Environment Integral to Flood Detention Dams on the River Mole

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SYNOPSIS A wealth of environmental legislation regulates development activities such as building new and improving existing dams. From the outset of any project there is a need to consider environmental constraints and sensitivities as the basis for good environmental design. An understanding of environmental issues ensures that the project team integrates these into the design and programme from the outset to avoid unexpected costs and delays. This paper aims to highlight some of the broad range of issues that may arise, and aid in understanding of the associated risks and mitigations that can be employed.

INTRODUCTION

The development of new and raising of existing dams in sensitive environmental sites can present numerous issues and constraints. This paper examines the process leading up to, through and post construction of such developments, with particular reference to the Upper Mole Flood Alleviation Scheme, which arose from an Environment Agency strategy seeking to reduce flood risk in Crawley and to Gatwick Airport. It comprises the development of two new and two raised dams on tributaries of the River Mole, together with a river restoration scheme, located in sites which have a range of environmental sensitivities.

THE UPPER MOLE FLOOD ALLEVIATION SCHEME

The project covers an area of 90km² at the upstream end of the River Mole, where it flows through Crawley, Horley and across Gatwick Airport. In 2000 there were 109 properties flooded in Crawley and the A23 under Gatwick Airport South terminal was closed for several days due to flooding, whilst in 1968 the terminal and runway were closed due to flooding with the airport closed for several days. The Business Case for the project was approved in 2009, and is to construct four flood detention dams and a river restoration scheme as summarised in Table 1 and Figure 1, with an overall project cost of £19M. The first scheme was built in 2010-11 at Tilgate Lake

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in Crawley. This scheme was prioritised as it was an existing dam under the Reservoirs Act and there were some outstanding "matters in the interests of safety". Worth Farm is being constructed during 2012 and Clay's Lake is planned for 2013. The Ifield site is currently deferred, while the Gratton's Park river restoration is being taken forward by the Local Planning Authority.

Table 1. Elements comprising Upper Mole FAS

Site	**Works**	**Embankment height (m)[1]**	**Volume (m^3)**
Worth Farm	New flood detention reservoir	7.0	241,000
Grattons Park	Renaturalisation of 300m of concrete river channel	N/A	N/A
Tilgate Lake	Raise existing dam to provide flood detention capacity, with no change in the existing permanent lake level	8.0 (5.4)	230,000
Clay's Lake	Replace existing dam by new dam and provide flood detention capacity, with no change in existing lake level	10.8 (3.6)	350,000
Ifield	New flood detention reservoir	2.7	520,000
		Total (m^3)	1,341,000

