

ENVIRONMENTAL MANAGEMENT UNIT

Environmental Management Audit THAMES BARRIER and associated on-site activities.



Main Report

	Page No.
Contents	3
Executive Summary and Key Recommendations	6
Audit Objectives	15
Site Description and History	19
Management	29
Operations	32
Environmental	47

Annexes

Site History, Geology, Hydrogeology and Hydrology	70
Contaminated Land Investigation Proposal	94
Energy Audit Report	99
Review of Halon Alternatives	217

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ENVIRONMENT AGENCY



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NRA

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Charlton, London,
and associated on-site activities.

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CONTENTS**EXECUTIVE SUMMARY****1.0 AIMS AND OBJECTIVES OF THE AUDIT**

- 1.1 Background
 - 1.1.1 Environmental Policy
 - 1.1.2 Environmental Auditing
- 1.2 Introduction to the Audit
- 1.3 Process
- 1.4 Audit Criteria
- 1.5 Audit Boundaries
- 1.6 Acknowledgements and Feedback

2.0 SITE DESCRIPTION

- 2.1 Site Setting
- 2.2 Geology, Hydrogeology, Water Quality and Hydrology
 - 2.2.1 Introduction
 - 2.2.2 Geology
 - 2.2.3 Hydrogeology
 - 2.2.4 Water Quality and Hydrology
 - 2.2.5 Significance of Geology, Hydrogeology, Water Quality and Hydrology
- 2.3 Site History
 - 2.3.1 Introduction
 - 2.3.2 Significance of Site History
- 2.4 Site Operations
 - 2.4.1 Site Layout and Description of Operations

3.0 MANAGEMENT

- 3.1 Introduction
- 3.2 Environmental Policy
- 3.3 Environmental Management Implementation
- 3.4 Objectives and Targets

- 3.5 Management Systems
- 3.6 Conclusions

4.0 OPERATIONS

- 4.1 Introduction
- 4.2 Energy Management
 - 4.2.1 Thames Barrier - Management Summary
 - 4.2.2 Thames Barrier - Major Conclusions and Recommendations
 - 4.2.3 Visitors Centre - Summary
 - 4.2.4 Visitors Centre - Conclusions
- 4.3 Water Consumption and Costs
 - 4.3.1 Thames Barrier - Previous survey
 - 4.3.2 Thames Barrier - Present Position
 - 4.3.3 Visitors Centre and Education Facility
 - 4.3.4 Conclusions
- 4.4 Transportation
 - 4.4.1 Thames Barrier Performance
 - 4.4.2 Conclusions
- 4.5 Procurement, Suppliers and Contractors
 - 4.5.1 Introduction
 - 4.5.2 Service Suppliers and Contractors
 - 4.5.3 Materials Suppliers
 - 4.5.4 Flood Defence
 - 4.5.5 Conclusions
- 4.6 Emergency Procedures
 - 4.6.1 Thames Barrier Site Performance
 - 4.6.2 Conclusions
- 4.7 Waste Minimization
 - 4.7.1 Site Performance
 - 4.7.2 Conclusions
- 4.8 Barrier Operations and Maintenance
 - 4.8.1 Site Performance
 - 4.8.2 Conclusions

5.0 ENVIRONMENTAL IMPACTS

- 5.1 Introduction
- 5.2 Past Environmental Reports
 - 5.2.1 Report to Thames RMT, July 1992
 - 5.2.2 Pollution Prevention Site Inspections, October 1994
 - 5.2.3 Conclusions
- 5.3 Land Use and Management
 - 5.3.1 Site Performance
 - 5.3.2 Conclusions
- 5.4 Contaminated Land
 - 5.4.1 Site Performance
 - 5.4.2 Conclusions

- 5.5 Air and Noise
 - 5.5.1 Site Performance
 - 5.5.2 Conclusions
- 5.6 Water and Wastewater
 - 5.6.1 Water Abstraction
 - 5.6.2 Wastewater
 - 5.6.3 Conclusions
- 5.7 Environmentally Hazardous Substances
 - 5.7.1 Introduction
 - 5.7.2 Storage
 - 5.7.3 Halons
 - 5.7.4 Use of Herbicides
 - 5.7.5 COSHH
 - 5.7.6 Conclusions
- 5.8 Waste Management
 - 5.8.1 Waste Sources
 - 5.8.2 Disposal Practice and Compliance
 - 5.8.3 Waste Disposal Contractors
 - 5.8.4 Conclusions

ANNEXES

- Annex 1** Geology, Hydrogeology, Geology and Site History Report prepared by EAG for NRA
- Annex 2** Contaminated Land - Proposal For Phase II Investigation prepared by EAG Ltd for NRA.
- Annex 3** Energy Use Report - Thames Barrier. Prepared by EAG Ltd for NRA.
- Annex 4** Energy Use Report - Visitors Centre, Cafeteria and Education Facility.
- Annex 5** Fire Protection Systems - A Replacement for Halon

EXECUTIVE SUMMARY

INTRODUCTION

The Chief Executive requested that a full environmental management audit be carried out on the Thames Barrier. Apart from ensuring that best environmental practice is being demonstrated at such an important and high profile site, it was also recognised that the Barrier has very significant environmental impacts associated with energy use. The overall objective was to produce an environmental audit report that would support and assist the Thames Barrier management in ensuring that "the jewel in the NRA crown" is an emerald.

ENVIRONMENTAL MANAGEMENT AUDITING

Environmental management auditing (as opposed to verification) is an essential and integral part of environmental management and is a regular management process that is carried out at all significant operational locations and functions on at least a 3 yearly basis. It entails:-

- check of the environmental effects of a location/function;
- optimizing resource use through identifying current and anticipated use and recommending ways to reduce those consumptions, and costs;
- identifying potential opportunities to reduce waste generation;
- identifying environmental best practice and disseminating as appropriate;
- encouraging the development of more formal procedures and standards for measuring environmental performance;
- accelerating the development of environmental management systems;
- assisting managers in communicating, understanding and interpreting regulatory requirements, Agency policy and guidelines and best environmental practice;
- increasing the overall level of environmental awareness through demonstrating top management commitment to environmental management;
- improving environmental risk management by identifying conditions that may have an adverse effect; and
- identifying and documenting legal compliance.

But above all, it is about maintaining the credibility of the Agency as an environmental body.

We have adopted a three tier approach to environmental management auditing.

- **Management:** the degree of understanding and commitment to environmental management by staff at all levels. Knowledge of NRA Environmental Policy and implementation. The production and promulgation of management procedures. The existence of a system for measuring, monitoring and reporting:

- **Operations:** environmental performance and efficiency gains through effective resource management and waste minimisation measures. Efficacy of procedures to measure and monitor management processes/activities. The inclusion in contracts of measures to ensure appropriate environmental standards; and
- **Environmental Impacts:** identification of emissions and waste streams. Existence of permits and consents for discharges. Compliance with statutory controls on emissions. Compliance with best practice.

Following completion of the 3 pilot site phase of introducing environmental management auditing to the NRA, the Board has agreed the implementation of a comprehensive environmental management audit programme. This will entail the development of a second set of environmental auditing procedures and protocols and a training programme for regional staff. This report is on the full environmental management audit of the Thames Barrier, employing the Audit Guidelines and Protocols developed by the Environmental Management Unit (EMU).

THAMES BARRIER

The Thames Barrier is a very different location from the depot/offices that were audited as part of the pilot phase. Careful planning was necessary to ensure that a credible approach was adopted. Following discussions with Barrier management, it was agreed that routine audit of site energy management would be extended to a full energy audit. In support of the audit, the EMU undertook a review of the alternatives to Halon as a fire extinguishant. The team carried out the audit over 2½ days from 22 - 24 November 1995. The site management were given a verbal de-brief on departure.

Best Practice

It is apparent that the management is now engaged in progressively reviewing the management practices and procedures that had been ongoing since the Barrier's commissioning in 1983. It is clear that this presents opportunities to incorporate best environmental practice and it is pleasing to note that this is being addressed.

Findings

Full recommendations (a total of 76) and best practice identified by the audit are found under "conclusions" under each section in the main document. Key recommendations are in the table following.

A brief summary of the findings is as follows:-

It is recommended that environmental management be fully integrated into all functions, systems and procedures. Extending the management principles being introduced for ISO 9001 to the whole site would facilitate this process.

Effective measuring and monitoring of the major site environmental effects should be introduced for management purposes.

Responsibility for environmental management at the site should be allocated to managers and job descriptions be issued, which include a requirement to pursue the objectives of the Environmental Policy.

Management should set local objectives and targets and produce an action plan to support the Environmental Policy.

Operations

Energy The Thames Barrier consumes 5.11 million kWh of electricity costing £243k last year. Action has recently been initiated to reduce this consumption (benefits unquantified), but not directly in pursuit of the NRA's 15% reduction target. Existing metering arrangements preclude effective monitoring of consumption. The energy audit report indicates the levels of consumption at different locations and highlights the opportunities for substantial savings. Some savings can be achieved on a nil or low cost basis by reviewing the energy management practices. There are benefits to changing from "leave it on just in case we need it" to "turn it off until it is required." The continuing extension of the initiatives associated with installing a building management system in all piers will support this process and produce benefits. A switch to gas fired boilers for the tower and workshops should save 262 tonnes of CO₂ per annum and give a 2.4 year payback. Implementation of these and other recommendations indicate possible savings in the order of 2,000,000 kWh, 1,600 tonnes CO₂ and £100,000 per annum.

Contracts/Procedures Across the spectrum of the Thames Barrier activities, flood defence, emergencies, transport, visitors' centre and procurement, there are opportunities to further implement environmental best practice into contracts and management procedures.

Environmental impacts

Contaminated Land/Methane Investigation of the site history concludes that both banks are likely to be heavily contaminated with a variety of toxic and polluting materials. There is also a possibility of methane gas from buried organic matter being present on the bank site areas. There is a likelihood that contamination from Authority land is migrating to the river Thames and possibly to the underlying aquifers. The suspected levels of contamination may be such that the soil presents a health and safety risk both to visitors and to contractors undertaking ground works. Consideration should be given to the process of furthering investigation and, if appropriate, remediation. Levels of methane gas should be monitored.

Practices We are pleased to note that regular documented inspections are carried out on the oil separators and that waste oil from the site is recycled. The situation in respect of a trade effluent consent should be clarified.

The practice of disposing of anti-freeze and the use of emulsifiers should be reviewed. All waste management at the site should be the responsibility of one manager. Drains should be properly marked.

Halon The use of 80 sets of Halon should be reviewed and progressed, removed or replaced with alternatives.

