CONSENTS MANAGEMENT SYSTEM

VOLUME 5

SECTION 36
ENVIRONMENTAL STATEMENT

SECTION 36

APPLICATION FOR PERMISSION TO CONSTRUCT & OPERATE POWER STATION

AMOCO POWER RESOURCES (EUROPE) LIMITED

GREAT YARMOUTH POWER STATION

ENVIRONMENTAL STATEMENT

APRIL 1996

M&M Document No. 35.00/PA58.0002
00566R0 000/S1/1/JT

CONTENTS

APPENDICES

FIGURES

LIST OF ABBREVIATIONS

BATNEEC	Best Available Techniques Not Entailing Excessive Cost
BPEO	Best Practicable Environmental Option
CCGT	combined cycle gas turbine
CIMAH	Control of Industrial Major Accident Hazard Regulations
CWS	Country Wildlife Sites
dB(A)	unit of sound pressure level with frequency weighting to compensate for the varying sensitivity of the human ear to different frequencies
DCS	distributed control system
DO	Dissolved Oxygen
EC	European Community
EEMUA	Engineering Equipment and Material Users Association
GIS	Gas insulated switchgear
GT	Gas Turbine
HGV	Heavy Goods Vehicle
HSE	Health and Safety Executive
HMIP	Her Majesty's Inspectorate of Pollution
IPC	Integrated Pollution Control
ISCST	Industrial Source Complex Short Term
JNCC	Joint Nature Conservancy Council
kV	kilovolt
L_{Aeq}	equivalent steady sound level in dB(A) containing the same acoustic energy as the actual fluctuating sound level over a given period
L_{AN}	The A weighted sound level exceeded N per cent of the time
L_N	The sound level exceeded N per cent of the time
LNR	Local Nature Reserve
MW	Megawatt
NO	nitric oxide
NO_2	nitrogen dioxide
NOx	oxides of nitrogen
NR	Noise rating
NRA	National Rivers Authority
OD	Ordnance Datum
PPG24	Planning Policy Guidance note 24: Planning and noise
ppm	parts per million
SO_2	sulphur dioxide
SF_6	sulphur hexafluoride
SSSI	Site of Special Scientific Interest
ST	Steam turbine
TTWA	Travel to work area
UNECE	United National Economic Commission for Europe
UK	United Kingdom
WHO	World Health Organization
WHRB	Waste heat recovery boiler

1. NON-TECHNICAL SUMMARY

Amoco Power Resources (Europe) Ltd proposed to construct and operate a Combined Cycle Gas Turbine Power Station at South Denes, Great Yarmouth. The proposed power plant will be located on part of the site previously used by the oil-fired South Denes Power Station which ceased operation in 1985.

The power station will provide 350 MW of electrical power and will burn natural gas and/or gas condensate. It will help-to displace power at present generated by less efficient and more polluting power stations elsewhere in the UK.

The site

The proposed site for the Combined Cycle Gas Turbine Power Station is situated in the south east of Great Yarmouth on South Denes - a strip of industrial land between the River Yare and the North Sea. Figure 1 shows the location of the proposed site. Great Yarmouth town centre lies 2 km to the north.

The South Denes Industrial Area is relatively flat and very low lying and is devoted to port-related and industrial activities.

Residential areas lie to the north and west of the site. Six hundred metres to the north the Barrack estate is separated from the proposed site by warehouses and factories. To the west, across the river, is the slightly elevated area of Gorleston.

The site itself is roughly square in shape, covering an area of about 7.4 hectares.

The construction of the power station on this site will return to productive use a site that has a long history of power generation but has been lying derelict for some years.

The proposed development

The plant will comprise a gas turbine, a waste heat recovery boiler and a steam turbine. Fuel is burnt in the combustion chamber of the gas turbine from where the hot gases expand through the gas turbine to generate electricity. The hot exhaust gases are then used in the waste heat recovery boiler to generate steam which in turn is used to generate electricity with the steam turbine. The gas turbine and the steam turbine will each be associated with an electrical generator. The power plant will be installed complete with a water treatment plant and once-through cooling water system.

The plant will burn natural gas and gas condensate which are inherently clean fuels. Two new pipelines will be required to bring these fuels to the site from Bacton, which lies 33 km to the north of the site. Natural gas will not be stored on site. Gas condensate will be stored on site in two storage tanks, with a total capacity of 3900 tonnes. The main reason for piping gas condensate to site is to enable its discharge to marine tankers for export.

The plant will operate continuously throughout the year and will be designed to have a minimum net operational life of 25 years.

Emissions of oxides of nitrogen will be controlled during gas firing by the use of Dry Low NO_x Burners. During gas condensate firing it will be necessary to use water or steam injection into t gas turbine to control the emissions of NO_x. The flue gases will be discharged from a 70 m tall stack.

The CCGT plant will be connected to the Eastern Electricity transmission system by a short underground electrical line running north from the plant to an existing overhead line crossing of the River Yare. As this overhead line is not of sufficient capacity, an underground line will also be constructed to cross the river. From the western edge of the river this transmission line will be routed underground to a connection point with the existing transmission line from Burgh Castle to Lowestoft at the existing T-connection to Gorleston. The existing transmission line from the existing river crossing to Burgh Castle will require reinforcement.

Towns water will be treated in a water treatment plant for use as boiler make-up and for water or steam injection during gas condensate firing.

Water will also be taken from the River Yare for use as cooling water. This water will then be discharged to the North Sea at a slightly elevated temperature.

Construction of the new plant is expected to commence in December 1996. The construction workforce will peak at about 250. The target date for full operation is November 1998. An operational staff of about 40 is expected.

Environmental controls at the plant must all be approved by Her Majesty's Inspectorate of Pollution (HMIP). All emissions must be within limits set by HMIP and in the case of aqueous effluents the limits must also be agreed with the National Rivers Authority.

Air quality

Dust may be emitted during several activities associated with the construction works for the proposed power station, for example during excavations and earth moving operations. It is very unlikely during most weather conditions and using the proposed dust mitigation measures that dust emitted from the site will cause nuisance at houses in the area.

During the operational phase the principal atmospheric emissions of concern from the proposed power station will be the oxides of nitrogen. During natural gas firing emission levels of NO_x will be below 60 mg/Nm^3 and during gas condensate firing the emission levels of NO_x will be below 125 mg/Nm^3. The emissions of sulphur dioxide during firing on either fuel will be negligible.

NO_x levels have been monitored in the vicinity of the proposed site and will continue to be monitored during construction and through the first months of operation. As would be expected, the highest long term background NO_x levels were found in the city centre of Great Yarmouth. The two monthly average level found at this site was 44.4 $\mu g/m^3$ which equates to a 98th percentile of 111 $\mu g/m^3$.

The atmospheric dispersion of the emissions of NO_x from the power station has been modelled and the maximum hourly and annual increments to NO_x ground level concentrations calculated.

The maximum predicted increments to annual average levels of NO_x inland due to the proposed power station during natural gas and gas condensate firing are 1.24 $\mu g/m^3$ and 2.58 $\mu g/m^3$

respectively. Adding these to the highest two monthly average the expected annual ground level concentrations for NO_x would be either 45.64 $\mu g/m^3$ (for gas firing) and 46.98 $\mu g/m^3$ (for gas condensate firing), neither of which exceeds the EC annual average limit of 50 $\mu g/m^3$. However, these would be overestimations of the true maximum annual average as the maximum calculated increments to ground level concentrations do not occur at the same location as the highest existing background NO_x level. Also a two monthly average value is likely to be higher than the actual annual average.

The maximum hourly increment during natural gas firing in the city centre is 30 $\mu g/m^3$ and that during gas condensate firing is 63 $\mu g/m^3$. Adding these figures to the 98th percentile value given above results in expected ground level concentrations of 141 $\mu g/m^3$ and 174 $\mu g/m^3$ for gas and gas condensate firing respectively. These are both within the EC statutory limit and the peak WHO air quality guideline.

The maximum hourly ground level concentrations due to the power station would occur approximately 5000 m to the south west (240°) of the plant where the existing background NO_x 98th percentile would be expected to be of the order of 77.5 $\mu g/m^3$ or less. The expected 98th percentile, including this background, would be 124 and 174 $\mu g/m^3$ for natural gas and gas condensate firing respectively, again within the EC statutory limit and the WHO guideline.

Water quality

There is no surface water on the proposed site. The North Sea lies approximately 150 m to the east of the site and 50 m to the west is the River Yare.

The discharge of any effluents during construction, including site drainage will be the responsibility of the Contractor who will reach agreement with the National Rivers Authority and the local sewerage undertakers with regard to the detailed methods of disposal. Standard good working practices should ensure that any impacts on the quality of water discharging from the site will be insignificant.

During the construction of the intake and outfall there is the possibility of disturbance of the river and sea beds respectively, with a corresponding temporary increase in levels of suspended solids. However, disturbance of the sea bed should be minimized should it be possible to float the outfall into position.

Cooling water for the plant will be taken from the River Yare and returned to the North Sea at a slightly elevated temperature. The cooling water is used to condense the steam returning from the steam turbine for reuse as boiler feedwater. It will be dosed with a biocide (sodium hypochlorite) to prevent the growth of mussels and other marine organisms and microbiological slimes within the cooling water system. The quantity of biocide added will be extremely small and it is thought that levels will be undetectable at the outfall to the sea and will have no impact on the marine ecology. It is also anticipated that the warm water discharge will have no significant impact on water quality.

All other water supply requirements will be taken from the Towns water supply. Towns water will be treated in a water treatment plant for make-up to the boiler water system and for water or steam injection to control NO_x during gas condensate firing.

On a day-to-day basis, in addition to the cooling water discharge, the effluents discharged from the power station will be boiler blowdown and the effluent from the water treatment plant. These effluents are discharged with the cooling water to the North Sea.

Boiler blowdown is the discharge of small quantities of boiler water in order to avoid the build-up of impurities in the boiler water. This effluent is virtually pure water, containing very small quantities of various chemicals that are used to prevent corrosion and scaling in the boiler.

The effluent from the water treatment plant will contain salts removed from the Towns water with some additional sodium sulphate produced by neutralization of the spent regenerants.

Any areas of the site that are likely to be contaminated with oil will drain to oil interceptor(s) to limit the oil in water content to below 10 ppm, before discharge with the cooling water. Sewage will be discharged to the local sewerage system.

Noise

Environmental noise levels have been predicted for the new Great Yarmouth Power Station based upon actual field measurements of similar CCGT stations in the UK. An assumption has been made for this development that a high degree of noise control treatment will be introduced primarily because of the proximity of residential areas to the west of the River Yare.

The likelihood that operating noise levels from the station might give rise to complaints has been assessed in accordance with procedures outlined in BS 4142:1990 "Method of Rating Industrial Noise Affecting Mixed Residential and Industrial Areas". Residential positions chosen for evaluation have been agreed with Great Yarmouth Borough Council Environmental Health Department, and measurements have been made of the background noise levels at night. The results show that levels have significantly reduced compared with levels recorded in a previous survey carried out in 1989.

The environmental noise levels from the proposed CCGT station at the four residential positions around the site are predicted to be between 1.0 dB(A) and 5.4 dB(A) below background. BS 4142 would state that complaints might be expected where the predicted level (the rated level) actually exceeds the background by 10 dB or more. An excess of just 5 dB would be considered of marginal significance only. With the station operating a further 6 dB below this 'marginal' level, it will only just be audible at night, and its impact upon residents will therefore be small.

From time to time a power station will generate intermittent levels of increased noise due to occasional venting to atmosphere of excess boiler steam. Additional noise control measures will therefore be allowed for in the design to minimise the environmental effects of such occurrences.

Visual impact

The industrial area in which the proposed site is situated is very flat and low lying and is dominated by the existing power station with its 110 m stack and its 45 m tall Turbine Hall. These buildings are visible for large distances along South Beach Parade (the promenade) and South Denes Road.

To the west of the site, across the river lies the residential area of Gorleston which is slightly elevated. Houses on the edge of this area have a clear view across the river to the site.

The residential area to the north of the site lies at the same elevation as the proposed site and clear views of the existing power station are not possible throughout the area, although the existing chimney is visible from several vantage points.

The proposed power station can be considered to be made up of two elements; the main power station buildings and the 70 m chimney. At this height the stack will rise above the surrounding plant and indeed all other buildings in the area. However, it will appear much smaller than the existing stack and will also have a smaller diameter.

The main power station buildings will be less than half the size of those of the existing power station. Of the six view points considered to be sensitive by Great Yarmouth Borough Council, the power station buildings will not be visible from South Beach Parade, Great Yarmouth or Marine Parade and Burgh Road, Gorleston. From Breydon Water and the A47 Acle New Road the buildings will merge into the horizon. It is the houses on the edge of Gorleston that will have the clearest view of the power station. An artist's impression of this view is shown on the front of this report. The power station will have a modern appearance with a clean outline and a simple bold structure, and will hopefully be seen as an improvement to the existing situation.

Traffic and infrastructure

Vehicular access to the site is via South Denes Road and the A47 which skirts the town centre. In 1992 a traffic survey of South Denes Road (which passes in front of the proposed site) recorded a low 12 hourly traffic flow. The original power station had a peak operational workforce of 270, with a correspondingly high number of associated traffic movements.

During construction a peak construction work force of 250 could result in a peak number of 250 cars travelling to the site. However, the use of minibuses, public transport and car sharing should reduce this number significantly.

In addition to staff transport movements, construction will include civil works traffic, mechanical works traffic and heavy and abnormal loads. Approximately 10 light vehicles per day and 20 heavy commercial vehicles per day on average would be expected to visit the site. Approximately 30 abnormal loads are expected over the 22 month construction period. Every attempt will be made to bring these loads to the site by sea.

During the operational phase approximately 50 journeys to the site may be expected, resulting in no significant increase in traffic in the South Denes area and no effect on local traffic patterns and infrastructure.

Fuel will not be brought to the site by road. Two new pipelines are to be constructed for this purpose and these are the subject of a separate Environmental Statement.

Socio economics

A peak construction work force of 250 is expected, a proportion of which it is hoped will be recruited from the local area.
The operational workforce will be small, with possibly up to 40 staff.

Total investment in the plant will be of the order of £150 million. Additionally operational and maintenance costs will be of the order of £2 million per annum, a significant proportion of which will benefit the local economy.

Ecology

Being a 'brown field' site there is little or no original vegetation present. The site is covered mainly in grass and has little or no ecological interest or value.

There are three Sites of Special Scientific Interest (SSSIs) within 10 km of the site and a further 43 SSSIs within 30 km. Operation of the CCGT plant will lead to slight changes in air quality at these sites. The calculated increments to ground level concentrations of NO_x due to the plant are well within WHO and UNECE guidelines which have been specifically developed to protect flora and fauna.

There are no designated areas of conservation interest such as Marine Nature Reserves or Heritage Coast in the vicinity of the site. Discussions with Anglian Water have shown that the communities of seabed organisms in the vicinity of the site are not diverse and are not of notable interest. The Great Yarmouth area is important for commercial fishing, with cod, herring, dog fish, skate, whiting, whelks, lobster and brown shrimp being landed locally. The inshore area is an important spawning and nursery ground for herring, but is not, however, formally designated as such.

The operation of the outfall will alter the micro-climate within the vicinity of the outfall and may result in the presence of more diverse communities within this immediate area. The small increase in levels of plankton and seabed organisms may have a slight positive effect on the local shellfish and fish communities. However, these changes may not be as notable as would be expected due to the previous existence of a power station outfall within the vicinity and of other pollution sources in the Great Yarmouth area.

Cultural heritage

An assessment of the archaeological impact of proposed development of the power station site indicates that the natural shingle spit upon which it stands dates form the early medieval period, with medieval levels surviving *in situ* beneath later deposits. The development site was unoccupied by modern buildings until the building of the power station in 1954. Archaeological observations at that time into the structure of the spit revealed a 12th/13th century 'beach' surface and associated pottery covered by later deposits. These levels mostly lie at least 3 m below the present surface, at -3.0 m to -4.0 m OD, and proposed redevelopment, where it reaches this depth, will allow specified investigation of these levels, the medieval pottery and its contemporary context, illustrating trading connections of the medieval port. An Archaeological Contractor will be invited to the site to inspect any excavations during the construction phase.

2. INTRODUCTION

Amoco Power Resources (Europe) Ltd propose to construct and operate a Combined Cycle Gas Turbine Power Station at South Denes, Great Yarmouth. The proposed power plant will provide electricity in the most efficient, reliable and environmentally acceptable manner currently possible commercially. The proposed site is located on part of the site previously used by South Denes Power Station. This oil fired power station was constructed in the 1950s and ceased operation in 1985. The old power station is currently being demolished.

The Combined Cycle Gas Turbine Power Station will provide approximately 350 MW of electrical power and will burn natural gas or gas condensate. Natural gas and gas condensate are inherently clean fuels. As its name suggests gas condensate is a by-product of natural gas. It is separated from the natural gas at Bacton.

Natural gas comes ashore at Bacton, 33 km to the north of Great Yarmouth. The gas condensate by-product is currently taken from Bacton by road to North Walsham and then on by train to Ipswich. This results in approximately 25 to 50 tonne lorries making the 9 km journey between Bacton and North Walsham. As part of a separate planning application Amoco propose to construct two new submarine or overland pipelines to carry natural gas and gas condensate from Bacton to the South Denes site. Gas condensate will be stored on site in one or two tanks, with a total capacity of 3900 tonnes. There will be no storage of natural gas. The gas condensate will normally be exported by marine tanker from the port of Great Yarmouth but may be used in the gas turbine, depending on the availability of natural gas, the price of natural gas and the price of gas condensate.

The power station site is situated in the south east of Great Yarmouth on a strip of land between the River Yare and the North Sea. Figure 1 shows the location of the proposed site. Parts of the site not presently built on are covered in grass.

The plant would comprise a gas turbine, a waste heat recovery boiler and a steam turbine. Steam for use in the steam turbine would be produced in the waste heat recovery boiler using the hot exhaust gases from the gas turbine. The electrical power generated will be transformed and dispatched to the Eastern Electricity transmission system. Facilities will be incorporated for abstraction of steam from the steam turbine for sale to adjacent factories if any suitable users can be located. This would increase the efficiency of fuel usage.

Towns water, from an existing supply to the site, will be used for drinking purposes, and will be treated in a new water treatment plant for boiler-make up and for steam or water injection for control of emissions of oxides of nitrogen when using gas condensate as fuel. Water for cooling purposes will be abstracted from the River Yare using a new intake structure and will be discharged to the sea using a new outfall.

In order to operate the plant an Integrated Pollution Control Authorisation under the Environmental Protection Act 1990 will be required from Her Majesty's Inspectorate of Pollution. The Environmental Protection Act 1990 introduced the concept of integrated pollution control to the United Kingdom. This requires processes of certain types and sizes, such as Great Yarmouth Power Station, to obtain an authorisation from HMIP before operation can begin. To obtain this authorisation it must be demonstrated to HMIP that discharges to air, water and land will be

controlled in an integrated manner and that the plant uses the best available techniques not entailing excessive cost (BATNEEC) to control pollution. Pollution control techniques chosen must result in the best possible environmental option (BPEO) ie measures taken to control one type of pollution must not result in an unacceptable increase in another type.

The new CCGT power station will be required to meet all relevant standards set by HMIP, as set out in the Process Guidance Note IPR 1/2 (Revised 1994) Combustion Processes Gas Turbines. The National Rivers Authority are statutory consultees to the IPC authorisation and must therefore also be satisfied with pollution control of the plant. HMIP control all aspects of the operation of the process including technical and procedural aspects, and give legally binding conditions for the plants operation. Discussions have been held with both HMIP and NRA who are to affiliate on 1 April 1996 to become the Environment Agency, and an application for Integrated Pollution Control Authorisation made. Amoco Power Resources are confident of obtaining this authorisation for Great Yarmouth Power Station.

Owing to the size of the electrical output of the plant (350 MW) it is necessary to apply to the Secretary of State of the Department of Trade and Industry for consent to build the power station under Section 36 of the Electricity Act 1989. This Environmental Statement has been prepared on behalf of Amoco Power Resources to accompany this application.

Applications for approval of the gas and gas condensate pipelines and the transmission lines necessary for the power station will be prepared separately by Amoco and Eastern Electricity respectively and do not therefore form part of this statement.

This statement has also been prepared to enable Great Yarmouth Borough Council to determine whether the plant complies with the following criteria as set in Policy INF4 in the draft Great Yarmouth Borough-Wide Local Plan:

a. The scale, height and design of the power station would not have a significant impact on the local environment including the landscape.

b. There will be no adverse effect on railways, roads, the port and other transport operations, taking into account the means of disposal of any residue materials.

c. There is no material adverse effect or harm on and to local amenities, the occupiers of any nearby properties, users of land or the environment.

d. Adequate access, parking and service arrangements can be provided before, during and after the construction period.

e. The construction strategy is satisfactory to ensure minimal disturbance during the construction period.

Policy INF4 also states that the construction of a power station will only be permitted where the applicant can demonstrate that "as far as practicable all cables and underground lines and any overhead lines are located away from built-up areas". This will be discussed in the Environmental Statement by Eastern Electricity.

This Environmental Statement is structured as follows:-

Section 1	-	Non Technical Summary
Section 2	-	Introduction
Section 3	-	Project Description
Section 4	-	The Existing Environment
Section 5	-	Environmental Impact
Section 6	-	Mitigating Measures and Monitoring Programmes

Air quality, water quality, noise and vibration have been covered in depth. Impacts on visual amenity, traffic and infrastructure, socio-economics, ecology and archaeology have also been assessed.

The potential impacts of the construction phase have been discussed separately for each sector of the environment.

As certain design aspects remain to be determined at the time of writing the assumption has been made that in each instance the worst case option will be necessary. This ensures that the environmental statement evaluates the plant alternatives of the greatest potential impact.

A list of the organisations consulted in the environmental impact assessment process is attached as Appendix A.

This Environmental Statement has been prepared by Merz and McLellan who have nearly 100 years experience in the power generation sector. Assistance on noise issues was provided by Spectrum Acoustic Consultants, on marine ecology by Fenviron and on archaeology by Norfolk Archaeological Unit. The archaeological report and its contents is the copyright of Norfolk Archaeological Unit and has been integrated into the main body of the text and is also repeated in full as Appendix B. The artist's impressions were prepared by Trevor Laidler. Additional information has been taken from the Environmental Statement prepared by Rendell Planning (part of High-Point plc) for a proposed power station, also at South Denes, Great Yarmouth in September 1989. This proposal has now been abandoned.

3. PROJECT DESCRIPTION

3.1 The proposed plant

This section briefly describes the proposed 350 MW combined cycle gas turbine power plant.

It is expected that for the majority of its life the CCGT plant will operate continuously at full load (maximum continuous rating), throughout the year, except for essential maintenance and statutory inspections. Thus the plant will be a "base load" plant. It will be designed and constructed with an average annual availability design target of at least 93 per cent.

The plant will be designed for a minimum net operational life of 25 years.

The proposed plant will consist of a gas turbine, a waste heat recovery boiler and a steam turbine. In a gas turbine fuel is burnt in a combustion chamber from where the hot combustion gases expand through the gas turbine to generate electricity. The hot exhaust gases are then used in the waste heat recovery boiler to raise steam. The high pressure steam produced will be used in the steam turbine to generate electricity. The steam leaving the steam turbine will pass to a water cooled condenser where the steam will be condensed and the resultant condensate returned to the waste heat recovery boiler for re-use. Facilities will be included to abstract steam from the steam turbine for sale to adjacent factories if suitable users can be located.

Figure 2 shows a schematic representation of the combined cycle gas turbine process.

The single gas turbine will be nominally rated at 230 MWe and will comprise an inlet air filter, an air compressor, combustion chamber, power turbine, exhaust silencer and electric power generator. The gas turbine will be enclosed in a steel framed building to reduce noise levels emanating from the site. It will have an air cooled generator complete with excitation system, controls and neutral grounding equipment, and all other auxiliaries. The gas turbine unit will be designed to operate either on natural gas or on gas condensate. The plant will be designed for automatic changeover from gas fuel to gas condensate.

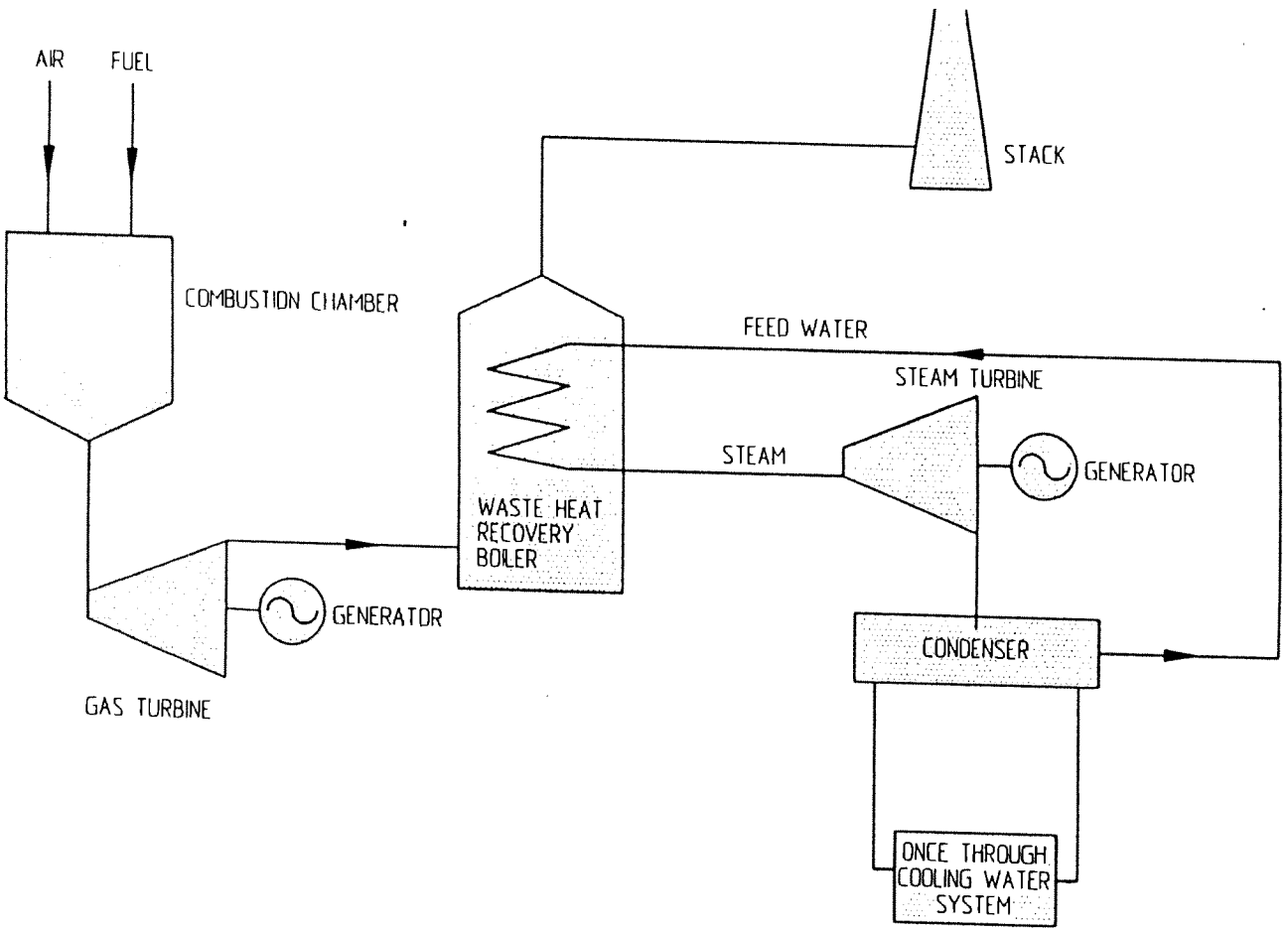
NOx levels during gas firing will be controlled by the use of Dry Low NOx Burners, while NOx levels during gas condensate firing will be controlled by the use of water or steam injection. State of the art firing controls will be used, enabling combustion to be optimised for all operating conditions on either fuel.

The flue gases will be discharged though a 70 m stack. There will be no by-pass stack.

Lubricating oil will be supplied to the gas and steam turbine and generator bearings and will also be supplied for the turbine control and hydraulic oil systems.

There will be one unfired multi pressure waste heat recovery boiler. The boiler may be of the forced draught or natural circulation type.

FIGURE 2



SCHEMATIC REPRESENTATION OF THE COMBINED CYCLE GAS TURBINE PROCESS

The steam turbine will comprise a steam turbine, air cooled generator complete with excitation system etc, a condenser and condensate extraction pumps and air extraction facilities. The steam turbine will be housed, with the gas turbine in a steel framed building.

The spent steam leaving the steam turbine passes to a water cooled condenser where the steam is condensed and the resultant condensate returned to the waste heat recovery boiler for re-use. The steam turbine condenser is directly cooled by a once-through cooling water system utilising water abstracted from the River Yare.

A new water treatment plant will treat Towns water to provide deionised water for boiler-make up and for either water or steam injection for NOx control during gas condensate firing. The water treatment plant will consist of cation and anion exchange units. Storage for chemicals will be provided and the effluents from the water treatment plant will be discharged to the cooling water system.

Cooling water will be abstracted from the River Yare and returned to the sea at a slightly elevated temperature. New cooling water intake and outfall structures will be constructed.

The steam turbine generator will be rated at approximately 120 MWe to give a nominal rated combined cycle output of 350 MWe. The net cycle efficiency would be of the order of 54 per cent. This is based on an average as-new performance and would rise if suitable steam users can be located.

In the event of a gas turbine or boiler trip the plant will shut down. In the event of a steam turbine trip a by-pass round the steam turbine will open, steam will be dumped to the steam condenser and the plant will remain in operation.

The electrical power output from the gas turbine generator and the steam turbine generator will be stepped up to 132 kV and distributed via the Eastern Electricity transmission/distribution system. Other transformers will be provided for plant electrical supplies. All transformers will be oil filled and each transformer will be provided with a containment bund that will contain all the transformer oil in the result of a spillage. These sumps will be drained by pumps to an oil water separator which in turn discharges to the site drainage system which discharges to the cooling water system.

SF_6 insulated switchgear will be installed.

A connection agreement has been concluded with Eastern Electricity for interconnecting the power plant with the Regional Electricity Authority System. The connection will be via a short underground electrical line running north from the plant to an existing overhead line crossing of the River Yare. As this overhead line is not of sufficient capacity, an underground line will also be constructed to cross the river. From the western edge of the river this transmission line will be routed underground to a connection point with the existing transmission line from Burgh Castle to Lowestoft at the existing T-connection to Gorleston. The existing transmission line from the existing river crossing to Burgh Castle will require reinforcement.

The remainder of the plant will consist of gas condensate storage tanks and pumps, electrochlorination plant, air compressing plant, gas pressure reduction and heating equipment,

electrical switchgear and control equipment. Control facilities will be provided as will fire fighting services.

Operation will be carried out under an operation contract. Planned maintenance will be carried out by an appointed operation and maintenance contractor and sufficient spares will be held on site to facilitate reliable operation of the plant.

Process parameters will be continuously recorded to ensure correct and efficient operation of the plant. Any major deviations will be alarmed and corrections carried out on occurrence. Records of performance and deviation will be maintained.

3.1.1 Choice of plant

It is undoubtedly the case that a combined cycle gas fired plant represents one of the more environmentally friendly power generation process requiring the use of fossil fuels. Her Majesty's Inspectorate of Pollution wrote in their report "Review of future of power generation and combustion" (1993) that "The combined cycle system therefore appears to take all the advantages for the foreseeable future." and "The use of combined cycle systems appears to be emerging as the best available technology".

The gas turbine selected will use the best available technology to minimise emissions at source. Oxides of nitrogen will be controlled to limits set by HMIP. The environmental advantages of burning natural gas and the gas condensate, in preference to other fossil fuels, include: the absence of high sulphur dioxide emissions and the absence of emissions of particulates and ash. Additionally natural gas has lower carbon dioxide emissions than other fossil fuels due to its higher hydrogen content.

CCGT power plants have much smaller foot prints than conventional thermal power plant such as the original South Denes Power Station. HMIP's report also acknowledges this "[CCGT] is extremely compact because the combustion turbine itself effectively generates the power equivalent to a large boiler in a fraction of the space". The proposed plant will not require such a large site as the original power station and could therefore free a portion of the land for other developments.

The efficiency of the CCGT plant will be of the order of 54 per cent which compares very favourably to a typical efficiency of 33 per cent for conventional thermal power generation plant such as the original South Denes Power Station.

Although the proposed plant will have a larger electrical output than the original power station (350 cf 254 MW) the annual emissions of carbon dioxide from the original power station were higher than those expected from the proposed plant. The original power station emitted of the order of 1.84 million tonnes per year of CO_2; the proposed plant during gas firing for a year would emit 1.18 million tonnes and in the unlikely event that gas condensate was fired for a year 1.35 million tonnes would be emitted. On a per MW basis the original power station emitted 0.23 kg/MW whereas the proposed power station would emit 0.11 kg/MW during gas firing and 0.12 kg/MW during condensate firing.

The CCGT plant will, therefore, offer the best practicable environmental option for the generation of electricity to the Great Yarmouth area as required by the Environmental Protection Act, 1990.

3.1.2 Fuel

The proposed fuels for the gas turbine are natural gas and gas condensate.

A new high pressure submarine or overland gas supply line will be constructed between the site and Bacton, one point at which the natural gas comes ashore from the gas fields in the North Sea. A gas condensate pipeline will be constructed in parallel. Amoco will design, construct and operate the pipelines and will be responsible for preparing a comprehensive Environmental Statement describing the impacts associated with the construction and operation of the pipelines.

The natural gas will be of a quality suitable for the British Gas Transmission system ie it will have the same composition as that used in domestic properties.

Fuel gas will be supplied from the new pipeline to a flanged terminal point at the site, at a pressure of 65 bar(g). There will be gas pressure reduction facilities and heating facilities on the site to reduce the pressure of the incoming gas supply and to overcome the Joule Thompson effect.

With the exception of temperature and pressure regulation neither the natural gas nor the gas condensate will be treated on site.

An indicative Calorific Value of the natural gas would be 48 000 kJ/kg.

Natural gas will not be stored on the site.

At times of interruption to the gas supply the plant will be capable of automatic changeover to gas condensate. A warning is usually given before an interruption to the gas supplies to give the plant operators time to either shut down in an orderly manner or to make arrangements to change over to the standby fuel. Thus the standby fuel system is not charged or pressurized until notice of an interruption of the gas supplies has been received.

Gas condensate will be stored on site in one or two tanks with a total storage capacity of 3900 tonnes and would have a Calorific Value of approximately 48 000 kJ/kg. This quantity of condensate storage will not require the site to be registered as a CIMAH site. The gas condensate will normally be exported by marine tanker from the adjacent port. Gas condensate may be used in the gas turbine on days when there is an interruption to the gas supply or when the price of natural gas rises above that of gas condensate.

The gas condensate will be treated at Bacton to remove polonium. Any gas condensate containing significant amounts of sulphur will be used for export only and not used as fuel for the power station. Thus two separate tanks may be installed; one for the export of gas condensate containing sulphur compounds and the other for sulphur free gas condensate for export and for use as a fuel.

The natural gas and gas condensate will be purchased under contract which will specify the analysis of the fuel. Intermittent analyses will be carried out to confirm that the fuels conform to the purchase specification. The analyses of the two fuels are shown below.

TABLE 3.1
FUEL ANALYSIS (MOLE PERCENT)

Component	Natural gas	Gas condensate
Methane	92.92	0.00
Ethane	3.11	0.01
Propane	0.63	0.06
Butane	0.24	0.30
Pentane	0.08	1.13
Hexane	0.04	5.09
Heptane	0.02	17.46
n-Octane	0.00	17.50
n-Nonane	0.00	4.96
Leman C7+	0.00	18.24
Inde C7+	0.00	35.25
Nitrogen	2.52	0.00
Carbon dioxide	0.41	0.00
Sulphur	0.00	0.00
Hydrogen disulphide	0.00	0.00

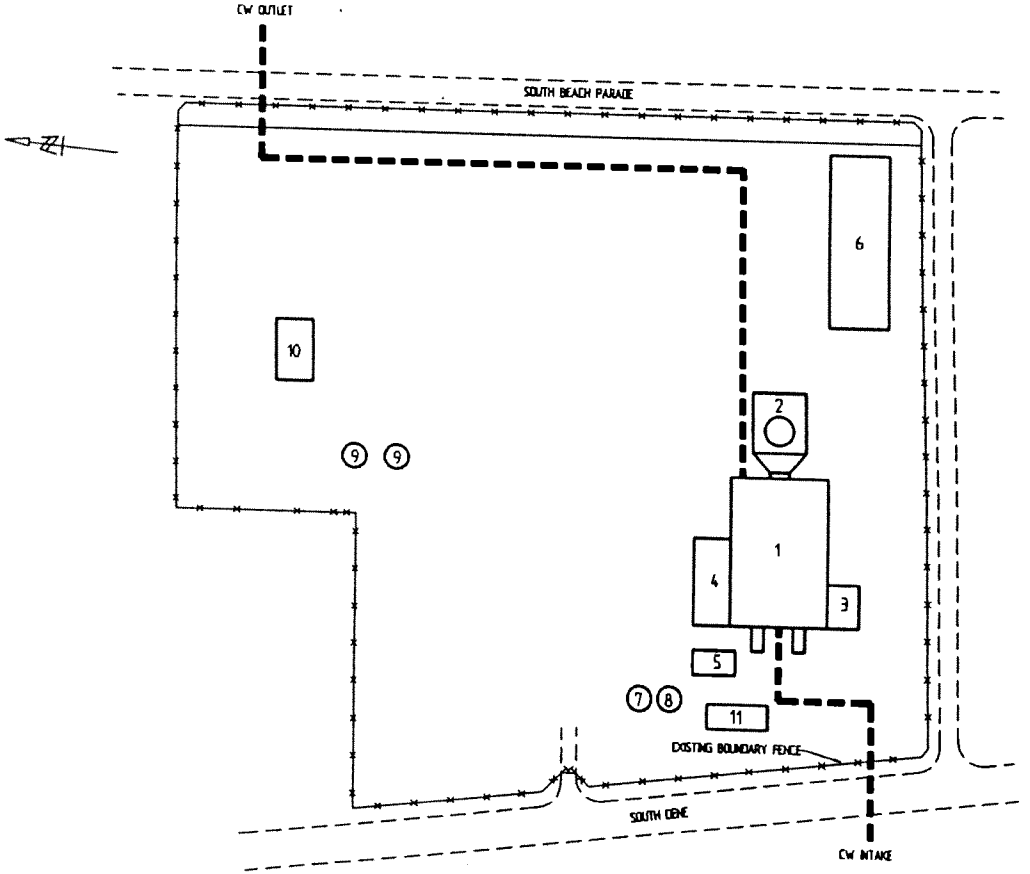
3.1.3 Plant layout

A possible layout of the power station is shown in Figure 3. The layout may be subject to some minor changes as the design process is completed.

The proposed plant layout has been designed taking the following factors into consideration:-

- presence of existing services
- road access
- provisions to minimise noise and visual impact
- compliance with regulatory requirements
- plant safety

FIGURE 3



LEGEND

1. GAS AND STEAM TURBINE BULDING
2. HEAT RECOVERY STEAM GENERATOR
3. WATER TREATMENT PLANT
4. CONTROL AND ADMIN/ BULDING
5. GENERATOR TRANSFORMERS
6. WORKSHOP, STORES AND LABORATORY
7. DEMIN. WATER TANK
8. RAW WATER TANK
9. GAS CONDENSATE STORAGE TANK
10. GAS TREATMENT/PRESSURE REGULATING STATION
11. GIS SWITCHGEAR BULDING

MERZ AND McLELLAN
Consulting Engineers

GREAT YARMOUTH CCGT POWER STATION

SITE LAYOUT FOR 350MW GAS TURBINE COMBINED CYCLE PLANT

- technical requirements

A number of new on site roads and paved areas will be provided as will a small element of landscaping. No off-site secondary developments such as roads or houses are necessary.

The stack will be 70 m high, a by-pass stack is not necessary.

The plant will be designed with a view to auto/remote operation with a minimum of operator intervention being necessary. All facilities for interfacing alarms, information and control systems will be installed so that the plant can be operated from the central control room via the distributed control system (DCS).

Planned maintenance will normally be conducted in the summer months. The design of buildings, enclosures and plant will also minimise regular and long term maintenance. Materials and finishes will be selected to meet this objective and to ensure that the appearance of the plant does not deteriorate with time.

A limited combination of materials will be used in the construction of external structures to give a cohesive appearance to the plant. Colour coated profiled aluminium sheeting will be used on upper levels and facing brickwork or dense concrete masonry will be used where appropriate at lower levels.

Roofs will be generally pitched throughout.

New intake and outfall structures will be required. The proposed length and location of the outfall would result in the end of the diffuser section lying in waters of a depth of approximately 6 m. The waters further to the east of the proposed outfall are shallower over various banks, but reach a depth of 25 m some 4 sea miles offshore.

A comprehensive fire protection system will be installed to cover all equipment on site which could constitute a fire risk. For the protection of equipment within the gas turbine packages, where water spray would cause damage, a total flood carbon dioxide system will be used. An automatic high velocity water spray system for the protection of the turbine lubricating oil tank, coolers and associated pipework will also be provided. Heat sensors will be used in conjunction with automatic spray nozzles and smoke detectors.

Transformer and transformer oil tank protection systems will be designed to meet the fire regulations.

A fire water storage tank sufficient in size to satisfy the relevant fire regulations will be installed and fire pumps, hose reels, fire hydrants and portable extinguishers will be supplied as required.

A compressed air system will be provided to compress and deliver air of a quantity and quality suitable for all general, instrument and control purposes at all necessary points in the station.

The station transformers will be enclosed within fencing with lockable access gates.

The existing metal railings around the site may be replaced by a steel palisade fence for security reasons. A gate house will be constructed and the site will be fitted with closed circuit television.

Storage

One or two condensate storage tanks will be required with a total storage capacity of 3900 tonnes. The tanks will be located within impermeable bunded areas sized to contain 110 per cent of the tank contents. The bund walls and base will be concrete without a drainage system. Rain water or spillage inside the bunded areas will be checked before being pumped out for disposal in an appropriate manner.

98 per cent sulphuric acid will be stored on site within an impermeable bund sized to contain 110 per cent of the contents of the tank. The acid will be used for the regeneration of the water treatment plant cation exchange units.

46 per cent caustic soda will also be stored within an impermeable bund sized to contain 110 per cent of the contents of the tank. This tank will be heated. The caustic soda will be used for regeneration of the water treatment plant anion exchange units.

Storage facilities will also be required for the small quantities of sodium phosphate, hydrazine, ammonia and other chemicals used in boiler water, feed water and cooling water dosing. The storage for these materials is still under consideration. All such chemicals will be retained in bunded areas.

Lubricating oils will be stored on the site within steel tanks in an impermeable bund sized to contain 110 per cent of the contents of each tank. Lubricating oil is used for the lubrication of the gas and steam turbines. Dirty lubricating oils will also be stored on the site for re-use or will be disposed of off-site by an approved and licensed contractor.

Miscellaneous materials such as oils, greases, cleaning substances and materials, laboratory chemicals etc, will be stored in suitable storage conditions or containers on site.

Solid wastes generated on site will include trash removed from the river water by the inlet band screens, domestic and commercial waste (paper etc), miscellaneous waste produced during maintenance (including oil and air filters and ion exchange resins), sludge removed from oil separators and any deposits removed from the boiler during maintenance. These wastes will be removed from site by a licensed contractor to a licensed waste disposal site.

3.1.4 Construction

Demolition of the existing power station is currently in progress. This is part of a separate contract and will remove all structures above ground level.

A contamination study will be prepared by the turn-key contractor before construction can begin. Comprehensive site investigation studies examining hydrology and soil composition will also be undertaken by the turn-key contractor.

The major activities during the construction phase of the project include, for the civil works:

1. preparation of site works;

2. construction of foundations

3. construction of superstructure

Site preparation works involves the levelling as necessary of the site, earthworks and the excavations for foundations.

An Archaeological Contractor will be invited to the site to inspect any excavations made.

The gas and steam turbines will be housed in a steel framed building.

Piling may be necessary for the waste heat recovery boiler, gas turbine, steam turbine and generator foundations due to the heavy loading and the tight tolerance on settlement. The remaining foundations, for the turbine building, skids, pumps, water treatment package and the like, will be spread footings and slabs of various thickness to suit the structural needs. Ground conditions are believed to be suitable for continuous flight auger piling, which is a relatively quiet and vibration free form of piling.

At present the method of construction for the outfall is not known. It is anticipated, that due to the lack of open areas within the vicinity of the proposed development, that this would be undertaken by floating the outfall into position prior to submerging it onto the seabed. This method would cause less disturbance to the marine sediments than should the outfall be dragged into position from the shore.

An area to the north of the proposed power station buildings will be allocated for the storage of plant and equipment and for any on-site fabrication which may be necessary for construction works. An area will also be set aside for car parking. The whole of the existing site will therefore be required at this stage. All necessary measures will be taken to return the laydown area to an environmentally acceptable state on completion of the construction phase. During the operational phase the small footprint of the proposed power station will free a portion of the site for other uses.

All necessary public utilities are already available on the site.

The programme for the mechanical and electrical plant can be considered in terms of the following activities:

1. steam turbine manufacture
2. gas turbine manufacture
3. power plant erection
4. power plant commissioning
5. power plant commercial operation
6. plant take-over
7. guarantee period.

Figure 4 shows the proposed construction programme.

The contract for construction of the main plant will be let out on a single turnkey basis. The turnkey contract will include all major plant items, but will exclude the provision of a high pressure g supply to the site (the responsibility of Amoco).

Commissioning of the power station will take of the order of 12 weeks and will be progressive from final erection checks, precommissioning and setting to work of individual component parts though to the overall testing to prove the technical acceptance of the plant. Tests on completion will demonstrate the fitness for purpose of the CCGT plant prior to commercial operation. Performance tests will demonstrate that the plant complies with the performance guarantees. The reliability of the power station will be demonstrated by operating the plant under commercial conditions for a period without major repair to any item of plant or equipment.

The construction phase is due to commence in the December of 1996, with commissioning in the summer/autumn of 1998 and a target date for full operation of November 1998.

3.2 The site

The proposed Great Yarmouth Power Station will be located on the now disused South Denes Powe Station site in Great Yarmouth, Norfolk.

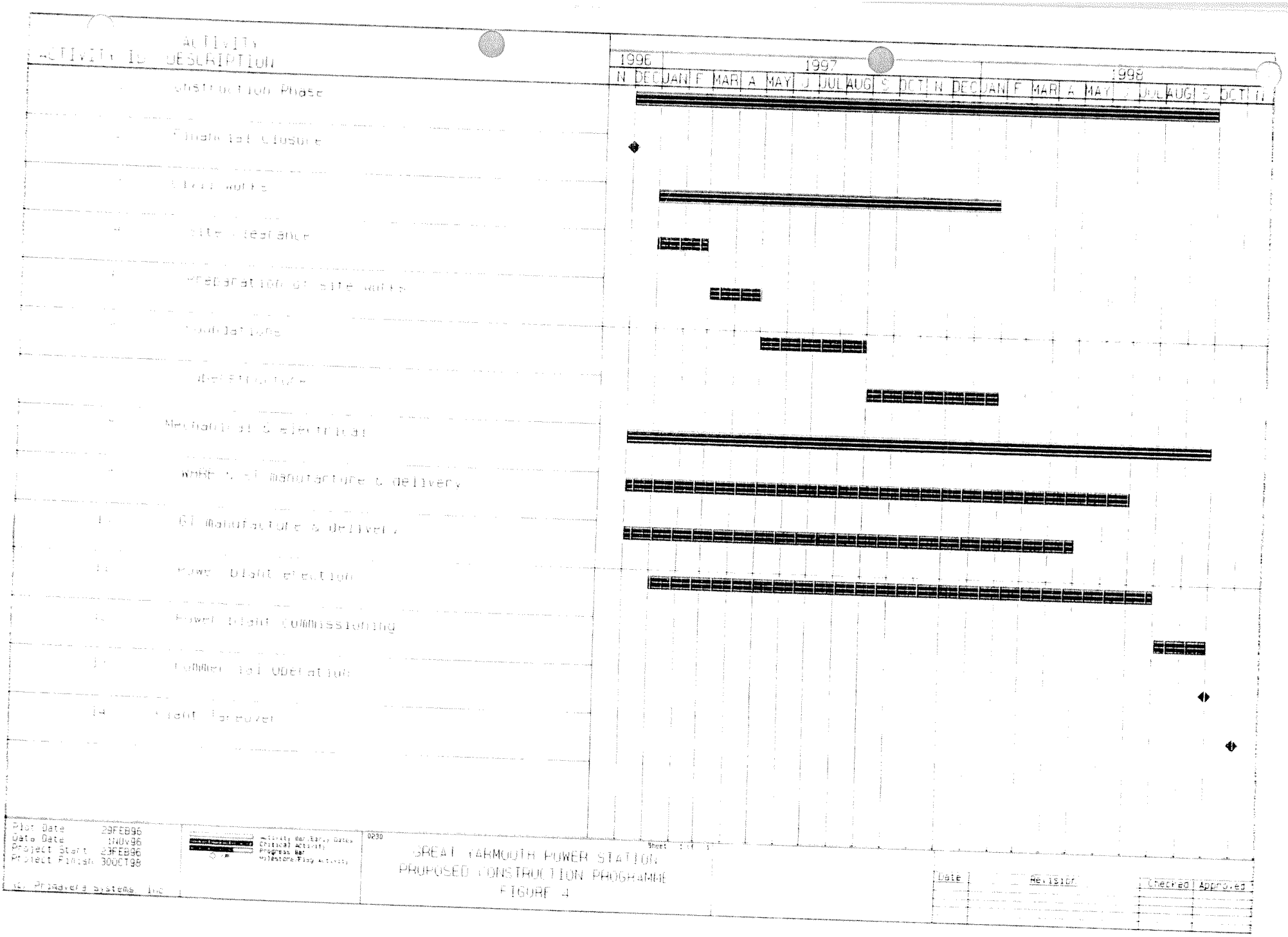
The location of South Denes Power Station is shown on Figure 1. The site is located on the south eastern edge of the town, on South Denes - a strip of land between the Rive Yare and the North Sea. The city centre lies approximately 2 km to the north. The site falls under the jurisdiction of Great Yarmouth Borough Council.

The site is bounded by roads, to the south, east and west. There are factories to the north and south.

Road access to the site is via South Denes Road which runs along the eastern bank of the River Yare to the town centre to join the A47 to Norwich and the A12 to Lowestoft and Ipswich. To the east of the site South Beach Parade runs from the mouth of the Yare northwards to the main seaside leisure and recreational area. There is a thin strip of land between South Beach Parade and the sea which contains a caravan and trailer park. Great Yarmouth Borough Council intend to close this site in the near future.

Residential areas lie to the west and north of the site. To the west High Street, Gorleston lies at 350 m distance across the river. This area is elevated, at approximately 10 m above sea level, and houses on the very edge of Gorleston look down on the power station site. The existing power station chimney is visible in many areas of Gorleston. To the north Harboard Crescent and Peggotty Road are at 600 m distance from the northern edge of the site. These streets are separated from the power station by several factory and warehouse buildings.

The South Denes area is almost entirely devoted to port-related and industrial activities and is the largest industrial area in Great Yarmouth. The South Denes Industrial Area is relatively flat and low-lying (about 4m above ordnance datum). The port activities associated with the oil and gas industry are one of the mainstays of Great Yarmouth's economy, along with tourism, manufacturing (particularly electronics, food processing and packaging), agriculture and service industries.


Activity
Activity Id Description
1996
1997
1998
N DEC JAN F MAR A MAY J JUL AUG S OCT N DEC JAN F MAR A MAY J JUL AUG S OCT N
Construction Phase
Financial Closure
Civil works
Site clearance
Completion of site works
Foundations
Structure
Mechanical & electrical
Manufacture & delivery
GT Manufacture & delivery
Power plant erection
Power plant commissioning
Summer tail operation
Plant handover
Plot Date 28FEB96
Data Date 1NOV96
Project Start 28FEB96
Project Finish 30OCT98
Activity Bar/Early Dates
Critical Activity
Progress Bar
Milestone/Key Activity
© Primavera Systems, Inc.
0230
GREAT YARMOUTH POWER STATION
PROPOSED CONSTRUCTION PROGRAMME
FIGURE 4
Sheet 1 of 1
Date
Revision
Checked
Appvd.

Vessels up to 125 m long and 5.7m draught can use the port. Vessels with a draught of less than 4.3 m can enter at all states of the tide and vessels less than 80 m long can turn in the river.

Some berths in the harbour have consents to handle explosives and therefore have defined hazardous areas of radii of the order of 100 to 500 m depending on the quantity of explosives handled. As the site falls within the outer safeguarding distance Great Yarmouth Borough Council will consult the Explosives Unit of the Health and Safety Executive during the course of their assessment of the Section 36 application for this project.

The power station is adjacent to East Quay which has a depth of 5.8 m, a length of 260 m and is used for the handling of general and bulk cargoes.

To the south of the site is Hartmann Road and beyond this is Omnipac UK, a plant that converts waste paper for re-use. To the north of the power station site there were two factories; the Millora Works which produced electronic components and the Birds Eye frozen food factory. Both these factories are now closed. The Birds Eye factory is used for storage and small factory units. The Millora site is now partly vacant and partly occupied by C-Mac Microcircuits and Farnell Mercator, two electronics companies. A further electronics company, Beck Electronics is sited further to the north. To the west of South Denes Road lies a roll-on-roll-off cargo ferry terminal which is currently undergoing modifications.

The site is roughly square in plan, measuring 300 m along the northern boundary. The site itself is very flat and lies approximately 2 to 4 m above sea level. A 2.5 m metal railing currently surrounds the site, which has a plan area of about 74,000 m^2 or 7.4 hectares.

The site already has comprehensive drainage systems for surface water and sewage.

Site history

Construction of the South Denes Power Station commenced in April 1954 and its four units were commissioned between September 1957 and March 1960. The power station was designed to be coal-fired, however consent to covert to oil firing was given before operation began. The station produced 254 MW of electricity from its 4 x 64 MW sets. Prior to this the site was "greenfield". It was in fact sand dunes on which fishermen maintained and repaired their boats and nets. Details on the archaeology of the site are given in Section 4.8. The power station ceased operating in 1985, was disconnected from the Grid in 1989, and is currently in the process of demolition.

Heavy fuel oil was delivered by sea and discharged to oil storage tanks on a separate site to the south of the power station buildings. There was no significant storage of heavy fuel oil on the main site of the power station.

The cooling system on the power station used river water in a "once through" system, discharging to the North Sea.

The power station chimney was 110 m tall.

Site Geology

The geology of the coastal area of east Norfolk is Pliocene covered with Pleistocene and more recent deposits. The Pliocene in the Great Yarmouth area is characterised by the Norwich Crag deposits. This comprises beds of sand, laminated clays and pebbly gravels. The Pleistocene deposits are represented by material originating from the advance and retreat of ice sheets during the ice ages. These are basically deposits of sands and clays. These in turn are overlain by the Fen deposits which are a flat expanse of peat, esturine silt and clay deposited in the changing conditions after the Ice Age. Seaward deposits tend to be silts and clays with peat further inland.

Along the banks of the river strips of alluvium, the latest material to be deposited have been formed. This consists of sandy clays. Blown sand deposits and sand dunes are found along much of the east coast.

Gravels of predominantly Holocene and Recent age occur along the coast within the vicinity of the site. These sediments rest unconformably on Pleistocene deposits or older strata (British Geological Survey. The Geology of the Southern North Sea, 1992).

The seabed sediments in this vicinity consist of muddy gravels (McCabe, 1981, etc). It is believed that deposition of mud results from the influence on the near shore zone of the turbidity maximum of the River Yare, although some mud may derive from local erosion of early Holocene estuarine muds exposed on the sea floor.

Great Yarmouth was established as a fishing village in about 1000 AD. The spit on which the site is located was formed after this date due to the southward drift of beach material diverting the mouth of the Yare. As recently as 1566 the construction of groynes contained the southward drift and stabilised the mouth of the river.

The geological strata below the power station are thought to consist of layers of sand, gravel, shingle, silts and silty clays extending to a depth of some 50m, where London clay is reached.

Site selection

The South Denes site was chosen as a potential site for a CCGT power station study during a site selection study carried out by Merz and McLellan Ltd on behalf of Amoco Power Resources (Europe) Ltd. This study considered four sites in detail in the East Anglia region where power demand is expected to rise from 580 MW in 1995/96 to about 790 MW in 2001/2 (NGC, 1995). A marking system which takes into account the major aspects of power site selection was used to assess the relative ranking of the various sites.

The marking system considered the following site related aspects:

- fuel supply
- cooling water supply
- fresh water supply
- space available

- transmission connection
- access
- population
- environmental aspects

Environmental aspects were further subdivided as follows:

- air pollution
- thermal water pollution
- other water pollution
- noise
- land use
- flora and fauna
- archaeological remains
- cultural heritage
- socio economic
- traffic

Of the four sites considered the South Denes site achieved the highest score. The advantages of the site include; the reuse of a brown field site; its previous use as a power station site and the existing infrastructure (for example water supplies and transmission lines).

The draft Great Yarmouth Borough-Wide Local Plan sets out the local planning authorities policies and proposals for the development and use of land in their area. The plan encourages the re-use of brownfield land and states that "Derelict land represents a wasted resource, creates a poor impression of the Borough to visitors and potential investors, can contaminate the natural environment and in some cases can be a danger to public health. The Borough Council recognises the importance of reclaiming derelict sites to: a) put land to beneficial use, thereby reducing the land take of greenfield sites".

In particular, the Council see the former South Denes Power Station Land as "A major opportunity to allocate a hitherto "brownfield" site for port-related purposes is the former South Denes (oil-fired) Power Station. It is ideally located to help contribute towards the supply of badly needed port-back up land and as possible alternative location for existing port users. Demolition of the power station is expected to take some time due to the cost of removing the power station and preparing the site for development. The Council is anxious to see the optimal use of the site as it lies in an area identified for economic regeneration as part of the authority's Single Regeneration Budget bids".

The plan specifically mentions the South Denes site on several additional occasions:

"Until its closure several years ago, Great Yarmouth was served by a conventional oil-fired power station which met the supply needs of the area as well as the national grid. The station and its surrounding site is in private ownership and is to be demolished. Planning permission was granted for a new thermal power station on the station's former coal stockyard but this expired in April 1994."

The council had therefore assumed that all interest in developing the site as a power station had been lost and designated the site as follows:

"POLICY PRT4 - THE SITE OF THE FORMER SOUTH DENES POWER STATION IS PROPOSED FOR PORT-RELATED USES IN CONNECTION WITH THE PORT AND AN OUTER HARBOUR OR FOR TEMPORARY INDUSTRIAL/STORAGE USES UNTIL REQUIRED FOR PORT-PURPOSES. IN THE EVENT OF AN OUTER HARBOUR SCHEME NOT PROCEEDING THE POWER STATION SITE CAN AS AN ALTERNATIVE BE USED FOR GENERAL INDUSTRY OR PORT-RELATED USES."

and

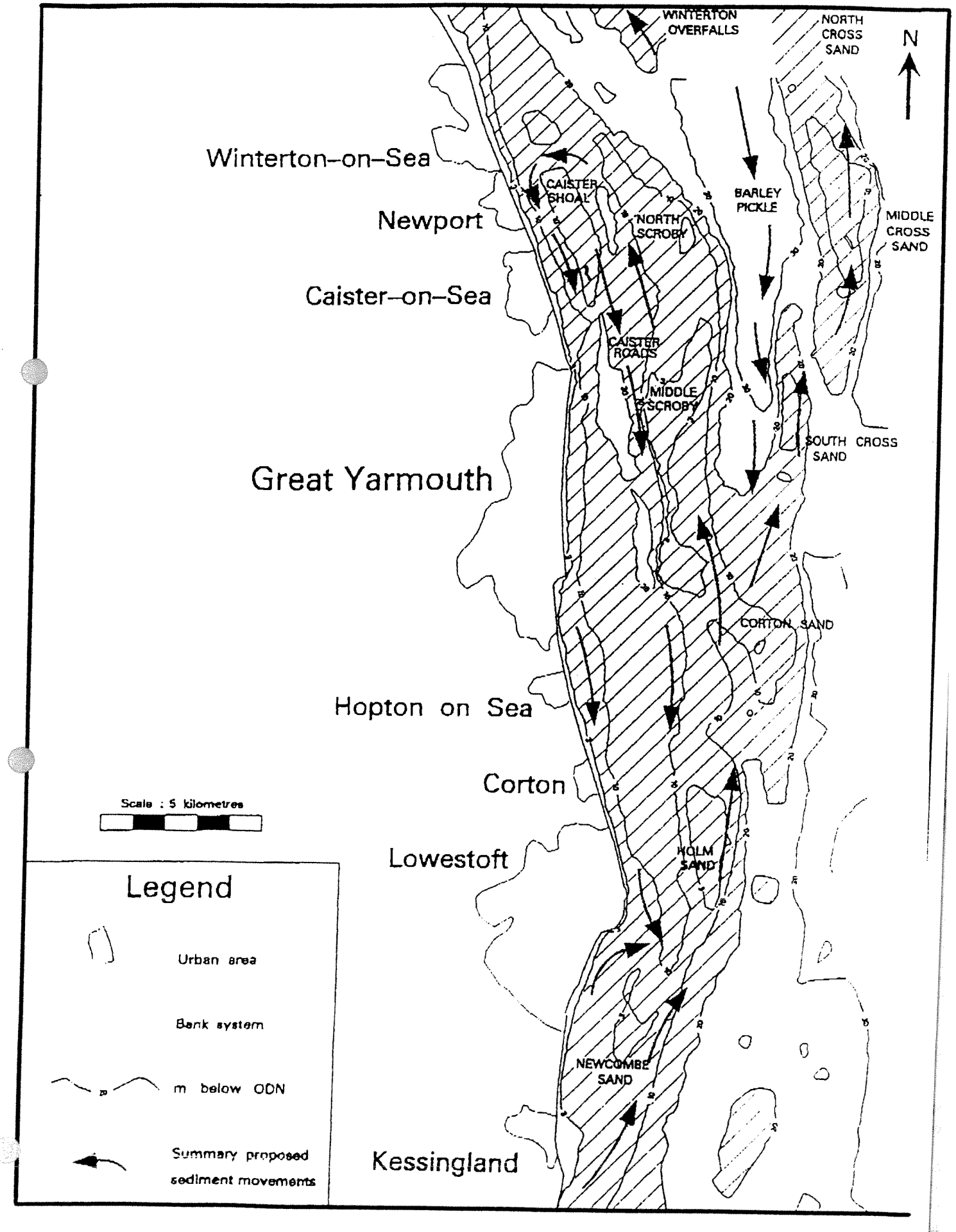
"POLICY EMP8 - THE SITE OF THE FORMER POWER STATION ON SOUTH DENES IS ALLOCATED FOR PORT-RELATED USES IN CONNECTION WITH THE PORT AND THE OUTER HARBOUR. IN THE EVENT OF THE OUTER HARBOUR SCHEME NOT PROCEEDING THE POWER STATION SITE CAN AS AN ALTERNATIVE BE USED FOR GENERAL INDUSTRY OR PORT RELATED USES."

The Planning Department of Great Yarmouth Borough Council have been consulted concerning the above designation and believe that a power station could be accommodated on the site.

The plan also states "A major opportunity for a new allocation of general industrial land is on the former Power Station site in South Denes. However, because of its location, the site could play a valuable role in helping to make up for the lack of back-up land for port related uses. A detailed study of the potential for this site to contribute towards the lack of industrial land is needed. It is unlikely that the site will be available in the short term due to the cost of removing the power station and preparing the site for development. There is a need to investigate sources of finance which will help to bring this site into early industrial use, such as a land reclamation grant. The possibility of declaring a Simplified Planning Zone to ensure that the development of the site is subject to minimal delays, will also be investigated".

The existing South Denes Power Station is in the process of demolition by the company Tony Cox (Demolition) Limited who own all the land on which the new power station will be sited.

FIGURE 6


WINTERTON OVERFALLS
NORTH CROSS SAND
N
Winterton–on–Sea
CAISTER SHOAL
BARLEY PICKLE
Newport
NORTH SCROBY
MIDDLE CROSS SAND
Caister–on–Sea
CAISTER ROADS
MIDDLE SCROBY
SOUTH CROSS SAND
Great Yarmouth
CORTON SAND
Hopton on Sea
Corton
Scale : 5 kilometres
Lowestoft
HOLM SAND
Legend
Urban area
Bank system
m below ODN
Summary proposed sediment movements
NEWCOMBE SAND
Kessingland

4. THE EXISTING ENVIRONMENT

4.1 Air quality

Nitrogen dioxide is the atmospheric pollutant of greatest significance in most urban areas of the UK, where it results from combustion processes such as those in motor vehicles and power plant.

The main source of nitrogen dioxide in the Great Yarmouth area is now traffic, particularly that associated with port activities.

As Great Yarmouth Borough Council have not previously undertaken any NOx monitoring in their area it was decided to carry out a monitoring scheme to establish the existing levels of oxides of nitrogen in the vicinity of the proposed power station site. Figure 5 shows the positions of the monitoring sites, which were agreed in conjunction with Great Yarmouth Borough Council. The monitoring sites were in fact chosen to be as close as possible to those used in an earlier study carried out by Rendel Planning in 1989 as part of an environmental assessment for the proposed Ranger Oil Power Station project which has now been abandoned.

Passive diffusion tubes were used to measure long term averages. A two week sampling period was used. Diffusion tubes are ideal for such long term measurements because of their cost and the absence of any requirement for maintenance, shelter or a power supply. Each perspex diffusion tube contains a stainless steel mesh which has been coated with the chemical triethanolamine, which absorbs nitrogen dioxide. The tubes are exposed for a two weekly period then taken back to the laboratory for analysis. Diffusion tubes are an absolute sampling method needing only knowledge of the tube dimensions and the diffusion coefficient in air of the compound being studied to predict the sampling rate. Diffusion tubes measure down to the micrograms/cubic metre level (ie parts per billion).

At the time of writing four sets of recent monitoring data are available. The results of the monitoring are shown below in Table 4.1, along with the summarised results of the original study prepared by Rendel Planning.

TABLE 4.1
RESULTS FROM NO_2 DIFFUSION TUBE MONITORING PROGRAMMES IN THE GREAT YARMOUTH AREA

Monitoring site	Background NO_2 air quality (micrograms/cubic metre)					
	Rendel Planning 1993	Merz and McLellan 1996				
	One month average	Two weekly averages				Two monthly average
		26 Jan - 2 Feb	2 Feb - 19 Feb	19 Feb - 4 Mar	4 Mar - 18 Mar	
A. 4 Micawber Ave	52	25.4	16.3	18.5	7.0	16.8
B. 4 Nelson Road South	49	24.4	16.2	25.9	16.5	20.8
C. 24 High Street, Gorleston	39	17.5	14.8	29.6	14.7	19.2
D. 184 Church Road	56	20.4	22.8	25.7	14.5	20.9
E. Port Authority Control Building	42	29.0	20.7	23.7	13.0	21.6
F. 48 Youell Avenue	43	27.2	28.0	52.0	10.6	29.5
G. 20 Elmgrove Road	43	68.2	22.1	21.0	11.8	30.8
H. 22 Spencer Avenue	44	34.5	25.4	30.6	7.1	24.4
I. 19 Sheldonian Crt	33	31.3	14.0	20.2	15.4	20.3
J. 9 Mallard Way	26	32.1	13.8	20.0	15.4	20.3
K. Greyfriars House	58	38.9	75.5	36.7	26.6	44.4

The results of both the surveys show that the highest long-term background NO_2 levels in the Great Yarmouth area are in the city centre (monitoring Site K) as would be expected. The 1996 survey found a two monthly average of 44.4 $\mu g/m^3$ in the city centre with 30.8 $\mu g/m^3$ being the highest two monthly average found elsewhere. This corresponds to the regional mean for East Anglia of 30.75 $\mu g/m^3$ for urban background and intermediate sites measured by AEA Technology in 1993 (Report to the Department of the Environment UK Nitrogen Dioxide Survey Results of the first year - 1993, KJ Stevenson and T Bush). In general the 1996 survey found lower levels of NO_2 than the earlier study at all the monitoring sites. This was even the case for monitoring Site H which at the

time of the earlier study was adjacent to a disused railway line which has since been developed into the Inner Relief Road.

There are no other developments expected in the Great Yarmouth area in the near future that would affect these background levels of NO_2.

The European Community has set ambient air quality guide-lines for nitrogen dioxide (Directive 80/779/EEC) and these have been implemented in the UK under the Air Quality Standards Regulations 1989 and as such are the only air quality standards in the UK to have legal status. A summary of the Directive is set out below in Table 4.2.

TABLE 4.2
EC AIR QUALITY STANDARDS

Parameter	Reference period	Statutory ground level concentration limit values	Recommended ground level concentration guide values	Notes
Nitrogen dioxide	Year peak (mean hourly value 98 percentile)	200 $\mu g/m^3$	-	-
	Year (mean hourly value 50 percentile)	-	50 $\mu g/m^3$	-
	Year (mean hourly value 98 percentile)	-	135 $\mu g/m^3$	In zones requiring special protection

The limit value is legally enforceable and should not be exceeded. The guidelines, however, are for the additional protection of human health and the environment and are not mandatory. For the 98th percentile values 2 per cent of all one hourly readings in a particular year may exceed the level. Two per cent of the year corresponds to 175 hours.

Guidelines from the World Health Organisation (WHO) may also be applied and are as follows.

TABLE 4.3
WHO AIR QUALITY GUIDE VALUES

	Reference period	Recommended ground level concentration guide values
Nitrogen dioxide	Short term exposure (24 hour mean)	150 $\mu g/m^3$
	1 hour average	400 $\mu g/m^3$

While a two monthly average can only be indicative of long term averages the two monthly average NO_2 concentration for each site is well within the EC year (mean hourly value 50 percentil recommended guide level of 50 $\mu g/m^3$.

The 98th percentile values for nitrogen dioxide can be estimated from measurements of annual mean concentrations. The ratio of the 98th percentile to the annual mean for urban/industrial sites has been found to be around 2.5 (Urban air quality in the UK, January 1993. First report of the Quality of Urban Air Review Group, DoE, London). The expected 98th percentile in the Great Yarmouth area would therefore be 111 $\mu g/m^3$ (based on two monthly average level for Site K). However, the highest calculated 98th percentile elsewhere in the borough is only 77 $\mu g/m^3$. These figures are well within both the EC limit value and the EC guide value for 98th percentile for mean hourly values.

4.2 Water quality

There is no surface water on the proposed site.

The North Sea lies approximately 150 m to the east of the site and 50 m to the west is the River Yare

Bore holes in the area of the site indicate the ground water to be about 4 metres below ground level. The water level in the boreholes is not affected by tidal changes. It is, however, affected by periods of heavy rainfall. It appears that the flow below ground is in a southern and eastern direction. The water does not appear to be saline.

The National Rivers Authority have indicated that there is a one in one hundred year risk of the site flooding and that a consent will be required to carryout works within 9 m of the river and to go through the sea defences.

The sea waters within the vicinity of the proposed site are well mixed by the strong tidal currents which pass parallel to the coast in a generally southerly direction (see Figure 6). Average surface velocities at spring tide are approximately 1.5 to 2 m/s, with near-bottom velocities slightly lower as the water depths tend to be shallow. It is believed that the off-shore shallow waters have a slow-moving southerly drift, influenced by the proximity of the offshore bank system running parallel to the coast. Of note is that Great Yarmouth has the lowest tidal range along the southern North Sea with a mean spring tide range of 1.9 m (Smith, 1988). It is understood, therefore, that the local marine conditions constitute a very high energy environment with a good dispersion potential. Tidal movements have been modelled by Delft Hydraulics and by Halcrow. A high degree of confidence can be placed on these detailed models, which indicate that tidal current residuals are well correlated with sediment paths derived by other means. The asymmetry to tidal currents is closely linked with the formation or otherwise of the bank system.

The morphology of the seabed off the coast of Great Yarmouth identifies sand banks (and sand waves), which have shown measurable displacement almost entirely parallel to the coastline in the direction of their long axes. For example, since 1866, South Cross Sand may have moved several hundred metres, and the Scroby Sands over 1 km to the north (Craig-Smith, 1972; British Geological Survey, 1992), while Corton Sand has moved approximately 1 km to the south in the same period. Beach processes are predominantly wave-driven, with longshore movement. The shoreline movement is in a predominantly southerly direction, with movement of banks further offshore being to the north, changing profiles and stability between shore and offshore features being closely inter-

related. A subsequent statistical analysis of historical bathymetric charts from 1846 to 1987 has indicated that the offshore movements in the area between Lowestoft and Winterton demonstrate recurrent patterns over a period of about 70 years (Halcrow).

The coast has a wide sandy beach, with a few remnants of sand dunes. Due to the construction of a breakwater to the south of Great Yarmouth, and as a result of the southward longshore drift of sand, the northerly beaches at Great Yarmouth have increased in size. By contrast, those to the south of the breakwater have become depleted and coastal erosion has taken place.

The National Rivers Authority (NRA) monitors water quality in estuarine and inshore coastal waters. They also undertake monitoring of the six classified bathing beaches within the area. These are at Gorleston, Great Yarmouth South (opposite Nelson Gardens), Great Yarmouth Pier (between the two Piers), Great Yarmouth North, Caister and Hemsby. Gorleston passed the bathing water quality standards in 1995, having failed previously. Great Yarmouth South regularly fails, as does Great Yarmouth Pier. In addition, the Environmental Health Department of Great Yarmouth Borough Council also samples bathing water throughout the year at Gorleston, Harbour Mouth (north side opposite Birds Eye Cold Store), Great Yarmouth (between the Piers), Great Yarmouth North, Caister Beach Road, Caister Second Avenue and Hemsby. Certain data derived from the NRA monitoring are presented in Tables 4.4 and 4.5 below. According to the 1990 NRA River Quality Survey the Yare estuary has a 'B' classification, reflecting fair quality.

TABLE 4.4
WATER QUALITY AT GREAT YARMOUTH BEACH (1 kM NORTH OF OUTFALL)

	Great Yarmouth Beach (1 km north of outfall)											
	March-May				June-August				Sept-Nov			
Year	1992	1993	1994	1995	1992	1993	1994	1995	1992	1993	1994	1995
Temp (Celsius)	12.75	12.25	11.26	12.80	16.00	17.00	16.80	18.00	15.60	16.00	16.50	17.00
Wind speed (m/s)	-	3.13	-	2.06	2.50	2.40	2.90	5.58	2.66	3.50	5.50	3.00
Total Coli	2005	1800	1880	2904	2900	4650	2970	2600	4600	4650	3675	7500

TABLE 4.5
WATER QUALITY 1.2 kM NORTH-EAST OF OUTFALL

	North Sea (1.2 km north-east of outfall)							
Year	1992		1993		1994		1995	
Indicator	min	max	min	max	min	max	min	max
Temp (C)	5.00	19.0	4.0	16.3	4.7	18.4	5.0	19.0
Chlorophyll (µg/l)	0.71	11.70	0.30	7.60	1.10	12.30	0.34	5.73
Salinity (g/l)	29.2	32.6	32.1	33.8	30.7	34.5	32.6	34.2
pH	8.0	8.5	8.1	8.6	7.7	8.4	7.8	8.4
DO (% satn.)	95	112	91	112	92	109	91	110

These data indicate generally good water quality, the beaches now starting to comply with bathing water quality standards under the European Union Directive (76/160/EEC).

The vertical temperature structure of the North Sea exhibits substantial temporal and spatial variability. The area is characterised by shallow waters with strong tides and consequently the water mass is well mixed. The mean of the monthly sea surface temperatures at Great Yarmouth between 1964 and 1985 are as shown in Table 4.6. These values are similar to those from the NRA data.

TABLE 4.6
MEAN MONTHLY SEA SURFACE TEMPERATURES

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Temp°C	4.5	4.3	5.3	7.7	10.9	14.7	17.1	18.0	16.4	13.1	9.3	6.3

Source: Near-surface sea temperatures in coastal waters of the North Sea, English Channel and Irish Sea. S Jones and T Jeffs. Fisheries Research Data Report No 24, 1991

Salinity within the southern, inshore areas of the North Sea is between 34.55 and 34, and such a value would be expected (from the NRA data) to be found in summer within the area. The salinity of the River Yare varies with the state of the tide but for much of the tidal cycle is in the range 32 to 36.

The National Rivers Authority (NRA) monitor pollutants in discharges. There are several sources of pollution which affect water quality within the study area. These include:

- discharges from the River Yare,
- discharges of municipal wastewater effluent into the sea,
- discharges of industrial effluents (including previously that from the former power station), and
- inputs from other coastal area.

It is understood that the main municipal discharge to the River Yare is shortly to be diverted to Caister (to the north). This will eliminate much of the effluent entering the North Sea at Great Yarmouth, under all but stormwater conditions. Controls are also being implemented on industrial discharges to the River Yare.

4.3 Noise and vibration

In order to assess the environmental noise impact of a proposed industrial development, it is generally accepted that projected noise levels from the development need to be compared with background levels at particularly sensitive residential locations close to the site. The difference between these two levels, or the change in level, generally correlates with the environmental impact and there are recognised Standards, Guidelines and Procedures that are referred to later (Section 5.3.2) where this aspect is dealt with.

A noise survey has therefore been carried out to establish existing background noise levels at critical environmental noise positions. The locations of these positions were agreed with Great Yarmouth Borough Council Environmental Health Department, to be representative of the local residential community. The positions are described below and shown diagramatically on Figure 7.

Position 1 : Riverside Road/rear of High Street, Gorleston

This position was adjacent to Riverside Road and also adjacent to the rear of No 7 High Street. Measurements were made on a small patch of grass adjacent to the road and protruding into the river frontage. The distance to the proposed exhaust stack position is approximately 350 m.

Position 2 : Riverside Road/South Icehouse Hill, Gorleston

This position was on the centre of a small grassed area adjacent to No 99 Riverside Road. The measurements were made 8 m from the side of the carriageway. The distance to the proposed exhaust stack is approximately 350 m.

Position 3 : Spencer Avenue/East Anglian Way, Gorleston

This position was at the end of Spencer Avenue overlooking some allotment gardens with a clear line of sight to the existing power station. The distance to the proposed exhaust stack position is 1000 m.

Position 4 : Micawber Avenue, Great Yarmouth

This position was at the north end of Micawber Avenue on the opposite pavement to No 1. There was a clear line of sight to the existing power station. It was chosen to represent the residential community on the east side of the River Yare to the north of the power station. The distance to the likely exhaust stack position is approximately 1150 m.

Measurements were carried out during the night of 14/15 February 1996, during which the weather conditions were dry with very light easterly and then northerly winds.

Instrumentation used to measure noise levels and meteorological conditions included the following items:

Bruel & Kjaer Type 2260 Real Time Sound Level Analyser, s/n 1772229
Bruel & Kjaer Type 4189 Microphone, s/n 1783724
Bruel & Kjaer Windshield
Bruel & Kjaer Type 4230 Calibrator, s/n 1234636
Tripod
Deutz Anemometer

The measurement procedure used was in accordance with BS 4142:1990 'Method of Rating Industrial Noise Affecting Mixed Residential and Industrial Areas'. Because the proposed CCGT power station is to run continually, it was deemed necessary to consider only the night period as this is the most critical time for environmental noise impact. Measurements were carried out at each of the four locations in turn and then repeated a further four times in order to establish a reasonable statistical basis for the background levels.

At each location, five minute samples were taken, recording values of L_{Aeq} (Equivalent Continuous Noise Level) and the L_1, L_{10}, L_{50} and L_{90} Percentile Levels.

The full result of the background noise survey are shown on Environmental Noise Record Sheets in Appendix C, they are also, however, summarized in Table 4.7.

TABLE 4.7
SUMMARY OF EXISTING BACKGROUND NOISE LEVELS

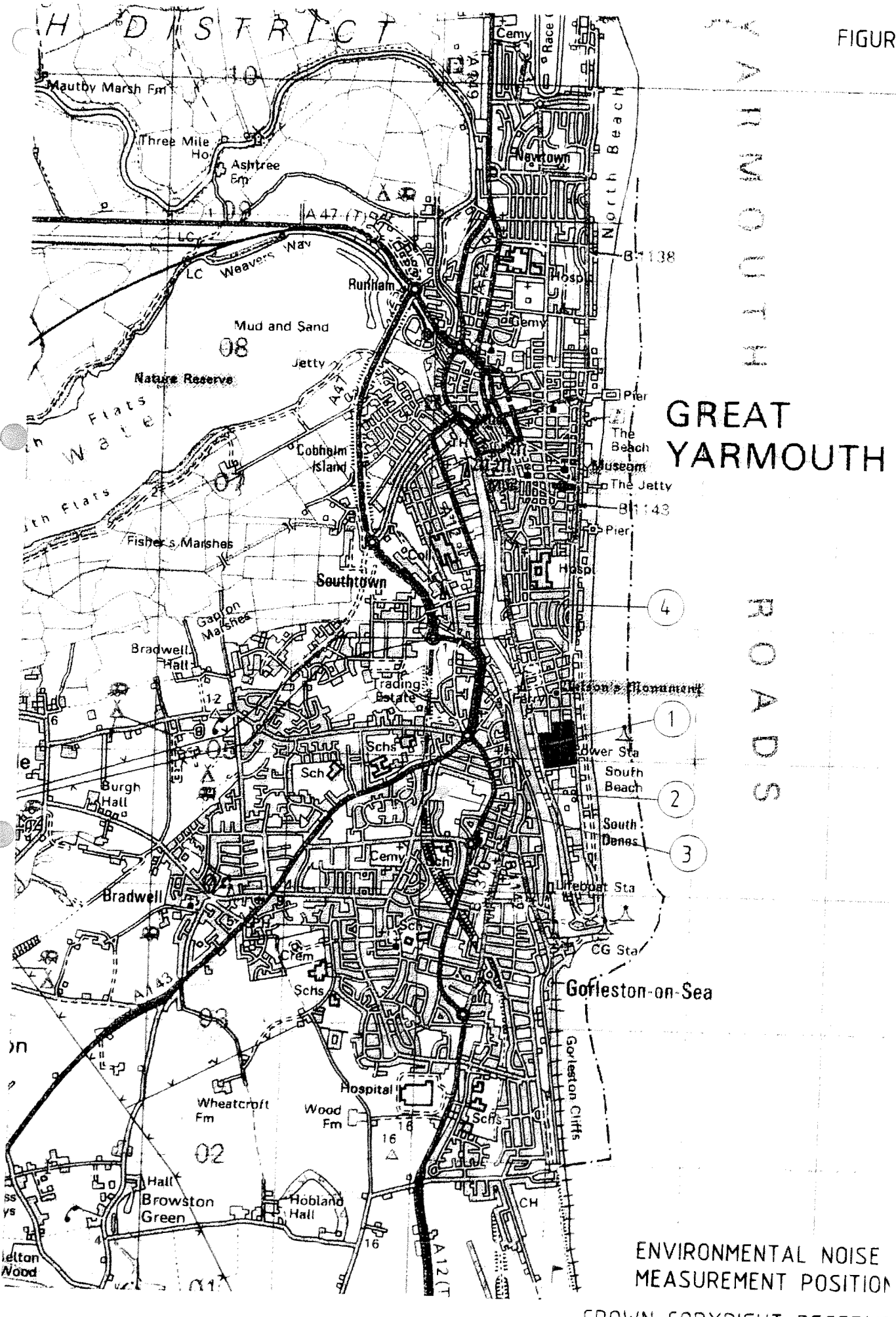
Measurement position	L_{A90} (Mean night-time)	Octave band pressure levels								
		31	63	125	250	500	1k	2k	4k	8k
No 1 - Riverside Rd/Rear of High Street	41.7	67	56	53	40	37	31	25	18	13
No 2 - Riverside Rd/South Icehouse Hill	39.6	60	56	53	40	34	30	23	17	14
No 3 - Spencer Av/East Anglian Way	36.9	44	41	40	37	31	30	26	21	17
No 4 - Micawber Av	36.8	49	47	46	39	33	31	23	16	13

Figure 8 shows the background frequency noise spectra that corresponds to this data.