[1] Brackets denote existing dam height

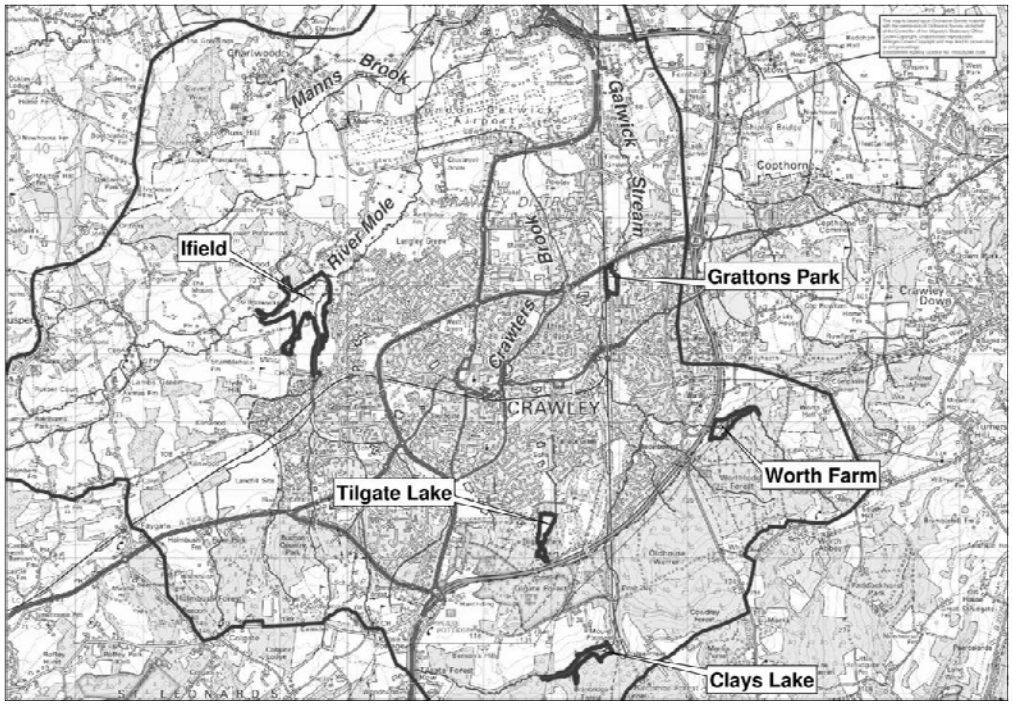

Figure 1. Project layout

ENVIRONMENTAL IMPACT ASSESSMENT

Figure 2 sets out the process of decision-making with regards to EIA. Schedule 3 of the Town and Country Planning (Environmental Impact Assessment) Regulations 2011 sets out three tests which need to be considered when assessing whether a Planning Application would need an EIA:

- The characteristics of the development;
- The location of the development; and
- The characteristics of the potential impacts.

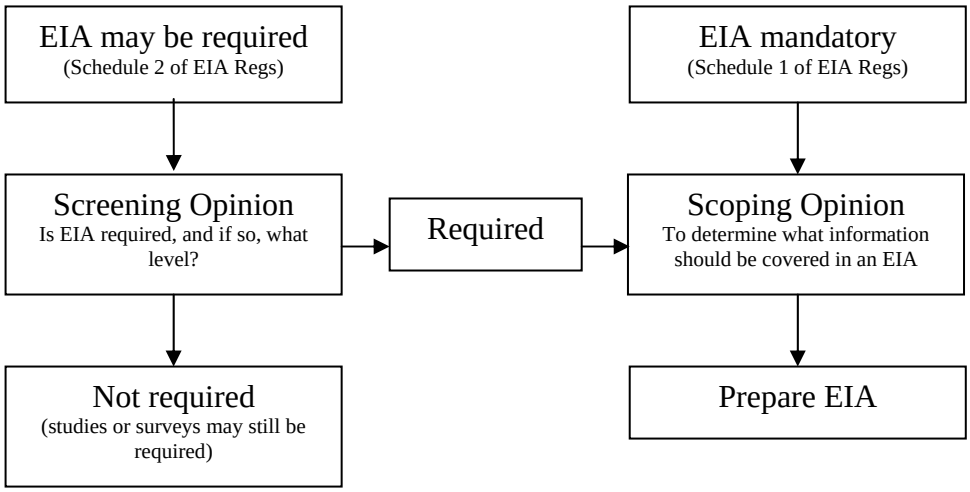

Figure 2. The EIA Decision-Making Process

ENVIRONMENTAL ISSUES ON UPPER MOLE FAS

As all the dam sites are located in countryside areas and are effectively greenfield areas that have previously been undeveloped (aside from the existing dams present at Clay's Lake and Tilgate), they typically have high environmental value. The first step when assessing the significance of each site, to accompany the request for a Screening Opinion to the Planning Authority, was to undertake a desk study. This looks at published sources such as records from the biodiversity records centre, published archaeological finds and site designations, which can be found on websites such as the Local Planning Authority and the Multi Agency Geographic Information for the Countryside (MAGIC, 2012). This identified that there was a range of environmental considerations at each of the sites, including designated ancient woodland (all sites), Site of Nature Conservation Importance (SNCI) (Ifield), Area of Outstanding Natural Beauty (AONB) (Worth Farm and Clay's Lake), a Site of Special Scientific Interest (SSSI) close downstream at Clay's Lake and a number of archaeological features of interest at Tilgate. Tilgate lake also lies within a regionally important countryside park. Given the nature of the works and sensitivity of the

working area at all of the sites, we concluded, in consultation with the Planning Authorities, that a statutory EIA would be required.

We then undertook a scoping exercise to identify what the EIA needed to cover in support of the planning application. This was submitted to the Local Planning Authority, which has a five week period to consult with internal functions and statutory bodies such as Natural England before issuing a Scoping Opinion.