CONCLUSIONS

The Thames Barrier is an important very high profile NRA site to which we openly invite the public. It is vital that all of its activities demonstrate best environmental practice and that effective environmental management is totally integrated throughout.

There are opportunities to significantly reduce the environmental impacts arising from the operations of the Barrier and achieve financial savings, particularly in the area of energy use (£100,000).

The recent changes to management practices and procedures including the introduction of a building management system and pursuit of ISO 9001, are most welcome. The opportunities to incorporate best environmental practice into these initiatives will result in a significant improvement in the environmental performance of the Thames Barrier.

The use of 80 sets of Halon should be reviewed and progressed, removed or replaced with alternatives.

The land at the site is likely to be heavily contaminated and may present a health and safety risk to visitors and contractors. Levels of methane gas should be monitored.

The EMU will be working with the Thames Barrier management to produce an action plan, following their consideration of the recommendations.

DAVE STANLEY

Head of Environmental Management Unit

SUMMARY OF KEY RECOMMENDATIONS ENVIRONMENTAL AUDIT; THAMES BARRIER, THAMES REGION

Audit Report No: NE2/4/2/7 Thames Barrier, Thames Region. Page 1						
Rec No	Report Para No	Recommendations	Est Cost Implementation	Management Comments and Action	Officer Responsible	Implementation of Target Date
	3.6	MANAGEMENT <ul style="list-style-type: none"> • The Area Management communicates the Environmental Policy, its objectives and targets to the Thames Barrier. • Barrier management integrate Environmental Policy throughout, sets local objectives and targets, and produces an Action Plan. • Environmental management responsibility be allocated to managers. • The requirements of Project Management Guidelines and the Environmental Procurement Policy be considered for every project /procurement. • The principles of ISO 9001 be extended in the site to facilitate the full integration of environmental management. • Job descriptions to include a requirement to pursue the objectives of the Environmental Policy. 				

These recommendations are summaries only, for full recommendations see report.

Audit Report No: NE2/4/2/7 Thames Barrier, Thames Region. Page 2						
Rec No	Report Para No	Recommendations	Est Cost Implementation	Management Comments and Action	Officer Responsible	Implementation of Target Date
	3.6	MANAGEMENT (contd) <ul style="list-style-type: none"> • Introduce effective measuring and monitoring of the major environmental effects for management purposes. • Environmental policy and environmental best practice should be incorporated into induction courses and all training programmes as required by the Executive Group. 				
	4.2.	OPERATIONS - Energy Management <ul style="list-style-type: none"> • The need to change the energy management strategy of leaving equipment, etc on is addressed. • A formal energy monitoring and management programme is adopted. • A site management plan is adopted for lighting. • The pier and abutment heating and ventilation systems are modified in accordance with the existing plan. • The electrode boilers are replaced with gas fired equipment. • Visitors Centre introduce energy monitoring and set targets. 				

These recommendations are summaries only, for full recommendations see report.

Audit Report No: NE2/4/2/7 Thames Barrier, Thames Region. Page 3						
Rec No	Report Para No	Recommendations	Est Cost Implementation	Management Comments and Action	Officer Responsible	Implementation of Target Date
		OPERATIONS contd.				
	4.4	<ul style="list-style-type: none"> Produce and implement best practice for refuelling of vessels. 				
	4.6	<ul style="list-style-type: none"> The site emergency plan is reviewed to incorporate all potential emergencies including the likely sources of spills. 				
	4.7	<ul style="list-style-type: none"> National waste minimisation targets are pursued. 				
	4.8	<ul style="list-style-type: none"> Job specifications and works instructions include environmental issues. The coverage of Technical Information Sheets is extended to include environmental issues. 				
		ENVIRONMENT				
	5.2	<ul style="list-style-type: none"> Measures are taken to comply with the pollution prevention conditions identified by the Thames staff. 				
	5.4	<ul style="list-style-type: none"> Further investigations are made to determine the extent and nature of the contamination to land. 				
	5.6	<ul style="list-style-type: none"> The levels of methane gas in the soil and Barrier are monitored. 				

These recommendations are summaries only, for full recommendations see report.

Audit Report No: NE2/4/2/7 Thames Barrier, Thames Region. Page 4						
Rec No	Report Para No	Recommendations	Est Cost Implementation	Management Comments and Action	Officer Responsible	Implementation of Target Date
		ENVIRONMENT - contd				
	5.6	<ul style="list-style-type: none"> • The requirement for trade effluent and discharge consents is clarified. • Best practice is adopted with respect to the use of degreasers for oil spills and the disposal of anti-freeze. • Drain covers, etc are colour coded in line with NRA guidance. 				
	5.7	<ul style="list-style-type: none"> • All forms of storage comply with the requirements of our own pollution prevention guidelines. • The bulk delivery points for hydraulic oil are fitted with sumps in lockable kiosks. • A risk assessment is made to determine the current requirements for fire protection. Halons should be removed or replaced with more acceptable alternatives. 				
	5.8	<ul style="list-style-type: none"> • Waste management responsibilities are identified and allocated to a single, named manager. 				

These recommendations are summaries only, for full recommendations see report.

Audit Report No: NE2/4/2/7 Thames Barrier, Thames Region. Page						
Rec No	Report Para No	Recommendations	Est Cost Implementation	Management Comments and Action	Officer Responsible	Implementation of Target Date
<p>BLANK FORM FOR THE USE BY THE FACILITY WHEN ACTION PLANNING THE AUDIT REPORT.</p>						

1.0 AIMS AND OBJECTIVES OF THE AUDIT

1.1 BACKGROUND

1.1.1 Environmental Policy

In 1992 the NRA Board acknowledged the importance of environmental management by adopting the NRA Internal Environmental Policy statement and objectives. The statement includes:

"In addition to vigorously pursuing its statutory responsibilities as Guardians of the Water Environment, the Authority will aim to establish and demonstrate wise environmental practice throughout all its functions."

The NRA has established a corporate environmental management organisation, which at the centre includes the Environmental Management Unit (EMU), with 3.5 staff, and an Environmental Steering Group (ESG). Together, the EMU and ESG have responsibility for advising on policy development, procedures, instruction, practices and proposing targets.

Regions nominate a Regional Co-ordinator to the ESG who should also be responsible for advising the Regional General Manager on the implementation of the NRA Environmental Policy and best environmental management practice. Line management is responsible for implementing best practice, for pursuing the objectives and achieving the targets. Regional Business Services Managers are responsible for producing quarterly environmental performance data. Many regions have also established environmental teams or circles to support the policy and gain the interest and enthusiasm of all staff.

1.1.2 Environmental Management Auditing

Generally, companies and organisations are becoming increasingly aware of the need to achieve an improved level of environmental performance. They have been motivated for a number of reasons including their potential liabilities resulting from environmental legislation; the potential for cutting costs; emerging fiscal measures; and a desire to improve their public relations image as, increasingly, public concern about the environment grows.

As a result many organisations have undertaken environmental management audits in order to identify and clarify potential liabilities, compliance status and to identify how their environmental performance can be improved. To be effective these audits must be undertaken within the framework of a structured environmental management organisation.

Formal environmental management systems, such as the British Standard on Environmental Management Systems (BS 7750: 1994) and the European Union Eco-Management and Audit Scheme (EMAS) Regulation (EU 1863/93), include environmental audits as an essential and integral part. They provide organisations with the necessary assurance that their activities comply with the appropriate legislative, regulatory and company policy requirements.

1.2 INTRODUCTION TO THE AUDIT

The Thames Barrier is a very high profile NRA location. It has the critical task of protecting the City of London from flooding; it is also open to the public. Following the pilot phase of the audit programme the Chief Executive requested that the Barrier be audited at the earliest opportunity to ensure that the location was demonstrating best practice. The overall objective is to produce an environmental audit report that supports and assists the Thames Barrier management in demonstrating effective environmental management.

The aim of the audit was to independently assess the environmental status and performance of the site, by examining in detail the activities of the operational facilities (Barrier structure, control tower and offices, workshop and storage areas) and related activities (Visitors Centre, Cafeteria, Education Facility and warehouses). The audit focused on the operational and environmental aspects of these activities, i.e. waste minimisation, buildings and their environs, elimination of toxic substances, energy efficiency and emissions.

The three main site specific objectives of the audit were:

- risks to the credibility of the NRA, specifically:
 - legal compliance;
 - concerns expressed by external organisations;
 - risks to the environment, especially water;
 - implementation of the NRA's own guidelines to external bodies. (Pollution Prevention Pays video, Pollution Prevention Guidance notes, etc.); and
 - visual appearance.
- the integration of environmental management into existing management systems:
 - waste minimisation/environmental performance against targets and procedures, etc, especially water and energy; and
 - environmental standards for internal operations and the use of contractors.
- the identification of strengths and best practice to highlight to other areas and regions.

1.3 PROCESS

Before visiting the site regulatory information was assessed (from water companies, local authorities, etc) and the environmental setting and past land-use of the site and surrounding area examined. On-site work was by auditors drawn from the Environmental Management Unit, Internal Audit and Pollution Prevention and from EAG Ltd, for energy use. The team audited with respect to management systems, operational systems and environmental impacts. The methods used included physical examination of the site, discussions with staff and examination of documentary evidence. In pursuing the objectives, we investigated the location at three levels.

Management:

- the degree of understanding, and commitment to environmental management by staff at all levels;
- the level of knowledge of the NRA's Environmental Policy and the approach to its implementation, and its objectives and targets;
- the resources allocated to environmental management;
- the managerial and administrative systems used to ensure implementation of best environmental practice;
- the production and promulgation of management procedures; and
- the existence of a system for measuring, monitoring and reporting.

Operations:

- environmental performance and efficiency gains through effective resource management and waste minimisation measures;
- efficacy of procedures to measure and monitor management processes/activities; and
- the inclusion in contracts (internal and external) of measures to ensure appropriate environmental standards.

Environmental Impacts:

- identification of emissions and waste streams;
- existence of permits and consents for discharges;
- effectiveness of measuring and monitoring of discharges whether controlled by statute or not;
- compliance with statutory controls on emissions;
- compliance with NRA best practice as given to outside bodies; and
- implementation of best practice above that required by national procedures.

1.4 AUDIT CRITERIA

The site was audited against best practice as described in:

- NRA Internal Environmental Policy, and its targets;
- legislative requirements, e.g. waste duty of care;
- NRA guidance to external bodies;
- industrial best practice; and
- environmental management systems standards, e.g. BS 7750 and EMAS.

