Rivers and Coastal Group

MAIDENHEAD, WINDSOR AND ETON FLOOD ALLEVIATION SCHEME

9/10 September 1999

THE BACKGROUND TO THE SCHEME

COLIN MARTIN

PROJECT MANAGER

The Maidenhead, Windsor and Eton Flood Alleviation Scheme

THE BACKGROUND TO THE SCHEME

Colin Martin

Project Manager
Environment Agency (Thames Region)

---

1. History

The towns of Maidenhead, Windsor and Eton and nearby villages have a long history of flooding from the River Thames. Through the annals of history major flooding has occurred twice a century. Minor flooding is reported much more frequently in earlier days, often once or twice a year. This is not the case in recent years due, I think, to two reasons. The river is now much more under control; it will run at up to 165 m^3/sec before all weirs are fully drawn. Formerly, if your entire year's food crop was alongside the river and it became ruined that would be a more reportable event than some meadowland being flooded.

The last major flood was in 1947 which had a peak of about 500 m^3/sec and before that 1894 which was larger, typically producing flood levels 100mm above those of 1947. There have been several lesser floods since 1947 the most recent being February 1990 with a peak of 320 m^3/sec and a return period of 1 in 7 years.

Should 1947 be repeated today it would affect some 5,500 properties, 4,800 domestic and 700 commercial, and 12,500 people. This compares with 2,000 properties in the flood plain in 1947. In addition there would be a major impact on communications of all sorts, for example the M4, which would be at risk, and on services. Thus giving the lie to the often-expressed local belief that it is only people living in the flood plain who are at risk; and it's their own fault anyway.

After the 1947 flood the Thames Conservancy, who was the responsible authority at that time, decided that the remedy would be two additional channels, each the same capacity as the river. Not surprisingly they concluded that this was too hard and too expensive. They recommended a policy of not allowing development in the flood plain and, when any property in the flood plain came up for sale, the County Council should buy it and demolish it. This was not popular and the idea soon died the death.

Nothing more happened until the establishment of Thames RWA by the 1974 Water Act. This required the Authority to examine the causes of flooding and seek to provide remedies. Thames Water Authority grasped this opportunity and in 1983, engineering and environmental consultants were engaged to study the problem and propose options for flood alleviation.

A comprehensive study of the river from Teddington to above Oxford showed quite clearly that in economic terms money would be best spent in Maidenhead. This economic decision had later repercussions in the parishes downstream of Maidenhead. It proved difficult to find a route to return a Flood Relief Channel around Maidenhead to the river and in January 1989 the decision was made to extend the scheme for Maidenhead to include Windsor and Eton. In March 1989, the Thames Regional Land Drainage Committee agreed to apply for outline Planning Approval for a Flood Relief Channel on the line subsequently adopted. The channel has to carry a flood flow of 215 m^3/sec and, in conjunction with the River Thames and some minor channels can accommodate a peak flow of 515 m^3/sec, which has a 1 in 65 year return period.

2. Scheme description

The Scheme adopted comprises a Flood Relief Channel on the east bank of the River Thames, some localised bank raising near to the river and improvements to the existing flood relief channel through Maidenhead.

The principal element of the Scheme is the 11.6 km long Flood Relief Channel on the east bank leaving the River Thames upstream of Boulter's Weir along the existing Taplow Mill Leat and rejoining the river downstream of Black Potts Viaduct. The majority of the channel is of trapezoidal section, unlined and with a bottom width of 30m and side slopes of 1 in 1½, which, with a depth of 5m, gives a top width of 45m. There are areas where the width is constrained and others of environmental enhancement and as a result of these the width varies from 25m to 102m and averages about 50m.

3. Scheme Design.

Graham Fryer is dealing with this topic and, as he will explain to you, the engineering is really very simple. The unique feature is that the whole concept was, and is, environmentally led.

The channel has been routed to avoid sensitive areas and every opportunity has been taken to enhance the environment and recreate wildlife habitats lost from the main river over the centuries. Water levels within the channel will be regulated by the control structures to match existing average groundwater levels. There will be a continuous summer flow and in a very short time the channel will behave like, and indeed become, a natural river

That this environmental enhancement has been achieved successfully in the design is demonstrated by the comments of the Inspector who took the Public Inquiry and who states in his report: -

> "Furthermore I find that the evidence strongly suggests that the scheme would be a uniquely attractive addition to the landscape between Maidenhead and Eton."