STUDIES AND SURVEYS

To support the EIA and to supplement the desk based surveys, a number of field surveys were undertaken. These were particularly focused on ecology, as an initial walkover identified suitable habitats for a number of protected species at all sites. Surveys carried out included bat, badger, dormice, reptiles and great crested newts. These surveys have to be carried out at the appropriate time of year to identify the target species, whilst some have a phased approach of initial establishing presence, and then where present follow-on surveys to establish population numbers; hence we had to develop the project programme carefully to reflect this requirement. Most species tend to hibernate in the winter, so therefore are only active and possible to easily survey in the summer. Other species are still more constraining, for example great crested newts have a primary three month survey window between mid March and mid June, when the newts return to ponds to breed (at other time of year they are more terrestrial or hibernating). European protected species also have to be surveyed by a licensed person.

Other site surveys that we carried out included fish sampling, a landscape and visual assessment (to identify sensitive viewpoints and changes in views) and a tree survey. Other aspects of the work require consultation. For example, the archaeological desk based assessment we prepared had to be agreed with the County Archaeologist, as it set out our proposed mitigation strategy. Consultees such as these can often be overloaded with consultations to respond to at any one time, and obtaining a response can sometimes be a time-consuming process. Furthermore, there is often a period of dialogue required following an initial response, to agree a mutually acceptable way forward. This is another aspect that needs to be factored into programming any project such as this. It is noted that at both Tilgate and Worth Farm the dormice survey extended over six months with several visits, and in both cases it was only on the last visit that dormice were found.

In addition to the identification of protected species at all of the sites, we found particular archaeological sensitivities at Tilgate, where a number of properties and feature were shown on historic mapping, although there were no surface features. We also identified the importance of trees at all of the

sites – as a collective and also some specific trees which had a particular landscape, historic or habitat value.

INTEGRATION OF ENVIRONMENTAL ISSUES INTO DESIGN

Having identified the key issues at each of the sites, we then had to develop the design to incorporate environmental issues. The mitigation hierarchy (Figure 3) was developed by Mitchell (1997), and is based on the principle that it is preferable to prevent the generation of an impact rather than counteract its effects. It thus suggests that mitigation measures higher up the hierarchy should be considered in preference to those further down the list.

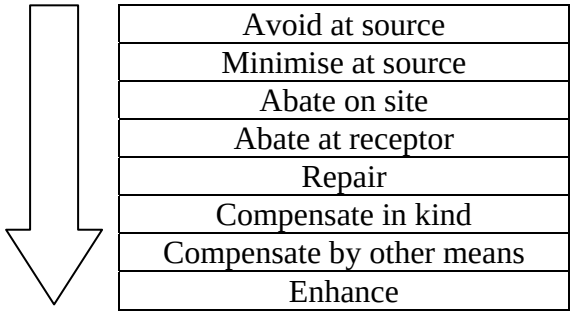

Figure 3. Mitchell's (1997) Mitigation Hierarchy

Following these principles, mitigation needs to begin in parallel with design development (to try to avoid impacts), but is unlikely to be able to completed until the scheme design is finalised (to allow full understanding of the type and amount of compensation required for example). On the Upper Mole we developed a range of mitigations for the varying effects identified. These ranged from adapting the design to avoid the most sensitive locations, moving protected species out of the working area and replacement tree planting to create an end result with a net increase of tree cover in the area (where possible). One of the most important things when developing mitigation is for the whole team to be involved, understand the implications of the findings from the early surveys, and buy in to the proposals that are being developed.

Mitigation should not just be "tagged on the end" of a scheme or developed in isolation from the decision-makers, as it can have significant effects in terms of costs and programme for the scheme going forward. One example of this is that if earthworks are to start in early spring, before some species have come out of hibernation, then the species must be translocated in the autumn before they hibernate. The need for Natural England licences, which in turn cannot be obtained until planning permission has been obtained, means that the planning application often has to be submitted well over a year in advance of any construction. This is to ensure that a licence

is not granted for works that may never go ahead for a planning reason. However, this makes the process more drawn out, in that applications for planning consent and protected species licences have to take place consecutively rather than in parallel. This is illustrated on Figure 4, for translocation of great crested newts at Clays' Lake.