1.5 AUDIT BOUNDARIES

The audit was limited to activities on-site at the Thames Barrier. It did not consider functions directly affecting the Barrier but performed by the Area Office. Geographically, the Barrier was examined together with the warehouses, Visitors Centre, Cafeteria, and Education Centre. Adjacent, non-NRA activities were not included.

1.6 ACKNOWLEDGEMENTS AND FEEDBACK

The audit team wish to thank the management and staff of the Barrier for their willing co-operation during the audit. We are particularly grateful to Trevor Noyes for co-ordinating the Barrier side of the audit.

Comments from auditees on how to further improve the report and any aspect of the audit are welcomed. Please contact Dave Stanley at the Environmental Management Unit in Peterborough.

2.0 SITE DESCRIPTION

2.1 SITE SETTING

The site consists of a large flood defence structure straddling the Woolwich Reach of the River Thames, with associated structures on the north bank at Silvertown (National Grid Ref TQ 414799) and the south bank at Charlton (NGR TQ 416792). (Figure 1).

The north bank is situated in an industrial area. To the west and north is derelict land and to the east a scrap yard and large sugar refining factory. The factory is regulated by HMIP as a Part A (combustion) process. On the derelict land the London Docklands Development Corporation is considering creating parkland adjoining the current Barrier viewing area to be surrounded by a residential development.

The south bank is similarly sited in an industrial area. Immediately west is an area of mixed warehousing, with some land currently being redeveloped. To the south is warehousing and light industry with residential and parkland areas beyond. East of the site the land is used for offices, warehouses and industry. Running through the site on the river bank is a public footpath, and linking to the south is a 'green chain' walk through landscaped parkland.

The southern site is in a very prominent public position and is promoted as a visitor and education centre and so is considered to be very high profile. The north bank is currently much less prominent, but if the proposed development is undertaken then this too will be high profile as it becomes more accessible to the public. It is estimated that the site has about 100,000 visitors per year.

2.2 GEOLOGY, HYDROGEOLOGY, WATER QUALITY AND HYDROLOGY

2.2.1 Introduction

In order to establish the potential for liabilities due to migration of contaminants onto the Barrier site, from adjacent uses, or away from the site onto third party land, EAG Ltd completed desk-based research of the local geology, hydrogeology and hydrology. In particular they assessed the surface and groundwater sensitivities. The full report is in Annex 1; a summary is below.

2.2.2 Geology

The north site is underlain by made ground over deposits of Alluvium and River Terrace Gravels overlying Thanet Sand which in turn overlies Upper Chalk. Woolwich and Reading Beds may lie between the River Terrace Gravels and Thanet Sand. The south site is on made ground over deposits of Alluvium and River Terrace Gravels. These are directly underlain by Upper Chalk.

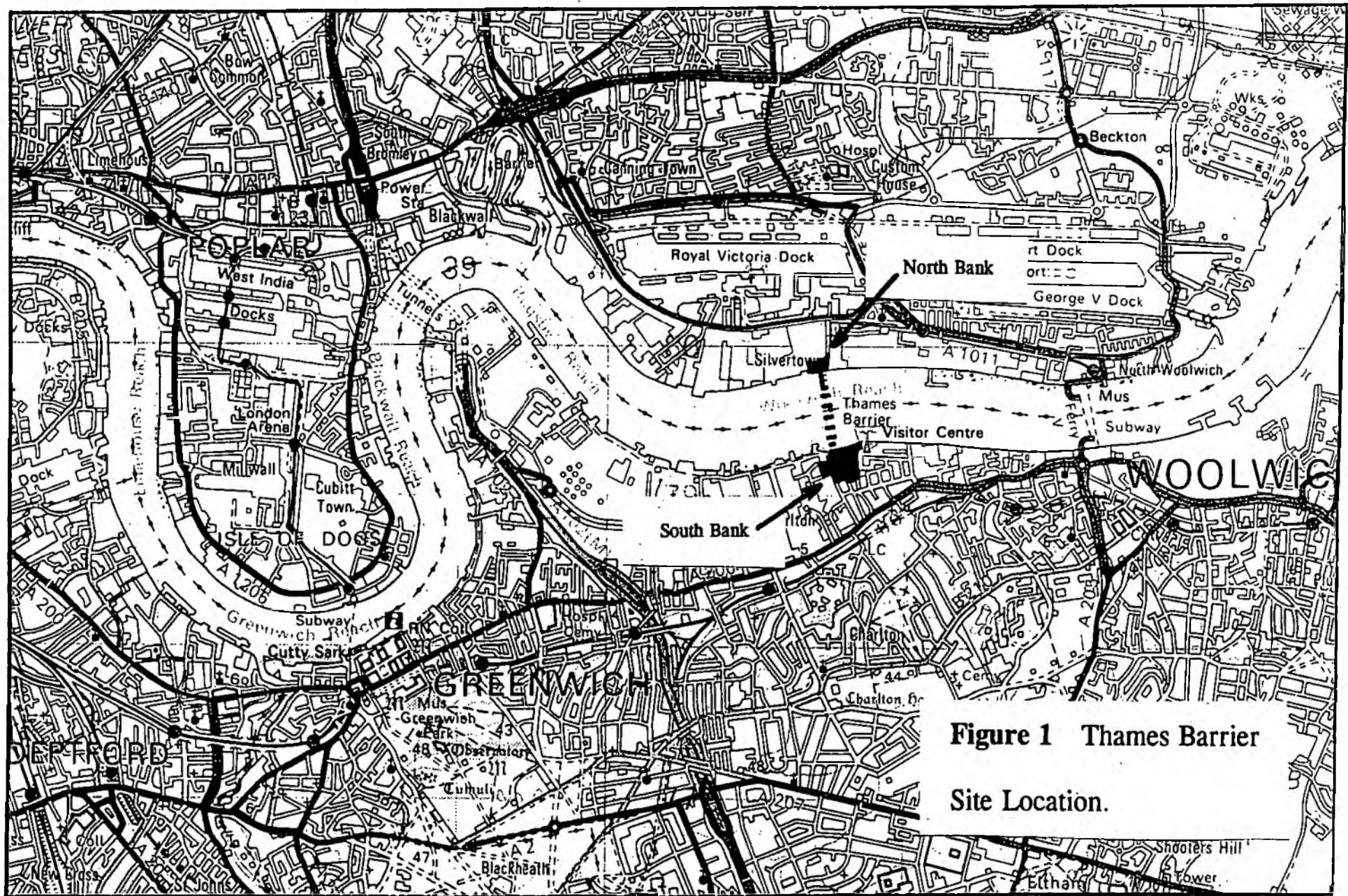


Figure 1 Thames Barrier
Site Location.

2.2.3 Hydrogeology

There are likely to be shallow water tables beneath both parts of the site, dependant upon made ground conditions, the thickness of alluvium, River Terrace Gravel, and possible Woolwich and Reading Beds on the north bank. The shallow groundwater is predicted to be in hydraulic continuity with both the adjacent River Thames and the underlying major aquifer within the Upper Chalk.

There are two licensed groundwater abstractions within 2 km of the site both on the south bank from the Upper Chalk. The site is not within any designated Source Protection Zone.

2.2.4 Water Quality and Hydrology

The River Thames at Woolwich Reach is classified fair (B) under the scheme for classifying estuaries (1990 River Quality Survey). There are fourteen consented discharges and three surface water abstractions within 2 km of the site.

2.2.5 Significance of Geology, Hydrogeology, Water Quality and Hydrology

The site (both sides of the river) is considered to be located in a sensitive groundwater area. The expected hydraulic continuity between the shallow groundwater and the underlying chalk deposits would facilitate the vertical migration of site derived contaminants, if present, into the major Chalk aquifer. Although the site is not located within a groundwater source protection zone, the Chalk aquifer is abstracted within 2km of the site and provides potable supplies to areas of London further to the east. The shallow strata and associated groundwater could also allow horizontal migration of mobile contaminants either beneath the site from off-site sources, or from the site onto third party land.

Similarly the site is considered to be located in a sensitive surface water area, due to the adjacent proximity of the River Thames. Although water quality in the Thames is only classified as B (fair) at present and there are several consented discharges within 2km of the site, the NRA is seeking an improvement in the water quality in the river at this point, to a level *"passable to migratory fish; maintenance of a euryhaline fish population; maintenance of a commercial eel fishery; aesthetically pleasing appearance."* The likely hydraulic continuity between shallow groundwater beneath the site and the surface water in the river, as well as the possibility of surface run-off entering the river directly, would allow the migration of mobile contaminants, if present on or beneath the site, into the river adversely affecting the water quality. However, the presence of the river wall, on both sides of the River Thames may serve to reduce or prevent such migration.

2.3 SITE HISTORY

2.3.1 Introduction

The site history was researched by EAG Ltd for the NRA, by reference to Ordnance Survey and County Series maps, and by referring to the site's planning history and other archive material. (Annex 1).

2.3.2 Significance of Site History

North Site

The site history research has shown the site to have been put to a number of uses which could have led to significant soil and groundwater contamination, namely; a petroleum works (approximately 1869-1897); chemical works (approximately 1897-1973/4) which included several above ground storage tanks; and pitch beds.

The site appears to have been undeveloped from the early 1970s to the early 1980s, during which time the site and surrounding area are thought to have been used as a construction site for the Thames Flood Barrier.

In the surrounding area there has been a diverse range of industrial land uses including, in close proximity to the site; a petroleum works, chemical works, colour works, Alizarine works, oil depot, scrap yard, timber yard, varnish works, and a coal depot.

Anecdotal evidence provided by Newham Borough Council Environmental Health Department (EHD), and from map evidence, would suggest that the area surrounding the site suffered from wartime bomb damage. Land filling operations are also known to have taken place alongside the River Thames, notably to the west of the site at the Former Graving Dock and the former marshy area further to the west of the site.

Consequently there is considerable potential for soil and groundwater contamination to have occurred, beneath the site and neighbouring properties, via a range of organic and inorganic compounds. These may include; coal tar, phenols, hydrocarbons, cyanide, sulphate, sulphide, elemental sulphur, volatile aromatic compounds, asbestos, polychlorinated biphenyls, ammonia and elevated acidity. There is also the potential for there to be elevated concentrations of landfill gases in the ground beneath the site, derived from natural peat deposits or from historical landfilling operations.

South Site

The site history research has shown the site to have been occupied by a Telegraph Works and subsequently an Electrical Engineering works from at least 1869 to 1968. Part of the site was occupied by a saw mill in 1869, and five above ground storage tanks were shown on site in 1968. The site was redeveloped to its current use associated with the Thames Flood Barrier, by 1982.

In the surrounding area a variety of industrial uses have been present since the late 1800's, notably; timber yard, Silicate paint works, petroleum storage depot, various engineering works, iron foundries, glass works, Asphalt Wharf, slag heap, and an electrical sub-station.