4. Structures

The channel passes under the M4 motorway, several roads (both trunk and local) and three railway lines. Major structures are necessary at all these crossing points, which, together with the associated service diversions, represent the major cost element of the scheme. Many footbridges will be provided to give continuity to severed footpaths and there will be a footpath/cycleway running the length of the channel and linking to the existing footpath network.

5. Spoil disposal

Whilst the finished channel will be a quiet and pleasant addition to the local scene, its construction is causing considerable local disturbance for a limited period of time. Excavation is mainly in Thames Valley sand and gravel and the major challenge is the removal of these minerals from the site. Non-mineral material is being used in landscape engineering around the site. The mineral will be taken along the line of the channel to three disposal points.

Mineral from the eastern and southern sections is being taken onto the M4 motorway via Junction 6. Mineral from the central section is being taken via a conveyor system to Bray Pit on the west bank of the river, whilst that from the northern section is being removed by barges along the Thames and across to North Maidenhead. This will fulfil the promises made to avoid any use of local roads for other than construction traffic to specific sites.

6. The Planning Sequence

Following the decision of the Regional Land Drainage Committee to apply for Planning Consent, the Project Team was established in October 1989, coinciding with the establishment of the National Rivers Authority. Planning applications were submitted to the three District Planning Authorities; the Royal Borough of Windsor and Maidenhead; Slough Borough Council and South Buckinghamshire District Council. Because it became a minerals application it was also submitted to the two County Authorities; the Royal County of Berkshire and Buckinghamshire County Council. The applications were submitted in January 1991. In March 1992 they were called in by the Secretary of State for the Environment for his own decision following a Local Public Inquiry

The Public Inquiry opened in October 1992 and closed just before Christmas of that year and the Inspector submitted his report in April of 1993. There then followed a long wait with little apparent action and it was not until November 1994 that the Secretary of State said he was minded to approve the applications.

There then followed another long wait until final confirmation of all the approvals was issued in March 1995. Then in June, the Provost and Fellows of Eton College issued a challenge in the High Court questioning the Minister's ability to confirm the Compulsory Purchase Order affecting college land as they said they were prepared to grant NRA a licence to undertake the work without the need to purchase the freehold. Eton College had Counsel's Opinion stating that this was possible; the NRA had an Opinion that said it was so complex as to be unworkable.

It was decided jointly by the college and the NRA to seek a third, defining, opinion. This was given by Michael Driscoll QC who declared that it was possible and, subsequently, he was invited to draw up an appropriate agreement. The agreement was drafted and gave NRA all rights as if they owned the freehold except for the extinguishment of Third Party Rights. Eton College's solicitors believed that the issue of a Partial Vesting Declaration could extinguish these; the NRA's solicitors were doubtful of the viability of this method.

A fourth Opinion was sought from Simon Read QC and he concluded that the only way the Third Party Rights could be extinguished was by the NRA owning the freehold, if only for a short time. The NRA insisted that if this was necessary then they should own the freehold until the completion of work.

An Agreement was eventually signed which gives the NRA the freehold until December 31st 2001 and, if work is not complete by that date, the proposed leasehold agreement will apply.

7. Programme and Costs

On April 1st 1996 the Environment Agency took over responsibility for the scheme.

The first sod was turned in October 1996 and final completion is anticipated by the end of 2001.

The estimated gross implementation cost of the Scheme is £85m including a projection of inflation at 3% to the end of the construction period. This sum will be offset by money arising from the sale of minerals.

Expenditure to date has just passed £50m and progress and timing are in line with this expenditure.

8. Operation and Maintenance of the Channel and Landscaping

The channel will be operated and maintained by South-East Area of the Thames Region. There is an agreement with the Planning Authorities for a 25-year Management Plan but of course the Environment Agency, or its successors, will manage and maintain the works in perpetuity.

A Study Group is being established to examine all aspects of Channel operation not just in flood flows but in normal times and most particularly at times of low, or very low, flow.

An Ecological Study Centre is being developed, which will be overseen by a warden and present thinking is that the warden will be in overall charge of the works.