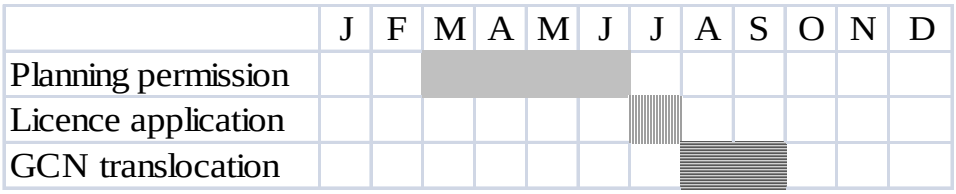

Figure 4. Example of early start required for translocation of Great crested newts

Another example at Tilgate related to a large Yew tree that was positioned just within the dam footprint. The tree was believed to be about 200 years old, and could readily reach 1000 years or over if undisturbed, so it seemed warranted to try to preserve it. It was not possible to move the dam away from the tree, but we incorporated a tree-well into the design to allow it to be retained. This included a semi-circular gabion wall to hold back the dam around the tree. As well as allowing the tree to be retained in its existing location, this also created a new seating area within the park (Figure 5). Other examples of mitigation on the Upper Mole FAS are given in the penultimate section of the paper, describing the environmental legacy of the construction works, which included aspects such as building in improved public access to the dam crest, with new seating and areas of public art.

Figure 5. Yew tree-well at Tilgate

CONSENTING

Planning permission

Once the project team had agreed on the scheme design and environmental mitigation the environmental statement (ES), the outcome of the EIA process, could be prepared. In this case, Tilgate was written as a standalone statement as it was progressed as a single scheme, with Worth Farm, Clay's Lake and Grattons Park forming parts of a larger ES.

The Environmental Statement was just one of a suite of documents that was prepared to support the planning application for these schemes. We also provided reports on all the studies that had been undertaken at different stages (for example the Clay's Lake Reptile Report), along with other reports that were requested such as a planning statement and a design and access statement. The time required to prepare and collate all this documentation should not be underestimated.

As the schemes all required a statutory EIA, the determination period for planning consent was 16 weeks. This allows the local authority time to undertake the relevant consultation with interested parties and advertise the scheme publically for eight weeks. The authority then has to collate all the comments and form a view, before taking the scheme to committee for approval. Tilgate, Worth Farm and Clay's Lake were all approved first time through the planning process.

Protected Species Licensing

As all of the schemes had potential impacts on European Protected Species EPS), an EPS licence was required for each species at each affected site.

These are obtained from Natural England's licensing team (separate from the team that is consulted on day-to-day matters) and take up to six weeks to determine. We required a dormouse licence for each site, and a great crested newt licence for Clay's Lake.

There are three parts to licence applications (Natural England, 2012):

- The application, which gives details of the project and proposed licenceholder;
- A method statement explaining how the development will be undertaken and what mitigation will be provided;
- A reasoned statement in support.

This last document is particularly crucial to make the case for the need for the development to take place, as it is not considered acceptable to disturb such highly protected species if at all avoidable. There are a number of potential legitimate reasons for a licence to be granted, with the key one in relation to dam developments being "Preserving public health or public safety or other imperative reasons of overriding public interest including

those of a social or economic nature and beneficial consequences of primary importance for the environment" (Regulation 53 of the Conservation of Habitats and Species Regulations 2010). A licence will only be granted by Natural England if:

- It meets the requirements in terms of health and safety/overriding public interest
- There is no satisfactory alternative
- The work will not be detrimental to the maintenance of the species at a favourable conservation status.

The protected species' licences for the Upper Mole drew on the business case prepared for the scheme. The reasoned statement in support explained how the scheme would protect homes and property in Crawley, as well as reduce flood risk to Gatwick Airport. This demonstrated the case appropriately in terms of overriding public interest.

In terms of explaining "no satisfactory alternative", we had to draw upon the optioneering process that the team had been through at strategy development stage, to provide evidence that there were no other sites in the area where a dam could be located that would not affect dormice. We also had to demonstrate that we had used each site in the best practicable way and minimised the extent of tree loss through careful on site positioning of the dam and ancillary activities. For example, this meant not locating areas such as site compounds and lay down areas within areas of dormouse habitat.

Demonstrating that there would be no long term detrimental impact on the species was done in two main ways. Firstly the method and timing of tree felling was undertaken so as to minimise disturbance to dormice (refer to Enabling Works), and secondly, we set out methods to ensure that the area of dormouse habitat was retained in the long term. This included provision of nest boxes to provide temporary habitat while the construction work was in place and new habitats were maturing, and planting of areas of new woodland at a ratio of at least 1:1 for those lost. It also included managing areas of existing woodland to improve their value for dormice.