Measured values lie typically in the range 37 to 42 dB(A) which is significantly lower than those recorded by Rendel Planning some six years ago (40-49 dB(A)) and probably reflect a reduction in port traffic during the intervening period.

The quality of the existing background noise is predominantly distant traffic, with port activity and some generator noise audible at Positions 1 and 2; the housing locations closest to the proposed CCGT power station, on the west bank of the River Yare. There was no significant noise observed from industrial premises in the area.

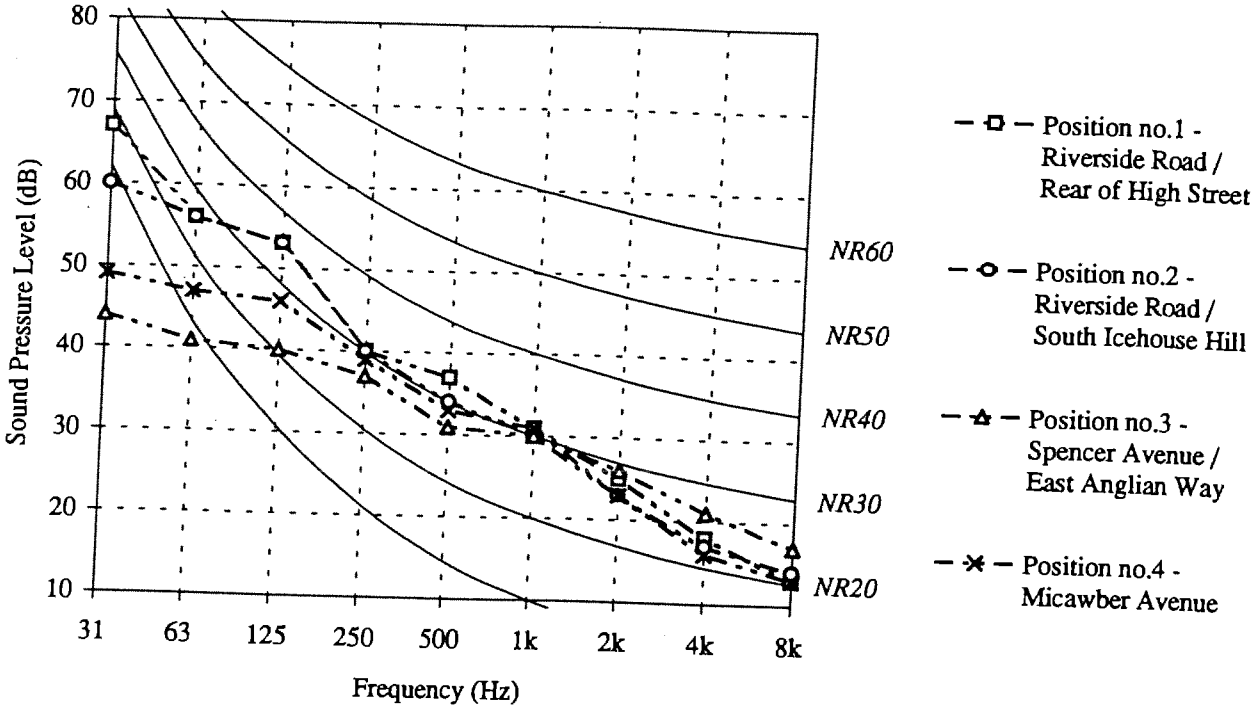
FIGURE 7



ENVIRONMENTAL NOISE MEASUREMENT POSITION

FIGURE 8

Background Noise Frequency Spectra



4.4 The existing landscape

The area of South Denes in which the proposed site is situated is industrial in character. The industrial area covers approximately 100 hectares and is situated on a spit of land between the River Yare and the North Sea. The port makes up a significant part of the industrial area. Neighbouring structures to the site include warehouses, oil tankers, cranes, jetties, and factory buildings, however, the area is currently dominated by the existing power station especially its 110 m tall stack and its 45m high boiler and turbine hall. In fact the chimney is visible for several kilometres to the north, south and west. The chimney is of course due for demolition. The industrial area has very flat terrain and is low lying.

Views up and down the river are dominated by the activities and buildings of the port and industrial area, particularly the existing power station.

Due west from the site, across the river, is the slightly elevated residential area of Gorleston, lying at approximately 10 m above sea level. The houses on the edge of this, on the eastern side of the High Street, have a clear view over the river to the industrial area.

The residential area to the north of the site lies at the same elevation as the power station and therefore clear views of the site are not possible throughout the area. However the existing chimney is visible from several vantage points and from South Beach Parade. The turbine hall of the existing power station is also visible for several hundred metres along South Beach Parade.

The frontage of the site is to South Denes Road. On the seaward side of South Beach Parade a trailer park lies less than 100 m from the power station site. The construction of the Outer Harbour proposed by the Port Authority will require the closure of the caravan park.

After consultation with the Planning Department of Great Yarmouth Borough Council, it has been decided that the most sensitive and representative receptors to views of the existing power station are:

a. Riverside Road on the edge of Gorleston

b. South Beach Parade

c. A47 Acle New Road

d. Burgh Road, Gorleston

e. Marine Parade, Gorleston

f. Breydon Water

The locations of these view points are shown in Figure 9 and photographs showing the existing views from these are shown in Figures 10 to 15 respectively.

Figure 15 actually shows the view from the dyke surrounding Breydon Water. Visitors to the Broad, boating on the water would not in fact see the existing power station to the same extent, as its view would be blocked by the dyke.

4.5 Traffic and infrastructure

The current operation of the port and the industrial area generate a significant volume of traffic.

In June 1992 Norfolk County Council Highways Department carried out a traffic analysis for the section of South Denes Road between the Birds Eye Factory and Hartmann Road. This section of the road passes directly in front of the proposed site.

The table below shows the number of vehicles using the road in both directions during the time of the survey.

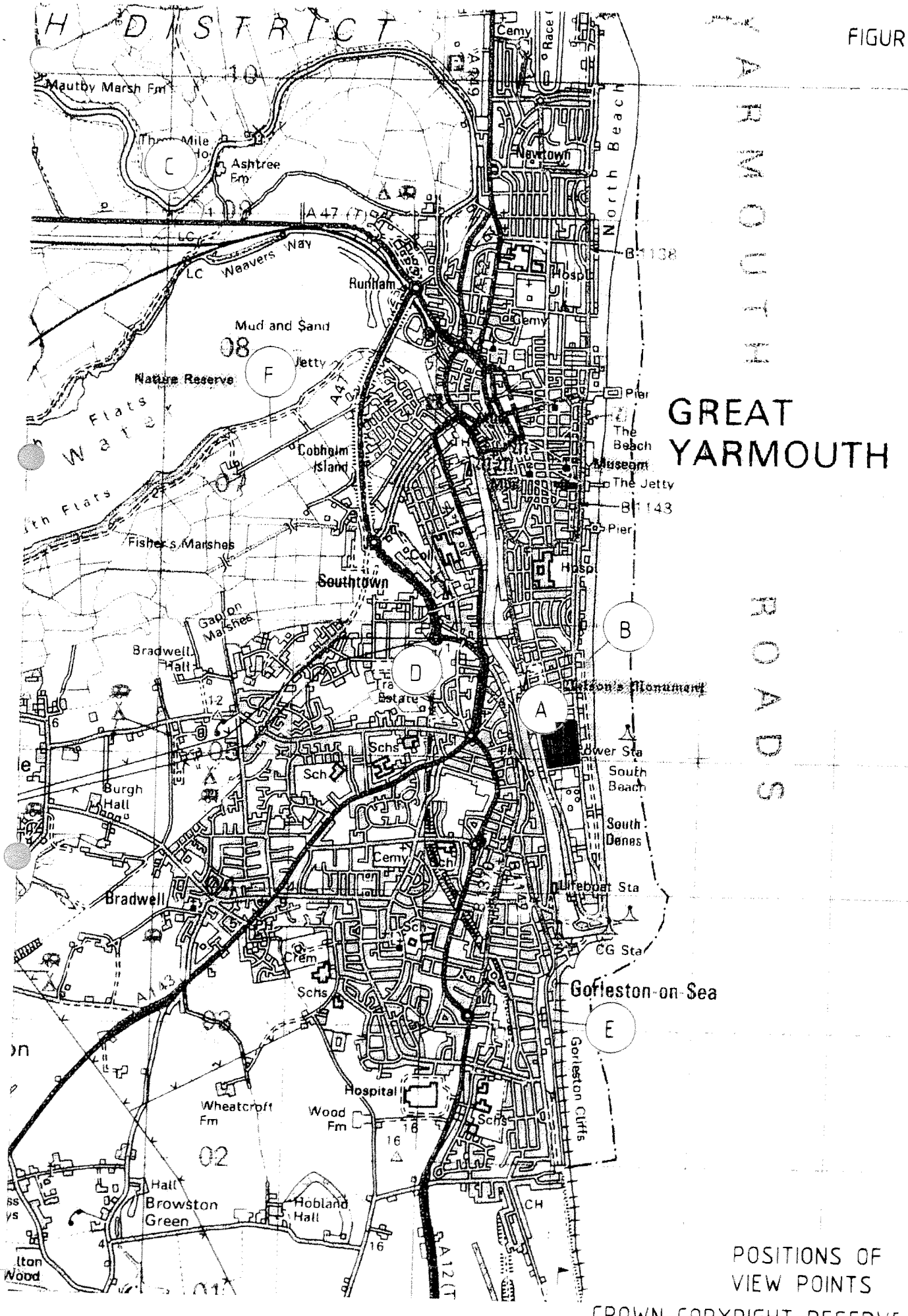
TABLE 4.8
RESULTS OF TRAFFIC ANALYSIS

Period	Pedal cycle	Motor cycle	Cars and taxi	Bus and coaches	Light goods vehicles	Heavy goods vehicles	Total
7.00-8.00	6	7	90	0	20	16	139
8.00-9.00	4	1	63	0	25	37	130
9.00-10.00	0	0	71	1	25	31	128
10.00-11.00	0	0	81	2	27	36	146
11.00-12.00	0	3	115	3	35	37	193
12.00-13.00	2	1	146	1	25	43	218
13.00-14.00	2	1	148	1	41	35	228
14.00-15.00	0	1	156	5	42	53	257
15.00-16.00	1	0	147	4	32	52	236
16.00-17.00	1	0	138	5	32	45	221
17.00-18.00	5	10	139	3	32	31	220
18.00-19.00	0	1	75	1	10	13	100

The survey monitored a 12 hourly two-way traffic flow of approximately 2216 with the maximum number of vehicles per hour being 257. This is low in comparison with the Department of Transport peak hourly flow of 2000 vehicles per hour for a road of this nature. The proportion of Heavy Goods Vehicles using the road was just less than 20 per cent.

Using data in the Department of Transport Traffic Appraisal Manual (August 1991) it is possible to extrapolate these figures to estimate current traffic flows and forecast those during the periods of

FIGURE 9



POSITIONS OF VIEW POINTS

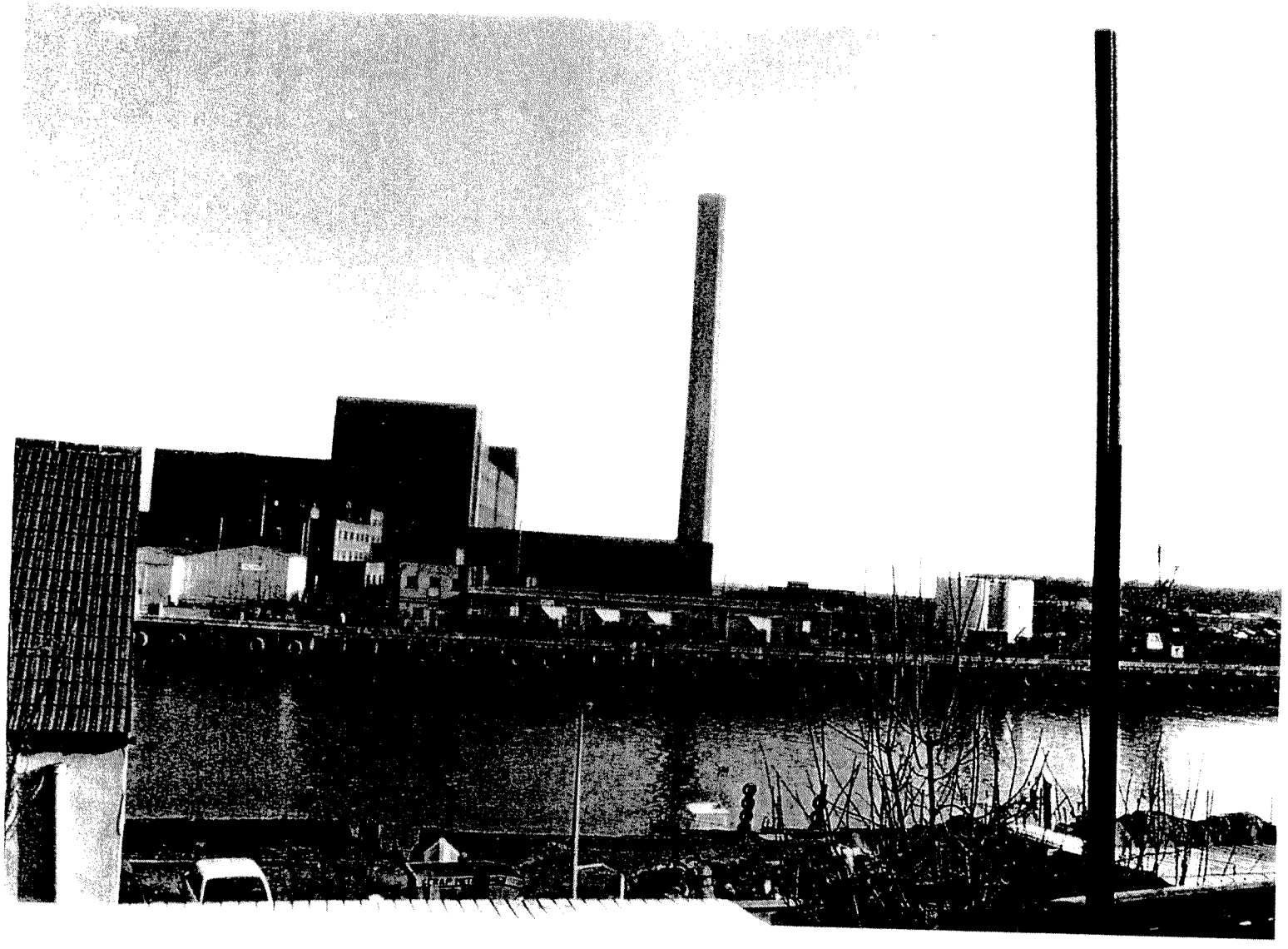


FIGURE 10 EXISTING VIEW FROM EDGE OF GORLESTON

FIGURE 10

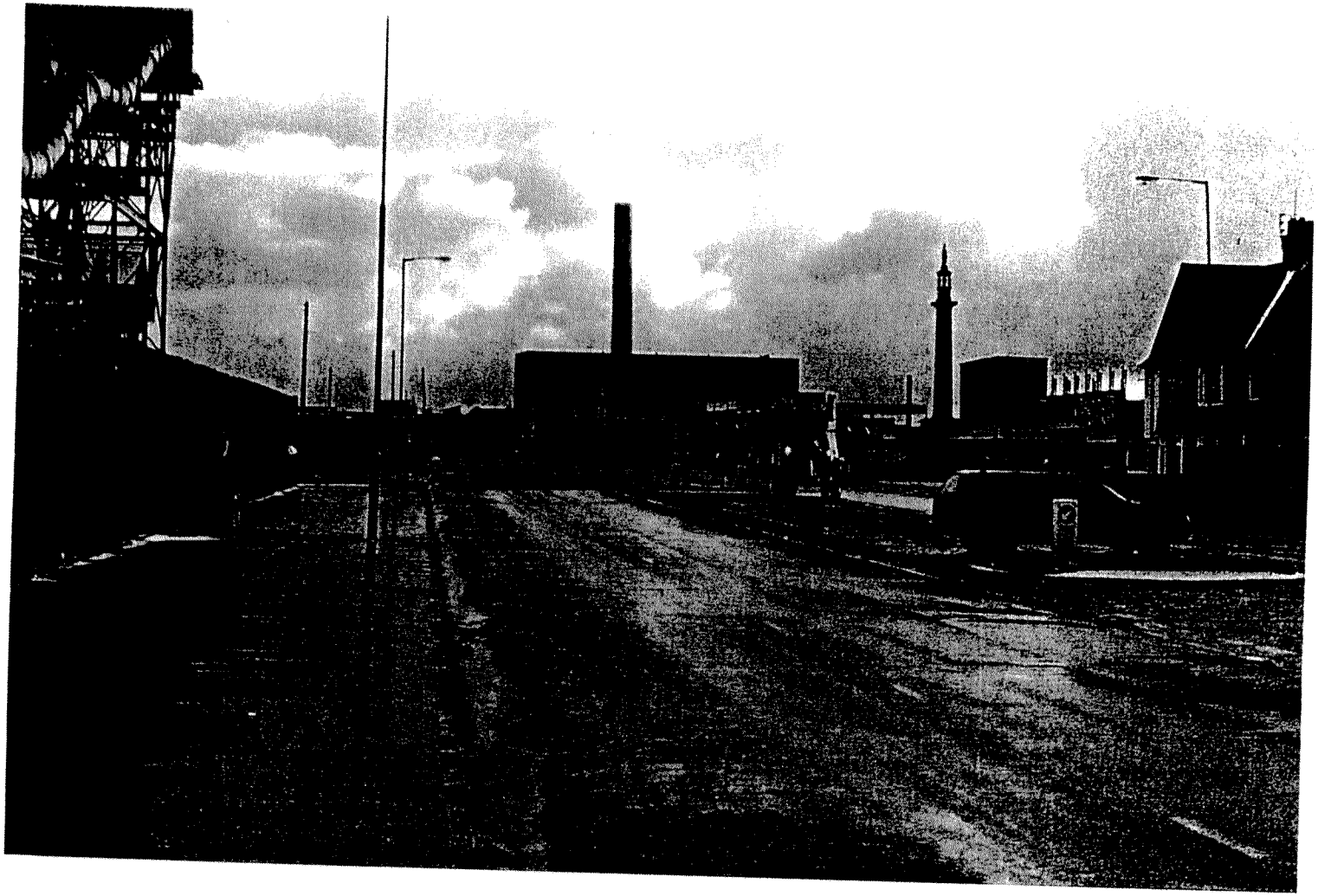


FIGURE 11 EXISTING VIEW LOOKING SOUTH DOWN BEACH PARADE

FIGURE 11

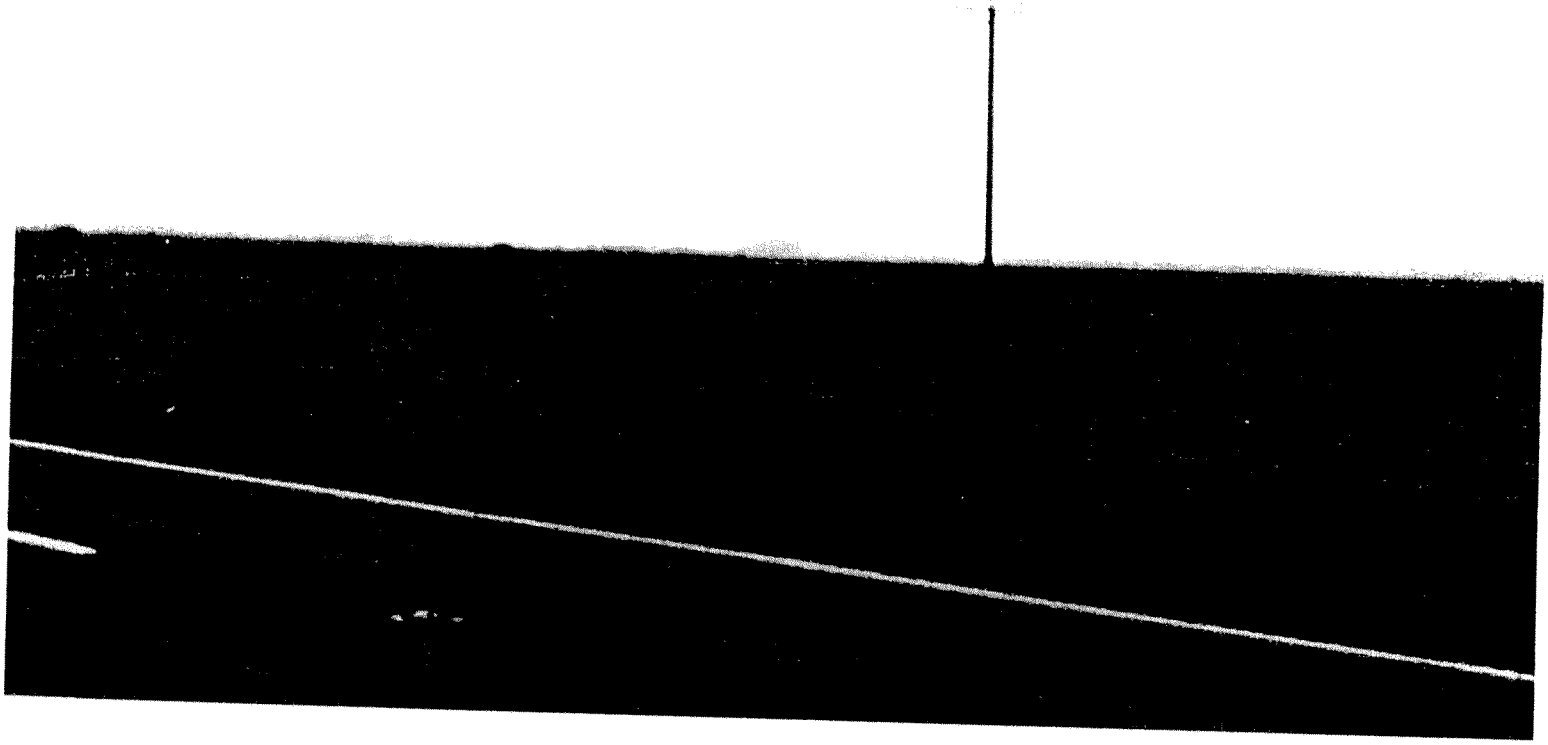


FIGURE 12 EXISTING VIEW FROM A47 ACLE NEW ROAD

FIGURE 12

FIGURE 13 EXISTING VIEW FROM BURGH ROAD

FIGURE 13

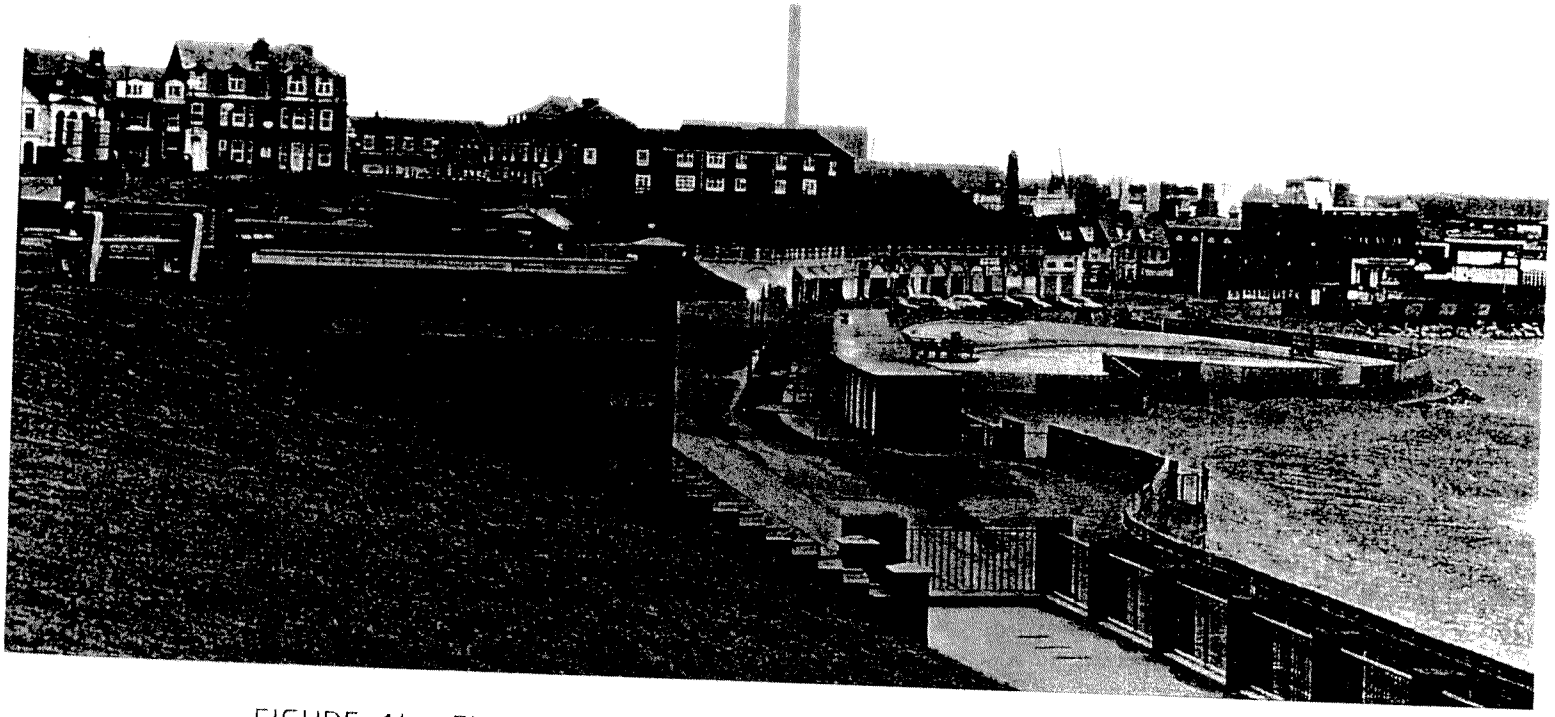


FIGURE 14 EXISTING VIEW FROM MARINE PARADE, GORLESTON

FIGURE 14

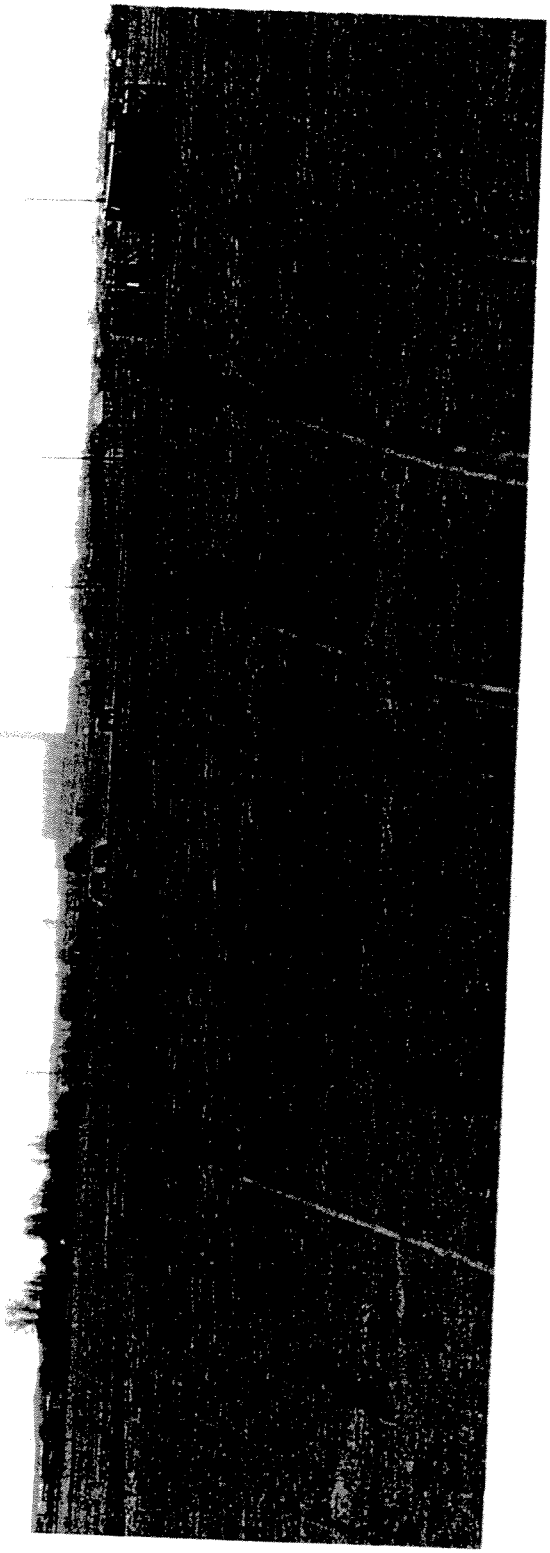
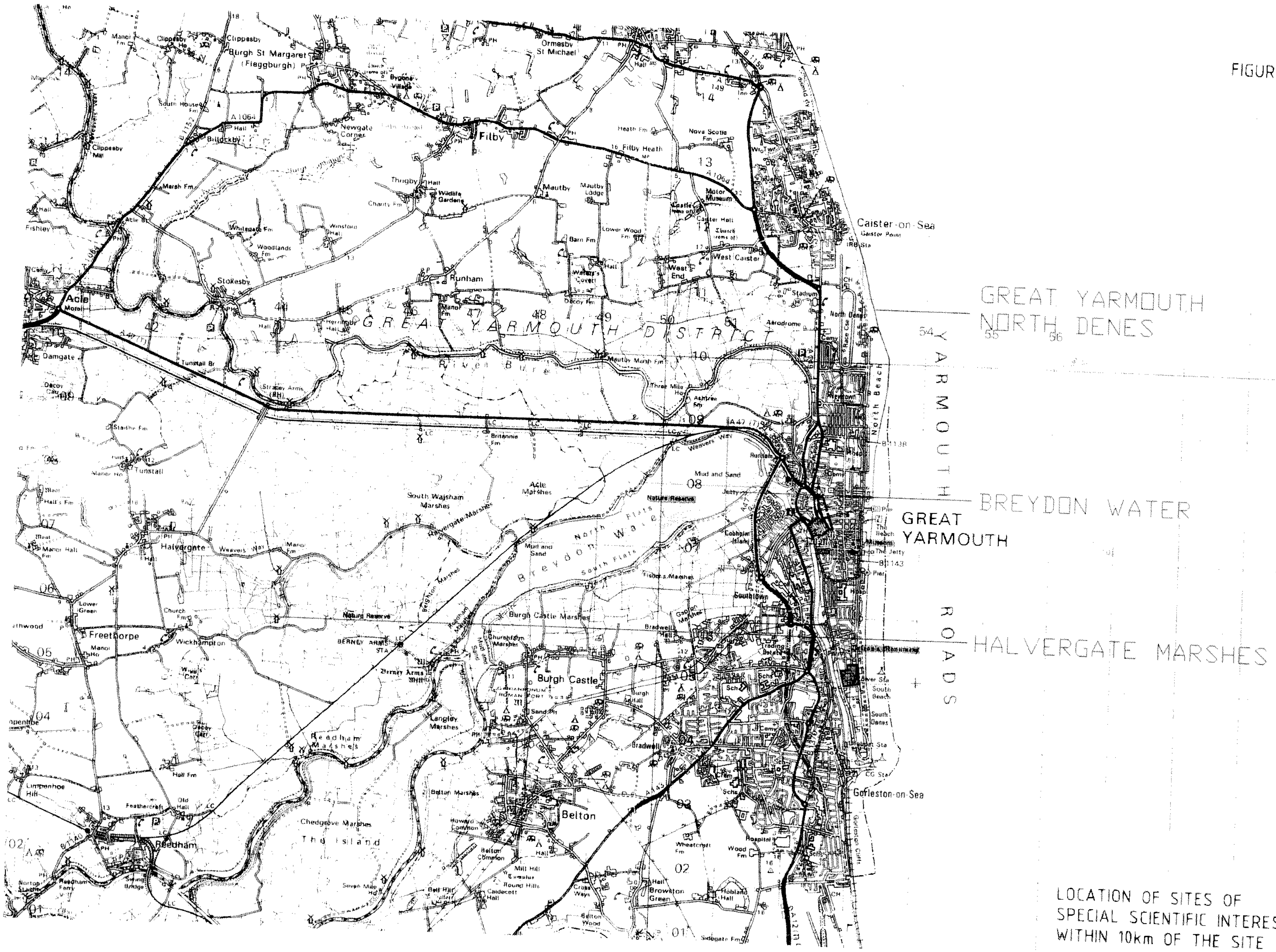


FIGURE 15 EXISTING VIEW FROM EDGE OF BREYDON WATER

FIGURE 16



LOCATION OF SITES OF
SPECIAL SCIENTIFIC INTEREST
WITHIN 10km OF THE SITE

construction and operation. These figures are shown below in Table 4.9. High traffic growth has been assumed.

TABLE 4.9

Predicated total traffic flows			
	1996	**1997**	**1998**
7.00-8.00	153	157	161
8.00-9.00	143	147	151
9.00-10.00	141	145	148
10.00-11.00	161	165	169
11.00-12.00	212	218	224
12.00-13.00	240	246	253
13.00-14.00	251	258	264
14.00-15.00	283	290	298
15.00-16.00	260	267	274
16.00-17.00	243	250	256
17.00-18.00	242	249	255
18.00-19.00	110	113	116
Total 12 hour two-way traffic flow	2439	2505	2569

The table above shows that traffic flows on this stretch of road are expected to be very low.

The local road network can be seen in Figure 1. However, since the preparation of the map the new Inner Relief Road has been constructed along the line of the disused railway shown on this map. The A47 lies just over 3 km to the north, and can be reached via South Denes Road which skirts the town centre. The A12 to Lowestoft is reached via Pasteur Road and the Inner Relief Road which are both dual carriageways. Pasteur Road is approximately 3 km from the site.

The port of Great Yarmouth makes up part of the South Denes Industrial Area. See Section 4.6 for further details.

There are no public footpaths on or access to the proposed site.

4.6 Socio-economics

Great Yarmouth has a population of 88 800 and a workforce of the order of 37 600. The town includes the East Anglia region's foremost industrial area, a major east coast port providing a strategically important link to the rest of Europe, the UK's major offshore gas service centre and Britain's third largest resort area.

The principal economic activities in the Great Yarmouth area are the port, the activities associated with the offshore oil and gas industry, tourism, manufacturing (particularly electronics, food processing, and packaging), agriculture and the service industries. Great Yarmouth Borough Council must therefore carefully balance the conflicting needs of tourism and industry, including the port activities.

The port is ideally placed to service the gas-rich offshore fields of the Southern Basin and is the closest UK port to Northern Germany, the Baltic and is 150 km by sea to the European Continent. It is a river port and can accommodate unrestricted access over 24 hours of up to 4.3 m draft and about 4000 tonnes at all states of the tide. Berthing is available for more than 50 ships at any one time. Vessels up to 125 m long and 5.7 m draft can also use the port and those less than 80 m long can turn in the river.

Dredging of sand and gravel for aggregates and coastal protection is a major activity off the Great Yarmouth coast. Large quantities are dredged from the Cross Sands block, located approximately 6-12 miles off the coast within inshore coastal fishing waters, as shown on Figure 6. This activity is understood to cause considerable damage to the static long-line nets used by local fishermen within the area. Some limited occasional dredging is also undertaken at the mouth of the River Yare.

To the north of the area the seabed has considerable use for cable laying and gas pipelines to the off-shore fields. Tourism and recreation remain important at Great Yarmouth, with its long amenity beach and associated features.

The port is run by Great Yarmouth Port Authority, a self financing independent trust, whose members represent the interests of the local community and port users. Port related industries provide between 5000 and 8000 jobs in the area.

The Port Authority is currently planning an Outer Harbour which will involve the creation of breakwaters on the seaward side of the South Denes peninsula, just to the south of the power station site. This will enclose an area of land for reclamation and allow the construction of new deep-water berths. Up to 40 hectares of new port operational land will be created and the scheme would make the port accessible to vessels of up to 20 000 dwt.

Great Yarmouth attracts 1.9 million day visitors a year and 1 million staying visitors. There are approximately 100 000 holiday bed spaces in the Great Yarmouth borough, with just over 60 per cent in self catering accommodation. This includes the coastal strip from Winterton in the north to Hopton in the south and the urban areas of Great Yarmouth and Gorleston. Of this accommodation approximately 85 per cent is occupied during the summer months with a peak occupancy of the order of 94 per cent. Of the 15 miles of beaches in the Great Yarmouth area those abutting the industrial area of South Denes are probably the least attractive.

Unemployment in the town is generally high in comparison with national and county rates. Fluctuating with the seasons the unemployment rate in the mid 1980s for the Great Yarmouth Travel to Work Area (TTWA) peaked at nearly 20 per cent. In 1991 the average monthly rate was 11.5 per cent which was 25 per cent above the national figure and 62 per cent above the corresponding figure for East Anglia as a whole. In July 1995 the unemployment rate was 12.2 per cent (13.4 per cent in March 1994). The seasonal nature of the tourist industry tends to mask the serious long term unemployment in the town. Although nationally it is usually the younger age groups that are affected, in Great Yarmouth a significant proportion of the long term unemployed are in the older age groups (ie 55-59).

The employment structure for Great Yarmouth Travel To Work Area (TTWA) is shown below in Table 4.10.

TABLE 4.10
EMPLOYEES IN EMPLOYMENT
GREAT YARMOUTH AND GREAT BRITAIN 1991

Division or class	Description	Great Yarmouth		Great Britain		Locational Quotiant
		Number	%	Number (1000's)	%	
0	Agriculture, forestry & fishing	759	2.03	290.1	1.34	1.5
1	Energy and water supply	2061	5.48	425.3	1.97	2.8
2	Metals, mineral and chemicals	162	0.43	645.2	2.99	0.1
3	Metal goods, engineering and vehicle industries	2936	7.80	2050.5	9.51	0.8
4	Other manufacturing	2380	6.32	1877.9	8.71	0.7
5	Construction	1312	3.49	970.6	4.50	0.8
6	Distribution	10546	28.03	4632.1	21.48	1.3
7	Transport and communication	3117	8.28	1323.8	6.14	1.3
8	Banking, finance, business services and leasing	3073	8.17	2613.9	12.12	0.7
91	Public administration	3291	8.75	1361.9	6.31	1.4
92-98	Other services	7993	21.24	5377.7	24.93	0.9
All sectors total		37630	100.00	21569.0	100.00	

NB:- A Locational Quotiant of 1.00 corresponds with GB average.

The table shows that distribution and other services are the major employers in the area with 28.03 and 21.24 per cent employed in these sectors respectively. Data on changes in the employment structure in these areas exists for 1981 to 1991 and show that the number of people in the energy and water supply sector increased by 1.8 per cent and that the number of construction workers dropped by 13 per cent.

It is possible to compare the percentage of employees in one type of work in Great Yarmouth with those in the same type in Great Britain as a whole. This factor is known as the Locational Quotient, a figure of 1 corresponds with the British average. For construction the Locational Quotient for Great Yarmouth is 0.8, showing that this activity is under represented in the Great Yarmouth TTWA.

Table 4.11 below shows data available for 1992 showing the former employment of a 10 per cent sample of the unemployed at that time.

TABLE 4.11
FORMER EMPLOYMENT OF THE UNEMPLOYED

	Socio-economic group	Males	Females
1.1	Employers in large establishments	0	0
1.2	Managers in large establishments	1	0
2.1	Employers in small establishments	0	0
2.2	Managers in small establishments	10	1
3	Professional workers - self-employed	0	0
4	Professional workers - employees	0	0
5.1	Ancillary workers and artists	2	4
5.2	Foreman and supervisors - non manual	0	0
6	Junior non-manual workers	18	22
7	Personal service workers	16	12
8	Foreman and supervisors - manual	6	0
9	Skilled manual workers	51	3
10	Semi-skilled manual workers	53	20
11	Unskilled manual workers	25	3
12	Own account workers (other than professional)	14	2
13	Farmers - employers and managers	0	0
14	Farmers - own account	0	0
15	Agricultural workers	1	0
16	Members of armed forces	1	0
17	Inadequately described/not stated occupations	4	1
	On a government scheme	n/a	n/a
Total		245	97

Local planning policies are contained in the draft Great Yarmouth Borough-Wide Local Plan prepared by Great Yarmouth Borough Council and issued for public consultation in October 1995. The plan sets out the local planning authority policies and proposals for the development and use of land in their area.

The plan aims to encourage the growth of new industry and employment in the area.
The Norfolk County Structure Plan identifies Great Yarmouth as a priority in terms of economic development and growth. It is stated that "Great Yarmouth is forecast to accommodate 15 per cent of the increase in the County workforce by 2006, with a net increase of some 8,700 jobs required if the structure plan target unemployment rate of 2 per cent is to be met."

Regional planning policy for East Anglia highlights a need to shift the emphasis of economic development away from the overheating south and west of the Region towards the less developed north and east.

4.7 Ecology

4.7.1 Terrestrial ecology

Being a derelict or "brown field" site there is little or no original vegetation present on the proposed site for the CCGT plant. The site is covered mainly in grass and appears to have little or no ecological interest or value.

This section of the Norfolk coastline is of physiographic interest as an area of active sand dune accretion and, as such, supports a full successional sequence of vegetation, including the nationally scarce Grey Hair-grass (*Corynephorus canescens*).

Figure 16 shows the positions of all Sites of Special Scientific Interest (SSSI), notified under Section 28 of the Wildlife and Countryside Act 1981, within 10 km of the site. The figure shows that there are no statutory sites within 1 km of the site. The nearest designated site is Breydon Water which lies just over 3 km to the north west of the site. In addition to being a Site of Scientific Special Interest the site is also a Local Nature Reserve. Local Nature Reserves (LNRs) are designated by the local authority under Section 21 of the National Parks and Access to the Countryside Act 1949. A further two sites lie within 10 km of the site, these are at Halvergate Marshes(8.5 km to the west) and Great Yarmouth North Denes, which lies 3.5 km to the north. The features of each of these sites is outlined below and detailed descriptions of the SSSIs (provided by English Nature) are reproduced in Appendix D.

a. **Breydon Water**: an inland tidal estuary at the mouth of the River Yare and its confluence with the rivers Bure and Waveney. Extensive areas of mud are exposed at low tide and these form the only intertidal flats occurring on the east coast of Norfolk. Large numbers of wildfowl and waders are attracted to an abundant food supply when on passage and during the winter months. Several wintering wildfowl reach nationally important population levels and the site occupies a key position on the east coast for these species and for migrating birds. Rare species are regularly recorded. There is also considerable botanical interest with small areas of saltmarsh, reedbeds and brackish water communities in the surrounding borrow dykes. The invertebrate fauna is rich and includes one scarce species of snail.

Duck Caravan Park. To the south of the lane the site is managed by the Norfolk Wildlife Trust as a nature reserve. This site lies at a distance of 5.5 km from the site.

Detailed descriptions of these three wildlife sites provided by Norfolk Wildlife Trust are included in Appendix D.

4.7.2 Marine ecology

There are no designated areas of conservation interest such as Marine Nature Reserves or Heritage Coasts in the vicinity of the site. The area around Great Yarmouth has been little studied within recent years. The majority of the research which has been undertaken within the study area has been commissioned by Anglian Water, as part of the relocation studies for the wastewater treatment works outfall and related Comprehensive Studies. A draft publication by the Joint Nature Conservancy Council (JNCC) on British Coastal Seas, Region 6 (which covers the vicinity of the proposed site), confirms that little has been published for the area.

Plankton

Plankton are small drifting plants and animals of the sea. They can be divided into two broad groups: phytoplankton and zooplankton. Phytoplankton, comprising mainly algae, are important within the marine ecosystem as a food source for zooplankton. The latter comprise invertebrates and larval fish, that are in turn food for a wide variety of fish and other marine life. Anecdotal evidence suggests that the existence of a power station outfall within the study area which previously discharged warm water resulted in increased algal production locally, and this is believed to have supported fish communities.

Benthic communities

Due to the mixed sediments within the area, which consist of mobile fine sands and muddy gravel, there are slight variations of the benthic communities which reflect these sediment distributions. Following discussions with Anglian Water, it was identified that the biomass of benthic (seabed) organisms found in the area are understood not to be diverse, and are not of notable interest. Work undertaken by Anglian Water in 1984 described the benthic community of the muddy gravel as characterised by infaunal plychaetes (burrowing worms) and by the epifaunal (surface substrate dweller) ascidian (*Molgula manhattensisis*). (Anglian Water, 1984. A preliminary survey of the inshore marine benthos in the vicinity of Great Yarmouth).

The high-energy mobile sands, located at the edge of the main tidal channels of Caister and Yarmouth Roads support a sparse community of fauna, while the more stable coarse sediments are understood to support communities of *Sabellaria* spp., (ross worms), infaunal plychaetes. It is understood that these are not reef-forming and that English Nature are aware of their existence and distribution.

Shellfish

The majority of the shellfish found within the vicinity of the area are as follows:

Whelks	*Buccinium undatum*

Lobster	*Hommarus gammarus*
Brown shrimp	*Crangon crangon*
Pink shrimp	*Pandalus montagui*

The brown shrimp (*Crangon*) is primarily associated with sandy-muddy substrates, but the pink shrimp (*Pandalus*) is also popularly believed to show preference for coarser substrates, including colonies of *Sabellaria* on which they feed. In recent years the *Sabellaria* communities within the vicinity of Great Yarmouth are understood to have declined as a result of pollution, and this is understood to have resulted in considerably decreased stocks of the pink shrimp within the area.

Fish

Great Yarmouth is important for commercial fishing and has 23 full-time vessels and 7 part-time vessels. Landings of the following species were made at Great Yarmouth during 1994: 62 902 kg of cod; 25 260 kg of herring; 26 800 kg of dog-fish and 121 970 kg of skate. There were also reasonable landings of whelks, lobster, whiting and brown shrimp. Historically Great Yarmouth had a large pink shrimp fleet consisting of 120 vessels but presently there are only 3 vessels, as the local pink communities have been affected by the reduced areas of *Sabellaria* beds upon which they feed. There is no known need for local compliance with European Union shellfish and fisheries Directives.

The area is an important spawning and nursery ground for herring (*Clupea harangus*) (Heath & Richardson 1989), but is not formally designated as such. Egg-laying takes place in areas of coarse shell, grit and gravel and can be roughly equated with the distribution of known gravel deposits. Larval herring are pelagic and drift in the currents until they are approximately 5 cm in length, when they begin to form shoals and move into the shallow inshore feeding area. Here they feed on plankton, which are noted above as having being formerly enriched in the outfall discharge area.

Mammals

The nearest sea mammal population is located 1-2 miles off the coast of Caister-on-Sea, at Scroby Sands, which is approximately 3-4 miles to the north of the proposed outfall.

The population here is relatively small, numbering 40-50 common seals (*Phoca vitulina*) and 50-60 grey seals (*Halichoerus grypus*). The Sea Mammal Research Unit conducts aerial surveys during August, studying several colonies along the Norfolk coastline. The grey seals are known to have small numbers of pups in the summer months, but the common seal is not thought to breed here. The seals forage for food along the coastline. Their diet consists mainly of flatfish, with occasional sand gobie and whiting in the winter months. The seals have been known to approach the coastline in search of food.

Birds

Of note are the seabirds that frequent this stretch of the coastline during the autumn and winter, including divers, sea duck and other waterfowl. Also of importance, the largest United Kingdom breeding colony of the rare little tern is located on the foreshore within the North Denes SSSI (to the north of the study area). A total of 277 breeding pairs was recorded in this nationally important population. It is the increasing presence of the terns that have led to the proposed Special Protection Area status. Associated with the ternery, ringed plover also frequently nest there.

Although there is little information specific to the site, it is worth noting that waders and wildfowl in general use the eastern coastline of Britain as winter feeding sites, staging posts during migration, and as breeding grounds. The presence of birds is directly related to an abundant food source, the invertebrate animals living in the soft, coastal sediments and tidal flats. Estuaries and adjacent coastlines of East Anglia are important breeding areas especially for wader populations.

The JNCC Director of North Sea Coastal margins illustrates the seasonal distribution of seabirds around the UK, providing as assessment of vulnerability based on the time the species spends on the water and the importance of the area to the world population of that species. The trend for the Norfolk coast in the vicinity of the area is low vulnerability during the summer months, progressing to moderate vulnerability during autumn and high vulnerability in winter.

4.8 Cultural heritage

The walled medieval town of Great Yarmouth stands on a long spit of sand, which effectively closes the mouth of the formerly wide estuary of the Rivers Yare, Bure and Waveney, but which did not reach its fullest extent southward until c1200. This topographical fact largely determined the historical development of the town. The estuary (often known as 'The Great Estuary') was open in Roman times, with the Shore Forts at Caister and Burgh Castle facing each other across 9 km of shallow open water, controlling the estuary (Darling and Gurney 1993) (Figure 17). There are currently of the order of 400 listed buildings within the jurisdiction of Great Yarmouth Borough Council.

The beginnings of the sand spit which came to close the estuary probably lie in the Early Saxon period. McEwen (1992, 23) argues that 'spit-building began in earnest after the Romano-British period', although it was not inhabited until late Saxon times at the earliest; he points to evidence of the complex and changing relationships between the erosion of underlying estuarine clays and the deposition of marine gravels in the estuary, based largely on the observations of Green and Hutchinson in 1954 during construction of the existing power station.

Almost nothing is known of the pre-conquest history of Great Yarmouth, but Domesday Book (1086) records that in 1066 the spit was occupied and had a church (site now lost) dedicated to St Benet. By 1086 the settlement here had 70 burgesses and 24 fishermen (who 'belonged' to Gorleston). It is likely that the town began as a fishing settlement in the late Saxon period, maybe at first seasonal, on the shingle and sand spit which had developed by then across the mouth of the estuary.

Around 1100 the settlement was laid out anew, with long streets running along the spit and a new church overlooking the market-place. Further development in the town included the laying out of the 'Rows' (narrow alleyways), probably in the 13th century (Rogerson 1976, 136), and the building of the town walls in the period 1285-1341, to enclose what was by then an important port (Rutledge 1978). The town remained confined within these walls until modern times, with a handful of windmills on the sand-dunes to the immediate east of the town (Rye 1970), as can be seen on Faden's map of 1797 (Figure 18).

The remarkable situation of the town on its narrow spit dominates its topography and archaeology, with the build-up of wind-blown sand within the town leading to very deep stratification in places, and good sequences of stratified deposits (Rogerson 1976). In the early medieval period the town appears to have stood some 4 m higher in relation to the sea (Green and Hutchinson 1960). The

FIGURE 17

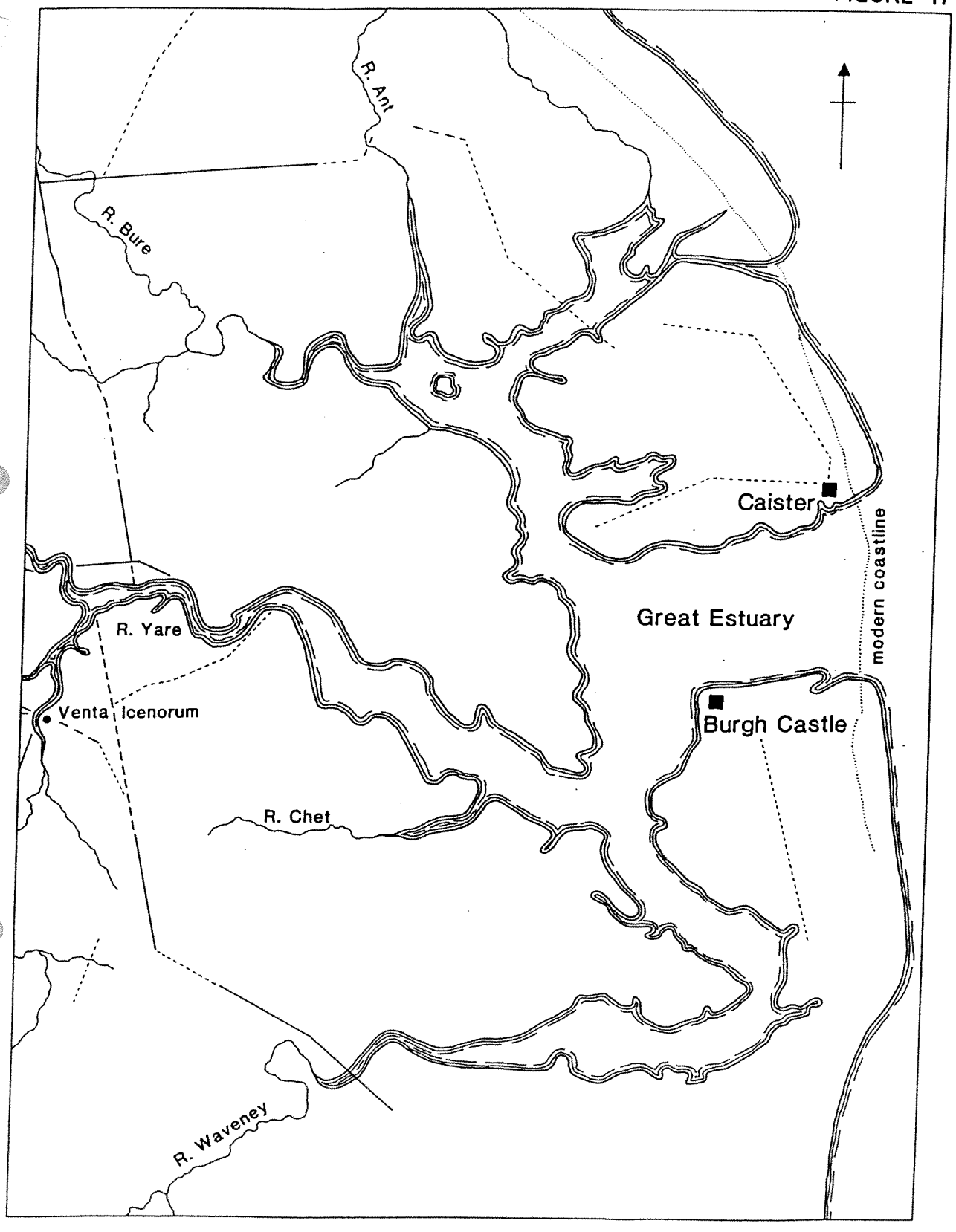


Fig 17 The 'Great Estuary' from Darling and Gurney (1993) fig 11

FIGURE 18

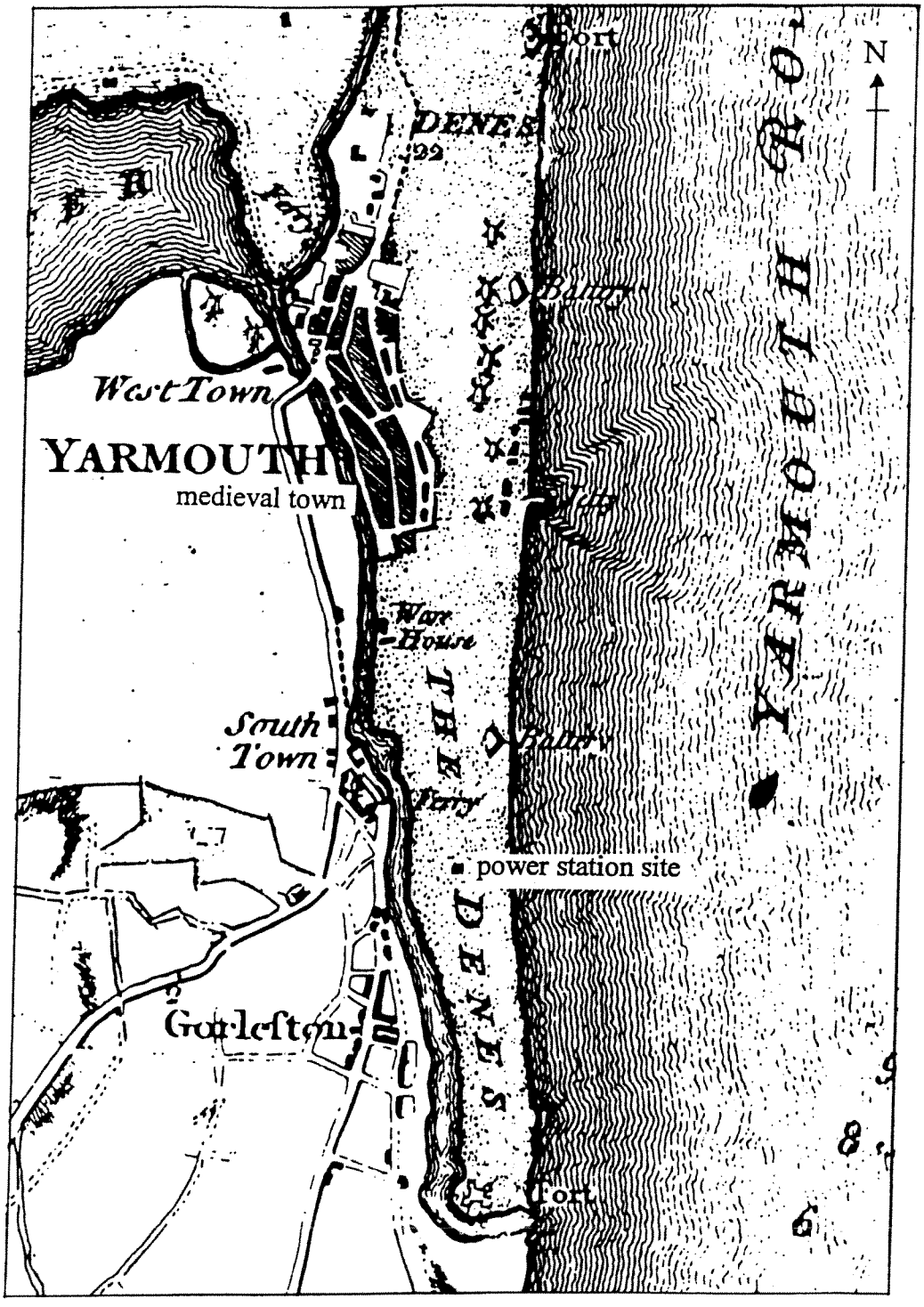


Fig 18 Detail from Faden's map of Norfolk 1797

situation of the medieval town on the west side of the spit and its sinuous street layout, seem to reflect a much narrower medieval spit, which was at its greatest height in the north part, where the town stands. The spit has accumulated material and grown seawards, as can be seen from a comparison of the later maps, eg Faden and OS 6" map of 1888 (Figures 18 and 19). The late Saxon/early medieval ship found buried at King Street (near the south-east part of the walled town at 0.3 m OD under 4.5 m of sand (Green and Hutchinson 1960, 129) may have been beached from the east, suggesting a contemporary beach in that quarter.

The Havens

The development of the spit has also involved the creation of a series of natural and artificial river outlets to the sea, with an early mouth of the River Bure at Grubb Haven (or Cockle Water) some way to the north of the walled town. This exit was finally closed by the early 14th century, the town standing on the peninsula thus formed (McEwen 1992, 23) whilst an early exit for the River Yare may have existed just beyond the North Gate of the town (Lark 1990, 14; McEwen 1992, 19).

Although the Yare exit (in effect, the south end of the spit) may have been just south of the town in the 11th century, by 1200 the spit had grown far to the south with its end just off the cost at Corton, but remaining very narrow throughout its length.

The present harbour mouth dates to the later 16th century, but is merely the last in a series of 'havens' (Eccleston 1959; Hedges 1959; McEwen 1992). As the medieval sandbank developed and river outlets became choked, artificial cuts were made to the sea. The exact locations of these cuts is mostly surmise, although Eccleston (1959) has suggested a succession of probable locations, with the power station site close to one of these (Figures 20 and 21). These may be summarized for information:

1st haven	1347 (blocked 1375)
2nd haven	1396 across the South Denes about 1.5 km below Wellington Pier and just north of the power station site
3rd haven	1408 at Newton
4th haven	1508
5th haven	1529 near the present-day harbour entrance
6th haven	1548-49 just north of the power station site
7th haven	1559-67

The structure and development of the spit, the most significant known aspect of the present site, has been most fully discussed by Green and Hutchinson (1960) drawing upon information from bores and in particular, the observations made during the construction of the South Denes Power Station in 1954-56.

Essentially the spit is composed of sand and shingle overlying about 20 m of an apparently homogenous estuarine clay, but its growth also involved channel erosion of the clay and reworking of the earlier deposits, a process driven by increasing sea-levels since Anglo-Saxon times and involving massive vertical accretion, resulting in the burial of early features, a characteristic of the archaeology of Great Yarmouth.

As has been seen, the spit developed from the north, and slopes from north to south, being at its lowest at the present harbour mouth. The spit has also become wider, growing both seaward and southward.

Archaeological observations

All excavations have revealed the extent of build-up and the survival of earlier features beneath later spit deposits. Excavations in 1974 near the highest part of the spit in the town, at Fuller's Hill, revealed that occupation of 11th and 12th century date was stratified between layers of windblown sand (Rogerson 1976), and observations of a sewer trench within the town in 1995 revealed a build-up of 2 m at least above the natural sand, within the walled area (Wallis 1995). At Fuller's Hill, the lowest occupation level was at 2.8 m OD, whilst the pavement outside the west door of the parish church to the east is 1.6 m OD, indicating the relative accretion here. It should be noted that Green found a medieval pot and hearth at depth, at 1.82 m OD in the town (Green and Hutchinson 1960, 196).

Two riverside sites in the town have also shed light on the significance of spit development; at south Quay, the remains of a 13th/14th century ship were found in silt 3.2 m below the pavement (at 0.7 m OD). The silt rested on sand which sloped to the west, possibly the natural beach surface. Similarly, at Hall Quay excavations exposed a sloping surface of sand, at about 0.0 m OD, again probably the natural shore line, lying under a thin band of redeposited peat and a deposit of brown soil containing bones and early medieval pottery (Rye 1990), showing that this was an open shore into the medieval period but was then buried.

Since the South Denes site, some 1.5 km from the town was unoccupied in medieval times, no formal archaeological work has taken place here but, during the construction of the power station in 1954-56, important observations were made in the contractors' trenches of the structure of the spit, and an assessment made of its major development, seen as probably beginning around AD 1000 (Green and Hutchinson 1960).

Notes were made of the strata and finds encountered down to -6.0 m during the building of the riverside intake cofferdam and the culvert to the Turbine House (A-C in Figure 22). Open excavation laid bare the structure of the spit to a depth of c-6.1 m OD.

The cofferdam itself stood on the riverside a little south of the power station, and recording of the stratification was begun here, with finds being encountered at great depth, indicating the depth of build-up since the medieval period. Discussion of the observed sequences follows.

Deposit sequence : 1954-56 Section A-C (Figures 22 and 23)

The intake at the riverside and the culvert were both dug to -6.1 m OD and revealed the following sequence (from the surface; E is the uppermost deposit):

E. 5.2 m OD - 3.3 m OD: recent blown sand and superficial deposits

D. 3.3 m OD: beach material with thin bands of silt

C. -3.0 m OD (at highest point) to -5.3 m OD: band of dark brown silty/clayey sand with much archaeological material. This material included French imported pottery of late 13th century date (not waterworn). The surface of the deposit was a mussel-bed, with the deposit as a whole interpreted as deriving from the great floods of 1287, the mussel-bed indicating its exposed surface.

B. -5.3 m OD and below: beach ballast, a sand and shingle mixture representing natural beach-building. This material contains pottery fragments of various dates, the latest of the 13th century, when this layer was overwhelmed by deposit C. The surface of this layer is a bed of barnacles of an inter-tidal species, indicating that this was an exposed beach surface until covered by deposit C (the flooding episode at the end of the 13th century). A hollow in the surface of deposit B seems to represent an early beach 'low', as may be seen on beaches today, separating the shore from an off-shore sandbank, and perhaps hinting at the process of spit formation. Deposit B lies unconformably upon the eroded surface of A.

A. the basal 'Red Beds' of fine compact reddish sands with silt and clay bands (current-bedded); the original surface has been eroded and lost during spit development. Archaeologically sterile, and probably of Pleistocene date.

Because of the shoring, the section at A-C (and to the outfall D) could only be examined and recorded at intervals. This section (Figure 23) demonstrates graphically the depth of material accreting on the spit since 1287.

Observations at the turbine house

During construction of the turbine house, the observed succession (County sites and Monuments Record) was of 'sand and shingle' over 'grey estuarine mud', which in turn overlay a shingle ballast which faded out eastwards. below this lay the 'Red Beds' and at the base, 'grey mud'.

Finds from these deposits (although not always precisely located) indicate their late date:

1. Glazed pottery was found just below the upper 'grey mud'.
2. Late medieval stoneware came from 'on top of the grey mud'.
3. Green-glazed sherds and other pottery, including a 'Saxo-Norman' jar, were found in the brown clay deposit below the mussel-beds at -5.7 m OD.
4. Bones and mica-schist bone were found at -6.0 m OD.

Cartographic sources

A good series of maps beginning in 1588 shows clearly that the long spit of sand upon which the medieval town stood was otherwise unoccupied by much other than windmills and shore gun batteries until modern expansion of Great Yarmouth in the early 19th century.

A plan of the intended fortifications of Great Yarmouth, dated to 1588, shows the town confined within its medieval walls, with a pair of opposed gun batteries (Nos 1 and 7 on the plan) some way t the south of the South Denes site, and a group of windmills on the sand-dunes to the east of the town (O'Neil and Stephen, 1942).

Gomme's map of Great Yarmouth (for Sir Robert Paston) in 1668 also shows the town within its walls and windmills on the dunes; on the map the South Denes are obscured by the key and were presumably empty (Rutledge 1978, pl 1).

The emptiness of the South Denes is well depicted by Faden's map of Norfolk of 1797 (Figure 18) where South Denes are empty, with a 'warehouse' on the river just below the South Gate, and South Star gun battery (1781) on the sea-shore, some distance north of the power station site. The only activity on the South Denes at this period was that of occasional fairs, such as the 'Dutch Fair' depicted by G Vincent c1825 (Hedges 1959, 15).

The beginnings of urban expansion onto the South Denes can be seen on the OS 1" lst Edition map of mid-19th century date (Figure 24), by which time major public works beyond the South Gate included the Barracks (1782), Naval Hospital (1809) and Gas Works (1824); the Nelson Monument was built in sandy isolation on the South Denes in 1817 (Palmer 1856, 297-290).

The Nelson Monument stood isolated on the Denes for many more years (apart from the racecourse of 1810), as can be seen from the OS 6" and 1:2500 maps of the 1880s. The power station was built on unoccupied land in 1954 (OS 1:2500 MAP 1958).

Since the spit had grown southward to Corton by c1200, it follows that the basal beach deposit B containing 12th and 13th century pottery and capped by inter-tidal barnacles must belong to this period. The barnacles also show that contemporary sea levels were much lower, perhaps about 4 m lower than today, in the 12th/early 13th century with accelerated submergence of existing levels after the floods of 1287 (Green and Hutchinson 1960, 134). The 1287 silt deposit was nowhere seen to be higher than 3.0 m OD. Rising sea levels in the medieval period probably accelerated the development of the spit, both in length and height, with the greatest in the north (oldest) part and least in the south (youngest) part.

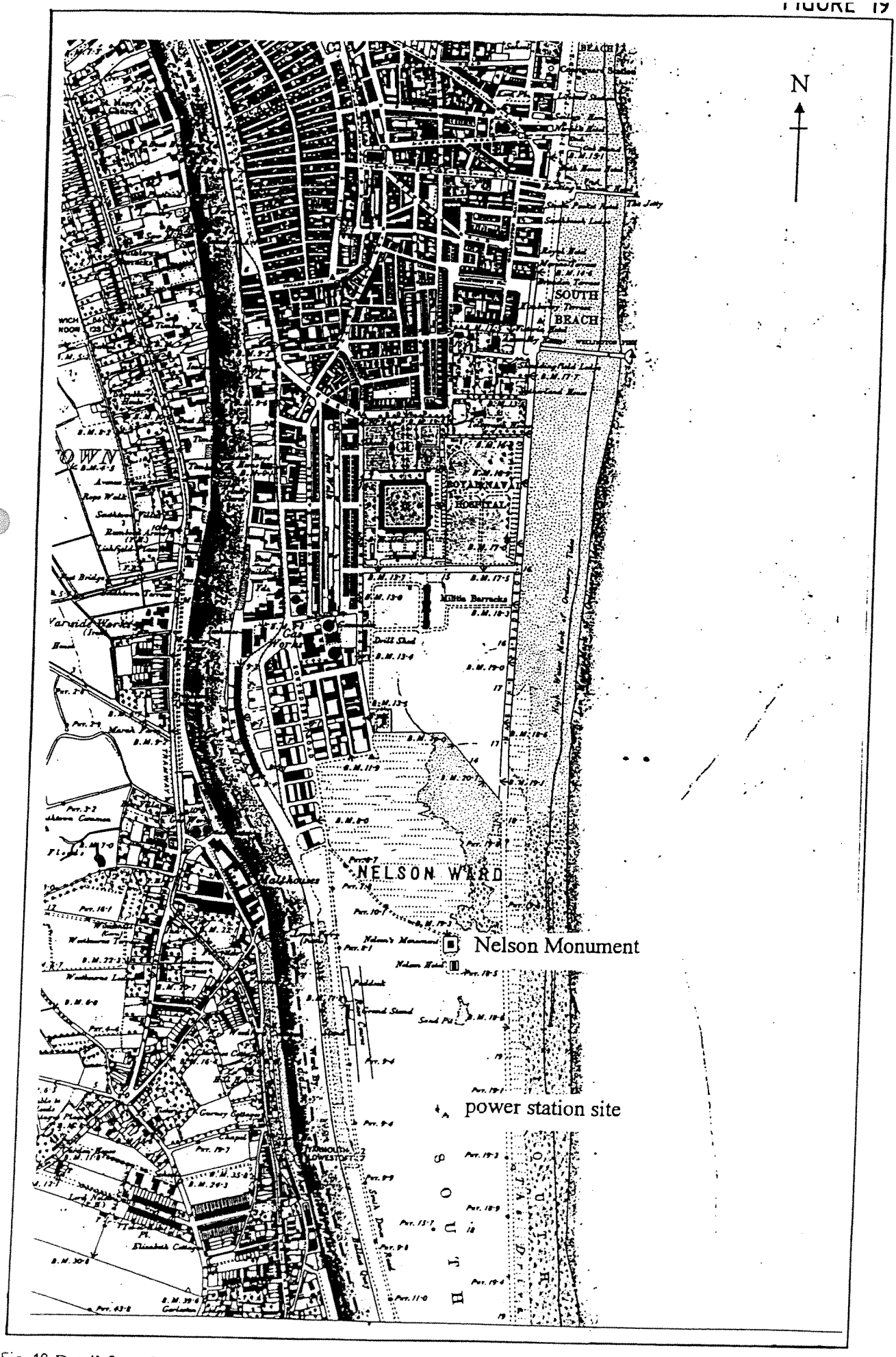


Fig 19 Detail from OS 6" map 1888

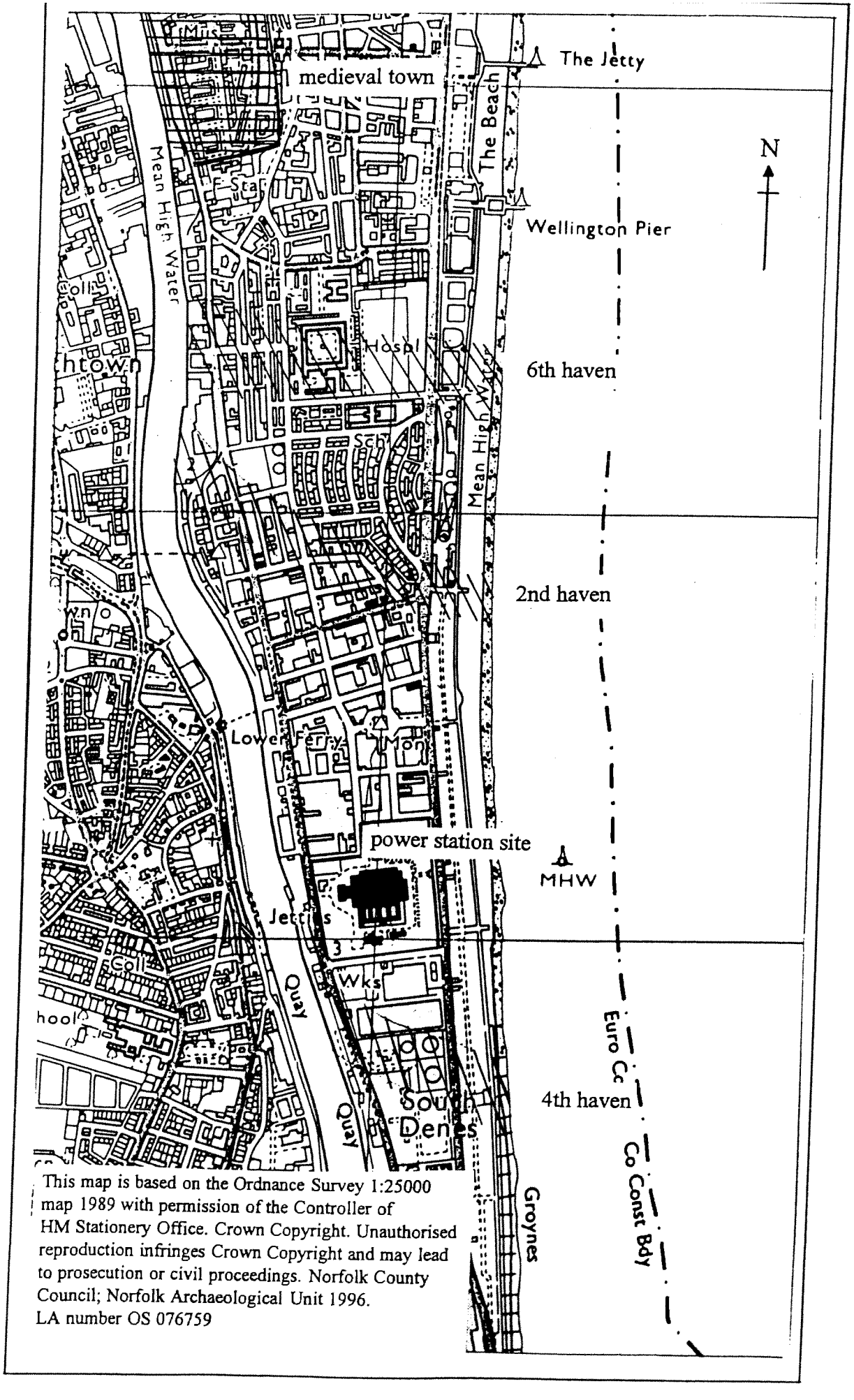


Fig 20 South Denes Power Station site (black) and postulated locations of medieval 'havens'. Scale 1:1250

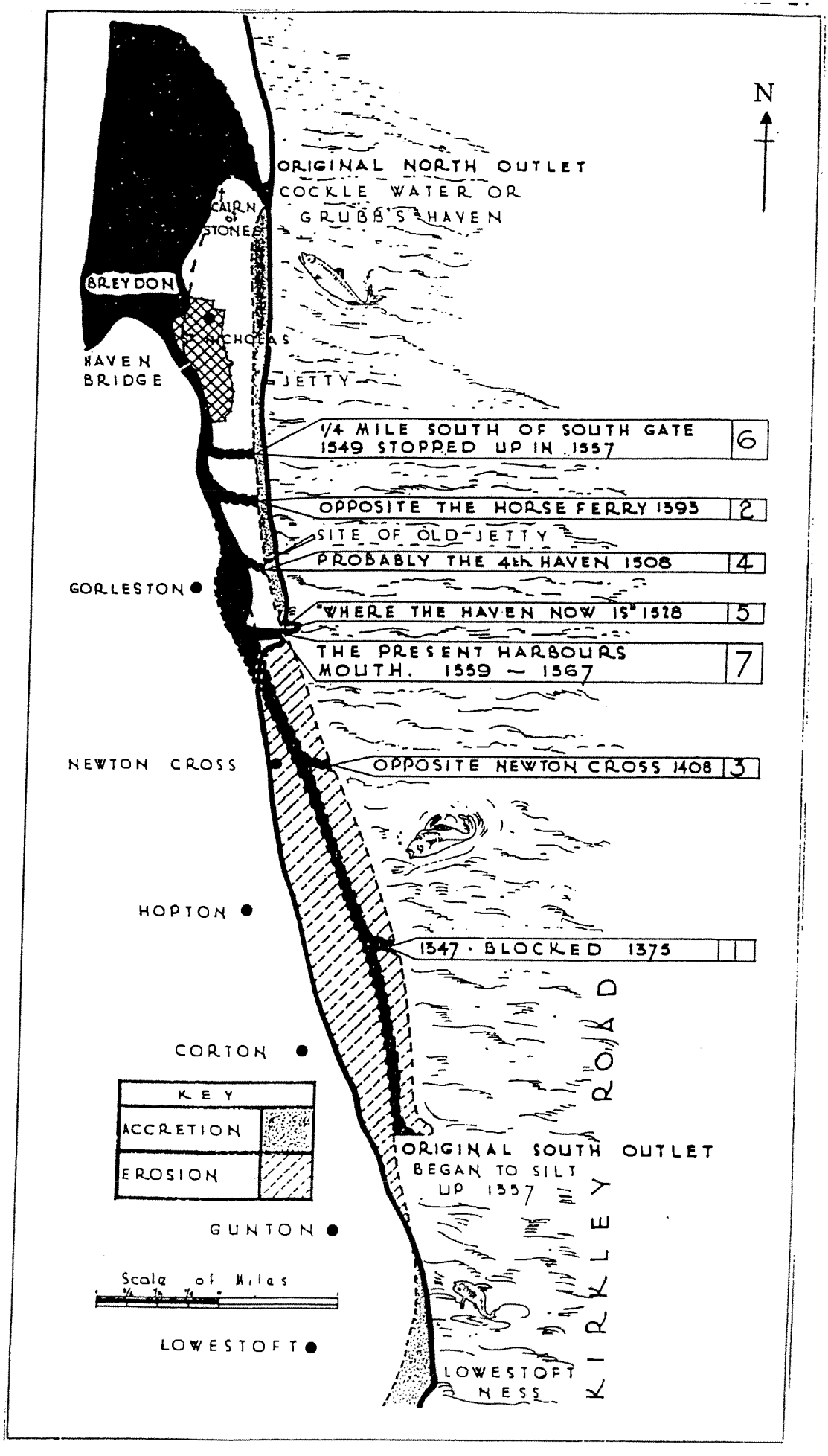


Fig 21 Earlier 'havens', from Ecclestone (1959)

FIGURE 22

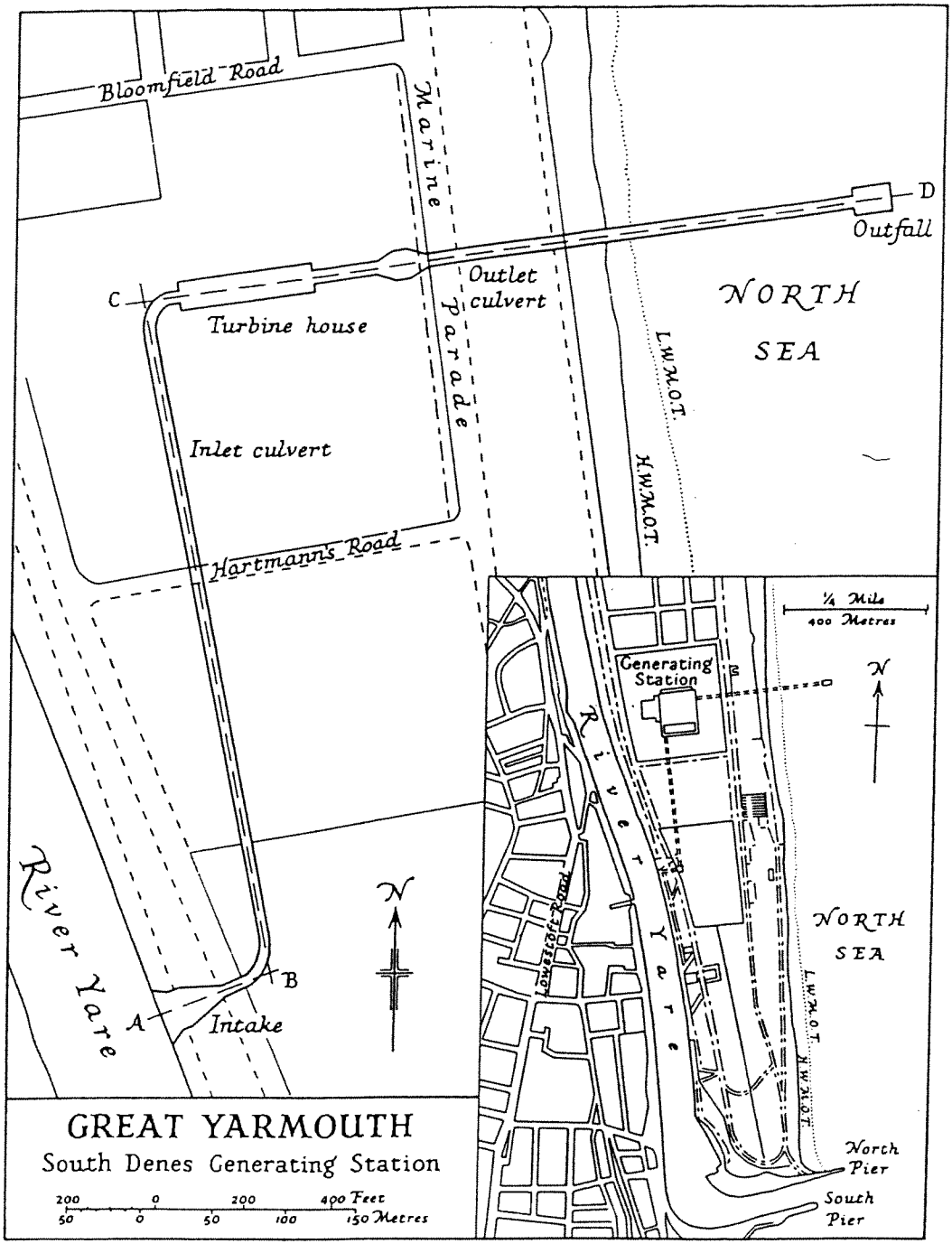


Fig 22 Plan of South Denes Power Station 1954-56, showing locations of sections A-D, from Green and Hutchinson (1960) fig 11

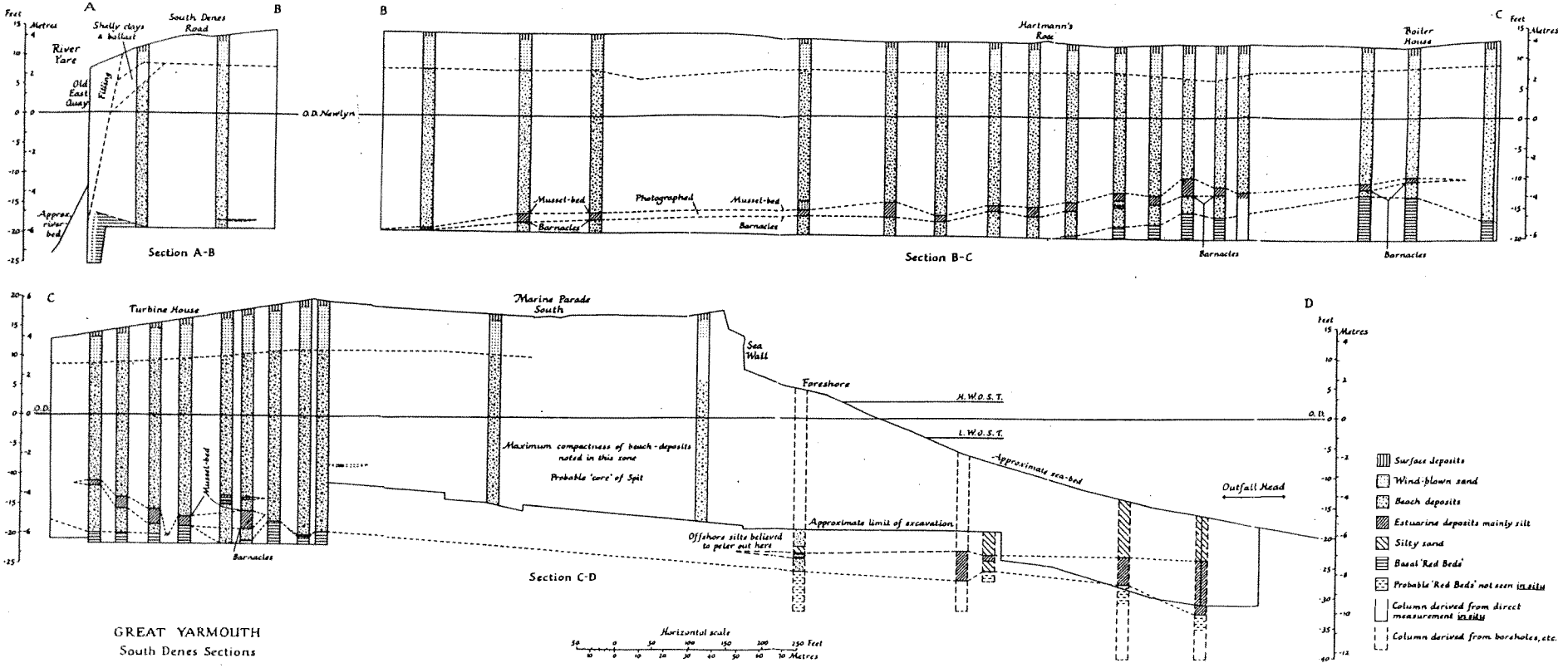
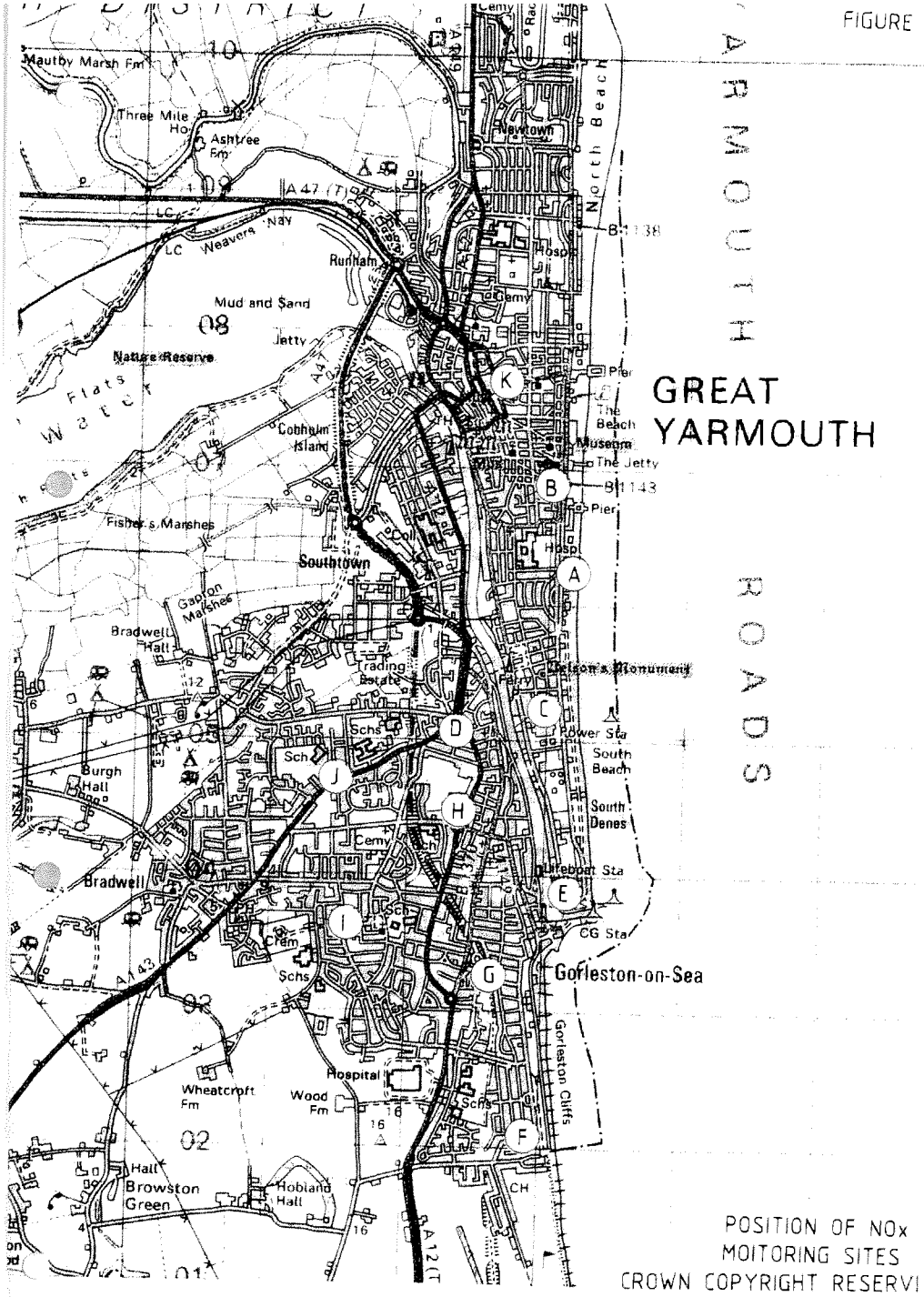


Fig 23 Sections A-C, recorded in 1954-56, from Green and Hutchinson (1960) fig 12

FIGURE 24

Fig 24 Detail from OS 1" map 1st Edn (enlarged)

FIGURE 5



POSITION OF NOx
MOITORING SITES
CROWN COPYRIGHT RESERVI

5. ENVIRONMENTAL IMPACT

5.1 Air quality and atmospheric emissions

5.1.1 Introduction

This section reviews the potential air pollution generated by the operation of Great Yarmouth Power Station. The proposed plant will be fired with natural gas and gas condensate.