Where landowners have expressed a wish to have land returned to them and have demonstrated their capability of achieving an acceptable level of management, the land will be returned and the management function for the Agency will be to police their performance. This will only extend to the hydraulic boundaries of the channel, and the remainder will stay with the Agency.

CONSULTANTS AND CONTRACTORS (PAST AND PRESENT)

Consultants

Babtie Group, Croydon

Contract Supervision

George Brownlee Partnership, Reading

Quantity Surveyor

Chris Blandford Associates, Uckfield

Landscape Consultants

Georald Eve, London

Mineral Evaluation Consultants

Lewin Fryer and Partners, Hampton

Lead Consultants

RPS Clouston, Didcot

Landscape, and Planning Consultants

Rona Partnership, Ilford

Property Surveyor

Robert Stebbings, Peterborough

Environmental Consultants

Geoffrey Walton, Charlbury

Mineral Consultants

Contractors

Balfour Beatty Construction Ltd, Walton on Thames

Channel excavation, disposal of material and structures from the River Thames to Dorney Rail Bridge

Edmund Nuttall Limited, Camberley

Channel excavation and structures from Dorney Rail Bridge to the River Thames, Windsor; Dorney Rail Bridge (Railtrack)

Mowlems, Bracknell

M4 Motorway Bridge (Highways Agency)

C A Blackwell Ltd, Earls Colne

Manor Farm Containment Cell

Onyx Waste Management, Gerrards Cross

Manor Farm Containment Cell (competent person)

Alfred McAlpine Ltd, Retford

A355 Road Bridge

Geoffrey Osborne Ltd, Chichester

Chalvey Rail Bridge (Railtrack)

P Trant Ltd, Southampton

Slough Allotments

ENHANCING THE ENVIRONMENT

ALASTAIR DRIVER

REGIONAL CONSERVATION MANAGER

The Maidenhead, Windsor and Eton Flood Alleviation Scheme

ENHANCING THE ENVIRONMENT

Alastair Driver

Regional Conservation Manager
Environment Agency (Thames Region)

The Maidenhead, Windsor and Eton Flood Alleviation Scheme has provided huge opportunities for genuine habitat enhancement, making it one of the most significant wetland creation schemes ever seen in the UK.

Enhancements designed and/or implemented so far include:

- Shady pools and nest boxes for Mandarin ducks
- Roosting, breeding and hibernation boxes for bats
- Nesting cliffs for Sand Martins and Kingfishers
- Reed beds for Bitterns, Reed Warblers and Water Rails
- Muddy scrapes to attract passage waders and dabbling duck
- Shingle islands and beaches for nesting Common Terns and Little Ringed Plovers
- Nest boxes for Barn Owls, Kestrels and Tree Sparrows
- Wet grassland for breeding Redshank, Snipe, Lapwing and Yellow Wagtail
- Stick-pile holts for Otters
- Steeper banks with marginal vegetation at the base for Water Voles
- Sheltered shallow margins for fish and ponds for breeding amphibians and dragonflies
- Wildflower-rich grasslands for butterflies an other insects
- Log piles for fungi, invertebrates and amphibians
- Aquatic and wetland planting for nesting waterfowl and dragonflies

All of the above techniques have been tried and tested by the Environment Agency on other river and wetland creation in the Thames catchment in recent years and the lessons learnt are being carried forward into this extensive and exciting project. The Agency has also been highly innovative in its approach to ensuring local provenance plant material is used throughout the scheme. The majority of the 150 thousand trees and shrubs for example, are being grown from native seed specially collected locally. Hopefully, it will only be a few years before the new channel is a wetland of regional, if not national importance for wildlife, and one that the residents of Maidenhead, Windsor and Eton will come to cherish.

CONTRACT 6 - RIVER THAMES TO MAINLINE RAILWAY

THE CONTRACTOR'S VIEW

MIKE CAMPBELL / GEORGE PARGETER

BALFOUR BEATTY CONSTRUCTION LTD
CIVIL ENGINEERING DIVISION

The Maidenhead, Windsor and Eton Flood Alleviation Scheme

CONTRACT 6 - RIVER THAMES TO MAINLINE RAILWAY

THE CONTRACTOR'S VIEW

Mike Campbell / George Pargeter

Balfour Beatty Construction Linited
Civil Engineering Division

THE TENDER

Balfour Beatty were invited to tender for Maidenhead, Windsor and Eton Flood Alleviation Scheme Contract 6 (MWEFAS 6) in early 1997.