ENVIRONMENTAL ENABLING WORKS

The main construction works at all sites were programmed to start early in the year, to allow construction to take place across the summer season and ideally be completed before the following winter. In preparation for the start of works on site there were a number of activities that needed to take place to clear the site of environmental constraints. We have termed these on site works as "environmental enabling works" (different to the civil enabling works, such as diverting services, improving access or laying compounds). The first of these was tree clearance. Typically tree clearance

must be done between September and February inclusive, to avoid the risk of harming nesting birds. However, here the timing was complicated further by the presence of dormice. The approach to tree felling therefore had to be agreed with Natural England in the protected species' licence, and was timed specifically to avoid sensitive periods for dormice.

Tree Clearance

At Tilgate, we undertook a two phased approach to tree felling. This meant that the trees were felled to stump level during the winter, while the dormice were in hibernation. However as the dormice hibernate within the roots of trees, there would have been a significant risk of killing them if the stumps were also to be removed in the winter. We therefore left the tree stumps in place until early May. This allowed time for the dormice to wake up from hibernation naturally and migrate to adjacent areas of woodland outside the works area. By the time the stumps were removed in May, there was a very low risk of any dormice remaining in the area.

At Worth Farm, we took a different approach, as the area of woodland to be felled was much smaller, was linear in shape, and was connected to a large area of woodland that was being retained. There, we utilised a window of about a month between mid September and mid October, to remove the trees and stumps in one operation. Before this time, the dormice have dependent young in nests which would be highly susceptible to harm caused by felling (Figure 6). Any later than this and the dormice would start hibernation, making stump removal prohibitive. The felling was undertaken starting at one end of the belt of trees, to "flush" the dormice gradually towards the woodland that was to be retained. This allowed the trees to be cleared well in advance of the start of main works the following February.

Figure 6. Dormouse in a nest found at Worth Farm

Reptile Translocation

Although not a European Protected Species (and therefore do not require a licence), reptiles are protected by UK legislation. At Clay's Lake we had a large area of suitable habitat (rough grassland and bracken) and survey work had identified an extensive reptile population which included all four common reptile species - grass snakes, slow worms, adders and common lizard. We therefore had to develop appropriate mitigation to exclude them from the working area before the works commenced. We did this through a translocation exercise, which involved fencing off the part of the working area that the reptiles were present in using reptile fencing – a low (approximately 600mm high) geotextile fence, which is dug into the ground.

The enclosed area was then subject to a trapping programme to catch the reptiles and move them outside the working area (to a receptor site). This trapping was facilitated by the placing of artificial refugia in the form of felt roofing tiles (which reptiles like to hide under because they warm up preferentially) and vegetation clearance, to gradually make the surrounding areas unsuitable and make it more likely that the reptiles would be caught. The guidance (HGBI, 1998) states that a minimum of 60 trapping days are required for a population of this size (although more visits are required if reptiles are still being found at the end of it). The whole process took four months, with over 1000 reptiles being relocated.

Archaeological Recording

In addition to ecological issues, we also had archaeological enabling works to carry out at Tilgate, investigating the presence of the historic buildings with no surface presence. We agreed a programme of excavation works with the County Archaeologist, with the aim of uncovering any relic features and allowing them to be recorded prior to removal to create the foundation of the dam (Figure 7).

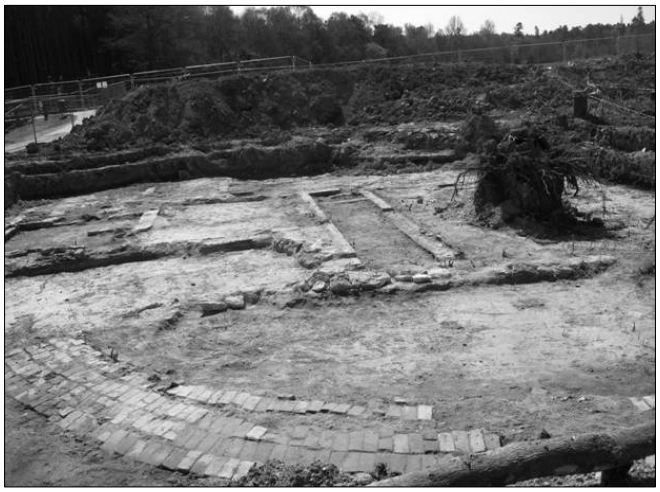

Figure 7. Archaeological excavations at Tilgate

We first undertook geophysical survey and then trial trenching to identify and uncover the foundations of a property dating from the late 19th /early 20th century, some post medieval ditches and the remains of an older structure, possibly relating to iron workings in the area. These were all successfully recorded prior to commencement of the works.