The EHD of Greenwich Borough Council highlighted the known metal contamination of land adjacent to the south of the site, a former cable yard. The possibility of elevated landfill gas levels in the area, which have been recorded on nearby sites, was also raised.

There is consequently the potential for both soil and groundwater contamination to be present beneath the site and in the surrounding area. The range of potential contaminants would be similar to that suggested at the north site, with the additional likelihood of elevated metal concentrations also being present beneath the site. Again, similarly to the north site there is also the potential for there to be elevated concentrations of landfill gases in the ground beneath the site, derived from natural peat deposits or from historical landfilling operations.

2.4 SITE OPERATIONS

2.4.1 Site Layout and Description of Operations

The Barrier structure consists of ten flood gates set between nine piers in the bed of the River Thames. (Photograph 1) The piers house the machinery used to move the gates. Two tunnels link the piers and banks and carry the services, ie electricity for power; water, both mains and for fire-fighting; sewerage, and electrical communications cables.

The south bank covers an area of about 4.1 hectare (10.2 acres). (Figure 2) It consists of a secure area containing a compound, control tower, workshop block, electrical generator house, electrical substations and generator cooling radiators. In the basement area of the secure area are various stores including fuel oil for the generator and a flammable/solvents store and an underground garage. The fully paved compound includes car parking, three temporary buildings and storage areas for new and waste oils. The buildings were all erected in the late 1970s or early 1980s. (Photograph 2)

To the south and east of the secure compound is a public area of landscaped grounds which includes hard-standing for car and coach parking. Within the grounds is a Visitors Centre, public Cafeteria and

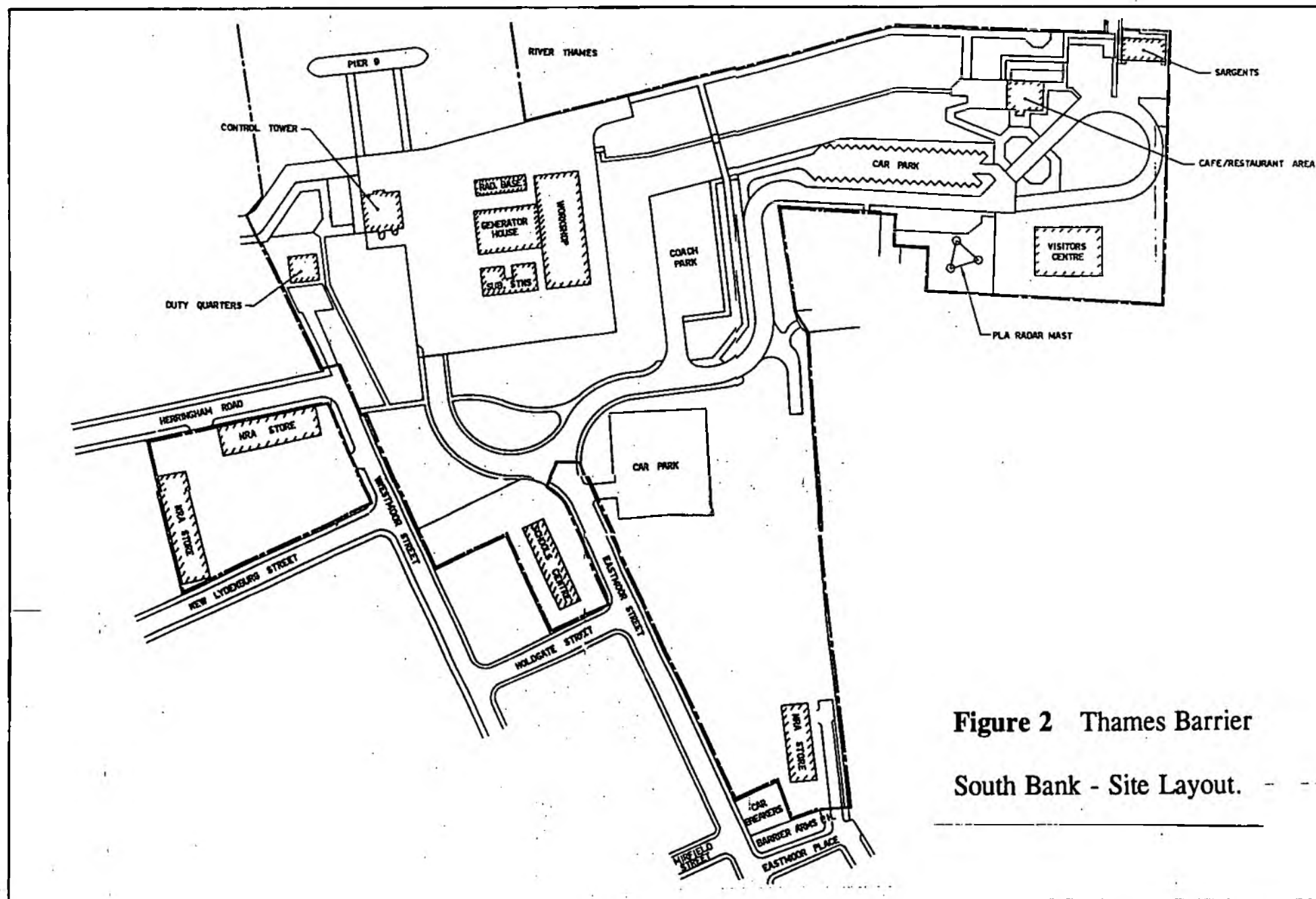


Figure 2 Thames Barrier

South Bank - Site Layout.

staff duty quarters. They are of similar age to the main buildings. (Photographs 3 & 4)

In addition on the south bank at Herringham Road are two warehouses within a walled compound and also a disused building at the southern end of the site. An Education Centre consisting of office style accommodation is located within a fenced compound. (Photograph 5)

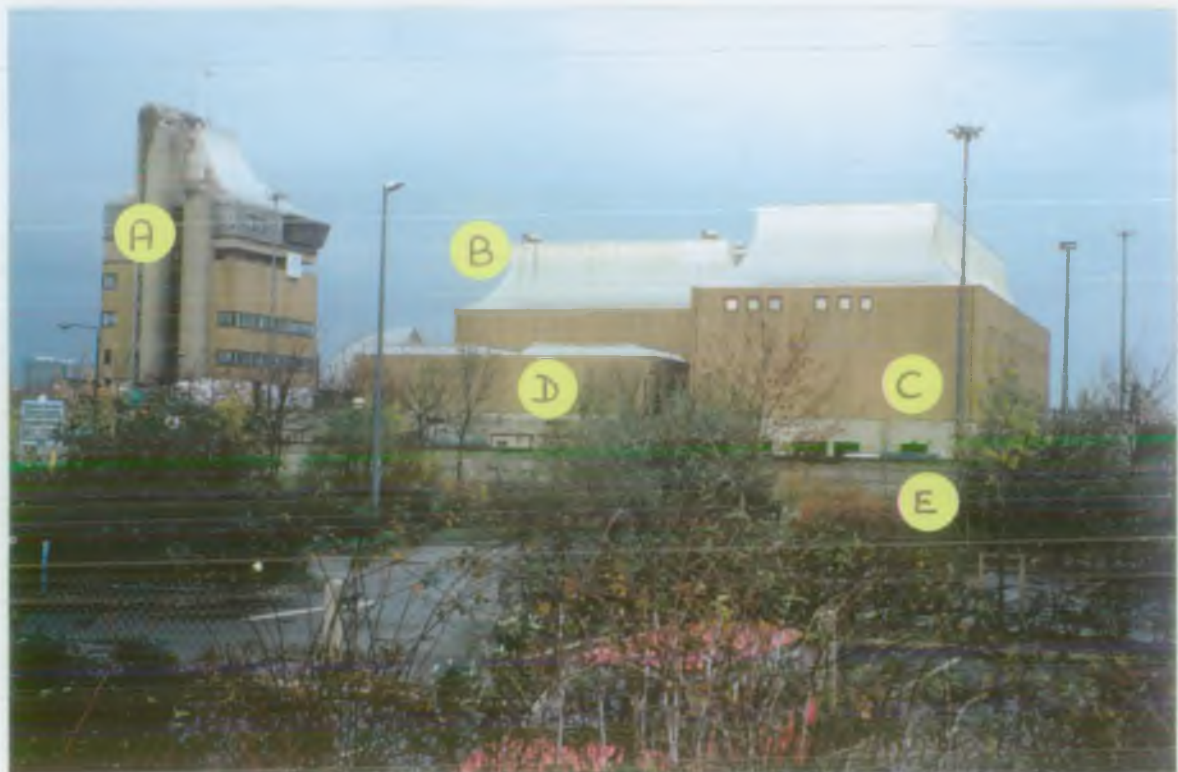
The staff accommodation and disused store were not included within the audit.

On the north site is an area of public access landscaped grounds of about 1 hectare (2.3 acre). Within it is a secure area containing electrical substations and hard standing for about fourteen vehicles.

The site primarily houses Tidal Thames Flood Defence Staff and facilities for the public visiting the Barrier. Also included is the client side for river maintenance for tributaries that flow into the tidal Thames. The facility reports to the South East Area Office (Sunbury on Thames) of Thames Region.



Photograph 1 A general view of the Barrier structure. (A) Gate in the closed position to allow maintenance.



Photograph 2 The operational area of the Barrier seen from the parking area. (A) Control Tower, (B) Generator House, (C) Workshop, (D) Electrical Sub-stations, (E) Walled Compound.



Photograph 3 Thames Barrier Visitors Centre; it contains an exhibition centre and shop.



Photograph 4 Thames Barrier public cafeteria building.



Photograph 5 Thames Barrier Education Centre building.

3.0 MANAGEMENT

3.1 INTRODUCTION

Management aspects audited at the Thames Barrier and Visitors Centre included the degree of understanding and commitment to environmental management by staff at all staff levels. Knowledge of NRA Environmental Policy was sought and the approach to its implementation and its objectives and targets examined. The resources allocated to environmental management were assessed. The managerial and administrative systems used to ensure implementation of best environmental practice were examined together with the production and promulgation of management procedures. The system for measuring, monitoring and reporting was audited.

3.2 ENVIRONMENTAL POLICY

Audit Criteria. The NRA Internal Environmental Policy as agreed by the NRA Board in 1992 and communicated to all regions.

Most of the employees interviewed had heard of the Environmental Policy but showed limited awareness of its content and purpose. Some information relating to environmental policy has filtered through to the location as apparent from various notices on boards and limited recycling action. There is acknowledgement of the need to generally reduce resource use. There appears to be a general willingness amongst many managers and staff to consider environmental improvement.