5.1.2 Air quality during construction

Dust could be emitted during several activities associated with the construction works for Great Yarmouth Power Station should preventative measures not be taken. Dust could arise from: earth moving operations for site clearance, back filling and foundations; blow-off and spillage from vehicles; and during wind blow over bare dry construction areas. Site clearance is expected to take place between January and February 1997.

The extent of any such emissions of dust is very dependent on wind speed, ground conditions and the use of preventative measures.

Dust emissions from the site will not be more onerous than those normally encountered on construction sites. Construction operations will be conducted so as to minimize the generation and spread of dust. A comprehensive mitigation and monitoring programme is proposed. This is described in Section 6.1.1. This will prevent construction work generating levels of atmospheric dust which would constitute a health hazard or nuisance to people working on the site or living nearby.

The dust particles that may be emitted during construction would be of large diameter and would therefore tend to resettle on the ground within 100 to 500 m of the site. Approximately 70 per cent of the dust would generally settle out of the atmosphere within 200 m of the source, and less than 10 per cent could be expected to remain at a distance of 400 m.

Only with high wind speeds would long distance transport of dust and the potential for soiling of buildings occur. In these conditions more dust would also be created at source.

The electronics factories to the north and the paper factory to the south could both be affected by significant emissions and it is thus essential that dust preventative measures are implemented.

Dust is unlikely to result in a significant environmental impact during the construction phase.

The commissioning of the power plant will take about 12 weeks. Firing of the gas turbine will be intermittent during this period. It is possible that during commissioning the NO_x emissions will exceed the limits quoted below. However, operational periods during commissioning are often short and operation is frequently at low load. Thus the total mass emissions of NO_x during commissioning will be low.

5.1.3 Atmospheric emissions during operation

The emissions of most concern from the new plant are the oxides of nitrogen during both natural gas and gas condensate firing.

The ground level concentrations of NO_x from the new plant have been quantitatively assessed using dispersion modelling techniques and have been compared with the background air quality in the ar and with European Community legislation.

Natural gas will be used as the primary fuel in the gas turbine. It is an inherently clean fuel which results in lower NO_x and SO_2 emissions when compared with oil or coal. The proposed plant will be more efficient than the original South Denes Power Station and will, therefore, result in lower carbon dioxide emissions per unit of electricity produced. Natural gas has a higher calorific value than coal or oil which also results in lower carbon dioxide emissions per unit of electricity. In fact when operating on natural gas the proposed power station will emit less than half the carbon dioxide per MW than the existing South Denes Power Station (see Section 3.1.1).

The combustion of natural gas or gas condensate results in the emission of flue gases containing carbon dioxide, water vapour, oxygen, nitrogen, carbon monoxide, the oxides of nitrogen and traces of sulphur dioxide.

Combustion in gas turbines is conducted at high excess air rates, typically 200-300 per cent excess air. There are, therefore, very low levels of carbon monoxide, unburnt carbon (ie particulate matter) or unburnt hydrocarbons present in the products of combustion when burning natural gas or gas condensate.

The water vapour emitted will be heated well above its dew point and will not produce a visible plume under normal operating conditions.

The quantity of sulphur dioxide emitted depends on the sulphur content of the fuel. Typical sulphur levels in natural gas and the gas condensate to be used in the power station are negligible.

The formation of oxides of nitrogen in the combustion of fossil fuels is unavoidable. There are three recognised mechanisms for the formation of oxides of nitrogen. Nitric oxide (NO) is the principal oxide of nitrogen produced, with a small proportion of nitrogen dioxide (NO_2).

At temperatures above 1200°C, "thermal NO_x" is produced by a chain reaction initiated by the oxidation of molecular nitrogen from the air by oxygen radicals. The rate of formation increases rapidly with temperature and is very significant at temperatures above 1700°C. The reaction rate is linear with respect to residence time. The maximum thermal nitric oxide formation therefore takes place using near stoichiometric air to fuel ratios, particularly with fuels of high flame temperature.

Another similar mechanism for nitric oxide formation is the reaction of molecular nitrogen radicals derived from the fuel in oxygen deficient regions of the flame. Molecular species containing nitrogen are formed which can then be further oxidised by oxygen radicals to nitric oxide. This route to nitric oxide is less significant than the first but can be important when combustion chambers operate fuel rich and at high temperatures. This is called "prompt NO_x".

The third mechanism for nitric oxide formation is by the oxidation of nitrogen compounds bonded in the fuel, such as ammonia in gaseous fuels or nitrogenous hydrogen compounds in liquid fuels. NO_x formed in this way is termed "fuel NO_x". This route is expected to be minimal for the clean gaseous and liquid fuels which will be used in the gas turbine.

Little can be done to reduce "fuel NO_x" when burning a specified fuel. The thermal formation of NO_x from the high temperature reaction between the nitrogen and the oxygen in the intake air is considerably more serious in quantitative terms.

Consideration of the mechanisms of formation of nitric oxide show that the design of combustion equipment to reduce its formation by the thermal route should limit the overall temperature and residence time and minimise the formation of hot spots by optimisation of air and fuel mixing.

When NO_x was first identified as a harmful pollutant, no effort had been made to limit NO_x emissions from gas turbines or any other system. The exhausts of gas turbines then typically contained from 280 to 470 mg/Nm^3 NO_x. The problem having been identified the manufacturers of gas turbines were able to reduce the levels to about 235 mg/Nm^3 by fairly simple changes to air and fuel distribution in the combustors.

Since the NO_x formation from atmospheric nitrogen is strongly dependent on the maximum flame temperature and also the time the hot gases remain at this temperature, the thermal NO_x component can be reduced either by cooling the flames by steam or water injection into the combustion zone or by the use of Dry Low NO_x Burners. Steam or water injection cannot reduce emissions of NO_x to the same extent as Dry Low NO_x Burners without excessive production of carbon monoxide.

Pre-mix and hybrid burners burn fuel with excess air and maintain the fuel air ratio across the load range. These techniques are grouped together as Dry Low NO_x Burners. The main volume of combustion air is supplied to dilute the flame and inhibit further NO_x formation. Unfortunately Dry Low NO_x Burners are not able to reduce NO_x emissions when burning liquid fuels. As flame stability cannot be maintained during periods of low load or start-up the formation of oxides of nitrogen cannot be reduced at these times.

Water injection reduces the temperature of the combustor by its heat absorption and also by its evaporation and so reduces the formation of thermal oxides of nitrogen. The water used must be of high purity, from a water treatment plant. The injection of water into a gas turbine causes damage to the gas turbine blades and therefore leads to a greater down time for maintenance.

Steam injection into the combustion chamber of a gas turbine has the same effect as water injection in reducing NO_x emissions. It is usually the preferred option to water at installations where steam raising plant is available, as gas turbine blade damage is not caused. The diversion of steam from the boilers to the gas turbine has the drawback of reducing the steam output from the plant. When starting from cold, there may be a delay in the availability of steam while the boiler is brought up to working temperature and pressure. During this period, reduction of the oxides of nitrogen is not possible.

It is therefore proposed that the emissions of NO_x from Great Yarmouth Power Station be controlled by the use of Dry Low NO_x Burners during gas firing and by steam or water injection during gas condensate firing. The concentrations of oxides of nitrogen in the exhaust gases will therefore not exceed 60 mg/Nm^3 (29 ppm) during gas firing and 125 mg/Nm^3 (60 ppm) during gas condensate firing. These limits are for 15 per cent oxygen, 0°C, dry and 1 atmosphere and are in accordance with the HMIP guidance note IPR1/2 - Combustion Processes Gas Turbines (1994).

The performance of the NO_x abatement system will be guaranteed by the manufacturer.

The relationship between NO_x emission, steam or water injection rate and carbon monoxide emission is interrelated. It is possible to obtain lower NO_x emissions with higher injection rates but this usually gives higher CO emissions, lower overall efficiency and thus higher mass emissions of carbon dioxide for a given electrical and steam output.

When the gas turbine is started the NO_x level will not be within the emission value. When burning natural gas, it is not until the load rises above 40 per cent that full NO_x control will be attained, this will be within approximately 20 minutes for a Hot Start and one hour for a Cold Start. When burning gas condensate with water injection the NO_x level will be controlled below 125 mg/Nm^3 within 20 minutes. If steam injection is used for NO_x control then the NO_x will be within the emission value of 125 mg/Nm^3 within one hour.

Carbon monoxide levels during both gas and gas condensate firing will be below the legislative limit of 100 mg/Nm^3 and are more likely to be of the order of 20 mg/Nm^3.

It must be remembered that the level of pollutants emitted by the new power station will be very low in comparison to the original South Denes Power Station. The original power station did not use any NO_x control technology and would probably have had a NO_x emission rate of about 1400 mg/Nm^3. The power station would also have used a high sulphur fuel.

All gaseous emissions from the new plant will be approved by Her Majesty's Inspectorate of Pollution, who must authorise all prescribed processes, such as this, prior to operation.

Emissions of volatile organic compounds from the gas condensate tanks during filling and during storage will be limited by installation of appropriate VOC removal plant. Active carbon filters are proposed and details will be available during the detailed design stage.

Odour will not be a problem from the proposed plant.

Chimney height

The proposed chimney height was originally calculated on the basis of the HMIP guidance note "Technical Guidance Note (Dispersion), Guidelines on Discharge Stack Heights for Polluting Emissions". This resulted in a calculated stack height of 36 m. Screening runs were then carried out using this stack height and it was found to give unacceptably high ground levels of NO_x. It was therefore necessary to carry out screening runs for chimney heights of 50 m, 60 m and 70 m. The screening runs were undertaken using the Industrial Source Complex Short Term model for various distances from the stack. For each distance a worst case elevation was considered. The emissions from the proposed power station during operation on gas condensate were modelled as this results in higher emissions of NO_x than operation on natural gas. Table 5.1 shows the maximum hourly ground level concentrations for each of the stack heights considered.

TABLE 5.1
RESULTS FROM THE SCREENING RUNS
MAXIMUM HOURLY GROUND LEVEL CONCENTRATIONS OF NO_x
($\mu g/m^3$)

Windspeed (m/s)	Pasquill Stability Category	Stack height (m)			
		36	50	60	70
1	F	144.18	121.26	107.59	95.53
2.6	A	18.80	18.91	18.75	18.46
	B	18.80	18.91	18.75	18.46
	C	19.61	19.51	19.28	18.98
	D	16.90	17.29	17.24	17.04
	E	69.06	54.72	49.75	44.33
	F	99.02	76.48	65.06	55.20
4.4	B	29.23	28.12	27.17	26.16
	C	28.83	28.08	27.12	25.99
	D	26.74	25.89	25.02	24.04
	E	57.09	44.39	37.75	32.01
7	C	42.19	38.92	36.51	34.09
	D	39.24	36.15	33.41	30.55
12.6	C	323.31	54.98	49.20	43.66
	D	278.62	53.85	47.63	41.65

It is therefore proposed that the power station have a 70 m high stack as this gives acceptable short term ground level concentrations. A taller chimney height, although reducing pollutant ground level concentrations associated with the plant, would have a greater visual impact and can not therefore be justified.

More detailed atmospheric dispersion modelling using ISCST has been carried out on the basis of a 70 m stack height.

The stack will be fitted with a continuous NO_x monitor. The measured value will be recorded and displayed in the Control Room. Routine calibration checks will be carried out as recommended by

the manufacturer and as agreed with HMIP. The stack will also be fitted with an oxygen monitor and results from this will be used to correct the NO_x measured value to the format required by HMIP.

Regular observations of chimney emissions will also be made.

With the high excess air rates used in gas turbines it is not considered necessary to install continuous monitors for opacity, carbon monoxide or particulate matter.

5.1.4 Atmospheric dispersion modelling

When flue gases are discharged from a chimney they have two sources of momentum. One is related to the velocity of discharge. This is usually designed to be in excess of 15 metres per second as this value has been found to be sufficient to avoid immediate downwash of the plume.

The momentum from the velocity of discharge is soon dissipated.

The second source of momentum is much more significant and is related to the discharge temperature of the flue gases. The flue gases being warmer than the surrounding atmosphere into which they are discharged have a buoyancy and thus rise. This process continues until the flue gases have cooled to the same temperature as the surrounding air.

Mathematical models calculate the effects of these two sources of momentum and determine the height to which the flue gases will rise. This height plus the height of the chimney gives an effective chimney height.

The mathematical model then determines the dispersion of the flue gases from this effective chimney height. Note that the effective chimney height can be many times greater than the actual chimney height due to the large amount of heat present in the flue gases.

The dispersion of the flue gases is dependent on wind speed and weather conditions.

The ability of the atmosphere to disperse chimney emissions is greatly influenced by its vertical and horizontal stability which, in turn, are affected by the vertical temperature gradient and by wind effects. A marked reduction in temperature with height denotes a situation with strong vertical turbulence and mixing and the atmosphere is described as unstable. On the other hand, a constant, increasing temperature with height denotes a stable situation where vertical mixing is inhibited. This case is described as a "temperature inversion"' or simply an "inversion".

Low level inversion layers can lead to two effects, depending on the height of the inversion layer and the height of the power plant chimney. With a tall chimney and a low inversion layer a plume may become trapped above the layer preventing the pollution reaching the ground in the vicinity of the chimney. With a chimney lower than the inversion height and with a plume of insufficient buoyancy to punch through the layer the pollutants become trapped close to the ground, leading to high ground level concentrations. However, inversions of such a height are rarely stationary at one level so the condition described above is normally transitory.

An unstable atmosphere with vigorous vertical motions can also lead to high ground level concentrations. Such conditions are associated with hot days and light winds and the large scale

FIGURE 26 NATURAL GAS FIRING

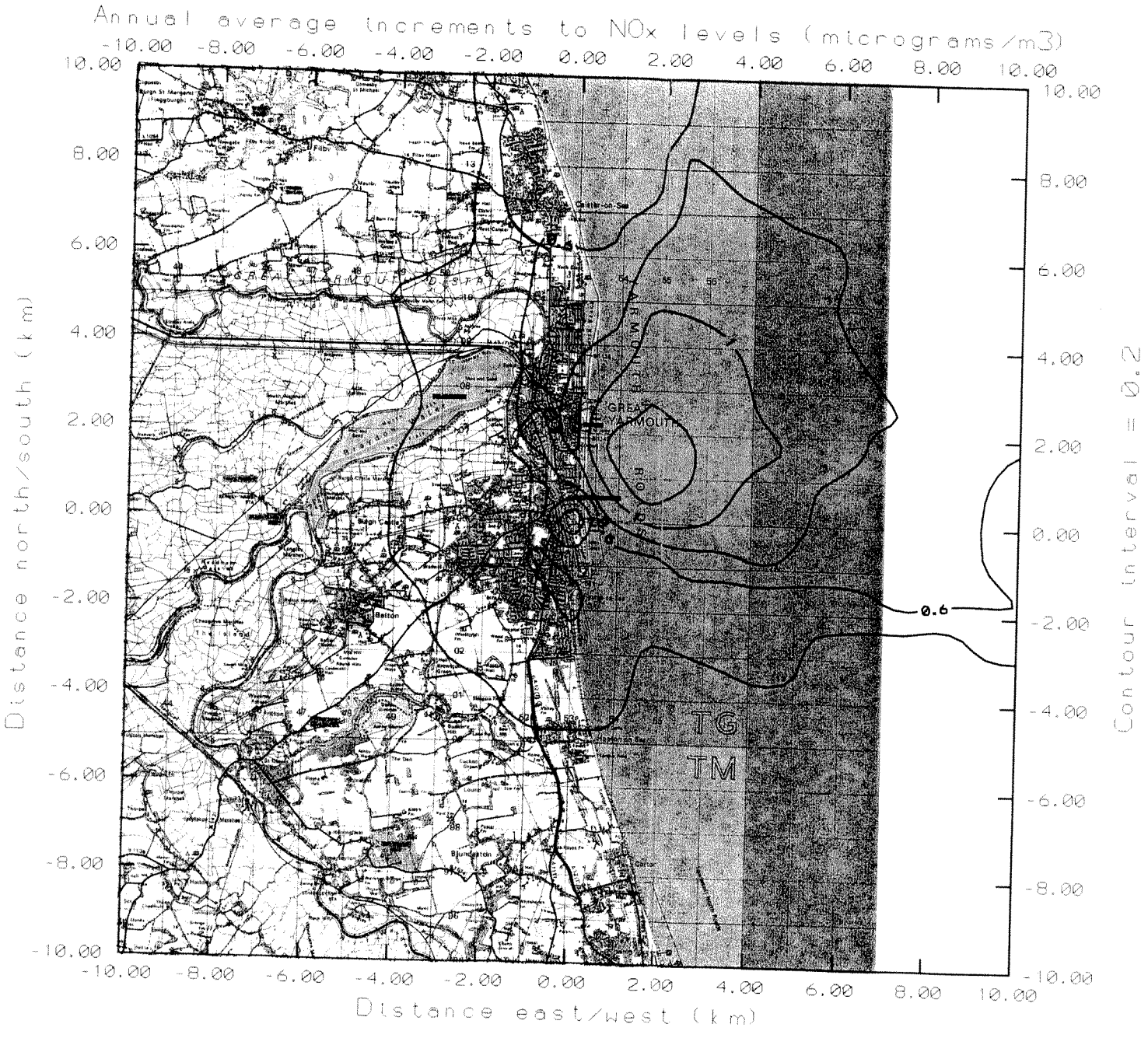


FIGURE 27 GAS CONDENSATE FIRING

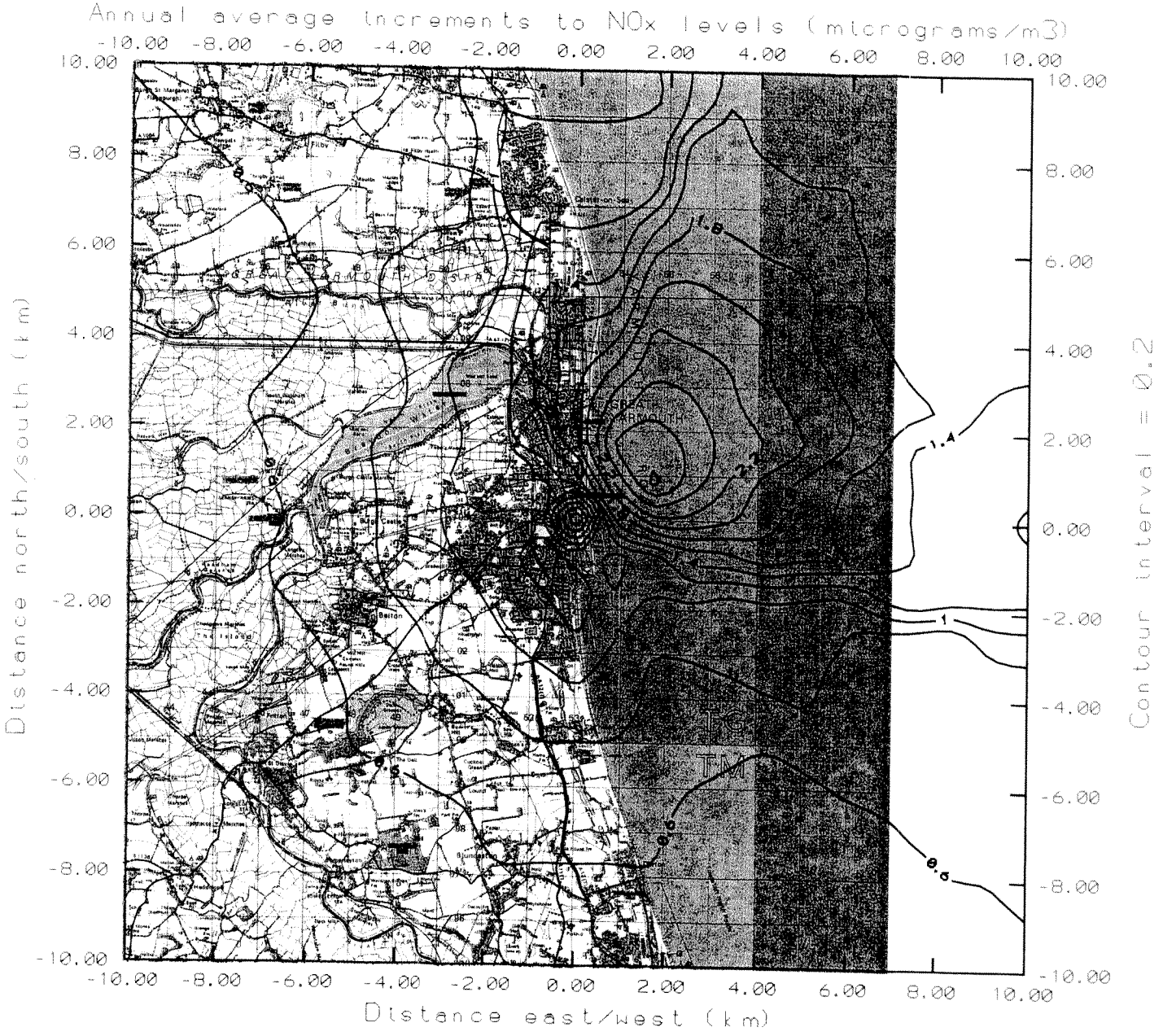
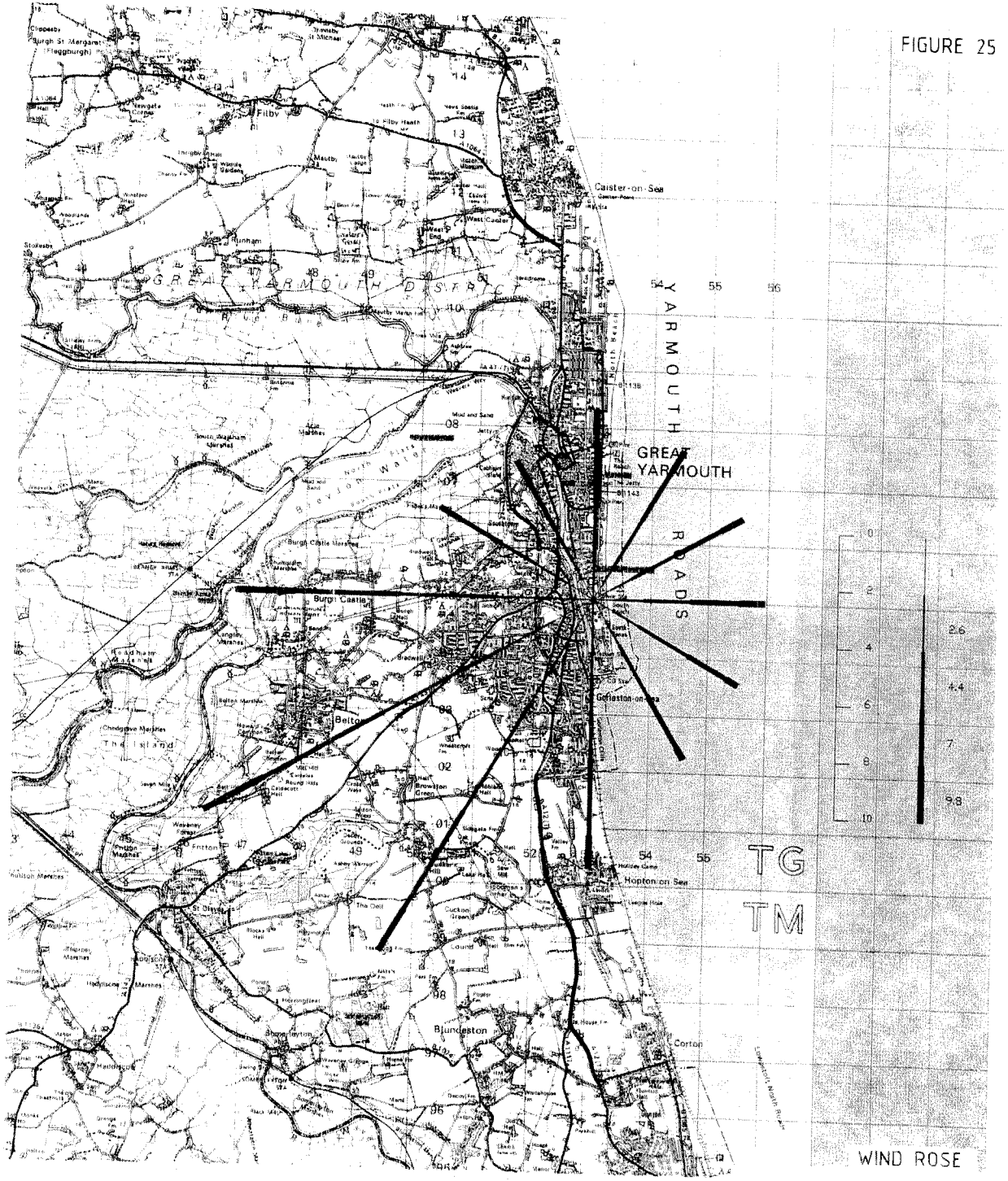


FIGURE 25



turbulence can cause the chimney plume to loop up and down as it dispersed downwind bringing part of the plume closer than normal to the ground. This can give rise to relatively high but very short term peaks of concentration quite close to the source of emission and lasting for a few minutes only.

Between these isolated occurrences the looping plume is also carried higher than normal above the ground so that the long term average concentrations are not affected by this strong lapse situation.

The stability of the atmosphere has been described using Pasquill Stability Categories. These are assigned labels A to F, where A is very unstable with large vertical motions, D is neutral and F is highly stable with all vertical motion suppressed and with temperature increasing with height. These categories are used in most atmospheric dispersion models. Pasquill Stability Category D is the most common condition.

Wind speed is of importance for the dispersal of chimney emissions in two mutually opposing ways. Because the wind is normally turbulent, particularly close to the ground, it disperses chimney emissions vertically and horizontally. The rate of horizontal dispersion is directly proportional to wind velocity. However, the wind also affects the plume by inhibiting its rise. The affect is in inverse proportion to wind velocity.

5.1.5 The dispersion model and inputs

The model chosen to calculate hourly average ground level concentrations due to the proposed plant is the Industrial Source Complex Short Term (ISCST) model which has been validated by the Environmental Protection Agency (EPA) of the USA and has been accepted by HMIP. The ISCST model is able to consider the effects of building downwash and is also able to take into account the effects of simple terrain. Simple terrain is described as that with an altitude below stack height. The area of interest, in this case taken to be within a radius 10 km of the South Denes site does not rise above the proposed stack height of 70 m. The elevation of the highest ground is just 30 m. Plant elevation was taken to be 0m for dispersion modelling purposes.

Building downwash affects the dispersion of atmospheric emissions by reducing the plume height and increasing the local wind turbulence. The plume can become caught up in the turbulent building wake (downwash) if the stack is less than 2.5 times the height of any building in the vicinity of the site. The presence of large buildings therefore results in higher ground level concentrations in the vicinity of the stack and brings the location of the maximum ground level concentration closer to the source.

The ISCST model also uses algorithms to represent either rural terrain or the greater roughness of urban terrain. In this case the model has been run in the urban mode as this usually results in predictions of higher ground level concentrations close to the stack and can be considered a worst case scenario.

The model calculates maximum hourly concentrations over any set of distances from the source. For the first run an area of one kilometre radius was considered in detail with 100 m increment between points. For the second run increments of 1 km were used to cover an area of radius of 10 km.

Table 5.2 shows the data used in the dispersion calculations.

TABLE 5.2
GAS TURBINE DATA

	Gas firing	Gas condensate firing
Fuel consumption kg/s	13.6	13.6
Fuel Calorific Value MJ/kg	48	48
Flue gas temperature °C	95	105
Stack height m	70	70
Estimated Stack diameter m	6	6
Flue gas velocity m/s	27	25
Actual flue gas flow rate m^3/s	843.23	772.6
NO_x flow rate g/s	33.48	69.75

In order to calculate annual average ground level concentrations it is necessary to use the hourly concentrations produced by the ISCST model in a Merz and McLellan in-house computer programme. The programme takes the hourly maximum figures and applies the frequency of each wind speed, direction and Pasquill stability category to calculate the average over a typical year. Meteorological data for a 10 year period was obtained from The Meteorological Office, for their weather station at Hemsby. Hemsby is situated 12.5 km to the north of the South Denes Power Station site and has a similar coastal orientation. It is the closest meteorological station where wind speed and direction data are divided into Pasquill Stability Categories.

This meteorological data is attached in Appendix E, and a wind rose is shown in Figure 25. The wind rose shows the predominant wind directions being from the south west.

An ambient temperature of 15 °C was assumed. For Pasquill Stability Categories A to D a mixing height of 1000 m was used and for Pasquill Stability Categories E and F a mixing height of 100[illegible] was used.

Annual averages have been calculated for both full load operation throughout the year on gas firing and for full load operation throughout the year on gas condensate firing, although it is not anticipated that gas condensate will be fired for more than a few days per year.

5.1.6 Modelling results

Predicted maximum hourly increases for various weather conditions are shown in the Table 5.3. Due to the large quantities of data produced by the model it is necessary to summarize it in this form. For each weather condition modelled the maximum increment calculated for any distance or direction is shown. Annual average increments are shown as isopleths in Figures 26 and 27.

NO_x emissions consist of the gases NO and NO_2. It is only nitrogen dioxide that is of concern in terms of direct health and environmental effects. However NO is a source of NO_2 in the atmospher[illegible]

The gases are in equilibrium in the air, with NO predominating at the stack exit. As the plume cools the equilibrium changes resulting in a predominance of NO_2.

NO is oxidised to NO_2 mainly by reaction with ozone. Within 5 km of the source less than 20 per cent of the nitric oxide will have converted to nitrogen dioxide under stable conditions. Under unstable conditions with more atmospheric mixing up to 50 per cent of the nitric oxide may have converted to NO_2. The rate of conversion of nitric oxide to NO_2 increases with rising ozone concentration, wind speed and solar radiation. [Jansenn (1988), "A classification of NO oxidation rates in power station plumes based on atmospheric conditions", Atmospheric Environment, 22, 43-53]. However, for this environmental assessment a worst case has been considered where all NO is assumed to be converted to NO_2 at the chimney outlet.

TABLE 5.3
PROPOSED PLANT
MAXIMUM HOURLY GROUND LEVEL CONCENTRATIONS
MICROGRAMS/M^3

Windspeed m/s	Pasquill Stability Category	Gas firing NO_2	Condensate firing NO_2	Distance (m)	Direction (degrees)
1	F	45.93	95.53	5000	240
2.6	A	8.90	18.46	1000	210, 240, 270
	B	8.90	18.46	1000	210, 240, 270
	C	9.13	18.98	2000	180, 270
	D	8.81	17.04	3000	180 to 300
	E	21.31	44.33	5000	240
	F	26.54	55.20	3000	180 to 300
4.4	B	12.60	26.16	800	210, 240, 270
	C	12.52	25.99	1000	210, 240, 270
	D	11.57	24.04	2000	180, 270
	E	15.39	32.01	3000	180 to 300
	C	16.41	34.09	800	210, 240, 270
	D	14.72	30.55	1000	210, 240, 270
12.6	C	20.57	43.66	500	270
	D	19.61	41.65	700	210, 240, 270

Analysis of results

Examination of Figures 26 and 27 shows that the increase in annual average ground level concentrations of nitrogen oxides produced by the new CCGT plant during both natural gas and gas condensate firing will be very small. The maximum predicted NO_x increase is just 1.39 $\mu g/m^3$ based on natural gas firing at 100 per cent load throughout the year or 2.89 $\mu g/m^3$ based on gas condensate firing throughout the year at 100 per cent load.

Due to the predominent wind direction, the site of the maximum annual average is at a direction of 60° and at a distance of 2 km from the stack, which is of course out to sea. The highest annual average on land is 1.24 $\mu g/m^3$ for natural gas and 2.58 $\mu g/m^3$ for condensate.

Adding these to the highest two monthly average monitored value (44.4 $\mu g/m^3$) the expected annual ground level concentrations for NO_x inland would be either 45.64 $\mu g/m^3$ (for gas firing) or 46.98 $\mu g/m^3$ (for gas condensate firing), neither of which exceeds the EC annual average of 50 $\mu g/m^3$. However, these figures are overestimations of the true maximum annual average as the maximum calculated increments to ground level concentrations do not occur at the same location as the highest existing background NO_x level. Also a two month average is likely to be higher than the actual annual average.

The expected increments to the background annual average in the town centre of Great Yarmouth would be 0.93 $\mu g/m^3$ for a year of gas firing and 1.93 $\mu g/m^3$ for a year of gas condensate firing.

The maximum hourly increment during natural gas firing in Great Yarmouth town centre is 30.41 $\mu g/m^3$ and that during gas condensate firing is 63.19 $\mu g/m^3$. Adding these figures to the 98th percentile calculated in Section 4.1 for the town centre results in expected 98th percentile ground level concentrations of 141 $\mu g/m^3$ and 174 $\mu g/m^3$ respectively. These are both within the EC statutory limit. The frequency of the weather conditions resulting in these maxima is just 0.56 per cent.

The maximum hourly concentration of NO_x when firing natural gas for any weather condition is 45.93 $\mu g/m^3$. When firing gas condensate this figure is 95.53 $\mu g/m^3$. These maxima occur at a distance of 5000 m to the south west of the plant (240°). The particular weather conditions causing these maxima (a wind speed of 1 m/s from a direction of 60° and Pasquill Stability Category F) occur only 0.20 per cent of a typical year. Pasquill Stability Category F occurs only at night. The possibility of these conditions occurring at a time of gas condensate firing is extremely small. These maxima are well within the WHO hourly guideline level of 400 $\mu g/m^3$. When added to the existing 98th percentile (calculated from the monitored data, as shown in Section 4.1) that could be expected at this point, (of the order of 77.5 $\mu g/m^3$ or less) the expected 98th percentile would be 124 $\mu g/m^3$ and 174 $\mu g/m^3$ for gas firing and gas condensate firing respectively. These are both within the EC statutory limit and that for gas firing is also within the EC guideline level.

In the town of Lowestoft the maximum hourly ground level concentration of NO_x would be 35.73 $\mu g/m^3$ during gas firing and 74.37 $\mu g/m^3$ during gas condensate firing. Again this maximum would only occur during Pasquill Stability Category F. The weather conditions leading to these maxima occur only 0.24 per cent of the year, with the wind blowing in the direction of Lowestoft for a total of 6.634 per cent per year. The corresponding annual average ground level concentrations are therefore 0.25 and 0.51 $\mu g/m^3$.

SF_6 gas

The switchgear to be installed in a building on the power station site will be of the SF_6 type. SF_6 gas is used as an insulating and arc quenching medium. It is an incombustible, non-toxic, odourless, chemically inert gas. It is about five times heavier than air and thus one of the heaviest known gases. Although it is a non-toxic gas it is not life supporting and can cause asphyxiation at concentrations greater than a certain level.

The SF_6 gas is sealed in metal enclosures and is not intentionally vented to atmosphere. The gas would only be released to the atmosphere in the event of leakage from the equipment, accidents or leakage during filling, all of which are very infrequent and the quantities released on such events would be very small.

When SF_6 is heated to a high temperature (1500 K), such as may occur due to a high current arc or fire it can form a small amount of toxic decomposition products. Gas and decomposition products would be released only if the equipment enclosure was ruptured. Because the equipment is indoors gaseous decomposition products, if released, would be contained within the building. Solid decomposition products would be deposited near the faulted equipment. The contaminated area would be within the switchgear building and would be accessible only to personnel trained in proper safety procedures. The area would be easily decontaminated by vacuum cleaning and washing with water or an alkaline solution to dilute and neutralize the contaminants.

The SF_6 gas is transported and stored as a liquid under pressure (at approximately 20 bar).

5.2 Water quality

This section looks at water use at the proposed CCGT plant and the disposal of its aqueous effluents.

5.2.1 Impacts on water quality during construction

A small amount of water will be required each day for the general construction works, this will be taken from the existing supply of Towns water.

Several construction activities could require the disposal of water from the site. This will be the responsibility of the Contractor who will reach agreement with the NRA and the local sewerage undertakers with regard to the detailed methods of disposal.

Should a temporary diesel storage tank be necessary on site during construction, then this will be contained within a bund, sized to hold 110 per cent of the tank's contents. Maintenance of construction machinery will not be allowed on site.

During the construction of the intake and outfall there is the possibility of disturbance of the river and sea beds respectively, with a corresponding temporary reduction in water quality due to increased levels of suspended solids. However, should the outfall be floated into position, as is currently proposed, this will cause less disturbance to the main sediments than dragging it into place from the shore.

5.2.2 Impacts on water quality during operation

Water required by the plant will be taken from two sources; cooling water will be taken from the River Yare and all other requirements will be taken from the Towns water supply. The capacity of the Towns water distribution system is sufficient to provide the water required. The total quantity of Towns water required by the power station will be of the order of 400 m^3/day when gas firing and 2000 m^3/day when burning gas condensate, due to the requirement for water or steam for injection for NO_x control.

During operation the CCGT plant will require, on a day to day basis, water for the following uses;

- for cooling purposes for the condenser and other cooling duties;
- for make-up to the boiler water system;
- for water or steam injection to control NOx during gas condensate firing.

Water will also be stored on site for fire fighting purposes and will be used occasionally for clean various items of plant.

All process effluents will be discharged to the cooling water discharge system and then to the North Sea. These effluents would be, on a day to day basis;

- cooling water 5 m^3/sec;
- boiler blowdown 150 m^3/day;
- water treatment plant effluent:
  - when firing natural gas 60 m^3/day
  - when firing gas condensate 300 m^3/day
- miscellaneous minor process effluents 50 m^3/day

Sewage will be discharged to the local sewage system.

Her Majesty's Inspectorate of Pollution (soon to become part of the Environment Agency) will set limits after discussions with the National Rivers Authority for the quality of water discharged from the site under the Integrated Pollution Control Authorisation. Anglian Water have been consulted concerning the sewage discharge to the existing sewer and this will require a separate discharge licence.

The cooling water systems

The CCGT plant will be cooled by the use of a "once-through" cooling water system. Its auxiliaries will be cooled by the use of a closed circuit cooling water system.

The major cooling duty is to condense the steam discharging from the steam turbine for re-use as boiler feedwater. This cooling will be provided by river water. The circulating water syste

supplies cooling water to the main condenser for condensing the low pressure turbine exhaust steam and to the closed loop cooling water system heat exchangers.

The cooling water for the power station will be abstracted from the River Yare from a new abstraction point due west of the southern corner of the site. It is not possible to use the existing intake structure as the Port Authority have plans to re-use that area.

The water abstracted will be passed though coarse bar screens (spacing approximately 50 mm) and then though fine band screens (mesh 6 to 10 mm hole size). The design of the intake structure will be such as to minimise the inflow velocity and to limit ingress of debris and marine life (particularly fish). Submerged acoustic deterrents will be located at the intake to further deter fish from entering the system. Any fish that do enter the system will be trapped on the band screen, collected and returned to the river or the sea. Details of the intake system and the fish return system will be submitted to the National Rivers Authority for approval.

Any weed or debris collected by the band screen will be removed by fixed spray water jets and will be taken to an appropriate landfill site.

From the fine band screens the cooling water will pass to three 50 per cent cooling water pumps which pump the water through the main steam condenser and also through a water/water heat exchanger which cools the closed circuit cooling system that cools various items of plant and equipment. This closed circuit system ensures that oil or other possible contaminants cannot enter the once -though cooling water system.

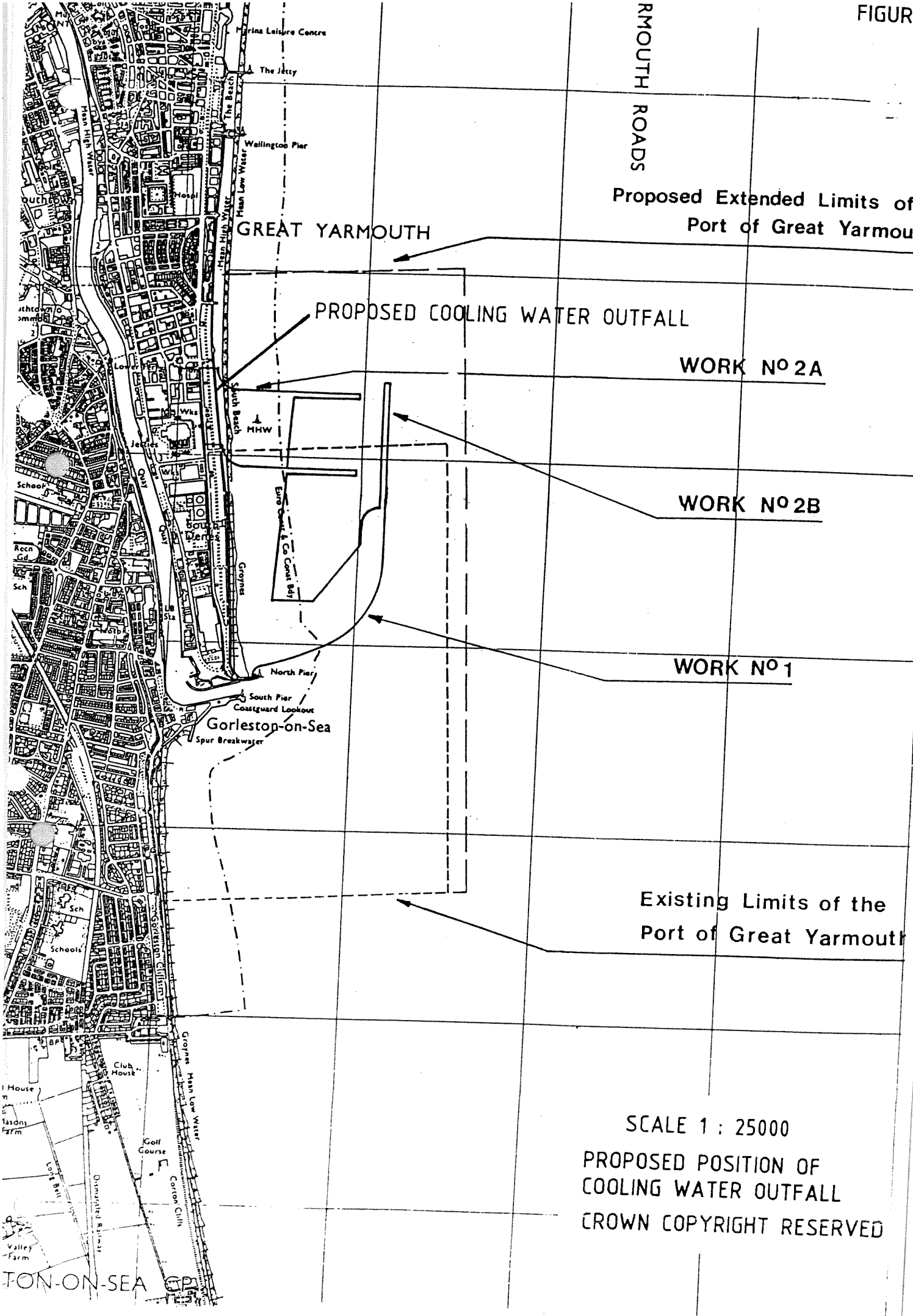
The closed circuit cooling water system will be filled with deionized water to which a suitable corrosion inhibitor has been added. Typical corrosion inhibitors for such systems are hydrazine or sodium nitrite/borate solutions. The total water in the closed cooling water system is small, of the order of 5 m^3 and thus the quantity of corrosion inhibitor used is also very small. These cooling water systems do not normally produce an aqueous effluent. On the rare occasions when these cooling systems have to be drained for maintenance the cooling water can be safely discharged at a low flow rate and allowed to mix with the main cooling water discharge.

From the condensers the cooling water is piped across the site, under the road (South Beach Parade) and out to the North Sea. A new outfall structure will be constructed as the existing outfall is within the area designated for the outer harbour development. The discharge point will be 650 m offshore at a depth of 6 m. The discharge will be through a diffuser. The discharged water will be at approximately 8°C above ambient temperature. The proposed position of the new outfall is shown in Figure 28.

The outfall is approximately 650 m from the north east corner of the site. A submerged outfall with a diffuser head is proposed. This may be subject to change on award of the contract for the power station.

An Act of Parliament was passed in 1986 for the expansion of the Port of Great Yarmouth by construction of an Outer Harbour. At present finance for construction of this Outer Harbour is being arranged. Discussions have been held with the Port Authority. The Port Authority advised that they propose to rerun the Delft Hydraulics model of the Outer Harbour during the summer of 1996. The opportunity will be taken during the rerun of the model to include the proposed location of the

FIGURE 2


RMOUTH ROADS
Proposed Extended Limits of t
Port of Great Yarmouth
GREAT YARMOUTH
PROPOSED COOLING WATER OUTFALL
WORK Nº 2A
WORK Nº 2B
WORK Nº 1
Existing Limits of the
Port of Great Yarmouth
Marina Leisure Centre
The Jetty
The Beach
Wellington Pier
Mean High Water
Mean Low Water
Hospl
MHW
Jetties
Quay
Groynes
North Pier
South Pier
Coastguard Lookout
Gorleston-on-Sea
Spur Breakwater
Schools
Club House
Golf Course
Gorton Cliffs
Valley Farm
SCALE 1 : 25000
PROPOSED POSITION OF
COOLING WATER OUTFALL
CROWN COPYRIGHT RESERVED

outfall. If the model shows that the proposed location is unsuitable, revised locations will be proposed and modelled until a suitable location is determined. It is not anticipated that major relocation will be required and therefore the impact of the outfall will be generally as described herein.

The quantity of river water required for cooling is of the order of $5m^3/s$. This compares with the nearly $8\ m^3/s$ of the original South Denes Power Station. Therefore on an annual basis 158 million tonnes will be used compared to 246 million tonnes for the original power station. As the total flow in the River Yare varies with the state of the tide, a calculation showing the percentage of the river flow required by the power station would not provide any beneficial information.

The cooling water will be dosed at the coarse screens with a biocide (sodium hypochlorite) to prevent the growth of mussels and other marine organisms and microbiological slimes within the cooling water system. The quantity added will be extremely small so that the quantity in the condenser outlet will be 0.1 mg/l total residual oxidant or less. At the outfall to the sea it is thought that the total residual oxidant will be undetectable. While chlorine dosing may have some impact on aquatic life entrained in the cooling water passing through the power station it should have no impact on the ecology of the North Sea. The dosage rate will also not be high enough to kill any fish that enter the system.

The biocide will be produced on-site in an electrochlorination plant which produces sodium hypochlorite by the electrolysis of river water.

The cooling water does not come into direct contact with any other process fluids in the course of its use.

The river water currently contains some organic matter. The quantity of such organic material will reduce as the new sewerage system is installed at Great Yarmouth. Some of the sodium hypochlorite dosed into the cooling water will react with this organic matter and some chlorinated organic matter will be produced. This will include chloroform and similar chlorinated hydrocarbons. It is difficult to estimate the amounts produced but based on the current organic content of the river water concentrations of up to $30\ \mu g/m^3$ could be present at the outfall. As the concentration of organic matter in the river water reduces this concentration should reduce to values of 12 to $15\ \mu g/m^3$. These levels are not considered to have any environmental impact.

The cooling water discharge will have a slight impact on the along-shore movement of sediment, which is transported parallel to the coast in a southerly direction. The alignment of the outfall will need to ensure that downshore areas of beach are not eroded as a result of deposition within the area of the outfall. The impact of the outfall regarding sedimentation will depend on the diameter of the structure and whether it is fully submerged under the seabed. The rate of release of water from the outfall will be significant and is likely to have a local effect on sediment nature and transport at the end of the outfall.

The discharge of a heated plume is unlikely to have a significant impact, as this area of coastline has shallow waters which are relatively warm. In addition, this is a high energy shoreline and the released water will quickly be mixed with the ambient coastal waters. However, the introduction of warm water will have a slight effect on the levels of dissolved oxygen, available nutrients and suspended solids within the plume. The release water will require consent from the NRA and hence

will have standards for various parameters such as temperature, total residual oxident etc., which will have to be met to ensure that there is no detrimental effect to the coastal water quality.

The thermal plume that will be created by the cooling water discharge from the power station has been modelled using a system prepared by Mostafa A Shiraz et al for the Environmental Protection Agency of the USA, published in 1972. The model assumes that the plume travels horizontally for a short distance before buoyancy lines lift it upwards. The plume continues to rise until it loses buoyancy or reaches the surface. Meanwhile the plume centreline temperature continues to decay due to dilution of the plume with the ambient water.

The following inputs were used in the model:-

Assumed jet diameter	=	1.26 m
Jet velocity	=	4 m/s
Jet temperature	=	26°C
Depth of discharge	=	6 m
Ambient temperature	=	18°C
Salinity	=	34 ppt

The ambient sea water was assumed to be non-stratified. The discharge angle with respect to the horizontal was taken to be zero. The model uses nonograms to estimate the plume centre-line temperature, horizontal distance to plume centre-line and plume width. The width is calculated as equal to four standard deviations of the local temperature distribution across the plume trajectory where this is taken to be Gaussian.

TABLE 5.4

On reaching the surface		**Stagnant conditions**	**Current of 1.5 m/s**	**Current of 2 m/s**
Centre line temperature	°C	4.8	0.19	0.14
Plume width	(m)	3.8	16.6	20.2
Horizontal distance from outfall	(m)	4.8	79.2	92.0

The results of the modelling are shown above in Table 5.4. It can be seen that with currents of 1.5 and 2 m/s that sufficient mixing and dilution of the plume occurs so that the temperature rise at the surface is minimal. The currents used in the modelling are the maximum tidal currents as indicated by the latest Admiralty Chart. Owing to the distance of the outfall from the mouth of the Yare it can be said with confidence that there is no risk of water of elevated temperature being recirculated back towards Breydon Estuary. There would therefore be no effect on smelt in the estuary or on the productivity of the estuarine mud flats.

As stated above, the Port Authority propose to rerun the Delft Hydraulics model of the Outer Harbour. It is proposed to incorporate the outfall in that model and to determine the temperature profiles resulting with the Outer Harbour constructed.

It is not anticipated that the warm water discharge will have any impact on water quality.

Boiler water

The boiler water/steam/condensate system has losses from its recycled water due to leakage plus some deliberate blowdown from the boilers to maintain correct chemical control. The water required to make up these losses must be of high purity and must therefore be treated in an ion exchange water treatment plant.

Feedwater entering the boiler contains small amounts of impurities. As the water in the boiler is evaporated the impurities become concentrated in the boiler water system. To ensure that these impurities do not cause corrosion or scaling of the boiler heat transfer surfaces, some chemicals are added to the boiler and in addition the concentration of the impurities is controlled by discharging some of the boiler water, either continuously or intermittently. This water is the "boiler blowdown". The boiler water will be dosed with trisodium phosphate in order to control corrosion.

As the feedwater will be of high purity the quantity of blowdown discharged from the boiler will be small, of the order of 150 m^3/day. The blowdown is discharged at boiler temperature and pressure. Some of the blowdown flashes off to steam in the boiler blowdown vessel thus reducing the volume still further. The boiler blowdown is discharged with the cooling water to the sea. It is virtually pure water containing very small quantities of various chemicals (for example, ammonia, phosphate and suspended solids) used to prevent corrosion and scaling in the boiler.

A typical analysis of the boiler blowdown is:

Conductivity	50 µS/cm
pH	10
Ammonia as NH_3	1 mg/l
Phosphate as PO_4	5 mg/l

The water treatment plant

The water treatment plant will treat Towns water to a quality suitable for use in the boiler. It will also supply water for water or steam injection during operation on gas condensate. The maximum estimated water requirement for water or steam injection is 13.6 kg/s.

The water treatment plant will consist of the following: a raw water break tank, a treated water storage tank, two 100 per cent duty ion exchange streams, an acid storage tank, a caustic storage tank, an automatic effluent neutralising system, a control panel and all interconnecting pipework. The treated water storage tank will have a capacity sufficient to hold at least one day's supply at full operational load on gas firing.

The treatment process to be used involves the exchanging of cations in the Towns water (calcium, magnesium, sodium, etc) for hydrogen ions by using cation exchange resins and then exchanging the anions in the decationized water (sulphate, chloride, carbonate, silicate, etc) for hydroxyl ions by using anion exchange resins. When the resins are exhausted the resin beds are backwashed,

regenerated with dilute acid (for the cation resin) and with dilute caustic soda (for the anion resin), rinsed to remove any excess regenerant and returned to service.

The effluents produced during this regeneration period are discharged to a dedicated neutralisation tank where they are mixed and neutralised prior to discharge with the cooling water into the sea.

The water treatment plant effluent will contain the salts removed from the Towns water with some additional sodium sulphate produced by neutralisation of the spent regenerants.

The caustic soda solution and the sulphuric acid used for regeneration may contain minute traces of mercury and cadmium. Every reasonable effort will be made to obtain supplies free of these metals.

The quantity of effluent produced per day will be of the order of 60 m^3/day during gas firing and 300 m^3/day during gas condensate firing. A typical analysis is given below:

Calcium sulphate	2000 mg/l
Magnesium sulphate	500 mg/l
Sodium sulphate	5000 mg/l
Sodium chloride	50 mg/l

The quantity of Towns water required by the water treatment plant to supply boiler water make-up will be about 400 m^3/d. When operating on gas condensate the water required by the water treatment plant will rise to 2000 m^3/day.

Alternatives to ion exchange such as distillation and reverse osmosis have been considered. Both have been found to more expensive in capital and operating costs.

Site drainage

There will be four drainage systems on site; the surface water drainage system; the oily water drainage system; the contaminated waste water system; and the sewerage system.

The surface water drainage system will drain areas of the site unlikely to be contaminated with and discharge the water to the cooling water outfall. The majority of the surface water drainage is uncontaminated and typical of surface water run off from areas of paved roads.

An oily waste water drainage system will drain all areas where oil spillages could occur. The design will incorporate oil interceptors and traps. These will discharge with the other surface water discharge to the cooling water outfall. The discharge from an oil interceptor will contain no visible oil or grease (ie less than 10 ppm).

The areas liable to oil spillage are:

- the oil unloading area adjacent to the lubricating oil tank;
- the electrical transformers (which will contain insulating oil);
- the bunded areas around the lubricating oil tanks and the gas condensate tank;

- the pipework from the gas condensate tank to the generating plant;
- the car parking areas.

Adequate facilities for the inspection and maintenance of oil interceptors will be provided and the interceptors will be regularly emptied and desludged to ensure efficient operation. The sludge will be disposed of off-site by a qualified contractor.

All process effluents will discharge with the cooling water to the North Sea.

All elements of the treatment systems will be regularly monitored to ensure optimum performance and maintenance.

Miscellaneous discharges

Sewage will be discharged to the local sewerage system.

From time to time it will be necessary to wash the blades of the air compressor section of the gas turbine to remove debris that has penetrated the inlet air filters and become lodged on the compressor blades. This will be done approximately twice a year and can be done in two ways: by on-line washing where a fine spray of water is allowed to pass through the gas turbine; or by off-load washing where the compressor blades are rotated slowly through a detergent solution. In the second case approximately 15 m^3 of waste water containing detergent will either be discharged to the local sewerage system or will be retained on-site in a storage tank and subsequently tankered off-site for disposal at a large sewage works.

Boiler flue gas side washing is not anticipated. However, during commissioning and at infrequent intervals during the life of the plant it will be necessary to chemically clean the water side of the boiler tubes. All effluents will be tankered off site by a licensed contractor for treatment and disposal at an appropriately licensed disposal site.

During maintenance it may be necessary to drain down the boiler, the cooling water system, the closed circuit cooling water system or parts of these systems. All will be discharged to the cooling water outfall. The boiler water will be high purity water containing traces of ammonia, phosphate and suspended solids. The rate of discharge will be limited to ensure that increases in the concentrations of ammonia and phosphate in the cooling water are undetectable. The cooling water will of course be river water. The closed circuit cooling water will be high purity water containing small amounts of corrosion inhibitor (probably hydrazine or nitrite/borate). The rate of drain down will be controlled so that the concentration of corrosion inhibitor is undetectable in the cooling water at the outfall.

Lubricating oil and other hazardous liquid storage tanks will be constructed on impervious bases and bunded to contain at least 110 per cent of the tank volume. Valves and couplings associated with the filling procedure will be within the bunded area. Surface water collected within the bund will be removed by manually started electrically operated pumps and its composition verified prior to disposal.

Sample points will be provided on the water treatment plant effluent, boiler blowdown discharge, outlet of the oil separators, and in any plant drains prior to dilution in the cooling water flow. A residual chlorine analyser will be provided for the cooling water discharge.

No solid wastes are generated by the process. Solid wastes generated on the site will include trash removed from the river water by the band screens, domestic and commercial waste (paper etc), miscellaneous waste produced during maintenance (including air filters, ion exchange resins), sludge removed from oil separators and any deposits removed from the boiler during maintenance.

No prescribed substances as described in The Environmental Protection (Prescribed Processes and Substances) Regulations 1991 are generated or used on the site.

5.3 Noise

5.3.1 Noise and vibration during construction

Some noise generation during the construction process will be inevitable, and with housing some 300 m from the proposed site, consideration will need to be given to ensuring construction noise is minimized. It is likely that construction activity will be limited to daytime working only, and the main contractor and subcontractor may need to modify working practices in order to control noise levels. Piling can be a noisy activity and can also be a source of some vibration. Site preparation, excavation, concreting and fabrication activities will also generate some noise.

Construction work will generally be carried out in accordance with BS 5228 - "Noise Control on Construction and Demolition Sites". Table 5.5 gives predictions of noise levels at the nearest housing on the west bank of the River Yare based upon data contained in BS 5228.

TABLE 5.5
PREDICTED NOISE LEVELS FROM SOME CONSTRUCTION ACTIVITIES AT HOUSING (POSITION 1, FIGURE 7)

Construction activity	L_{Aeq}
Demolition	
Tracked crane/dropping ball	65
Pneumatic breaker	60
Piling	
Drop hammer/steel casing pile	72
Continuous flight auger injected piling	52
Excavation and construction	
Dozer	64
Tracked excavator	56
Concrete pump	50
17 m^3/min compressor	55
Typical acceptability criteria	75

During the noisiest phases of the project, the noise level is likely to be no greater than an $L_{Aeq.12\ hour}$ of 70 dB(A) from all sources.

Vibration is unlikely to be discernible at housing positions. During piling activities, however, the maximum level of vibration expected at a closer distance of perhaps just 100 m from a drop hammer piling rig could be in the rage 2-3 mm/s (ppv). However it is likely that the use of intrinsically quiet piling methods such as continuous flight auger injected piling will be possible and both the noise and vibration levels associated with this would be negligible.

5.3.2 Noise and vibration during CCGT station operation

There are now a large number of UK CCGT power stations operating in a variety of environments. Some are surrounded by industrial developments, others are in green-field sites, many are located on the site of a previous power station as is the case with this development.

Each of the new generation of CCGT stations has been designed to achieve acceptable noise levels under both normal and also intermittent operating conditions. Whilst the noise levels achieved at housing are typically in the region 40-45 dB(A), there is a large variation in the distances to nearest housing and this means that some stations have had to have extensive high performance noise control treatment, involving major items of machinery (gas turbines and waste heat recovery boilers) all located in acoustically treated buildings. Other stations have only had to have minimal noise control treatment, and much of the plant has been able to be located outside.

Indications are with this particular site that because the background noise levels are quite low, and the nearest houses are relatively close, a high level of noise control treatment will be required.

Table 5.6 lists measured noise data on a range of projects showing what noise levels can be achieved with different levels of noise control treatment.

TABLE 5.6
TYPICAL L_{Aeq} LEVELS OF NOISE GENERATED BY UK CCGT POWER STATIONS (NORMALISED TO A DISTANCE OF 250 M FROM THE ACOUSTIC CENTRE)

Noise control treatment/No of stations	Average station power output	Octave band centre frequency (Hz)									
	(MW)	dB(A)	31	63	125	250	500	1 k	2 k	4 k	8 k
High level treatment/4 station average	580	43	63	59	52	40	37	33	28	26	21
Medium level treatment/2 station average	380	49	62	59	59	48	43	43	40	36	34
Low level treatment/1 station	1875	62	68	66	59	50	52	54	59	57	46

There are very large variations in noise levels between different station designs, however some of the variation can be attributed to differences in size and power output. The overall range of noise levels recorded for the four high performance stations was 39-46 dB(A). With the proposed Great Yarmouth Power Project expected to comprise just one gas turbine/steam turbine unit having a power output at 350 MW, substantially lower than the 580 MW average in Table 5.6, it should be possible to assign a value for noise output of 39 dB(A) L_{Aeq} for this size of station incorporating high performance noise control treatment. The octave band levels expected from such an installation would be as shown in Table 5.7.

TABLE 5.7
PREDICTED 250 m NOISE LEVEL (L_{Aeq}) FROM 350 MW CCGT STATION FITTED WITH HIGH PERFORMANCE NOISE CONTROL TREATMENT

(MW)	Octave band centre frequency (Hz)									
	LAeq	31	63	125	250	500	1 k	2 k	4 k	8 k
350 MW CCGT station with high performance control treatment	39.0	59	55	48	36	33	29	26	22	

The measures that would need to be included in the scheme will depend upon the detailed arrangement and final choice of plant and equipment. However, the type of measures likely to be considered are detailed in Section 6.3.2.

Equipment used in CCGT power stations is generally rotary in motion rather than reciprocating, and therefore there is little in the way of out-of-balance or impact forces that might cause ground vibration. Ground-borne vibration problems do not generally arise on CCGT power stations.

Assessment of environmental noise impact

The impact of noise from a fixed industrial development on the surrounding residential community is dependent upon a number of factors. There are a number of references available which discuss in some detail what these factors are, and their relative importance, however perhaps those of most relevance are the Department of Environment Planning Policy Guidance PPG24: Planning and Noise (September 1994) and the British Standard to which it refers, BS 4142:1990 'Method of Rating Industrial Noise Affecting Mixed Residential and Industrial Areas'. The importance of these documents, particularly the former, lies in the fact that they have been specifically produced to provide guidance to Local Authorities on the appropriate methodology to be used when considering noise from a proposed new industrial development.

In Annex 3 of PPG24 the particular section headed 'Noise from industrial and commercial development' cites BS 4142 as being useful is assessing the likelihood of complaints being received about noise. Tonal or impulsive characteristics of the noise are likely to increase the scope for complaints and this is taken into account by the 'rating level', and it is the 'rating level' that should be used when stipulating the level of noise that can be permitted. The Standard indicates that where the rating level exceeds the background level by 10 dB(A) or more, complaints are likely. Where this is reduced to 5 dB(A), the development will be of marginal significance. At a difference below 5 dB(A) the lower the value the less the likelihood that complaints will occur.

This study has established that there are not expected to be significant tonal or impulsive characteristics to the predicted noise and the expected frequency spectrum will closely follow an NR curve characteristic (see Figure 29). The 'rating level' will therefore numerically be the same as the measured contribution from the CHP plant.

Comparisons are shown in Table 5.8 of the predicted level of noise from the station against background levels at night, at each of the four assessment positions.

TABLE 5.8
PREDICTED L_{Aeq} NOISE LEVEL FROM PROPOSED CCGT POWER STATION AT RESIDENTIAL POSITIONS (NORMAL OPERATION)

Residential position number (Reference Figure 7)	Predicted L_{Aeq} level from proposed CCGT power station - dB(A)	Measured L_{90} night-time background noise level - dB(A)
No 1 Riverside Road/Rear of High Street	39.1	41.7
No 2 Riverside Road/South Icehouse Hill	38.6	39.6
No 3 Spencer Avenue/East Anglian Way	32.3	36.9
No 4 Micawber Avenue	31.4	36.8

Note: The inverse square law does not apply to the propagation from power stations because of changes in effective acoustic directivity of the stack as distance is increased.

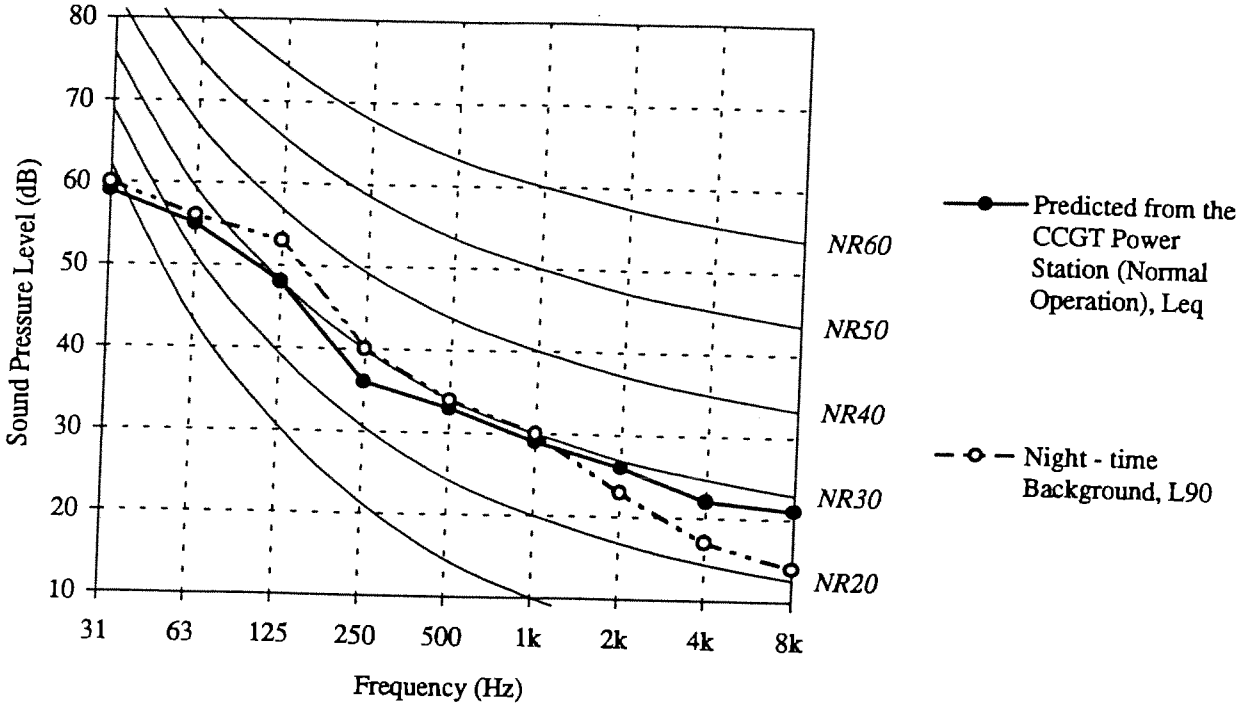
The study predicts that the 'rating level' will be between 1.0 and 5.4 dB(A) below the background noise, depending upon position. At this level the station will be just audible at night, but will not significantly impact upon the residential community.

BS 4142 and PPG24 consider only noise in the audible range of frequencies. For most types of development it is sufficient to consider only a single dB(A) value of noise with no special evaluation of low frequency noise. However, where a development is known to have the potential to generate significant low frequency acoustic energy, it is appropriate to consider in addition the potential impact of acoustic energy in the octave bands 31 and 63 Hz. The NR 'Noise Rating' curves, for example, shown in Figures 8 and 29 are curves established in human perception tests, and show the variation in sound pressure level with frequency, for a series of sounds rated by listeners as equally noisy. Because of the diminishing sensitivity of the human ear at low frequencies, these curves are seen to rise significantly below 125 Hz.

Whilst the human ear is relatively insensitive in its response to low frequency acoustic energy, some elements of buildings, eg windows, doors etc., can vibrate and rattle when exposed to energy at these frequencies. The amplitude of the acoustic energy necessary to cause rattling will depend to a great extent upon the structural response of the particular building element. Some windows are very stiff and will require much higher incident levels of low frequency acoustic energy to cause them to rattle. Sash windows, however, can rattle at relatively low incident levels.

FIGURE 29

Predicted Octave Band Pressure Levels From the CCGT Power Station at Position 2 - Riverside Road / South Icehouse Hill



There has been a substantial amount of research into the levels of low frequency acoustic energy required to rattle windows. Typically, most windows will vibrate when subjected to incident sound pressure levels of 80-90 dB. Some will vibrate in the range 70-80 dB, and a few, but a significant number all the same, will respond in the region 65-70 dB.

The maximum levels of low frequency noise predicted from the proposed CCGT power station will be 59 dB at (31 Hz) at Position 2, which is below the 60 dB background level and also comfortably below the levels where window rattle can begin to be a potential problem.

5.4 Visual impact

5.4.1 Visual impact during construction

Throughout the 22 months of the construction period the proposed site will have the appearance of a typical construction site and will have a similar appearance to the site during the previous period of demolition. The majority of activity on the site will only be visible to the west ie from the houses on the edge of Gorleston and to traffic on the South Denes Road and South Beach Parade directly opposite the power station.

In order to minimize the visual impact of construction, cranes of the minimum size possible will be used.

5.4.2 Visual impact during operation

The visual impact of the site can be considered to be made up of two elements; the main power station buildings and the 70 m chimney. At this height the stack will rise above the surrounding plant and indeed all other buildings in the area. The main power station buildings will be less than half the size of those of the original power station.

The only substantial building envisaged is the turbine hall. It is likely that the administration offices will abut this building. The remaining plant and equipment will in the main be housed in relatively low buildings, of the order of 3 to 6 m in height.

An advantage of using a once-through cooling system is that there will be no cooling towers associated with the plant and of course no cooling tower plumes.

The dimensions of the main items of plant will be of the order of the following:-

TABLE 5.9
PLANT DIMENSIONS (M)

	Height	Length	Breadth
Turbine hall	15	60	40
Waste heat recovery boiler	20	20	20
Workshop, stores and laboratory	6	70	24
Generator transformers	3	18	10
Gas treatment/pressure reducing station	3	25	15
Water treatment plant	6	17	13
GIS switchgear	10	25	10

	Height	Diameter
Demin water tank	7	10
Raw water tank	7	10
Two gas condensate storage tanks - each	9	17.5

The architectural design of the buildings and the treatment of spaces between buildings, roads and pavings will be carefully considered to provide a high standard of visual amenity, given practical and economic constraints.

Roofs will generally be pitched throughout.

The external structures of the buildings will be designed such that there will be no deterioration in the power station's appearance over the next 20 to 25 years, ie the lifetime of the plant.

As the buildings will be prominent every attempt will be made to ensure the plant makes a positive contribution to the appearance of the industrial area.

The development, generally, will be in materials to match nearby buildings and particularly at upper levels colours would be neutral and subdued to provide the least visual intrusion and to minimize contrasts with the existing environment. Some colour accents would be envisaged at low levels on the seaward and river frontages, in order to give the buildings a less industrial appearance.

A limited combination of materials will be used in the construction of the external structures to give a cohesive appearance to the plant. Colour coated profiled aluminium sheeting will be used on upper levels and facing brickwork or dense concrete masonry will be used, where appropriate, at lower levels.

The power station will of course be much smaller in scale than the existing power station. It will be modern in appearance, with a clean outline and a simple bold structure. The modern power station buildings will help to give the area an impression of industrial regeneration and will be seen as part of the industrial backdrop of the South Denes area.

The flatness of the terrain within Gorleston will inhibit views of the power station buildings, within the residential area, thus it is only houses at the very edge that have a view across the river to the power station buildings. Residents in the Barrack estate area will also not be able to see the power station buildings, however the chimney may be visible from certain vantage points in both areas.

The power station buildings will also be visible for short distances along South Beach Parade, South Denes Road and from High Street, Gorleston and from the length of Riverside Road, Gorleston. The traffic on these roads, in addition to the residents of High Street, Gorleston will comprise the principal receptors to the appearance of the power station buildings.

The power station chimney will be visible over a much wider area, although in many locations its view will be blocked by buildings due to the flatness of the local terrain. It must be remembered however, that the stack will be just two thirds of the height of the existing chimney and will not therefore be visible over such a large area nor, when it is visible, will it dominate the view to the same extent.

Figures 30 to 32 show artists impressions of the proposed plant from the rear of High Street, Gorleston, South Beach Parade, Great Yarmouth and the A47, Acle New Road. These give an indication of the probable height and siting of the various components and the power stations general appearance. Final details of the layout and appearance of the project will be developed during the detailed design stage and in consultation with the local planning authorities. The outline of the original power station is shown in the artist's impressions by a dotted line.

From the near of High Street Gorleston the power station buildings (Figure 30) will be seen as part of the industrial make-up of the area and will not dominate the view to the same extent as the existing power station. The new chimney will appear to be smaller and thinner than the existing chimney.

Figure 31 shows that the power station buildings will not be visible from the tourist area of South Beach Parade. The 70 m stack will be visible but will not dominate the skyline to the same extent as the existing chimney.

From the A47 (Figure 32) the power station buildings will no longer be prominent and will, to some extent, merge in with the other features on the horizon. Only the new 70 m chimney will break the skyline.

Figures 33 to 35 show photomontages of the expected views from the remaining sensitive receptors.

From the Burgh road the new power station buildings will not be visible and the stack will appear shorter and thinner. The expected view is shown in Figure 33.

From the beach at Gorleston (and Maine Parade) the power station buildings will not be visible. The expected view is shown in Figure 34.

It is unlikely that the power station will be visible to pleasure boats on the Breydon Broads due to the presence of a dyke running along its southern edge. The expected view from the dyke is shown in Figure 35.

Non visual characteristics of a development can also affect people's perception of a landscape, however, in this case, there will be no odour associated with the plant, no visible emissions from the stack and as shown in Section 5.3 there will be no significant impact on noise levels.

To conclude - when viewed by the principal receptors the new plant will be seen to be in keeping with the industrialised nature of South Denes and will not cause a significant impact. There will be no change to the existing landscape character and there will be no loss of a specific visual amenity. Visually the proposed power station may be seen as a vast improvement over the existing South Denes Power Station.

5.5 Traffic and infrastructure

5.5.1 Impacts on traffic and infrastructure during construction

During the 22 month construction phase the power station will give rise to additional traffic movements. Due to the large number of construction workers, in the worst possible case, up to 250 private vehicles, will travel to the site daily. The use of minibuses and public transport will be encouraged and could reduce this number significantly. There is adequate space for car parking on the South Denes site. If carefully managed there should be no significant detrimental effects on local traffic levels and infrastructure due to the transport of the construction staff.

In addition to staff transport movements construction traffic will consist of civil works traffic, mechanical works traffic and a small number of abnormal loads.

Vehicular access to the site would be via South Denes Road and the A47, skirting the town centre of Great Yarmouth.

Materials used during the civil works will include ready mixed concrete, reinforcing bars, structural steelwork, cladding and road materials. Materials brought to site for the mechanical works will comprise all items of plant. This traffic would consist of light and heavy commercial vehicles. Approximately 10 light vehicles per day would be expected on average with 15 per day at peak times. Approximately 20 heavy commercial vehicles per day would be expected on average with 25 per day at peak times.

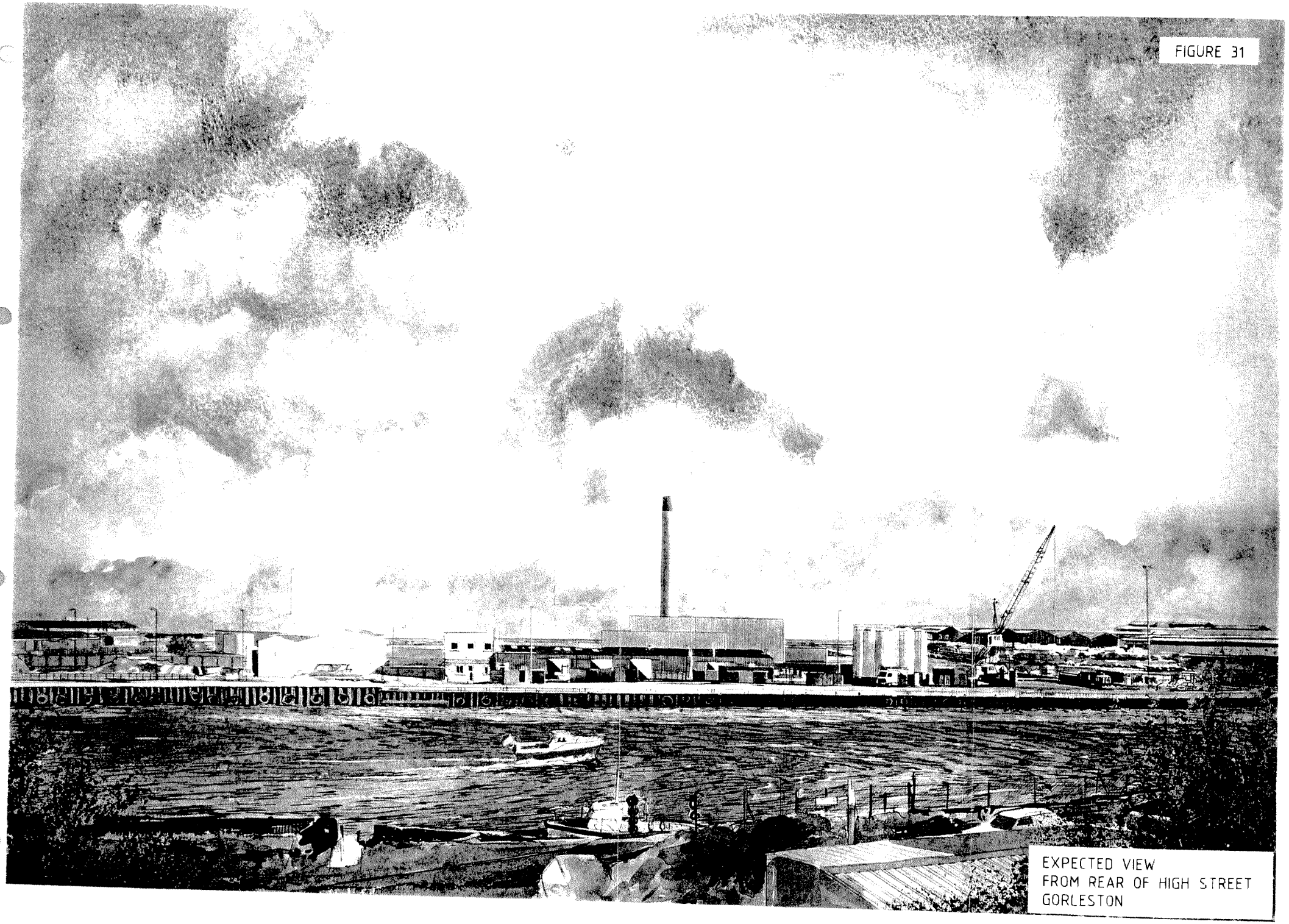
During the peak period of construction a maximum of 290 vehicles may be expected to visit the site per day. This is of the order of 23.2 per cent of the expected two-way 12 hour traffic flow in 1997. The Institute of Environmental Assessment state that if generated traffic flows are less than 30 per cent of the base line flow, as in this case, and also that HGV flows do not increase by more than 30 per cent, then no environmental effects should be expected. An increase of this order should have no impact on pedestrians and cyclists.