During the tender preparation period it became clear to Balfour Beatty that there was scope to amend some aspects of the Client's design which would be of benefit from a cost point of view, but would retain the original parameters of content, appearance, quality and environmental impact in the original scheme.

Balfour Beatty retained the services of Arup Geotechnical who undertook a review of the changes which Balfour Beatty believed could be readily incorporated

A Design Basis Report was produced which outlined the scope of the proposed changes together with the design parameters upon which the alternatives would be based.

The changes which were brought to a level of outline design to incorporate in a tender covered the following areas of the original concept design: -

1 **Modified Channel Design** - trapezoidal cross-section for rectangular.

2 **Reno-Mattress alternative** - Dycel 100 concrete blocks for reno-mattress.

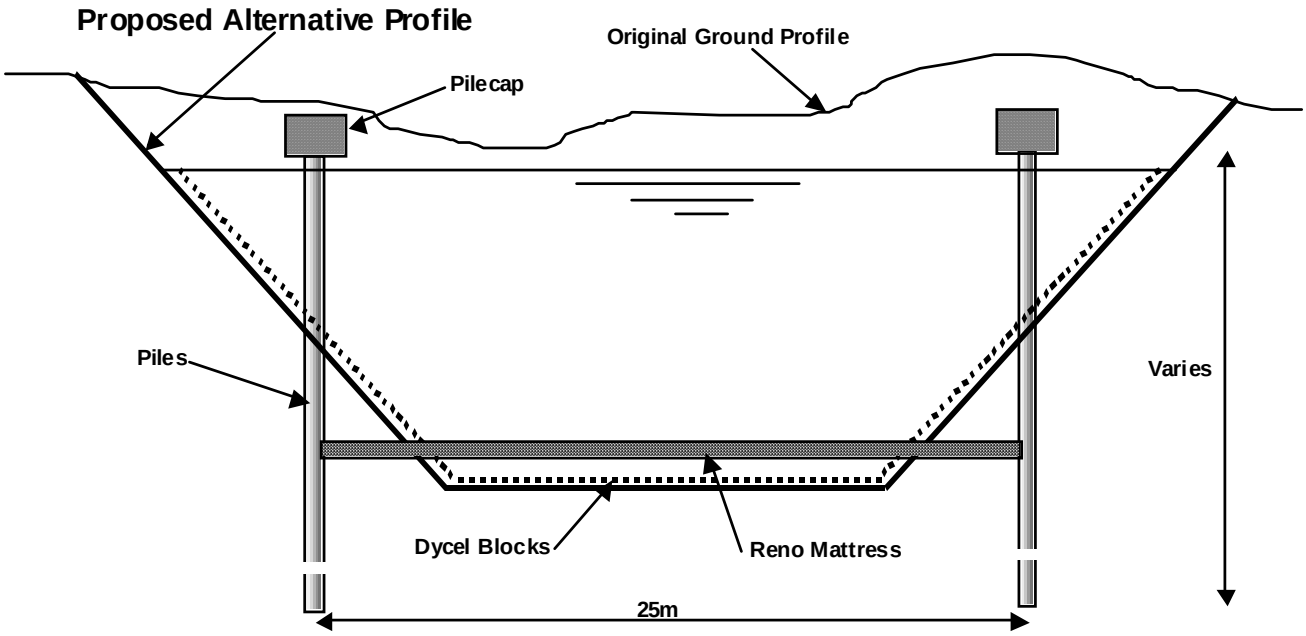
3 **Pile reinforcement design optimisation** - reduces amount of reinforcement in piles.

4 **Modified ground anchor design** - higher working loads in proprietary ground anchors.

5 **Geotextile alternative** - substitute specified material with alternative

6 **Value Engineering** - Value Engineering Clause introduced with reduction in tender sum.

Maidenhead Contract 6 - Alternative Design by Balfour Beatty



Trapezoidal Open Cut in lieu of Piled Rectangular Section

A tender fully in compliance with the Client's original scheme was submitted in April 1997 and an alternative tender based on the changes outlined above was submitted at the same time. The savings offered were arrived at by a simple process of omitting certain basic billed items from the original scheme and adding the additional items from the revised design. The basic contract format - re-measured as per CESMM under ICE 6th Conditions of Contract - remained and applied to the alternative designs as well as the remaining conforming sections.