3.3 ENVIRONMENTAL MANAGEMENT IMPLEMENTATION

Audit Criteria. Key environmental management principles in the NRA Environmental Policy and best environmental management practice.

Area management do not appear to have communicated the policy objectives and targets to local management for the year 1995/96. Consequently, no attempt has been made to generally translate the overall Environmental Policy into specific site objectives. Responsibility for environmental management at the site has not been allocated and there is no formal method of communicating its objectives and targets. The site has no representative on the Thames Environmental Circle. In general, the requirements of the Environmental Procurement Policy and Project Management Guidelines in respect of environmental management have not been incorporated into management practices. However, it is pleasing to note that a number of very recent projects have included some Environmental Policy issues and have specified some aspects of best environmental practice.

The site management are introducing ISO 9001 Quality Management Systems for some of its activities. The draft Quality Assurance Manual incorporates an environmental policy statement. This should lay a firm foundation on which to build future improvements in environmental performance.

3.4 OBJECTIVES AND TARGETS

Audit Criteria. NRA Environmental Policy objectives and annual environmental performance targets.

As stated above, the objectives and targets appear not to have been communicated to the location for the current year. Few managers are able to state the energy target or water target. Some staff are able to report the target in respect of stationery and paper use.

The Thames Barrier energy consumption equals or exceeds that of each of our regions except Anglian. A reduction at the Thames Barrier would have a very significant impact. The management and monitoring of energy is carried out from information supplied by the Thames Barrier energy management system in the form of kWh consumed on a half-hourly basis. This information is repeated to the Thames Barrier together with cost per half hour from London Electricity plc. Management monitoring of overall energy use is on the basis of financial information received from the Region; the purpose being budget management.

3.5 MANAGEMENT SYSTEMS

Audit Criteria. To establish and implement an appropriate environmental management system which optimises existing skills and resources and integrates with the overall framework of existing business and site quality management systems.

Few managers spoken to have a job description and no one reported the Environmental Policy having been incorporated into their job descriptions. A recent recruit did not receive a briefing on the Environmental Policy in the Regional induction course. No employee reported receiving training in environmental management issues.

As mentioned above the site is pursuing ISO 9001 quality management system in respect of its process management and monitoring of component failures. The general extension of the management techniques being adopted for ISO 9001 would, if the Environmental Policy and its objectives were to be incorporated, facilitate the possible accreditation to a full environmental management system such as BS 7750 or EMAS. Of all the NRA's sites the Thames Barrier is probably the nearest to what could be classified as an "industrial location." At some future date, it would be worth considering the Thames Barrier for EMAS. This would give the Authority/Agency useful insight into the implications of EMAS and increase our understanding of the efforts involved by industry in order to achieve

accreditation. Whilst the main function of the Thames Barrier does not qualify under EMAS, its electrical generation capability may well enable it to qualify under Schedule E of EMAS.

3.6 CONCLUSIONS

The site does not currently have a fully structured approach to implementing the Environmental Policy into its management organisation. It is pleasing to note that recent documents incorporate environmental requirements. We recommend that:

- the Area Management communicates the Environmental Policy, its objectives and targets to the Thames Barrier;
- management at the Thames Barrier integrates the Environmental Policy throughout, sets local objectives and targets, and produces an Action Plan;
- responsibility for environmental management at the site be allocated to managers;
- the requirements of Project Management Guidelines and the Environmental Procurement Policy be considered for each and every project/procurement;
- consideration be given to achieving a direct link with Thames Environmental Circle;
- the principles being introduced for ISO 9001 be generally extended to the site in order to facilitate the full integration of environmental management;
- subsequent to the award of ISO 9001 consideration should be given to the site piloting certification in accordance with EMAS;
- job descriptions be issued which include a requirement to pursue the objectives of the Environmental Policy;
- effective measuring and monitoring of the major environmental effects of the site be introduced for management purposes; and
- environmental policy and environmental best practice should be incorporated into induction courses and all training programmes as required by the Executive Group.

4.0 OPERATIONS

4.1 INTRODUCTION

The facility was audited at an operational level to determine the efficacy of procedures to measure and monitor appropriate management processes. Evidence of gains in environmental performance and efficiency through effective resource management and waste minimization measures was sought. Contracts (internal and external) were examined for inclusion of measures to ensure appropriate environmental standards.

4.2 ENERGY MANAGEMENT

4.2.1 Thames Barrier - Management Summary

During pre-audit discussions Barrier management indicated that a full energy audit report would be welcomed as it would offer an external perspective on their current energy management programme. Consultants (EAG Ltd) were commissioned to undertake the energy audit of the Barrier and some of its associated activities. They were not requested to investigate the Visitors Centre, Cafeteria and Education Facility. Below is summarised the report recommendations and details of estimated net annual savings (cost and energy), implementation costs and simple payback (years). The full report is in Annex 3.

We recommend that:

- the energy audit recommendations are actioned.

Summary of Energy Savings

Table 1 (below) is a summary of the key findings and recommendations from the energy survey.

4.2.2 Major Conclusions and Recommendations

Energy Management Strategy (report reference 4.1)

The Thames Barrier engineering services design and operational strategy has been based on providing a high level of reliability and security to ensure availability of service at all times. This philosophy has resulted in an operational culture which tends toward leaving equipment "switched on". The review identified several opportunities where a change in this approach would result in significant energy savings being achieved as lighting, transformers, pier heating and ventilation systems etc.

EAG recommends that:

- senior management review the present site strategy to consider whether a change in operational approach could be implemented without comprising health and safety and the security of the Thames Barrier.

Table 1 - SUMMARY OF ENERGY SAVINGS				
Annex 3 Report Reference	Description	Savings		
		kWh	CO ₂ Tonnes	£
4.5.3	Transformer Isolation	157,680	110	7,000
4.6	General Lighting	134,980	95	6,000
	- high efficiency luminaires			
	- continue BMS strategy for piers and abutments	649,728 ¹	455	29,237
	- reduce pier and abutment lighting to 50 %	267,696	187	12,046
4.7.1	Complete heating and ventilation upgrades	636,000 ³	445	28,620
4.7.2.1	Control Tower heating improvements	26,296	18	1,183
	Control Tower and Workshops - replace electrode boilers with gas fired units		262	17,800
4.7.2.3	Control tower air conditioning improvements	110,376	77	5,000
4.7.2.4	Workshop/offices improve heating controls	10,800	8	500
4.7.2.6	Generator room - improve heating controls and reduce air infiltration	36,000	25	1,800
Total		2,029,556	1,682	109,186
% savings against current energy usage and cost (1994/95)		40.3 %	47.7 %	48.2 %

Energy Records and Monitoring (report reference 4.1.1, 4.1.2, 4.3.1, 4.3.2)

A detailed energy analysis over an appropriate time frame (minimum 12 months) was not possible due to absence of accurate and consistent data (electricity company invoices, site measurements, load

profiles) and the limited local metering arrangements for individual facilities (control tower, workshop/offices etc).

¹ Energy improvements implemented by the site.

EAG recommends that the site develops a formal energy management programme to include:

- the installation of local metering to monitor energy consumption;
- the collection and collation of monthly energy data including: kWh, kVAh, maximum demand (kVA), power factor and load profile information for a summer and winter period (month);
- a comprehensive review of one years energy data to establish an accurate picture of the sites energy performance and identify the primary targets for energy reduction and effective load management;
- regular senior management energy performance reviews; and
- procedures to monitor energy usage and conservation achievements using "real time" data to confirm actual savings achieved.

Electricity Tariff Arrangements (report reference 4.2.2)

A full tariff analysis was not part of the energy audit.

Electricity is currently being purchased from the 'pool' at an average rate of 4.5p/kWh. This compares favourably with electricity charges for other similar office/operational facilities.

EAG recommends that:

- the electricity contract be competitively tendered to establish whether further cost savings could be achieved.

Transformer Isolation (report reference 4.5.3)

The piers, abutments and substations generally have duplicate transformers installed as part of the security of supply strategy. Isolating 50% of the transformers would achieve energy and cost savings of approximately 157,680kWh and £7,000 per year.

EAG recommends that:

- senior management review the present operational strategy to establish the viability of transformer isolation.

Lighting

General Office Areas (report reference 4.6.3)

Lighting levels were generally in accordance with the CIBSE guidelines apart from the Control Tower (recently refurbished areas) and the Planning Office which were measure at 750/800 and 1,000 lux.

EAG recommends the establishment of a Site Asset Management Plan to include:

- on-going replacement of office luminaires with "state of the art" fittings. Potential annual energy savings 134,980kWh and £6,000 based on all the fluorescent luminaires being replaced and a 15 % improvement in fitting efficiency;
- provisions to ensure that all new and refurbished office lighting installations comply with the EC Directive for workstation VDUs;
- the introduction of individual luminaire switching and PIR control in low occupancy areas and the establishment of a lighting "switch-off" strategy through the work card system.

Piers, Abutment and Tunnel Lighting (report reference 4.7.1)

The pier, abutment and tunnel lighting represent a significant electrical load (230.4kW) amounting to approximately 33 % of the sites total energy consumption. The ongoing upgrades to the sites Building Management System (BMS) will achieve considerable energy savings (649,728kWh and £29,237) when completed.

EAG recommends that:

- subject to health and safety requirements the site management considers the potential for additional energy savings by a further reduction in the pier lighting, eg, a reduction by say 50% would achieve energy savings of 267,696kWh and £12,046.

Heating, Ventilation and Air Conditioning Systems

Piers and Abutments (report reference 4.7.1)

The pier and abutment heating and ventilation systems are being modified in accordance with a series of recommendations by Oscar Faber. These proposals were reviewed and are considered an effective solution to meet the present operational criteria whilst achieving effective energy management. The

savings resulting from the proposed changes when implemented for all the piers and abutments are estimated at approximately £28,620 and £636,000kWh, based on a 50% energy saving.

EAG recommends that:

- the upgrade programme is continued.

Electrode Boiler Replacement (report reference 4.7.2.1 and 4.7.2.4)

Replacement of the existing electrode boilers would result in annual energy cost savings of £17,800 and a reduction in indirect CO₂ emissions of approximately 262 tonnes. The capital cost of replacing the boilers was estimated at £43,000 giving a simple payback period of 2.4 years.

EAG recommends that:

- the existing boilers be changed to gas fired units subject to confirmation of the savings (through on-site metering) and capital plant estimates (competitive tendering).