The two-way movement of HGVs will increase by only 10 per cent. The Department of Transport have indicated that for a 5 per cent increase in the number of residents being bothered "quite a lot" or "very much", then HGV flows would have to double. This will clearly not be the case for this

FIGURE 30

EXPECTED VIEW
FROM SOUTH BEACH PARADE
GREAT YARMOUTH

FIGURE 31



EXPECTED VIEW
FROM REAR OF HIGH STREET
GORLESTON

FIGURE 32

EXPECTED VIEW
FROM A47,
ACLE NEW ROAD

FIGURE 33 EXPECTED VIEW FROM BURGH ROAD

FIGURE 33

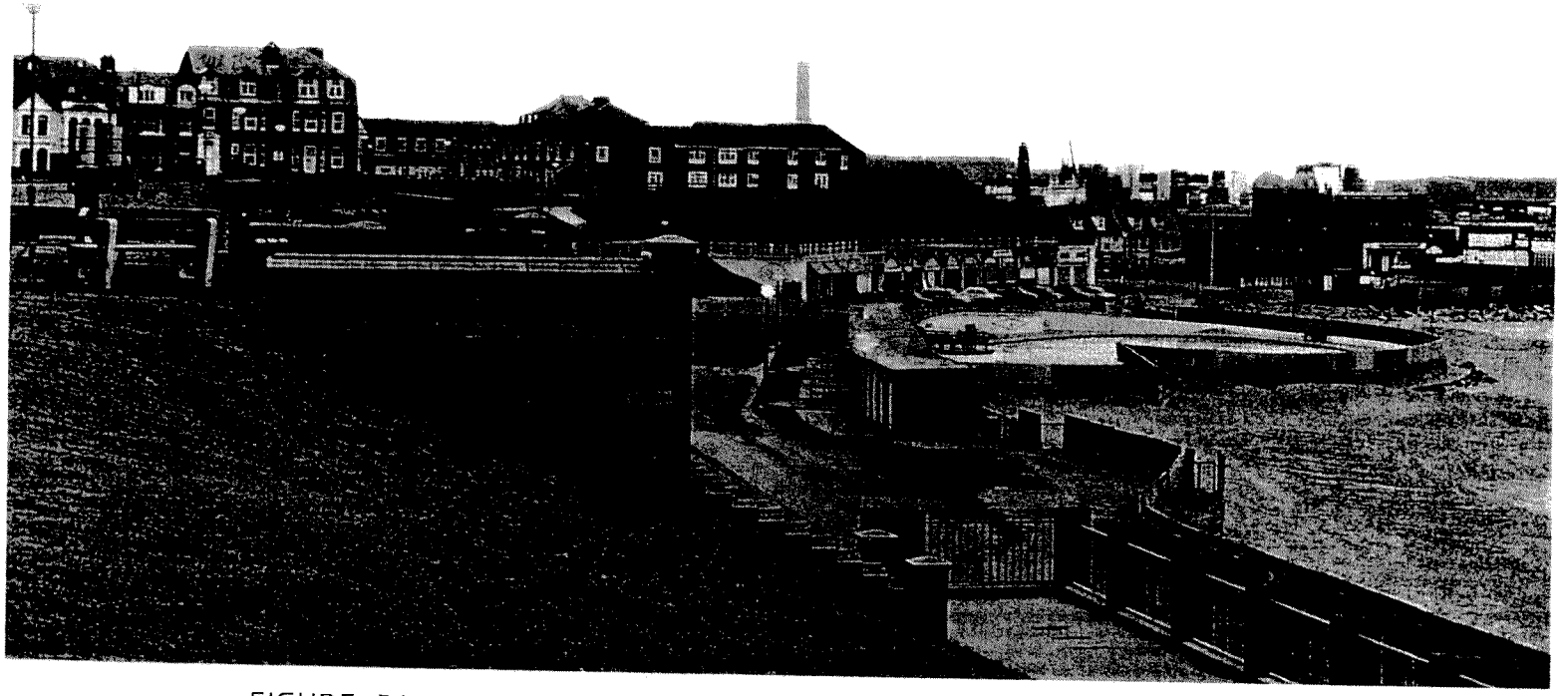


FIGURE 34 EXPECTED VIEW FROM MARINE PARADE, GORLESTON

FIGURE 34

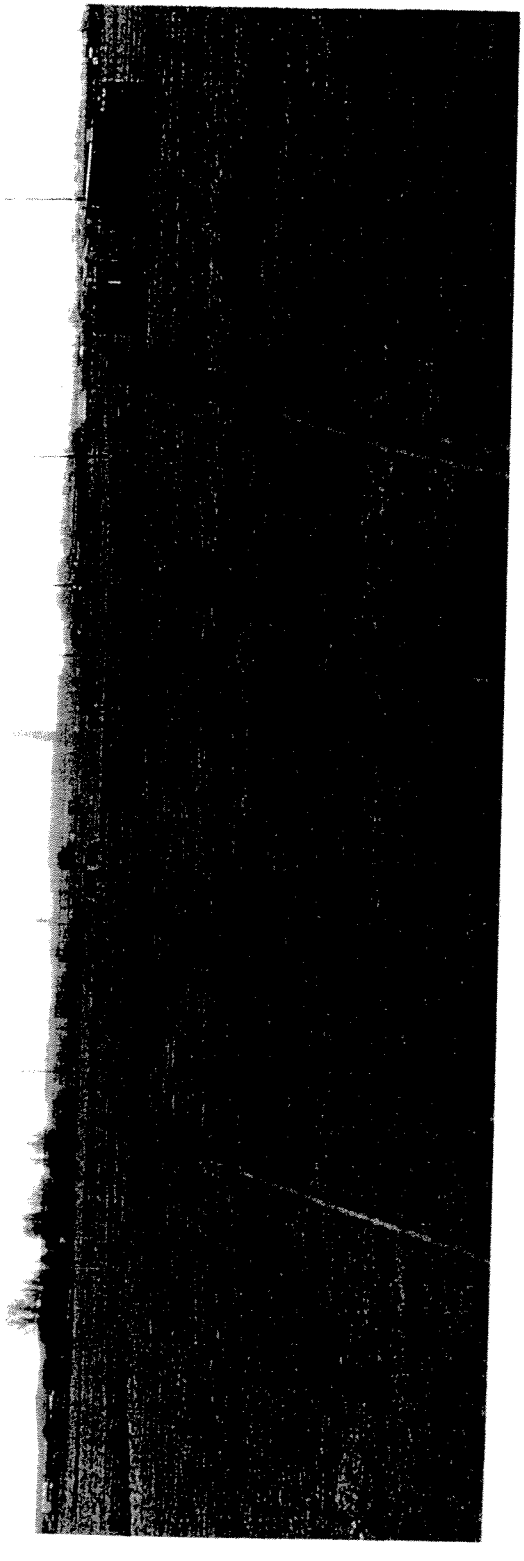


FIGURE 35 EXPECTED VIEW FROM THE EDGE OF BREYDON WATER

development. Also it must be remembered that South Denes Road is not a residential street and contains no especially sensitive receptors to increases in traffic flows and that predicted traffic flows along the road during the construction period are well below those expected for a road of this type.

It is estimated that 30 abnormal loads would be necessary over the 22 month construction period, consisting of 25 wide loads and 5 heavy loads. However every attempt will be made to bring these loads to the site by sea. It is expected that this will be possible for the majority of the abnormal loads. The Contractor will be responsible for surveying all routes to ensure that any abnormal load that cannot be transported to site by sea can be transported to site by road. The Contractor would be responsible for the cost of any route strengthening requirements. Routes and timings of the transport of any abnormal loads will be discussed with the relevant authorities in order to minimize disruption. A police escort would also be used. The transport of any abnormal loads that cannot be brought to site by sea may lead to delays and cause inconvenience to other road users.

It is anticipated that the road traffic generated by the construction of the proposed development will not be sufficient to significantly affect traffic related air quality or noise in the area.

In summary any impact due to increased traffic levels during the construction period will be slight and of short duration.

The draft Great Yarmouth Borough-Wide Local Plan notes that "with the demolition of the former South Denes Power Station opportunities may emerge to facilitate the improvement of the local highway network in this vicinity". As the proposed plant will have a smaller footprint than the original power station it may be possible to assist the Highways Department by making available a portion of the site for such an improvement.

5.5.2 Traffic and infrastructure during operation

The peak number of operational workers at the existing South Denes Power Station was 270, with a correspondingly high number of associated traffic movements. Operation of the proposed power station will naturally result in much fewer traffic movements, of the order of 100 per day. A large proportion of these movements will be due to the 40 staff operating the power station and the majority of the journeys will therefore be local. This number of traffic movements will have no significant impact on the expected traffic flow in 1998 of 2569 vehicle movements.

Due to the high reliability of the new plant requirements for maintenance will be minimised, reducing the number of site visits necessary by maintenance staff.

Fuel will not be delivered to the site by road. Two new pipelines will be constructed to bring natural gas and gas condensate to site. These will be the subject of a separate Environmental Statement. Gas condensate will be transported off site by marine tanker for sale in Rotterdam.

During the operational phase there will be no significant increase in the daily traffic to and from the South Denes area due to the power plant and there will be no effect on local traffic patterns and infrastructure.

5.6 Socio-economics

5.6.1 Socio-economics

During the peak period of construction activity the proposed project will employ of the order of 250 construction workers. This will coincide with the erection of the boiler and the gas and steam turbines. The construction period will be of approximately 22 months duration and will provide a significant value of work for local contractors. It is likely that construction work will take place only during daylight hours.

As far as is possible, depending on the skills available in the local area, the workforce will be recruited locally. It can be seen from Table 4.12 of Section 4.5 that of the approximately 12 per cent unemployed in the Great Yarmouth area a significant proportion were formerly employed as skilled, semi-skilled and unskilled manual labourers. However, the locational quotient for construction shows that this activity is under represented in the Great Yarmouth TTWA. It may, therefore, be necessary to recruit from outside the Great Yarmouth area, especially for specialist staff. In the initial phase of construction ie the civil works, a small unskilled workforce will be required, later the mechanical and electrical works will require a larger workforce with more specialised skills.

It is anticipated that a single contract will be awarded for the supply, construction and commissioning of the proposed power station. This single, "turnkey" contractor will in turn appoint specialist subcontractors. The use, where possible, of local subcontractors will have a positive impact on the rate of unemployment and local economic activity.

The proportion of the workforce coming into the area will probably commute weekly. They will therefore seek temporary accommodation in local hotels, guest houses, or privately, helping to boost this section of the local economy and increase spending in the area. Should none of the construction work force live locally then a maximum of 250 bed spaces would be required. This is just 0.25 per cent of the available bed spaces in the Great Yarmouth borough and could easily be accommodated even in high summer when occupancy of the 100 000 bed spaces peaks at approximately 94 per cent. There should therefore be no conflict with other users of temporary accommodation.

Construction workers typically comprise a high proportion of single males who make relatively light demands on education, health, or recreation facilities. If a large proportion of the labour requirements are met by the local labour force, this will avoid the need for large numbers of in-migrants and their associated impacts on local services.

The money injected into the local economy in terms of the wages of the construction force and the project expenditures on local supplies of goods and services and local contractors will in turn generate further economic activity and indirect employment benefits in the area. Total investment in the new plant will be of the order £150 million.

Construction activities will be carried out under the provisions of The Construction (Design and Management) Regulations 1994.

The construction of the outfall is expected to have a minimal, temporary effect on the present harbour activities which take place to the south of the area, although there will be increased activity offshore during the construction period.

As the outfall will not be located within close proximity to any grounds with dredging consent the construction of the outfall will have an insignificant effect on the dredging activities off Great Yarmouth. The activities being undertaken during construction will only require that vessels take care when within the vicinity.

During the construction of the outfall there will be increased activity within the inshore coastal waters and this will prevent fishing within the immediate area. This temporary disturbance is not considered to be significant due to the limited area which will be affected.

The construction of the power station is unlikely to effect any other economic activity in the area.

5.6.2 Socio-economic impacts during operation

Operation of the power plant will be carried out under an operation contract. As the plant will be designed to operate remotely with the minimum number of staff the workforce will be small, with possibly up to 40 staff.

During the operational phase plant employees require more permanent accommodation. Due to the small number of staff at the plant no significant impact on the local housing market is expected.

Work at the power station will probably be based on a five shift basis.

Staff will have a background appropriate to their discipline and will be trained in the operation of the plant. Skilled jobs will constitute approximately 90 per cent of the work force. Staff at all levels will receive proper training related to process and emission control. Manufacturers' know-how will be transferred to the operating staff through participation in the trial runs and testing during the commissioning period. The plant will be operated in accordance with the manufacturers' instructions. Staff training requirements will be regularly appraised.

The plant's permanent staff will be in charge of operation and daily maintenance, including management of sub-contracted services. Major repairs and overhauls will be carried out by outside contractors.

Again there will be an economic injection into the local economy, although, this will not be on the same scale as during the construction period. The injection will consist of employees wages, local purchases, goods and services and local capital expenditure. These operation and maintenance costs will be of the order of £2 million per annum.

The design of the CCGT plant will incorporate all necessary features to ensure that it complies with all relevant safety regulations and requirements. The Health and Safety Executive (HSE) will be consulted with regard to safety issues associated with the proposed plant.

The chosen Contractor will take into account and comply with all UK statutory regulations including in particular, the Health and Safety at Work Act and the Electricity at Work Regulations and any other standards and Code of Practice relevant to the type of plant.

There will be no substances stored on site that would make the site notifiable to the HSE under the Control of Industrial Major Accident Hazard (CIMAH) Regulations 1983. The threshold limit for the

Fire Certificates (Special Premises) Regulations 1976 for gas condensate is 4000 tonnes. 3900 tonnes of gas condensate will be stored on site.

Fire detection and protection systems will be provided throughout the plant and site area. These will include fixed water protection systems, with gas protection enclosures, fire alarms and portable appliances.

There will be no impact on dredging activities during the operational phase.

The discharge of the warm cooling water may attract fish to the area and hence have a positive effect on the fishing industry. No other economic activities in the area will be affected by the operation of the power station.

5.7 Ecology

5.7.1 Impacts on ecology during construction.

5.7.1.1 Terrestrial ecology

The construction of the power station will result in the loss of the existing vegetation on the site. The development site is not known to contain any plant species that are notable or rare. The previous use of the site has resulted in it having no particular habitat value for birds, invertebrates or mammals.

Due to the industrial nature of the vicinity of the site dust, noise and light pollution are unlikely to have any significant effects on terrestrial ecology.

5.7.1.2 Marine ecology

During the construction of the outfall there will be a significant, temporary disturbance to the local ecology within the immediate area of the outfall. However, these effects are not considered to be significant, due to the absence of marine communities of ecological importance.

Plankton

Although little data is available on the abundance of plankton it is believed that the construction of the outfall will have a temporary, minor adverse impact due to increased suspended solids within the water column, and hence reduced light penetration. This would limit the presence of phytoplankton within the area as they require light for growth. Local zooplankton levels would also be temporarily reduced, as their food source would have diminished.

Benthic communities

During the construction of the outfall any benthic organisms within the immediate area would be adversely affected as a result of the disturbance. However, there is not believed to be a diverse benthic community within this area and the former, dominant *Sabellaria* communities are understood to have already been affected by contamination from the River Yare. These ross worms are widely distributed and such loss can only be considered of relatively minor local significance.

Shellfish/fish

During the construction stage there will be a temporary disturbance within the vicinity of the outfall. This may have a minor detrimental effect on the local shellfish and fish communities, but is not considered to be significant due to the comparatively short duration of the construction activity.

Birds

The lack of any protected or conservation areas for seabirds in the immediate vicinity suggests that the impact of the proposed outfall would not be significant. However, due to the seasonal variation of bird activity, the impact would be minimized by undertaking construction operations during the summer months.

5.7.2 Impacts on ecology during operation

5.7.2.1 Terrestrial ecology

Operation of the CCGT plant may lead to changes in air quality at the nearby wildlife sites and SSSIs, however, there are no other aspects of the plant and its design that could impact on these sites.

Section 5.1 describes the changes in air quality associated with the operation of the CCGT plant. Table 5.10 shows the expected additional increments to the existing ground level pollutant concentrations at the wildlife sites and SSSIs within 10 km of the site.

TABLE 5.10
EXPECTED INCREMENTS TO GROUND LEVEL CONCENTRATIONS OF NO_X AT THE WILDLIFE SITES AND SSSIs IN THE GREAT YARMOUTH AREA
($\mu g/m^3$)

	Gas firing		Gas condensate firing		
	Maximum hourly	**Annual average**	**Maximum hourly**	**Annual average**	**Percentage occurrence of associated weather conditions***
Breydon Water	37.38	0.55	84.68	1.34	0.40
North Dunes	37.32	0.69	84.68	1.69	0.56
Halvergate Marshes	34.79	0.28	72.39	0.57	0.28
Waveney Forest	39.02	0.27	81.19	0.56	0.23
Belton Common	40.64	0.32	84.53	0.62	0.23
Howards Common and Wild Duck Caravan Park	37.38	0.32	84.68	0.81	0.23

* For maximum hourly figures.

Table F1 in Appendix F shows the expected changes in air quality at the remaining SSSIs within 30 km of the site. Increments to ground level concentrations at these sites are lower than those shown above.

The highest maximum hourly figure of NO_x due the CCGT at any of the above sensitive areas is 84.68 $\mu g/m^3$. This would occur during gas condensate firing at three sites, Breydon Water, North Denes and Howards Common and Wild Duck Caravan Park. For gas firing the maximum hourly figure is 40.64 $\mu g/m^3$, this occurs at Belton Common.

The annual average increments to ground level concentrations of NOx at the SSSIs are all below 1.7 $\mu g/m^3$ for a year of gas condensate firing and less than 0.7 $\mu g/m^3$ for a year of natural gas firing.

Table 5.11 shows the legislative limits developed by the WHO and the United Nations Economic Commission for Europe (UNECE) specifically to protect sensitive flora and fauna. A comparison of Table 5.10 with Table 5.11 and allowing for background levels shows that the expected increments are well within the guide levels. Such small increases are unlikely to cause any exceedence of the guide-lines and the long term air quality impact will be minimal.

Although the maximum hourly level at the six sites in the table approaches the four hourly short term limit, it can be safely said that due to the infrequent occurrence of the weather conditions leading to such levels that it is very unlikely that the four hour average at any of the sites would be exceeded.

TABLE 5.11

GUIDELINES FOR THE PROTECTION OF WILDLIFE
($\mu g/m^3$)

	Oxides of nitrogen	
	4-hourly	**Annual**
WHO	95	30
UNECE	-	29

5.7.2.2 Marine ecology

The operation of the outfall will alter the micro-environment within the vicinity of the outfall, and may result in the presence of more diverse communities within this immediate area. This change may not be as notable as would be expected, due to the previous existence of a power station outfall within the vicinity, and of other pollution sources in the Great Yarmouth area.

Plankton

The operation of the outfall and the release of warm water into the marine environment is expected to increase the production of phytoplankton within the surrounding waters and hence may have a slight, positive effect on the foodchain within the area. The local presence of warmer water may also increase the diversity of plankton present.

Benthic communities

The operation of the proposed outfall would be expected to have a slight effect on the local conditions, and may attract a more diverse benthic community to the area. This is dependent on the quality of the water which would be discharged and the contrast between the ambient water and discharged water temperatures.

Shellfish/fish

When operational, the outfall may have a slight positive effect on the local shellfish and fish communities, as the likely increase in plankton within the area will provide an enhanced food course for the higher food chain. The presence of an outfall should also reduce the activity of trawlers within the immediate area and hence provide a small area of sheltered water for fish.

Birds

During operation of the power station, the presence of an increased food source within the vicinity of the outfall may attract birds to the area and hence have a slight beneficial effect.

5.8 Cultural heritage

5.8.1 Impacts on cultural heritage during construction

Archaeological interest in the South Denes Power Station site lies chiefly in evidence of medieval character and development of the spit, its succession of beaches and the associated deposits of pottery. It is evident that these levels survive in situ at some depth (at least 3 m) below the present superficial deposits, except where destroyed by the construction of the power station in 1954-56. It may be seen from Figure 21 that the inlet/outlet section recorded by Green and Hutchinson in 1954-56 was a deep trench (c-6.0 m OD) running from river to sea, passing under the turbine house. Whilst excavations for the inlet/outlet system and the chimney base reached down to c-6.0 m OD, the main buildings rested on a concrete raft over ducting, reaching down to c-3.0 m OD. Thus the earlier medieval levels recorded in the lowest parts of the 1954-56 section may be intact elsewhere and beyond the reach of shallow foundations.

The proposed power station (see Figure 36) will be rather smaller than the existing one, and its main buildings, with the deepest foundations, will stand just south of the present power station main buildings. However, its major foundations are likely no more than c3 m in depth.

Any deep excavations for the proposed power station will almost certainly result in further exposures of the spit structure and medieval beach deposits, part of the natural accretional sequence, although it is possible that they will not reach the pre-1287 deposits.

Proposed development will therefore afford a further opportunity to record the spit structure, and perhaps confirm the postulated date for early levels from any associated pottery. Additionally, recovered material and features will assist the still nascent study of the maritime trading port.

Little is known of the exact location or character of the artificial cuts through the spit (see Figures 19 and 20), and close attention to the north-to-south sections may shed light on this question.

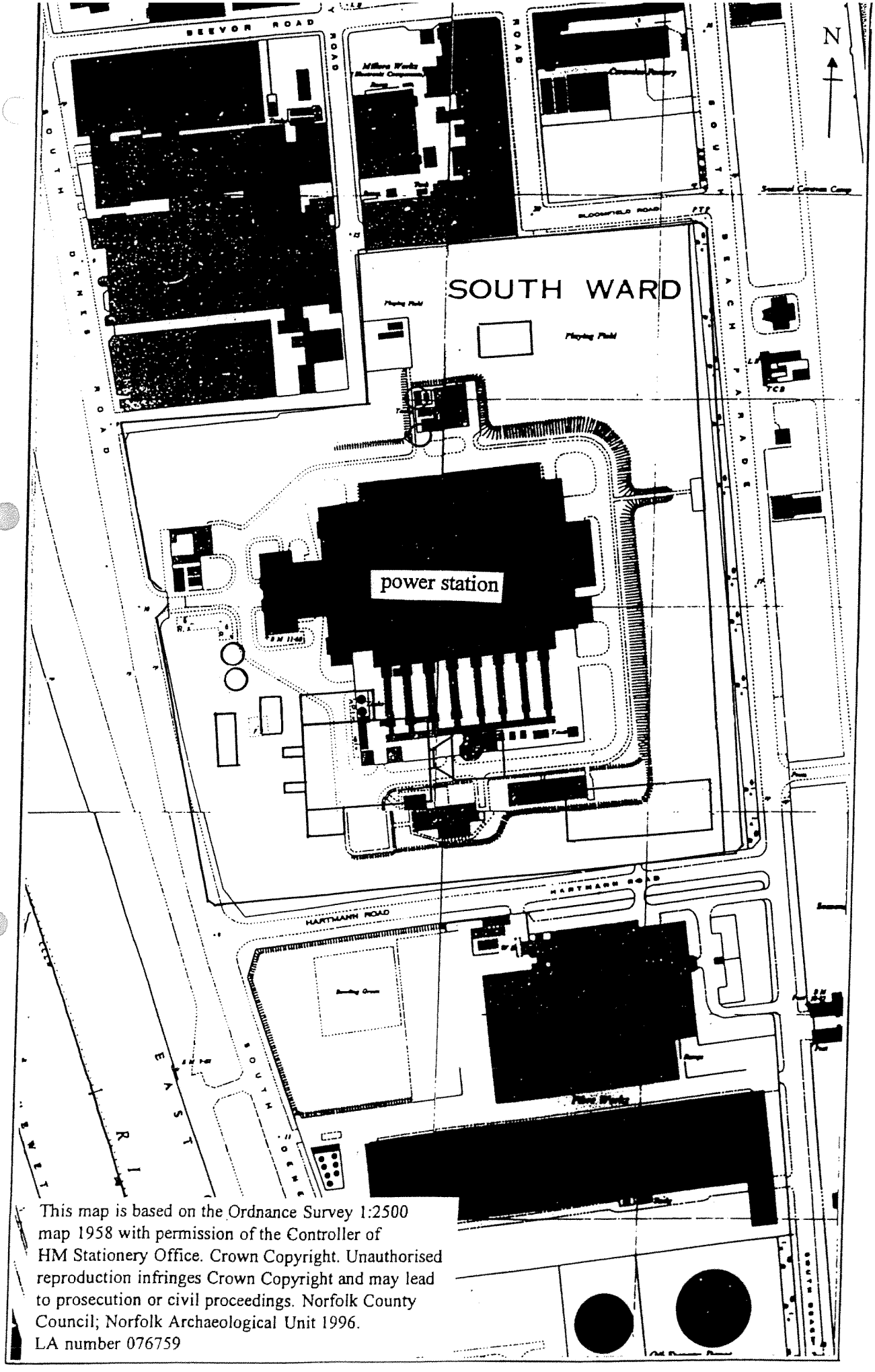
Any arrangements for archaeological work will need to make special provision for recording procedures, particularly since sections may be obscured by shoring. The focus of archaeological interest will most probably lie at -3.0 m - -6.0 m OD.

It is therefore proposed Norfolk Landscape Archaeology (a department of Norfolk County Council) be kept fully informed of the plans for the project and that an Archaeological Contractor be invited to attend the site during the construction phase to inspect any excavations.

5.8.2 Impacts on cultural heritage during operation

It is only atmospheric pollution that may impact on the cultural heritage of the area during the operational phase. However, as even the maximum annual increment to existing NO_x levels on land are just 1.24 $\mu g/m^3$ or 2.58 $\mu g/m^3$ for gas firing and gas condensate firing respectively no impact on stone or metal work is expected.

FIGURE 3



This map is based on the Ordnance Survey 1:2500 map 1958 with permission of the Controller of HM Stationery Office. Crown Copyright. Unauthorised reproduction infringes Crown Copyright and may lead to prosecution or civil proceedings. Norfolk County Council; Norfolk Archaeological Unit 1996. LA number 076759

Figure 36 The relative positions of the existing power station and the proposed development (red outline). Scale 1:2500

6. MITIGATING MEASURES AND MONITORING PROGRAMMES

A range of measures will be undertaken during the design, construction and operation of the project to ensure that any identified impacts are minimised as far as is reasonably possible.

6.1 Air quality

6.1.1 Construction

Good site management practices during the construction works will help to prevent the generation of airborne dust. It will be the responsibility of the nominated contractor to ensure that sufficient precautionary measures to limit dust generation are in fact taken.

To ensure that atmospheric dust, contaminants or dust deposits generated by the construction work do not exceed levels which could constitute a health hazard or nuisance to those persons working on the site or living nearby a dust monitoring programme will be carried out throughout the construction period. It is proposed that environmental monitoring of dust be carried out at areas of excavation, the stockpiles, various additional locations across the site and at locations on the site boundary. Monitoring will be carried out on a weekly basis by a trained and competent person. However if dry windy weather prevails then the rate of monitoring will be increased. An aerosol monitoring system will be used. The results will be checked against the table below.

TABLE 6.1
MAXIMUM ALLOWABLE EXPOSURE LEVELS AT GREAT YARMOUTH POWER STATION

Dust	Monitoring location	Level	Action
Aerosol monitoring system (directional, with instantaneous read-out) Environmental Dust Sampler (gravimetric over fixed time period)	Excavation areas Stockpiles	>1 and <5 mg/m^3	Review PPE* level if >1 mg/m^3
		>5 mg/m^3 continuously	Stop work in breathing zone Identify cause and carry out remedial work Review PPE level, go to level 2 respiratory protection Monitor every 30 minutes
	Site perimeter	0.2 mg/m^3	Stop work Identify cause and carry out remedial work
Visual and odour checks	Site wide	Excessive dust or odour	Further monitoring or control measures as appropriate. All such instances to be logged

*PPE - Personal protection equipment.

If the above values are exceeded then the rate of monitoring will be increased to four times a day or to a level consistent with the results that have been logged and additional remedial actions described below will be taken.

A wheel washing facility will be provided adjacent to the site exit and will be used by all heavy commercial vehicles leaving the site, preventing the transmission of soil from the site to the public highway.

If a potential for dust emissions exists, for example on dry windy days, then the following procedure will be followed:

- materials will be tested for moisture content;
- if material is dry then water will be sprayed on to the working area to suppress dust;
- excavation faces not being worked will, if required be either sheeted or treated with a chemical dust suppressant;
- in addition all operatives working in areas of potential dust emission will be provided with paper type face masks.

Materials deposited on stockpiles on site will be closely monitored for any possible emission of dust and if required they will be damped down, covered or treated with a chemical dust suppressant.

If finely ground materials are delivered, these should be in bag form or stockpiled in specified locations where the material can be suitably covered.

All vehicles carrying bulk materials into or out of the site will be covered to prevent dust emission. Minimum drop heights will be used during material transfer.

Dust emission from moving construction plant and site transport will be mitigated by the use of water bowsers which will dampen all movement areas being utilised by traffic.

Possible dust emission from areas outwith the main construction area eg laydown areas, storage areas, and accommodation areas will be controlled by laying geotextile membrane and a crushed stone layer. Any further suppression measures will be effected by dampening the surface by the use of water bowsers.

Also a road sweeping vehicle will be employed throughout the whole of the construction time to remove dust and dirt from all the hard surfaced roads.

The above measures may only be necessary should the activities leading to the greatest dust generation occur during a dry period.

If care is taken dust emissions will not impact on local air quality.

6.1.2 Operation

The following mitigating measures have been included in the design of the CHP plant;

- the use of Dry Low NO_x Burners during gas firing
- the use of water or steam injection for NO_x control during gas condensate firing;
- the choice of fuels inherently low in sulphur;
- a stack of sufficient height and flue gases of sufficient temperature and velocity to ensure good dispersion.

These measures, in combination, result in acceptable increases in background concentrations of oxides of nitrogen such that no further measures are deemed necessary.

The performance of the NO_x abatement system is guaranteed by the manufacturer. If NO_x values are outwith the guarantee value the operation and calibration of the instrument will be checked and if found in order the plant will be examined and the fault corrected.

Amoco Power Resources propose to continue monitoring the ground level concentrations of NO_x through the construction period and into the first few months of operation. This should confirm the results of the atmospheric modelling and that the impacts of the emissions from the CCGT plant are in fact acceptable.

The stack will be fitted with a continuous NO_x monitor. The measured value will be recorded and displayed in the Control Room. Routine calibration checks will be carried out as recommended by the manufacturer and as agreed with HMIP. Any other ad-hoc calibration checks required by HMIP will be carried out. A cross-the-stack NO_x analyser is proposed. An oxygen monitor will also be supplied and results from this will be used to correct the NO_x measured value to the format required by HMIP. Either a moisture meter will be provided or a mathematical correction factor based on combustion of natural gas will be used to convert to the dry condition. The results from this stack monitoring will be available to the public in the Republic Register held by HMIP.

Sampling points and safe access adjacent to the continuous monitoring points will be installed.

Regular observation of chimney emissions will also be made.

With the high excess air rates used in gas turbines it is not considered necessary to install continuous monitors for opacity, carbon monoxide or particulate matter.

6.2 Water quality

6.2.1 Construction

It is recommended that to ameliorate any adverse effects during the construction of the outfall that discussions are undertaken with the local fishing community, and that they are kept informed of expected activities. Further agreement will also be needed with the Port Authority. Construction of the outfall during the less windy summer months will ensure that no impacts affect breeding birds.

The NRA have initiated the development of a shoreline/coastal management system for East Anglia. This is being designed to ensure the implementation of cost-effective sustainable coastal defence, and an integrated approach to the protection of environmentally sensitive areas. Any decision regarding the outfall should be taken into account in this management system.

Full recommendations for mitigating measures during the construction of the proposed power station outfall cannot be ascertained until engineering details are available. At this stage a detailed application can be made to the Ministry of Agriculture, Fisheries and Food for a licence to construct the outfall.

6.2.2 Operation

All aqueous process effluents are discharged to the cooling water outfall. No on-site treatment further to that described in Section 5.2 is therefore necessary. This represents the best practicable environmental option for these effluents.

The water treatment plant effluent will be monitored for pH value. If the pH is outwith the limit of 6 to 9 the discharge will automatically stop until the failure is corrected.

Additional samples of the water treatment plant effluent and boiler blowdown will be taken quarterly for more detailed analyses.

Cooling water discharge will be monitored for temperature and residual total oxidant (chlorine) concentration.

The use of oil interceptors on all areas susceptible to oil spillage prevents the release of visible oil to the sea. The effluent from the oil interceptors will be monitored for oil in water content.

The new storage tanks for gas condensate, raw and treated water, lubricating oil and other hazardous liquids will all be constructed on impervious bases and bunded to contain at least 110 per cent of each tank's volume. Any water or spillage that collects in the bund will be discharged by a manually started electrically operated pump. These will be checked before disposal in an appropriate manner.

6.3 Noise

6.3.1 Noise and vibration control measures during construction

The main method of mitigating the effects of temporary construction noise on the residential environment will be to limit site activity to daytime periods only. Pumps and generators used to sustain basic services 24 hours/day will be fitted with appropriate silencers and acoustic hoods as necessary in order to minimize the effects of noise.

All work will be carried out in accordance with BS 5228 "Noise Control on Construction and Demolition Sites".

It is expected that piling may be able to be carried out using continuous flight auger injection techniques which are quieter than drop-hammer methods. This cannot be confirmed absolutely until later in the project.

It is planned that construction noise will be monitored at housing on two separate occasions, one of which will include the period during which piling is occurring. The other occasion will be during one of the other potentially noisy stages, eg site excavation.

During the commissioning of the station, purging of the waste heat recovery boiler will be carried out using silenced temporary vent systems to minimize the potential for any disturbance.

6.3.2 Noise control measures during operation

The proximity of housing to the CCGT power station site will necessitate consideration to be given at the earliest stage of design to measures to minimize the effect of noise.

Computer simulation

Because the design will require substantial detailed acoustic design work, it will be necessary for the designers to utilize a computer simulation of environmental noise to the community, where each noise source is modelled, and the total noise level predicted at nearby housing and checked to ensure it complies with the limit, through the design phase.

Site layout and orientation

The final arrangements of layout and orientation will be subject to detail designs and equipment selection, however particularly noisy sources will be directed wherever possible away from the sensitive westerly direction. Use will be made of the easterly direction where it is understood that the strip of land along the shore which is currently used for caravan/camping will no longer be used for this purpose once the station is built.

Intermittent noise

Recognizing that intermittent high levels of noise can occur occasionally, measures will be adopted including in particular atmospheric vent silencers and acoustic pipe lagging to control these sources.

Tonal and impulsive quality

The 'rating' of a noise will automatically increase when tones, whines or impulses are noticed in the audible noise. Care has been taken therefore, both to identify particular sources on the plant and to ensure that these will be adequately silenced. The two most significant sources of tonal energy are the Compressor Blade Passing Frequency noise at the inlet to the gas turbine, which will generate a high frequency whine in the 2 - 4 kHz octave band range, and also the generator transformer, which will contain middle to low frequency tonal energy at the second and fourth harmonics (100 Hz and 200 Hz).

Equipment choice

Where options become available for selecting intrinsically quiet equipment, these will be taken up wherever practical. An example of this is the choice of cooling system. Utilizing a once-through system will mean that large banks of cooling towers - the fans of which would have generated significant noise - will not be required.

High performance noise control treatment

In addition to the benefits from selecting intrinsically quiet equipment, a package of high performance proprietary noise control treatments has also been considered in the proposed scheme. The package comprises treatments broadly as follows, although the final noise data on selected equipment items may mean significant variations in the nature and extent of such treatments.

a. High performance gas turbine inlet silencer providing maximum attenuation at high frequencies, and abatement of the compressor whine, in particular.

b. High performance acoustic enclosure around the gas turbine.

c. Acoustic insulation to the gas turbine inlet ductwork.

d. High performance outlet attenuator to the waste heat recovery boiler, tuned to attenuate low frequencies from the exhaust of the gas turbine.

e. 'Low noise' trims used on noise generating steam valves and acoustic pipework lagging used extensively.

f. Acoustic cladding panels to the walls and roof of the gas turbine and steam turbine building. Acoustic doors fitted.

g. The waste heat recovery boiler to be housed in its own building comprising acoustic cladding panels to walls and roof. The panels to be effective in reducing noise levels at low frequencies.

h. Ventilation systems serving buildings to be fitted with silencers to prevent the escape of both ventilation fan noise and internal machinery noise.

i. Main cooling water pumps and motors will be housed in an acoustically treated building.

j. Main generator transformer to have a heavy acoustic enclosure tuned to attenuate 100 and 200 Hz characteristic tones.

6.3.3 Commissioning noise survey

After commissioning the plant and with the station plant on baseload, a series of measurements will be carried out at the same positions 1 - 4 at which the background noise readings were made in order to be able to demonstrate that the plant complies with its design objectives. A copy of this report will be submitted to Great Yarmouth Borough Council.

6.4 Visual Amenity

No mitigating measures additional to those integral to the CCGT plant design and outlined in Section 5.4 are thought to be necessary.

6.5 Traffic and Infrastructure

No mitigating measures or monitoring programmes are thought to be necessary.

6.6 Socio economics

No mitigating measures or monitoring programmes are deemed necessary due to the positive socio-economic impact of the project.

6.7 Ecology

No mitigating measures or monitoring programmes are deemed necessary.

6.8 Cultural heritage

No mitigating reasons or monitoring programmes are thought to be necessary.

A. CONSULTEES

A. CONSULTEES

- Great Yarmouth Borough Council:Planning Department, Envrionmental Health Department.
- English Nature - Norwich
  - Marine Team, Peterborough
- Countryside Commission
- Norfolk Wildlife Trust
- National Rivers Authority
- Her Majesty's Inspectorate of Pollution
- Norfolk Landscape Archaeology
- Omnipac
- Health and Safety Executvie
- Great Yarmouth Port Authority
- Eastern Electricity
- Beck Electronics
- C-Mac Microcircuits
- Farnell Mercator
- Broads Authority
- Ministry of Agriculture, Food and Fisheries
- Marine Conservation Society
- Marine Nature Conservation Group
- Anglian Water
- Eastern Sea Fisheries Committee
- Heritage Coast Officer
- Advisory Committee on the Pollution of the Sea (ACOPS)
- Sea Mammal Research Unit, Cambridge
- Whale and Dolphin Conservation Society

B. ARCHAEOLOGICAL IMPACT ASSESSMENT

(Prepared by Norfolk Archaeological Unit)

NORFOLK ARCHAEOLOGICAL UNIT

Report No 168

South Denes Power Station Site, Great Yarmouth

An Archaeological Impact Assessment

on behalf of Merz and McLellan (Consulting Engineers)

Kenneth Penn

March 1996

Contents

List of Figures (as shown in the main body of the text)

South Denes Power Station

****

Location:	South Denes, Great Yarmouth
Grid Ref:	TG 53 05
Date of work:	March 1996
SMR number:	Site 4305

****

Summary

An assessment of the archaeological impact of proposed development of the South Denes Power Station site indicates that the natural shingle spit upon which it stands dates from the early medieval period, with medieval levels surviving ***in situ*** *beneath later deposits. The development site was unoccupied by modern buildings until the building of the power station in 1954. Archaeological observations at that time into the structure of the spit revealed a 12th/13th century 'beach' surface and associated pottery covered by later deposits. These levels mostly lie at least 3m below the present surface, at -3.0m to -4.0m OD, and proposed redevelopment, where it reaches this depth, will allow specific investigation of these levels, the medieval pottery and its contemporary context, illustrating trading connections of the medieval port.*

Acknowledgements

The writer is grateful to Edwin Rose of NLAS for his help, to Andrew Lowes and Brian Eagers of Merz and McLellan for information regarding likely foundation depths for the proposed power station, and W Milligan of the Castle Museum, Norwich for access to original records.

1.0 Introduction

1.1 This assessment has been carried out by staff of the Norfolk Archaeological Unit (NAU), on behalf of Merz and McLellan Ltd. The aim of this work is to determine the known archaeological constraints and assess the impact of proposed works on the archaeology of the development site, as it is currently understood.

1.2 The proposed power station will stand on part of the site at present occupied by the South Denes Power Station, built in 1954-56, which lies about 1.5km south of the medieval walled town of Great Yarmouth and 1km north of the present harbour entrance (Fig 20). This report considers the evidence for the history of the sand-spit, and relevant archaeological observations, both for the site and locally. A number of maps have been used as evidence of the development of the town and also the absence of settlement until the 19th century in the South Denes, the large area of sand dunes south of the town.

2.0 Methodology

2.1 For the purpose of this study, attention was restricted to the sand spit upon which Great Yarmouth and the South Denes site stand. Entries in the County Sites and Monuments Record have been consulted and reference made to appropriate maps and literature concerning archaeological work. It is understood that the original construction drawings are held by Merz and McLellan, and these have not been consulted. No fieldwork was undertaken in connection with this report.

3.0 Background

3.1 The walled medieval town of Great Yarmouth stands on a long spit of sand, which effectively closes the mouth of the formerly wide estuary of the Rivers Yare, Bure and Waveney, but which did not reach its fullest extent southward until c1200. This topographical fact largely determined the historical development of the town. The estuary (often known as 'The Great Estuary') was open in Roman times, with the Shore Forts at

Caister and Burgh Castle facing each other across 9km of shallow open water, controlling the estuary (Darling and Gurney 1993) (Fig 17).

3.2 The beginnings of the sand spit which came to close the estuary probably lie in the Early Saxon period. McEwen (1992, 23) argues that 'spit-building began in earnest after the Romano-British period', although it was not inhabited until Late Saxon times at the earliest; he points to evidence of the complex and changing relationships between the erosion of underlying estuarine clays and the deposition of marine gravels in the estuary, based largely on the observations of Green and Hutchinson in 1954-56 during construction of the present power station.

3.3 Almost nothing is known of the pre-conquest history of Great Yarmouth, but Domesday Book (1086) records that in 1066 the spit was occupied and had a church (site now lost) dedicated to St Benet. By 1086 the settlement here had 70 burgesses and 24 fishermen (who 'belonged' to Gorleston). It is likely that the town began as a fishing settlement in the Late Saxon period, maybe at first seasonal, on the shingle and sand spit which had developed by then across the mouth of the estuary.

3.4 Around 1100 the settlement was laid out anew, with long streets running along the spit and a new church overlooking the market-place. Further development in the town included the laying out of the 'Rows' (narrow alley-ways), probably in the 13th century (Rogerson 1976, 136), and the building of the town walls in the period 1285-1341, to enclose what was by then an important port (Rutledge 1978). The town remained confined within these walls until modern times, with a handful of windmills on the sand-dunes to the immediate east of the town (Rye 1970), as can be seen on Faden's map of 1797 (Fig 18).

3.5 The remarkable situation of the town on its narrow spit dominates its topography and archaeology, with the build-up of wind-blown sand within the town leading to very deep stratification in places, and good sequences of stratified deposits (Rogerson 1976). In the early medieval period the town appears to have stood some 4m higher in relation to the sea (Green and Hutchinson 1960). The situation of the medieval town on the west side of the spit and its sinuous street layout, seem to reflect a much narrower medieval spit, which was at its greatest height in the north part, where the town stands. The spit has accumulated material and grown seawards, as can be seen from a comparison of the later maps, eg Faden and OS 6" map of 1888 (Figs 18 and 19). The Late Saxon/early medieval ship found buried at King Street (near the south-east part of the walled town) at 0.3m OD under 4.5m of sand (Green and Hutchinson 1960, 129) may have been beached from the east, suggesting a contemporary beach in that quarter.

4.0 **The Havens**

4.1 The development of the spit has also involved the creation of a series of natural and artificial river outlets to the sea, with an early mouth of the River Bure at Grubb Haven (or Cockle Water) some way to the north of the walled town. This exit was finally closed by the early 14th century, the town standing on the peninsula thus formed (McEwen 1992, 23), whilst an early exit for the River Yare may have existed just beyond the North Gate of the town (Lark 1990, 14; McEwen 1992, 19).

4.2 Although the Yare exit (in effect, the south end of the spit) may have been just south of the town in the 11th century, by 1200 the spit had grown far to the south, with its end just off the coast at Corton, but remaining very narrow throughout its length.

4.3 The present harbour-mouth dates to the later 16th century, but is merely the last in a series of 'havens' (Eccleston 1959; Hedges 1959; Lark 1990; McEwen 1992). As the medieval sandbank developed and river outlets became choked, artificial cuts were made to the sea. The exact locations of these cuts is mostly surmise, although Eccleston (1959) has suggested a succession of probable locations, with the power station site close to one of these (Fig 20 and 21). These may be summarised, for information;

1st haven: 1347 (blocked 1375)
2nd haven: 1396 across the South Denes about 1.5km below Wellington Pier and just north of the Power Station site.
3rd haven: 1408 at Newton
4th haven: 1508
5th haven: 1529 near the present-day harbour entrance.

6th haven: 1548-9 Just north of the Power Station site?
7th haven: 1559-67

(Havens 2,4 and 6 are shown on Fig 20).

4.4 The structure and development of the spit, the most significant known aspect of the present site, has been most fully discussed by Green and Hutchinson (1960) drawing upon information from bores and in particular, the observations made during the construction of the South Denes Power Station in 1954-56.

4.5 Essentially, the spit is composed of sand and shingle overlying about 20m of an apparently homogeneous estuarine clay, but its growth also involved channel erosion of the clay and reworking of the earlier deposits, a process driven by increasing sea-levels since Anglo-Saxon times and involving massive vertical accretion, resulting in the burial of early features, a characteristic of the archaeology of Great Yarmouth.

4.6 As has been seen, the spit developed from the north, and slopes from north to south, being at its lowest at the present harbour mouth. The spit has also become wider, growing both seaward and southward.

5.0 **Archaeological Observations**

5.1 All excavations have revealed the extent of build-up and the survival of earlier features beneath later spit deposits. Excavations in 1974 near the highest part of the spit in the town, at Fuller's Hill, revealed that occupation of 11th and 12th century date was stratified between layers of windblown sand (Rogerson 1976), and observations of a sewer trench within the town in 1995 revealed a build-up of 2m at least above the natural sand, within the walled area (Wallis 1995). At Fuller's Hill, the lowest occupation level was at 2.8m OD, whilst the pavement outside the west door of the parish church to the east is 1.6m OD, indicating the relative accretion here. It should be noted that Green found a medieval pot and hearth at depth, at 1.82m OD in the town (Green and Hutchinson 1960, 196).

5.2 Two riverside sites in the town have also shed light on the significance of spit development; at South Quay, the remains of a 13th/14th century ship were found in silt 3.2m below the pavement (at 0.7m OD). The silt rested on sand which sloped to the west, possibly the natural beach surface. Similarly, at Hall Quay, excavations exposed a sloping surface of sand, at about 0.0m OD, again probably the natural shore line, lying under a thin band of ?redeposited peat and a deposit of brown soil containing bones and early medieval pottery (Rye 1990), showing that this was an open shore into the medieval period but was then buried.

5.3 Since the South Denes site, some 1.5km from the town, was unoccupied in medieval times, no formal archaeological work has taken place here but, during the construction of the Power Station in 1954-56, important observations were made in the contractors' trenches of the structure of the spit, and an assessment made of its major development, seen as probably beginning around AD 1000 (Green and Hutchinson 1960).

5.4 Notes were made of the strata and finds encountered down to -6.0m during the building of the riverside intake coffer-dam and the culvert to the Turbine House (A-C in Fig 22). Open excavation laid bare the structure of the spit to a depth of c-6.1m OD.

5.5 The coffer-dam itself stood on the riverside a little south of the Power Station, and recording of the stratification was begun here, with finds being encountered at great depth, indicating the depth of build-up since the medieval period. Discussion of the observed sequences follows.

6.0 **Deposit Sequence: 1954-56 Section A-C** (Figs 22 and 23)

6.1 The intake at the riverside and the culvert were both dug to -6.1m OD and revealed the following sequence (from the surface; E is the uppermost deposit):

E 5.2m OD - 3.3m OD: recent blown sand and superficial deposits
D 3.3m OD: beach material with thin bands of silt
C -3.0m OD (at highest point) - -5.3m OD: band of dark brown silty/clayey sand with much archaeological material. This material included French imported pottery of late 13th century date (not waterworn). The

surface of the deposit was a mussel-bed, with the deposit as a whole interpreted as deriving from the great floods of 1287, the mussel-bed indicating its exposed surface.
B -5.3m OD and below: beach ballast, a sand and shingle mixture representing natural beach-building. This material contains pottery fragments of various dates, the latest of the 13th century, when this layer was overwhelmed by deposit C. The surface of this layer is a bed of barnacles of an inter-tidal species, indicating that this was an exposed beach surface until covered by deposit C (the flooding episode at the end of the 13th century). A hollow in the surface of deposit B seems to represent an early beach 'low', as may be seen on beaches today, separating the shore from an off-shore sandbank, and perhaps hinting at the process of spit formation. Deposit B lies unconformably upon the eroded surface of A.
A the basal 'Red Beds' of fine compact reddish sands with silt and clay bands (current-bedded); the original surface has been eroded and lost during spit development. Archaeologically sterile, and probably of Pleistocene date.

6.2 Because of the shoring, the section at A-C (and to the outfall D) could only be examined and recorded at intervals. This section (Fig 23) demonstrates graphically the depth of material accreting on the spit since 1287.

7.0 Observations at the Turbine House

7.1 During construction of the Turbine House, the observed succession (County Sites and Monuments Record) was of 'sand and shingle' over 'grey estuarine mud', which in turn overlay a shingle ballast which faded out eastwards. Below this lay the 'Red Beds' and at the base, 'grey mud'.

7.2 Finds from these deposits (although not always precisely located) indicate their late date.
1 glazed pottery was found just below the upper 'grey mud'.
2 late medieval stoneware came from 'on top of the grey mud' at -3.3m OD/-3.9m OD.
3 green-glazed sherds and other pottery, including a 'Saxo-Norman' jar, were found in the brown clay deposit below the mussel-beds at -5.7m OD.
4 bones and a mica-schist hone were found at -6.0m OD.

The section at the Turbine House was excavated to -6.0m OD.

8.0 Cartographic sources

8.1 A good series of maps beginning in 1588 shows clearly that the long spit of sand upon which the medieval town stood was otherwise unoccupied by much other than windmills and shore gun batteries until modern expansion of Great Yarmouth in the early 19th century.

8.2 A plan of the intended fortifications of Great Yarmouth, dated to 1588, shows the town confined within its medieval walls, with a pair of opposed gun batteries (Nos 1 and 7 on the plan) some way to the south of the South Denes site, and a group of windmills on the sand-dunes to the east of the town (O'Neil and Stephen 1942).

8.3 Gomme's map of Great Yarmouth (for Sir Robert Paston) in 1668 also shows the town within its walls and windmills on the dunes; on the map the South Denes are obscured by the key and were presumably empty (Rutledge 1978 pl 1).

8.4 The emptiness of the South Denes is well-depicted by Faden's map of Norfolk of 1797 (Fig 18) where South Denes are empty, with a 'warehouse' on the river just below the South Gate, and South Star gun battery (1781) on the sea-shore, some distance north of the Power Station site. The only activity on the South Denes at this period was that of occasional fairs, such as the 'Dutch Fair' depicted by G Vincent c1825 (Hedges 1959, 15).

8.5 The beginnings of urban expansion onto the South Denes can be seen on the OS 1" 1st Edn map of mid-19th century date (Fig 24), by which time major public works beyond the South Gate included the Barracks (1782), Naval Hospital (1809) and Gas Works (1824); the Nelson Monument was built in sandy desolation on the South Denes in 1817 (Palmer 1856, 297-290).

8.6 The Nelson Monument stood isolated on the Denes for many more years (apart from the racecourse of 1810), as can be seen from the OS 6" and 1:2500 maps of the 1880s. The Power Station was built on unoccupied land in 1954 (OS 1:2500 map 1958).

9.0 **Discussion**

9.1 Since the spit had grown southward to Corton by c1200, it follows that the basal beach deposit B containing 12th and 13th century pottery and capped by inter-tidal barnacles must belong to this period. The barnacles also show that contemporary sea levels were much lower, perhaps about 4m lower than today, in the 12th/early 13th century with accelerated submergence of existing levels after the floods of 1287 (Green and Hutchinson 1960, 134). The 1287 silt deposit was nowhere seen to be higher than 3.0m OD. Rising sea levels in the medieval period probably accelerated the development of the spit, both in length and height, with the greatest in the north (oldest) part and least in the south (youngest) part.

10.0 **Assessment**

10.1 Archaeological interest in the South Denes Power Station site lies chiefly in evidence of medieval character and development of the spit, its succession of beaches and the associated deposits of pottery. It is evident that these levels survive *in situ* at some depth (at least 3m) below the present superficial deposits, except where destroyed by the construction of the power station in 1954-56. It may be seen from Fig 22 that the inlet/outlet section recorded by Green and Hutchinson in 1954-56 was a deep trench (c-6.0m OD) running from river to sea, passing under the turbine house. Whilst excavations for the inlet/outlet system and the chimney base reached down to c-6.0m OD, the main buildings rested on a concrete raft over ducting, reaching down to c-3.0m OD (based on information from A Lowes, Merz and McLellan). Thus the earlier medieval levels recorded in the lowest parts of the 1954-56 section may be intact elsewhere and beyond the reach of shallow foundations.

10.2 The proposed power station (see Fig 36) will be rather smaller than the existing one, and its main buildings, with the deepest foundations, will stand just south of the present power station main buildings. However, its major foundations are likely no more than c3m in depth (information B Eagers: Merz and McLellan).

10.3 Any deep excavations for the proposed power station will almost certainly result in further exposures of the spit structure and medieval beach deposits, part of the natural accretional sequence, although it is possible that they will not reach the pre-1287 deposits.

10.4 Proposed development will therefore afford a further opportunity to record the spit structure, and perhaps confirm the postulated date for early levels from any associated pottery. Additionally, recovered material and features will assist the still nascent study of the maritime trading port.

10.5 Little is known of the exact location or character of the artificial cuts through the spit (see Figs 20 and 21), and close attention to the north-to-south sections may shed light on this question.
Any arrangements for archaeological work will need to make special provision for recording procedures, particularly since sections may be obscured by shoring. The focus of archaeological interest will most probably lie at -3.0m - -6.0m OD.

Bibliography

Darling, M. and Gurney, D. 1993
'Caister-on-Sea: Excavations by Charles Green 1951-1955' *E. Anglian Archaeol.* 60

Eccleston, A.W. and J.L. 1959
The Rise of Great Yarmouth: the story of a sandbank (Great Yarmouth)

Green, C. and Hutchinson, J.N. 1960
"Evidence of Land and Sea Changes from Minor Excavations in the Yarmouth District" in Lambert *et al* (1960) *The Making of The Broads* , 129-144

Hedges, A.A.C. 1959 (rev 1973)
Yarmouth is and Antient Town (Great Yarmouth)

Lambert, J.M. *et al* 1960
The Making of the Broads (RGS Research Series 3)

Lark, A. 1990
'The Havens and Marshes of Yarmouth' *Yarmouth Archaeology*, 13-19

McEwen, A. 1992
'The Yarmouth Spit' *Yarmouth Archaeology*, 18-24

O'Neil, B.H.St J. and Stephen, W.E. 1942
'A Plan of the Fortifications of Yarmouth 1588' *Norf. Archaeol.* 28, 1-6

Palmer, C.J. 1856
The History of Great Yarmouth

Rogerson, A. 1976
'Excavations on Fuller's Hill, Great Yarmouth' *E. Anglian Archaeol.* 2, 131-245

Rutledge, P. 1984
'Two Little Yarmouth Deeds' *Yarmouth Archaeology* 17-19

Rutledge, E. and P. 1978
'King's Lynn and Great Yarmouth: Two Thirteenth Century Surveys' *Norfolk Archaeol.* 37, 92-114

Rye, C.G. 1970
'Yarmouth Windmills on the Denes' *Norfolk Archaeol.* 35, 148-151

Rye, G. 1990
'Excavations at Number 12 Hall Quay' *Yarmouth Archaeology* (reprinted from *Bulletin* 1968)

Wallis, H. 1995
Bryants Quay: Great Yarmouth to Caister Watching Brief (NAU report 147)

Maps
1 1588 A plan of the intended fortifications of Yarmouth (O'Neil and Stephen 1942)
2 1668 A view of Great Yarmouth, by Gomme (Rutledge 1978)
3 1797 Faden's map of Norfolk
4 mid-19th century OS 1" map 1st Edn
5 1887 OS 1:2500 map 1st Edn
6 1888 OS 6" map 1st Edn
7 1958 OS 1:2500 map

C. ENVIRONMENTAL NOISE RECORD SHEETS

(Background noise survey of 14/15 February 1996)

ENVIRONMENTAL NOISE RECORD SHEET

Sheet No: 1

Location: Position 1: Riverside Road, rear of High Street, Gorleston
Date: 14 February 1996 **Surveyed by:** David Philip
Calibration Times: 22.00, 04.00

Project: South Denes Power Station
Instrumentation: B & K 2260
Plant Operating Condition: Background survey

DATE	TIME		WEATHER			NOISE LEVEL dB(A)						COMMENTS
	Start	Dur'n (Min)	Wind Speed m/s	Wind Dir'n	Cloud (%)	L_{10}	L_{50}	L_{90}	L_{MAX}	L_{MIN}	L_{Aeq}	(Including description of noise (eg whine, hiss, rumble, impact, vehicle rain, vegetation, or animal noise).
14.2.96	22.45	5	1-2	E	75	53.6	46.4	44.6			58.9	Distant traffic + ship generator
15.2.96	00.05	5	1-2	E	50	47.4	44.2	43.6			46.0	Distant traffic + ship generator
15.2.96	01.15	5	0-1	N	50	48.2	41.2	40.2			52.6	Distant traffic + ship generator
15.2.96	02.15	5	0-1	N	25	43.4	42.0	41.0			42.6	Distant traffic + ship generator + boat engine (low frequency)
15.2.96	03.20	5	0-1	N	25	40.6	39.8	39.2			40.0	Distant traffic + ship generator

DATE	TIME	dB(A)	Octave Band Pressure Level									COMMENTS
			31	63	125	250	500	1k	2k	4k	8k	
15.2.96	02.15	41.0	67	56	53	40	37	31	25	18	13	Distant traffic + ship generator and boat engine at low frequencies.

ENVIRONMENTAL NOISE RECORD SHEET

Location: Position 2: Riverside Road/South Icehouse Hill, Gorleston
Date: 14 February 1996 **Surveyed by:** David Philip
Calibration Times: 22.00, 04.00

Sheet No: 2

Project: South Denes Power Station
Instrumentation: B & K 2260
Plant Operating Condition: Background survey

DATE	TIME		WEATHER			NOISE LEVEL dB(A)						COMMENTS
	Start	Dur'n (Min)	Wind Speed m/s	Wind Dir'n	Cloud (%)	L_{10}	L_{50}	L_{90}	L_{MAX}	L_{MIN}	L_{Aeq}	(Including description of noise (eg whine, hiss, rumble, impact, vehicle rain, vegetation, or animal noise).
14.2.96	23.00	5	1-2	E	75	54.4	44.6	43.0			55.7	Distant traffic + local traffic + distant ship generator
15.2.96	00.15	5	1-2	E	50	53.8	40.8	39.6			55.4	Distant traffic + local traffic + distant ship generator
15.2.96	01.25	5	0-1	N	50	40.4	38.6	37.6			39.1	Distant traffic + local traffic + distant ship generator
15.2.96	02.25	5	0-1	N	25	44.8	41.2	39.6			42.8	Distant traffic + local traffic + distant ship generator
15.2.96	03.30	5	0-1	N	25	47.2	39.4	38.4			42.9	Distant traffic + local traffic + distant ship generator

DATE	TIME	dB(A)	Octave Band Pressure Level									COMMENTS
			31	63	125	250	500	1k	2k	4k	8k	
15.2.96	02.25	39.6	60	56	53	40	34	30	23	17	14	Distant traffic, some local traffic, general port activity

ENVIRONMENTAL NOISE RECORD SHEET

Location: Position 3: Spencer Avenue/East Anglian Way, South Denes
Date: 14 February 1996 **Surveyed by:** David Philip
Calibration Times: 22.00, 04.00

Sheet No: 3
Project: South Denes Power Station
Instrumentation: B & K 2260
Plant Operating Condition: Background survey

DATE	TIME		WEATHER			NOISE LEVEL dB(A)						COMMENTS
	Start	Dur'n (Min)	Wind Speed m/s	Wind Dir'n	Cloud (%)	L_{10}	L_{50}	L_{90}	L_{MAX}	L_{MIN}	L_{Aeq}	(Including description of noise (eg whine, hiss, rumble, impact, vehicle rain, vegetation, or animal noise).
14.2.96	23.15	5	1-2	E	50	59.2	53.4	42.2			55.7	Traffic from A12
15.2.96	00.25	5	1-2	E	50	41.6	39.0	37.4			39.8	Traffic from A12
15.2.96	01.35	5	0-1	N	50	41.0	37.4	33.8			38.5	No noticeable sources
15.2.96	02.40	5	0-1	N	25	40.2	37.6	35.2			38.3	No noticeable sources
15.2.96	03.45	5	0-1	N	25	42.0	38.0	36.0			42.8	Distant traffic

DATE	TIME	dB(A)	Octave Band Pressure Level									COMMENTS
			31	63	125	250	500	1k	2k	4k	8k	
15.2.96	03.45	36.0	44	41	40	37	31	30	26	21	17	No noticeable sources

ENVIRONMENTAL NOISE RECORD SHEET

Sheet No: 4

Location: Position 4: Micawber Avenue, South Denes
Date: 14 February 1996 **Surveyed by:** David Philip
Calibration Times: 22.00, 04.00

Project: South Denes Power Station
Instrumentation: B & K 2260
Plant Operating Condition: Background survey

DATE	TIME		WEATHER			NOISE LEVEL dB(A)						COMMENTS
	Start	Dur'n (Min)	Wind Speed m/s	Wind Dir'n	Cloud (%)	L_{10}	L_{50}	L_{90}	L_{MAX}	L_{MIN}	L_{Aeq}	(Including description of noise (eg whine, hiss, rumble, impact, vehicle rain, vegetation, or animal noise).
14.2.96	22.25	5	1-2	E	75	43.8	39.2	37.4			41.0	Distant traffic
14.2.96	23.50	5	1-2	E	50	44.4	36.2	35.4			50.0	Distant traffic
15.2.96	01.00	5	0-1	N	50	40.6	39.0	37.4			39.4	Distant traffic
15.2.96	02.00	5	0-1	N	50	40.6	38.2	36.6			39.0	Distant traffic
15.2.96	03.05	5	0-1	NW	25	44.4	38.2	37.0			40.7	Distant traffic

DATE	TIME	dB(A)	Octave Band Pressure Level									COMMENTS
			31	63	125	250	500	1k	2k	4k	8k	
15.2.96	03.05	37.0	49	47	46	39	33	31	23	16	13	Distant traffic

ENVIRONMENTAL NOISE RECORD SHEET

Sheet No: 5

Location: Position 5: South Beach Parade, South Denes
Date: 14 February 1996 **Surveyed by:** David Philip
Calibration Times: 22.00, 04.00

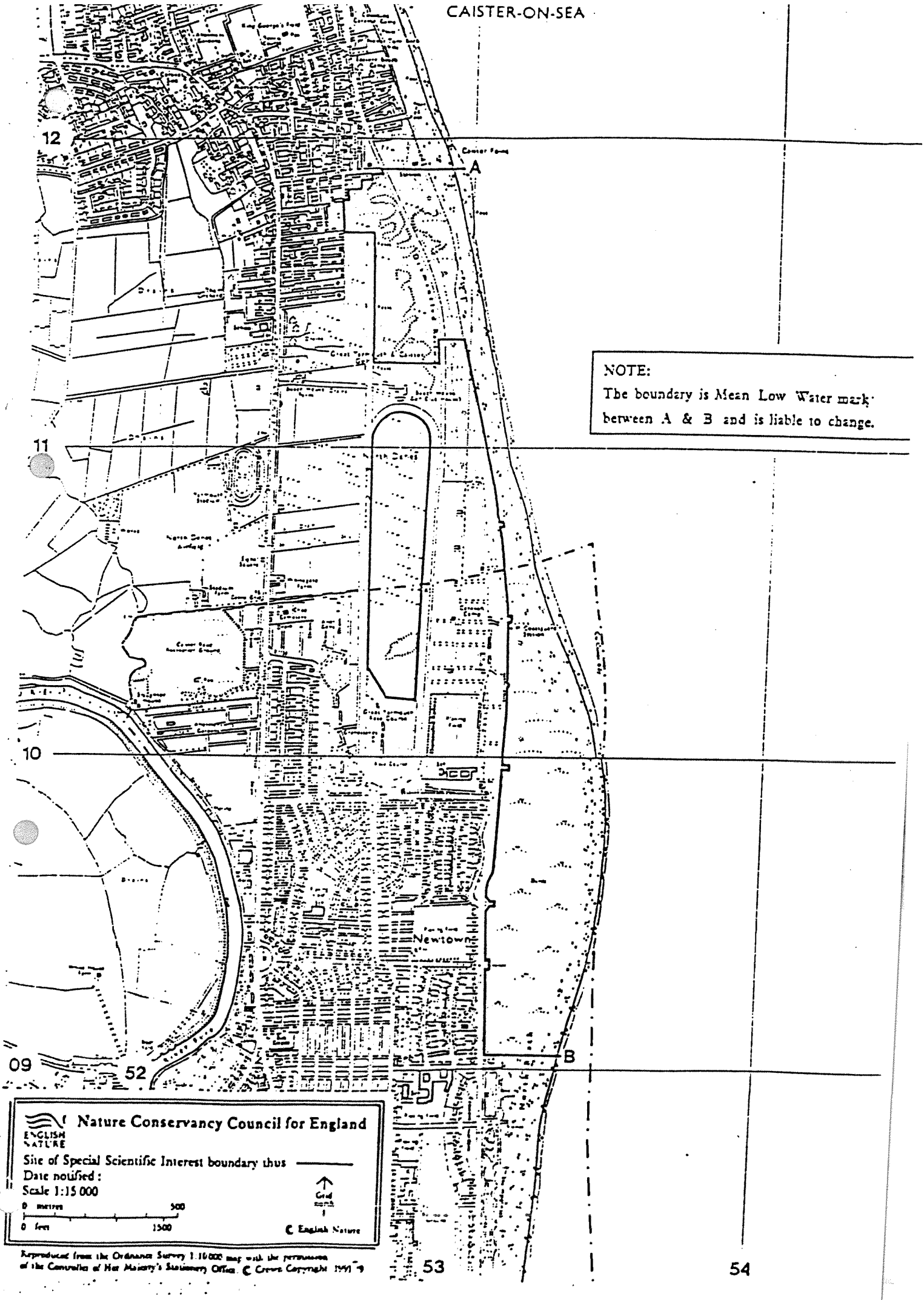
Project: South Denes Power Station
Instrumentation: B & K 2260
Plant Operating Condition: Background survey

DATE	TIME		WEATHER			NOISE LEVEL dB(A)						COMMENTS
	Start	Dur'n (Min)	Wind Speed m/s	Wind Dir'n	Cloud (%)	L_{10}	L_{50}	L_{90}	L_{MAX}	L_{MIN}	L_{Aeq}	(Including description of noise (eg whine, hiss, rumble, impact, vehicle rain, vegetation, or animal noise).
14.2.96	22.10	5	2-3	E	75	57.8	42.6	40.8			58.3	Distant traffic and sea noise
14.2.96	23.40	5	1-2	E	50	43.6	42.2	41.0			42.5	Distant traffic and sea noise
15.2.96	00.50	5	0-1	N	50	53.2	40.6	38.6			53.7	Distant traffic and sea noise
15.2.96	01.50	5	0-1	N	50	44.2	42.2	40.6			42.7	Distant traffic and sea noise
15.2.96	02.55	5	0-1	NW	25	52.2	41.6	40.2			61.3	Distant traffic and sea noise + local HGV

DATE	TIME	dB(A)	Octave Band Pressure Level									COMMENTS
			31	63	125	250	500	1k	2k	4k	8k	
15.2.96	01.50	40.6	55	52	47	41	38	34	27	16	13	Distant traffic and sea noise

D. DETAILS OF SSSIs AND WILDLIFE SITES IN THE AREA OF THE PROPOSED SITE

SSSIs IN NORFOLK


CAISTER-ON-SEA
12
A
11
10
Newtown
B
09
52
53
54
NOTE:
The boundary is Mean Low Water mark between A & B and is liable to change.
Nature Conservancy Council for England
ENGLISH NATURE
Site of Special Scientific Interest boundary thus
Date notified :
Scale 1:15 000
0 metres 500
0 feet 1500
Grid north
© English Nature
Reproduced from the Ordnance Survey 1:10000 map with the permission of the Controller of Her Majesty's Stationery Office. © Crown Copyright 1991

File ref: EA/N/355/14 PA1

COUNTY: NORFOLK SITE NAME: GREAT YARMOUTH NORTH DENES

DISTRICT: GREAT YARMOUTH

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981.

Local Planning Authority: GREAT YARMOUTH BOROUGH COUNCIL

National Grid Reference: TG 533 100 Area: 92.4(ha) 228.2(ac)

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TG 50 NW, TG 51 SW

Date Notified (Under 1949 Act): Date of last revision:

Date Notified (Under 1981 Act): 1992 Date of last revision

Other Information: New site and Proposed Special Protection Area (SPA)

Description and Reasons for Notification

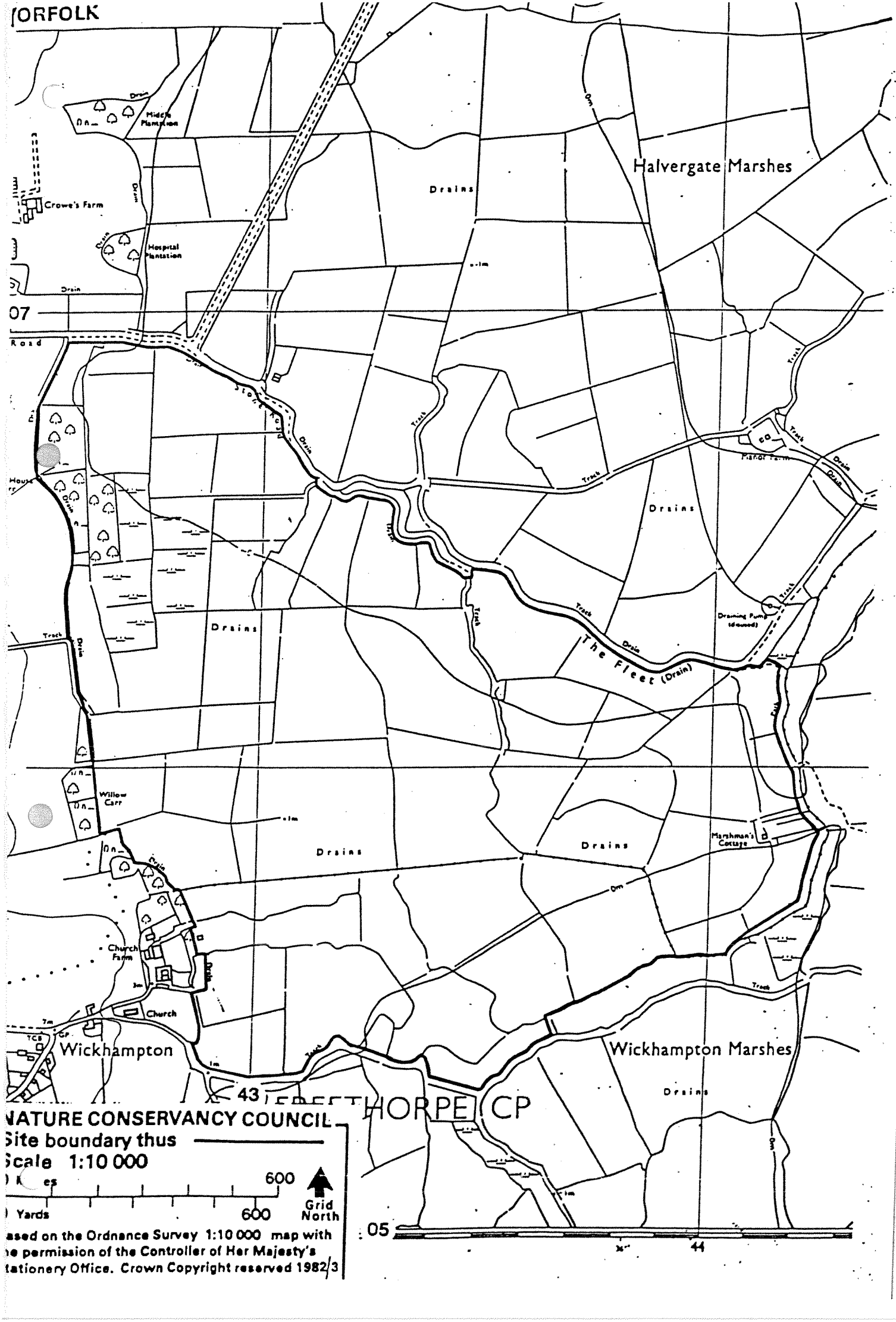
The site consists of a dune system on the east coast of Norfolk between Great Yarmouth and Caister and is an important example of an accreting "ness" or promontory. It supports a full successional sequence of vegetation from pioneer to mature types; foredune, mobile dune, semi-fixed dune and dry acid dune grassland are all represented, the latter being particularly extensive. The largest United Kingdom breeding colony of the rare Little Tern is located on the foreshore.

There is a strip of accreting dune vegetation along most of the seaward edge of the dunes, consisting of the Sand Couch-grass Elymus farctus and Lyme-grass Leymus arenarius. Landward lies a band of mobile dune vegetation characterised by Marram Ammophila arenaria and Red Fescue Festuca rubra. Within this community the rare grass, Rush-leaved Fescue Festuca juncifolia is usually found. In places the mobile dune vegetation is backed by a more species-rich semi-fixed dune community.

The mobile and semi-fixed communities quickly give way to a broad band of fixed dune vegetation indicative of acid conditions, characterised by Sand Sedge Carex arenaria and the lichen Cornicularia aculeata. The nationally scarce Grey Hair-grass Corynephorus canescens is often very abundant and many species of lichens are also found. Towards the north of the site the vegetation appears less acid with areas of the Red Fescue - Lady's Bedstraw Galium verum community frequently occurring. Landward of the seawall there is an extensive area of well developed acidic dune grassland with Sand Sedge, Sheep's Fescue Festuca ovina and Common Bent Agrostis capillaris.

The Little Tern colony has increased in size over each of the last five years with 201 pairs nesting in 1990. This represents 8.4% of the UK population, while the colony has supported an average of 133 breeding pairs during the last five years. Associated with the ternery, Ringed Plover also frequently nest.

The site is of physiographic significance as one of a number of 'ness' features which are characteristic of the East Anglian coast. However unlike many other dune systems in the region this site is actively accreting. It is this accumulation of sediment which is responsible for the good representation of mobile dune vegetation communities.


ORFOLK
Halvergate Marshes
Drains
Middle Plantation
Crowe's Farm
Hospital Plantation
Drain
07
Road
Track
Manor Farm
Drains
Drains
Drainage Pump (disused)
The Fleet (Drain)
Willow Carr
Drains
Drains
Marshman's Cottage
Church Farm
Church
Wickhampton
Wickhampton Marshes
Drains
43
HORPE CP
05
44
NATURE CONSERVANCY COUNCIL
Site boundary thus
Scale 1:10 000
600
Yards
600
Grid North
ased on the Ordnance Survey 1:10 000 map with
e permission of the Controller of Her Majesty's
tationery Office. Crown Copyright reserved 1982/3

File Ref: BA/NW/17 [illegible]

SITE NAME: HALVERGATE MARSHES

COUNTY: Norfolk

DISTRICT: Broadland

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Broads Authority

National Grid Reference: TG 435060 Area: 162 [ha] 400

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TG 40 NW

Date Notified [Under 1949 Act]: 1981 Date of Last Revision: -

Date Notified [Under 1981 Act]: 1982 Date of Last Revision:

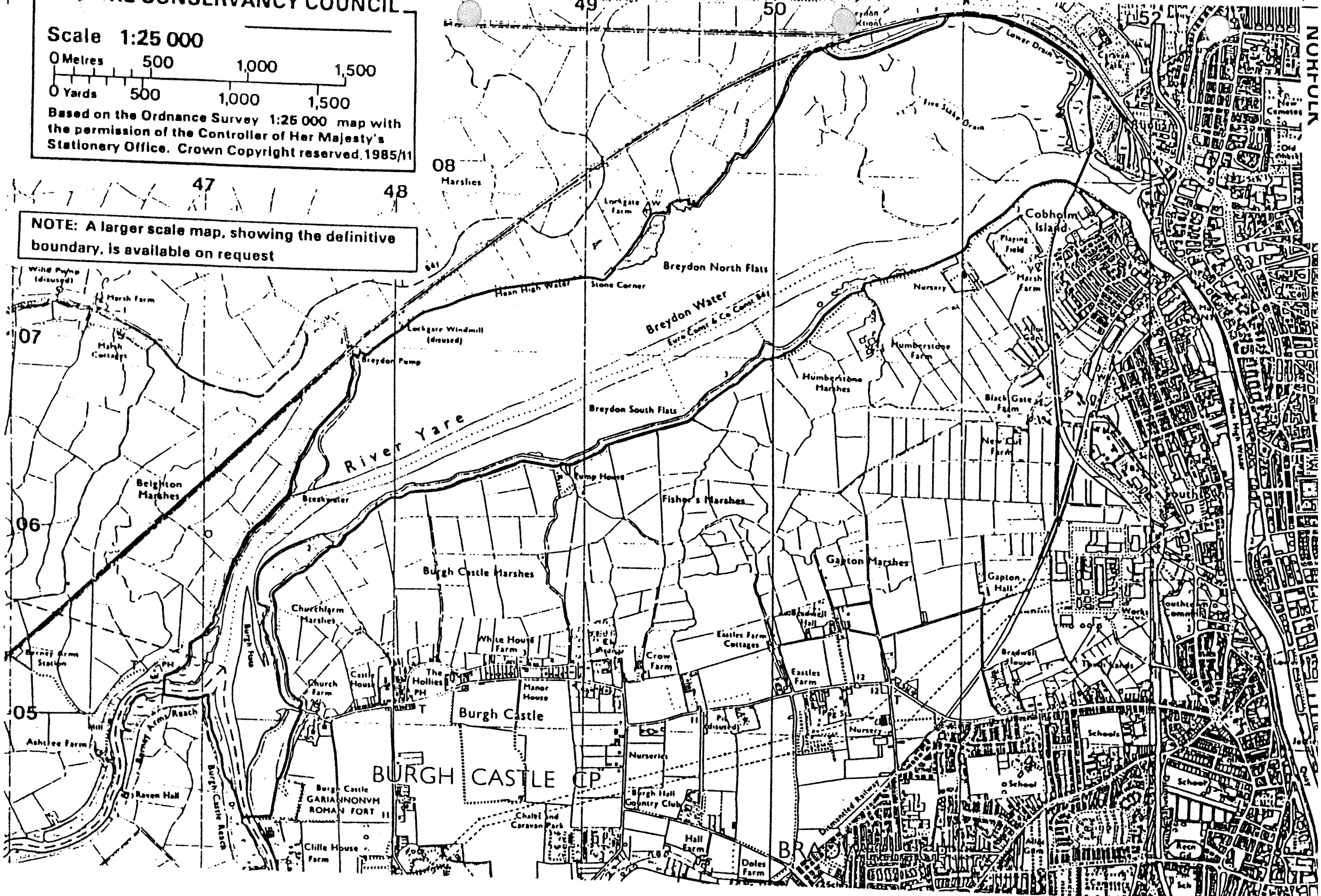
Other Information:

Reasons for Notification:

This site forms a well-defined block of grazing marsh, alder carr woodland and unimproved fen grassland intersected by a system of drainage dykes. These dykes support a high diversi of aquatic plant and animal species characteristic of the Broadland region including the loc occurring Water Soldier [Stratiotes aloides] and the nationally rare Norfolk Aeshna Dragonf [Aeshna isosceles] The areas of grassland are important for breeding marshland birds such Snipe and Yellow Wagtail and for overwintering and migrant wildfowl and waders including Golden Plover. The areas of alder carr woodland provide additional habitat diversity for wo birds and insects and in places a fern-rich ground flora has developed.

NATURE CONSERVANCY COUNCIL

Scale 1:25 000



Based on the Ordnance Survey 1:25 000 map with the permission of the Controller of Her Majesty's Stationery Office. Crown Copyright reserved. 1985/11

NOTE: A larger scale map, showing the definitive boundary, is available on request

COUNTY: Norfolk SITE NAME: BREYDON WATER

DISTRICT: Great Yarmouth

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Great Yarmouth Borough Council

National Grid Reference: TG 500075 Area: 306.5 [ha] 1251.5

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TG 40 NE, SE TG 50

Date Notified [Under 1949 Act]: - Date of Last Revision: -

Date Notified [Under 1981 Act]: 1987 Date of Last Revision: -

Other Information:

A new site; the majority has been established as a Local Nature Reserve since 1968.

Reasons for Notification:

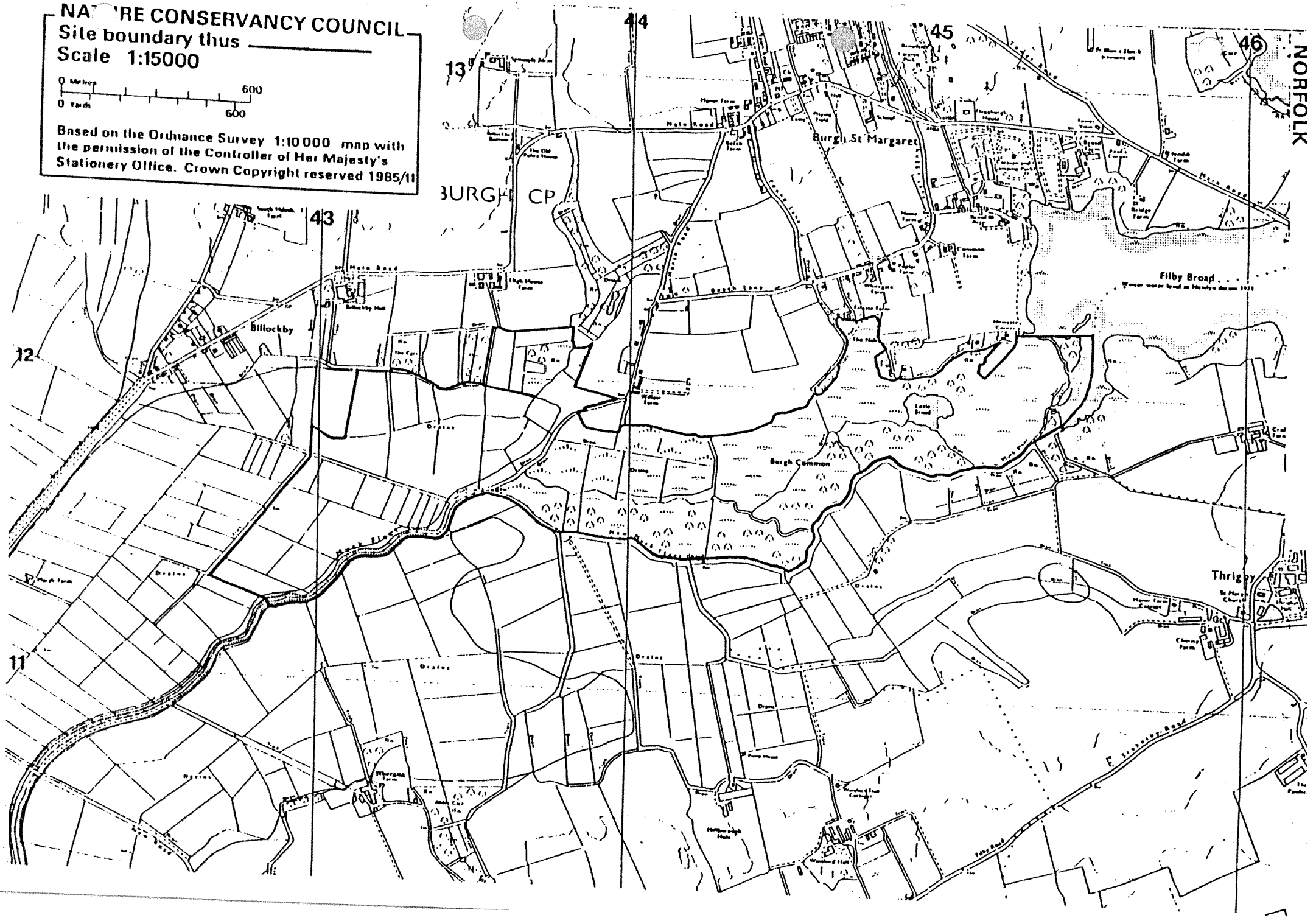
Breydon Water is an inland tidal estuary at the mouth of the River Yare and its confluen with the rivers Bure and Waveney. Extensive areas of mud are exposed at low tide and the form the only intertidal flats occurring on the east coast of Norfolk. Large numbers of wildfo and waders are attracted to an abundant food supply when on passage and during the wint months. Several wintering wildfowl reach nationally important population levels and the si occupies a key position on the east coast for these species and for migrating birds. Rare speci are regularly recorded. There is also considerable botanical interest with small areas saltmarsh, reedbeds and brackish water communities in the surrounding borrow dykes. T invertebrate fauna is rich and includes one scarce species of snail.