With the alternative tender Balfour Beatty added a note stating that there were further areas of the works which had not been subject to alternative design but which had scope for further savings. A formula for pursuing savings through design change was included with the submission (Value Engineering).

Between April 1997 and November 1997 a protracted negotiation between The Environment Agency and Balfour Beatty culminated with the award of Contract 6. The contract was for the alternative tender submitted by Balfour Beatty and included an agreed format for pursuing further savings to the project cost through Value Engineering.

VALUE ENGINEERING and ALTERNATIVE DESIGN

I have grouped these two topics together for reasons which will become obvious.

Shortly after award a Value Engineering workshop was organised and representatives from all the interested parties (Client, designers, contractor, about 12 people in all) met at a location remote from their usual workplace and following a "get to know you" dinner and several "getting to know you really well" drinks spent a full day in a brainstorming session. Every aspect of the tendered design was subjected to cursory review and possible changes, which ranged from the conventional to the bizarre, were considered.

Suggestions ranged from "Do we really need a new channel at all?" to "What about a large diameter pipeline?"

From the day's discussions which were lively and in some instances, radical, a list of proposals were put forward for further consideration.

The first full meeting of the Design Change Group took place a few weeks later and the list of possible ideas were whittled down to a running list of approximately 10. These were further rationalised to approximately 10 worthwhile and distinct items.

Outline designs and budget costings were put together over the next few weeks and at the second meeting decisions were made to run with those alternatives which were viable both from an engineering point of view, and an expectation that a worthwhile saving in cost would be forthcoming. The precise number is difficult to define because some items overlapped with others and with the alternative designs upon which the tender was based, so we had to sort out the evaluation and costing of the Value Engineering proposals and separate it from the alternative tender.

The detailed designs were on-going during the run-up to the start of construction work on site in early August 1998 and continued thereafter. We had to be careful that the time involved in the design and approval of the larger changes did not compromise the start on site of those activities. Projected savings could very quickly be eroded if works were delayed. Generally speaking the programme has been unaffected by the Value Engineering process.

The main Value Engineering changes which involved a reasonable level of design input were as follows:

(Note: - *Conforming* means as per the Alternative design which is the accepted Tender)

1. A4 Road and Service Bridges

Conforming Two span conventional bridges with centre pier and abutments on piled foundations, in-situ deck with bearings and inspection platforms.

VE Alternative Single span integral bridge with piled abutments and in-situ arched soffit bridge. No bearings hence no inspection platforms.

2 Berry Hill Lined Channel North

Conforming Bored concrete piles on both sides of rectangular channel with sheet piles at northern end to form lead-in from Main Channel.

VE Alternative Reduced number of bored piles and deletion of sheet piles. Trapezoidal open cut to slopes.

3 Taplow Lined Channel South

Conforming Combination of open slope cutting with slope stability piles, contiguous bored concrete piles and extensive crib walling.

VE Alternative All piles removed, slopes re-designed and quantity of crib walling reduced substantially.

4. Mill Lane Bridge

Conforming Diaphragm wall abutments with single span voided in-situ deck with 13 weeks settlement/deflection period.

VE Alternative Three-span box culvert structure without piles constructed within cofferdam.

5. Taplow Intake Structure

Conforming Contiguous bored pile outer walls, two staggered splitter walls with water control radial gates.

VE Alternative Traditional RC concrete outer walls, squared splitter walls, all constructed within cofferdam. Radial gates as conforming.

These Value Engineering initiatives have realised worthwhile savings for both the Client and the Contractor, none of which would have been possible without the co-operation and commitment of all parties working together for the overall good of the project.

Partnering is a buzz word in contracts these days and in an informal way this has and continues to be a good example of partnering at work.

PROGRAMME

The project very simply involves forming a channel, part on line of an existing Leat from the River Thames, and partly across virgin ground. The channel varies in width but is on average 24m wide and 4/5/6m deep. There are a few structures along the way and varying degrees of channel lining and landscaping complete the picture. All pretty easy!

