 to 65m wide auxiliary spillway, on abutment – formed with reinforced concrete
A2 + C2	40m wide auxiliary spillway, on embankment; and 50m wide auxiliary spillway, on abutment – both formed with reinforced concrete

APPENDIX B: COST ESTIMATE

High level estimated budget costs

APPENDIX C: APPRAISAL SUMMARY TABLE

APPENDIX D: TREE CONSTRAINTS PLAN

APPENDIX E: PHASE 1 HABITAT SURVEY PLAN AND TARGET NOTES

APPENDIX F: DESIGNATED SITES AND HERITAGE PLAN

APPENDIX G: AQUATIC ECOLOGY SURVEYS

G1: Environment Agency 2005 aquatic invertebrate data (D/S Mote Park)

Species	18-May-05	16-Nov-05	07-Nov-07
Oligochaeta	60	70	50
Piscicola geometra	1		
Glossiphonia complanata			1
Erpobdella testacea			2
Hydracarina	1		1
Asellus aquaticus			2
Gammarus pulex/fossarum agg.	200	150	200
Baetis rhodani	20	12	1
Elmis aenea	5	30	15
Limnius volckmari		2	5
Agapetus fuscipes		30	30
Lype reducta	3	15	10
Plectrocnemia		5	9
Plectrocnemia conspersa	8	1	6
Hydropsyche siltalai	1		
Lepidostomatidae			3
Crunoecia irrorata			1
Lasiocephala basalis		12	
Limnephilidae	2		
Apatania muliebris		1	
Micropterna			3
Micropterna sequax		1	
Mystacides	1		
Tipulidae			1
Limoniidae		4	
Simuliidae		1	
Chironomidae	60	100	4
Polycelis felina		50	150
Polycelis tenuis	17		
Potamopyrgus antipodarum	1	2	
Biological Monitoring Working Party (BMWP) Score	**70**	**75**	**76**
Average Score per Taxon (ASPT)	**5**	**5.36**	**5.07**
Number of Taxa	**14**	**14**	**15**

G2: Kent, South London and East Sussex Fisheries Survey 2017 Report – Turkey Mill

G3: Environment Agency aquatic invertebrate And Fish Survey Sites Map

APPENDIX H: LANDSCAPE PHOTOGRAPHIC SURVEY

APPENDIX I: CULTURAL HERITAGE AND ARCHEOLOGY PLANS

I1: Designated Heritage Assets

I2: Undesignated Heritage Assets

I3: Events recorded by HER

APPENDIX J: MEETING NOTES

Start-up meeting with Maidstone Borough Council 14-Nov-2017

Meeting with Turkey Mill 5 February 2018