The mudflats are characterised by growths of green algae [Enteromorpha sp. and Ulva sp and two uncommon species of Eel-grass [Zostera marina and Z. noltii]. These plants, togeth with an abundant invertebrate fauna, attract large numbers of ducks and waders to feed the estuary at the appropriate seasons. There are nationally important wintering flocks Wigeon [winter maximum 4,500 birds] and Shelduck [1,000] and an internationally importa flock of Bewick's Swans [120]. Other notable wintering wildfowl include Goldeney Red-breasted Merganser, Pintail, White-fronted Goose and Pink-footed Goose. Larg floc of waders are also present with a total winter maximum of 3-6,000 birds. The most numero species are Knot, Dunlin, Redshank and Ringed Plover. Several uncommon species are record with some regularity, the most noteworthy being Spoonbill, Avocet and Mediterranean Gul Breeding species include Little Grebe, Shelduck, Common Tern and Bearded Tit.

Small areas of saltmarsh occur at the lower end of the estuary. Glasswort [Salicornia sp is dominant on the lower marsh and this zone grades into midmarsh where typical species inclu Sea Lavender [Limonium vulgare], Sea Aster [Aster tripolium], Sea Purslane [Halimion portulacoides], Sea Plantain [Plantago maritima] and Sea Poa [Puccinellia maritima]. T saltmarsh is replaced by brackish reedswamp at the upper end of the estuary and there a extensive stands of Common Reed [Phragmites australis].

A flood-bank surrounds the estuary and behind this is a borrow dyke which contains distinctiv brackish water communities of plants and invertebrates. Marginal plants include Sea Club-rus [Scirpus maritimus] and Mud Rush [Juncus gerardi] while the dominant water plant is Spike Water-milfoil [Myriophyllum spicatum]. The maritime grassland on the edge of the estua includes the rare Bulbous Fox-tail [Alopecurus bulbosus].

The uncommon mollusc, Assiminea gravana has been recorded from the upper estuary.


NATURE CONSERVANCY COUNCIL
Site boundary thus
Scale 1:15000
0 Metres 600
0 Yards 600
Based on the Ordnance Survey 1:10000 map with the permission of the Controller of Her Majesty's Stationery Office. Crown Copyright reserved 1985/11
BURGH CP
Burgh St Margaret
Billockby
Filby Broad
Burgh Common
Thrigby
NORFOLK
43
44
45
46
12
11

File Ref: EA/N/19/14 WE

COUNTY: Norfolk

SITE NAME: BURGH COMMON AND MUCKFLEET MARSHES

DISTRICT: Great Yarmouth

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Broads Authority

National Grid Reference: TG 440117 Area: 118.0 [ha] 291.6

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TG 41 SW, TG 41 SE

Date Notified [Under 1949 Act]: 1959 Date of Last Revision: 1981

Date Notified [Under 1981 Act]: 1986 Date of Last Revision: -

Other Information:

The boundary has been amended by several minor deletions.

Description and Reasons for Notification:

Burgh Common and Muckfleet Marshes lie in a shallow valley at the western of Filby Broad and drain to the River Bure by way of the Muck Fleet. The s lies on fen peats and retains a high water-table throughout the year. Th is one of the most important unreclaimed wetlands in Broadland and larg are still managed by traditional grazing and mowing regimes. A wide ra habitats is present, the most important being the fen meadows, tall fen vege and the drainage dykes. These are floristically-rich and contain an assem of rare plants. The site has, in addition, an entomological and ornithologi interest.

Marshy grassland, dominated by Blunt-flowered Rush [Juncus subnodulosus] Creeping Bent [Agrostis stolonifera], covers a large part of the site. The major of the area is grazed by horses and cattle but some parts are mown and a dive flora has been retained by this traditional management. Species present incl Yellow Iris [Iris pseudacorus], Marsh Pennywort [Hydrocotyle vulgaris], Grea Tussock Sedge [Carex paniculata], and the locally rare Pugsley's Mars Orc [Dactylorhiza traunsteineri] and Marsh Fern [Thelypteris thelypteroides]. Hig ground is present along the northern edge of the site and here there is a gradat to unimproved neutral grassland.

A tall fen community has developed on wetter, low-lying ground where the l slopes to the Muck Fleet. This habitat is dominated by Common Reed [Phragmi australis], Reed Sweet-grass [Glyceria maxima] and Saw Sedge [Cladium mariscu Other species present include Purple Small-reed [Calamagrostis canescens], Angel [Angelica sylvestris] and the uncommon Marsh Pea [Lathyrus palustris], Ma Sow-thistle [Sonchus palustris] and Milk Parsley [Peucedanum palustre].

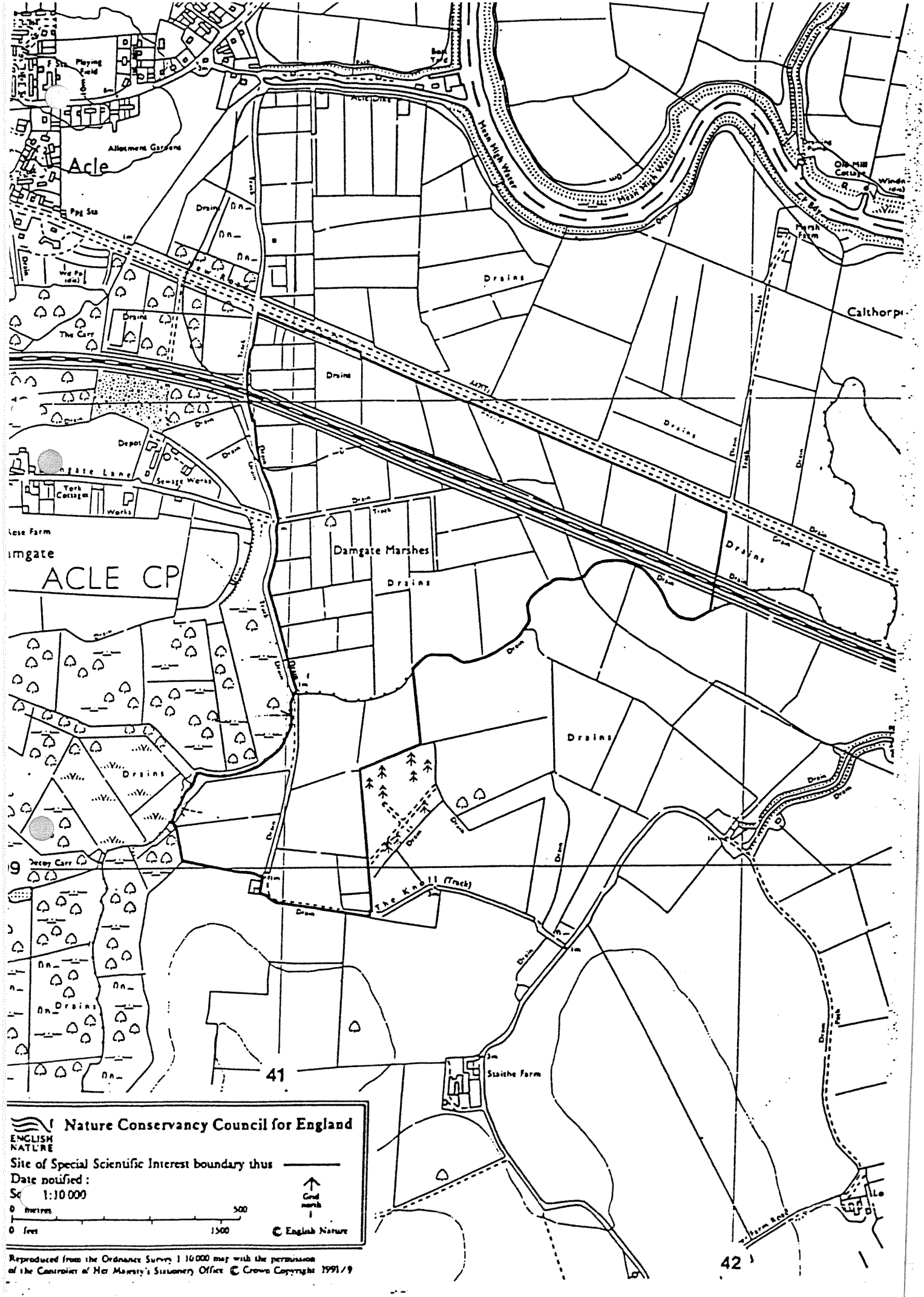
The drainage dykes on the grazing marshes contain clear waters and support a wi range of aquatic plants and invertebrates. The rare Water Soldier [Stratio aloides] is dominant in most of the dykes with frequent Spiked Water-milf [Myriophyllum spicatum], Frogbit [Hydrocharis morsus-ranae], Water Violet [Hottor palustris], Opposite-leaved Pondweed [Groenlandia densa], Stoneworts [Chara spp and the uncommon Fen Pondweed [Potamogeton coloratus].

continued....

The invertebrate fauna includes several rare species, including the Norfolk Aeshna dragonfly [Aeshna isoceles], Swallowtail [Papilio machaon], and a freshwater snail, [Anisus vorticulus].

Mixed scrub on fen peats has developed where the tall fen vegetation is no longer cut. Grey Sallow [Salix cinerea] and Alder [Alnus glutinosa] are frequent and the ground flora includes Meadowsweet [Filipendula ulmaria], Bittersweet [Solanum dulcamara] and Royal Fern [Osmunda regalis].

A wide range of marshland breeding birds is present including Reed Warbler, Grasshopper Warbler and the rare Cetti's Warbler.



File Ref: EA/N/356/14 PA2

COUNTY: NORFOLK

SITE NAME: DAMGATE MARSHES, ACLE

DISTRICT: BROADLAND

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: BROADLAND DISTRICT COUNCIL

National Grid Reference: TG 413 097 Area: 63.9(ha) 157.7(ac)

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TG 41 SW, TG 40 NW

Date Notified (Under 1949 Act): Date of Last Revision:

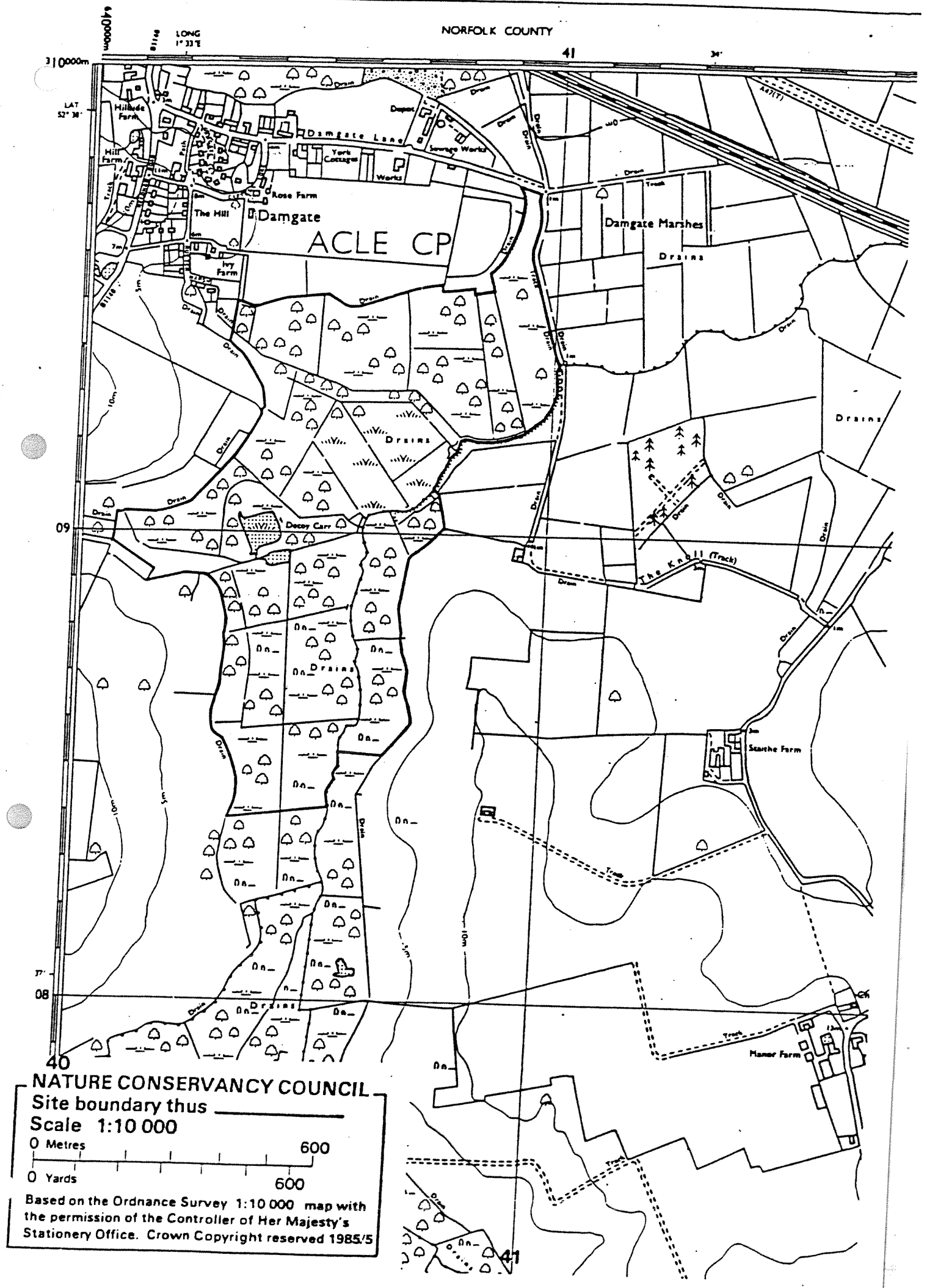
Date Notified (Under 1981 Act): 1993 Date of Last Revision:

Other Information:

Description and Reasons for Notification

These grass marshes south of the River Bure (and east of Acle) are one of the richest areas of traditionally managed grazing marsh and dykes now remaining in Broadland and are a nationally important wetland site. They lie on fen peats and alluvial clays and are summer-grazed by cattle and cut for hay. Their nature conservation importance is concentrated principally on the aquatic flora and fauna of the dykes which support a wide range of water plants, including several uncommon species in the relatively nutrient-poor waters. There is a great diversity of aquatic invertebrates including several species of dragonflies.

Many of the ditches along the peaty margin contain a community typified by Broad-leaved Pondweed Potamogeton natans, Water-violet Hottonia palustris and the nationally scarce Whorl Water-milfoil Myriophyllum verticillatum. The nationally scarce Fen Pondweed Potamogeton coloratus and Flat-stalked Pondweed Potamogeton friesii are also well represented within these peaty ditches. Away from the margins, on the clay soils, the ditches tend to be dominated by the nationally scarce Water Solider Stratiotes aloides.



NATURE CONSERVANCY COUNCIL

Site boundary thus

Scale 1:10 000

0 Metres 600

0 Yards 600

File Ref: EA/N/30/14 WEM

COUNTY: Norfolk

SITE NAME: DECOY CARR, ACLE

DISTRICT: Broadland

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Broads Authority

National Grid Reference: TG 405090 Area: 55.36 [ha] 136.79 [ac

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TG 40 NW

Date Notified [Under 1949 Act]: 1959 Date of Last Revision: -

Date N[illegible] [Under 1981 Act]: 1985 Date of Last Revision: -

Other Information:

Reasons for Notification:

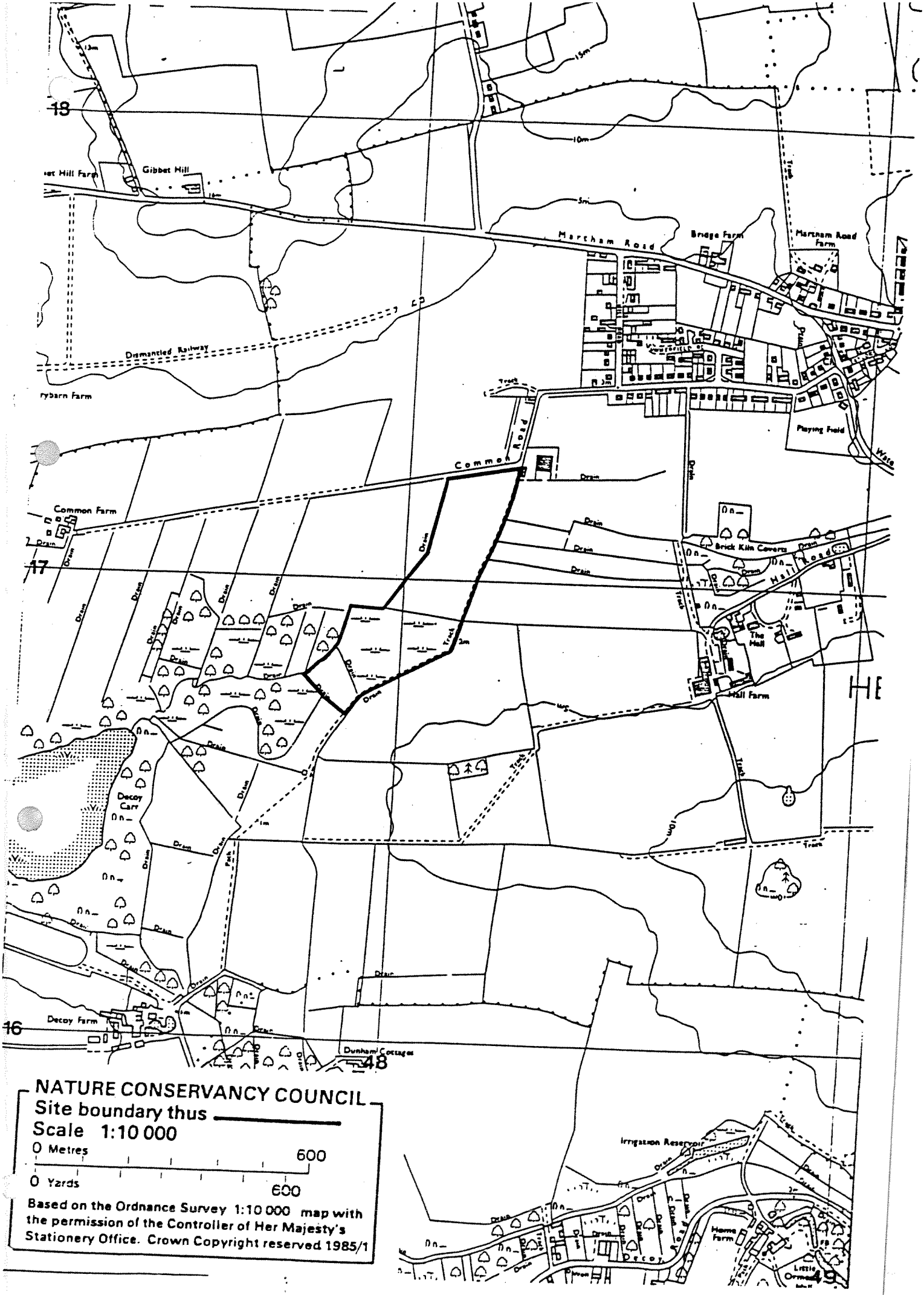
A large area of wet carr woodland and open fen occupying a side-valley of the River Bur immediately to the south of Acle. The site which is spring-fed and isolated from the mai Broadland river system supports excellent examples of the wetland communities characteristi of the region including alder carr, reedbed, mixed fen and open water habitats. Several rar Arctic-alpine mosses have been recorded which indicate that the plant communities hav remained relatively undisturbed since post-glacial times. The sedge and reedbeds are stil regularly cut for thatching material and the site supports a wide range of fenland plants including several locally uncommon species.

Open areas of mixed fen vegetation are dominated by Saw Sedge [Cladium mariscus] an Blunt-flowered Rush [Juncus subnodulosus]. The more extensive areas are cut and a diverse fen community has developed with Marsh Pennywort [Hydrocotyle vulgaris], Water Mint [Menth aquatica], Panicled Sedge [Carex paniculata] and the locally uncommon Marsh Fern [Thelypteri thelypteroides]. Commercially managed reedbeds are also present and are dominated b Common Reed [Phragmites australis]. These areas are naturally rather species-poor but includ the scarce Marsh Sow-thistle [Sonchus palustris].

The majority of the woodland is sump alder carr on fen peats. Alder [Alnus glutinosa] i dominant with frequent Common Sallow [Salix cinerea] and Ash [Fraxinus excelsior]. The groun flora is well-developed and includes Lesser Pond Sedge [Carex acutiformis], Yellow Iris [Iri pseudacorus], Bittersweet [Solanum dulcamara] Redcurrant [Ribes rubrum agg.] and Mars Fern. Small areas of acid valley alder woodland occur on higher ground where sandy soil underlie a thin layer of peat. Pedunculate Oak [Quercus robur] and Birch [Betula pubescens are frequent and the ground flora contains much Bracken [Pteridium aquilinum].

A network of dykes drains the wet areas and they contain clear springwaters. A wide rang of water plants is present including Water Violet [Hottonia palustris], Greater Bladderwor [Utricularia vulgaris agg.], Frogbit [Hydrocharis morsus-ranae], Shining Pondweed [Potamogeto lucens] and the locally uncommon Water Soldier [Stratiotes aloides]. Hornwort [Ceratophyllur demersum] is abundant in the old decoy pond.

The rare mosses Cinclidium stygium and Camptothecium nitens have been recorded on th site.



NATURE CONSERVANCY COUNCIL

Site boundary thus

Scale 1:10 000

0 Metres 600

0 Yards 600

File Ref: EA/N/257/14 WQA

COUNTY: Norfolk

SITE NAME: HALL FARM FEN, HEMSBY

DISTRICT: Great Yarmouth

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Part Great Yarmouth Borough Council, part Broads Author

National Grid Reference: TG 481170 Area: 9.0 [ha] 22.2

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TG 41 NE

Date Notified [Under 1949 Act]: N/A Date of Last Revision: N/A

Date Notified [Under 1981 Act]: 1986 Date of Last Revision: -

Other Information:

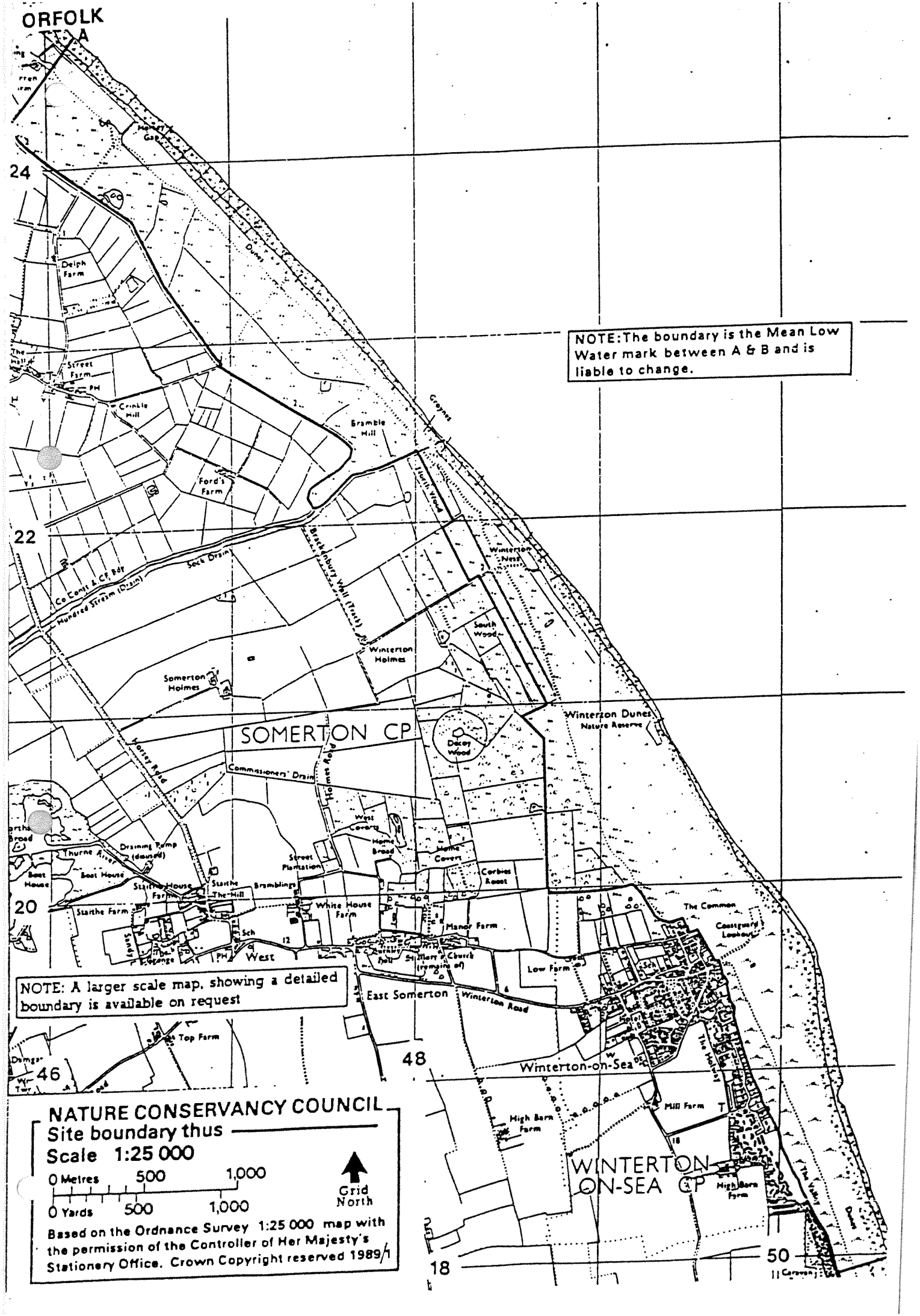
A new site.

Description and Reasons for Notification:

Hall Farm Fen, Hemsby, lies to the north-east of Ormesby Broad and consists of an area o unimproved fen grassland with dykes. It is unusual in supporting plant communities favourin both acidic and calcareous conditions and is consequently very rich in species, including great abundance of orchids with some unusual hybrids. The site is bisected by numerous dyke and these support a well developed aquatic flora and fauna, including a nationally rare specie of water snail.

Wet unimproved grassland, grazed by cattle and horses, covers much of the site Blunt-flowered Rush [Juncus subnodulosus] and Jointed Rush [J articulatus] are abundan with frequent Bogbean [Menyanthes trifoliata] and Marsh Cinquefoil [Potentilla palustris Several uncommon species are present including Bog Pimpernel [Anagallis tenella], Mars Arrow-grass [Triglochin palustris], Marsh Lousewort [Pedicularis palustris], Comm Cotton-grass [Eriophorum angustifolium], Creeping Willow [Salix repens]. Purple Moor-gras [Molinia caerulea] and Heath Grass [Danthonia decumbens] are locally developed. There a good variety of sedges present including Star Sedge, Spring Sedge, Flea Sedge and Ova Sedge. The orchids are mainly Southern Marsh [Dactylorhiza praetermissa], Early Mars [D. incarnata] and Heath Spotted Orchid [D. maculata] with their hybrids. A short swar vegetation indicative of rather drier chalkier soils is present in places characterised by Commo Quaking Grass [Briza media], Sweet Vernal-grass [Anthoxanthum odoratum], Yellow Ratt [Rhinanthus minor], Hairy Sedge [Carex hirta] and Devil's-bit Scabious [Succisa pratensis Narrow strips of disturbed dry grassland are present near some boundaries where dyke dredging have been placed.

The dykes are also an important feature of the site. Canadian Pondweed [Elodea canadensis and Broad-leaved Pondweed [Potamogeton natans] form the principal aquatics, with Wate Violet [Hottonia palustris], Opposite-leaved Pondweed [Groenlandia densa], Frogbit [Hydrochar morsus-ranae], Flat-stalked Pondweed [P. friesii] and Stoneworts [Chara spp]. Emerger and bank-edge species include Water Dropwort [Oenanthe fistulosa], Cyperus Sedge [Care pseudocyperus], Bottle Sedge [Carex rostrata], Fool's Watercress [Apium nodiflorum] an Water Plantain [Alisma plantago-aquatica]. The dyke also supports a rich invertebrate faun which includes the rare mollusc [Segmentina nitida].


ORFOLK
24
22
20
46
48
18
50
NOTE: The boundary is the Mean Low Water mark between A & B and is liable to change.
NOTE: A larger scale map, showing a detailed boundary is available on request
SOMERTON CP
WINTERTON-ON-SEA CP
Delph Farm
Street Farm
Crinkle Hill
Bramble Hill
Ford's Farm
Groynes
Dunes
Winterton Ness
South Wood
Winterton Holmes
Somerton Holmes
Winterton Dunes Nature Reserve
Decoy Wood
Sock Drain
Hundred Stream (Drain)
Co Const & CP Bdy
Commissioners' Drain
Holmes Road
Yarmer Road
Thurne River
Boat House
Drainage Pump (disused)
Stathe House Farm
Stathe Farm
The Hill
Brambles
White House Farm
Street Plantation
West Carr
Home Broad
Home Covert
Corbies Roost
Manor Farm
The Common
Cassegrain's Lookout
West
Church (remains of)
East Somerton
Winterton Road
Low Farm
Top Farm
Winterton-on-Sea
High Barn Farm
Mill Farm
NATURE CONSERVANCY COUNCIL
Site boundary thus
Scale 1:25 000
0 Metres 500 1,000
0 Yards 500 1,000
Grid North
Based on the Ordnance Survey 1:25 000 map with the permission of the Controller of Her Majesty's Stationery Office. Crown Copyright reserved 1989/1

File Ref: EA/N/308/14 OJE

COUNTY: Norfolk

SITE NAME: WINTERTON-HORSEY DUNES

DISTRICT: North Norfolk, Great Yarmouth

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: North Norfolk District Council, Gt Yarmouth Borough

National Grid Reference: TG 490210 Area: 427.2 [ha] 1055.6

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TG 41 NE, TG 51 NW TG 42 SW

Date Notified [Under 1949 Act]: 1954 Date of Last Revision: -

Date Notified [Under 1981 Act]: 1989 Date of Last Revision: -

Other Information:
This is a composite site made up of the NNR at Winterton Dunes and the for separate SSSIs at Horsey Warren, Winterton Dunes and Winterton Great Valley. whole area is a Grade 1 NCR site.

Description and Reasons for Notification:

This site consists of an extensive dune system situated on the east coast of Norf between Hemsby and Horsey. The site is unusual in that it shows greater ecologic similarities to the dune system of the west coast, supporting acidic pl communities, than the geographically closer dunes within the North Norfolk Co SSSI, where the sand is calcareous. The site supports well developed areas dune heath, 'slacks' and dune grassland verging into grazing marsh and bi woodland. A wide range of both breeding and overwintering birds occur, includi Little Terns on the foreshore, while the areas of scrub attract passage migrant A rare amphibian breeds in shallow pools behind the main dune ridge, and the si is the only Norfolk locality for a rare butterfly. Part of the site embrac an earlier coastline and this feature together with the dunes which have develo in front of it are of outstanding physiographical interest.

The seaward edge of the dunes is well vegetated with Marram Grass (Ammoph arenaria) and Lyme-grass (Leymus arenarius). The older, grey dunes s port more diverse flora with frequent Sand Sedge (Carex arenaria) Sheep's Fescue (Fest ovina), Common Polypody (Polypodium vulgare) and Narrow Buckler-fern (Dryopte carthusiana). Three rare grasses are present in abundance, Grey Hair-gr (Corynephorus canescens), Rush-leaved Fescue (Festuca juncifolia) and Purple Mar (x Ammocalamagrostis baltica). A notable assemblage of the bryophytes and lich occur on these acidic dunes. Dune heath has developed on the landward side w Heather (Calluna vulgaris), Bell Heather (Erica cinerea), Cross-leaved Heath (Er tetralix) and Bog Moss (Sphagnum spp) in the damper hollows. The dune sla contain an interesting plant community that includes Common Sedge (Carex nigr Soft Rush (Juncus effusus), Cross-leaved Heath and Creeping Willow (Salix repen The rare Round-leaved Wintergreen (Pyrola rotundifolia) has also been recor from the slacks.

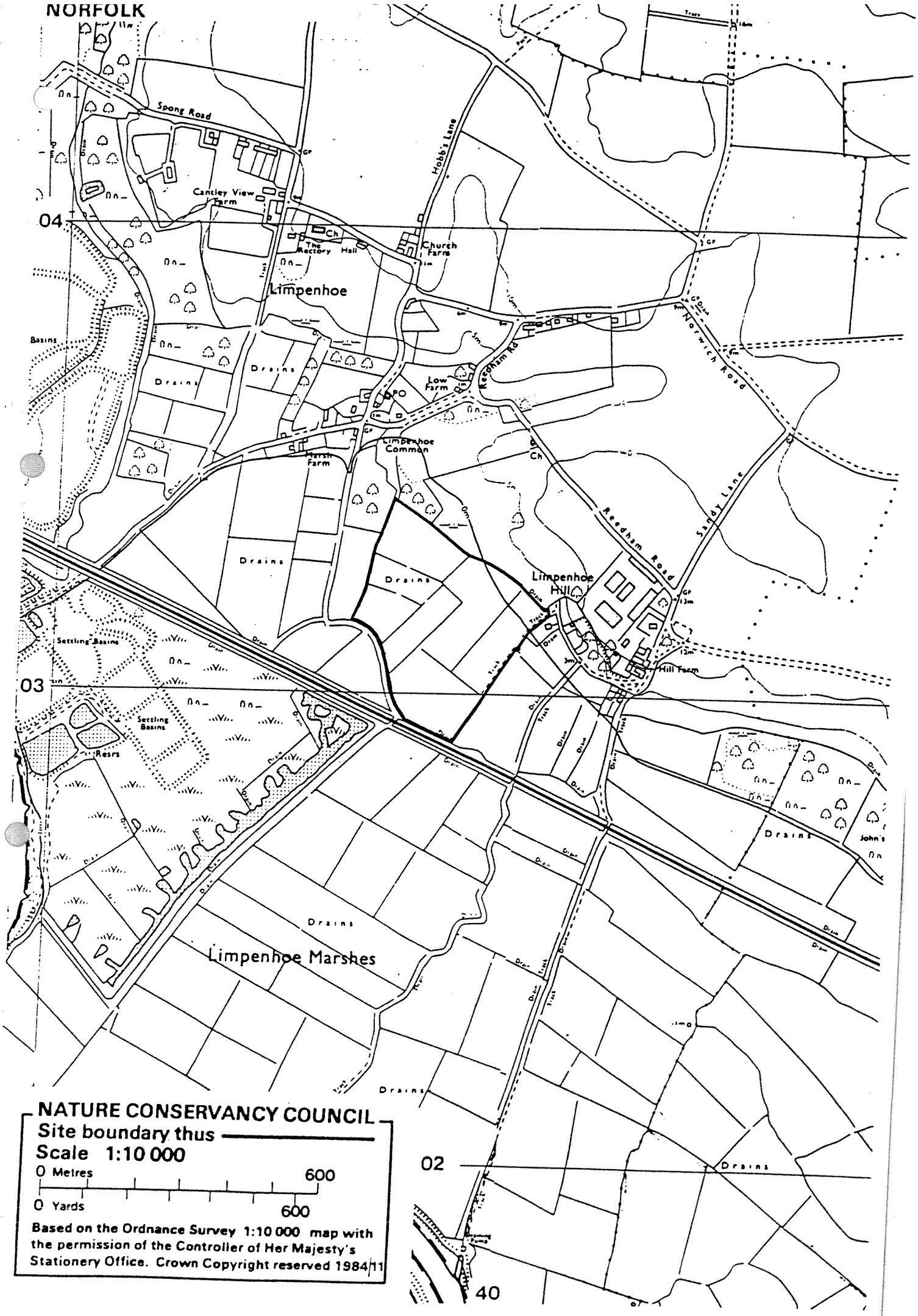
Damp, fern rich meadows form a large area of rough, tussocky grassland beh the main dunes. Sand Sedge is dominant with abundant Purple Marram and Nar Buckler-fern, Broad Buckler-fern (Dryopteris dilatata), Common Polypody, Ro Fern (Osmunda regalis) and the nationally rare Crested Buckler-fern (Dryopte cristata). Other species include Soft Rush, Compact Rush (Juncus conglom atu

Tormentil (Potentilla erecta), Heath-grass (Danthonia decumbens) and Honeysuckle (Lonicera periclymenum). Marshy areas in damp hollows have a distinctive flora with Marsh Pennywort (Hydrocotyle vulgaris), Ragged Robin (Lychnis flos-cuculi), Southern Marsh Orchid (Dactylorhiza praetermissa) and Adder's-tongue (Ophioglossum vulgatum). There are smaller areas dominated by Purple Moor-grass (Molinia caerulea) which locally occurs as a virtually pure, ungrazed sward.

The grassland communities grade into stunted birch woodland. Downy Birch (Betula pubescens) is dominant with some Pedunculate Oak (Quercus robur) and invasive Rhododendron (Rhododendron ponticum). The ground flora is dominated by Bramble (Rubus fruticosus agg), Honeysuckle and Broad Buckler-fern with Sphagnum abundant in wetter areas.

Small populations of Ringed Plover and the uncommon Little Tern nest on the beach. The areas of heath, grassland and scrub are notable for breeding Nightjar, Grasshopper Warbler, Corn Bunting and the locally scarce Stonechat. Raptors frequently hunt over the dunes in the winter months and Hen Harrier, Sparrowhawk, Barn Owl and Rough-legged Buzzard are all regularly recorded.

The site is also of physiographic significance in being one of a number of 'ness' features which are characteristic of the East Anglian coast. It is significant both for the well-formed dunes which are its most characteristic landform, and the processes which affect its continuing development. At Winterton there appears to be a slight sediment budget surplus and some growth in the volume of sediment retained within the 'ness'. There is both erosion and deposition within the site and an important aspect of the interest is the dynamism of the features present.



NATURE CONSERVANCY COUNCIL

Site boundary thus

Scale 1:10 000

0 Metres 600

0 Yards 600

File Ref: EA/N/248/14 WDN

COUNTY: Norfolk SITE NAME: LIMPENHOE MEADOWS

DISTRICT: Broadland

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Broads Authority

National Grid Reference: TG 399031 Area: 11.6 [ha] 28.7 [

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TG 30 SE TG 40 SW

Date Notified [Under 1949 Act]: N/A Date of Last Revision: N/A

Date Notified [Under 1981 Act]: 1985 Date of Last Revision: -

Other Information:

A new site.

Reasons for Notification:

Limpenhoe Meadows are situated in the Lower Yare valley and form a large and particularly fine example of unimproved fen grassland with dykes. The underlying soils change from deep poorly-drained fenland peats at the upland edge to alluvial clays in the valley bottom. Springs emerge from the peats in places and an unusual sequence of communities occur around flushed areas which are not found elsewhere in the Yare valley. Many uncommon plants are present in the species-rich meadows and the site forms an interesting contrast to the more calcareous conditions found on the nearby Poplar Farm Meadows, Langley SSSI.

Unimproved mixed fen grassland, maintained by summer grazing, occurs on the fenland peats and this community is dominated by a mosaic of Jointed Rush [Juncus articulatus] and Blunt-flowered Rush [Juncus subnodulosus]. This fen grassland community is exceptionally diverse with frequent Common Quaking Grass [Briza media], Lesser Spearwort [Ranunculus flammula], Ragged Robin [Lychnis flos-cuculi], Marsh Arrow-grass [Triglochin palustris] and Yellow Rattle [Rhinanthus minor]. Several uncommon species are also present, notably Bog Pimpernel [Anagallis tenella], Marsh Lousewort [Pedicularis palustris], Fragrant Orchid [Gymnadenia conopsea], Marsh Helleborine [Epipactis palustris], Southern Marsh Orchid [Dactylorhiza praetermissa] and Marsh Fern [Thelypteris thelypteroides].

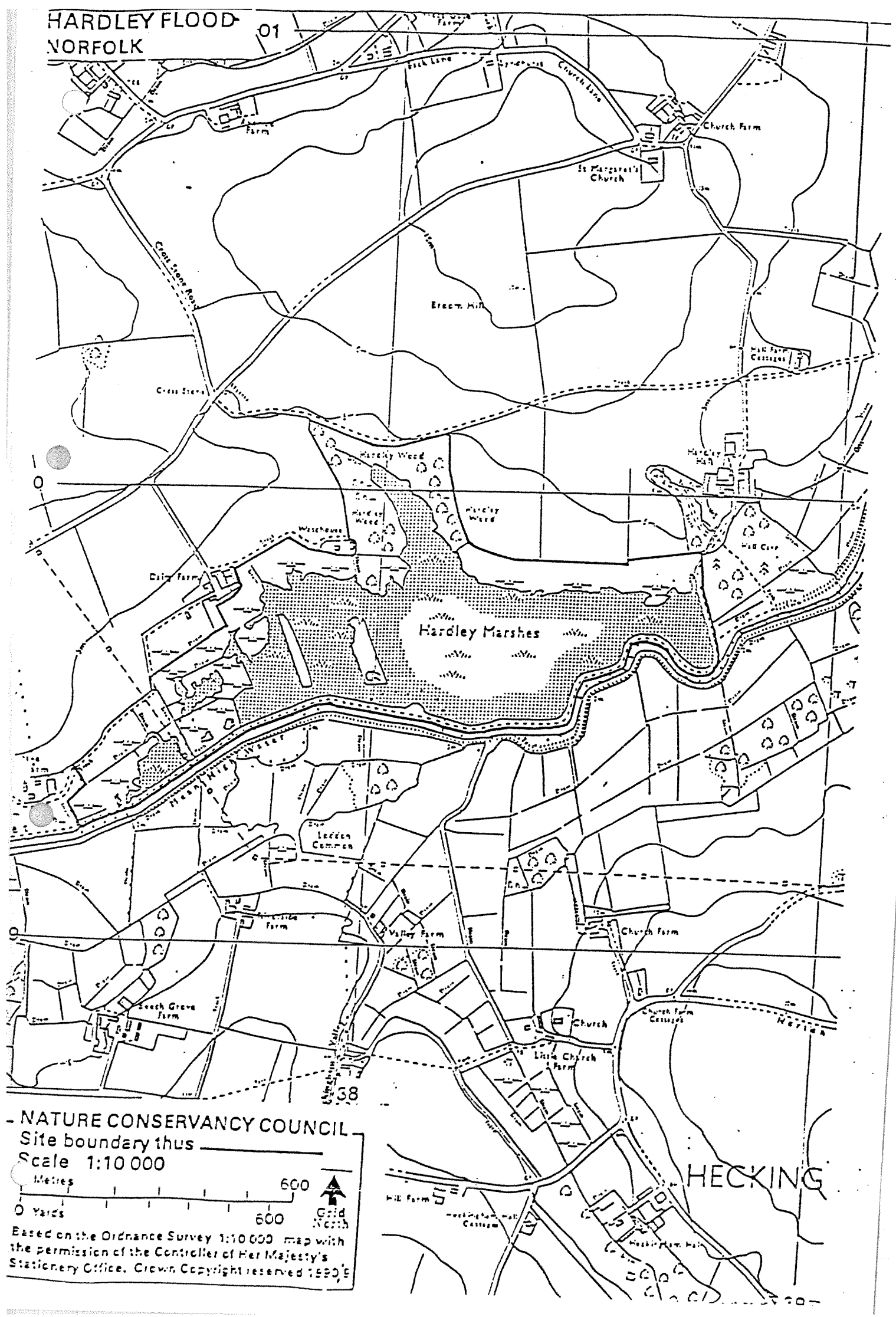
Springs emerge within the meadows close to the base of the valley slope. These wet boggy conditions are very localised and quickly grade into drier areas. The spring flushes are dominated by Bog Mosses [Sphagnum spp.] with Sundew [Drosera rotundifolia], a locally uncommon species, being frequent. Other notable species associated with the Sphagnum areas are Grass of Parnassus [Parnassia palustris], Marsh Helleborine, Creeping Willow [Salix repens], Bog Pimpernel, Cotton Grass [Eriophorum sp.] and Heath Lousewort [Pedicularis sylvatica].

A drier variant of fen grassland occurs on the highest ground and is dominated by Purple Moor-grass [Molinia caerulea] with an abundance of low-growing sedges including Star Sedge [Carex echinata], Carnation Sedge [C panicea] and Flea Sedge [C pulicaris]. Several species associated with more acidic conditions are present including Heath Grass [Danthonia decumbens], Eyebright [Euphrasia officinalis], Tormentil [Potentilla erecta], Creeping Willow, Devil's-bit Scabious [Succisa pratensis] and Many-headed Woodrush [Luzula multiflora].

Continued.....

The remainder of the site is mostly unimproved or semi-improved wet neutral grassland. Yorkshire Fog [Holcus lanatus] is generally co-dominant with Soft Rush [Juncus effusus] and there is a less well developed flora including Water Mint [Mentha aquatica], Greater Bird'sfoot Trefoil [Lotus uliginosus] and Reed-grass [Glyceria maxima]. The grassland on the alluvial clays has been partly improved but wet hollows are dominated by Marsh Foxtail [Alopecurus geniculatus] and Flote-grass [Glyceria fluitans] with Silverweed [Potentilla anserina] and Red Shank [Polygonum persicaria].

A network of dykes drains the site, supporting a good range of emergent and aquatic plants including a nationally rare species of pondweed [Potamogeton acutifolius] and the local species, Water Soldier [Stratiotes aloides].


HARDLEY FLOOD
NORFOLK
Hardley Marshes
HECKING
NATURE CONSERVANCY COUNCIL
Site boundary thus
Scale 1:10 000
Metres
600
0 Yards
600
Grid North
Based on the Ordnance Survey 1:10 000 map with the permission of the Controller of Her Majesty's Stationery Office. Crown Copyright reserved 1990/5

Citation Sheet

COUNTY: Norfolk

SITE NAME: HARDLEY FLOOD

DISTRICT: South Norfolk

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981.

Local Planning Authority: South Norfolk District Council

National Grid Reference: TM 380997

Area: 48.1 (ha) 118.8 (ac)

Ordnance Survey Sheet 1:50,000: 134

1:10,000: TM 39 NE, TG 30 SE

Date Notified (under 1949 Act): N/A

Date of last revision: -

Date Notified (under 1981 Act): 1990

Date of last revision: -

Other Information:

A new site. Part managed as a nature reserve by the Norfolk Naturalists' Trust

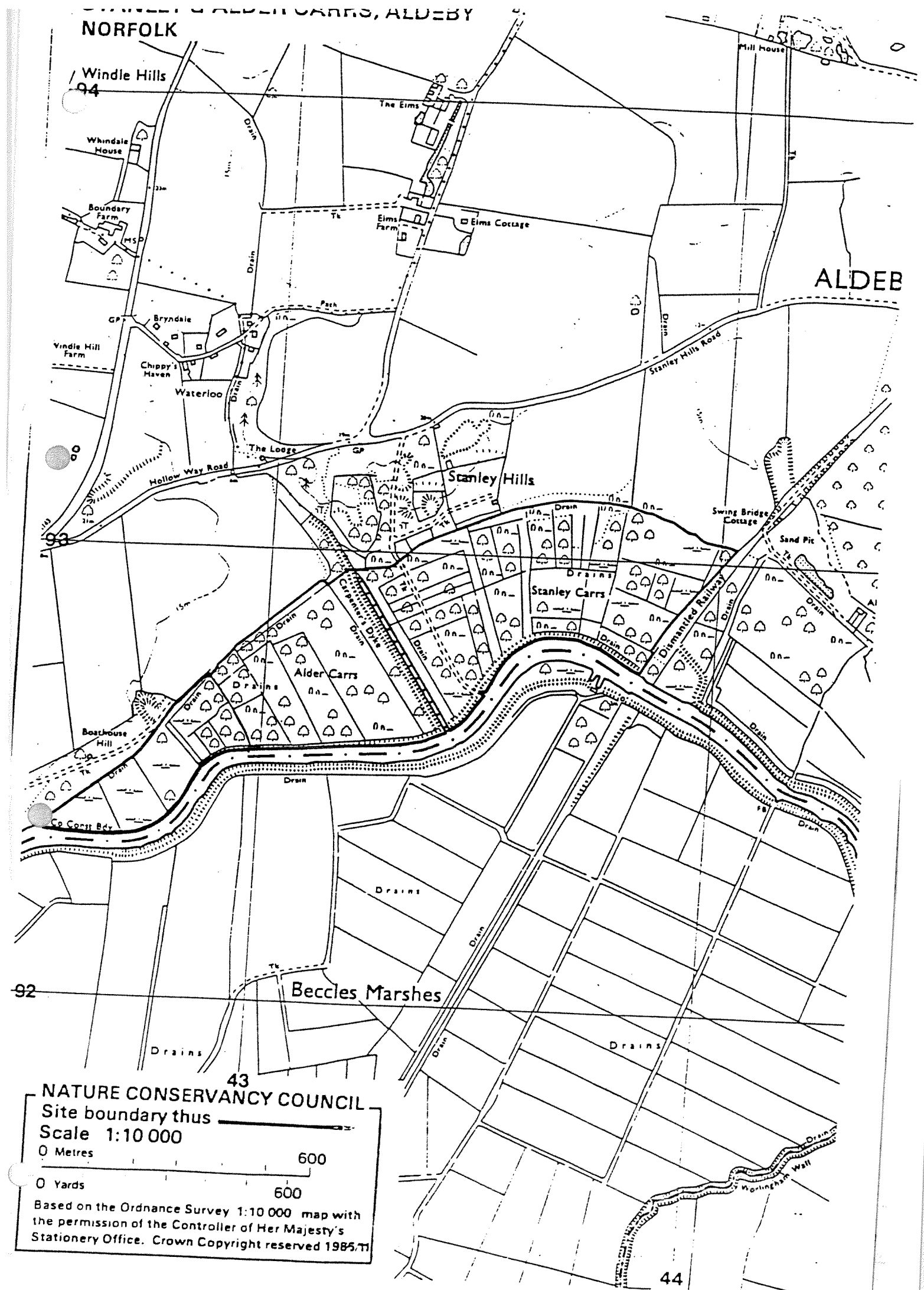
Description and Reasons for Notification:

Hardley Flood is an area of shallow lagoons and reedbeds that act as a spillway for the River Chet. Breaches in the river-bank allow tidal waters to move freely between the river and the marsh. Soft muds are exposed at low tide and these attract a range of wading birds in spring and autumn while the undisturbed reedbeds support nesting wildfowl and other fenland birds, including nationally important breeding populations of Shoveler, Pochard and Gadwall.

The tidal lagoons are shallow and because of fluctuating levels do not contain any water-plants. Swamp vegetation surrounds the lagoons, dominated by dense strands of Common Reed (Phragmites australis) with some Reed Sweet-grass (Glyceria maxima) and Great Reedmace (Typha latifolia). Tall fen vegetation occurs on drier ground and this too is dominated by Common Reed with a variety of fen species present including Greater Tussock Sedge (Carex paniculata), Purple Small-reed (Calamagrostis canescens), Angelica (Angelica sylvestris) and Marsh Thistle (Cirsium palustre). The locally uncommon Marsh Sow-thistle (Sonchus palustris) is frequent by the river-bank. The site also includes areas of Alder carr woodland, broad-leaved plantation and grassland.

Many species of duck nest in the reedbeds including Mallard, Teal, Gadwall, Shoveler, Tufted Duck, Pochard and Shelduck. Shoveler, Pochard and Gadwall are of national importance with 1% or over of the British population nesting on the site. Other breeding birds include Common Tern, Grasshopper Warbler and Reed Warbler, with Cetti's Warbler also known to nest on occasion. Many birds are attracted to the site in the winter months and Hen Harrier, Bittern, Jack Snipe, Water Rail and Bearded Tit are regular visitors. Small flocks of Bean Geese and White-fronted Geese have wintered on the flood in recent years.

Three rare flies have been recorded (Elachiptera uniseta, E. scrobiculata and Lonchoptera scutellata) and these insects are associated with tussocks of the Greater Tussock Sedge. Otters occasionally visit.



NATURE CONSERVANCY COUNCIL

Site boundary thus

Scale 1:10 000

0 Metres 600

0 Yards 600

File Ref: EA/N/89/14 WHD

COUNTY: Norfolk

SITE NAME: STANLEY AND ALDER CARR ALDEBY

DISTRICT: South Norfolk

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Broads Authority

National Grid Reference: TM 434928 Area: 43.5 [ha] 107.4 [

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TM 49 SW

Date Notified [Under 1949 Act]: 1973 Date of Last Revision: -

Date Notified [Under 1981 Act]: 1986 Date of Last Revision: -

Other Information:

Part of the site is managed as a nature reserve by the Otter Trust.

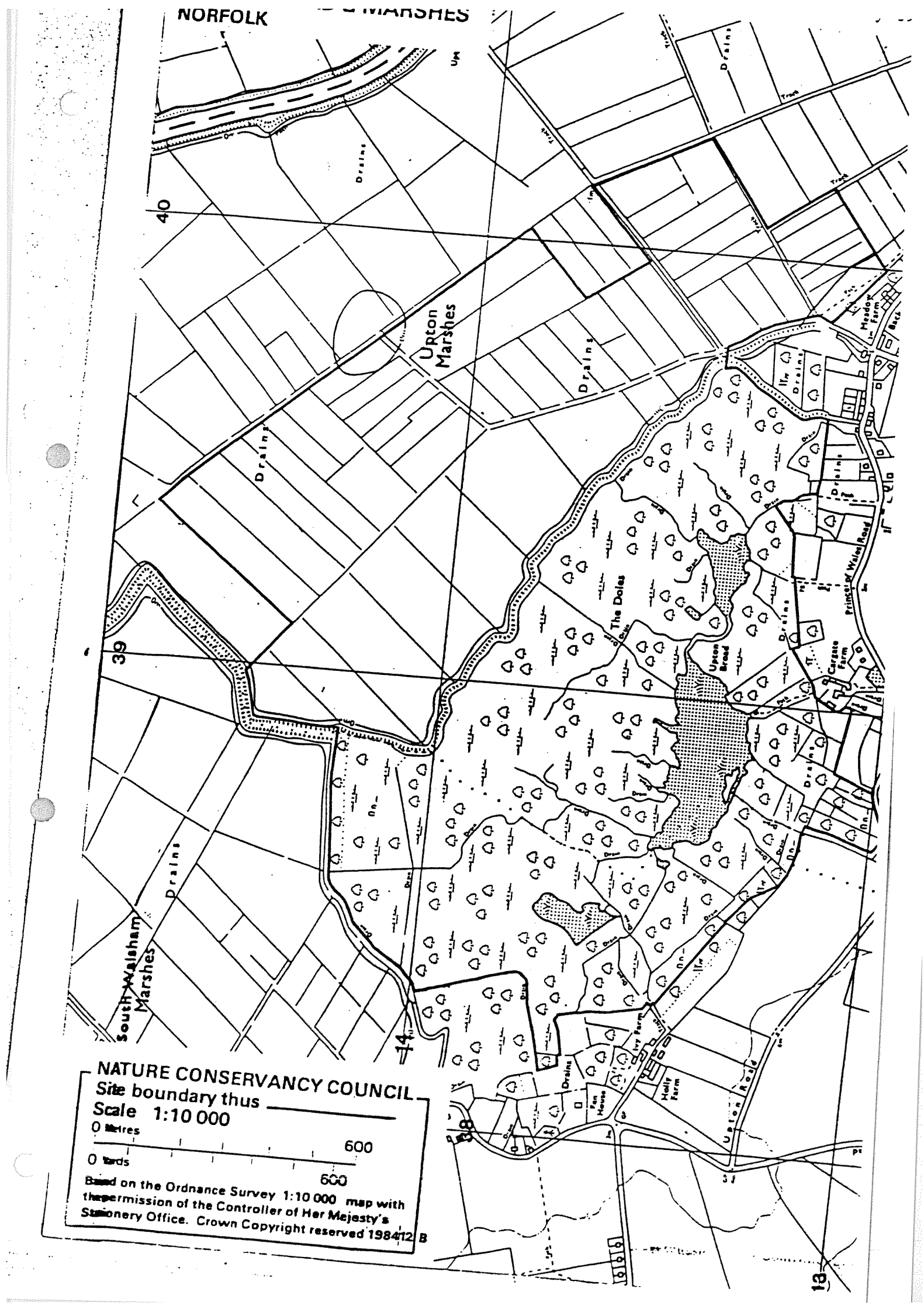
Description and Reasons for Notification:

Stanley and Alder Carrs lie adjacent to the River Waveney and form the only extensive area of regularly flooded alder carr woodland and fen in the Waveney Valley, the whole site acting as a "wash" at times of high river flows. The site supports a variety of plants characteristic of Broadland. Part has been set aside as a conservation area for otters.

The majority of the site is very wet, semi-mature carr woodland dominated by Alder [Alnus glutinosa] with White Willow [Salix alba], Sallow [Salix cinerea] and some Ash. The ground flora is well-developed, dominated by nettle, with locally plentiful Meadowsweet [Filipendula ulmaria], Yellow Iris [Iris pseudacorus], Marsh Marigold [Caltha palustris], Tufted Sedge [Carex elata] and Lesser Pond Sedge [Carex acutiformis]. Wild Hop [Humulus lupulus] forms a straggling liane and tussocks of the Greater Tussock Sedge [C. paniculata] occur locally.

Areas of open fen support a mixed vegetation of tall herbs and grasses. The dominant species is Reed [Phragmites australis] with Reed Canary Grass [Phalaris arundinacea], Hemp Agrimony [Eupatorium cannabinum], Purple Loosestrife [Lythrum salicaria], Water Figwort [Scrophularia auriculata], Gipsywort [Lycopus europaeus] and Water Mint [Mentha aquatica]. The uncommon Gold Dock [Rumex maritimus] also occurs.

The insect fauna is rich in species and the bird breeding community includes a regionally uncommon species.



NATURE CONSERVANCY COUNCIL

Site boundary thus

Scale 1:10 000

0 Metres 600

0 Yards 600

Based on the Ordnance Survey 1:10 000 map with the permission of the Controller of Her Majesty's Stationery Office. Crown Copyright reserved 198412 B

File Ref: EA/N/101/14 WHS

COUNTY: Norfolk - SITE NAME: UPTON BROAD AND MARS

DISTRICT: Broadland

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Broads Authority

National Grid Reference: TG 390137 Area: 194.0 [ha] 479.3

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TG 31 SE, TG 41 SW

Date Notified [Under 1949 Act]: 1959 Date of Last Revision: 1980

Date Notified [Under 1981 Act]: 1986 Date of Last Revision: -

Other Information:

Whole site is NCR Grade 1. Part is owned and managed as a nature reserve by Norfolk Naturalists' Trust.

Reasons for Notification:

This site which lies in the middle Bure Valley forms an outstanding example of unreclaimed wetland and grazing marsh. Because of its isolated position and freedom from direct riverine influences the complementary habitats of open water, fen, carr woodland and marsh dyke represent a unique example of a condition that was once common before the effects of nutrient enrichment, recreational over-use and agricultural improvement became widespread in Broadland. The Broad is now one of only four broads that retain clear water and abundant water plants, while the surrounding fens, carr woodlands and marsh dykes support an exceptional variety of plants and animals, including many rare species.

The clear waters of Upton Broad, derived from springs bearing groundwater from the adjacent uplands, are base-rich, slightly brackish and with relatively low levels of available nutrients, support a range of water-plants including an abundance of the nationally rare Holly-leaved Naiad [Najas marina] which is better developed here than any other site in the country. Stoneworts [Chara spp.] are present with small quantities of Fennel-leaved Pondweed [Potamogeton pectinatus], White and Yellow Water Lilies [Nymphaea alba and Nuphar lutea] and the nationally scarce Grass-wrack Pondweed [P. compressus]. Little Broad, an arm of the main water body, supports an abundance of Flat-stalked Pondweed [P. friesii].

The invertebrate fauna of the Broad is rich in species and includes eighteen species of freshwater snail including Viviparus contectus and Valvata macrostoma which are both of restricted distribution.

Surrounding the Broad is swamp vegetation which is unusual for the prominence of Saw Sedge [Cladium mariscus], in having both species of Reedmace [Typha latifolia and T angustifolia] and large amounts of Bulrush [Schoenoplectus lacustris]. Reed [Phragmites australis] is plentiful throughout the swamp and the Greater Tussock Sedge [Carex paniculata] has developed locally.

Sedge-rich and mixed herbaceous fen vegetation has developed on the peat soils, with Saw Sedge dominant or co-dominant with Reed or Bog-rush [Schoenus nigricans]. Past peat cutting has created variations in the depth and thus wetness of the peat which is reflected in the species composition of the vegetation. In depressions, species such as Greater Spearwort [Ranunculus lingua], the nationally scarce Milk Parsley [Peucedanum palustre],

Continued.....

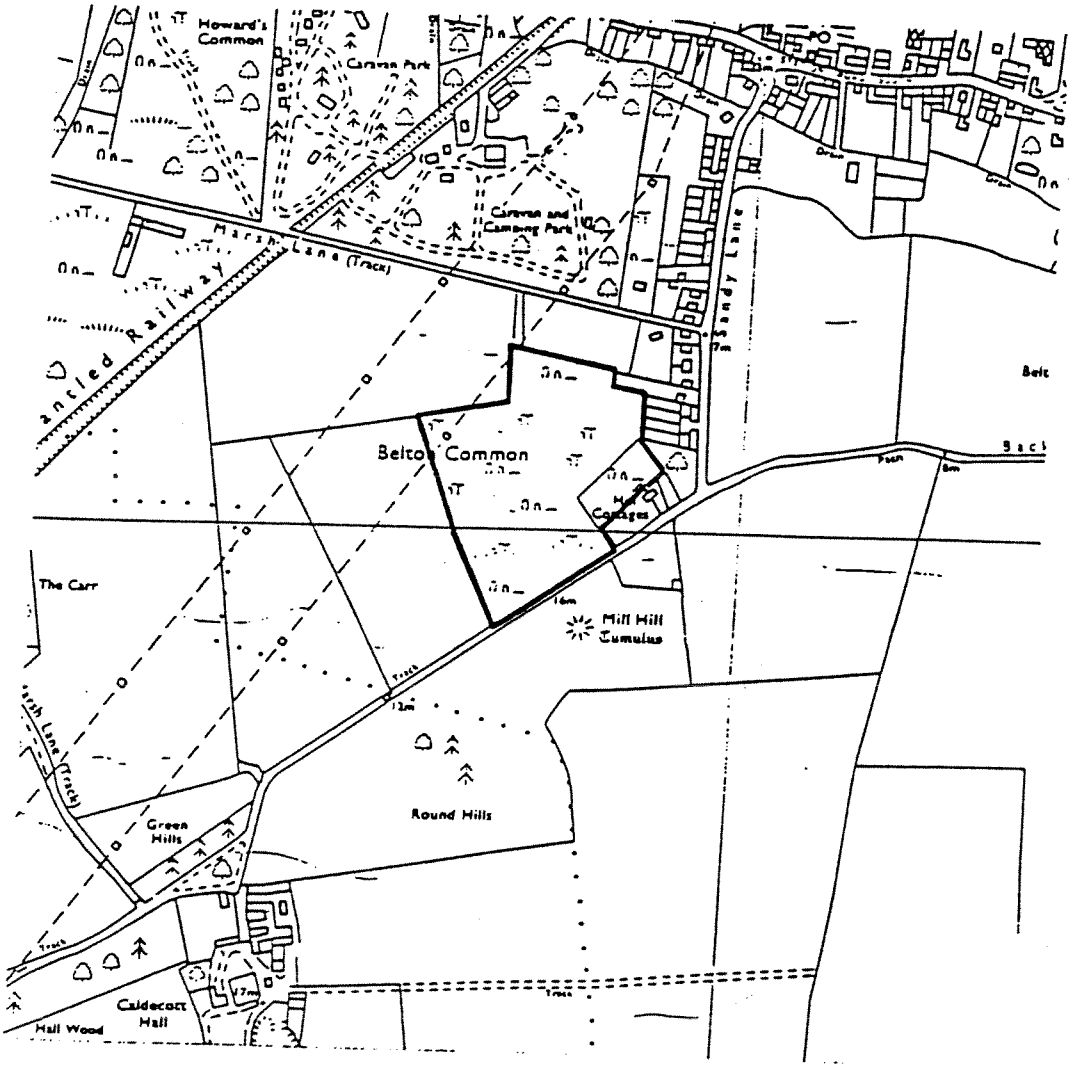
Cowbane [Cicuta virosa] and Marsh Fern [Thelypteris thelypteroides] occur with the Sedges [Carex appropinquata, C. lasiocarpa, and C. elata]. Paths and glades through the fen which have been regularly mown for many years have also developed a rich flora with many low-growing species such as the locally rare Bog Pimpernel [Anagallis tenella], Lesser Butterfly Orchid [Platanthera bifolia], Grass of Parnassus [Parnassia palustris], Marsh Lousewort [Pedicularis palustris], Marsh Helleborine [Epipactis palustris] and the Sedges [Carex flacca, C. diandra, C. lepidocarpa and C. pulicaris]. A moss carpet is present in places on flushed, nutrient-poor peats and the vegetation is characterised by both Sphagnum and pleurocarpous mosses. Shallow pools within this community contain Stoneworts, the nationally scarce Fen Pondweed [Potamogeton coloratus] and the locally rare Bladderwort [Utricularia minor]. Round-leaved Wintergreen [Pyrola rotundifolia] is another nationally scarce species which grows locally on ride and glade edges.

Mixed scrub has invaded many former areas of open fen and includes Bog Myrtle [Myrica gale], Creeping Willow [Salix repens], Guelder Rose [Viburnum opulus], Buckthorn [Rhamnus catharticus] and Alder Buckthorn [Frangula alnus]. Alder carr occurs in long established areas of woodland on permanently waterlogged soils. Alder [Alnus glutinosa] and Sallow [Salix cinerea] are dominant over a ground flora characterised by Yellow Iris [Iris pseudacorus], Lesser Pond Sedge [Carex acutiformis], Greater Tussock Sedge, Gipsywort [Lycopus europaeus], Marsh Fern and, locally, Bog moss [Sphagnum spp.]. A drier, more mature fen woodland occurs on the margins of the site. Pedunculate Oak [Quercus robur] and Ash [Fraxinus excelsior] are abundant and the ground flora includes Herb Robert [Geranium robertianum], Primrose [Primula vulgaris], Ground Ivy [Glechoma hederacea] and the lianes Honeysuckle [Lonicera periclymenum] and Wild Hop [Humulus lupulus].

A large area of permanent grazing marsh lies adjacent to the broad and fen. The grassland is generally improved but a network of drainage dykes contain clear-waters and one of the richest aquatic communities now remaining in Broadland. The dykes are generally dominated by the rare Water Soldier [Stratiotes aloides] but other abundant water-plants include Frogbit [Hydrocharis morsus-ranae], Canadian Pondweed [Elodea canadensis], Stoneworts, Broad-leaved Pondweed [Potamogeton natans] and the nationally scarce Grass-wrack Pondweed. Other notable species include Opposite-leaved Pondweed [Groenlandia densa], Greater Water-parsnip [Sium latifolium], Flowering Rush [Butomus umbellatus], River Water Dropwort [Oenanthe fluviatilis], and Fen Pondweed.

The fens and dykes support an outstanding assemblage of dragonflies and damselflies [Odonata], with the nationally rare Norfolk Aeshna [Aeshna isosceles] present in great abundance. The Swallowtail [Papillo machaon], another rare Broadland speciality also breeds on the site. Grass snakes are unusually common, while Marsh Harriers, and in the winter months, Hen Harriers frequently hunt over the area.

County Wildlife Site
(Ref No: 1428)



Local Authority No. 076759

This transparency / print is reproduced from / based upon the .....Ordnance Survey..... map with the permission of the Controller of H.M. Stationery Office © Crown Copyright. "Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings."

Norfolk County Council
County Hall
Norwich Date .....

County Wildlife Site
(Ref No: 1428)

Site Name: Belton Common

Parish: Fritton and St Ola

Grid Reference: TG 478019

Field Numbers: TG 4701 (17)

Area: 6.10 ha

Map Numbers: TG 40 SE

Site Description

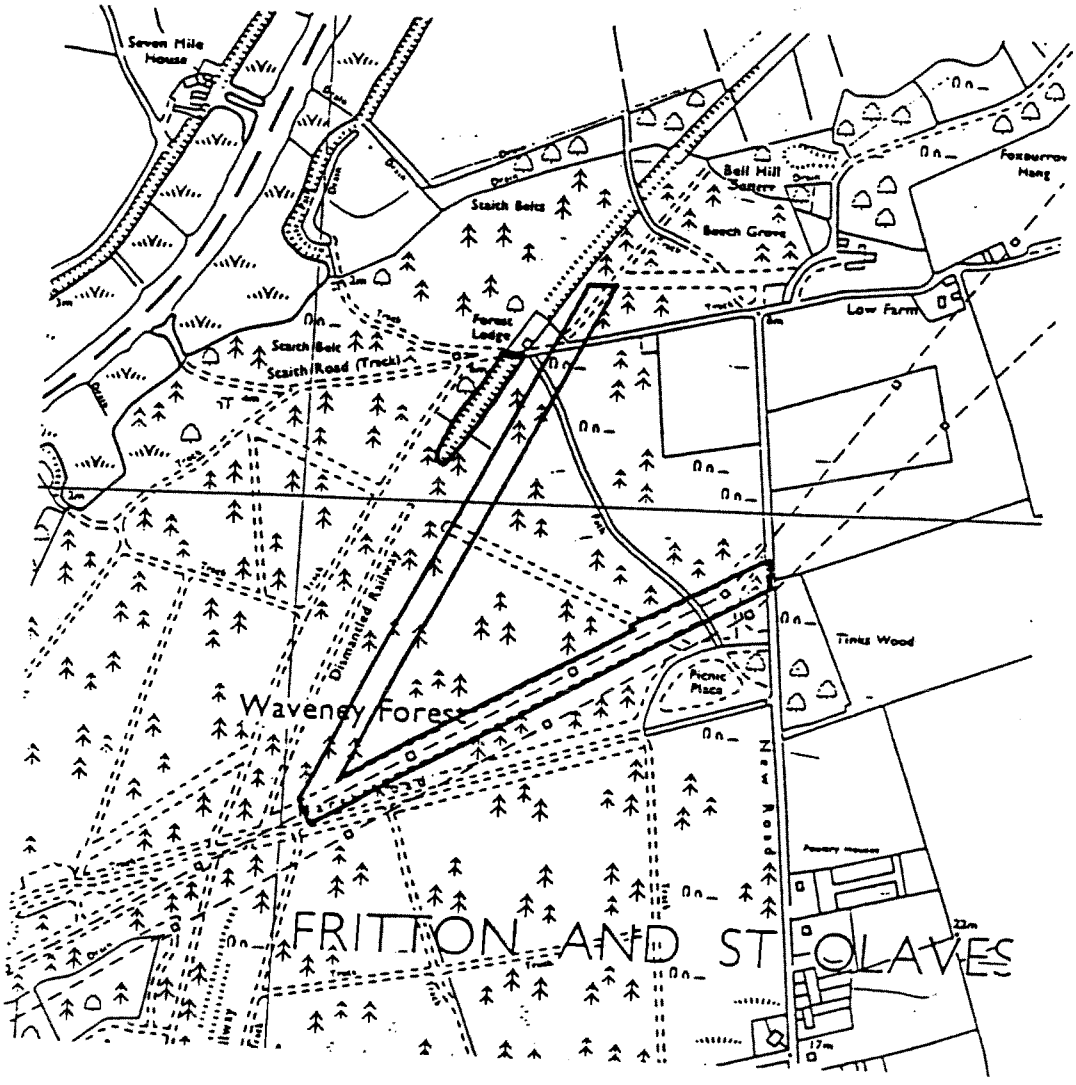
Belton Common is a relatively small site situated on the outskirts of the village of Belton. It is one of a complex of heathland County Wildlife Sites, and remnant heathland communities still cover the majority of the site. These communities vary from acidic and neutral grassland to continuous stands of dense gorse *(Ulex europaeus)* or open sand.

Relatively species-rich acidic grassland occurs throughout the site, particularly along paths. Species present include sheep's sorrel *(Rumex acetosella)*, sheep's fescue *(Festuca ovina)*, small cudweed *(Filago minima)*, bird's foot *(Ornithopus perpusillus)*, bird's-foot trefoil *(Lotus corniculatus)*, dove's-foot crane's-bill *(Geranium molle)*, viper's bugloss *(Echium vulgare)*, common stork's-bill *(Erodium cicutarium)*, little mouse-ear *(Cerastium semidecandrum)* and the moss *Polytrichum piliferum*. Sand sedge *(Carex arenaria)* is abundant in the more open and sandy area disturbed by motorbike scrambling and walking, with occasional lady's bedstraw *(Galium verum)* and musk thistle *(Carduus nutans)*.

Throughout the site continuous stands of dense gorse *(Ulex europaeus)* and patches of consolidated bracken *(Pteridium aquilinum)* are present, with scattered young oak *(Quercus robur)*, hawthorn *(Crataegus monogyna)* and silver birch *(Betula pendula)*. Towards the west scrub is sparser, giving way to a coarser sward dominated by false oat-grass *(Arrhenatherum elatius)*. Of interest in this area is the very local presence of sea couch (*Elymus atherica)* and common restharrow *(Ononis repens)*, giving a coastal feel to the sward. Elsewhere, the sward becomes locally species-rich, and includes species such as bird's-foot trefoil and broad-leaved everlasting pea *(Lathyrus latifolius)*.

Mixed semi-natural broadleaved woodland dominates the south-eastern part of the site and includes silver birch and oak with a bracken-bramble *(Rubus fruticosus* agg.*)* field layer including false oat-grass, rough meadow grass *(Poa trivialis)* and Yorkshire fog *(Holcus lanatus)*. This is surrounded by a mature hedge of hawthorn, with some large old oak trees, extending to the northern boundary.

County Wildlife Site
(Ref No: 1427)



Local Authority No. 07E759

This transparency / print is reproduced from / based upon the .....Ordnance Survey..... map with the permission of the Controller of H.M. Stationery Office © Crown Copyright. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings.

Norfolk County Council
County Hall
Norwich Date .....

County Wildlife Site
(Ref No: 1427)

Site Name: Waveney Forest

Parish: Fritton and St Ola

Grid Reference: TG 464008

Field Numbers: TG 4600 (07)

Area: 5.12 ha

Map Numbers: TG 40 SE

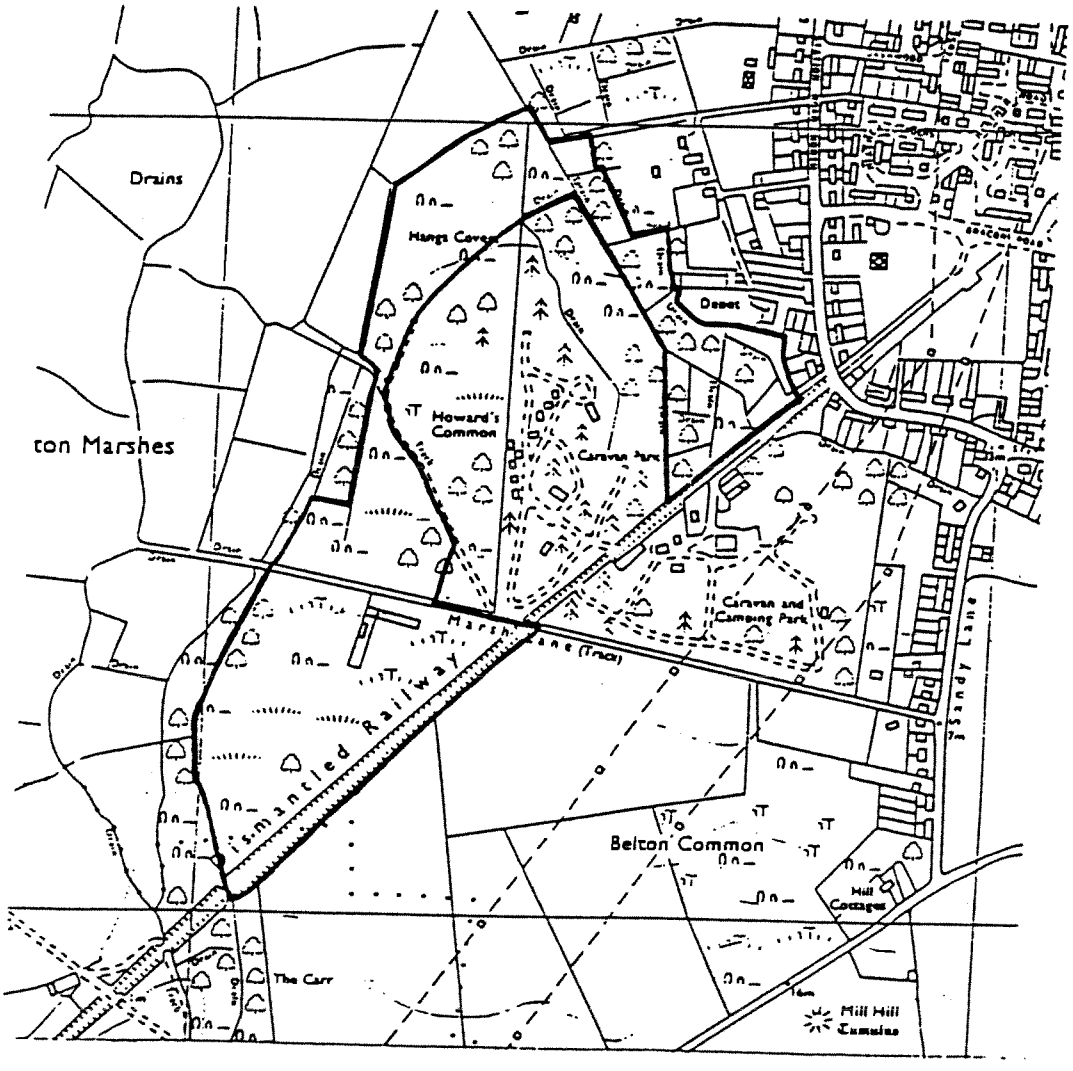
Site Description
Situated adjacent to the River Waveney flood plain, this site is one of a complex of heathland County Wildlife Sites that presumably once formed a larger, continuous stretch of heathland. (cf. Belton Common, ref. 1428; Howards Common and Wild Duck Caravan Park, ref. 1429). On this site, dry ericaceous heath is now limited principally to unwooded paths, along the course of a dismantled railway and under the route of overhead pylons. The vegetation is generally vigorous and structurally diverse, although the site is currently unmanaged.

Heather *(Calluna vulgaris)* is abundant to dominant where present, and can be found in building, mature and degenerate growth phases. It is accompanied by a range of associate species, including frequent bell heather *(Erica cinerea)*, heath bedstraw *(Galium saxatile)* and early hair-grass *(Aira praecox)* with occasional sheep's fescue *(Festuca ovina)*, fine-leaved sheep's fescue *(Festuca ovina* ssp. *hirtula)*, sheep's sorrel *(Rumex acetosella)* and small cudweed *(Filago minima)*. Also present are common stork's-bill *(Erodium cicutarium)*, common bent *(Agrostis capillaris)*, silver hair-grass *(Aira caryophyllea)*, pill sedge *(Carex pilulifera)*, sand sedge *(Carex arenaria)*, field woodrush *(Luzula campestris)*, and the mosses *Polytrichum commune*, *Hypnum cupressiforme*, *Hypnum jutlandicum* and *Pseudocleropodium purum*. A mosaic of this vegetation with patchy bare ground occurs in places, largely over the sloping sides of the old railway embankment where slight erosion is caused by trampling.

In other areas patches of consolidated bracken *(Pteridium aquilinum)* and acidic scrub are present forming a canopy over the remaining heather. The acidic scrub includes occasional to dominant bramble *(Rubus fruticosus* agg.*)*, frequent silver birch *(Betula pendula)*, occasional gorse *(Ulex minor)* and rare broom *(Cytisus scoparia)*, oak *(Quercus robur)* and rowan *(Sorbus aucuparia)*.

Evidence of a once more extensive heathland is also found within the coniferous plantation surrounding the site, where heather and heath bedstraw are occasionally present.

County Wildlife Site
(Ref No: 1429)



Local Authority No. 076759

This transparency / print is reproduced from / based upon the .....Ordnance Survey..... map with the permission of the Controller of H.M. Stationery Office © Crown Copyright. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings."

Norfolk County Council
County Hall
Norwich Date .....

County Wildlife Site
(Ref No: 1429)

Site Name: Howards Common and Wild Duck Caravan Park

Parish: Belton, and Fritton and St Olaves

Grid Reference: TG 472024

Field Numbers: TG 4702 (08), TG 4702 (06), TG 4702 (07)

Area: 17.04 ha

Map Numbers: TG 40 SE

Site Description

This site is located immediately adjacent to the village of Belton and forms a remnant area of a once larger tract of heathland. The site is divided north-south by Marsh Lane, to the north of which lies the Wild Duck Caravan Park. To the south the site is managed by the Norfolk Wildlife Trust as a nature reserve.

South of Marsh Lane, the site is characterised by a mosaic of dwarf shrub heath and dry acidic grassland with scattered acidic scrub. Areas of open heath support all growth phases of ling heather *(Calluna vulgaris)* and bell heather *(Erica cinerea)* juxtapositioned with very short rabbit-grazed acidic grassland rich in mosses and lichens, including *Peltigera* spp. and *Cladonia* spp.. Dwarf cudweed *(Filago minima)* also grows in some abundance, as does sand sedge *(Carex arenaria)*. Other species present include abundant common bent *(Agrostis capillaris)*, frequent early hair-grass *(Aira praecox)*, perforate St John's-wort (*Hypericum perforatum*) and mouse-ear hawkweed *(Pilosella officinarum)*, occasional heath bedstraw *(Galium saxatile)* and bird's-foot trefoil *(Lotus corniculatus)*, and rare creeping cinquefoil *(Potentilla reptans)*, pill sedge *(Carex pilulifera)*, bird's-foot *(Ornithopus perpusillus)* and whitlow grass *(Erophila verna)*.

The scattered acidic scrub is typified by patches of co-dominant gorse *(Ulex europaeus)*, hawthorn *(Crataegus monogyna)* and silver birch *(Betula pendula)* with broom *(Cytisus scoparius)*. Bracken *(Pteridium aquilinum)* is also present.