Fish Removal

Tilgate was an existing dam and lake, which was well used by the public for activities such as fishing and boating. To enable the works on the dam to proceed safely, there was a requirement to lower the water level in the lake. Given the large numbers of fish present, they would not all have survived for the duration of the construction period in the much reduced volume of water that would have been left once the lake was lowered, and oxygen levels would have rapidly depleted. We therefore employed a specialist fish consultant to remove the majority of the fish from the lake and store them while the works were in process. The removal was done in a phased approach – partly while the lake was still full, and then again as it was partially lowered. The fish were removed through a combination of electrofishing and netting, and although a certain percentage mortality is expected, this allowed the majority of the fish to be successfully relocated outside the works area. This process gave the parks team the opportunity to selectively restock the lake and change the type of fishery, in line with their aims for the park in the future.

MITIGATION DURING CONSTRUCTION

The aim of the enabling works is to create a site free of constraints, over which the main contractor can then have a "free run". However, inevitably there will be some residual constraints (such as trees close to the working area, which can be retained, but works around them need to be managed to avoid damage). There is also a whole host of environmental legislation and guidance which determines how the contractor should work on site, for example the Environment Agency's Pollution Prevention Guidelines. The Environmental Clerk of Works (ECW) has a role through the construction phase to supervise the works in regard to both of these aspects. The intention of the ECW is to work with and help the contractor to understand and comply with the law, rather than being an auditor.

At Tilgate, a key aspect that required monitoring was silt control, given the large volume of earthworks close to the lake and stream. All exposed watercourse edges were protected by at least one layer of geotextile silt fencing, which acted as a barrier to prevent sediment running directly into the watercourse. We also utilised straw bales in the stream itself and settlement tanks when dewatering (for example from the borrow area). These worked effectively to minimise silt loading of the lake and stream.

Fish health checks were undertaken each month (more frequently in hot weather) to monitor those fish that remained within the reduced lake area and check they were not in distress.

ENVIRONMENTAL LEGACY (MITIGATION FOR PERMANENT WORKS)

The environmental legacy of the scheme includes the sensitive design and landscaping of the new dams to maximise their fit within the landscape. It also includes consideration of materials to be used within the structure, to be sensitive to the surroundings. For example, rustic timber handrails were used at Tilgate to fit within the parkland environment. In all cases, soft solutions such as grass and reinforced grass were chosen in preference to concrete and grasscrete type products where possible, allowing for the predicted operating conditions of the dam. These will ensure that the dams become a pleasant and useable feature of the landscapes that they sit within. We also included new features such as public art, new seating areas along the crest (Figure 8) and the yew tree-well (Figure 5).

Figure 8. View of completed crest at Tilgate, including seating on rear crest wall

The other main type of mitigation is woodland planting to recreate areas of woodland lost under the dam footprint and working area, and to provide screening where possible to shield the more intrusive structures. We are using the borrow areas at all sites to create mitigation / habitat gain; at Tilgate this was used to create a reedbed (see photo of the borrow area at the end of construction, but before reed planting), at Worth Farm it will be used for woodland planting, and at Clay's Lake, it is anticipated that a pond with marginal vegetation will be created.

Figure 9. Borrow area at Tilgate (before planting)

An important implication of landscaping works is the associated time and cost, and the fact that these activities are usually best carried out by a specialist landscape sub-contractor, who will be experienced in this type of works. There will also usually need to be a three or five year maintenance or management programme, to ensure that the habitats are developing in the desired manner and unwanted species are not creeping in, and so are often let as separate contracts to the civil construction contract. This requires a source of ongoing funding and management activities, which should not be overlooked.

CONCLUSIONS

This paper has considered the environmental issues and processes that should be considered when undertaking major dam works, either new or raised dams. The sites considered on the Upper Mole scheme were particularly challenging, as they were all countryside locations with numerous environmental sensitivities. This should therefore be a key consideration in site selection, and decision-makers should be aware of the potential environmental design issues when looking to develop a site in the countryside.

Consideration of environmental issues from the outset will enable the development of a scheme where the environment is fully integrated into both the design and programme. If overlooked or poorly managed,

environmental issues can lead to unexpected costs or delays at key stages such as planning or construction. It is therefore critical to allow sufficient time within the project programme for consideration of these issues, early consultation, appropriate Environmental Enabling Works and to ensure that you have an appropriately experienced team to provide specialist advice as needed.

ACKNOWLEDGMENTS

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