4.2.3 Visitors Centre - Summary

Energy usage is considered by Visitors Centre staff. However, energy management is hampered by the diverse nature of the Visitors Centre complex and the inability to monitor specific buildings. The benefits derived from any changes in heating or lighting regimes would be difficult to monitor. Problems associated with heat loss as a result of frequently opening exterior doors, and safety lighting considerations are equally relevant to operational efficiency as they are to environmental policy considerations. Whilst the operation of the Cafeteria is franchised, the NRA retains overall responsibility for its environmental integrity. (See Annex 4)

4.2.4 Visitors Centre - Conclusions

We recommend that:

- the feasibility of obtaining discrete electricity and gas metering for the Visitors Centre Building should be investigated;
- energy usage should be suitably recorded and monitored, linked to the setting of energy savings targets;
- current electricity tariffs are investigated to confirm they are the most appropriate ones for the Visitors Centre;

- the feasibility of connecting the gas fired central heating system in the upper level seating area of the Cafeteria is investigated;
- when the lighting units in the Education Facility building are replaced, a suitable low energy type should be installed; and
- the single oil filled electric radiator which remains in one of the Education Facility kitchen areas is included within the heater replacement programme.

4.3 WATER CONSUMPTION AND COSTS

Audit Criteria. NRA Environmental Policy Target (10% reduction in use by March 1995, compared to 1991/92), best practice as issued by BSRIA, CIRIA and Buildings Research Establishment.

4.3.1 Previous Survey

A report by the Linden Partnership in June 1993 failed to adequately identify water consumption at the site. They state that the combined costs of water and sewage disposal in 1992 were £12,000. They made no recommendations for improvements.

4.3.2 Present Position

Reports supplied to the Environmental Policy Unit by Thames Region indicate water consumption of 4,714m³ at a cost of £11,303.

Table 2 Reported Water Use, 1994/5

Period	Use m ³	Cost £
Qtr 2 1995/6	671	2547
Qtr 1 1995/6	1966	2875
Qtr 4 1994/5	1102	2961
Qtr 3 1994/5	<u>975</u>	<u>2920</u>
Total	4714	11303

There is limited validity to commenting on the efficiency of water use due to the industrial nature of the site; use is about 100m³ per annum per employee, the norm for office staff is about 11m³. The high consumption in Q1 1995/6 compared to the previous and subsequent reading are unusual for a continually operating site and may indicate problems with the accuracy of data collection. Despite the fluctuations in reported use there is no corresponding trend in the financial data.

The cost data show a small decrease in expenditure from 1992 to 1994/5, but the Linden Partnership's figure is only approximate. It is not possible to determine if the facility has met the NRA's target for a 10% reduction in the volume used.

We are unable to identify any formal monitoring and reporting process for the use of water, but figures are collected quarterly for reporting to the regional centre. There is no technical instruction for identifying and rectifying water leaks. Some measures taken to reduce consumption include reducing the urinal flush rates and repairing a dribbling urinal.

4.3.3 Visitors Centre and Education Facility

Present Consumption

Separate water meters exist for the Visitors Centre Building and the Cafeteria. Consumption during the 12 month period to September 1995 was 516m³ and 951m³ respectively. It is difficult to compare these figures against any recognised standards due to the variable impact of visitors to both these facilities.

Action Taken to Reduce Consumption

Movement detector controls for urinal flushing have been installed in male WCs replacing previous timer mechanisms. This action should reduce water consumption.

Other Measures for Consideration

The basin taps installed in the WCs are standard fittings, which allow them to be left open. The Cafeteria operator commented that taps are frequently left open in the public toilets, emptying the hot water cylinder.

4.3.4 Conclusions

Water consumption for the main site appears to be largely unchanged from the baseline (1991/92). Measures to reduce consumption include:

- a reduced urinal flushing rate; and
- fitting movement detectors in the Visitors Centre's male toilets.

Several issues are identified for further action. We recommend that:

- meter readings are made on a regular basis, best practice is weekly, and performance is reported to site staff;
- procedures to investigate anomalies in consumption are written and promulgated; and
- self closing faucets are installed within the public toilets located in the Cafeteria building.

4.4 TRANSPORTATION

Audit Criteria. NRA Environmental Policy Targets, (90% of vehicles to be diesel by March 1995, a 15% reduction in energy use, measured as CO₂ emissions, compared to 1991/92); Industry best practice including systems to minimize use (car sharing, route planning, journey elimination, etc) driver training, correct vehicle specification.

4.4.1 Thames Barrier Performance

There are few vehicles controlled from the Barrier site, the majority of staff are located on-site. There are also three vessels controlled by the Tidal Thames Section at the Barrier. There is little awareness of the NRA's targets.

Driver Training

The efficient driver training video was shown to some staff. However, not all staff who have access to NRA vehicles have undertaken the Efficient Driver Training course despite the date for the expected completion of the programme in Thames Region being prior to the audit.

Fuel and Mileage Monitoring

Drivers do not receive regular, agency derived, reports on their fuel consumption. We found no system for formally monitoring badged and lease vehicle use and mileage driven, although some staff do monitor their own fuel use. There is no evidence of on-going monitoring of casual and essential driver mileage by line management at the local level.

Vehicle Maintenance

It was reported that the NRA vehicles held on site receive only "first aid" repairs at the Barrier. All other maintenance is carried out by a Regionally appointed contractor.

Boats

The Thames Barrier is shortly to procure a new boat. Discussions indicate that environmental best practice is not being considered in respect of the specification.

The Thames Barrier operates three vessels of which *Barrier 2* was inspected. It is generally clean and tidy but one 5 gallon hydraulic oil drum was observed unsecured on the decks. Refuelling is normally carried out from 5 gallon drums hoisted on board using a crane. No spill procedures are displayed nor are absorbents carried. It was stated that there are no specific refuelling procedures for this or any of the other vessels. The vessel's diesel tank is unlabelled in respect of its contents.

4.4.2 Conclusions

Overall there are few Authority owned vehicles used by site employees, and there has been no systematic attempt to manage their use. We recommend that:

- fuel efficiency data for Authority vehicles is actively managed and provided to all drivers;
- line management monitor vehicle mileage;
- all employees with access to Authority vehicles undergo Efficient Driver Training;
- environmental considerations are included in the specification for the new vessel; and
- best practice procedures in refuelling of vessels be produced and implemented.

4.5 PROCUREMENT, SUPPLIERS AND CONTRACTORS

Audit Criteria. NRA Environmental Policy - suppliers of products and systems should produce evidence of their positive environmental management; NRA procurement manual; evidence of environmental considerations in letting contracts, etc.

4.5.1 Introduction

Staff and managers based at the Thames Barrier are responsible for the majority of contract and procurement decisions relating to the site.

4.5.2 Service Suppliers and Contractors

Grounds Maintenance

The site grounds are maintained by NRA staff working to a landscape management plan drawn up by operations staff based in the Barrier office. The plan is currently being redrawn and was not available

for inspection during the audit. A plan produced by the same staff for a related site, the Barking Barrier, contains much good practice including creating spring and summer meadows.

Weed-killing is carried out occasionally on an as and when basis. Barrier staff could not confirm the chemical used, but say that the results indicate that it is not an aggressive agent. Insecticides are used to control the Brown Tailed Moth. Both pesticides and herbicides are cleared by the conservation and pollution control staff. Two of the NRA staff are qualified sprayers.

Domestic (Cleaning) Services

The tunnel and service bridges are spring cleaned by external contractors every twelve months. The tunnel lining is cleaned using a mild detergent, the floor mechanically scrubbed using detergent, and pipe-work is damp wiped. Any oil spills are emulsified and dispersed via the drainage system. A second contract is let for the cleaning of gratings, plus the foul water and rain water sumps. The sumps are treated with disinfectant and flushed through.

The current contractor, who is well known by Barrier management, supplies the chemicals to be used on the job. The contract specification does not cover chemicals to be used in carrying out the works and so excludes environmental considerations. However, Barrier management say they know what chemicals are used.

Additional cleaning work is carried out by Barrier staff under the works instruction system. This includes vacuuming, sweeping and wiping down work. Sumps are also flushed through, approximately every six weeks. All piers are cleaned by Barrier staff. Management report that a training programme, which involves working in tandem with an experienced operative, ensures that new recruits are shown the correct procedures.

Four part-time staff are employed to clean the offices and the adjacent staff house.

The Cafeteria franchise Agreement refers generally to compliance with statutory requirements but does not specifically mention COSHH nor the use of environmentally friendly products for cleaning, etc.

Building Maintenance Contracts

A computer cleaning contract has recently been let. No specification is made by the site staff in respect of the cleaning materials used because they consider that the contractors are the experts in this respect. There is also a contract for the maintenance of green plants. Similarly, no specification is made in respect of the non-use of peat as the growing medium in accordance with the environmental policy. By examination the growing medium is thought to be peat, contrary to the policy.

Barrier Mechanical and Electrical Maintenance

Contracts and specifications that were current during the audit were inspected for best environmental practice. The draft tender document (dated 9/11/95) for Replacement Inverters for Pier 3, North Abutment and South Abutment contains items of good environmental practice and addresses the potential environmental impacts of the work. It states that the contractor shall demonstrate in his written Method Statement proposals to minimise environmental impacts, which are detailed. It also contains clauses on pollution prevention, waste disposal, and specific environmentally hazardous substances.

In contrast older contracts, etc contain no such considerations, for example the Fire and Security Services Specification.

The Electrical Engineer is incorporating environmental standards in new contracts for all Barrier staff use and considers it an appropriate method to improve the environmental performance of the site. The draft contract (above) is an example of considerations that are to be placed in new contracts.

Contractors

The understanding of the Authority's environmental policy and concerns was checked with the contractors on-site during the audit. Silvertch Ltd hold the contract for replacing the electronic controls, etc for the Barrier gates with a PC based system. Their employee on site reported that before starting work he had received no briefing from the NRA on environmental issues nor on health and safety matters. The site management report that briefing individual employees is the responsibility of the contractor but that they have a close working relationship with all Silvertch's employees. They did not instruct Silvertch on their environmental requirements.

However, the contractor's working practices with respect to disposal of waste, spills, etc are good. Sivertch's employee did express surprise that the Authority, as an environmental agency, did not specify on the works instruction system the type of cleaners and solvents that could be used on the site.

4.5.3 Materials Suppliers

Stationery and Paper Suppliers

Paper and stationery for the main site are procured from the national contracts. Stationery in the Visitors Centre is purchased largely from the national contract core list. Similarly paper is obtained through the national contract although brochures produced for retail purposes, an area where management believe appearance is a critical factor, are obtained from other sources.