To the north, broadleaved semi-natural woodland covers the land sloping down to the Waveney flood plain. On higher ground the woodland is largely dominated by oak *(Quercus robur)* and silver birch, with extensive areas of derelict sweet chestnut *(Castanea sativa)* coppice. Ash *(Fraxinus excelsior)* and hazel *(Corylus avellana)* are rarely present. At the foot of the western slope the ground becomes sufficently wet to support alder *(Alnus glutinosa)* and willow *(Salix* sp.*)* with a field layer of scattered soft rush *(Juncus effusus)*, common reed *(Phragmites australis)*, red campion *(Silene dioica)*, honeysuckle *(Lonicera periclymenum)* and lesser pond-sedge *(Carex acutiformis)*. The north-eastern boundary is marked by similar species, although a more open understorey allows common reed, reed sweet-grass (*Glyceria maxima*), flag iris (*Iris pseudacorus*) and bramble (*Rubus fruticosus* agg.) to dominate the field layer.

Much of the woodland has a diverse age structure, including saplings of most species present. Dead and fallen trees are frequent.

Other notable species include Natterjack toad (*Bufo calamita*) introduced in 1994.

E. METEOROLOGICAL DATA

E. METEOROLOGICAL DATA

TABLE E1
FREQUENCY OF WIND SPEED AND DIRECTION
HEMSBY WEATHER STATION (1985 TO 1994)

	WIND DIRECTION (DEGREES)											
Wind speed (m/s)	350-10	20-40	50-70	80-100	110-130	140-160	170-190	200-220	230-250	260-280	290-310	320-340
1	0.659	0.606	0.660	0.706	0.775	0.839	1.115	1.564	1.548	1.484	1.078	0.809
2.6	0.750	0.743	0.825	1.008	1.021	0.991	1.609	2.694	2.204	1.885	1.258	0.714
4.4	1.946	1.871	1.734	1.626	1.987	2.050	2.824	4.461	4.505	3.401	1.524	1.222
7	2.379	2.029	1.804	1.664	1.555	2.034	2.732	3.982	4.797	3.603	1.529	1.847
>9.8	0.900	0.834	0.858	0.900	0.443	0.453	1.153	1.710	2.389	2.058	0.798	0.935

TABLE E2
FREQUENCY OF PASQUILL STABILITY CATEGORIES
HEMSBY WEATHER STATION (1985 TO 1994)

Wind direction (degrees)	Wind speed (m/s)	Pasquill Stability Category					
		A	B	C	D	E	F
350-10	1	.047	.184	.117	.293	0	.358
	2.6	.001	.088	.352	.294	.163	.101
	4.4	0	.144	.333	.454	.069	0
	7	0	0	.113	.887	0	0
	>9.8	0	0	0	1	0	0
20-40	1	.054	.151	.123	.292	0	.381
	2.6	.004	.163	.375	.275	.119	.065
	4.4	0	.166	.313	.448	.073	0
	7	0	0	.117	.883	0	0
	>9.8	0	0	.007	.993	0	0

Wind direction (degrees)	Wind speed (m/s)	Pasquill Stability Category					
		A	B	C	D	E	F
50-70	1	.096	.251	.096	.246	0	.309
	2.6	.010	.197	.350	.246	.124	.074
	4.4	0	.174	.294	.427	.105	0
	7	0	0	.138	.862	0	0
	>9.8	0	0	.006	.994	0	0
80-100	1	.073	.228	.124	.246	0	.329
	2.6	.022	.197	.355	.248	.119	.059
	4.4	0	.175	.274	.443	.109	0
	7	0	0	.091	.909	0	0
	>9.8	0	0	0	1	0	0
110-130	1	.063	.174	.084	.314	0	.366
	2.6	.003	.127	.350	.291	.146	.083
	4.4	0	.186	.313	.414	.088	0
	7	0	0	.103	.897	0	0
	>9.8	0	0	.007	.993	0	0
140-160	1	.029	.146	.083	.270	0	.472
	2..6	.002	.049	.269	.373	.192	.114
	4.4	0	.077	.311	.496	.116	0
	7	0	0	.106	.894	0	0
	>9.8	0	0	.002	.998	0	0

Wind direction (degrees)	Wind speed (m/s)	Pasquill Stability Category					
		A	B	C	D	E	F
170-190	1	.013	.108	.080	.297	0	.502
	2.6	.001	.029	.214	.415	.226	.116
	4.4	0	.022	.223	.624	.131	0
	7	0	0	.025	.975	0	0
	>9.8	0	0	.003	.997	0	0
200-220	1	.017	.140	.062	.257	0	.524
	2.6	0	.028	.205	.355	.268	.145
	4.4	0	.034	.203	.578	.185	0
	7	0	0	.033	.967	0	0
	>9.8	0	0	.002	.998	0	0
230-250	1	.027	.152	.068	.244	0	.508
	2.6	0	.042	.243	.350	.218	.147
	4.4	0	.057	.248	.550	.145	0
	7	0	0	.054	.946	0	0
	>9.8	0	0	0	1	0	0
260-280	1	.027	.174	.065	.243	0	.491
	2.6	0	.044	.251	.321	.230	.153
	4.4	0	.070	.292	.488	.150	0
	7	0	0	.064	.936	0	0
	>9.8	0	0	0	1	0	0
290-310	1	.024	.195	.079	.294	0	.408
	2.6	.001	.046	.289	.331	.233	.101
	4.4	0	.080	.269	.538	.113	0
	7	0	0	.072	.928	0	0
	>9.8	0	0	0	1	0	0

Wind direction (degrees)	Wind speed (m/s)	Pasquill Stability Category					
		A	B	C	D	E	F
320-340	1	.035	.165	.096	.287	0	.417
	2.6	.001	.052	.281	.406	.175	.085
	4.4	0	.070	.328	.543	.059	0
	7	0	0	.075	.925	0	0
	>9.8	0	0	0	1	0	0

F. EXPECTED CHANGES TO AIR QUALITY AT ADDITIONAL SSSIs

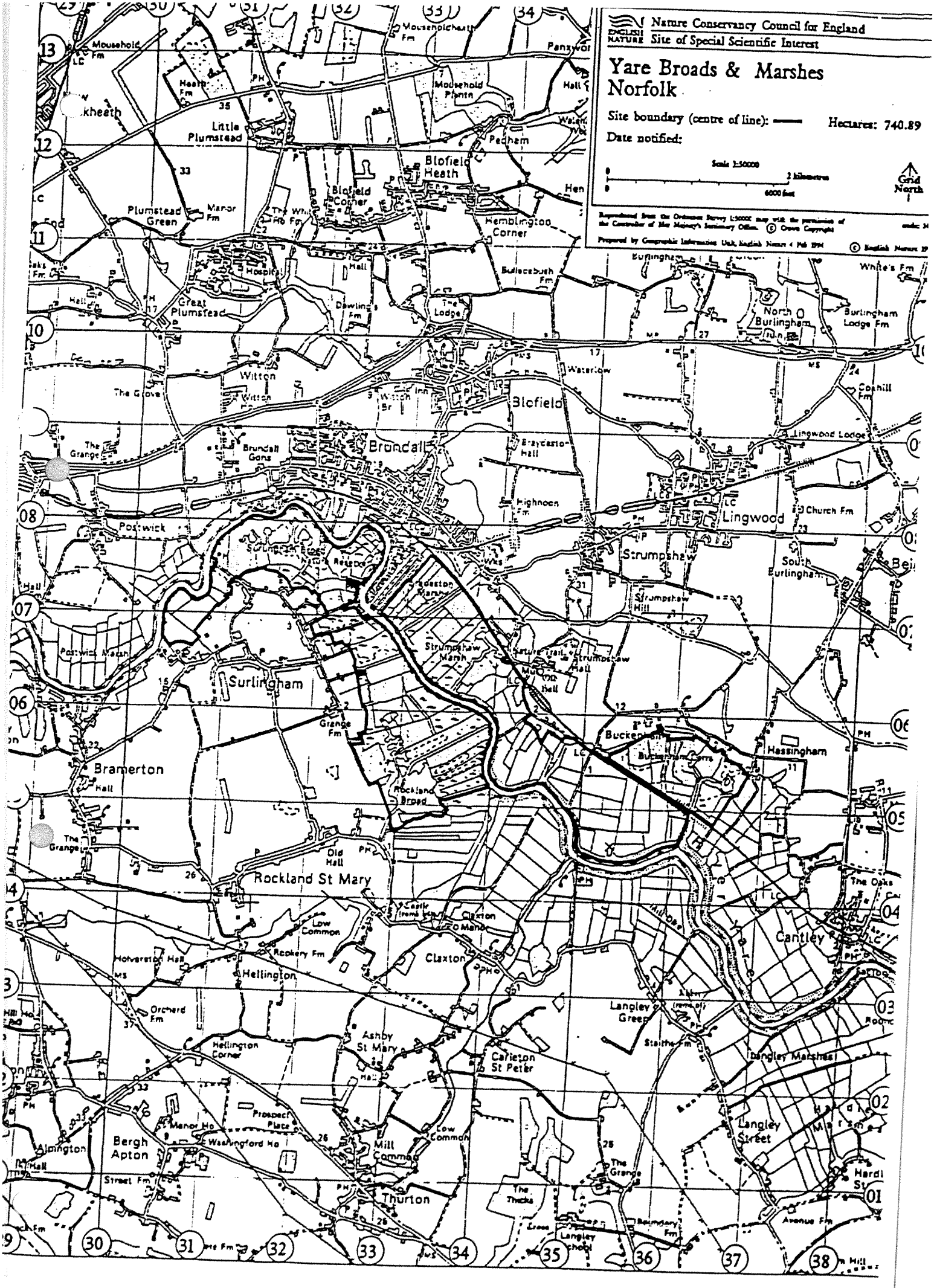
TABLE F1
EXPECTED CHANGES TO AIR QUALITY AT ADDITIONAL SSSIs
INCREMENTS TO NO_X LEVELS $\mu g/m^3$

Norfolk	Gas firing		Gas condensate firing		Percentage occurance of associated weather conditions for maximum hourly figures
	Maximum hourly	Annual	Maximum hourly	Annual	
Burgh Common and Muckfleet Marshes	30.21	0.30	62.88	0.62	0.40
Damgate Marshes, Acle	28.80	0.52	59.94	1.08	0.28
Decoy Carr, Acle	27.47	0.49	57.18	1.02	0.28
Hall Farm Fen, Hemsby	27.47	0.20	57.18	0.41	0.56
Winterton - Horsey Dues	27.47	0.27	57.18	0.56	0.40
Limpenhoe Meadows	26.23	0.47	54.61	0.97	0.23
Hardley Flood	25.08	0.52	52.22	1.09	0.23
Stanley and Alder Carrs, Aldeby	25.08	0.56	52.22	1.18	0.23
Upton Broad and Marshes	24.54	0.24	51.09	0.50	0.28
Yare Broad and Marshes	24.02	0.43	50.00	0.89	0.23
Poplar Farm Meadows, Langley	23.51	0.42	48.96	0.87	0.23
Shallam Dyke Marshes, Thurne	22.75	0.22	47.36	0.46	0.40
Ludham - Potter Heigham Marshes	23.03	0.22	47.95	0.47	0.40
Upper Thurne Broads and Marshes	23.03	0.22	47.95	0.47	0.28
Geldeston Meadows	21.26	0.45	44.27	0.93	0.20
Duncan's Marsh, Claxton	20.86	0.37	43.43	0.77	0.23

Norfolk	Gas firing		Gas condensate firing		Percentage occurance of associated weather conditions for maximum hourly figures
	Maximum hourly	Annual	Maximum hourly	Annual	
Ant Broads and Marshes	19.73	0.19	41.07	0.40	0.40
Priory Meadows, Hickling	19.73	0.14	41.07	0.29	0.40
Bramerton Pits*	18.39	0.33	40.34	0.72	0.23
Calthorpe Broad	18.39	0.13	40.34	0.29	0.40
Alderfen Broad	18.39	0.18	40.34	0.39	0.28
Tindall Wood, Ditchingham	19.27	0.43	38.29	0.87	0.23
Hedenham Wood	18.93	0.31	39.42	0.69	0.23
Sexton Wood, Hedenham	17.67	0.41	36.80	0.82	0.23
Broad Fen, Dilham	15.70	0.17	32.69	0.33	0.40
Smallburgh Fen	15.70	0.17	32.69	0.33	0.40
Caister St Edmund Chalk Pit*	15.76	0.29	32.82	0.60	0.23
Crostwick Marsh	15.25	0.29	31.76	0.58	0.28
East Ruston Common	15.25	0.12	31.76	0.23	0.40
Shotesham Woodton Hornbeam Woods	16.06	0.34	33.45	0.71	0.23
Shotesham Common	15.80	0.34	32.90	0.70	0.23
Happisburgh Cliffs*	15.09	0.11	31.42	0.23	0.40
Westwick Lakes	13.84	0.14	28.82	0.29	0.40

Suffolk	Gas firing		Gas condensate firing		Percentage occurance of associated weather conditions for maximum hourly figures
	Maximum hourly	Annual	Maximum hourly	Annual	
Sprats Water and Marshes	28.80	0.41	59.94	0.85	0.24
Barnby Broad and Marshes	27.47	0.62	57.18	1.30	0.23
Sotterley Park	21.01	0.47	43.75	0.98	0.24
Benacre to Eastern Bavents	18.39	0.26	40.34	0.57	0.24
Titsal Wood, Shadingfield	18.49	0.42	38.50	0.87	0.23
Abbeywood, Flixton	15.76	0.34	32.82	0.70	0.20
Minsmere - Walberswick Heath and Marshes	15.25	0.23	31.76	0.46	0.24
Holton Pit*	15.09	0.15	31.42	0.31	0.40
Flixton Quarry*	15.16	0.32	31.58	0.68	0.23
Chippenhall Green	12.76	0.30	26.57	0.62	0.23

*Represents a site notified for its geological interest.


Nature Conservancy Council for England
Site of Special Scientific Interest
Yare Broads & Marshes
Norfolk
Site boundary (centre of line):
Hectares: 740.89
Date notified:
Scale 1:50000
2 kilometres
Grid North
Reproduced from the Ordnance Survey 1:50000 map with the permission of the Controller of Her Majesty's Stationery Office. © Crown Copyright
Prepared by Geographic Information Unit, English Nature 4 Feb 1994
© English Nature
Mousehold Fm
Mousehold Heath
Mousehold Plantn
Pedham
Little Plumstead
Blofield Heath
Blofield Corner
Plumstead Green
Manor Fm
Hemblington Corner
Great Plumstead
Dawling Fm
The Lodge
Bullacebush Fm
North Burlingham
Burlingham Lodge Fm
White's Fm
Witton
Blofield
Brundall
Brundall Gdns
Braydeston Hall
Lingwood Lodge
Highnoon Fm
Lingwood
Church Fm
Postwick
Strumpshaw
South Burlingham
Strumpshaw Hill
Strumpshaw Marsh
Surlingham
Grange Fm
Bramerton
Buckenham
Buckenham Carrs
Hassingham
Rockland Broad
Old Hall
Rockland St Mary
Low Common
Rookery Fm
Claxton
Cantley
Hellington
Holverston Hall
Orchard Fm
Hellington Corner
Ashby St Mary
Carleton St Peter
Langley Green
Langley Marshes
Prospect Place
Manor Ho
Washingford Ho
Bergh Apton
Almington
Mill Common
Thurton
The Thicks
Langley Street
Langley Sch
Avenue Fm
Boundary Fm

FILE REF: EA/N/282 14 WVX

COUNTY: Norfolk

SITE NAME: YARE BROADS & MARSHES

DISTRICT: Broadland, South Norfolk

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Broads Authority

National Grid Reference: TG 330063

Area: 740.89 (ha)

Ordnance Survey Sheet 1:50,000: 134

1:10,000: TG 30 NW, NE, SW, SE

Date Notified (Under 1949 Act):

1954 - Surlingham and Rockland Broads and Strumpshaw Fen

1981 - Buckenham Marshes

Date of Last Revision:

1981 - Surlingham and Rockland Broads and Strumpshaw Fen

Date Notified (Under 1981 Act): 1988

Date of Last Revision:

Other Information: This is a composite site made up of two former separate SSSIs known as Surlingham and Rockland Broads, and Strumpshaw Fen and Buckenham Marshes, plus two substantial addition. The majority of the site appears in a Nature Conservation Review (Ratcliffe 1977). Substantial areas are managed as nature reserves by the RSPB and NWT.

Description and Reasons for Notification:

The Yare Broads and Marshes are nationally important wetland site consisting of extensive areas of unreclaimed fen, carr woodland, open water and grazing marsh on shallow fenland peats. The site lies in the middle reaches of the River Yare and is one of the key Broadland sites with great botanical and ornithological interest. The species-rich fens, dykes and unimproved meadows hold an outstanding assemblage of plants including many rare species. An important community of breeding birds is found on the fens and includes most of the typical Broadland species. The only regular wintering flock of Bean Geese in England frequent the grazing marshes. A Broadland speciality, the Swallowtail butterfly is also present in good numbers on the site.

Continued .....

The fenland vegetation is notable for the large areas that are dominated by Reed Sweet-grass *Glyceria maxima*, which is infrequent in other Broadland river valley fens. Reed Sweet-grass is the primary coloniser around the nutrient-rich broads and forms floating mats of vegetation (hover), extending out into the open water. These areas tend to be rather species-poor but a more diverse fen community occurs where Reed *Phragmites australis* is dominant or co-dominant with Reed Canary-grass *Phalaris arundinacea*. Typical species include Meadowsweet *Filipendula ulmaria*, Marsh Thistle *Cirsium palustre*, Angelica *Angelica sylvestris*, Greater Spearwort *Ranunculus lingua* and Ragged Robin *Lychnis flos-cuculi*. Several rare species occur in these areas, notably Fibrous Tussock Sedge *Carex appropinquata*, Cowbane *Cicuta virosa*, Marsh Pea *Lathyrus palustris*, Marsh Sow-thistle *Sonchus palustris*, Milk Parsley *Peucedanum palustre* and Marsh Fern *Thelypteris palustris*. Further diversity results from the presence of small areas of fen dominated by Saw Sedge *Cladium mariscus* with frequent Bog Myrtle *Myrica gale*, but this community is much rarer than in the other Broadland valleys. Mixed scrub on fenland peats occurs on many areas which are no longer managed; Common Sallow *Salix cinerea* is abundant with frequent Guelder Rose *Viburnum opulus*, Alder Buckthorn *Frangula alnus* and Wild Privet *Ligustrum vulgare*.

Several unimproved fen meadows are present on the site. The traditional management of summer mowing for hay followed by grazing has favoured a herb-rich sward. Blunt-flowered Rush *Juncus subnodulosus* and Yorkshire Fog *Holcus lanatus* are dominant where the underlying peats are fairly calcareous and other species include Marsh Helleborine *Epipactis palustris*, Southern Marsh Orchid *Dactyloriza praetemissa*, Yellow Rattle *Rhinanthus minor*, Bog Pimpernel *Anagallis tenella*, Marsh Lousewort *Pedicularis palustris*, Devil's-bit Scabious *Succisa pratensis* and Grass of Parnassus *Parnassia palustris*. Purple Moor-grass *Molinia caerulea* and a variety of sedges including Small-fruited Yellow Sedge *Carex serotina* and Flea Sedge *Carex pulicaris* occur where there are more acidic, nutrient-poor peats. A number of characteristic species are present including Cotton-grass *Eriophorum angustifolium*, Heath Grass *Danthonia decumbens*, Meadow Thistle *Cirsium dissectum* and Tormentil *Potentilla erecta*.

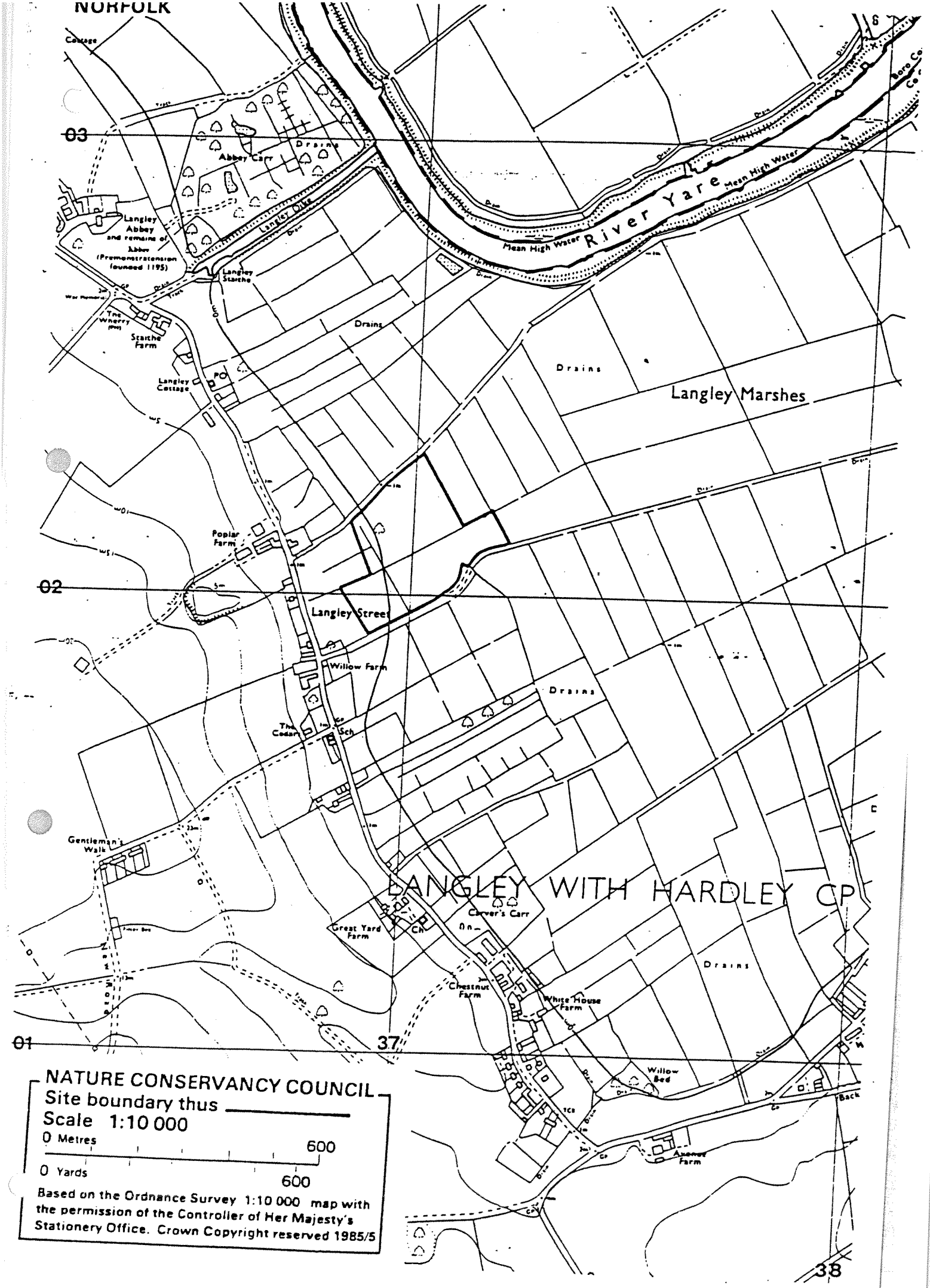
Open water habitats are well-represented in the middle stretches of the Yare. There are several broads but most are directly connected to the nutrient-rich waters in the main river and water plants are poorly-developed in the phytoplankton-dominated waters. However, Strumpshaw Broad has been mud-pumped to remove the enriched sediments and also isolated from the River Yare. This management technique has resulted in clear water and the return of several water plants. The complex network of dykes around the grazing marshes is also isolated from the main river and contains an exceptional assemblage of water plants including several rare species. The most notable is Sharp-leaved Pondweed *Potamogeton acutifolius*, a national rarity that has declined markedly in recent years but is still widespread on the site. Other water plants include Frogbit *Hydrocharis morsus-ranae*, Water Violet *Hottonia palustris*, Whorled Water Milfoil *Myriophyllum verticullatum*, Hair-like Pondweed *Potamogeton trichoides* and the rare Water Soldier *Stratiotes aloides*.

Mature alder carr is not widespread in the Yare Valley but a well-developed stand of sump alder occurs around Buckenham and Hassingham Broads. The ground flora is typically diverse and contains Greater Tussock Sedge *Carex paniculata*, Lesser Pond Sedge *Carex acutiformis*, Yellow Flag *Iris pseudacorus*, Gipsywort *Lycopus europaeus*, Hemp Agrimony *Eupatorium cannabinum* and Common Figwort *Scrophularia nodosa*.

Continued .....

The fens are the breeding site of many species of wetland bird including Snipe, Water Rail, Mar Harrier and Grasshopper Warbler. A large population of Cetti's Warblers is present and the site the main stronghold for the species outside Kent. A wide variety of duck nest around the wate bodies and include Teal, Shoveler, Pochard, Tufted Duck and a nationally important popr tion Gadwall. There is an active heronry in the carr woodland.

The wintering flock of Bean Geese, which has increased in recent years to a maximum of 329 bird feeds on Buckenham Marshes and roosts nearby on the site. The marshes also support a national important wintering flock of wigeon with a maximum of 7,000 birds. Elsewhere on the site there a wintering roost of up to 8 Hen Harriers.


NORFOLK
03
02
01
37
38
Abbey Carr
Drains
Langley Abbey and remains of Abbey (Premonstratensian founded 1195)
Langley Dike
Langley Staithe
River Yare
Mean High Water
The Wherry (PH)
Staithe Farm
Langley Cottage
PO
Drains
Langley Marshes
Poplar Farm
Langley Street
Willow Farm
The Cedars
Sch
Gentleman's Walk
LANGLEY WITH HARDLEY CP
Great Yard Farm
CH
Carver's Carr
Chestnut Farm
White House Farm
Willow Bed
Back
Ancient Farm
NATURE CONSERVANCY COUNCIL
Site boundary thus
Scale 1:10 000
0 Metres
600
0 Yards
600
Based on the Ordnance Survey 1:10 000 map with the permission of the Controller of Her Majesty's Stationery Office. Crown Copyright reserved 1985/5

File Ref: EA/N/72/14 WGH

COUNTY: Norfolk

SITE NAME: POPLAR FARM MEADOWS, LANGLEY

DISTRICT: South Norfolk

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: South Norfolk District Council

National Grid Reference: TG 370021 Area: 7.23 [ha] 17.87 [

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TG 30 SE

Date Notified [Under 1949 Act]: 1981 Date of Last Revision: -

Date Notified [Under 1981 Act]: 1985 Date of Last Revision: -

Other Information:

Reasons for Notification:

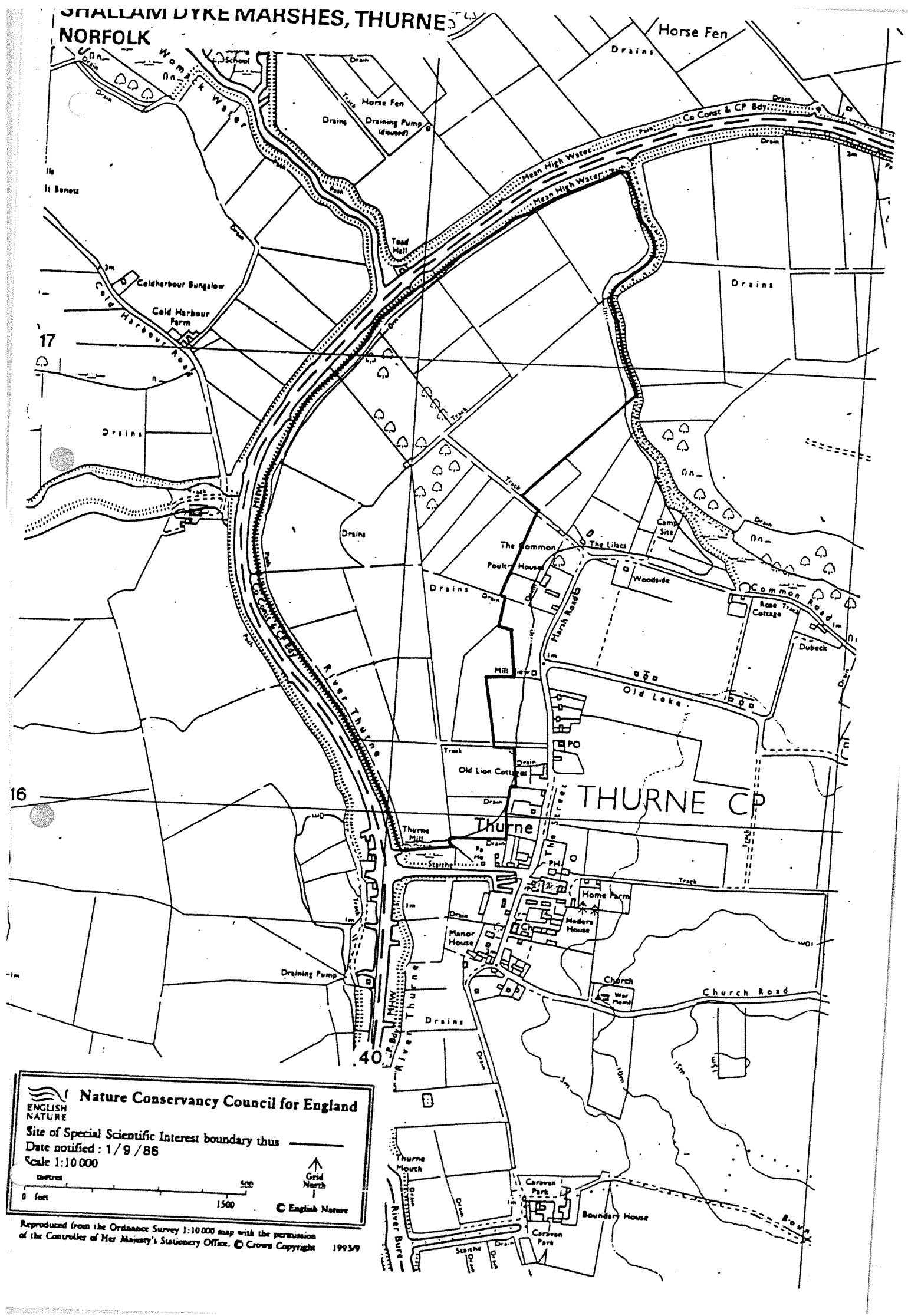
This site is a small spring-fed calcareous fen situated on the edge of the flood-plain of River Yare. The meadows are exceptionally diverse and several scarce and locally uncomm plants are present. Species-rich calcareous fens are virtually confined to East Anglia a this site is an unusual example with intergrading fen grassland communities. These ri communities are maintained by light summer grazing. The surrounding dykes contain cle spring-waters and support an interesting assemblage of water-plants.

The fen meadows are generally dominated by Blunt-flowered Rush [Juncus subnodulosus] w abundant Yorkshire Fog [Holcus lanatus] and Marsh Valerian [Valeriana dioica]. The floristically-rich areas contain many interesting species including Bog Pimpernel [Anaga tenella], Grass of Parnassus [Parnassia palustris], Marsh Helleborine [Epipactis palustri Common Spotted Orchid [Dactylorhiza fuchsii] and Fragrant Orchid [Gymnadenia conopse Two locally uncommon plants, Greater Water-parsnip [Sium latifolium] and Fibrous Tusse Sedge [Carex appropinquata] are also present.

An area of tall fen vegetation dominated by Saw Sedge [Cladium mariscus] with abundant Ble Bog-rush [Schoenus nigricans] and Meadowsweet [Filipendula ulmaria] occurs in one of t meadows. Bushes of Bog Myrtle [Myrica gale] and Creeping Willow [Salix repens] are freque and other species present include Meadow Thistle [Cirsium dissectum], Primrose [Prim vulgaris] and Devil's-bit Scabious [Succisa pratensis].

A transitional zone occurs on the edge of the Cladium-dominated fen where Purple Mo grass [Molinia caerulea] is dominant with frequent Quaking Grass [Briza media], Tormer [Potentilla erecta] and Carnation Sedge [Carex panicea]. Other characteristic plant spec of this community include Lesser Spearwort [Ranunculus flammula], Marsh Arrow-gr [Triglochin palustris], Ragged Robin [Lychnis flos-cuculi] and Common Butterwort [Pinguic vulgaris].

The clear-water dykes hold a number of species of Stonewort [Chara spp.].


SHALLAM DYKE MARSHES, THURNE
NORFOLK
Horse Fen
Drains
Womack Water
Horse Fen
Draining Pump (disused)
Co Const & CP Bdy
Mean High Water
Toad Hall
Coldharbour Bungalow
Cold Harbour Farm
Cold Harbour Road
17
Drains
Track
The Common
The Lilacs
Camp Site
Poultry House
Woodside
Common Road
Rose Cottage
Dubeck
Marsh Road
River Thurne
Mill View
Old Lake
PO
Old Lion Cottages
THURNE CP
Thurne
16
Thurne Mill
Staithe
PH
Home Farm
Hedera House
Manor House
Church
Church Road
War Memorial
Draining Pump
MHW
River Thurne
40
Thurne Mouth
Caravan Park
Boundary House
River Bure
Staithe
ENGLISH NATURE
Nature Conservancy Council for England
Site of Special Scientific Interest boundary thus
Date notified : 1/9/86
Scale 1:10 000
metres
0 feet
1500
Grid North
© English Nature
Reproduced from the Ordnance Survey 1:10000 map with the permission of the Controller of Her Majesty's Stationery Office. © Crown Copyright 1993/9

File Ref: EA/N/272/14 WTQ

COUNTY: Norfolk SITE NAME: **SHALLAM DYKE MARSHES, THURNE**

DISTRICT: **Great Yarmouth**

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: **Broads Authority**

National Grid Reference: TG 399 165

Area: 70.42 (ha) 173.94 (ac)

Ordnance Survey Sheet 1:50,000: 134

1:10,000: TG 31 NE, TG 41 NW

Date Notified (Under 1949 Act): N/A

Date of Last Revision: -

Date Notified (Under 1981 Act): 1986

Date of Last Revision: 1993

Other Information:

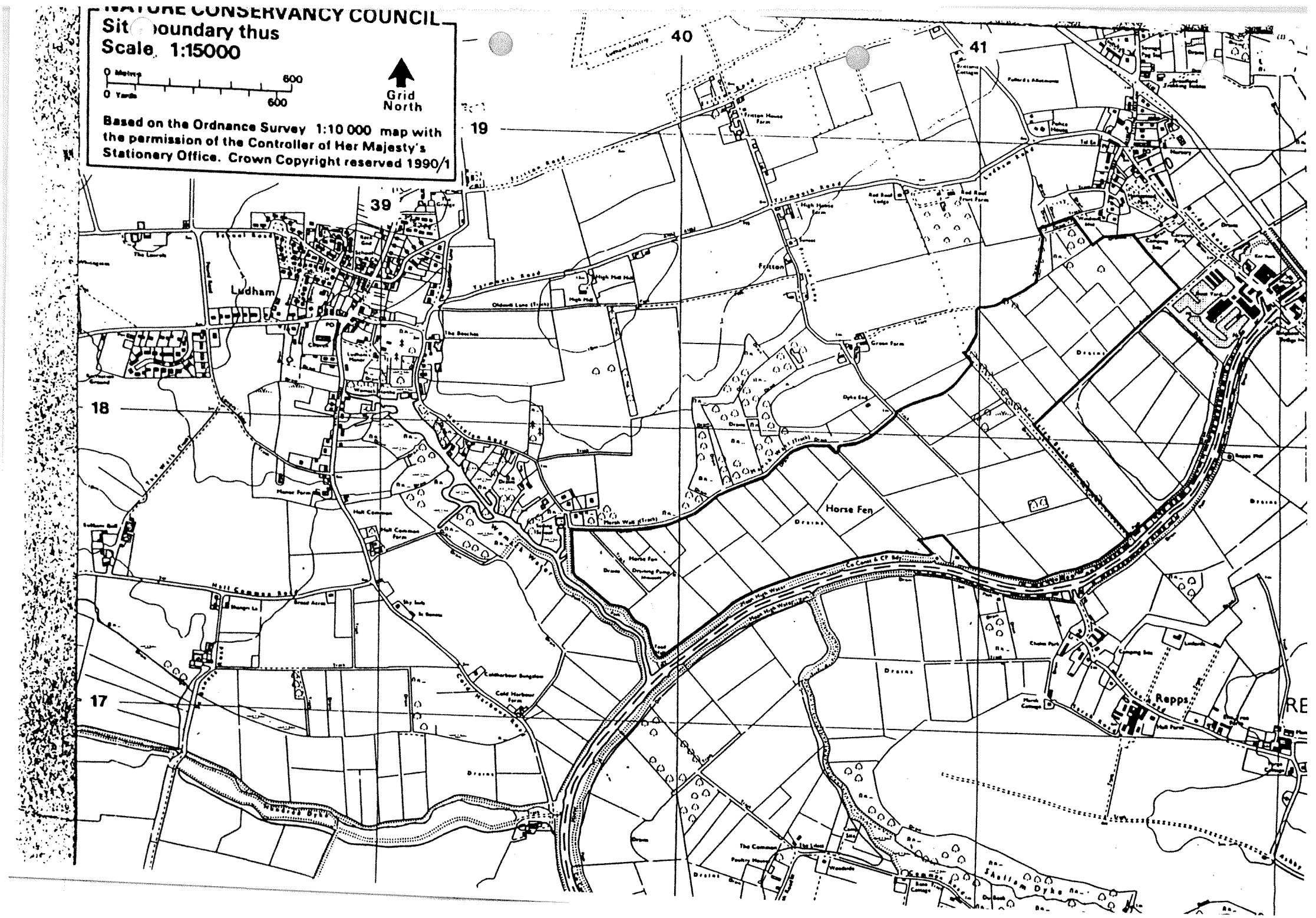
A new site

Description and Reasons for Notification:

This site consists of an area of grazing marsh situated on alluvial clays in the lower reaches of the River Thurne. The semi-improved pasture is seasonally wet and the tussocky grassland, together with lack of disturbance, provides ideal nesting conditions for several wetland birds and the site is considered to be the most important area of grazing marsh for waders in Broadland. A network of clearwater drainage dykes is also present and which provide habitat for nesting wildfowl and a range of water plants including several uncommon species.

Lapwings are the most abundant nesting waders but there are also notable populations of Redshank, Oystercatcher and Snipe. The reed-fringed dykes provide suitable cover for the nests of Shoveler, Tufted Duck, Gadwall, Mallard and Mute Swan.

A variety of water-plants are present in the dykes including Frog-bit *Hydrocharis morsus-ranae*, Spiked Water-milfoil *Myriophyllum spicatum*, Shining Pondweed *Potamogeton lucens*, Stoneworts *Chara spp* and the rare Water Soldier *Stratiotes aloides*. Emergent plants are well-represented and include Bulrush *Schoenoplectus lacustris*, Arrowhead *Sagittaria sagittifolia*, Mare's-tail *Hippuris vulgaris* and the locally uncommon Flowering Rush *Butomus umbellatus*.


NATURE CONSERVANCY COUNCIL
Site boundary thus
Scale 1:15000
0 Metres 600
0 Yards 600
Grid North
Based on the Ordnance Survey 1:10 000 map with the permission of the Controller of Her Majesty's Stationery Office. Crown Copyright reserved 1990/1
40
41
19
39
18
17
Ludham
Horse Fen
Repps
Drains

File Ref: EA/N/63

COUNTY: NORFOLK

SITE NAME: LUDHAM-POTTER HEIGHAM MA

DISTRICT: NORTH NORFOLK

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Broads Authority

National Grid Reference: TG 410178 Area: 99.0 [ha] 244.629

Ordnance Survey Sheet 1:50,000: 134 1:10,000:

Date Notified [Under 1949 Act]: 1981 Date of Last Revision:

Date Notified [Under 1981 Act]: 1990 Date of Last Revision:

Other Information:
Part of the site is a National Nature Reserve and a Grade 1 NCR site.

Description and Reasons for Notification:

The grass marshes on the north side of the River Thurne between Ludham and Potter Heigham are both a nationally important wetland site and one of the richest areas of traditionally managed grazing marsh and dykes now remaining in Broadland. These marshes lie on fen peats and alluvial clays and are summer-grazed by cattle. The nature conservation importance of the marshlands is concentrated principally on the aquatic flora and fauna of the dykes. These support a wide range of water plants, including several uncommon species, in the acidic or neutral, relatively nutrient-poor waters. There is a great diversity of aquatic invertebrates including a rich assemblage of dragonflies. Most of the grassland has been semi-improved but small areas of an unusual acidic heath and grassland community occur on the peats. Areas of tussocky grassland and open water provide suitable nesting habitat for several ducks and waders.

AQUATIC FLORA

The flora of the dykes has developed in response to variations in water quality, water depth and management techniques. A distinct community grows in the base-poor, slightly acidic, low nutrient waters along the upland margin. The principal species of water-plant are Bog Pondweed (Potamogeton polygonifolius), Greater Bladderwort (Utricularia vulgaris), Bulbous Rush (Juncus bulbosus var. fluitans), Floating Scirpus (Eleogiton fluitans), and the rare Floating Water-plantain (Luronium natans). The emergent and bank-edge vegetation is rather sparse but includes Common Cottongrass (Eriophorum angustifolium), Lesser Spearwort (Ranunculus flammula), Marsh Pennywort (Hydrocotyle vulgaris) and Common Spikerush (Eleocharis palustris). The majority of the dykes contain neutral waters of moderate base status with medium levels of nutrients. The diverse vegetation includes Whorled Water-milfoil (Myriophyllum verticillatum), Frogbit (Hydrocharis morsus-ranae), Water Violet (Hottonia palustris), Floating Pondweed (Potamogeton natans) and a great abundance of the rare Water Soldier (Stratiotes aloides). The emergent vegetation is similarly diverse with Flowering Rush (Butomus umbellatus), Water Dropwort (Oenanthe fistulosa), Bottle Sedge (Carex rostrata) and Water Plantain (Alisma plantago-aquatica).

Cont ...

A discrete community occurs where there is seepage of brackish nutrient-enriched waters from the River Thurne into dykes near the river bank. Fennel-like Pondweed (Potamogeton pectinatus), Horned Pondweed (Zannichellia palustris) and Mare's tail (Hippuris vulgaris) are the dominant water-plants with emergent Grey Clubrush (Schoenoplectus tabernaemontani) and Great Reedmace (Typha latifolia).

TERRESTRIAL FLORA

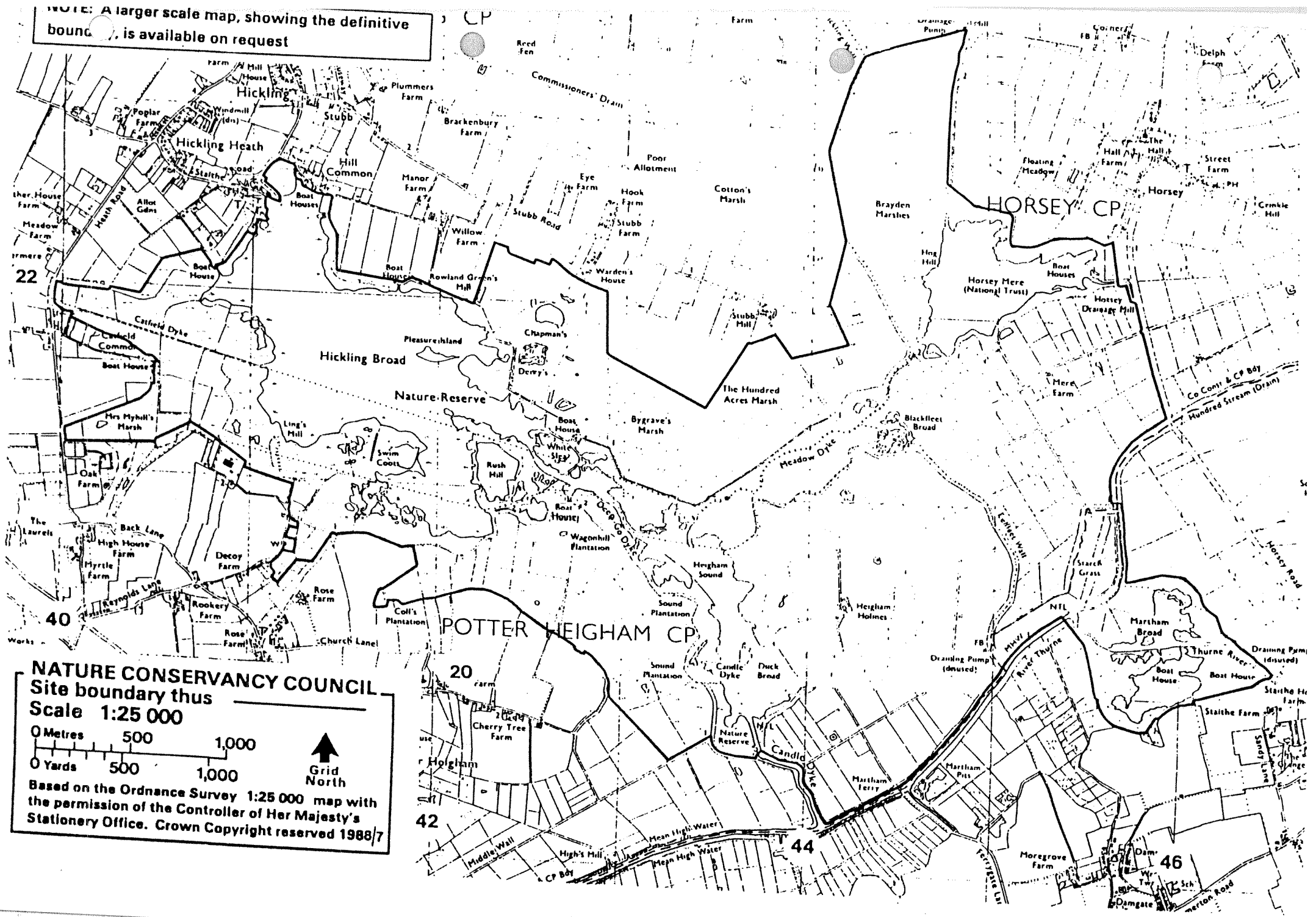
An unusual wet heath and acidic grassland mosaic occupies part of the site near the upland margin. The deeper peats support a community dominated by Purple Moor-grass (Molinia caerulea), Cross-leaved Heath (Erica tetralix) and Bog Mosses (Sphagnum spp). Other characteristic plants include Sundew (Drosera rotundifolia), Heather (Calluna vulgaris), Common Cotton-grass, Mat-grass (Nordus stricta) and Tawny Sedge (Carex hostiana). This grades into a type of fen grassland where conditions are drier and less acidic. Here the community is dominated by Soft Rush (Juncus effusus) and Sweet Vernal Grass (Anthoxanthum oderatum) with Common Spotted Orchid (Dactylorhiza fuchsii), Bog Pimpernel (Anagallis tenella), Meadow Thistle (Cirsium dissectum), Marsh Lousewort (Pedicularis sylvatica) and Marsh Cinquefoil (Potentilla palustris).

FAUNA

Aquatic invertebrates are well represented with a diverse coleoptera and Mollusca fauna. The site is particularly rich in dragonflies and includes the rare Norfolk Aeshna (Aeshna isosceles), scarce Libellula (Libellula fulva) and Hairy Dragonfly (Bracytron pratense). Forty species of moth have been recorded including the scarce Brown-veined Wainscot (Archanara dissoluta).

Those marshes that retain a tussocky grassland structure provide suitable nest sites for small numbers of Redshank, Lapwing, Oystercatcher, Snipe and Yellow Wagtail. The marginal vegetation and open water of the dykes also support nesting Gargeney, Shovelor, Tufted Duck, Reed Bunting and Sedge Warbler.

NOTE: A larger scale map, showing the definitive boundary, is available on request



NATURE CONSERVANCY COUNCIL

Site boundary thus

Scale 1:25 000

0 Metres 500 1,000

0 Yards 500 1,000

Grid North

SITE NAME: UPPER THURNE BROADS AND

COUNTY: NORFOLK

DISTRICT: North Norfolk, Great Yarmouth

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Broads Authority

National Grid Reference: TG 430210

Area: 1159.15 (ha) 2864.2

1:10,000: TG 32 SE TG 41 NW TG 42 SE TG 41 NE TG 42 SW

Ordnance Survey Sheet 1:50,000: 134

Date Notified (Under 1949 Act):

1954 - Hickling Broad-Horsey Mere
Martham Broad

Date of Last Revision:

1971 - Martham Broad
1981 - Hickling Broad-Horse

Date Notified (Under 1981 Act): 1988

Date of Last Revision: -

Other Information: This is a composite site made up of the Hickling Broad National Nature Reserve, and the 2 former separate Sites of Special Scientific Interest known as Hickling Broad-Horsey Mere and Martham Broad. Several additional areas are now included. The majority of the site is listed in "A Nature Conservation Review" (Ratcliffe 1977) and recognised as a wetland site of international importance under the Ramsar Convention. It is included within the Broads Environmentally Sensitive Area.

Description and Reasons for Notification:

The broads and marshes associated with the upper reaches of the River Thurne form one of the finest examples of an unreclaimed wetland complex in Britain. They are of national and international importance for nature conservation in supporting a wide range of wetland plant communities and associated animal species. The site comprises four large shallow lakes: Hickling Broad, Heigham Sound, Horsey Mere and Martham Broad, which together with several smaller water-bodies, are thought to have been formed by flooding of peat-diggings prior to the 13th century. These are surrounded by extensive areas of reedbed and species-rich sedge fen, with significant areas of associated grazing marsh and fen meadow. In addition, there are small areas of Alder carr and deciduous woodland. Several factors distinguish the Upper Thurne from the other Broadland River Valley Systems. In particular, the large expanse of open water, fen and grazing marsh habitats; the slightly brackish conditions which have arisen locally as a result of salt water seepage from the nearby coast, and the development of unusual acidic plant communities on the peaty soils. Furthermore, the site includes two of only four broads which have not suffered significant deterioration in water quality in recent years. Several of the fen plant communities present are almost exclusively confined to Broadland and the site supports an outstanding number of plant and animal species which are considered nationally rare.

Open Water and Marginal Swamp

Martham (South) and Blackfleet Broads retain one of the most diverse assemblages of aquatic plants in Broadland, supporting Yellow Water-lily (Nuphar lutea), White Water-lily (Nymphaea alba), Whorled Water-milfoil (Myriophyllum verticillatum), Greater Bladderwort (Utricularia vulgaris) and Common Club-rush

Continued/....

(Schoenoplectus lacustris). Mare's-tail (Hippuris vulgaris), Fennel Pondweed (Potamogeton pectinatus) and the nationally rare Holly-leaved Naiad (Najas marina) are all present in quantity, and the Stonewort Nitellopsis obtusa, which is scarce throughout Europe, has been recorded. The latter three species are indicative of the brackish nature of the broad. In contrast Hickling Broad, one of the largest and oldest expanses of open water in East Anglia, and the adjacent Horsey Mere have suffered deterioration in water quality over recent years due to increased nutrient input from several sources, including a roost of overwintering Black-headed Gulls. Nevertheless they retain a limited aquatic flora including Mare's-tail and Spiked Water-milfoil (Myriophyllum spicatum), and together the two broads attract outstanding numbers of wintering wildfowl, with particularly notable populations of Teal, Shoveler and Gadwall. Shallow scrapes have been created in places near the Broads, and these provide both feeding areas for migrant birds and nesting areas for several uncommon species such as Avocet, Ringed Plover and Little Tern.

A fringing zone of reedswamp dominated by Common Reed (Phragmites australis) and Lesser Bulrush (Typha angustifolia) surrounds the broads, and the presence of Marsh-mallow (Althaea officinalis), Danish Scurvygrass (Cochlearia danica) and Sea-milkwort (Glaux maritima) in places attests to the influence of brackish water here. Birds nesting around the margins of the broads include Water Rail, Bittern, Gadwall, Garganey and particularly significant numbers of Pochard. The wildfowl also nest along drainage dykes in the grazing marshes.

Fen

Fen communities occur on the more consolidated ground behind the reedswamp, and these take the form of extensive reedbed dominated by Common Reed, commercial sedge beds dominated by Great Fen-sedge (Cladium mariscus) and species-rich mixed fen of both reed and sedge. The reedbeds in particular, most of which are regularly cut, are of outstanding importance for their characteristic Broadland birds including nationally important breeding populations of rare species such as Marsh Harrier, Bittern, Bearded Tit and Savis Warbler. The complementary mixed fen areas are of a vegetation type now almost entirely confined to Broadland, and this highly characteristic community comprises Common Reed and Great Fen-sedge with a wide variety of tall associates such as Yellow Loosestrife (Lysimachia vulgaris), Hemp Agrimony (Agrimonia eupatoria), Purple Loosestrife (Lythrum salicaria), Greater Spearwort (Ranunculus lingua) and a number of localised species such as Milk-parsley (Peucedanum palustre), Cowbane (Cicuta virosa), Marsh Sow-thistle (Sonchus palustris) and Greater Water-parsnip (Sium latifolium). Beneath these components is a lower layer generally dominated by Blunt-flowered Rush (Juncus subnodulosus), Tufted Sedge (Carex elata) and Black Bog-rush (Schoenus nigricans), and probably developed in response to traditional mowing of the fens as in parts of the Ant Valley. A further particularly distinctive feature of this community in the Thurne Valley is the presence of salt-tolerant plants such as Parsley Water-dropwort (Oenanthe lachenalii) and Brookweed (Samolus valerandi). In places within the fen protected from the rise and fall in water levels acidic conditions have developed. Here the vegetation is characterised by carpets of Bog Mosses (principally Sphagnum fimbriatum and S palustre) under a canopy of Downy Birch (Betula pubescens). Round-leaved Wintergreen (Pyrola rotundifolia) occurs sporadically and large populations of the rare Crested Buckler-fern (Dryopteris cristata) are present.

In contrast to the fen communities which have developed in the river's flood-plain under the influence of calcareous groundwater, a second type of acidic community has arisen locally on the margins of the site where fed by base-poor seepage water. This community, found rarely in the other Broadland river valleys, supports

Continued/....

locally uncommon species such as White Sedge (Carex curta), Marsh Cinquefo (Potentilla palustris), Bogbean (Menyanthes trifoliata), Cross-leaved Heath (Eri tetralix) and Petty Whin (Genista anglica), together with the Bog Mosses S-hagnu plumulosum and S subsecundum var inundatum.

The large size, floristic diversity, restricted distribution and historica continuity of these fen communities has resulted in a highly specialised habita which supports a remarkable number of rare and notable insect species. It i one of the principal remaining strongholds of the Swallowtail Butterfly (Papili machaon brittanica), whose larvae feed on Milk-parsley, and the moth fauna include an exceptional total of 48 species considered uncommon such as the Fenn's Wainsco (Photedes brevilinea), Reed Leopard (Phragmataecia castaneae) and Small Dotte Footman (Pelosia obtusa), the latter known from only one other British site These areas support an unusual coleopteran (beetle) fauna dependant on manage fen areas with relatively low levels of litter, including the rare ground beetl Dromius longiceps. Wetter areas and dykes within the fen are also of considerabl importance for their aquatic coleoptera, with several relict fen species includin the rare Agabus striolatus and Hydroporus scalesianus.

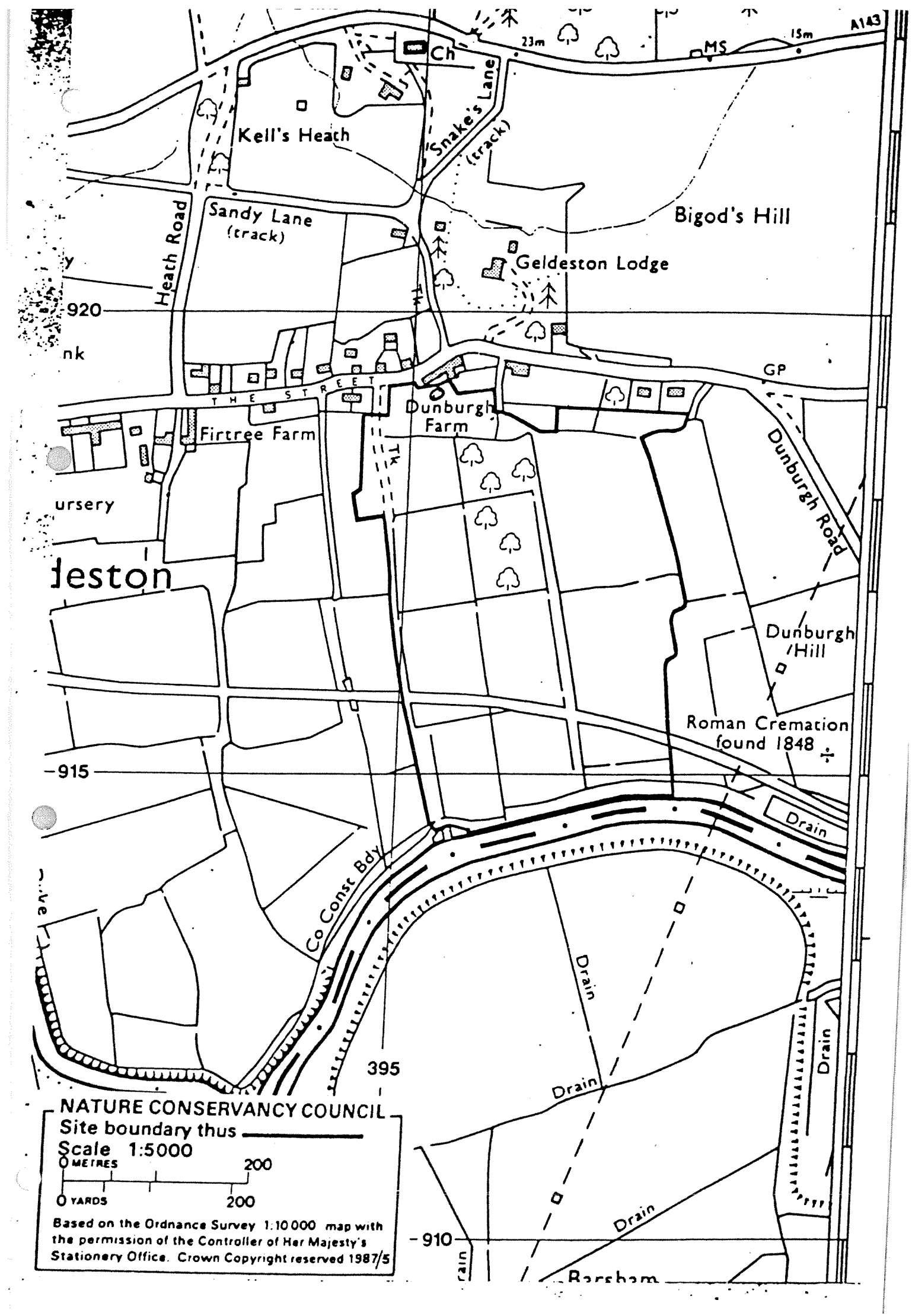
Grazing Marsh

Extensive areas of grazing marsh provide breeding grounds for birds such as nipe Lapwing and Redshank and are important feeding areas for the large numbers o wintering wildfowl, including a nationally important flock of Bewick's Swans attracted to the site. The associated dykes have a diverse aquatic flora an show a range of salinities, with Sea Club-rush (Scirpus maritimus), Grey Club-rus (Schoenoplectus tabernae-montani), Whorled Water-milfoil (Myriophyllu verticillatum) and Fen Pondweed (Potamogeton coloratus) present in the brackis dykes nearest the coast. Further inland they support a more typical freshwate Broadland flora that includes Frogbit (Hydrocharis morsus-ranae), Water-viole (Hottonia palustris), Greater Bladderwort and the scarce Water-soldier (Stratiote aloides). A wide variety of dragonflies is associated with the dykes, amongs which are the uncommon Coenagrion pulchellum, Brachytron pratense and Norfol Aeshna (Aeshna isosceles), the latter known from only a few Broadland localitie in Britain. Floristically rich mowing marsh is present locally and is notabl for the large populations of Common Spotted-orchid and Southern Marsh-orchi (Dactylorhiza fuchsii and D praetermissa).

Woodland

Areas of old Oak plantation and Alder (Alnus glutinosa) and Grey Willow (Sali cinerea) carr within the site are not extensive, and support a flora o shade-tolerant fen plants such as Bittersweet (Solanum dulcamara) and Yello Iris (Iris pseudacorus). A number of specialised beetles and moths generall associated with old woodland have been recorded from these areas, which contribut to the overall diversity of the site. Scattered trees and scrub provide winte roost sites for raptors.

Hickling Broad is an important site for research into the origin of the Norfol Broads and problems currently affecting them.



NATURE CONSERVANCY COUNCIL

Site boundary thus

Scale 1:5000

0 METRES 200

0 YARDS 200

File Ref: EA/N/292/14

COUNTY: Norfolk

SITE NAME: GELDESTON MEADOWS

DISTRICT: South Norfolk

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981.

Local Planning Authority: South Norfolk District Council

National Grid Reference: TM 396916 Area: 3.4 [ha] 8.5

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TM 39 SE

Date Notified [Under 1949 Act]: - Date of Last Revision: -

Date Notified [Under 1981 Act]: 1988 Date of Last Revision: -

Other Information:

A new site.

Description and Reasons for Notification:

The site lies in the flood plain of the River Waveney and forms an exceptionall diverse example of the traditionally managed grazing meadows of the area. high water-table is maintained throughout the year with light summer grazin by cattle with some areas mown for hay. Gradation of the water-table an variations in soil type which range from peats to clays have provided condition for the development of a number of plant communities and as a result a very divers flora has developed. In addition, an area of Alder carr and a series of drainag dykes are included within the site.

The major part of the site is wet meadow grassland dominated by Sweet Verna Grass (Anthoxanthum odoratum), Common Quaking Grass (Briza media) and Creste Dog's-tail (Cynosurus cristatus). A floristically diverse short-sward grasslan has developed in some fields on peaty soils, with mosses and sedge well-represented including Carnation Sedge (Carex panicea), Glaucous Sedge (Care flacca) and Flea Sedge (Carex pulicaris). Associated herbs characteris c o calcareous conditions, include Marsh Arrowgrass (Triglochin palustris), Bo Pimpernel (Anagallis tenella), Bogbean (Menyanthes trifoliata) and Blunt-flowere Rush (Juncus subnodulosus). Within this turf a number of plants associated wit less calcareous conditions are present, the most distinctive of which are Mars Cinquefoil (Potentilla palustris), Tormentil (Potentilla erecta), Common Sedg (Carex nigra) and the uncommon Marsh Fern (Thelypteris thelypteroides).

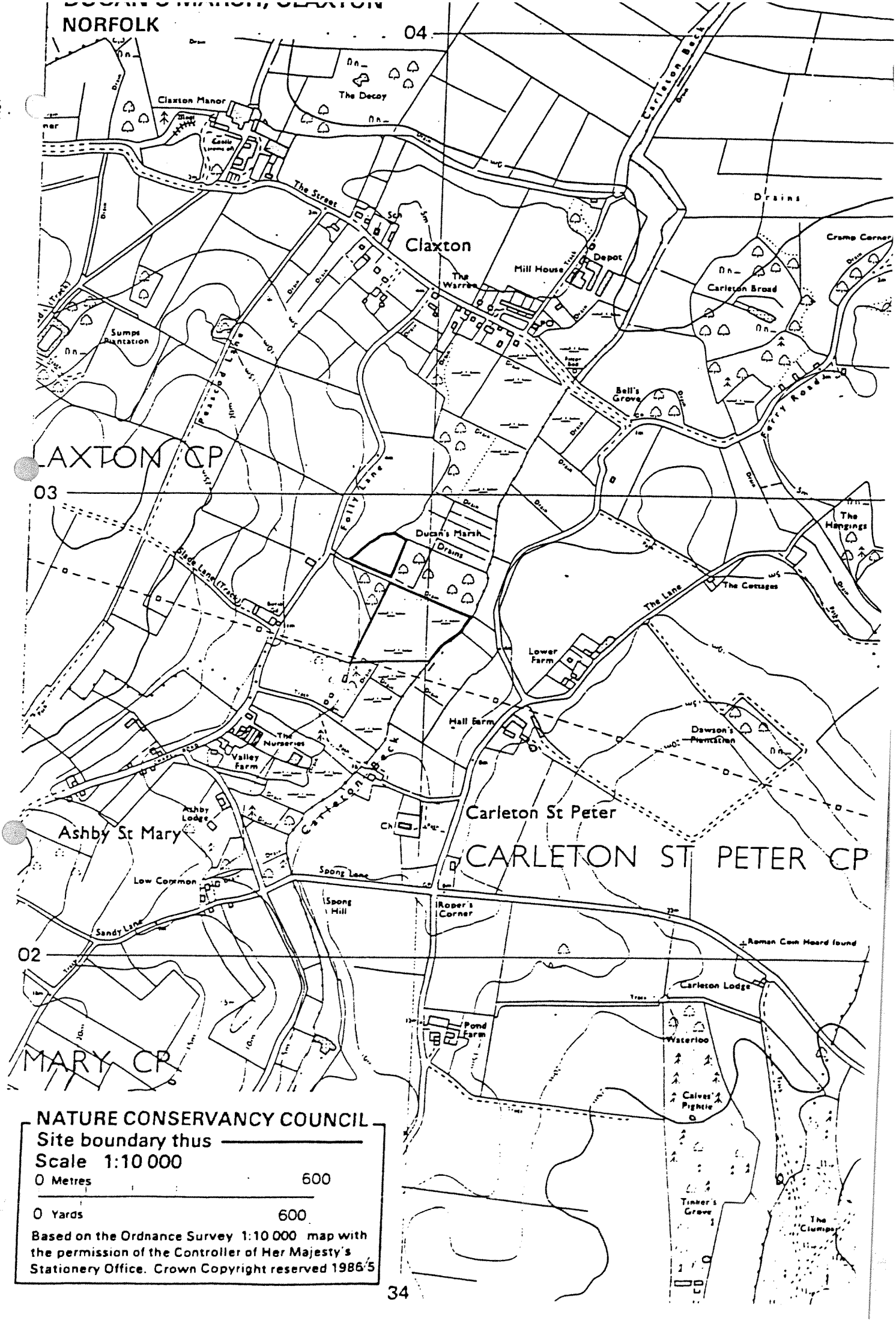
A particularly interesting feature of the grasslands is the close associatio of typically drier hay-meadow species such as Oxeye Daisy (Leucanthemum vulgare) Yellow-rattle (Rhinanthus minor agg.), Autumn Hawkbit (Leontodon autumnalis and Common Knapweed (Centaurea nigra) with the fen grassland flora. On the highe valley slope where conditions become drier these species replace the dampe grassland species.

Continued....

The influence of periodic winter flooding over more mineral soils adjacent to the river has resulted in the establishment of a taller ranker vegetation with abundant Reed Canary Grass (Phalaris arundinacea), Marsh Valerian (Valeriana officinalis), Meadowsweet (Filipendula ulmaria) and Marsh Marigold (Caltha palustris).

The system of drainage dykes supports a number of aquatic plants including Water Dock (Rumex hydrolapathum), Lesser Water-parsnip (Berula erecta), Tubular Water Dropwort (Oenanthe fistulosa), Water Milfoil (Myriophyllum spicatum) Cyperus Sedge (Carex pseudocyperus) and Floating Sweet Grass (Glyceria fluitans). An area of Alder (Alnus glutinosa) Carr is present within the site.

Typical grazing-marsh birds are well represented including breeding snipe, lapwing, reed warbler and reed bunting.



NATURE CONSERVANCY COUNCIL

Site boundary thus

Scale 1:10 000

0 Metres 600

0 Yards 600

File Ref: EA/N/263/14 WQE

COUNTY: Norfolk

SITE NAME: DUCAN'S MARSH, CLAXTON

DISTRICT: South Norfolk

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: South Norfolk District Council

National Grid Reference: TG 339027

Area: 3.6 [ha] 8.8

Ordnance Survey Sheet 1:50,000: 134

1:10,000: TG 30 SW

Date Notified [Under 1949 Act]: N/A

Date of Last Revision: -

Date Notified [Under 1981 Act]: 1986

Date of Last Revision: -

Other Information:

A new site

Description and Reasons for Notification:

Ducan's Marsh is situated in the valley of a small tributary of the River Ya and is one of the richest areas of unimproved, wet valley grassland now remaini in East Norfolk. Springs emerge from the valley-side and species-rich fen a fen grassland communities have developed in the seepage zones. The plant communiti include several uncommon species and are maintained by a traditional manageme of light summer grazing.

Calcareous fen communities cover much of the site and are of the type dominat by Blunt-flowered Rush [Juncus subnodulosus] and Black Bog-rush [Schoenus nigrican with abundant Purple Moor-grass [Molinia caerulea] Glaucous Sedge [Carex flacca Common Sedge, [C.nigra] and Marsh Horsetail [Equisetum palustre]. This specie rich community includes many notable plants such as Common Butterwort [Pinguicu vulgaris], Bog Pimpernel [Anagallis tenella], Marsh Helleborine [Epipact palustris], Fragrant Orchid [Gymnadenia conopsea], Flat-sedge [Blysmus compressus Meadow Thistle [Cirsium dissectum] and the locally uncommon Marsh Fern [The[illegible]teri thelypteroides].

Fen grassland occurs on the drier parts of the site where the sward is dominate by Blunt-flowered Rush and a variety of grasses including Crested Dog's-tai [Cynosurus cristatus], Quaking Grass [Briza media] and Sweet Vernal-gras [Anthoxanthum odoratum]. Associated species include Yellow Rattle [Rhinanthu minor], Ragged Robin [Lychnis flos-cuculi], Cuckoo Flower [Cardamine pratensis and large populations of Common Spotted Orchid [Dactylorhiza fuchsii] and Souther Marsh Orchid [D.praetermissa].

There is, in addition, a small area of carr woodland dominated by Alder [Alnu glutinosa] on the edge of the site. Scrub is scattered thinly over the meadow and includes Purple Osier [Salix purpurea].

NATURE CONSERVANCY COUNCIL

Site boundary thus

Scale 1:25 000

0 500 1,000 Yards

0 500 1,000 Metres

Grid North

Based on the Ordnance Survey 1:25 000 map with the permission of the Controller of Her Majesty's Stationery Office. Crown Copyright reserved 1989/3

NOTE: A larger scale map, showing a detailed boundary is available on request

COUNTY: Norfolk

DISTRICT: North Norfolk

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Broads Authority

Area: 742·64(ha)1834·32(a

National Grid Reference: TG 362 213

Ordnance Survey Sheet 1:50,000: 134

1:10,000: TG 32 SW SE
TG 31 NE

Date notified (Under 1949 Act): 1954 Barton Broad
Sutton Broad
1971 Ant Marshes

Date of last Revision:
1968 - Barton Broad
1974 - Sutton Broad
- Ant Marshes

Date notified (Under 1981 Act): 1989

Date of last Revision:

Other Information:
This is a composite site made up of the 3 former separate SSSIs known as Sutton Broad, Barton Broad and Ant Marshes. The site is listed in "A Nature Conservation Review" (Ratcliffe 1977) and is included within the Broads Environmentally Sensitive Area.

Reasons for Notification

The flood-plain of the middle Ant valley, one of the 5 principal river valley systems constituting Broadland, supports one of the most extensive remaining areas of undeveloped primary fen habitats in Britain, and is considered to form the finest example of unpolluted valley fen in Western Europe. Nationally important stands of carr woodland are also present, principally in the vicinity of Barton Broad, and the wide range of wetland habitats has given rise to an associated fauna of exceptional interest.

In contrast with other Broadland river valleys, there are extensive areas of species-rich mixed fen communities that are still regularly cut for reed and sedge. Past management coupled with local hydrological and substrate variations has resulted in the development of the most diverse pattern of fen vegetation of all the Broadland valleys, and provides the only known sites for several plant communities and uncommon species that were once more widespread in Broadland. Further particularly distinctive features of the Ant Valley wetlands include the presence of numerous pools and turf ponds within the fen, plus a diversity of woodland types which exhibit similarities to those of the Bure Valley. The site also supports a wide range of breeding birds and insects including the majority of the broadland specialities.

Open Water and Marginal Swamp

The River Ant runs the length of the site and is extensively utilised by boat traffic. Closely associated with the river are three areas of open water created by the flooding of medieval peat-diggings, namely Sutton Broad, Cromes Broad and Barton Broad. Formerly, these areas supported a very rich flora and fauna, but nutrient enrichment over the last three decades has resulted in a marked deterioration in water quality and consequent disappearance of most aquatic plants. Algal blooms occur in summer, and the broads support only small amounts of aquatic macrophytes such as Yellow Water-Lily (Nuphar lutea) and White Water Lily (Nymphaea alba).

continued

Active measures are now being taken to reduce phosphate levels and restore a more diverse flora in Barton Broad. At the turn of the century, Sutton Broad was a large area of open water, but has now been reduced to a central navigable channel surrounded by a floating raft of fen vegetation. Crome's Broad, which lies in a small side-valley, is more isolated from the river than the other three areas, and supports a less impoverished aquatic flora. Rigid Hornwort (Caratophyllum demersum) dominates, with small amounts of Water Starwort (Callitriche spp) present. Together with Barton Broad it attracts moderate numbers of wintering wildfowl; including Mallard, Teal, Wigeon, Shoveler, Pochard and Tufted Duck.

Areas of Reedswamp dominated by Common Reed (Phragmites australis), Lesser Reedmace (Typha angustifolia), and more locally, Common Club-rush (Schoenoplectus lacustris), occur around the margins of the Broads, providing a nesting habitat for wildfowl such as Gadwall, Pochard, Teal, Shoveler and Tufted Duck. Near Barton Broad, tussocks of Tussock-sedge (Carex paniculata) have gained a hold within areas of reedbed, depressing the vegetation and recreation swampy hollows between them. Here, a tall-fen vegetation has developed on the tops of tussocks, and this is prone to invasion by tree saplings with consequent development to swamp carr. Swamp vegetation also occurs in association with pools in the fen vegetation, locally dominated by Saw Sedge (Cladium mariscus) or Tufted Sedge (Carex elata).

A network of species-rich dykes support an abundance of aquatic plants, including Frogbit (Hydrocharis morsus-ranae), Water Violet (Hottonia palustris), Spiked Water-milfoil (Myriophyllum spicatum) and the local Broadland species, Water Soldier (Stratiotes aloides).

Fen

Extensive areas of fen vegetation have developed on flat waterlogged floodplains on peat alongside the river, and show an outstanding range of variation, including plant communities almost wholly restricted to Broadland. These species-rich fens are principally dominated by Common Reed, and associates include Great Fen-sedge (Cladium mariscus), Purple Small-reed (Calamagrostis canascens), Yellow Loosestrife (Lysimachia vulgaris), Purple Loosestrife (Lythrum salicaria), Common Valerian (Valeriana officinalis), Yellow Iris (Iris pseudacorus), Water Dock (Rumex hydrolapathum), and a large population of Milk Parsley (Peucedanum palustre). Associated with these, is a diverse understorey of Blunt-flowered Rush (Juncus subnodulosus), Marsh Cinquefoil (Potentilla palustris), and Purple Moor-grass (Molinia caerulea), together with a variety of herbs such as Marsh Bedstraw (Galium palustre), Water Mint (Mentha aquatica) and occasional Marsh Helleborine (Epipactis palustris).

Within this tall-fen community there is considerable variation, and several distinct vegetation types can be recognised. Fairly extensive areas are managed as commercial sedge-beds cut on a three to four year rotation so that Great Fen-sedge has attained prominence. Black Bog-rush (Schoenus nigricans) is an important component of the understorey throughout much of the cut areas, and in derelict mowing-marshes, woody species such as Bog-myrtle (Myrica gale), have invaded the open fen. Ferns are especially abundant and include Royal Fern (Osmunda regalis), the uncommon Marsh Fern (Thelypteris palustris) and populations of the nationally rare Crested Buckler-fern (Dryopteris cristata). In contrast, wetter areas remain as unmown primary fen, often developed as a floating mat of vegetation which has colonised open water, as at Sutton Broad. Cyperus sedge (Carex pseudocyperus), Greater Spearwort (Ranunculus lingua) and Slender Sedge (Carex lasiocarpa), are all markedly more frequent here than in other fen areas, and particularly notable species include Greater Water Parsnip (Sium latifolium), Cowbane (Cicuta virosa), and Fibrous Tussock-sedge (Carex appropinquata).

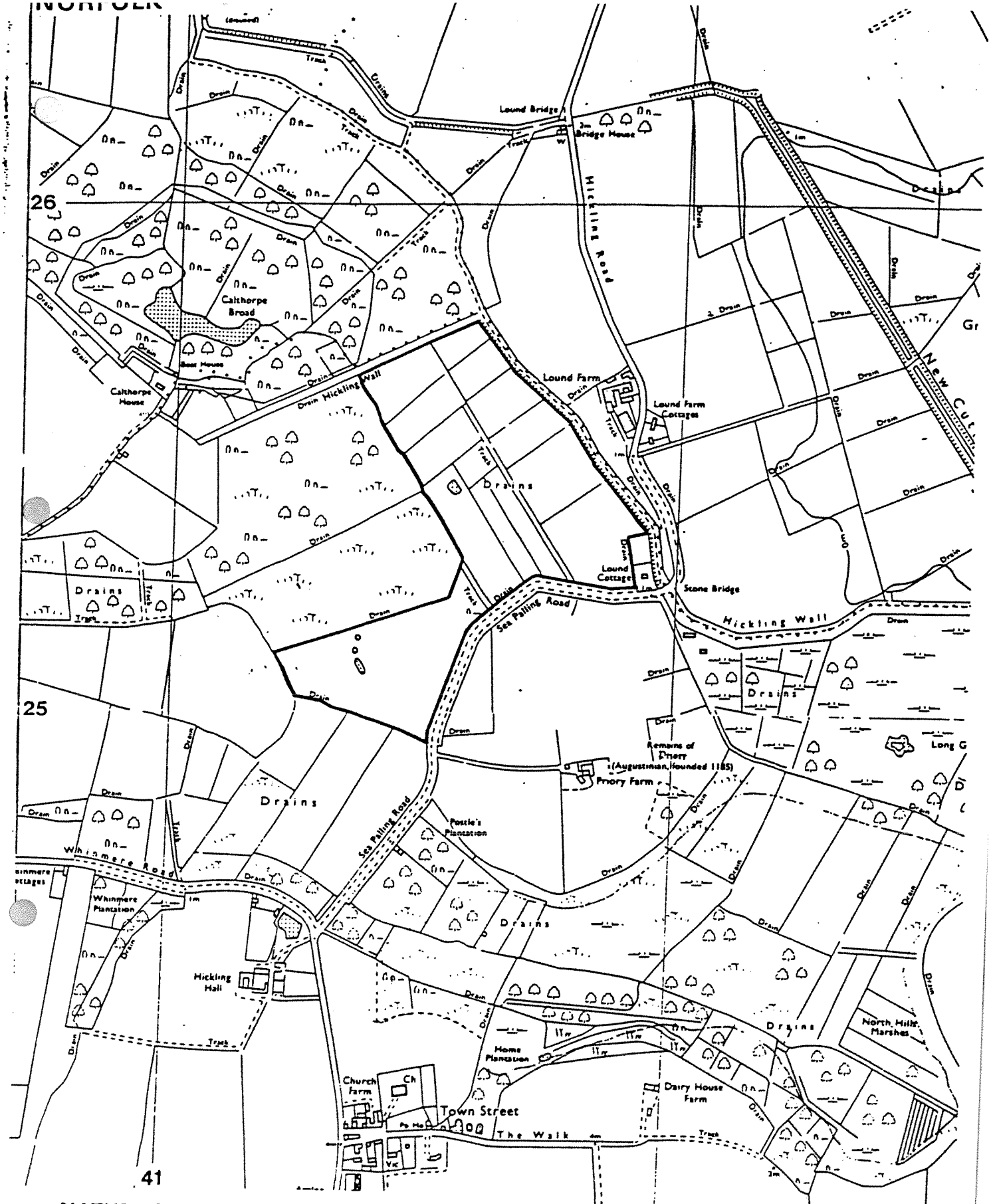
continued

An interesting community occurs along the edge of the fens where they ba[illegible] onto the valley slopes of the adjoining upland. Here, Purple Moor-grass is generall[illegible] dominant with frequent Meadow Thistle (Cirsium dissectum) and Heather (Callun[illegible] vulagaris), Cross-leaved Heath (Erica tetralix), Mat Grass (Nardus stricta) and Tormentil (Potentilla erecta).

Small pools and stands of mire vegetation occur in shallow depressions as an intimate mosaic within the tall fen, and are largely associated with nineteenth century peat-diggings and turf ponds. Such areas are relatively isolated from the influence of nutrient-rich river water and support a number of plant communities not found elsewhere in Broadland. The numerous permanent pools attest to the high water levels throughout the year, and support a diversity of aquatic plants including the local species: Lesser Water-plantain (Baldellia ranunculoides), Fen Pondweed (Potamogeton coloratus), Marsh St John's wort (Hypericum elodes) and three species of Bladderwort (Utricularia spp). These pools, together with associated wetter areas of fen, are of exceptional interest for their aquatic coleoptera (water-beetles), and indeed the site is considered to be the most important in Britain for this group. The many rare relict fen species present are indicative of an undisturbed post-glacial history, and include (Agabus striolatus), (Hydranea palustris) and (Hypdroporus scalesciarius).

Hydroseral succession has resulted in the development of particularly species rich communities in old turf-ponds, characterised by Slender Sedge, Bottle Sedge (Carex rostrata) and the notable Lesser Tussock Sedge (Carex diandra) over a carpet of bryophytes such as the uncommon mosses (Cinclidium stygium) and (Scorpidium scorpiodes). Other species present include Common Cotton-grass (Eriophorum angustifolium), Bogbean (Meyanthes trifoliata), Grass-of-Parnassus (Parnassia palustris), Great Sundew (Drosera anglica), Bogsedge (Carex limosa), Early Marsh-orchid (Dactylorhiza incarnata), Marsh Lousewort (Pedicularis palustris) and the notable Narrow-leaved Marsh-orchid (Dactylorhiza traunsteineri). The nationally rare Fen Orchid (Liparis loeselii) also grows here at one of its few British stations.

The site is of national importance for its fenland invertebrate fauna, and a considerable number of rare or notable species have been recorded from several groups. There is a large population of the Swallow-tail Butterfly (Papilio machaon brittanica), whose larvae feed on Milk-Parsley, and it is the only known site in Britain for (Trogus lapidator), a wasp parasite on the Swallowtail. 45 species of moth considered rare or notable are present, including the only British localities for the Small Dotted Footman (Pelosia obtusa), whose larvae depend on algae attached to Reed litter. The weevil, (Ceutorhynchus querceti) is one of several rare coleoptera in addition to the water-beetles, and a particularly large number of rare or notable Diptera (Trueflies) has been recorded.



NATURE CONSERVANCY COUNCIL

Site boundary thus

Scale 1:10 000

0 Metres 600

0 Yards 600

File Ref: EA/N/270/14

COUNTY: Norfolk

SITE NAME: PRIORY MEADOWS, HICKLI

DISTRICT: North Norfolk

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: North Norfolk District Council

National Grid Reference: TG 417254 Area: 24.0 [ha] 59.