However, what makes the thing a bit more interesting and challenging is the fact that in forming a new channel a home needs to be found for the material excavated either in deepening the Leat or digging the channel in virgin ground. The planning approval for the project dictates that no excavated material can leave the site by road. All materials excavated either stay on site for future use (topsoil) or are transported by barge to a designated disposal area at North Maidenhead.

The linear nature of the channel (approx. north-south) therefore dictated that from an earthworks point of view the progression of the earthworks should be from south to north, on the basis that when you dig away any part of the channel (which effectively occupies the full width of the site) the haul route has effectively been removed. A further constraint limiting access to the site from the public highway to a single point at the south end of the scheme also had a major influence on the timing of the excavations Remove the haul route and there is no access for materials deliveries to the north of the site.

Don't leave anything behind was at the forefront of the planner's thinking, and "don't cut off your access to spite your haul route!"

Essentially then the plan was to construct the structures and channel walls and follow up with the channel excavation and finishes. This is essentially how things have actually progressed on site- with one or two exceptions.

The contract construction period runs from August 1998 to October 2000, a period of 117 weeks. An original requirement to install some piles at the extreme south end of the scheme at the Mainline rail embankment for the Railtrack contract was removed at an early stage, and a constraint which denied access to part of the site until late August 1998 effectively dictated that works on site did not start until early August 1998.

At the A4 end of the channel a new bridge to carry the A4 over the channel is required and there is insufficient room to carry out this work safely or indeed practically without closing the A4 to traffic. This is a major traffic route and total closure is unthinkable because of the proximity of the River Thames which limits the possibilities for diverting traffic.

The Client's design therefore allows for a full diversion of the A4 into the open land to the north and along the route of the new channel at Berry Hill Lined Channel North. The new bridge at the A4 therefore has to be constructed and the road re-diverted before work can start on the channel excavation immediately north of the A4. This temporary diversion is currently in use.

An added complication is the proliferation of public utility apparatus (gas, electricity, water in its many forms, BT, cable TV etc) in the footpaths, verges and in the carriageway of the existing A4. These all need to be diverted (either temporarily or permanently) before work can start on the main bridge. Again this all takes time and if BT are to be believed their cables along this route are the most important set of cables in the UK. Given the time it is taking to carry out the diversion work they might well be right!

For those of you who know Maidenhead, the new traffic signals at the east end of the A4 where it crosses the channel are another major issue which has had its own impact on the contract.

So, the idea was to construct the structures, divert the services and carry out de-silting of the Mill Leat between August 1998 and late autumn 1999. The main excavation would then run until mid-summer 2000 with finishings completing the project by October 2000.

CONSTRUCTION

Despite the long run-in between contract award and commencement on site it was not possible to eradicate all the problems which inevitably affect a project of this nature. With the best will in the world problems often only come to light when you start to do the work and this proved to be the case on Contract 6. Access to parts of the site proved to be a problem - additional trees had to be felled, statutory undertakers apparatus was either in the way or had to be lowered to afford access, and access roads had to be constructed to provide a route at North Maidenhead for disposal of excavated materials. A temporary wharf on the west bank of the River Thames was constructed and a second wharf in the Mill Leat has also been constructed. These two wharfs are the loading and un-loading points for the excavated materials which are to be transported from the main site and disposed of at North Maidenhead.

The excavated material is loaded on to dumptrucks, transported to the Leat wharf, loaded on to barges, transported up river, unloaded from barges and on to dumptrucks at the North Maidenhead wharf From there it is hauled approx. 3km to its final resting place at North Maidenhead. Approximately 246,000m^3 of excavated material will be disposed of in this manner.

To allow this to happen Taplow Mill Leat has been deepened by the dredging of 30,000m^3 of silt, which is also transported to North Maidenhead by barge. The existing Leat was not deep enough to allow the sort of navigation we required. Following the installation of sheet piles along the sides of the Mill Leat the channel will be excavated to its final profile. This activity and the anti-scour protection to the new bed are virtually the last activities to be carried out.

Perhaps the most significant problem associated with the construction phase of the project is the need to control ground water.

During the winter of 1998/99 ground water rose to a level approximately 1.2m above its mean level. This caused major problems as many of the activities taking place at the time were associated with foundations for structures which are founded below water table level. A de-watering system was introduced and this enabled work to proceed on construction of the structures foundations.