Merchandising Goods

High priority is given to secure goods that are safe, particularly for children, and of a suitable quality. While environmental specifications are considered for paper goods generally specifications do not include any environmental requirements concerning the sustainability of materials, relating to either the products or the packaging.

4.5.4 Flood Defence

Limited aspects of the site operations in respect of flood defence were investigated. The majority of flood defence maintenance and support work is contracted to the IBU at Sunbury.

The maintenance and minor capital works contract is held in a loose leaf form. Its quality plan does not incorporate any requirements in respect of environmental best practice. There is scope to improve considerably the environmental best practice requirements within the contract. There is no reference to refuelling practices in and around watercourses.

It was reported by Barrier staff that in accordance with best practice, the Thames Barrier requires the JCBs at Sunbury to operate with biodegradable hydraulic oil. However, this is not in the contract. In addition the conditions for the use of herbicides do not require the user to be certified other than in accordance with the Control of Pesticides Regulations 1986. It was stated that monitoring of contractors' performance is "minimal." These issues could be addressed by adopting a national standard contract for use in this and any similar operations contracts.

In respect of pollution prevention and the management of waste, the contract's requirements for a COSHH assessment makes no reference to the NRA's Environmental Policy on Toxic and Harmful Substances.

The maintenance contract for the tidal monitoring stations contains limited environmental issues. It would benefit from the incorporation of a site visit checklist of actions that incorporate concerns with environmental consequences ie serviceability/maintenance of the site building's heating, lighting etc.

4.5.5 Conclusions

Environmental issues are being progressively incorporated into procurement decisions. Items of good practice include:

- the incorporation of environmental best practice in the land management plans; and
- best practice being introduced in contract documents, for example the replacement inverters contract.

Principal issues for further action are identified. We recommend that:

- the requirements of the Environmental Procurement Policy are followed for all procurement decisions;
- all functions routinely consult the NRA's Commodity Checklist (for environmental considerations) when requiring goods and services;
- existing National Facilities Management Contracts are used where applicable;
- contractors, both new and existing, are briefed on the Authority's Environmental Policy, and its objectives; and its understanding by contractor's employees is regularly checked; and
- Visitors Centre management are made aware of the environmental impacts of products made from natural materials and also the concerns associated with packaging material. Specifications for the supply of goods to be retailed in the shop should aim to address these issues and fully reflect the NRA's environmental policy standards.

4.6 EMERGENCY PROCEDURES

***Audit Criteria.** NRA guidance to external bodies (PPG 18, Pollution Prevention Measures for the Control of Spillages and Fire Fighting Run-Off); best industry practice.*

4.6.1 Thames Barrier Site Performance

There is no comprehensive emergency plan available for the site. Specific plans exist for fire and in the Technical Instructions for electrical failures etc. There are no plans for spills, for example during oil delivery, or for floods relating to the site. The site staff believe that because it is manned 24hrs a day and on a combined sewerage system the risk of significant harm from spills is limited. However, any spill that escaped initial detection could result in entry to Thames Water's sewage system. We do not consider the risk due to flood to be significant.

4.6.2 Conclusions

The production of a Site Emergency Plan is good practice. We recommend that:

- the existing site emergency plan is reviewed to incorporate all potential emergencies. This should include the likely sources of spills; and
- the Technical Instructions include procedures for handling major spills.

4.7 WASTE MINIMIZATION

Audit Criteria. Best industry practice; NRA Internal Environmental Policy priority issue.

4.7.1 Site Performance

There are several waste minimization initiatives at the Barrier but there is no formal waste minimization programme. Specific points are listed below:

- energy, the prime area for waste minimization is covered in Section 4.2;
- water use is in Section 4.3;
- old headed paper is made into scrap pads for general use;
- some offices re-use paper for printing drafts;
- the location is considering the recycling of plastic cups and cans; and
- used oils are recycled.

Considerable effort has gone into recycling of paper and board; 120 black bags of mixed paper and board were removed by contractors on the 20 October. However, there is no attempt to separate white paper from the coloured paper and board which reduces the value of the process. Recently the use of green paper for faxes was adopted. Consideration should be given to using white paper only wherever possible and separating the white paper in the recycling stream.

It was stated that considerable paper is wasted through very minor amendments being made to hard copy by managers and supervisors. It is felt there could be a substantial reduction in paper use if managers' reluctance to use E-Mail is overcome.

Amongst staff in the Barrier administration there is no awareness of specific environmental targets, although the requirement to reduce stationery use by 10% was stated categorically to be a financial target. There is no record of expenditure on stationery because it is not believed by facility administration to be necessary as the location only bought the stationery that it needed. There is no record of paper consumption. It is not possible to determine whether the site is meeting the national waste minimization targets.

4.7.2 Conclusions

There is little action to reduce waste through a reduction in purchases. We recommend that:

- the national waste minimisation targets are pursued.

4.8 BARRIER OPERATIONS AND MAINTENANCE

Audit Criteria. Best industry practice for similar activities.

4.8.1 Site Performance

Working practices are specified in Job Specifications supported in some cases by Technical Information sheets. Few contained environmental concerns. These are combined with a system of works instructions to ensure that work is effectively planned and carried out. In general the sample examined did not contain environmental concerns, although the detailed nature of the documents may preclude inclusion.

Site and pier heating and lighting is left on during the working day and, in some cases for 24 hours. (Section 4.2.1). There would be considerable environmental gain if only those areas where work is in progress or are occupied had these services on, subject to essential equipment and safety needs. The new electronic control systems coupled with the permission to work system should enable the relevant areas to be activated on an "as needed" basis instead of the current "always on" approach.

4.8.2 Conclusions

The work control system provides a method for integrating environmental issues into all work practices. We recommend that:

- the coverage of Technical Information Sheets is extended to include issues such as waste disposal, use of environmentally hazardous materials, spill prevention and control, etc;
- job specifications and works instructions include environmental issues, such as energy reducing measures and waste disposal. All job specifications are to be reviewed to ensure that environmental issues are fully addressed; and
- consideration should be given to implementing the activation of heating, lighting and fire systems on a strict "permission to work in specified areas" basis.

5.0 ENVIRONMENTAL IMPACTS

5.1 INTRODUCTION

The facility was examined to assess its immediate environmental impacts and the controls on them. Emissions and waste streams were identified together with the existence of permits or consents for any discharges. Compliance with statutory controls on emissions was assessed together with compliance with NRA best practice as given to outside bodies. Implementation of best practice above that required by national procedures was sought for use as examples for Areas or Regions to adopt. The effectiveness of measuring and monitoring of discharges, whether controlled by statute or not, was appraised.

5.2 PAST ENVIRONMENTAL REPORTS

Audit Criteria. An assessment of the progress on issues identified.

5.2.1 Report to Thames RMT, July 1992

A summary report produced for Thames RMT by the Finance and General Services Manager in July 1992 identified the Thames Barrier and associated sites as relatively low risk. The report recommended that a bund be constructed beneath the generator radiators to contain any leaks of cooling water and that drums of oil and antifreeze be stored in a bunded compound.

5.2.2 Pollution Prevention Site Inspections, October 1994

Pollution prevention site inspections were carried out by Thames Region Pollution Control Staff in October 1994. Site Inspection Certificates were issued in March 1995.

Thames Barrier

The Pollution Prevention Site Inspection Certificate was issued subject to a number of conditions being satisfied by 30 June 1995:

- protective and advisory measures to be taken to prevent pollution from spillages from drums, remote hydraulic fill points and batteries in line with NRA pollution prevention guidance;
- compliance with waste disposal regulations and the Duty of Care; and
- enhancement of inspection and maintenance procedures for the site's oil separators.

When tested, only two of the six conditions (conditions 1 and 3) appear to have been fully actioned. Sections 5.6 & 5.7)

Education Facility and Visitors Centre

Certificates were issued with no conditions.

Herringham Road

The Pollution Prevention Site Inspection Certificate contains three conditions:

- drum storage to be brought to PPG 11, etc;
- the oil interceptor to be inspected and maintained in line with PPG2, etc; and
- the development of a housekeeping policy.

The certificate requires the completion of all actions by 30/6/95. Where tested (Sections 5.3.1 & 5.7.2) these conditions have not been actioned.

5.2.3 Conclusion

The actions required by the report of July 1992 and the majority of conditions attached to the certificates of March 1995 have not been acted upon. We recommend that:

- appropriate measures are taken to comply with the conditions identified by the Thames Pollution Control staff.

5.3 LAND USE AND MANAGEMENT

Audit Criteria. Best industry practice, for example as outlined in Welsh Water's "Making the Most of Your Site." NRA Guidance in The New Rivers and Wildlife Handbook; and South Western Region's Regional Environmental Policy for NRA Grounds Maintenance.

5.3.1 Site Performance

Introduction

The Barrier includes an open access site and a public amenity area. Picnic benches and children's playground facilities are provided within the riverside area adjacent to the Cafeteria. There are also hard surface car parking areas. The grounds are landscaped and incorporate trees, shrubs and grassed areas.

The site is situated in a difficult area for maintaining grounds, clearing litter etc. It is in an industrial area and adjoins scrap yards, etc. There is evidence of vandalism to the glass sculpture and disused

store building. However, the grounds presented a tidy appearance and were reasonably litter free, especially near the Barrier itself.

Maintenance of the grounds is managed in two ways. General tidying of the site is undertaken by Visitors Centre staff. Grass cutting, pruning, etc. is carried out by operations staff.

General Maintenance of Grounds, etc.

While the grounds were generally found tidy, the area alongside the Visitors Centre building, where the Portakabins are sited, falls below this standard. Old signage, bathroom fittings and a shopping trolley were among the discarded items identified in this unkempt area. Rat infestation has recently been reported at the Visitors Centre and several vermin control boxes are in place around the site.

The Herringham Road site is not kept in a tidy condition. The yard has equipment placed in a haphazard way and there is substantial weed growth. There is a considerable accumulation of rubbish inside Store Shed 2 that reflects very poorly on the site management; it is a potential health hazard and fire risk.

In the autumn substantial quantities of leaves accumulate on roads, car parks and pathways within the Visitors Centre grounds. These are generally swept up, placed in plastic sacks and disposed of into a general rubbish skip located adjacent to the Cafeteria.

The option of using this biodegradable material as a natural compost within the grounds has not been fully considered. Leaves can be either spread directly onto borders/coppiced areas, or collected for composting and applied later as a mulch.

5.3.2 Conclusions

The site presents an acceptable appearance to the public although the grounds around the Portakabin and the inside of Store Shed 2 give the appearance of an out of sight dumping area. This is unlikely to be conducive to the discouragement of rodents.