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TG 42 NW, SW

Date Notified [Under 1949 Act]: - Date of Last Revision: -

Date Notified [Under 1981 Act]: 1986 Date of Last Revision: -

Other Information:

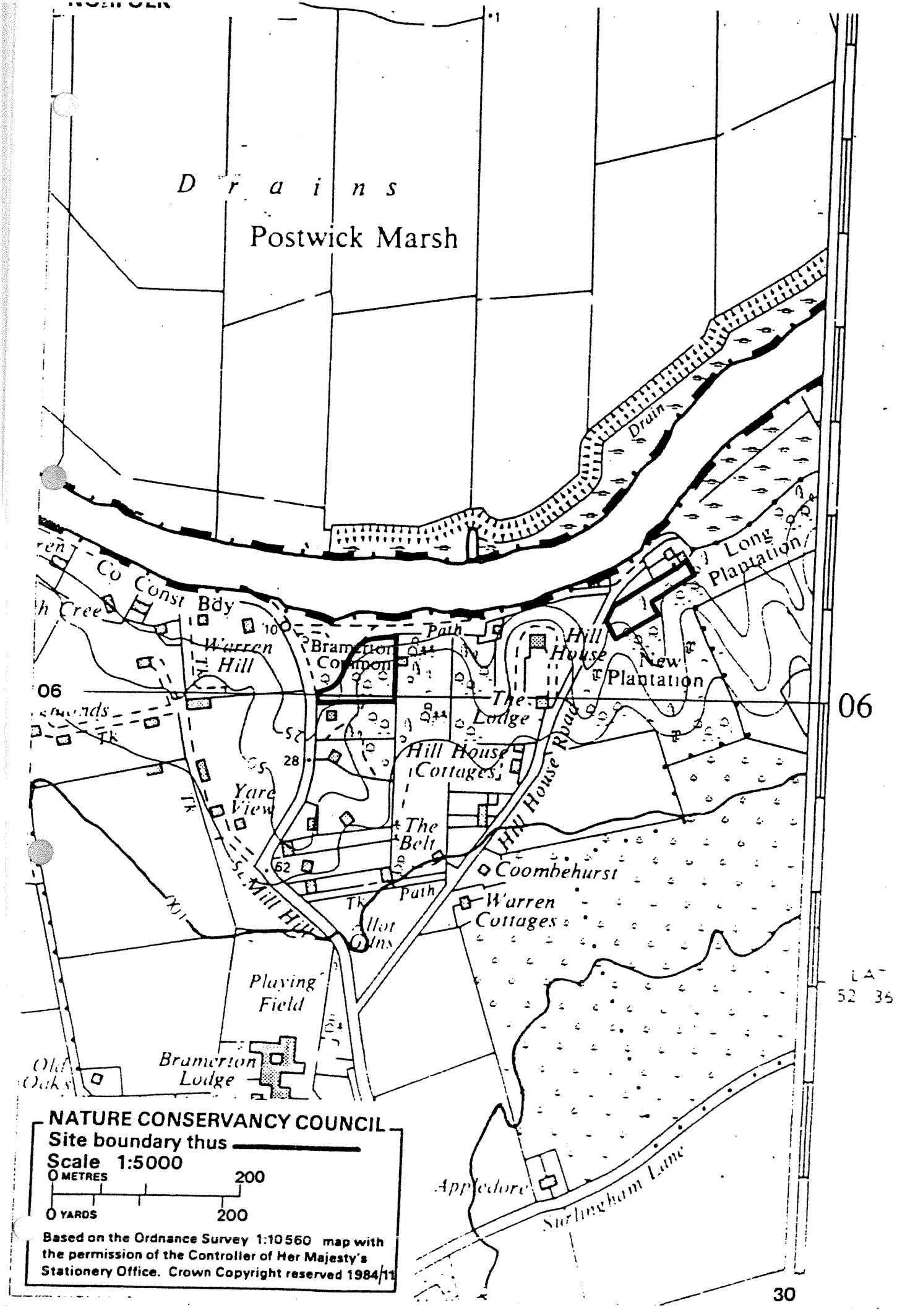
A new site.

Description and Reasons for Notification:

This site consists of an extensive area of permanent grassland on damp, ac peats. The sward receives an annual hay-cut in mid-summer and the meadows re an exceptionally rich and varied flora due to this traditional management. acidic plant communities are very unusual for Broadland where the majority fen meadows are on shallow calcareous peats. A system of dykes drains the mea and these contain a distinctive assemblage of water-plants.

The grass-sward is dominated by Heath Grass [Danthonia decumbens], S Vernal-grass [Anthoxanthum odoratum] and Velvet Bent [Agrostis canina] with loc frequent Purple Moor-grass [Molinia caerulea] and Yorkshire Fog [Holcus lanat Many herb species are present which are characteristic of underlying damp ac soils and include Tormentil [Potentilla erecta], Heath Bedstraw [Galium saxati Marsh Cinquefoil [Potentilla palustris] and exceptionally large populations Meadow Thistle [Cirsium dissectum] and Heath Spotted Orchid [Dactylorhiza macula Other notable plants include Common Cotton-grass [Eriophorum angustifoli Creeping Willow [Salix repens] and Lousewort [Pedicularis sylvatica].

A distinctive flora has developed along the dry dyke edges where there is freq Royal Fern [Osmunda regalis], White Climbing Fumitory [Corydalis clavicul and the uncommon Milk Parsley [Peucedanum palustre]. The slightly acidic wa in the dykes supports a wide range of water plants including Blunt-leaved Pondw [Potamogeton obtusifolius], Bog Pondweed [P. polygonifolius], Small Bur-r [Sparganium minimum] and Floating Scirpus [Eleogiton fluitans].


Drains
Postwick Marsh
Drain
Co Const Bdy
Warren Hill
Brameton Common
Path
Hill House
New Plantation
Long Plantation
06
The Lodge
Hill House Cottages
Hill House Road
Yare View
The Belt
Coombehurst
Warren Cottages
Mill Hill
Playing Field
Brameton Lodge
Appledore
Surlingham Lane
NATURE CONSERVANCY COUNCIL
Site boundary thus
Scale 1:5000
0 METRES 200
0 YARDS 200
Based on the Ordnance Survey 1:10560 map with the permission of the Controller of Her Majesty's Stationery Office. Crown Copyright reserved 1984/11

File Ref: EA/N/13/14 WDS

COUNTY: Norfolk

SITE NAME: BRAMERTON PITS

DISTRICT: South Norfolk

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: South Norfolk District Council

National Grid Reference: TG 295060
TG 298061

Area: 0.5 [ha] 1.2 [

Ordnance Survey Sheet 1:50,000: 134

1:10,560 : TG 20 NE

Date Notified [Under 1949 Act]: 1954

Date of Last Revision: -

Date Notified [Under 1981 Act]: 1985

Date of Last Revision: -

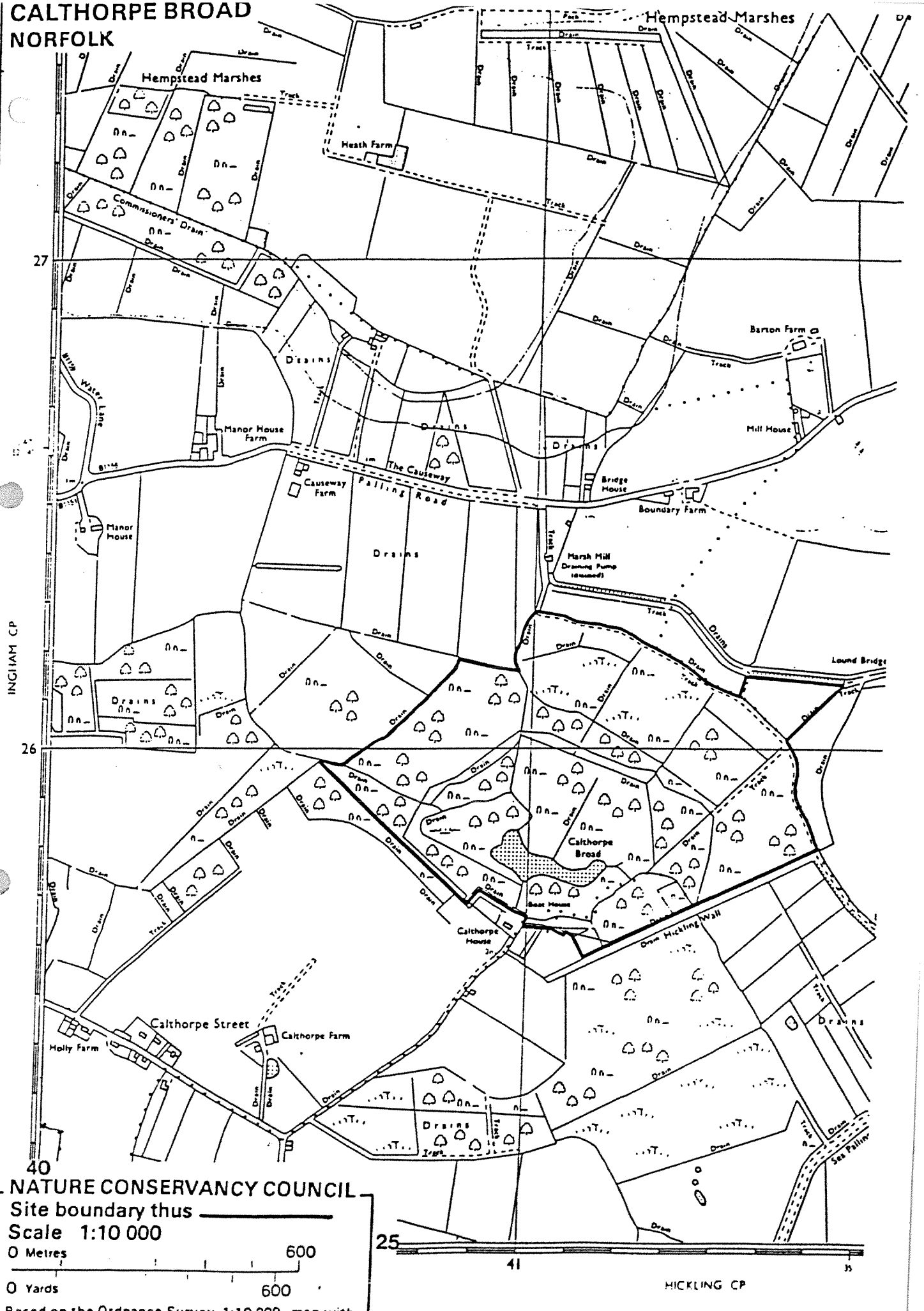
Other Information:

Reasons for Notification:

This site which consists of two disused gravel pits is notified for its geological interest. Bramerton Common Pit has been regarded as the type section for the Norwich Crag of Lower Pleistocene age since the last century. Blake's Pit has recently been designated the type site for the Bramertonian temperate stage. At both localities sands, silts and gravels have yielded marine Mollusca [together with rare non-marine species], Foraminifera and vertebrates. Studies of pollen, Foraminifera and Mollusca from Blake's Pit have demonstrated change from temperate [Bramertonian] to cold [Pre-Pastonian] climatic conditions. A key locality of national importance to Pleistocene studies.

The Bramerton Pits with their marine 'crag' deposits are remarkable for their rich vertebrate fossils. The main fauna includes marine fishes, extinct voles, a gomphothene mastodont and an extinct otter. This is the only fauna definitely attributable to the Bramertonian Stage making this an outstanding site in our understanding of the succession of vertebrate [particularly mammalian] faunas in the Pleistocene.

CALTHORPE BROAD
NORFOLK



NATURE CONSERVANCY COUNCIL

Site boundary thus

Scale 1:10 000

0 Metres 600

0 Yards 600

COUNTY: Norfolk

File Ref: EA/N/25/14 WEG

SITE NAME: CALTHORPE BROAD

DISTRICT: North Norfolk

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: North Norfolk District Council

National Grid Reference: TG 412258 Area: 43.5 [ha] 107.4

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TG 42 NW

Date Notified [Under 1949 Act]: 1954 Date of Last Revision: 1971

Date Notified [Under 1981 Act]: 1984 Date of Last Revision: -

Other Information:

A Grade 1 NCR site. Owned by the Nature Conservancy Council.

Reasons for Notification:

Calthorpe Broad is a small isolated Broad situated in the Upper Thurne catchment. Th principal interest of this site is centred on the Broad itself, which unlike the majority of ope waters in the region still retains a diverse and productive aquatic flora and fauna. Sever locally uncommon marginal and water plants are present. Surrounding the Broad is alde willow-birch carr, small areas of open fen and to the north, an area of unimproved grazin marsh. The Broad is an important research site and it has been used by MAFF for extensiv studies on the ecology of the coypu, an introduced mammal that has become a pest i Broadland.

The Broad and surrounding dykes are isolated from the adjacent farmland and the water are naturally base-poor and low in nutrients. The low nutrient status has ensured the retentio of a rich assemblage of water plants that include Mare's-tail [Hippuris vulgaris], Water Viole [Hottonia palustris], Bluntleaved Pondweed [Potamogeton obtusifolius], Spiked Water-milfoi [Myriophyllum spicatum], Yellow and White Water-lilies [Nuphar lutea and Nymphae alba] Floating Scirpus [Eleogiton fluitans] and the nationally scarce Water Soldier [Stratiotes aloides]. The marginal and emergent vegetation is also diverse with Sweet Flag [Acorus calamus], Yellow Flag [Iris pseudacorus], Flowering Rush [Butomus umbellatus], Marsh Pennywort [Hydrocotyle vulgaris] and Bogbean [Menyanthes trifoliata]. A small area of open fen on the north side of the Broad includes Marsh Cinquefoil [Potentilla palustris], Lesser Spearwort [Ranunculus flammula] and Adder's Tongue [Ophioglossum vulgatum].

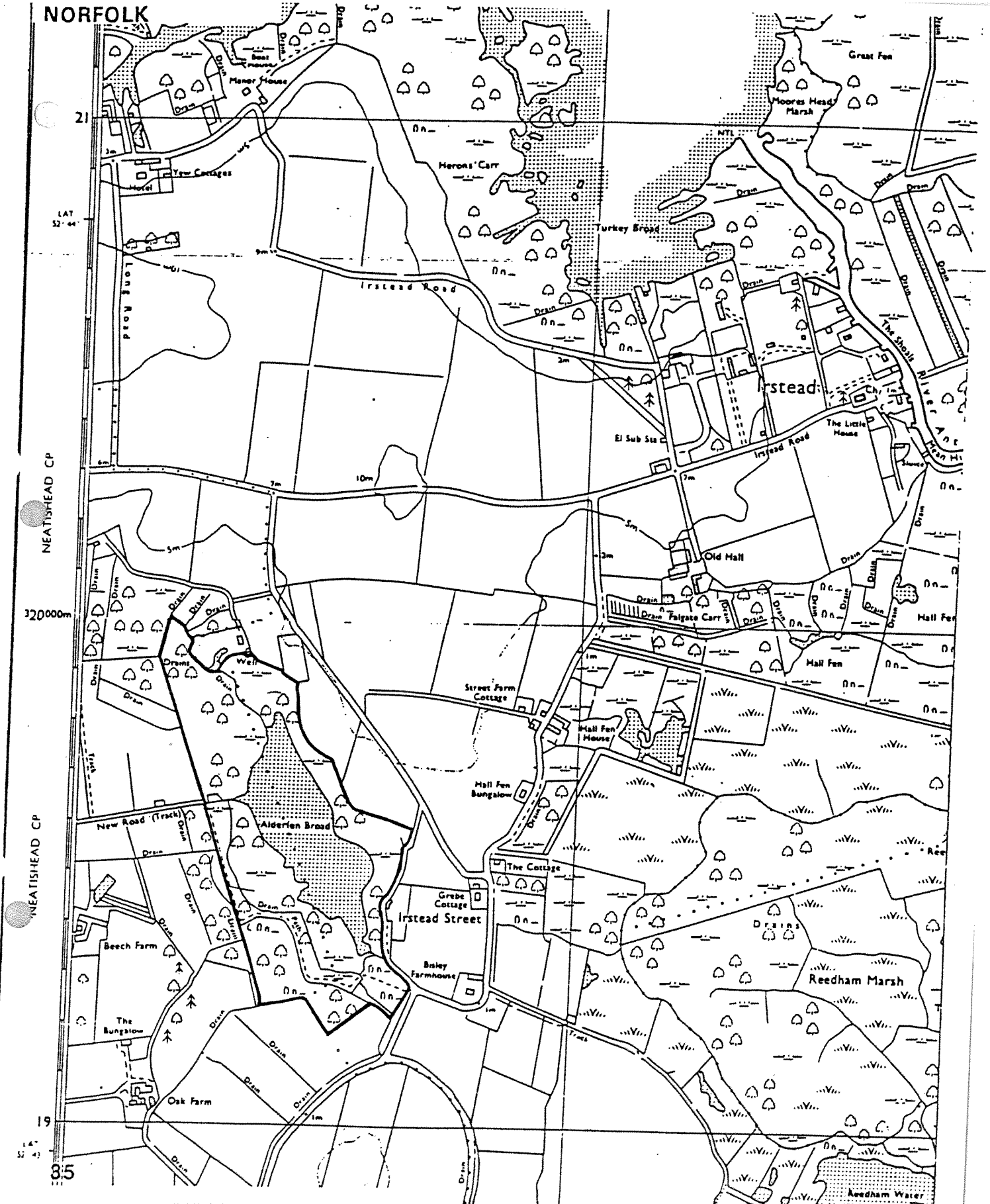
Mixed carr woodland surrounds the Broad and is dominated by Alder [Alnus glutinosa], Common Sallow [Salix cinerea] and Birch [Betula pubescens]. The ground flora is varied and includes species typical of Broadland carrs eg. Lesser Pond Sedge [Carex acutiformis], Yellow Flag, Gypsywort [Lycopus europaeus], Marsh Fern [Thelypteris thelypteroides] and species associated with more acidic conditions, eg. Royal Fern [Osmunda regalis], Cotton-grass [Eriophorum angustifolium] and the bog moss [Sphagnum molle].

The carr woodland grades into broad-leaved plantation which is well established with abundant secondary re-growth. Pedunculate Oak [Quercus robur] and Birch are dominant with frequent Rhododendron [Rhododendron ponticum] in the shrub layer. The ground flora includes Honeysuckle [Lonicera periclymenum] as a straggling liane, Bracken [Pteridium aquil-um] and White Climbing Fumitory [Corydalis claviculata].

Continued.....

Several open areas of mixed herbaceous fen occur within the carr and these are dominated by Reed [Phragmites australis], Lesser Reedmace [Typha angustifolium], Purple Small-reed [Calamagrostis canescens] and Yellow Flag. Typical species present include Marsh Marigold [Caltha palustris], Angelica [Angelica sylvestris], Royal Fern, Greater Spearwort [Ranunculus lingua] and the uncommon Milk Parsley [Peucedanum palustre].

Grazing marsh consisting of acidic grassland, provides additional interest and the sward is dominated by Common Bent-grass [Agrostis capillaris], Brown Bent-grass [A. canina] and Yorkshire Fog [Holcus lanatus]. Other species include Tormentil [Potentilla erecta], Sheep's Sorrel [Rumex acetosella] and Hard Rush [Juncus inflexus].



NATURE CONSERVANCY COUNCIL

Site boundary thus ——

Scale 1:10 000

0 Metres 600

0 Yards 600

File Ref: EA/N/1/14 WDE

COUNTY: Norfolk SITE NAME: ALDERFEN BROAD

DISTRICT: North Norfolk

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Broads Authority

National Grid Reference: TG 355195 Area: 21.37 [ha] 52.78 [a

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TG 31 NE

Date Notified [Under 1949 Act]: 1954 Date of Last Revision: 1971

Date Notified [Under 1981 Act]: 1984 Date of Last Revision: -

Other Information:

Owned and managed as a nature reserve by Norfolk Naturalists' Trust.

Reasons for Notification:

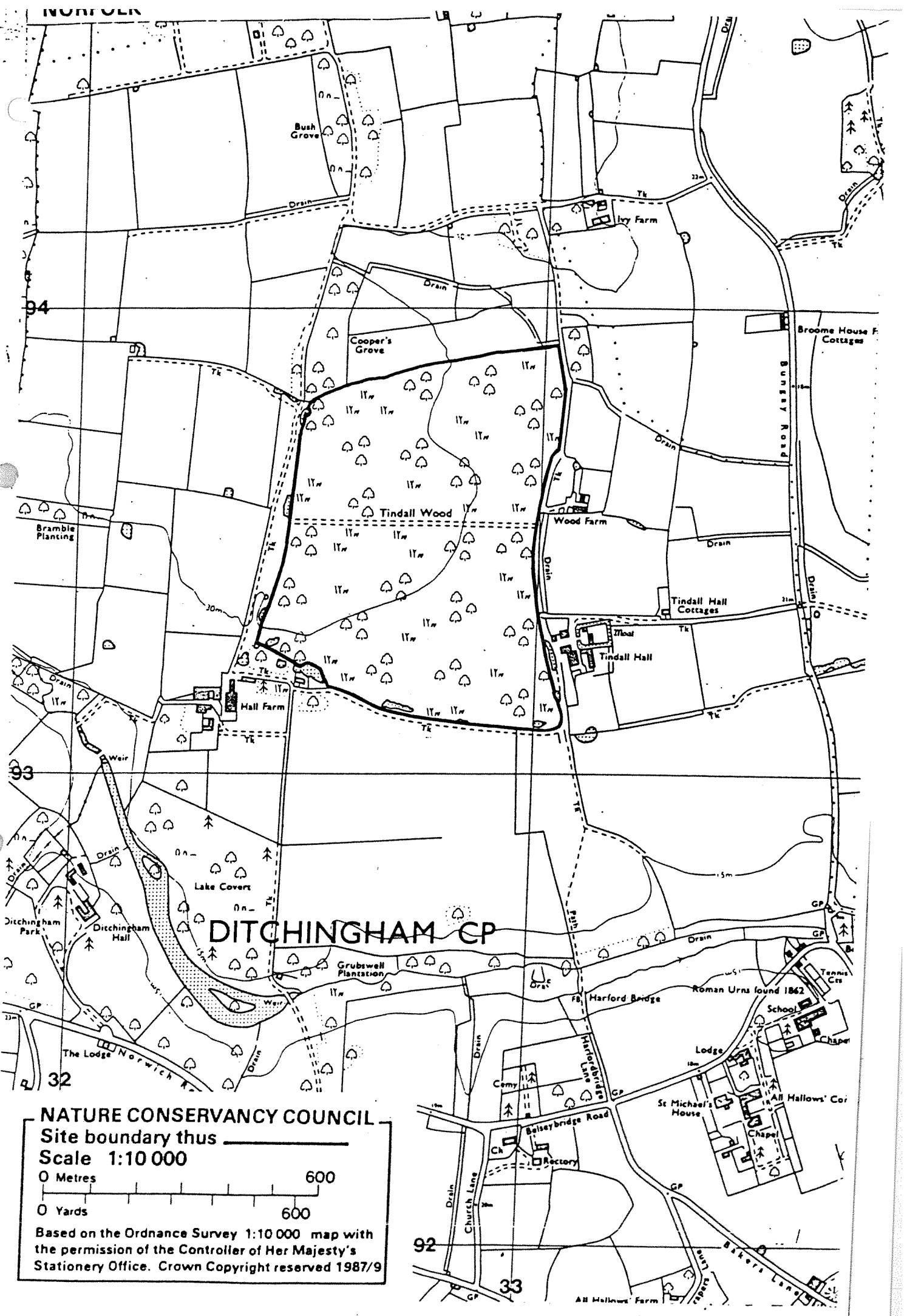
Alderfen Broad is situated on shallow fenland peats in a side valley of the River Ant. The site shows a classic succession of plant communities from open water, through marginal reedswamp, to carr woodland. The Broad is undergoing restoration following isolation from nutrient-enriched waters from the catchment and is an important research site for studying the problems associated with eutrophication in Broadland. Water plants have re-established and a wide range of breeding birds nest in the reedbeds and woodland.

Several species of water plant have re-colonised the open water following isolation of the Broad and a reduction in nutrient levels. Rigid Hornwort [Ceratophyllum demersum] is generally dominant, with small populations of White Water-lily [Nymphaea alba], Water Violet [Hottonia palustris], Starworts [Callitriche spp.] and Fennel Pondweed [Potamogeton pectinatus].

The marginal vegetation shows an interesting transition depending on the depth of the water. Lesser Reedmace [Typha angustifolia] and Bulrush [Schoenoplectus lacustris] are the primary colonisers in deep water. Reed [Phragmites australis] invades the shallower water and forms a band of reedswamp. Tall fen vegetation surrounds the Broad. This habitat is also dominated by Reed but is relatively diverse and includes Greater Tussock Sedge [Carex paniculata], Purple Small-reed [Calamagrostis canescens], Milk Parsley [Peucedanum palustre], Meadowsweet [Filipendula ulmaria] and Bog Myrtle [Myrica gale].

Carr woodland is invading the open fen on the landward side. Alder [Alnus glutinosa] is dominant with frequent Common Sallow [Salix cinerea] and the ground flora includes Yellow Flag [Iris pseudacorus], Gipsywort [Lycopus europaeus], Lesser Pond Sedge [Carex acutiformis] and Greater Tussock Sedge. Pedunculate Oak [Quercus robur] is frequent in woodland on the driest soils.

Breeding birds in the fen and reedbeds surrounding the Broad include Great Crested Grebe, Pochard, Water Rail, Grasshopper Warbler and Reed Warbler.



NATURE CONSERVANCY COUNCIL

Site boundary thus ——

Scale 1:10 000

0 Metres 600

0 Yards 600

File Ref: EA/N/290/14 WRQ

COUNTY: Norfolk

SITE NAME: TINDALL WOOD, DITCHINGHAM

DISTRICT: South Norfolk

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: South Norfolk District Council

National Grid Reference: TM 327935 Area: 41 [ha] 101.3

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TM 39 SW

Date Notified [Under 1949 Act]: N/A Date of Last Revision: N/A

Date Notified [Under 1981 Act]: 1988 Date of Last Revision: -

Other Information:

A new site.

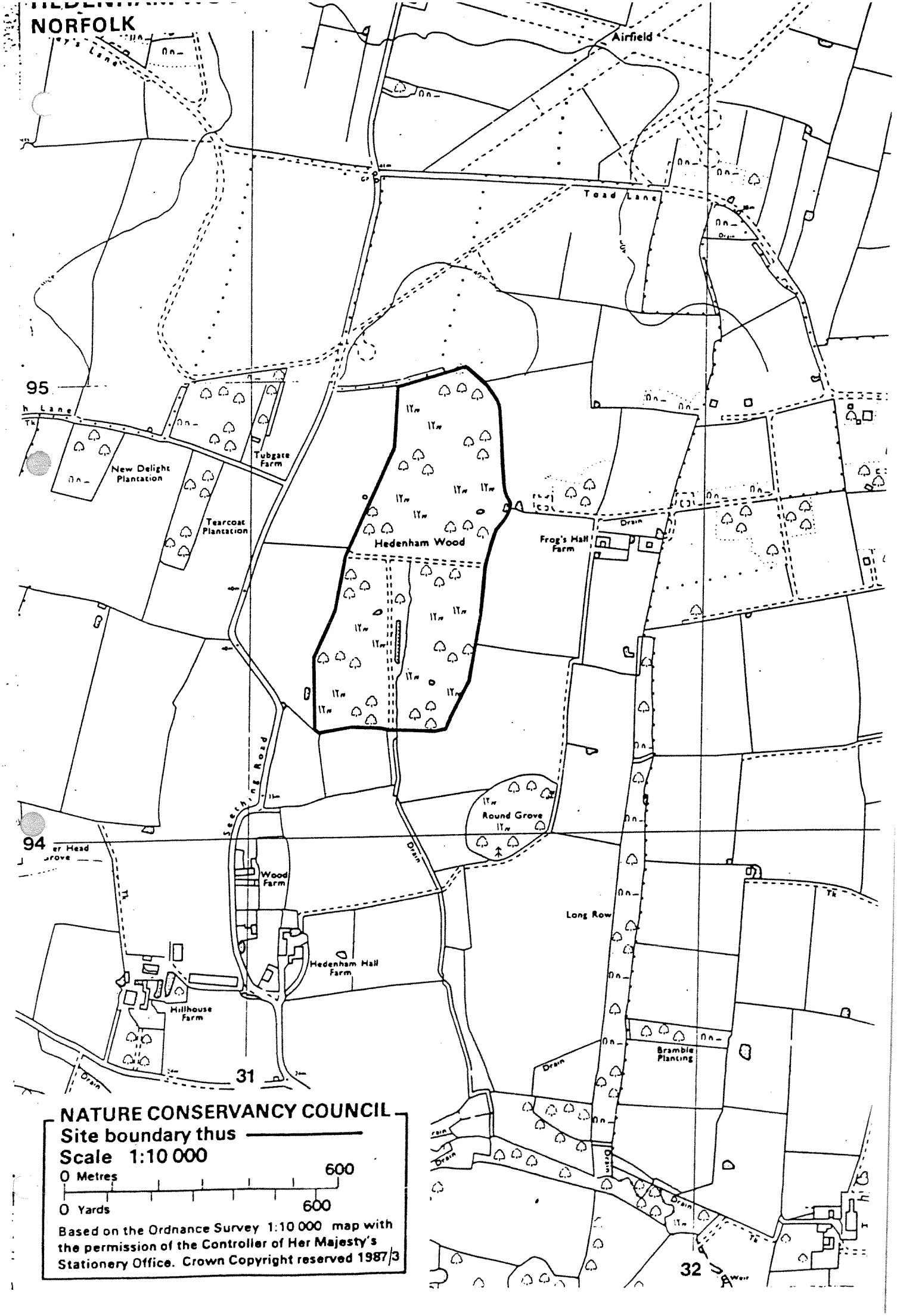
Description and Reasons for Notification:

Tindall Wood is one of the largest hornbeam woods in the county and is consider representative of the type. It is an ancient woodland situated on poorly drain south Norfolk boulder clay which is overlain in places by sandy loam. Surround by a massive woodbank and ditch, the wood mainly supports Hornbeam and Oak wi Ash, Maple and Hazel. Several uncommon species are found in the ground flo which indicate that the woodland may be primary.

The dominant stand-type is pedunculate Oak-Hornbeam woodland with a structu of coppice-with-standards. Standard trees are of Oak (Quercus robur), Ash (Fraxin excelsior) and Hornbeam (Carpinus betulus). The coppice layer is overgrown a is mainly Hornbeam with scattered Ash, Field Maple (Acer campestre) and Haz (Corylus avellana). Spindle (Euonymus europaeus), Dogwood (Cornus sanguinea Guelder Rose (Viburnum opulus) and Midland Hawthorn (Crataegus laevigata) a frequent shrubs on the heaviest soils where there is also a rich ground flor Dog's Mercury (Mercurialis perennis) is dominant with Enchanter's Nightsha (Circaea lutetiana) and Primrose (Primula vulgaris). Other species include Wo Melick (Melica uniflora), Stinking Iris (Iris foetidissima), Herb Paris (Par quadrifolia), Ramsons (Allium ursinum), Greater Butterfly Orchid (Platanthe chlorantha) and Common Spotted Orchid (Dactylorhiza fuchsii). The ground flo of lighter, more acid soils is dominated by Bramble (Rubus fruticosus agg) wi Honeysuckle (Lonicera periclymenum), Bracken (Pteridium aquilinum) and Wood Sorr (Oxalis acetosella).

Other stand-types are represented by fragments of wet valley alderwood and invasi elm woodland. The coppice structure has been lost in parts of the wood and h been replaced by high forest of Oak, Ash and Hornbeam.

Wide rides have been cut through the wood and marshy grassland has developed. T rides are dominated by Tufted Hair-grass (Deschampsia cespitosa) and Meadowswe (Filipendula ulmaria) with Ragged Robin (Lychnis flos-cuculi), Common Figwo (Scrophularia nodosa), Marsh Thistle (Cirsium palustre) and Lesser Spearwo (Ranunculus flammula).


NORFOLK
Airfield
Toad Lane
95
New Delight Plantation
Tubgate Farm
Tearcoat Plantation
Hedenham Wood
Frog's Hall Farm
Round Grove
94
Wood Farm
Hedenham Hall Farm
Hillhouse Farm
Long Row
Bramble Planting
31
32
NATURE CONSERVANCY COUNCIL
Site boundary thus
Scale 1:10 000
0 Metres
600
0 Yards
600
Based on the Ordnance Survey 1:10 000 map with the permission of the Controller of Her Majesty's Stationery Office. Crown Copyright reserved 1987/3

File Ref: EA/N/298/14 WWD

COUNTY: Norfolk

SITE NAME: HEDENHAM WOOD

DISTRICT: South Norfolk

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: South Norfolk District Council

National Grid Reference: TM 314946 Area: 34.03 [ha] 84.09

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TM 39 SW, NW

Date Notified [Under 1949 Act]: N/A Date of Last Revision: -

Date Notified [Under 1981 Act]: 1988 Date of Last Revision: -

Other Information:

A new site.

Description and Reasons for Notification:

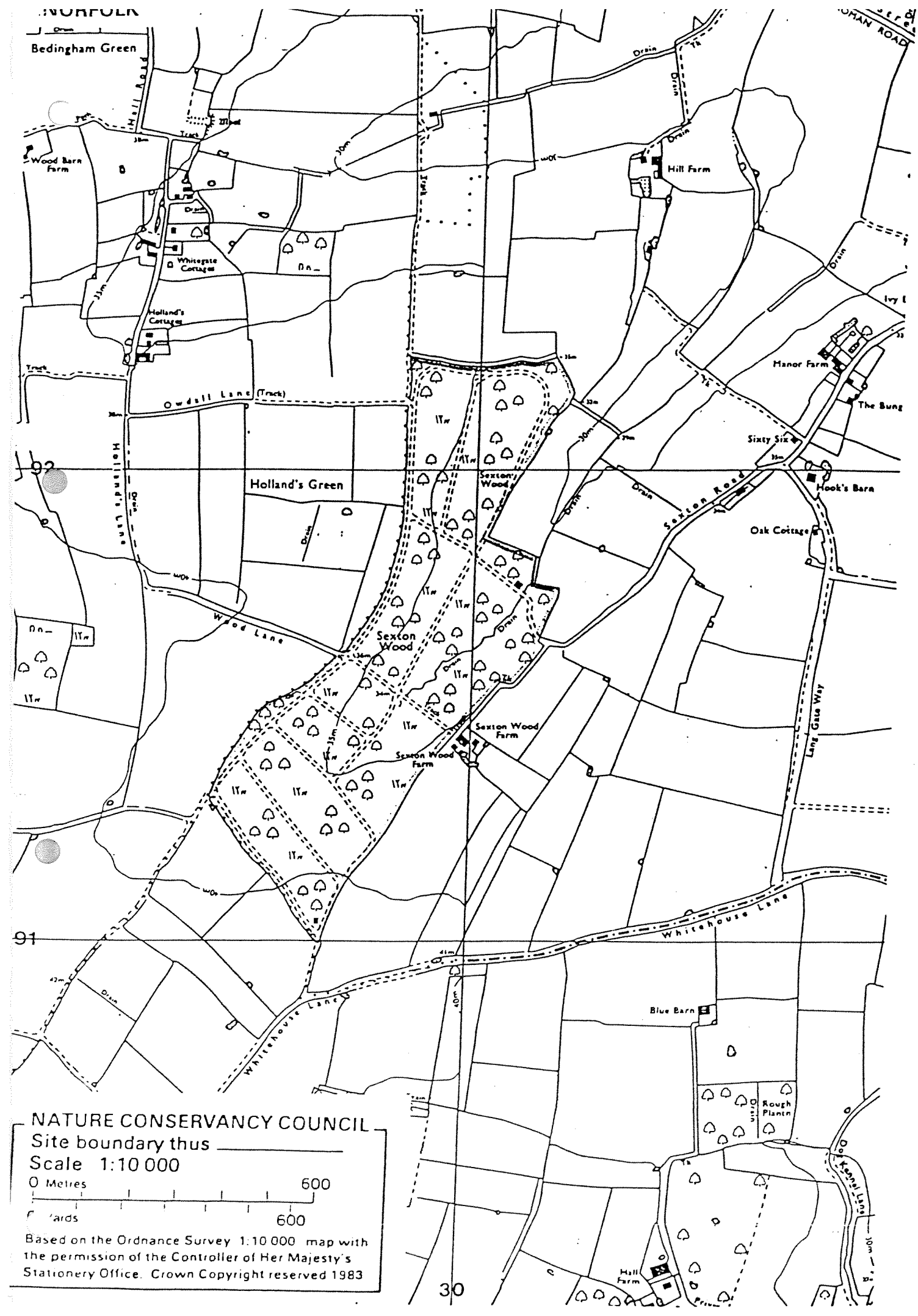
Hedenham Wood is an ancient woodland situated at the head of a shallow vall on the South Norfolk boulder clay. Much of the wood comprises Oak standards ov mixed Hornbeam coppice but the valley bottom contains wet Ash-Maple wood wi stands of Elm. The ground flora is diverse and includes several uncommon species.

Heavy calcareous clay on the valley sides supports Hornbeam [Carpinus betulu coppice with Maple [Acer campestre], Ash [Fraxinus excelsior] and Hazel [Coryl avellana] under large standards of Oak [Quercus robur], Ash and Hornbeam. Oth woody species include Goat Willow [Salix caprea], Aspen [Populus tremula], Spind [Euonymus europaeus], Guelder Rose [Viburnum opulus], Dogwood [Cornus sanguine and Midland Hawthorn [Crataegus laevigata]. On lighter soils Hornbeam and A coppice is almost pure. This is replaced by predominantly Ash and Maple in t valley bottom, with big, high-cut Elm [Ulmus procera] stools in the sou Suckering Elm covers the site of Hedenham Hall.

Where ground flora is not completely shaded out by the Hornbeam, Dog's ercu [Mercurialis perennis] is generally dominant but Enchanter's Nightshade [Circa lutetiana], Ramsons [Allium ursinum] and Bluebell [Hyacinthoides non-scripta are locally abundant. Overall, the wood's ground flora appears rather unifor but many species are present at low frequency, most notably Greater Butterf Orchid [Platanthera chlorantha], Herb Paris [Paris quadrifolia] and Stinkin Hellebore [Helleborus foetidus], but also including Dewberry [Rubus caesius] Hairy Wood-rush [Luzula pilosa], Hairy St John's Wort [Hypericum hirsutum], Woo Anemone [Anemone nemorosa], Sanicle [Sanicula europaea], Primrose [Primula vulgaris and Water Mint [Mentha aquatica].

Despite recent replanting [with Oak and Ash] in the north, and incomplete coppic recovery there, the vegetation types described above are still discernible. Tufte Hair-grass [Deschampsia cespitosa], Soft Rush [Juncus effusus], Hairy St John' Wort and Selfheal [Prunella vulgaris] are more frequent there.

Where light penetrates to the rides the flora is fairly rich, including Pendulou Sedge [Carex pendula], Wood Sedge [C. sylvatica], Meadowsweet [Filipendula ulmaria] Hybrid Avens [Geum x intermedium], Yellow Pimpernel [Lysimachia nemorum] and ello Loosestrife [L. vulgaris].



NATURE CONSERVANCY COUNCIL

Site boundary thus

Scale 1:10 000

0 Metres 600

Yards 600

Based on the Ordnance Survey 1:10 000 map with the permission of the Controller of Her Majesty's Stationery Office. Crown Copyright reserved 1983

File Ref: EA/N/82/14 NGV

COUNTY: Norfolk SITE NAME: SEXTON WOOD

DISTRICT: South Norfolk

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: South Norfolk District Council

National Grid Reference: TM 299 916 Area: 37.55 38 (ha.) 92.7994 (ac.)

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TM 29 SE/TM 39 SW

Date Notified (Under 1949 Act): 1971 Date of Last Revision:

Date Notified (Under 1981 Act): 1983 Date of Last Revision:

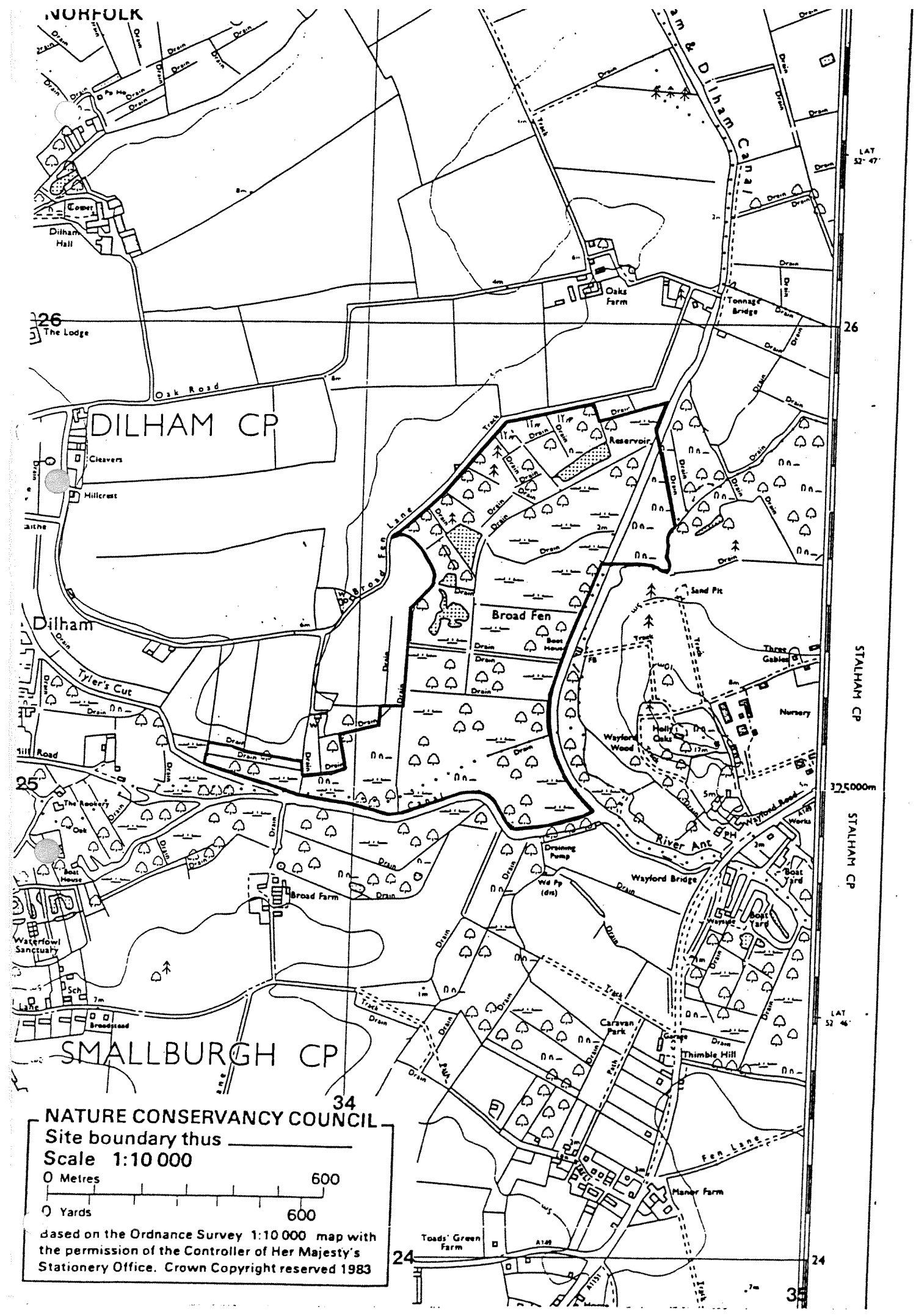
Other Information:

Reasons for Notification:

Sexton Wood is one of the largest woods in South-east Norfolk and is almost entirely of ancient origin. The structure is largely coppice-with-standards, with a few areas of high forest. The main stand-type is hornbeam-pedunculate oak on a boulder clay plateau, and the ground flora is characteristic of an ancient wood of this type.

The standard trees are mostly of Oak (Quercus robur) with some Hornbeam (Carpinus betula) and suckering Elm (Ulmus sp). The coppice is chiefly Hornbeam with Ash (Fraxinus excelsior), Field Maple (Acer campestre) and Sallow (Salix caprea). Other shrub species present include Midland Hawthorn (Crataegus laevigata), Spindle Tree (Euonymus europeaus) and Guelder Rose (Viburnum opulus). Coppicing is still continued in the Wood, and as a result, a diverse ground flora is present. Dog's Mercury (Mercurialis perennis) is dominant with Bramble (Rubus fruticosa), Primrose (Primula vulgaris), Bluebell (Endymion non-scriptus), Ramsoms (Allium ursinum) Woodruff (Galium odoratum), Wood Sorrel (Oxalis acetosella), and early Purple Orchid (Orchis mascula). The areas of high forest are chiefly of oak over a ground flora of Bracken (Pteridium aquilinum).

Many species of bird breed in the wood including Sparrowhawk and Hawfinch. The ride system is unusual in that most were concreted during the 1939-45 war to serve as storage areas.



NATURE CONSERVANCY COUNCIL

Site boundary thus

Scale 1:10 000

0 Metres 600

0 Yards 600

File Ref: EA/N/16/14 WDW

COUNTY: Norfolk

SITE NAME: BROAD FEN DILHAM

DISTRICT: North Norfolk

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Broads Authority

National Grid Reference: TG 343255 Area: 36.86 (ha.) 91.08 (ac.

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TG 32 NW, SW

Date Notified (Under 1949 Act): 1959 Date of Last Revision: N/A

Date Notified (Under 1981 Act): 1983 Date of Last Revision: -

Other Information:

Boundary amended by small deletion in North-east corner

Reasons for Notification:

Broad Fen occupies the basin of the former Dilham Broad and now supports a mixture of fen, fen meadow, open water and carr woodland communities. Open areas of fen are maintained through regular cutting of reed, sedge and for marsh hay and as a result a species-rich vegetation has developed characteristic of undrained wetland in Broadland.

Tall fen communities are dominated by reed (Phragmites australis) and Saw-Sedge (Cladium mariscus) often with abundant Purple Reed-Grass (Calamagrostis canescen and herbs such as Yellow Loosestrife (Lysimachia vulgaris) and Milk Parsley (Peucedanum palustre) - the food plant of the larva of the Swallowtail Butterfly (Papilio machaon) which is well established here. Sweet Gale (Myrica gale) is a common shrub in those areas dominated by Saw-Sedge. A shorter more diverse fen vegetation occurs closer to the edge of the basin which is dominated by mixtures of Fen Rush (Juncus subnodulosus) and Bog Rush (Schoenus nigricans) with Marsh Helleborine (Epipactis palustris), Bogbean (Menyanthes trifoliata), Marsh Loosewort (Pedicularis palustris), Marsh Cinquefoil (Potentilla palustris) and several species of Sedge (Carex spp.) as typical associates.

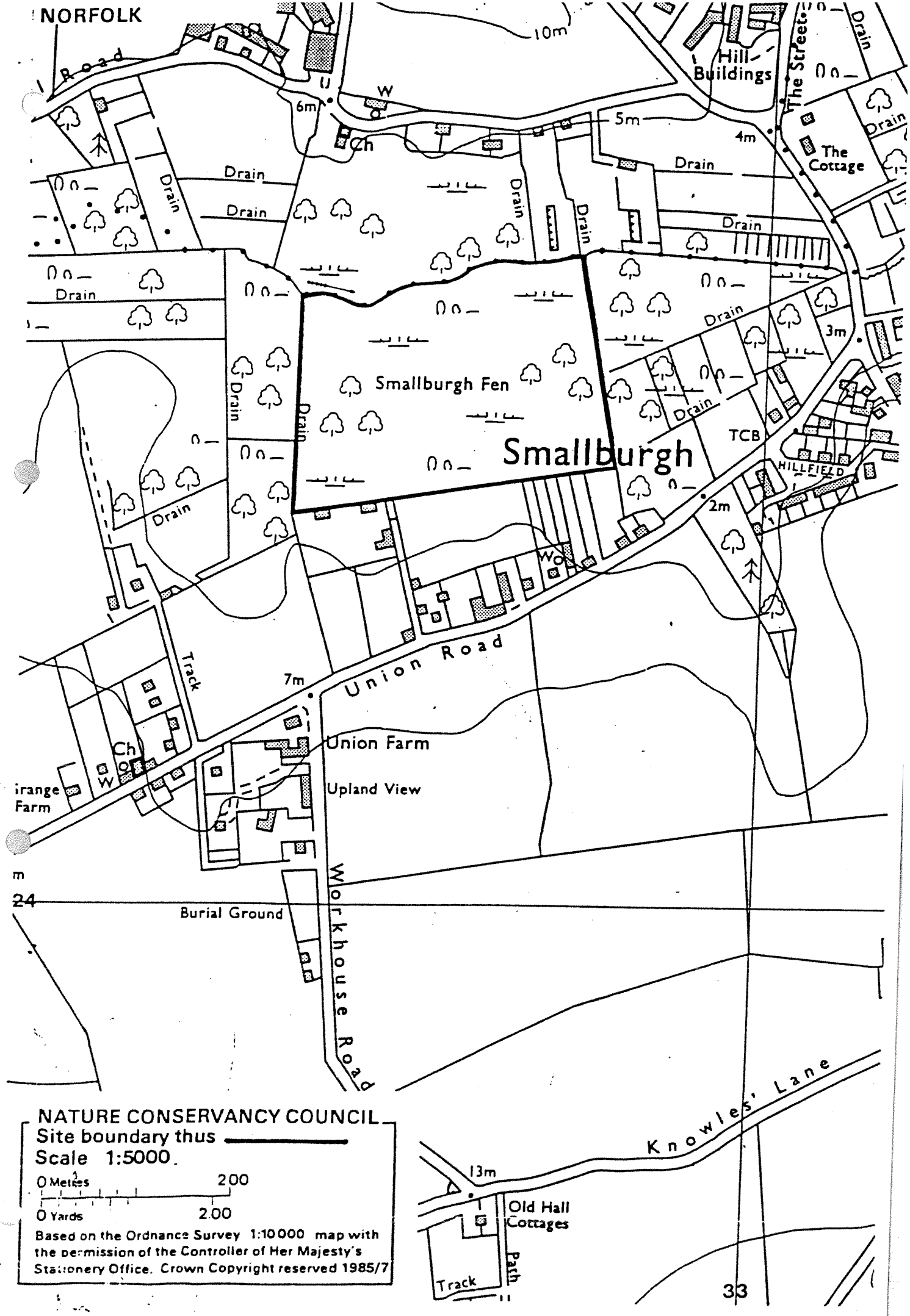
These fen communities grade into fen meadow with abundant Fen Rush with Marsh Stitchwort (Stellaria palustris), Lesser Spearwort (Ranunculus flammula), Large Birdsfoot-Trefoil (Lotus uliginosus), Yellow Flag (Iris pseudacorus), Water Dropwort (Oenanthe fistulosa) and Marsh Marigold (Caltha palustris).

The open water areas consist of dykes, a section of the Dilham Canal and a series of ponds, most of which were dug to attract wildfowl. The Dilham Canal and dykes linked to it are nutrient enriched and with turbid water support rather few aquatic plants. The ponds away from this influence contain low nutrient, low alkalinity water, and aquatic plant development is limited to a few species which favour these conditions. The pondweeds (Potamogeton obtusifolius) and (P. friesii) are frequent with Bladderwort (Utricularia vulgaris) and White Water Lily (Nymphaea alba).

Surrounding the open fen are large areas of semi-mature alder carr. Here the ground flora is dominated by Lesser Pond-Sedge (Carex acutiformis) and Marsh Fern (Thelypteris palustris), with Lesser Tussock-Sedge (Carex appropinquata), Yellow Flag (Iris pseudacorus) and Twayblade (Listera ovata) as characteristic

associates. Oak (Quercus robur) and Ash (Fraxinus excelsior) woodland is developing along the drier western edge of the site.

Breeding birds include Sedge, Reed and Grasshopper Warblers. Bitterns are regular during the winter but have not nested for several years. The rare fen slug Agriolimax agrestis has been recorded.



NATURE CONSERVANCY COUNCIL

Site boundary thus

Scale 1:5000

0 Metres 100 200

0 Yards 100 200

File Ref: EA/N/86/14 WHA

COUNTY: Norfolk

SITE NAME: SMALLBURGH FEN

DISTRICT: North Norfolk

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: North Norfolk District Council

National Grid Reference: TG 327246 Area: 7.27 [ha] 17.96

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TG 32 SW

Date Notified [Under 1949 Act]: 1972 Date of Last Revision: -

Date Notified [Under 1981 Act]: 1985 Date of Last Revision: -

Other Information:

The site is listed in "A Nature Conservation Review" [1977 Cambridge University Press, ed. Ratcliffe].

Reasons for Notification:

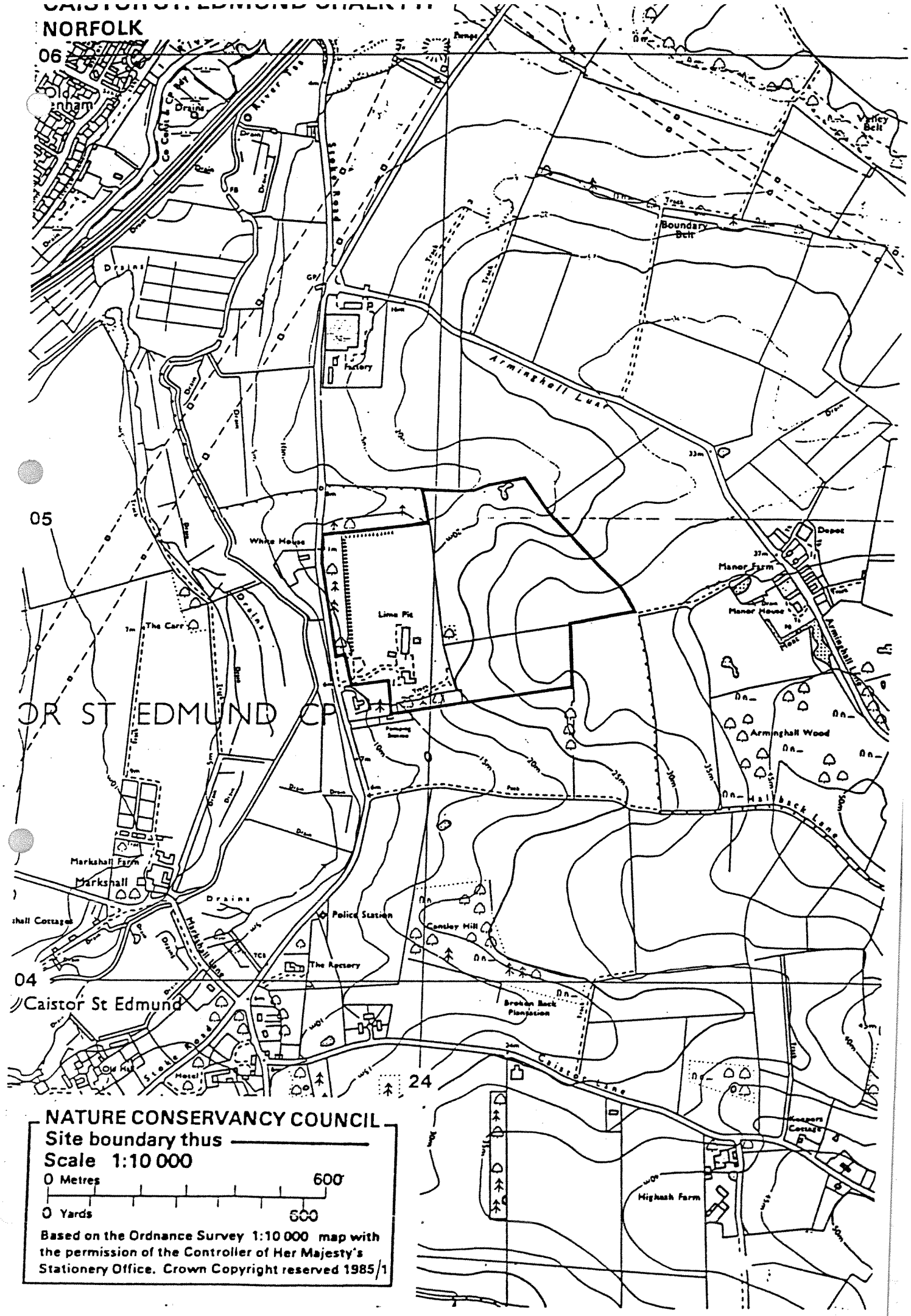
Smallburgh Fen is a small spring-fed valley fen bordering a minor tributary of the Riv Ant. It is of exceptional ecological interest and is considered to be the second most importa example of this type of fen in Norfolk. In the central part of the site open, moss-dominat communities have developed under the influence of the irrigating chalk-rich spring wate and here a very diverse plant community is present which includes a number of rare a local species, all restricted to this uncommon habitat type.

The central fen is characterised by a short-sward community with abundant Black Bog-ru [Schoenus nigricans] and a well-developed bryophyte carpet which includes the moss Campylium stellatum, Drepanocladus revolvens, Acrocladium cusdpidatum, and Lophocol bidentata. Wet hollows within this area contain Stoneworts [Chara spp.]. Associated her and sedges include such characteristic species as Grass of Parnassus [Parnassia palustri Bog Pimpernel [Anagallis tenella], Bogbean [Menyanthes trifoliata], Marsh Helleborin [Epipactis palustris], Marsh Valerian [Valeriana dioica], Marsh Pennywort [Hydrocoty vulgaris], Glaucous Sedge [Carex flacca] and Dioecious Sedge [Carex dioica]. tall vegetation has developed away from the seepage points and this is characteridsed by Blun flowered Rush [Juncus subnodulosus], Marsh Fern [Thelypteris thelypteroides] and Southe Marsh Orchid [Dactylorhiza praetermissa]. On the margin where some scrub developme has occurred there are tussocks of the bog moss [Sphagnum palustre].

Surrounding the moss-dominated communities is a patchily developed zone of ranker f vegetation. Reed is dominant with other tall species present including Meadowswe [Filipendula ulmaria] and Hemp Agrimony [Eupatorium cannabinum].

Carr woodland occupies the remainder of the site. Alder is dominant with Brown Birch ar Common Sallow. The ground flora is generally typical of a Broadland alder carr, with Less Pond Sedge [Carex acutiformis], Marsh Fern, Meadowsweet and Broad Buckler Fern [Dryopter dilatata].

The site also forms the only known Norfolk locality for the rare moss [Bracthytheciu mildeanum].



Based on the Ordnance Survey 1:10 000 map with the permission of the Controller of Her Majesty's Stationery Office. Crown Copyright reserved 1985/1

File Ref: EA/N/ /14 WEE

COUNTY: Norfolk

SITE NAME: CAISTOR ST EDMUND CHAL

DISTRICT: South Norfolk

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: South Norfolk District Council

National Grid Reference: TG 239048 Area: 23.8 [ha] 58.8 [

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TG 20 SW, NW

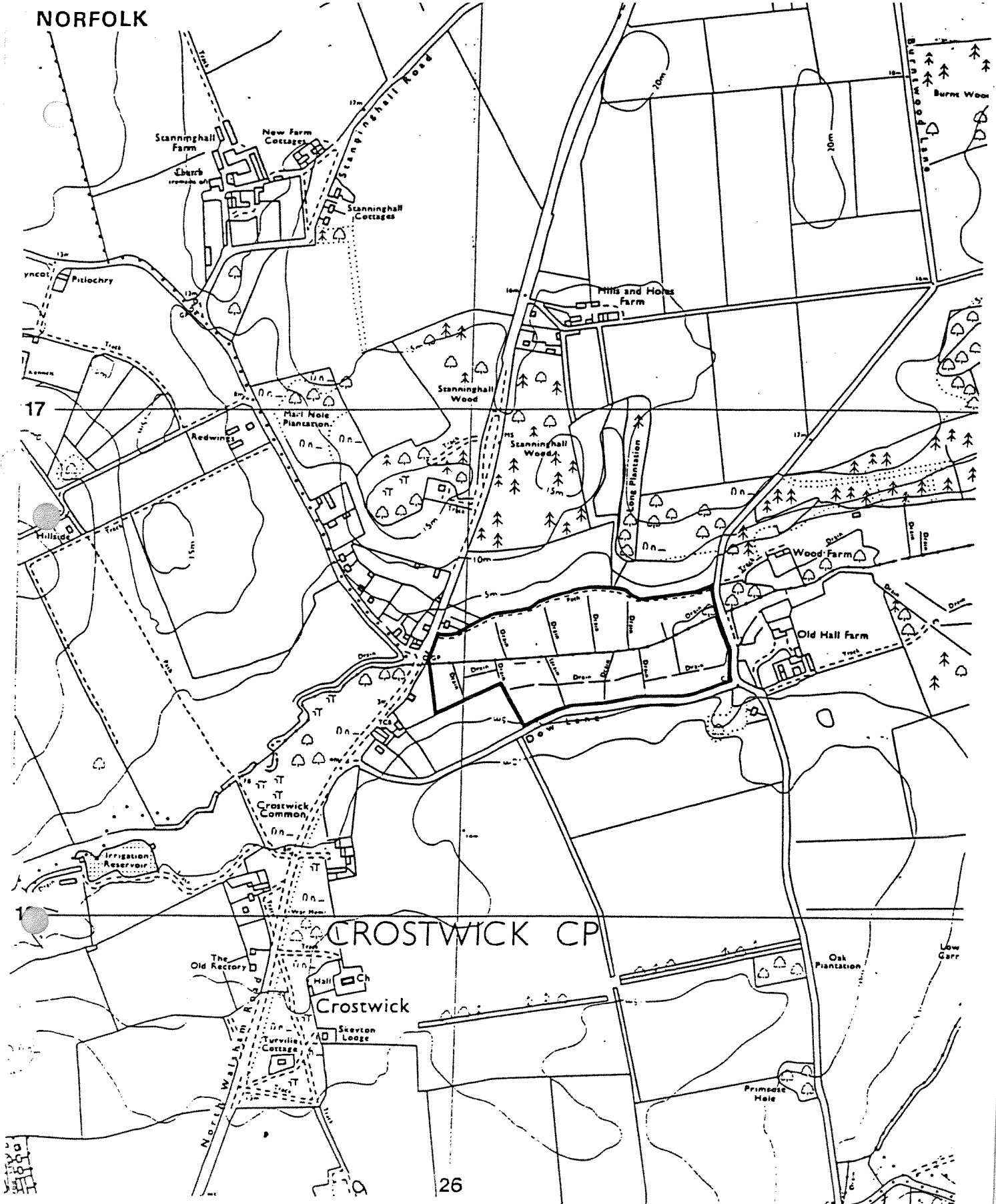
Date Notified [Under 1949 Act]: 1968 Date of Last Revision: N/A

Date Notified [Under 1981 Act]: 1985 Date of Last Revision: -

Other Information:

Reasons for Notification:

A geological site which displays the best exposure of The Upper Cretaceous [Late Campanian] Beeston Chalk, a unit not exposed in coastal sections, and representing some of the youngest in situ chalk in Britain. The site is famous for its large flints, known as 'potstones' and 'paramoudras', with their remarkable contained burrow systems. The Chalk is here very fossiliferous; of note are the specimens of the molluscs Belemnitella and Inoceramus and Sea Urchin Echinocorys which it commonly yields.



NATURE CONSERVANCY COUNCIL

Site boundary thus

Scale 1:10 000

0 Metres 600

0 Yards 600

File Ref: EA/N/259/14 WHE

COUNTY: Norfolk SITE NAME: CROSTWICK MARSH

DISTRICT: Broadland

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Broadland District Council

National Grid Reference: TG 263165 Area: 11.2 [ha] 27.6 [a

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TG 21 NE

Date Notified [Under 1949 Act]: N/A Date of Last Revision: N/A

Date Notified [Under 1981 Act]: 1985 Date of Last Revision: -

Other Information:

A new site.

Reasons for Notification:

Crostwick Marsh lies about 3 miles west of Wroxham in the valley of the Crostwick Beck, a tributary of the River Bure. The site forms an excellent example of unimproved valley meadow and supports a series of intergrading plant communities ranging from damp neutral grassland through species-rich fen grassland to tall fen in the valley bottom. A spring line is present on the valley slopes which provides irrigating water, and calcareous flushes have developed locally at seepage points. The site drains to the Crostwick Beck through a series of dykes. A number of uncommon plants are present, several in great abundance and there is additional ornithological interest.

The damp neutral grassland is lightly grazed by cattle and the sward is dominated by a variety of grasses including Creeping Bent [Agrostis stolonifera], Crested Dog's-tail [Cynosurus cristatus], Sweet Vernal-grass [Anthoxanthum odoratum] and Yorkshire Fog [Holcus lanatus]. Typical herb species include Water Mint [Mentha aquatica], Cuckoo Flower [Cardamine pratensis], Black Knapweed [Centaurea nigra] and Marsh Pennywort [Hydrocotyle vulgaris] and these areas are notable for the great abundance of Southern Marsh Orchid [Dactylorhiza praetermissa], Yellow Rattle [Rhinanthus minor] and Ragged Robin [Lychnis flos-cuculi].

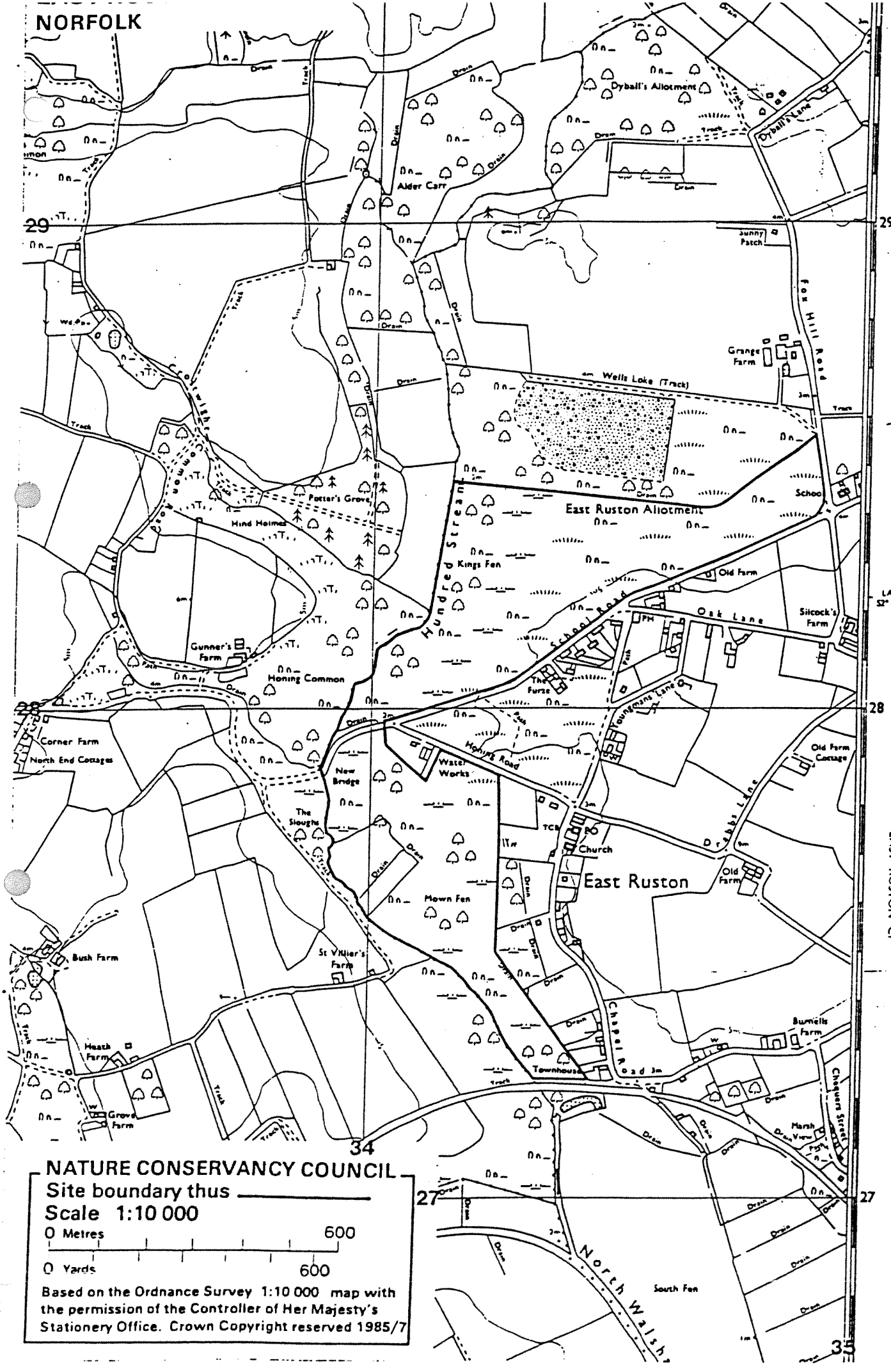
Species-rich fen grassland dominated by Blunt-flowered Rush [Juncus subnodulosus] occupies the lower valley slopes. Plants of interest include Lesser Spearwort [Ranunculus flammula], Marsh Valerian [Valeriana dioica], Devil's-bit Scabious [Succisa pratensis] and Marsh Marigold [Caltha palustris]. A taller-growing, but less diverse tall fen community is present on the wettest soils. Greater Pond Sedge [Carex riparia], Reed Sweet-grass [Glyceria maxima] and Meadowsweet [Filipendula ulmaria] are dominant with Greater Tussock Sedge [Carex paniculata], Marsh Thistle [Cirsium palustre] and Angelica [Angelica sylvestris].

Calcareous flushes are characterised by areas of short vegetation within the Juncus grassland. Flea Sedge [Carex pulicaris], Star Sedge [C. echinata] and Carnation Sedge [C panicea] are dominant over a bryophyte carpet. Other notable species include Bog Pimpernel [Anagallis tenella], Quaking Grass [Briza media] and Common Spike-rush [Eleocharis palustris].

Continued.....

Additional interest is provided by small areas of Alder carr, mixed scrub, the drainage d es and a length of the Crostwick Beck.

Marshland birds are well represented with breeding Snipe, Woodcock, Lapwing, Grasshopper Warbler and Sedge Warbler.



NATURE CONSERVANCY COUNCIL

Site boundary thus

Scale 1:10 000

0 Metres 600

0 Yards 600

File Ref: EA/N/35/14 WES

COUNTY: Norfolk SITE NAME: EAST RUSTON COMMON

DISTRICT: North Norfolk

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: North Norfolk District Council

National Grid Reference: TG 340280 Area: 38.3 [ha] 94.6 [a

Ordnance Survey Sheet 1:50,000: 133 1:10,000: TG 32 NW

Date Notified [Under 1949 Act]: 1959 Date of Last Revision: -

Date Notified [Under 1981 Act]: 1986 Date of Last Revision: -

Other Information:

Description and Reasons for Notification:

East Ruston Common is a large area of unimproved heathland and fen situated in the valley a tributary of the River Ant. Acidic flushes emerging from sands and gravels at the base surrounding high ground, are a notable feature of the site and an unusual plant community developed in these conditions, providing a contrast with the majority of spring-fed fens wh are calcareous. There is a very clear zonation of vegetation types from acidic grassland thro acidic flush and fen to carr woodland on the lowest-lying ground. Two rare species of spider h been recorded on the site.

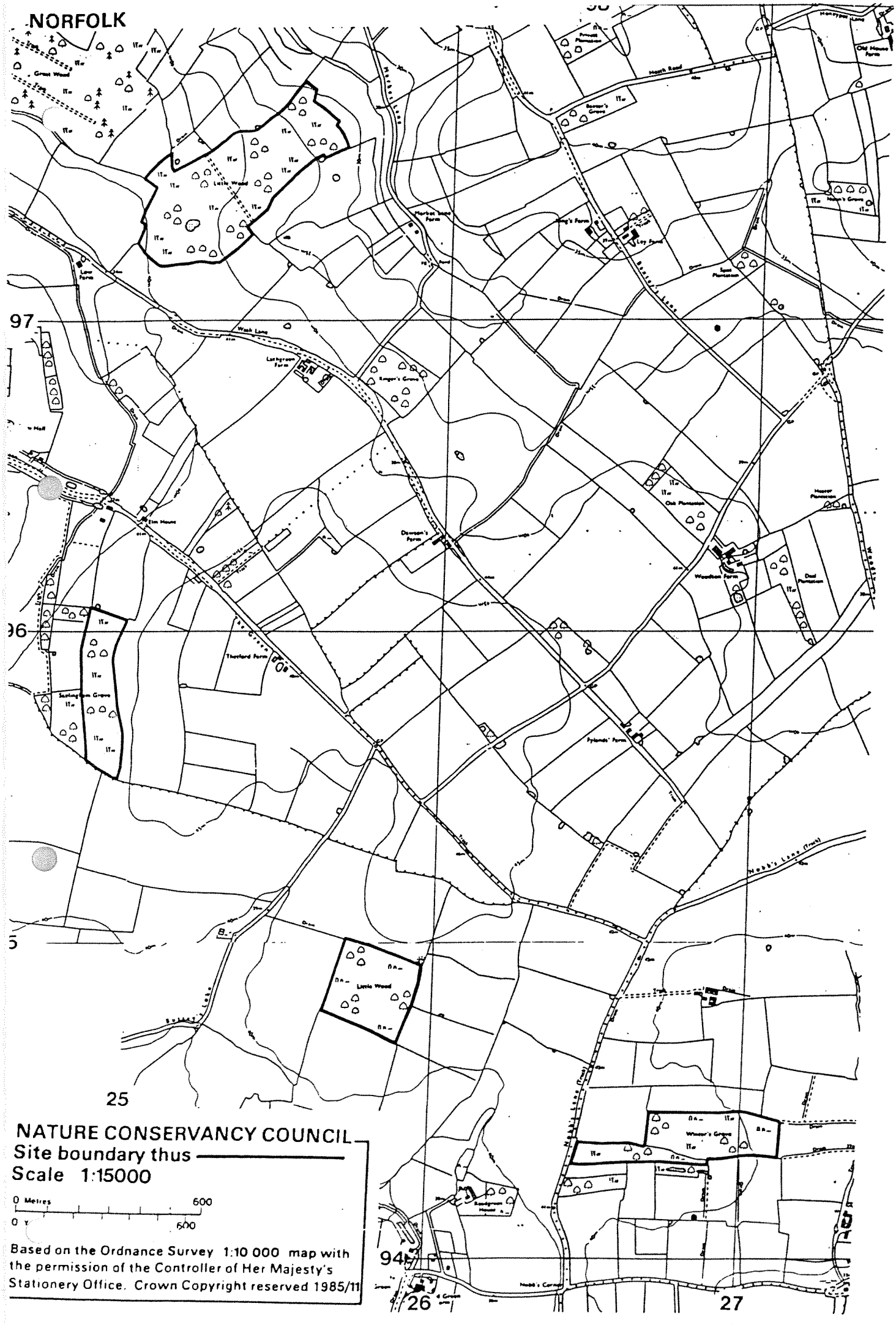
Dry acidic grassland and heath occupies the sands and gravels on high ground. The grass sw is dominated by Brown Bent-grass [Agrostis canina], Common Bent-grass [A capillaris] and W Hair-grass [Deschampsia flexuosa] with frequent Tormentil [Potentilla erecta], Common Milkw [Polygala vulgaris], Sheep's Sorrel [Rumex acetosella] and Heath Bedstraw [Galium saxat Heather [Calluna vulgaris] is present in places. Much of the grassland is invaded by Gorse [U europaeus] and young trees of Birch [both Betula pendula and B. pubescens] and dense s ub n covers the majority of the dry ground.

Damp acidic heathland occurs locally between the dry land and the fen. Heather is frequent w abundant Marsh Pennywort [Hydrocotyle vulgaris], Tormentil and Narrow Buckler-fern [Dryopte carthusiana]. Elsewhere the base of the slope is marked by acidic flushes. Bog mosses [Sphagn spp.] form a carpet in places but the vegetation is generally dominated by Soft Rush [Juncus effus and White Sedge [Carex curta]. Several notable plants are present in this zone includi Cotton-grass [Eriophorum angustifolium], Marsh Cinquefoil [Potentilla palustris], Bogbe [Menyanthes trifoliata], Jointed Rush [Juncus articulatus] and Bottle Sedge [Carex rostrata].

The flushes grade into areas of mixed fen vegetation on low-lying ground. The fen is at first acic near the slope but soon becomes base-rich towards the Hundred Stream. Marsh Cinquefoil a Soft Rush are abundant on the acidic fen but the remaining areas are dominated by Re [Phragmites australis] with Saw Sedge [Cladium mariscus] co-dominant in places. Typical fenla plants include Purple Smallreed [Calamagrostis canescens], Branched Bur-reed [Sparganiu erectum], Water Dock [Rumex hydrolapathum], Greater Bird'sfoot Trefoil [Lotus uliginosus] a the uncommon Milk Parsley [Peucedanum palustre].

Carr woodland has developed along the stream. Alder [Alnus glutinosa] is dominant with abundant Common Sallow [Salix cinerea] and the ground flora includes Yellow Flag [Iris pseudacorus], Meadowsweet [Filipendula ulmaria] and Royal Fern [Osmunda regalis].

The rare spider Acanthophyma gowerensis has been recorded and the site is the only known English locality for the species. Another nationally rare spider, Hygrolycosa rubrofasciata, is also present.



NATURE CONSERVANCY COUNCIL

Site boundary thus

Scale 1:15000

0 Metres 600

0 Yards 600

SITE NAME: SHOTESHAM-WOOD
HORNBEAM WOODS

COUNTY: Norfolk

DISTRICT: South Norfolk

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife & Countryside Act 1981

Local Planning Authority: South Norfolk District Council

National Grid Reference: TM 253975 TM 258948 / TM 249978 TM 268944

Area: 40.9 (ha) 101.0 (

Ordnance Survey Sheet 1:50,000: 134

1:10,000: TM 29 NW, SE

Date Notified (Under 1949 Act):

Date of Last Revision:

Date Notified (Under 1981 Act): 1988

Date of Last Revision:

Other Information:

A new site.

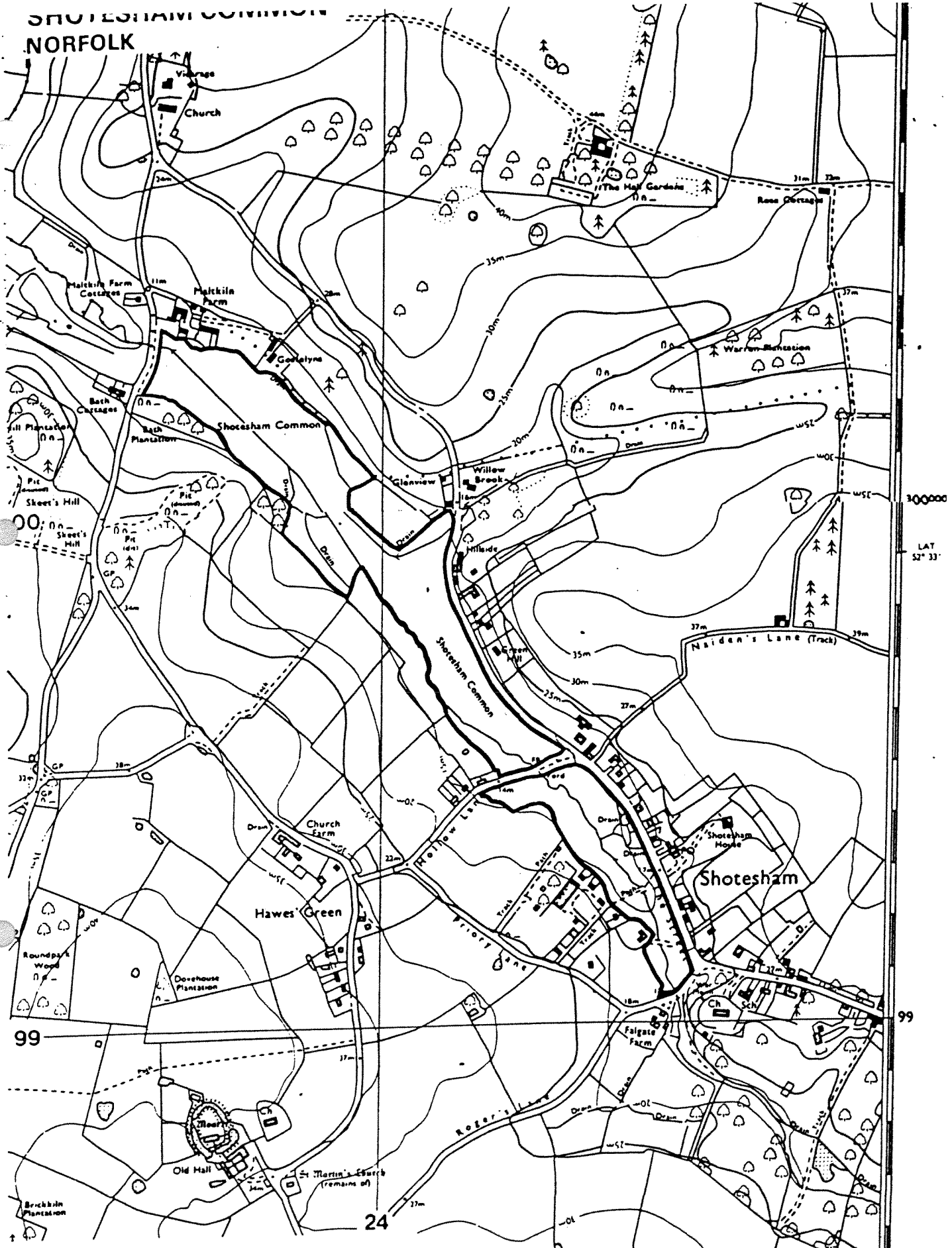
Reasons for Notification:

This site consists of a group of four ancient coppice-with-standards woodlands th were probably once part of a continuous cover of primary hornbeam forest. The ho woods of south Norfolk and north-east Suffolk form a very distinctive group and Shotesham Little Wood, Saxlingham Grove, Hempnall Little Wood and Winter's Grove are some of the most representative examples of this type. All four woods are situated on heavy boulder clays but in places there is an overlying layer of sandy loam. Consequently there are variations in the acidity and drainage of the soils and these differences are reflected in the range of stand-types and in the ground flora. The flora is exceptionally rich and there are several locally scarce and uncommon plants present.

The major stand-type is pedunculate oak-hornbeam woodland and both the heavy soil form and the nationally uncommon light soil variant are present. The standard trees are mostly Pedunculate Oak (Quercus robur) and Ash (Fraxinus excel and the main coppice species are Hornbeam (Carpinus betulus), Maple (Acer campest Hazel (Corylus avellana) and Ash. Free-draining acidic soils occur in Shotesham Little Wood and here the ground flora is dominated by Bramble (Rubus fruti us), Bluebell (Hyacinthoides non-scripta) or Dog's Mercury (Mercurialis perennis) with frequent Honeysuckle (Lonicera periclymenum) and Wood Sorrel (Oxalis acetosella). A diverse ground flora is present on the wet calcareous clays in Saxlingham Grove and Hempnall Little Wood. Dog's Mercury is dominant with frequent Primrose (Primula vulgaris), Sanicle (Sanicula europaea), Enchanter's Nightshade (Circaea lutetiana) and Wood Anemone (Anemone nemorosa). A number of uncommon species are present including Herb Paris (Paris quadrifolia), Greater Butterfly Orchid (Platanthera chlorantha), Early Purple Orchid (Orchis mascula), Stinking Iris (Iris foetidissima) and Ramsons (Allium ursinum). In addition, Hempnall Little Wood is the only site for Wild Service Tree (Sorbus torminalis) in south Norfolk.

Small areas of other stand-types occur and these include wet ash-wych elm woodlan and wet ash-maple woodland.

The core of Winter's Grove is surrounded by a massive medieval woodbank and ditch and although small is a complete example of an ancient wood.



NATURE CONSERVANCY COUNCIL

Site boundary thus

Scale 1:10 000

0 Metres 600

0 Yards 600

SHOTESHAM CP

File Ref: EA/N/280/14 WQG

SITE NAME: SHOTESHAM COMMON

COUNTY: Norfolk

DISTRICT: South Norfolk

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: South Norfolk District Council

National Grid Reference: TM 241998 Area: 19.6 [ha] 48.4

Ordnance Survey Sheet 1:50,000: 134 1:10,000: TG 20 SW, TM 29 NW

Date Notified [Under 1949 Act]: - Date of Last Revision: -

Date Notified [Under 1981 Act]: 1987 Date of Last Revision: -

Other Information:

A new site.