In addition, access to the designated disposal areas for excavated materials became very difficult due to the high level of the ground water. In this case it was totally impractical to even consider pumping and there was nothing which could be done but wait until the level dropped to a safe level. As in all situations like this the safety of all personnel was paramount.

On site at the moment we are building two structures (Mill Lane Bridge and the Intake structure) inside a large cofferdam. We have installed a de-watering system which is coping with in excess of 250l/sec of ground water. In real money this is equivalent to 200,000 gallons/hr or 4.8M gallons/day. To deal with this we have 9 No. 5.5kw in well points plus 2/3 6" pumps inside the cofferdam. All this water has to be disposed of and the new main channel to the south of Mill Lane forms a suitable if not exactly convenient lagoon.

The environmental impact of our activities is a continuing subject for debate and we have had to give considerable thought to the timing and methods to be adopted before proceeding.

We have worked in close co-operation with the Client and his Engineers in formulating our methods and in agreeing the best, most acceptable times to proceed.

The specification indicated that great emphasis would be made in minimising the impact of the works on existing trees, fauna and wildlife. Many trees have been removed out of necessity but many more have been retained. In some cases we have had to work with fairly large pieces of kit (e.g. piling rigs and cranes) in close proximity to overhanging trees. However, together we believe we have managed to keep the number of trees to be removed to a minimum.

Bats have been re-housed and badgers have had their habitat protected by high fencing. Measures were taken before the nesting season to remove potential nesting sites before the various species in the Mill Leat could establish themselves.

In the disposal area at North Maidenhead we have allowed nesting sand martins to hatch their young un-disturbed and not until the nests were abandoned did we backfill that particular area.

Water plants were removed and re-planted under the direct guidance of The Environment Agency.

Noise monitoring and dust control measures are an on-going part of everything we do. There are clearly defined parameters with respect to noise levels parameters and our activities are being closely monitored by the local environmental authorities.

The finishes associated with all sections of the project ensure that the maximum attention is paid to ensuring that, given time, the new channel will take on the appearance of a stretch of waterway that was always there, and hopefully the disruption which inevitably accompanies such a scheme during the construction phase will be a distant memory. It is to be hoped that the efforts by all involved in achieving what will undoubtedly be a major asset to the local environment will be appreciated by all who avail themselves of the many pleasurable pursuits which the channel will offer.

CONTRACT 9 - MAIN CHANNEL AND ASSOCIATED WORKS

JAMES MORGAN

EDMUND NUTTALL LTD

The Maidenhead, Windsor and Eton Flood Alleviation Scheme

CONTRACT 9 - MAIN CHANNEL AND ASSOCIATED WORKS

James Morgan

Project Manager
Edmund Nuttall Limited

In December 1998 Edmund Nuttall Limited was awarded Contract 9 of the Maidenhead, Windsor and Eton Flood Alleviation Scheme [MWEFAS] by the Environment Agency. Valued at £20 million the contract has a programmed duration of 149 weeks. [Contract 9 is an amalgamation of four separate contracts].

The overall MWEFAS scheme comprises the construction of an 11.8 kilometre flood alleviation channel for the River Thames. Contract 9 represents a major element within this scheme and involves the excavation of a trapezoidal channel that extends 9.2 kilometres between Dorney Bridge in the West to Black Potts, Eton in the East, where it joins the River Thames.

This presentation will address the following issues:

- **The sequence of construction**: Mobilisation; the procurement of plant; the management and implementation of the works.

- **The structures**: Eleven bridges, two level retaining structures [weirs] and one 'Integral structure' [a siphon structure under the main channel] are being constructed. The paper will give two or three examples of the construction methods for both culverts and bridges, particularly the Black Potts viaduct works. Two alternative designs have also been incorporated into the scheme by Nuttalls. These involve top-down construction methods on the Slough Road and Pococks Lane bridges.

- **Mineral removal:** In particular this section will highlight the use of the GPS [Global Positioning System] satellite system for all the excavation works, and will explain the removal of minerals to stockpiles prior to final removal from site. Some 2.5 million cubic metres of material is being excavated of which 1.7 million cubic metres are gravel for export.

- **The problems:** This part will examine, quite briefly, the problems that have bean confronted in the project: the difficulties in recruiting labour locally; the restrictions on working hours due the proximity of residential areas.