Description and Reasons for Notification:

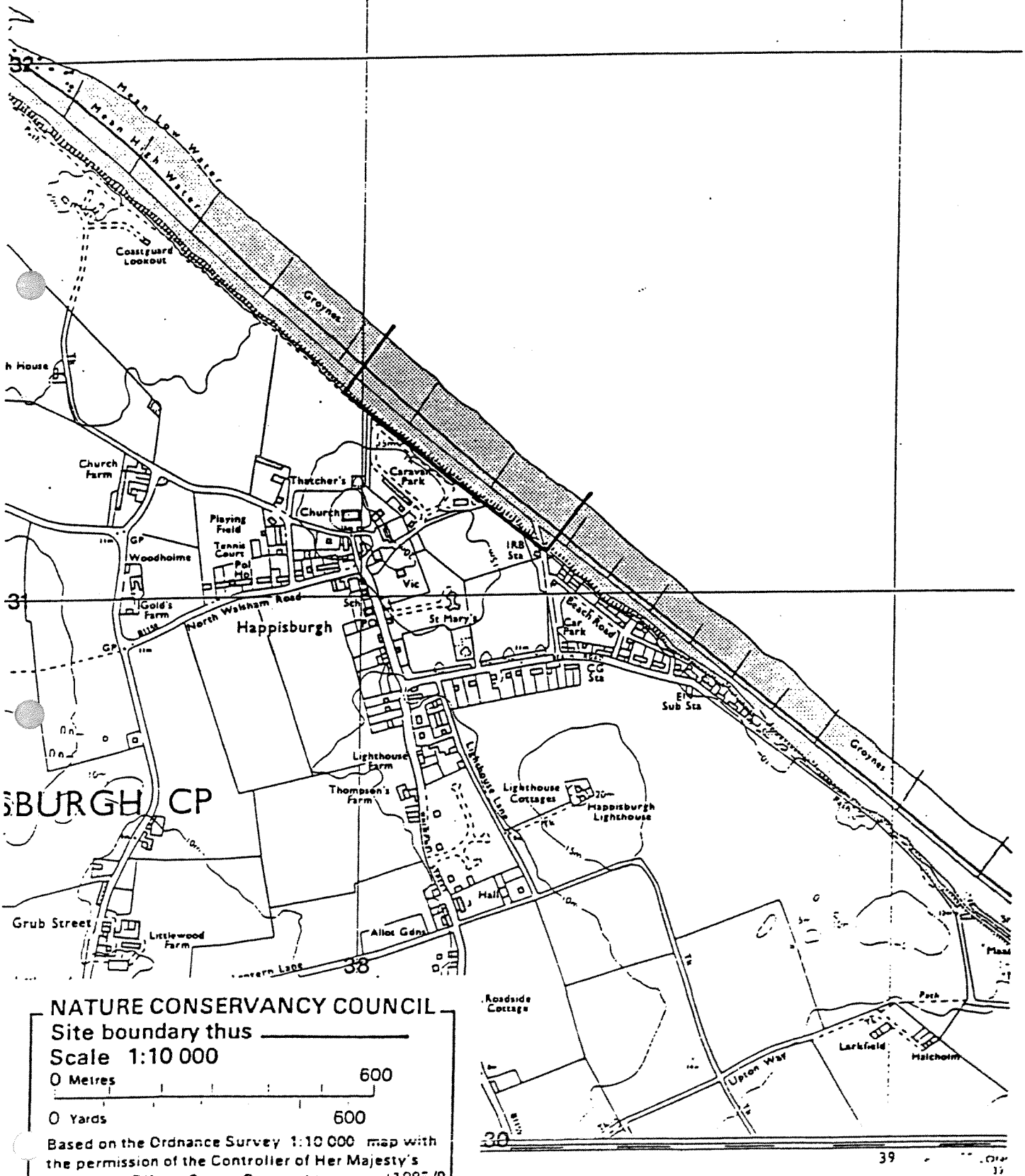
Shotesham Common is a valley site in the catchment of the River Tas. Extensive area of unimproved grassland are now rare in Norfolk due to agricultural improvement but th majority of Shotesham Common has remained under a traditional management regime an a good variety of grassland types are present. These range from permanently wet marsh grassland on the valley bottom, through wet neutral grassland, to drier grassland on th slopes. A stream runs through the site and there is a small area of basic flush on the valle side. The scientific interest of the site is maintained by light grazing and a diverse we developed flora is present with several uncommon species.

The areas of marshy grassland are dominated by Blunt-flowered Rush [Juncus subnodulosus Sharp-flowered Rush [J. acutiflorus] and Meadowsweet [Filipendula ulmaria] with frequer Bogbean [Menyanthes trifoliata], Marsh Marigold [Caltha palustris], Ragged Robin [Lychn flos-cuculi] and Southern Marsh Orchid [Dactylorhiza praetermissa]. More uncommon specie present include Marsh Lousewort [Pedicularis palustris], Marsh Helleborine [E pacti palustris] and Common Cotton-grass [Eriophorum angustifolium].

Wet neutral grassland is present on less waterlogged soils. Grasses are dominant in the swar and the more frequent species are Tufted Hair-grass [Deschampsia cespitosa], Yorkshir Fog [Holcus lanatus] and Creeping Bent [Agrostis stolonifera]. Herb species are we represented and include Cowslip [Primula veris], Common Spotted Orchid [Dactylorhiz fuchsii], Common Twayblade [Listera ovata] and Adder's Tongue [Ophioglossum vulgatum Small areas of dry, neutral grassland on hummocky ground are dominated by Sweet Vern Grass [Anthoxanthum odoratum] and Yorkshire Fog with Meadow Saxifrage [Saxifrag granulata], Lady's Bedstraw [Galium verum] and Common Quaking Grass [Briza media].

The small flush has a bryophyte-dominated carpet with a short-sward vegetation tha includes Marsh Arrow-grass [Triglochin palustris], Common Quaking Grass and Cuckc Flower [Cardamine pratensis].

The site also includes small areas of semi-improved and improved grassland.



NATURE CONSERVANCY COUNCIL

Site boundary thus

Scale 1:10 000

0 Metres 600

0 Yards 600

File Ref: EA/N/ /14 WRE

COUNTY: Norfolk

SITE NAME: HAPPISBURGH CLIFFS

DISTRICT: North Norfolk

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlif and Countryside Act 1981

Local Planning Authority: North Norfolk District Council

National Grid Reference: TG 379314
TG 383311

Area: 5.9 (ha.) 14.5 (a

Ordnance Survey Sheet 1:50,000: 133

1:10,000: TG 33 SE

Date Notified (Under 1949 Act): N/A

Date of Last Revision: N/A

Date Notified (Under 1981 Act): 1985

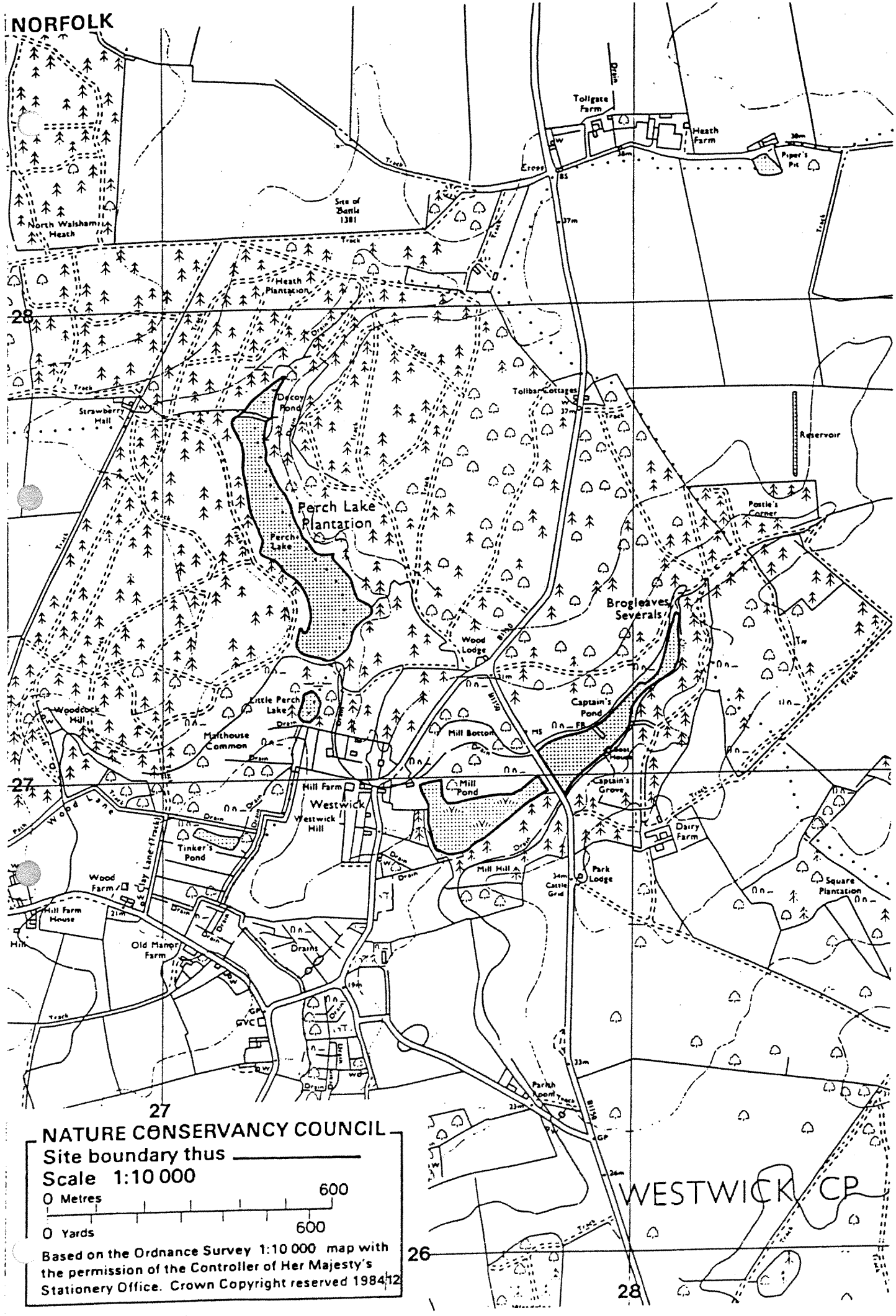
Date of Last Revision: -

Other Information:

A new site.

Reasons for Notification:

This locality is important both for the cliff exposures which uniquely show three glacial deposits, the Cromer Tills (of Anglian age) with intercalated waterlain sediments, and for the underlying Cromer Forest-bed Formation, exposed in the foreshore, with excellent development of pre-Pastonian and Pastonian sediments. An important site for dating the Pleistocene succession of East Anglia with a range of sediments from marine to freshwater and glacial spanning five stages, from the pre-Pastonian to the Anglian.



NATURE CONSERVANCY COUNCIL

Site boundary thus

Scale 1:10 000

0 Metres 600

0 Yards 600

COUNTY: Norfolk

SITE NAME: WESTWICK LAKES

DISTRICT: North Norfolk

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: North Norfolk District Council

National Grid Reference: TG 273274 Area: 9.55[ha] 23.6

Ordnance Survey Sheet 1:50,000: 133 1:10,000: TG 22 NE

Date Notified [Under 1949 Act]: 1973 Date of Last Revision: N/A

Date Notified [Under 1981 Act]: 1985 Date of Last Revision: -

Other Information:

The boundary has been amended by a small deletion.

Reasons for Notification:

Westwick Lakes form a compact group of five secluded, man-made lakes. The Perch Lake group is of a type rarely found in East Anglia and closely resembles nutrient-poor lakes found in the upland areas. The acidic waters support an unusual aquatic flora and plankton fauna which includes one locally uncommon species. The other lakes are more typical with abundant water weeds and provide an interesting contrast to the Perch Lake group. There is considerable ornithological interest with large flocks of wildfowl overwintering in the lakes.

Perch Lake is the largest and deepest of the lakes. It has a sandy bottom and is fed by underground springs. Aquatic plants are naturally poorly represented in the highly acidic nutrient-poor waters but White Water-lily [Nymphaea alba] is present in addition to the locally very uncommon Shoreweed [Littorella uniflora]. Carpets of Bog mosses [Sphagnum spp.] project into the lake in places and the muddy margins are dominated by Marsh Pennywort [Hydrocotyle vulgaris].

Little Perch Lake is shallow and shows an interesting succession from open water to Birch [Betula pubescens] woodland. Yellow Water-lily [Nuphar lutea] is dominant in the lake but the fringing vegetation of Bog Pondweed [Potamogeton polygonifolius], Bulbous Rush [Juncus bulbosus] and Bog mosses is extending into the open water. The swampy, marginal vegetation is being invaded and stabilised by Birch.

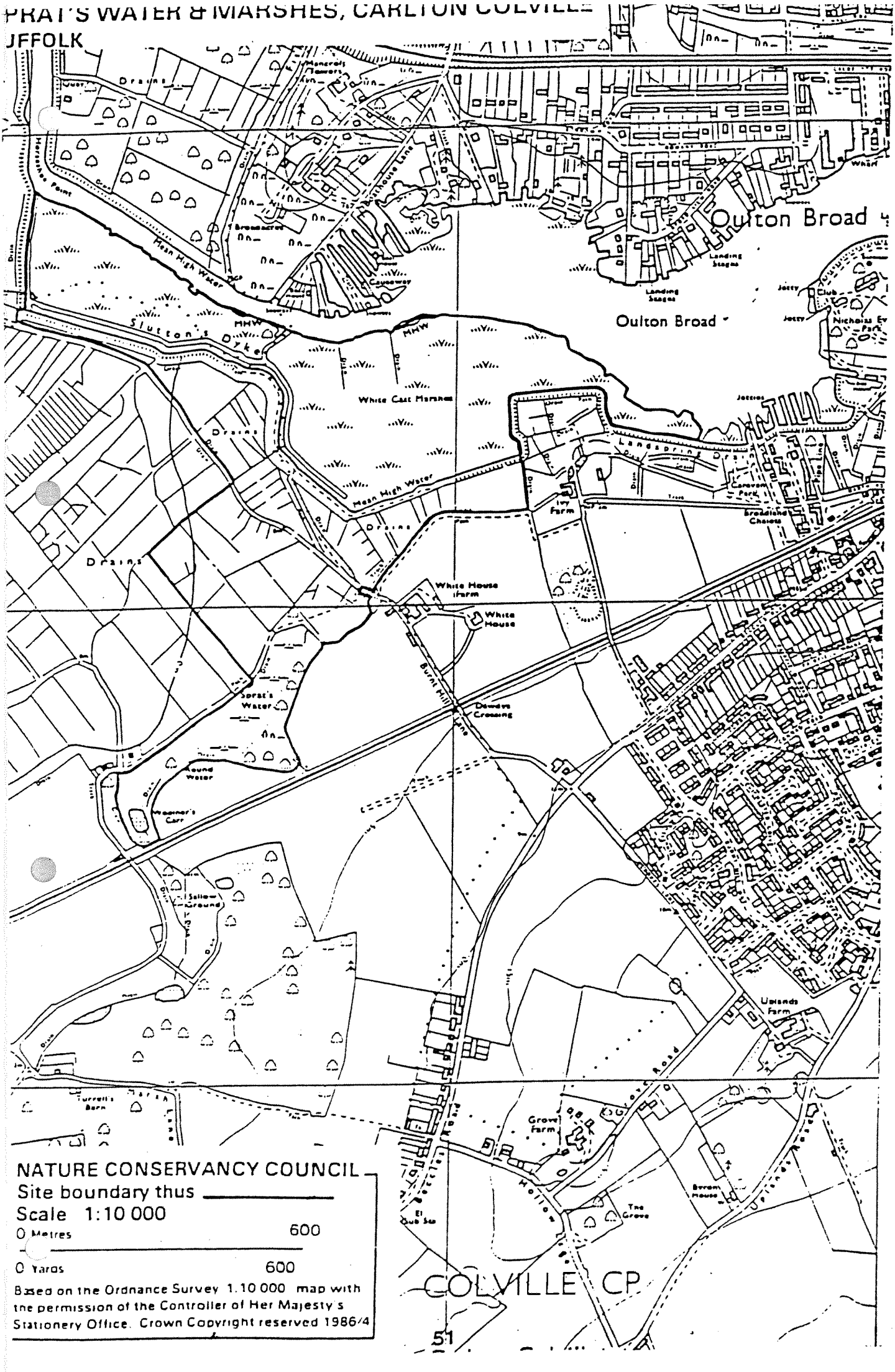
Water-lilies dominate Mill Pond and Captain's Pond, the two eutrophic water-bodies. Other water plants include Duckweed [Lemna minor], the free-floating Liverwort [Riccia fluitans] and several species of Pondweed [Potamogeton spp.]. The marginal vegetation is dominated by Lesser Reedmace [Typha angustifolia] with Soft Rush [Juncus effusus], Sweet Flag [Acorus calamus], Marsh Cinquefoil [Potentilla palustris], Reed Sweet-grass [Glyceria maxima] and Great Reedmace [T latifolia].

Perch Lake attracts many species of diving duck in winter including Goldeneye and Goosander.

SSSIs IN SUFFOLK

PRAT'S WATER & MARSHES, CARLTON COLVILLE

SUFFOLK



NATURE CONSERVANCY COUNCIL

Site boundary thus

Scale 1:10 000

0 Metres 600

0 Yards 600

File Ref: EA/S/83/14 WMW

COUNTY: Suffolk **SITE NAME:** SPRAT'S WATER AND MARSHES

DISTRICT: Waveney

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife a Countryside Act 1981

Local Planning Authority: Waveney District Council

National Grid Reference: TM 507921 **Area:** 55.5 (ha) 137.2 (ac)

Ordnance Survey Sheet 1:50 000: 134 **1:10 000:** TM 59 NE

Data Notified (Under 1949 Act): 1979 **Date of Last Revision:**

Date Notified (Under 1981 Act): 1986 **Date of Last Revision:**

Other information:

Much of the site is owned by the Suffolk Trust for Nature Conservation. The remaining area is held by t Trust under an annual management agreement.

Description and Reasons for Notification:

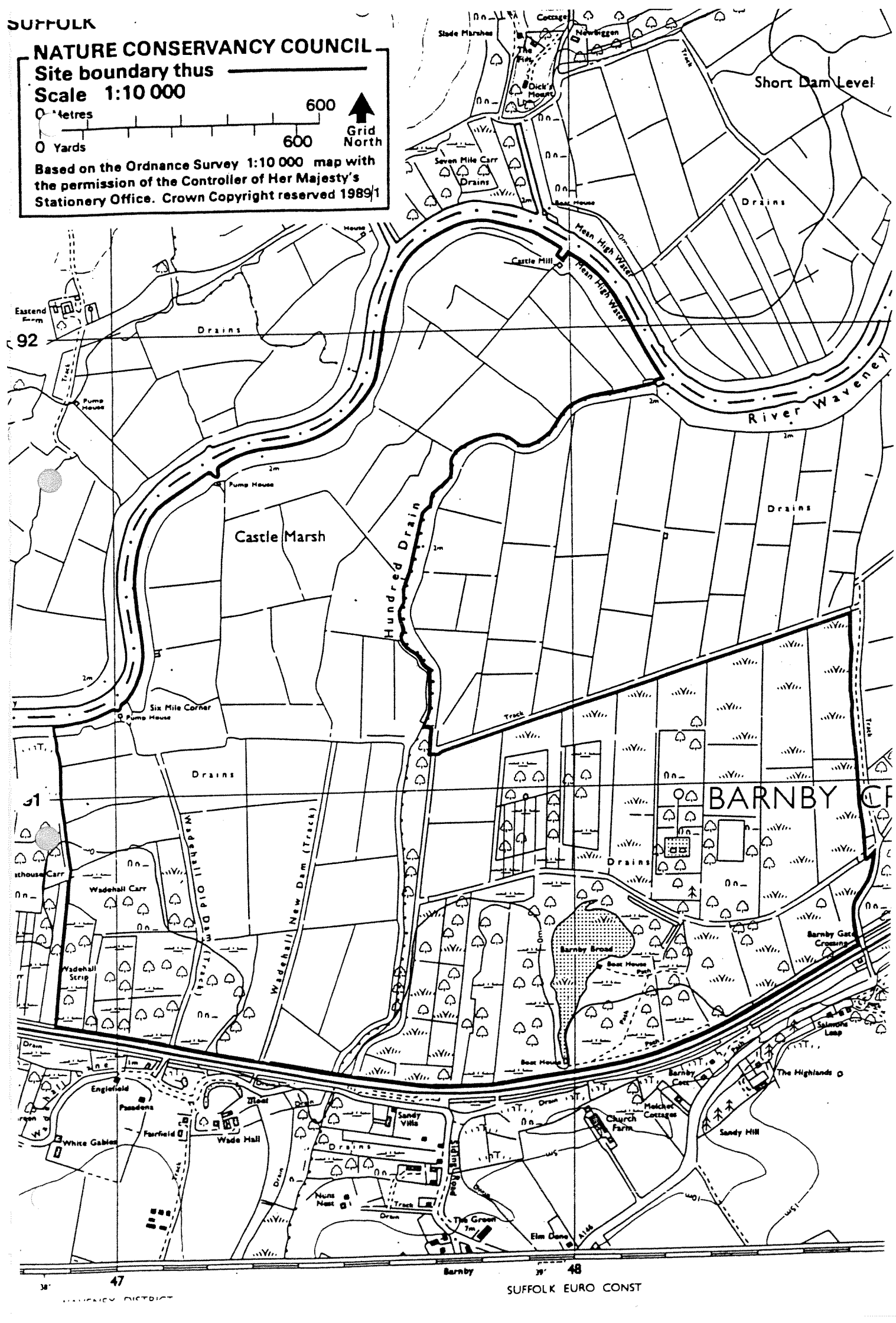
Sprat's Water and Marshes are situated in the Lower Waveney Valley and comprise areas of spring-f mixed fen, open water, alder carr and wet grazing marsh on deep peat. The fen community is of a type th is typical of Broadland but which is rarely found elsewhere in Suffolk. Maintenance of high summer wat levels together with seasonal grazing and reed cutting have led to the development of a very rich flora whi includes several uncommon species. The site is also important for breeding birds.

The tall fen communities of Sprat's Water and White Cast Marshes are dominated largely by Re (Phragmites australis) and Saw Sedge (Cladium mariscus). Characteristic plants include Lesser Reedma (Typha angustifolia), Greater Spearwort (Ranunculus lingua), Bogbean (Menyanthes trifoliata), Ma Pennywort (Hydrocotyle vulgaris) and the uncommon Milk Parsley (Peucedanum palustre). Other unusu species include Cowbane (Cicuta virosa), Marsh Sow-thistle (Sonchus palustris) and Marsh Pea thyr palustris). In drier parts of the fen, Sweet Reed-grass (Glyceria maxima) becomes abundant.

Wet grazing marshes link the two areas of fen. These show a gradation from neutral to marshy grassla and are dominated by Yorkshire Fog, Meadow Fescue and Tufted Hair-grass with a variety of rushes a sedges. Ragged Robin, Cuckoo Flower, and Quaking Grass (Briza media) are common, whilst more notab species include Adder's Tongue (Ophioglossum vulgatum), Southern Marsh Orchid (Dactylorhi praetermissa) and Marsh Pea.

A well-developed system of spring-fed drainage dykes serve the grazing marshes. These support a vari aquatic and fringing vegetation including Spiked Water Milfoil (Myriophyllum spicatum), Rigid Hornwo (Ceratophyllum demersum), Frogbit (Hydrocharis morsus-ranae), Arrowhead (Sagittaria sagittifolia), Wat Soldier (Stratiotes aloides), Flowering Rush (Butomus umbellatus) and Pondweeds (Potamogeton spp Shallow ponds have developed from former peat workings at Sprat's Water and contain abunda bladderwort and hornwort.

Alder carr and scattered sallow fringe much of Sprat's Water and occur in isolated patches on W e C Marshes. The ground flora is typical of wet woodland and includes opposite-leaved Golden Saxifra (Chrysosplenium oppositifolium).


SUFFOLK
NATURE CONSERVANCY COUNCIL
Site boundary thus
Scale 1:10 000
0 Metres
600
0 Yards
600
Grid North
Based on the Ordnance Survey 1:10 000 map with the permission of the Controller of Her Majesty's Stationery Office. Crown Copyright reserved 1989/1
Short Dam Level
Slade Marshes
Cottage
Newbiggen
The Flats
Dick's Mount
Seven Mile Carr Drains
Boat House
Drains
Mean High Water
Castle Hill
Eastend Farm
92
Track
Pump House
River Waveney
Castle Marsh
Hundred Drain
Six Mile Corner
BARNBY
Wadehall Carr
Wadehall Old Dam (Track)
Wadehall New Dam (Track)
Wadehall Strip
Barnby Broad
Boat House Path
Barnby Gate Crossing
Salomons Lamp
The Highlands
Barnby Cross
Malcher Cottages
Church Farm
Sandy Hill
Englefield
Pasadena
Fairfield
White Gables
Wade Hall
Sandy Villa
Nuns Nest
The Grove
Elm Dene
A146
Barnby
47
48
SUFFOLK EURO CONST

File Ref EA/S/217/14WSM

COUNTY: SUFFOLK

SITE NAME: BARNBY BROAD AND MARSHES

DISTRICT: WAVENEY

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981.

Local Planning Authority: WAVENEY DISTRICT COUNCIL

National Grid Reference: TM 480910 Area: 189.62 (ha.) 468.56 (ac.)

Ordnance Survey Sheet 1:50,999: 1:10.000

Date Notified (under 1949 Act): N/A Date of last revision:

Date Notified (under 1981 Act): 16.5.90 Date of last revision:

Other Information:

Description and Reasons for Notification:

Barnby Broad and Marshes are situated in the Waveney Valley and comprise a large and varied area of open water, carr woodland, fen, grazing marsh and dykes. Several of the communities are confined to the Broadland area of Norfolk and Suffolk where they are under increasing threat. The large area of semi-natural habitats and traditional grazing marsh make this site especially important as other areas of Broadland become fragmented. The plant communities are very rich in species and the site has an outstanding assemblage of rare and uncommon plants. The range of habitats is also attractive to nesting birds and several rare species breed in the area. There is, in addition, considerable entomological interest.

Barnby Broad is a small, shallow, man-made lake which is the result of medieval peat-cutting. Although isolated from the nutrient-rich waters in the river, the Broad contains few water-plants apart from White Water-lily (Nymphaea alba). The marginal vegetation is more diverse and is dominated by Common Reed (Phragmites australis) and the scarce Fibrous Tussock-sedge (Carex appropinquata). On the landward side of this fringe is a zone of floating, but well-consolidated, carpets of bog-moss (Sphagnum spp.). A diverse community of low-growing plants is present which includes Marsh Arrowgrass (Triglochin palustris), Marsh Fern (Thelypteris palustris), Milk-parsley (Peucedanum palustre) and Southern Marsh-orchid (Dactylorhiza praetermissa).

Mature carr woodland surrounds the Broad. Alder (Alnus glutinosa) is the dominant tree species with frequent Ash (Fraximus excelsior) and Pedunculate Oak (Quercus robur). The shrub layer includes bushes of Grey Willow (Salix cinerea), Guelder Rose (Viburnum opulus) and Hawthorn (Crataegus monogyna). Numerous springs emerge in the carr and the variable wetness of the ground is reflected in a diverse ground flora. Nettle (Urtica dioica) and Raspberry (Rubus idaeus) are locally dominant and other species include Yellow Iris (Iris pseudacorus), Lesser Pond-sedge (Carex acutiformis), Purple Small-reed (Calamogrostis canescens), Marsh Fern and Primrose (Primula vulgaris).

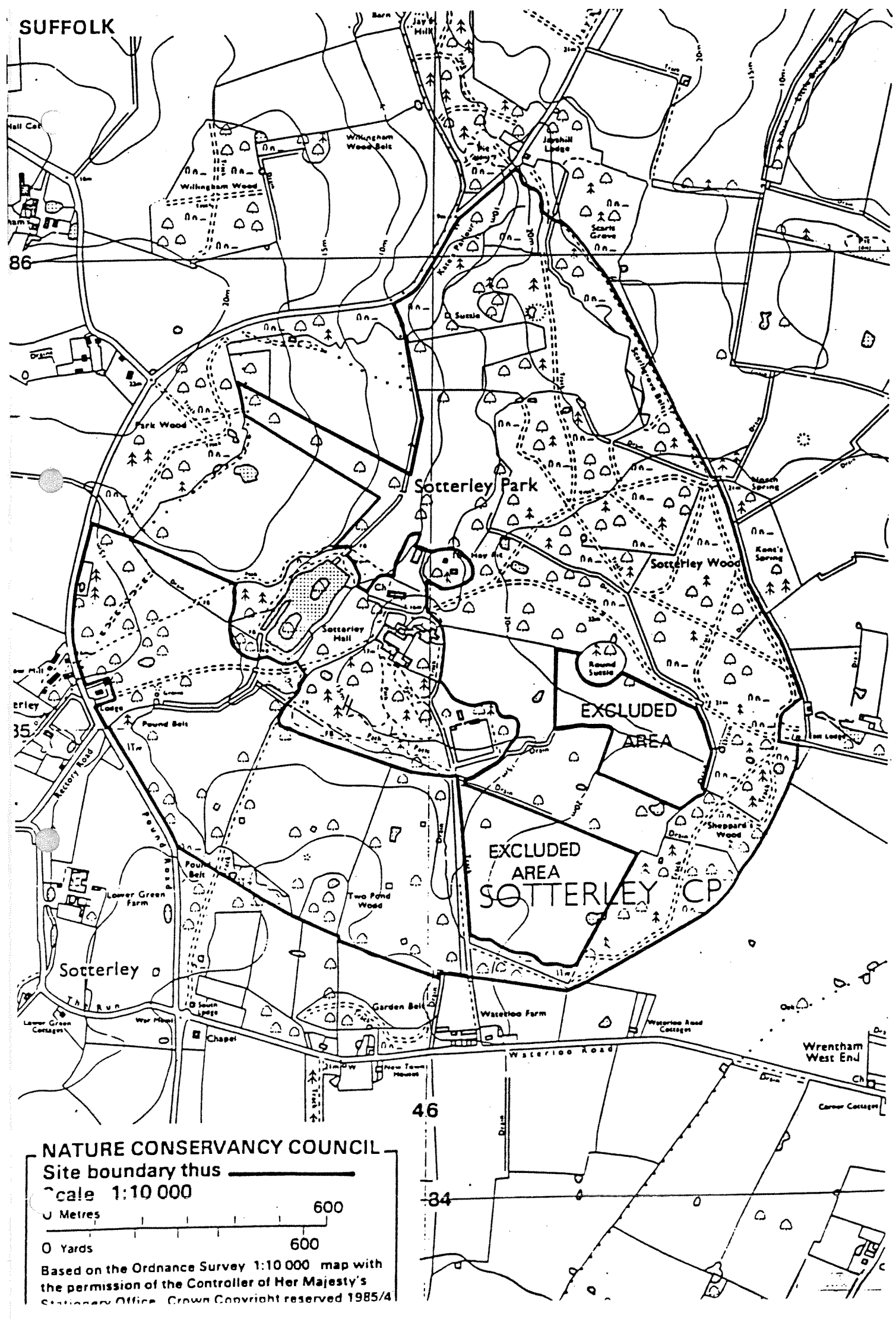
Tall fen vegetation is well developed on the site. The richest areas are on fen peats and are regularly cut. Reed is dominant and other species include Milk-parsley, Marsh Sow-thistle (Sonchus palustris), Common Spotted-orchid (Dactylorhiza fuchsii), Angelica (Angelica sylvestris) and Purple Loosestrife (Lythrum salicaria). Drier, relatively species poor fen, characterized by False Oat-grass (Arrhenatherum elatius), is also present, on former grazing marsh.

A range of grassland types is present on the site. The richest areas are those that have remained unimproved and are dominated by a variety of species of rush (Juncus spp) and Purple Moor-grass (Molinia caerulea). In places the fen peats have become acidic through leaching and here bog mosses are abundant. Other plants occurring include Bog Pimpernel (Anagallis tenella), Marsh Pea (Lathyrus palustris), Meadow Thistle (Cirsium dissectum), Yellow-rattle (Rhinanthus minor) and Adder's-tongue (Ophioglossum vulgatum).

A large part of the site is improved grazing marsh. Although the fields are of no special botanical interest they are crossed by a network of species-rich, clear water dykes. An impressive number of water-plants is present and the dykes can be divided into two main types. The dykes close to the river are on alluvial clays and are dominated by the uncommon Water-soldier (Stratiotes aloides). Other species present include Stoneworts (Chara spp.), Frogbit (Hydrocharis morsus-ranae), 5 species of pondweed (Potamogeton spp.), and the uncommon Whorled Water-milfoil (Myriophyllum verticillatum). Away from the river the dykes cut through fen peats and are characterised by an abundance of Greater Bladderwort (Utricularia vulgaris agg.)

The fens and tussocky grassland provide suitable conditions for a number of breeding birds which include Tufted Duck, Barn Owl, Sparrowhawk and Snipe. There are also breeding records for several other rare species of bird.

The extensive areas of undisturbed fen and waterways are ideal hunting grounds for Otters. There is also considerable entomological interest and a local rarity, the Norfolk Aeschna Dragonfly (Aeschna isosceles), is present in a number of dykes.



NATURE CONSERVANCY COUNCIL

Site boundary thus

Scale 1:10 000

0 Metres 600

0 Yards 600

Based on the Ordnance Survey 1:10 000 map with the permission of the Controller of Her Majesty's Stationery Office. Crown Copyright reserved 1985/4

File Ref: EA/S/82/14 WMV

COUNTY: Suffolk

SITE NAME: SOTTERLEY PARK

DISTRICT: East Suffolk

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Waveney District Council

National Grid Reference: TM 463853 Area: 121.2 [ha] 299.5 [a

Ordnance Survey Sheet 1:50,000: 156 1:10,000: TM 48 SE & NE

Date Notified [Under 1949 Act]: 1971 Date of Last Revision: N/A

Date Notified [Under 1981 Act]: 1985 Date of Last Revision: -

Other Information:

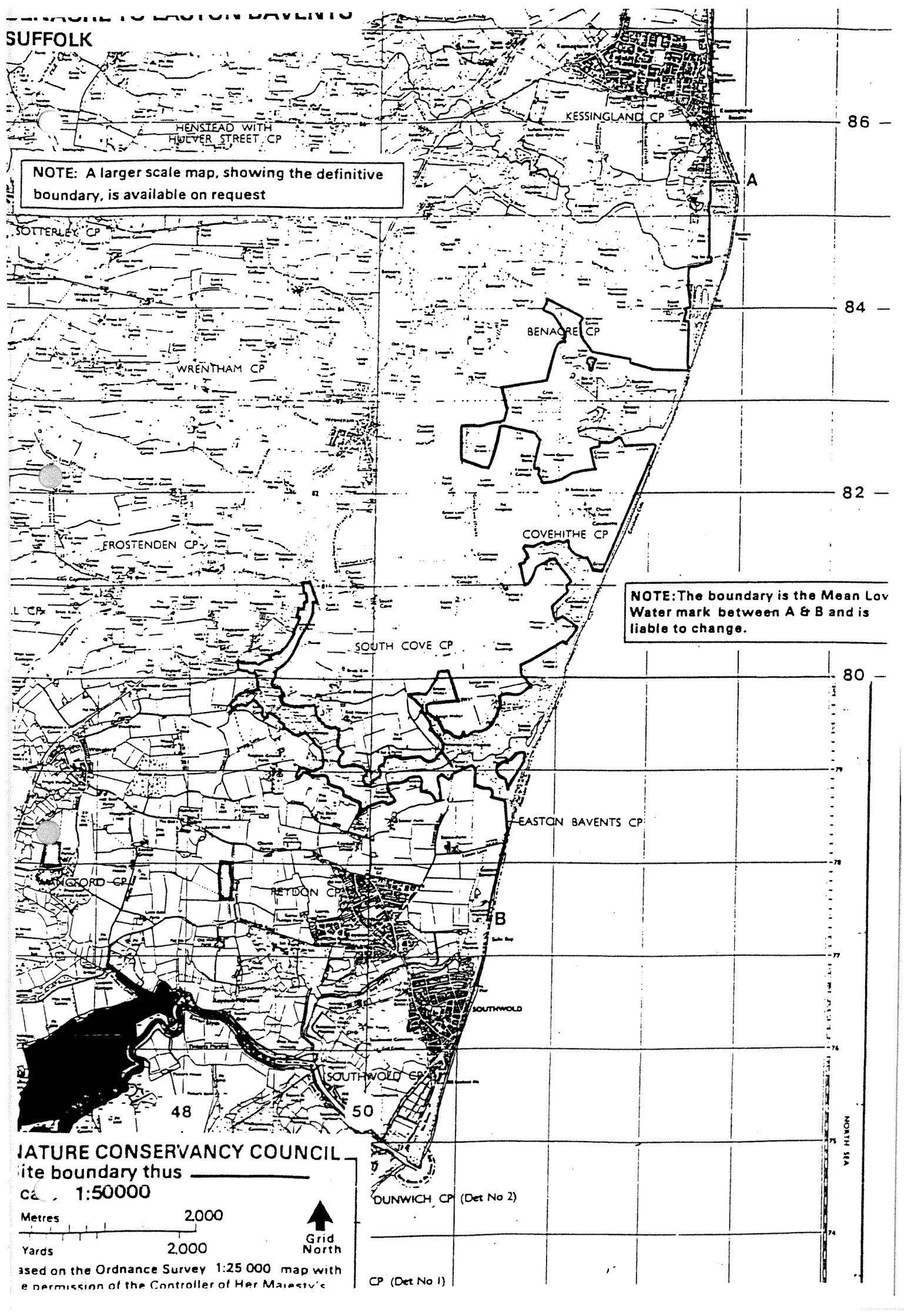
SSSI boundary revised and site reduced in size. The site is listed in a "Nature Conservation Review" [ed. by Dr Ratcliffe, Cambs University Press.

Reasons for Notification:

Sotterley Park may occupy the site of an early medieval deer park but, if so, this is obscured by the present park which was laid out in the 18th Century, and which includes some ancient semi-natural woodland. The parkland trees support the richest epiphytic Lichen flora in East Anglia.

Many of the parkland trees are of huge size and great age. On these, ninety-two species of Lichen and fourteen species of Bryophytes have been recorded. The most notable of these include Anaptychia ciliaris, Calicium abietinum, Chaenotheca brunneola, Normandia pulchella, Opegrapha sonedufera, and Ramalina fraxinea and Hechancha premnea. The parkland pasture has been improved and contains few herb species of interest.

The surrounding woodlands shelter the park. Sotterley and Shepards Woods are remnants of a larger semi-natural Hornbeam-Ash wood incorporated into the park. However, substantial areas of this have been structurally modified over the years including the modern introduction of conifer stands. The woodland flora is typical for woods on light soil. Brambles [Rubus spp.] are abundant and primrose [Primula vulgaris], Bluebell [Hyacinthoides non-scripta] and Dog's Mercury [Mercurialis perennis] are frequent.


SUFFOLK
HENSTEAD WITH HULVER STREET CP
KESSINGLAND CP
NOTE: A larger scale map, showing the definitive boundary, is available on request
SOTTERLEY CP
BENACRE CP
WRENTHAM CP
COVEHITHE CP
FROSTENDEN CP
NOTE: The boundary is the Mean Low Water mark between A & B and is liable to change.
SOUTH COVE CP
EASTON BAVENTS CP
REYDON CP
SOUTHWOLD
SOUTHWOLD CP
48
50
DUNWICH CP (Det No 2)
CP (Det No 1)
NATURE CONSERVANCY COUNCIL
Site boundary thus
Scale 1:50000
Metres 2,000
Yards 2,000
Grid North
Based on the Ordnance Survey 1:25 000 map with the permission of the Controller of Her Majesty's
NORTH SEA
86
84
82
80
A
B

COUNTY: Suffolk

File Ref: EA/S/239/14 W

SITE NAME: BENACRE TO EASTERN BAVENTS SSSI

DISTRICT: Waveney

STATUS: Site of Special Scientific Interest (SSS) notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Waveney District Council

National Grid Reference: TM 537855
TM 512772

Area 526.3 (ha) 1300.6 (ac)

Ordnance Survey sheet 1:50,000: 156

1:10,000: TM57NW, 58NW, 58SW

Date notified (under 1949 Act): 1954*
1962+

Date of last revision: N/A

Date notified (under 1981 Act): 1989

Date of last revision: N/A

Other information:

The site combines and extends three former SSSIs - Benacre Broads and Denes*, Easton and Covehithe Broads*, and Easton Bavents Cliffs+. It also includes Benacre Broad NNR.

Reasons for Notification:

This site extends along the coast from Kessingland south to Southwold and includes Benacre, Covehithe and Easton Broads and the cliffs at Covehithe and Easton Bavents.

Benacre, Covehithe and Easton Broads are coastal lagoons separated from the sea by retreating shingle bars. They are fringed by extensive reedswamp and both Benacre and Easton are sheltered by surrounding secondary and ancient woodland. The foreshore from Kessingland t Southwold is shingle, behind which are areas of saltmarsh, relict sand dune, and grassland, bracken or soft cliff. This combination of habitats together with an exceptional ornithological interest and the geological and physiographical importance of the cliffs and beach, makes this a valuable site for nature conservation.

Coastal Lagoons and Reedbeds

The Broads are classic coastal lagoons, formed by the ponding of a freshwater outlet by a barrier of sea deposited sand and shingle. They are shallow with a peat bottom. The depth and area of open water varies according to water supply, land drainage and infiltration through the beach. They are liable to flooding by seawater during storms or very high tides; salinity is therefore variable which influences the aquatic wildlife. The Broads are also diminishing in size as a result of coastal erosion. All three Broads are fringed with reedbeds which are extensive at Benacre and Easton. These contain saltmarsh elements to the seaward side, but freshwater species occur inland. The reedbeds are dominate by Common Reed (Phragmites australis) but have a notable population of the uncommon marsh plant Marsh Sow-thistle (Sonchus palustris).

The Frostenden Valley shows a transition from brackish to fresh water along its length, thus giving rise to an interesting distribution of saltmarsh, brackish and fresh water plants in the drainage dykes and grazing marshes. The Broads and reedbeds attract a wide variety of wildfowl and marshland birds throughout the year.

The Beach

The foreshore is composed of loose shingle but may be intercalated with sand from cliff erosion or be temporarily swept clear to expose the underlying strata. The beach supports a number of colonising shingle plants including Sea Pea (Lathyrus japonicus), Yellow Horned-poppy (Glaucium flavum), Sea Beet (Beta vulgaris ssp maritima), Saltwort (Salsola kali), Sea Rocket (Cakile maritima), Biting Stonecrop (Sedum acre), and Sticky Groundsel (Senecio viscosus). Inland at Benacre, there are relict sand dunes vegetated with Sand Sedge (Carex arenaria), Marram Grass (Ammophila arenaria), Sand Couch Grass (Elymus farctus) and the rare Grey Hair-grass (Corynephorus canescens). An unusual feature of the lichen flora here is the presence of the epiphytic lichen Evernia prunastre in addition to the common Cladonia lichens. Also at Benacre, there are three former gravel pits, two of which contain deep water. Acid grassland with some heathland elements, bracken and scrub occur in places behind the beach and cliffs.

Woodland

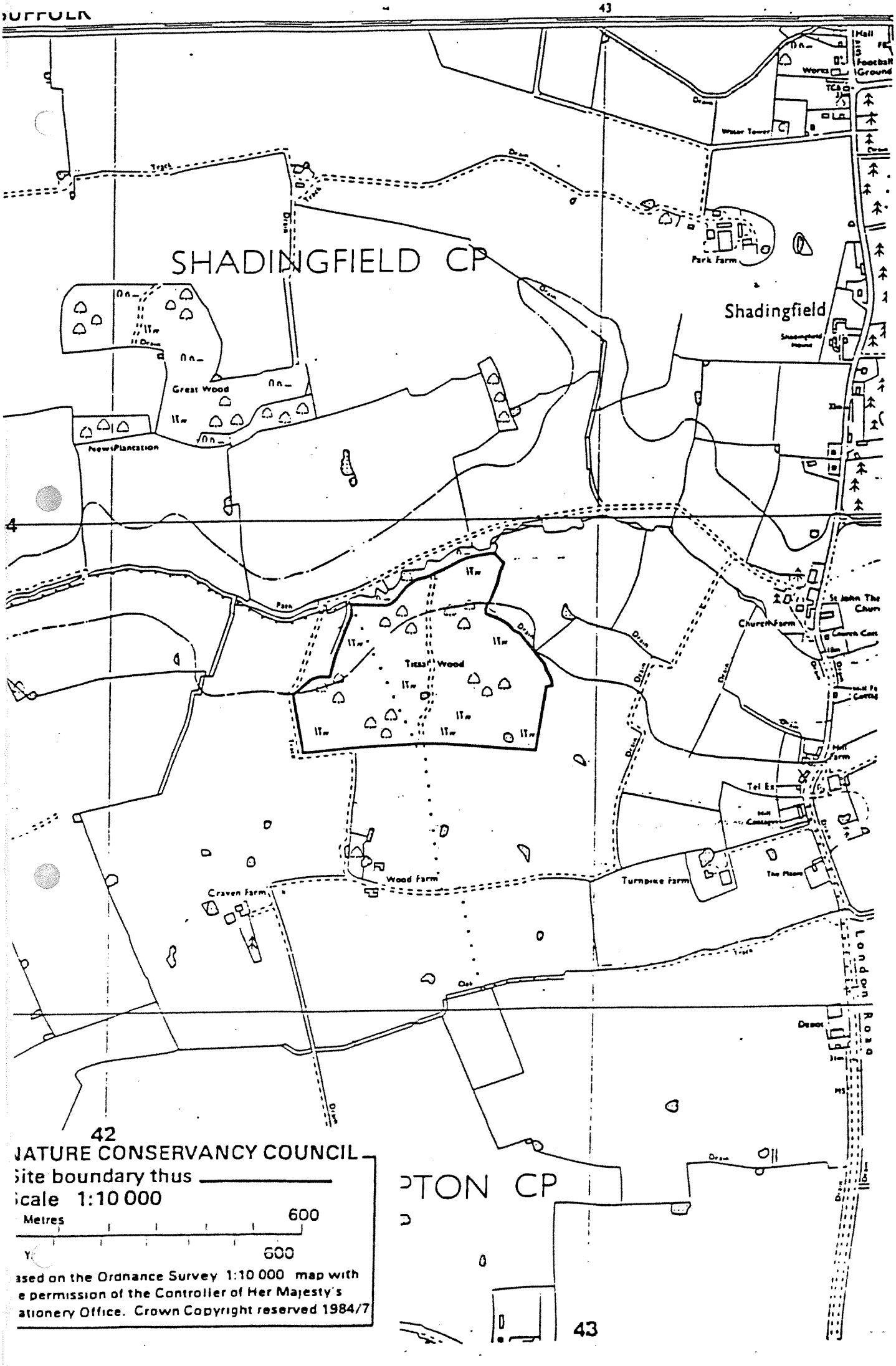
Woodlands at Benacre and Easton vary in tree species, structure, age and origin.

Mature Plantations of Oak, Sweet Chestnut, Elm, Sycamore and Scots Pine are present at Benacre together with more recent plantations. The Broad is fringed with self-sown Birch, Alder, Oak and Sallow.

Holly Grove contains ancient Ash-Hazel woodland and some aged Oaks. It has a diverse flora including Wood Sorrel (Oxalis acetosella) and Wild Daffodil (Narcissus pseudonarcissus). Easton Wood is a rare example of an ancient wood meeting an exposed and eroding coastline. It is predominantly Oak and Sweet Chestnut with Sweet Chestnut underwood but contains a very impressive Alder glade along an internal valley. Except for wet ground around the broads and springs the woods are on dry sandy soils with a characteristic but restricted ground flora including Bracken (Pteridium aquilinum), Brambles (Rubus spp), Bluebells (Hyacinthoides non-scripta), and a notable population of Climbing Corydalis (Corydalis claviculata).

Ornithology

The variety of habitats present support a high diversity of breeding birds. These include Bearded Tit, Water Rail, Gadwall, Common and Little Terns, Wheatear, Redstart and Nightingale. It is also an important site for wintering and passage birds, especially wildfowl, and attracts many rare species. The Broads are used by substantial numbers of Mallard and Teal as well as Pochard, Wigeon, Goldeneye, Tufted Duck and various species of Divers and Grebes. These are hunted by over wintering raptors such as Sparrowhawk, Buzzard and Hen Harriers.


SHADINGFIELD CP
Shadingfield
Park Farm
Great Wood
New Plantation
Tissa Wood
Church Farm
Wood Farm
Craven Farm
Turnpike Farm
London Road
42
43
NATURE CONSERVANCY COUNCIL
Site boundary thus
Scale 1:10 000
Metres
600
600
Based on the Ordnance Survey 1:10 000 map with the permission of the Controller of Her Majesty's Stationery Office. Crown Copyright reserved 1984/7

SITE NAME: TITSAL WOOD, [illegible]

COUNTY: Suffolk

DISTRICT: Waveney

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Waveney District Council

National Grid Reference: TM 426837 Area: 14.4 [ha] 35.5

Ordnance Survey Sheet 1:50,000: 156 1:10,000: TM 48 SW

Date Notified [Under 1949 Act]: 1971 Date of Last Revision:

Date Notified [Under 1981 Act]: 1984 Date of Last Revision: -

Other Information:

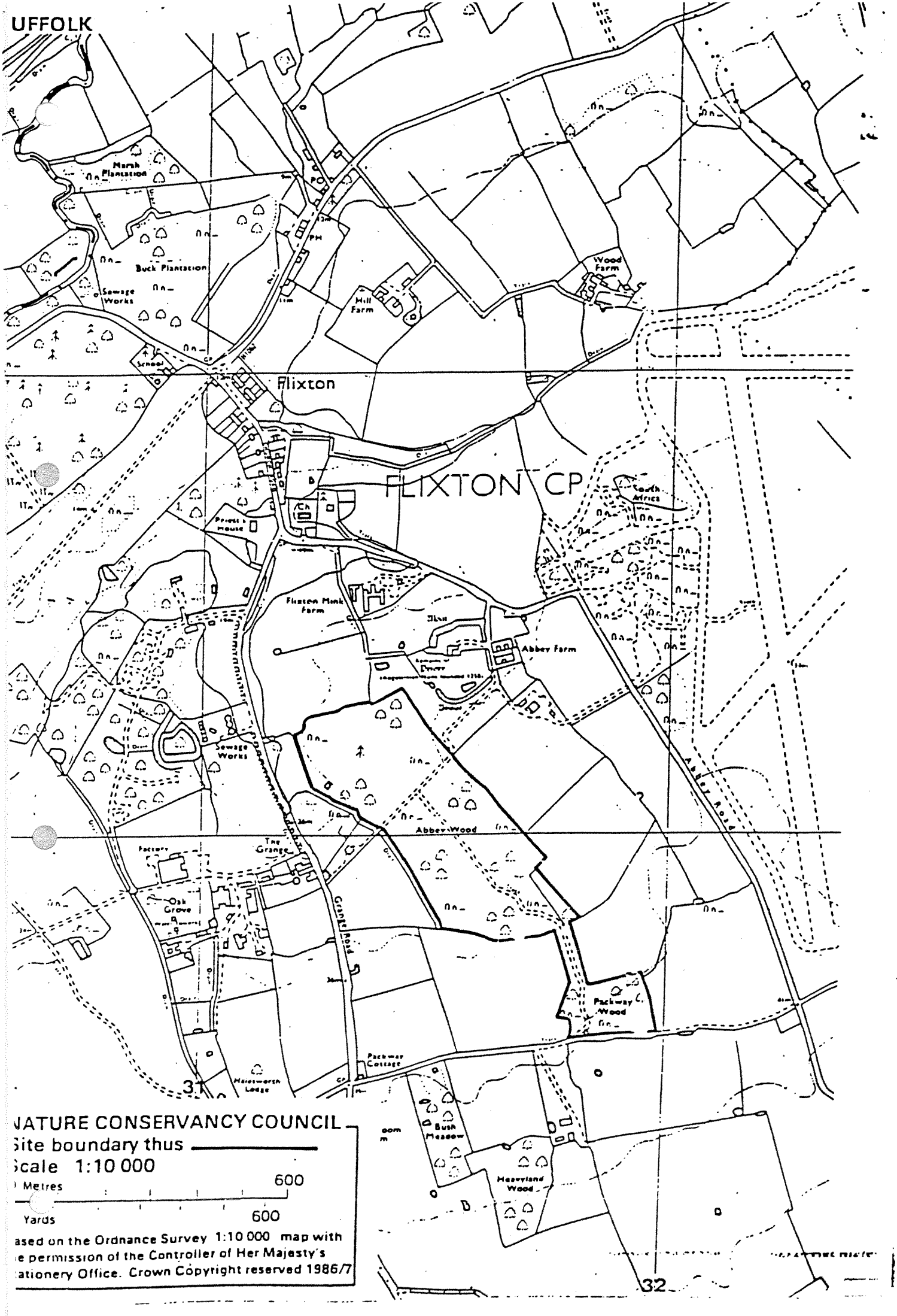
Reasons for Notification:

Titsal Wood is an ancient woodland on boulder clay overlain by sand. The site is the interesting example of the sloping type of East Suffolk hornbeam wood. It has a rich including ancient woodland plants and one scarce species.

Pedunculate oak-hornbeam woodland of the ash-maple variant is the dominant stand-type much of the wood. Young standard trees of Oak [Quercus robur] and Ash [Fraxinus exc are frequent. There are some areas of pure Hornbeam [Carpinus betulus] coppice but usually mixed with Ash. Field Maple [Acer campestre] and Hazel [Corylus avellana]. Small of mixed ashwood and suckering elmwood are also present.

The ground flora is dominated by Bramble [Rubus fruticosus agg.] with frequent patches of Mercury [Mercurialis perennis]. Ground Ivy [Glechoma hederacea] and Wood Sorrel [acetosella]. Interesting species include Common Spotted Orchid [Dactylorhiza fuchsii]. Pr [Primula vulgaris]. Wood Bitter-cress [Cardamine flexuosa] and the rare Thin-spiked Wood [Carex strigosa].

A wide ride bisects the wood. This has a distinctive flora that includes Creeping Soft-grass [mollis]. Remote Sedge [Carex remota] and Creeping Buttercup [Ranunculus repens].


UFFOLK
Marsh Plantation
Buck Plantation
Sewage Works
PH
Hill Farm
Wood Farm
School
Flixton
FLIXTON CP
Private House
Flixton Mink Farm
Abbey Farm
Sewage Works
Abbey Wood
Abbey Road
The Grange
Factory
Oak Grove
Grange Road
Packway Wood
Packway Cottage
Horsleworth Lodge
31
Bush Meadow
Haseyland Wood
32
NATURE CONSERVANCY COUNCIL
Site boundary thus
Scale 1:10 000
Metres
600
Yards
600
ased on the Ordnance Survey 1:10 000 map with
e permission of the Controller of Her Majesty's
tationery Office. Crown Copyright reserved 1986/7

File Ref: EA/S/1/14 WJL

COUNTY: Suffolk

SITE NAME: ABBEY WOOD, FLIXTON

DISTRICT: Waveney District

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Waveney District Council

National Grid Reference: TM315859 Area: 18.5 [ha] 45.7 [a

Ordnance Survey Sheet 1:50,000: 156 1:10,000: TM38NW

Date Notified [Under 1949 Act]: 1972 Date of Last Revision: -

Date Notified [Under 1981 Act]: 1986 Date of Last Revision: -

Other Information:

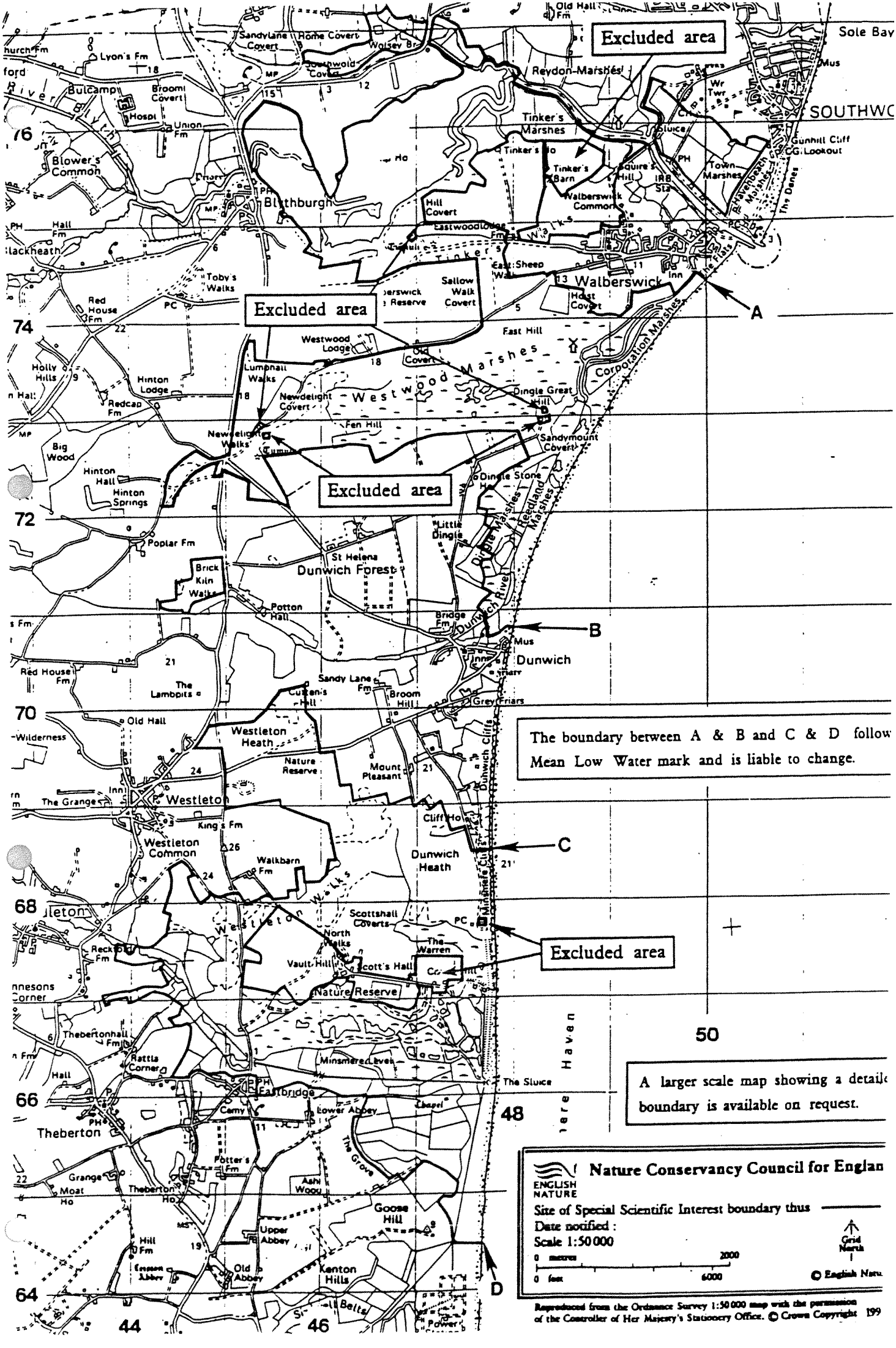
Description and Reasons for Notification:

Abbey and Packway woods are ancient woodland on a plateau of boulder clay over-lain by sand. The woodland structure consists of coppice with standards although there is some 19 and 20 century planting of broadleaves and a few conifers. The woods have a varied flora including ancient woodland plants and one scarce species.

The dominant stand type is pedunculate oak-hazel-ash of the heavy soil form. Wet ash-maple and pedunculate oak-hornbeam (typical ash-maple) stands are also present along with small suckering elm wood stands around the woodland edge. Hazel (Corylus avellana) coppice occurs over much of the wood with some Hornbeam (Carpinus betulus) to the south-east. Oak (Quercus robur), Ash (Fraxinus excelsior) and Field Maple (Acer campestre) standards are found with the coppice. Scattered groups of planted Turkey Oak (Quercus cerris), Picea sp and Populus sp are also found.

Dogs Mercury (Mercurialis perennis) dominates the shaded woodland floor. Where the light penetrates the canopy, patches of the grass Poa trivialis are present. Brambles (Rubus fruticosus), Ground Ivy (Glechoma hederacea) and nettles (Urtica dioica) are frequent. Interesting occasional species include Early Purple Orchid (Orchis mascula), Bugle (Ajuga reptans), Wavy Bitter Cress (Cardamine flexuosa), Yellow Archangel (Lamiastrun galeobdolon), Wood Millet (Milium effusum), Primrose (Primula vulgaris) Ramsons (Allium ursinum), Broad Helleborine (Epipactis helleborine) and the rare thin-spiked Wood Sedge (Carex strigosa).

The woods have a long and varied history ranging from the medieval association with the Augustinian Abbey of Flixton to its more recent use in the Second World War. The concrete ride in the centre of Abbey Wood dates from this time.


Excluded area
Excluded area
Excluded area
Excluded area
A
B
C
D
The boundary between A & B and C & D follow
Mean Low Water mark and is liable to change.
A larger scale map showing a detail
boundary is available on request.
Nature Conservancy Council for Englan
ENGLISH NATURE
Site of Special Scientific Interest boundary thus
Date notified :
Scale 1:50 000
Grid North
Reproduced from the Ordnance Survey 1:50 000 map with the permission
of the Controller of Her Majesty's Stationery Office. © Crown Copyright 199
Blythburgh
Walberswick
Dunwich
Westleton
Eastbridge
Theberton
Dunwich Forest
Westwood Marshes
Dunwich Heath
Westleton Heath
Tinker's Marshes
Corporation Marshes
Sole Bay
SOUTHWO
River Blyth
Haven
74
72
70
68
66
64
50
48
46
44

File Ref: 14/WMG

COUNTY: Suffolk

SITE NAME: MINSMERE-WALBERSWICK HEATHS AND MARSHES

DISTRICT: Suffolk Coastal/Waveney

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981 (as amended)

Local Planning Authority: Suffolk Coastal District Council/Waveney District Council
Suffolk County Council

National Grid Reference: TM 475645
TM 467772

Area: 2325.89 (ha) 5747.27 (ac)

Ordnance Survey Sheet 1:50 000: 156

1:10 000: TM 46 NE-NW-SW
TM 47 NE-NW-SE-SW

Date Notified (Under 1949 Act): see below

Date of Last Revision: 1972

Date Notified (Under 1981 Act): 1989

Date of Last Revision: 1993

Other information: This site amalgamates Minsmere Level SSSI (notified in 1954). Walberswick SSSI (notified in 1954) and Brick Kiln Walks SSSI (notified in 1972).

Much of this site has been designated a Special Protection Area under EC Directive 79/409 on the Conservation of Wild Birds, and as a Wetland of International Importance under the Ramsar Convention.

Much of the site is included within 'A nature conservation review' by Ratcliffe (1977). It is within the Suffolk Coast and Heaths Area of Outstanding Natural Beauty.

Parts of the site are owned and/or managed as nature reserves and are listed below

Walberswick National Nature Reserve (English Nature)
Westleton Heath National Nature Reserve (English Nature)
Minsmere Reserve (Royal Society for the Protection of Birds)
Dunwich Heath (National Trust)
Norman Gwatkin Reserve (Suffolk Wildlife Trust)

Description and Reasons for Notification:

This composite site is situated on the coast of Suffolk between Southwold in the north and Sizewell in the south. It contains a complex series of habitats, notably mudflats, shingle beach, reedbeds, heathland and grazing marsh, which combine to create an area of exceptional scientific interest.

The tidal mudflats of the River Blyth estuary form sheltered feeding grounds for wildfowl and shorebirds, notably wigeon, shelduck, redshank and dunlin. Saltmarsh, dominated by sea purslane (Halimione portulacoides), but also composed of sea lavender (Limonium vulgare), sea aster (Aster tripolium) and common cord-grass (Spartina anglica) fringes the southern shore of the estuary. Other saltmarsh species include glasswort (Salicornia spp), sea rush (Juncus maritimus), common saltmarsh grass (Puccinellia maritima) and sea couch-grass (Elymus pycnanthus).

Shingle beach forms the coastline at Walberswick and Minsmere. This is subject to sea erosion and human disturbance but, nevertheless, it supports a variety of scarce shingle plants including sea pea (Lathyrus japonicus), sea campion (Silene maritima) and small populations of sea kale (Crambe maritima), grey hair-grass (Corynephorus canescens) and yellow horned-poppy (Glaucium flavum). A narrow strip of yellow dune extends southwards at Minsmere behind which is a strip of dune grassland. A series of shallow, brackish lagoons and saltmarsh occurs behind the shingle beach between Walberswick and Dunwich.

Extensive reedbeds, consisting largely of pure stands of reed (Phragmites australis), occur at Minsmere and Walberswick. These developed on former grazing marshes which were flooded as a war-time defence measure in 1940. Both marshes contain shallow pools of open water and are intersected by deep water channels. The reedbeds are an important habitat for birds and insects. There are large breeding populations of reed warbler and bearded tit. Other notable breeding species include marsh harrier, bittern, cetti's warbler, garganey and water rail. The marshes have a rich insect fauna, particularly moths, which includes a number of rare species: notably Archanara neurica, Photedes brevilinea and Senta flammea.

At Minsmere, a 20 hectare area of shallow lagoons and islands has been created for wading birds and wildfowl. This area is renowned for its breeding colony of avocets; shoveler, gadwall, teal and shelduck also breed.

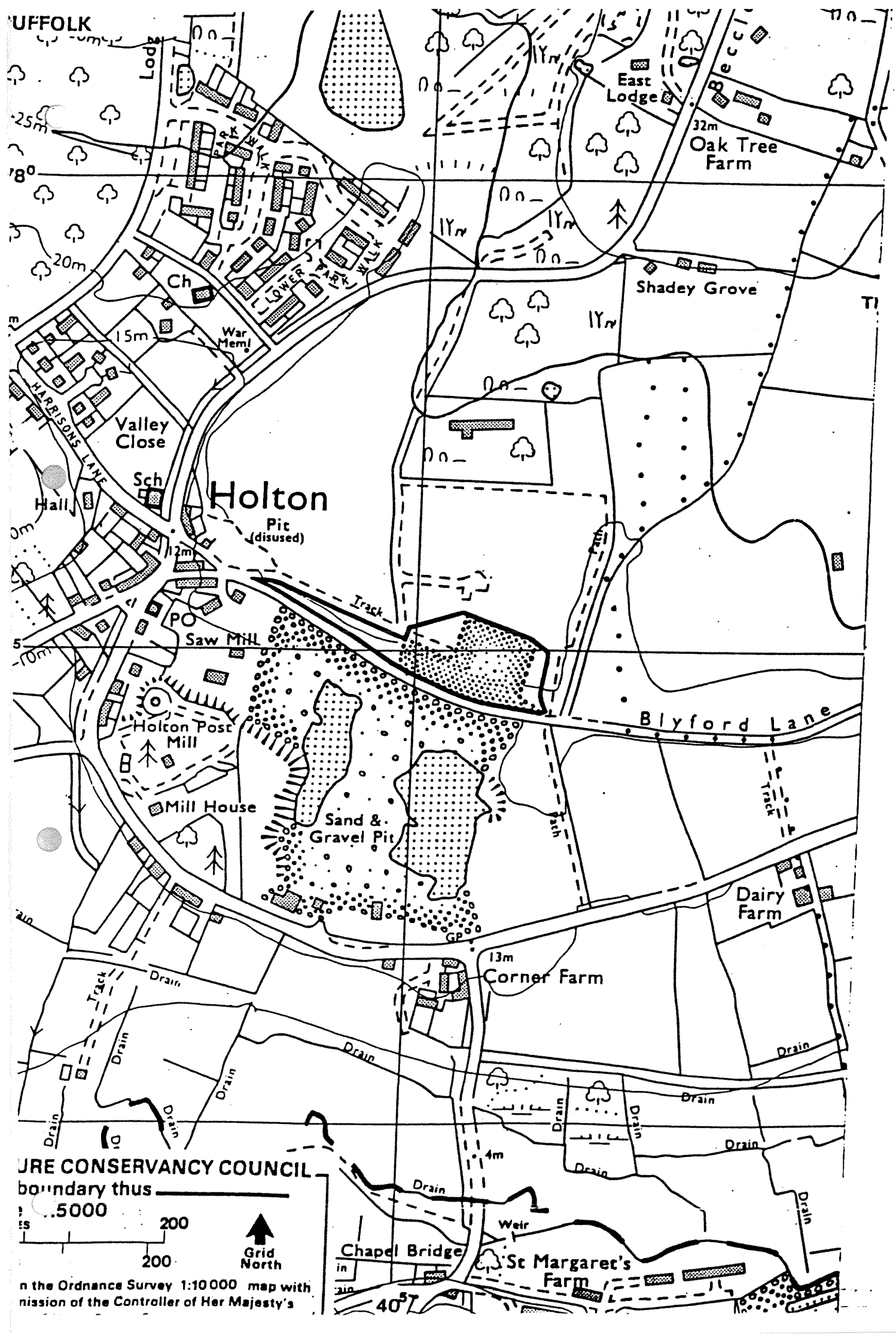
Large blocks of grazing marsh are found near Eastbridge and Southwold. These marshes support a high number of species of breeding waterfowl such as snipe, redshank, gadwall, shoveler and black-tailed godwit. Dykes within the marshes contain very diverse aquatic plant communities, with brackish and freshwater types represented. Many nationally rare and scarce invertebrates such as the soldier fly (Odontomyia ornata) are found east of Eastbridge, as are a number of nationally scarce plants including sea barley (Hordeum marinum) and whorled water-milfoil (Myriophyllum verticillatum). The marshes west of Eastbridge support a mosaic of different unimproved wetland communities including fen-meadow characterised by blunt-flowered rush (Juncus subnodulosus) and marsh thistle (Cirsium palustre), reed beds, swamps dominated by lesser pond sedge (Carex acutiformis), marshes dominated by meadowsweet (Filipendula ulmaria) with some angelica (Angelica sylvestris), and alder (Alnus glutinosa) woodland.

High land at Minsmere, Westleton and Walberswick forms part of the East Suffolk Sandlings and is composed of infertile sands and gravels. This supports large areas of lowland heath, bracken, dry acidic grassland, woods and scrub.

Lowland heath, dominated by ling (Calluna vulgaris) but also containing bell heath (Erica cinerea) and cross-leaved heath (E.tetralix), occupies a large continuous tract of about 4(ha at Minsmere, Dunwich and Westleton Heath with smaller areas at Walberswick. This heathland provides a valuable habitat for two nationally decreasing birds, the nightjar and woodlark.

Patches of unimproved acid grassland in which red fescue (Festuca rubra) and common bent (Agrostis capillaris) predominate, occur through the site but areas dominated by wavy hair-grass (Deschampsia flexuosa), purple moor-grass (Molinia caerulea) and sand sedge (Carex arenaria) also occur. A variety of other acid grassland plants is also present, of which heath bedstraw (Galium saxatile) and sheeps sorrel (Rumex acetosella) are common. Scarce species include bird's foot clover (Trifolium ornithopodioides) and mossy stonecrop (Crassula tillaea) together with a small colony of red-tipped cudweed (Filago lutescens). There are also substantial areas dominated by bracken (Pteridium aquilinum) or gorse (Ulex europaeus and U. gallii).

Mature plantation woodland, chiefly of oak (Quercus robur) or Scots pine (Pinus sylvestris) but also including sycamore (Acer pseudoplatanus) and sweet chestnut (Castanea sa a), occur at Minsmere and Walberswick. Naturally regenerated woods of birch (Betula pendula) and Scots pine have arisen on former heathland and alder (Alnus glutinosa), sallow (Salix spp) and birch woodlands are also present on wet ground. This woodland and scrub provides important additional habitat diversity for birds and invertebrates.


UFFOLK
East Lodge
Oak Tree Farm
32m
Shadey Grove
Ch
War Mem
15m
Valley Close
Sch
Holton
Pit (disused)
Hall
12m
Track
PO
Saw Mill
Holton Post Mill
Mill House
Sand & Gravel Pit
Blyford Lane
Track
Path
Dairy Farm
GP
13m
Corner Farm
Track
Drain
Drain
Drain
Drain
Drain
Drain
Drain
Drain
Drain
Drain
Drain
4m
Weir
Chapel Bridge
St Margaret's Farm
JRE CONSERVANCY COUNCIL
boundary thus
.5000
200
200
Grid North
n the Ordnance Survey 1:10000 map with
nission of the Controller of Her Majesty's

SITE NAME: HOLTON PIT

COUNTY: SUFFOLK

DISTRICT: WAVENEY

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Waveney District

National Grid Reference: TM 404776 Area: 1.64 [ha] 4.09 [ac

Ordnance Survey Sheet 1:50,000: 156 1:10,000: TM 47 NW

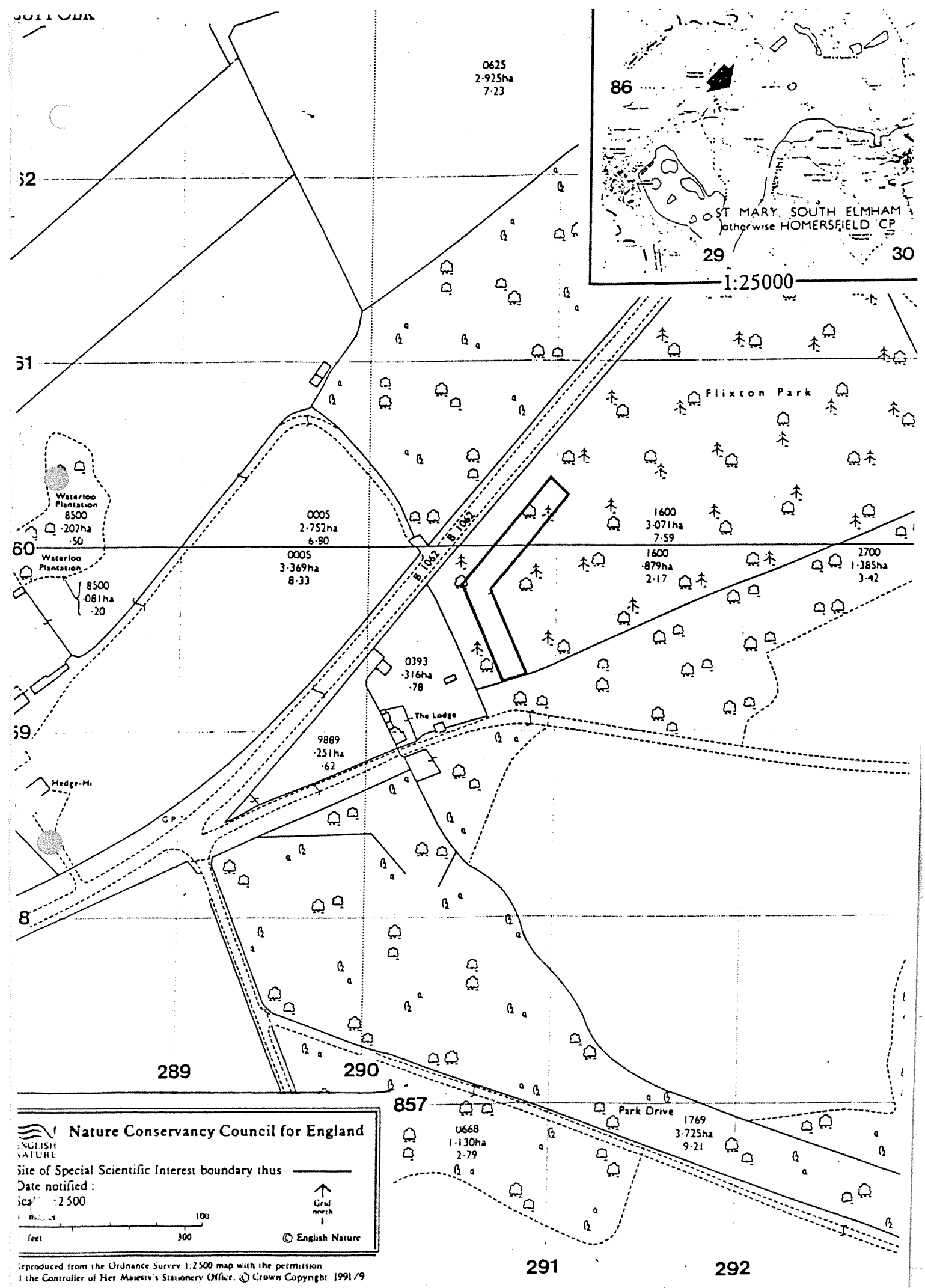
Date Notified [Under 1949 Act]: Date of Last Revision:

Date Notified [Under 1981 Act]: 1988 Date of Last Revision:

Other Information:

Description and Reasons for Notification:

Holton Pit is of geological interest because the exposures north of Blyford Lane show around 5m of Westleton Beds overlain by Kesgrave Gravels and till. Although the last two units are not well exposed, this is the only section now known to show this sequence. The Westleton Beds are an early Pleistocene coastal gravel accumulation, perhaps part of a shingle foreland like the modern Dungeness. The site is therefore important in demonstrating a lower stratigraphic boundary for the Kesgrave Gravels. The sediments exposed in Holton Pit are also close to the inland limit of the Westleton Beds, and are therefore important for studies on the spatial variation of the beds.



CITATION

File ref: 14/WSC

COUNTY: SUFFOLK SITE NAME: FLIXTON QUARRY

DISTRICT: WAVENEY

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: SUFFOLK COUNTY COUNCIL;
WAVENEY DISTRICT COUNCIL

National Grid Reference: TM 290 860 Area: 0.17 (ha) 0.42 (ac)

Ordnance Survey Sheet 1:50 000: 156 1:10 000: TM 28 NE

Data Notified (Under 1949 Act): - Date of Last Revision: -

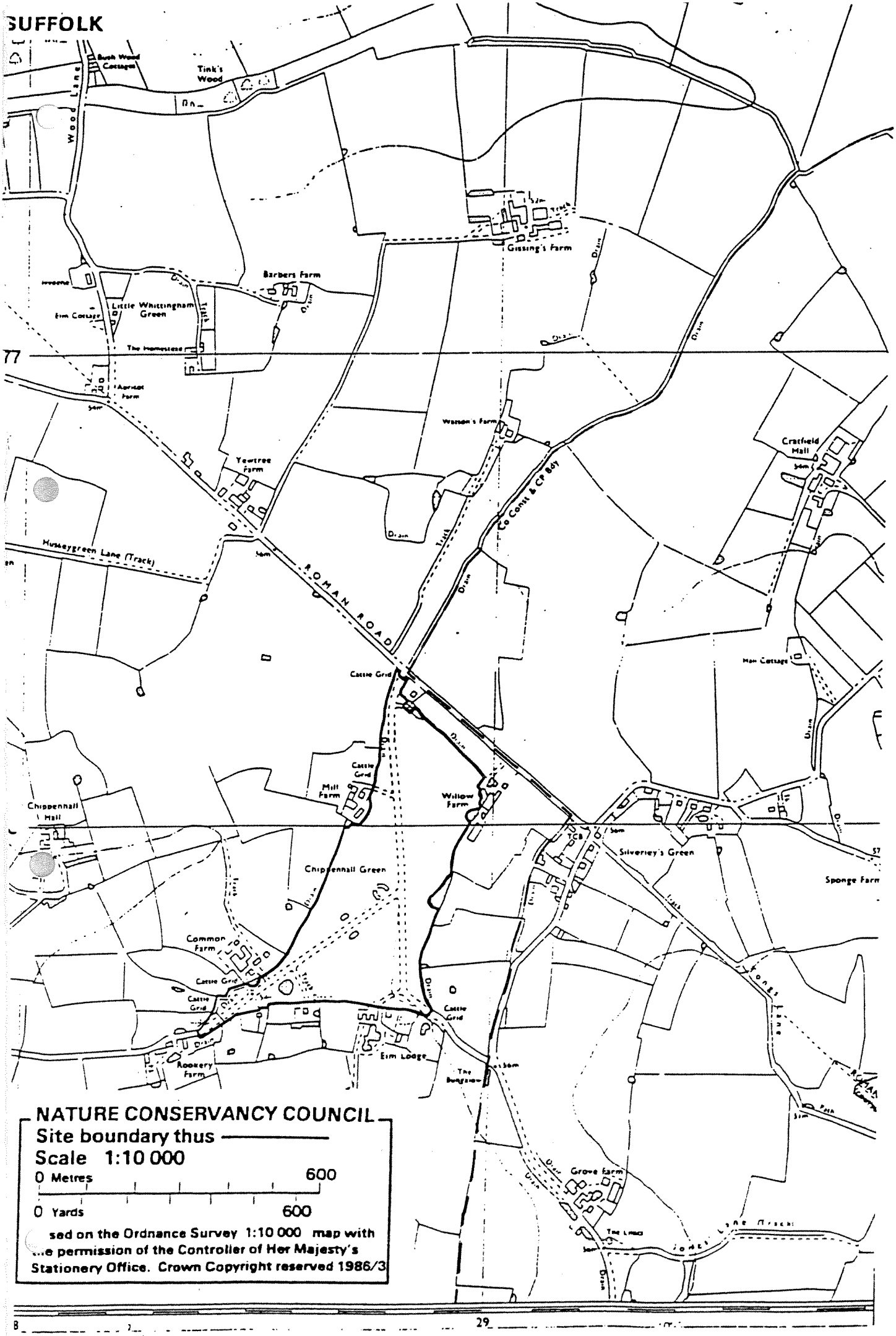
Date Notified (Under 1981 Act): 1991 Date of Last Revision: -

Other information:

A new site, listed as being of national importance in the Geological Conservation Review.

Description and Reasons for Notification:

This pit provides excellent exposures in the Homersfield Terrace - the highest terrace of the River Waveney. The deposits comprise gravels and sands, probably in the main glacial outwash, resting on chalky till. The site shows many fine sedimentary structures, including ice-contact slope structures and ice wedge casts. The intimate association with localised flow till indicates an Anglian age. The site is of importance because of its relationship to the deposits of the Broome Terrace and to the type Hoxnian site at Hoxne.


SUFFOLK
Bush Wood Cottage
Tink's Wood
Wood Lane
Gissing's Farm
Barbers Farm
Little Whitingham Green
Elm Cottage
The Homestead
Apricot Farm
Watson's Farm
Yewtree Farm
Cratfield Hall
Co Const & CP Bdy
Hunneygreen Lane (Track)
ROMAN ROAD
Cattle Grid
Mill Farm
Willow Farm
Chippenhall Hall
Chippenhall Green
Silverley's Green
Sponge Farm
Common Farm
Rookery Farm
Elm Lodge
The Bungalow
Grove Farm
Jones Lane
NATURE CONSERVANCY COUNCIL
Site boundary thus
Scale 1:10 000
0 Metres 600
0 Yards 600
sed on the Ordnance Survey 1:10 000 map with
e permission of the Controller of Her Majesty's
Stationery Office. Crown Copyright reserved 1986/3

File Ref: EA/S/256/14 WVH

COUNTY: Suffolk

SITE NAME: CHIPPENHALL GREEN

DISTRICT: Mid Suffolk

Status: Site of Special Scientific Interest [SSSI] notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Mid Suffolk District Council

National Grid Reference: TM 288758 Area: 16.1 [ha] 39.7 [

Ordnance Survey Sheet 1:50,000: 156 1:10,000: TM 27 NE

Date Notified [Under 1949 Act]: N/A Date of Last Revision: N/A

Date Notified [Under 1981 Act]: 1986 Date of Last Revision: N/A

Other Information:

This is a new site.

Description and Reasons for Notification:

Chippenhall Green is a large area of commonland on calcareous clay soil. It is made up of species-rich unimproved neutral grassland and supports a variety of grasses and herbs including an outstanding population of Green-winged Orchids [Orchis morio].

The grass sward contains a mixture of species, including Sweet Vernal Grass [Anthoxanthum odoratum], Meadow Foxtail [Alopecurus pratensis], Red Fescue [Festuca rubra] and Smooth-stalked Meadow Grass [Poa pratensis]. Flote Grass [Glyceria fluitans] and Tufted Hair-grass [Deschampsia cespitosa] are dominant in wet areas.

Herb species include Cuckoo Flower [Cardamine pratensis], Cowslip [Primula veris], Meadow Saxifrage [Saxifraga granulata] and Marsh Bedstraw [Galium palustre]. The meadow is most notable for its Green-winged Orchids which are abundant in patches of short grazed turf.

COUNTY WILDLIFE SITES

(These sites were suggested for consideration by Norfolk Wildlife Trust)