Grounds maintenance can be carried out in greater harmony with natural processes. We do not dispute the need to remove leaves from paths and roadways, but the need to dispose of this material off site is questionable.

Areas have been identified where there is scope for improvement. We recommend that:

- the area alongside the Visitors Centre, where the Portakabins are sited, is tidied and the discarded items and other materials suitably disposed;

- the Herringham Road site should be tidied and a housekeeping policy should be developed which encourages tidiness;
- dead leaves cleared from paths and roadways should be either placed directly to shrubberies etc, or collected for compost; and
- other plant material from the grounds maintenance is composted or used as a mulch where practicable.

5.4 CONTAMINATED LAND

Audit Criteria. Assessment of past land use, HM Government Guidance on the Redevelopment of Contaminated Land.

5.4.1 Site Performance

In order to establish the potential for contamination of the site EAG Ltd undertook extensive desk based research of the history of the site and the surrounding area. (Section 2.3 and Annex 1). They report that both banks have an extensive history of industrial land use and concluded that both were likely to be heavily contaminated with a variety of materials, including heavy metals, coal tar, phenols, hydrocarbons, cyanide, sulphate, sulphide, elemental sulphur, volatile aromatic compounds, asbestos, PCBs, ammonia and elevated pH. There is also a possibility of methane gas from buried organic matter being present in the bankside areas. As a result of recent investigations the land adjoining the north bank of the site has been described as the most contaminated site so far investigated in the UK.

We are unable to determine whether any remedial work took place during the construction of the Barrier.

There is every likelihood that contamination from Authority land is migrating to the River Thames, and possibly to the underlying aquifers. Depending on groundwater movement there is also a strong probability that the contamination of adjoining land is migrating into the NRA site, and thence to the River Thames.

The suspected levels of contamination may be such that the soil presents a health and safety risk both to visitors and to contractors undertaking groundworks.

An outline proposal for Phase II investigations of both the north and south sites is in Annex 2. We estimate the total cost of the investigations at about £40,000.

In the event of any land on the north bank being transferred to another owner, in connection with the proposed development (Section 2.1), such investigations will be required to show due diligence.

5.4.2 Conclusions

The site has considerable potential for contamination from past land uses. This may result in releases to the water environment and health and safety risks to contractors and visitors. We recommend that:

- past Barrier records are reviewed to determine any investigation or remediation undertaken when the Barrier was built or subsequently;
- the levels of methane gas in the soil and Barrier are monitored;
- further investigation to determine the extent and nature of the contamination be undertaken; and
- any decisions on possible remediation work take account of new DoE guidance on contaminated land to be issued early in 1996.

5.5 AIR AND NOISE

Audit Criteria. *Legislative requirements, Clean Air Act 1993, Environmental Protection Act Part III, 1990 - statutory nuisance.*

5.5.1 Site Performance

The regulation of emissions to atmosphere from this site does not come within the scope of the Environmental Protection (Prescribed Processes and Substances) Regulations 1991. The generators have a combined thermal input, under maximum load, of 14.7MW which is within the 20MW limit set for control as a Part B process.

The generators are regulated under the Clean Air Act provisions relating to dark smoke. This makes it an offence to emit dark or black smoke other than for certain specified short periods. We were unable to observe the generators in action but were informed that they do not emit smoke. Under normal operating conditions and with correct maintenance they should not give rise to excessive emissions.

The facility lies within a smoke control area but there are no specific regulations in force for bonfires. The only other regulatory control rests with the local authority provisions regarding nuisance. It is considered that the risks of nuisance emissions arising are small. Specific atmospheric emission sources from each part of the site are listed below.

Barrier - North and South Banks

The Greater London Council's safety policy at the time of the Barrier's construction means that no gas heating is present on the main Barrier site. Heating for the control tower, workshops, gatehouses,

warehouses and the Barrier itself is provided by electricity. (See Section 4.2 and Annexes 3 & 4). The only other significant potential source of atmospheric emissions are the generators, above.

The operations undertaken at this site are not inherently noisy and the location of the buildings in a largely industrial /commercial area make it unlikely to present a significant potential for noise nuisance.

Visitors Centre, etc

A gas fired central heating boiler is the sole atmospheric emission source. The risk of any emission from this boiler constituting a nuisance is small.

Emission sources from the Cafeteria consist of a gas fired central heating boiler and an extractor unit from the kitchen area. Currently the franchisees do not prepare and cook food on site, other than reheating using a microwave oven. While this continues, the risk of adverse environmental impact from emissions is small.

There is no potential for significant atmospheric emissions from the Education Facility building.

The noise from the audio presentations is generally confined within the building when all doors are closed. The site lies within an industrial area. Noise levels emitting from an adjacent factory suggested that, during weekdays, there is little risk of noise nuisance from the Visitors Centre. If noise levels from the audio presentations are more noticeable at weekends, the risk of any real disturbance is small because the site is not close to residential properties.

5.5.2 Conclusions

There is limited possibility of significant emissions to air from the site. However, the reliance on electricity as the prime energy source results in considerable emissions remote from the site. The generators do not require an authorization under Local Authority Air Pollution Control. Any nuisance due to noise is similarly limited.

5.6 WATER AND WASTEWATER

Audit Criteria. *Legislative requirements, eg Water Resources Act 1991, section 24 (abstractions) and section 88 (discharges) and relevant Statutory Instruments. Advice by NRA to outside bodies, eg Pollution Prevention Guidance Notes and Pollution Prevention Pays video.*

5.6.1 Water Abstraction

There is no abstraction of water at this site.

5.6.2 Wastewater

Wastewater discharges comprise:

- foul drainage from toilets, kitchen, etc;
- boiler draindown and air conditioning unit condensate;
- anti-freeze from the generators;
- Barrier washdown effluent;
- storm-water drainage; and
- vehicle washing.

Specific waste water discharges from each part of the site are given below.

Main Barrier Site

- foul drainage from toilets, workshop block kitchen etc;
- Barrier washdown effluent from regular cleaning and from wash down of oil-spills;
- storm-water drainage; and
- vehicle washing.

Herringham Road

- storm-water drainage.

Visitors Centre Building

- foul drainage from toilets, mess-room kitchen, etc;
- central heating boiler draindown; and
- storm-water drainage.

Cafeteria

- foul drainage from toilets, kitchen, etc.
- central heating boiler draindown; and
- storm-water drainage.

Education Facility

- foul drainage from toilets, kitchen areas, etc; and
- storm-water drainage.

Site Drainage

The vast majority of the site is on a combined drainage system. Drainage plans were available for inspection which - for a representative sample of the site - accurately identified drainage routes and the location of inspection chambers. A small part of the north bank surface water appears to drain to the River Thames via a tidal flap. This route was followed by tracing the line of manhole covers to the tidal flap which was not discharging at the time of inspection, but did show evidence of clean water discharges by staining of the embankment wall. None of the surface water drains, inspection covers, etc are colour coded.

Discharges to Sewer

With the exception of the small area of the north bank referred to above, all effluent from the site discharges to the foul drainage system which connects with the sewer in Westmoor Street on the south bank. This discharges to the Crossness Sewage Treatment Works operated by Thames Water Ltd.

All surface water from the south bank and barrier structure discharge via a large two-chamber oil separator (linked to drains D61 and D62 on drawing no. TB/5ABS/AA352). This is inspected and the level dipped weekly (prompted by a works instruction) and has a level alarm. It is emptied twice yearly by Associated Reclaimed Oils who, staff report, recycle the waste. Visual inspection revealed that the interceptor was reducing oil levels, but there was evidence of oil still remaining in the final chamber. Barrier waste water includes washings from 6-weekly cleaning of sumps with anti-bacterial agents and oil from hydraulic/lube oil spills which is emulsified using general purpose degreaser and flushed into the drainage system. Barrier staff estimate hydraulic oil losses through filter exchanges and leaks to be 2-3,000 litres per annum, disposed of by emulsifying. Generator antifreeze is also disposed of to sewer, in the course of two-yearly anti-freeze changes. Staff estimated discharges of 2x45gallon drums per generator x 3 generators = ca 135 gallons per annum (approx 330 litres). Staff reported that this practice was verbally agreed with Thames Water in 1987/8. It was stated that following servicing of the boats, the engine oil from the vessel is either tipped into the interceptor or disposed of as waste oil.

No trade effluent consent exists for the site. Thames Water Services Ltd have indicated that they may require a consent for the current discharges.

A smaller three-stage oil interceptor serves the underground car park. This was not inspected. Responsibility for the maintenance of the two interceptors is divided between two members of the Barrier staff. Co-ordination of this activity is at risk because each person has sole responsibility for just one of the interceptors.

Discharges to River

The surface water from the paved area of the compound on the north bank drains via a tidal flap to the River Thames. This is unlikely to require a consent.

The silt from the rising sector and radial gates is washed out using mains water and discharged directly into the river. There may be a need for a discharge consent depending on whether the effluent is contaminated.

Discharges to Groundwater

The site geology, etc indicates that the location may be considered sensitive to the pollution of groundwater. No discharges to groundwater from this site were noted.

5.6.3 Conclusions

Risks from discharges to the water environment are limited because of the combined drainage system. We identified the following good environmental practices:

- oil separators are installed, with regular inspection carried out and documented;
- oil from separators is re-cycled; and
- drainage plans are readily available and appear to be accurate.

Several issues are identified for further action. We recommend that:

- single point responsibility is assigned for all aspects of site drainage;
- the requirement for a Trade Effluent consent is clarified with Thames Water Services;
- the practice of disposal of antifreeze to sewer is reviewed; best practice is recycling;
- the use of de-greasers to clean-up oil spills and subsequent disposal of emulsified oil to sewer is reviewed to identify the best practicable environmental option;
- the drainage to the tidal flap should be checked for oil contamination;
- the requirement for a discharge consent for the gate washings is clarified; and
- surface water drains, inspection covers, etc are colour coded in line with NRA advice. (Pollution Prevention Pays video, etc).

5.7 ENVIRONMENTALLY HAZARDOUS SUBSTANCES

Audit Criteria. NRA Environmental Policy for the elimination of toxic substances and emissions where practicable. NRA policy on the elimination of ozone depleters. NRA Guidance in Pollution Prevention Guidelines and in "The Use of Herbicides in or Near Water."

5.7.1 Introduction

A wide range of environmentally hazardous substances, especially oils including diesel oil, hydraulic oil, lubricating oil and waste oil are stored on the site with smaller volumes of other liquids including cleaning fluids, de-greaser, battery acid, solvents and paints. Details of many substances stored are contained in COSHH sheets which are available within the various departments, although the absence of a single central point with an overview of all hazardous substances stored made it difficult to assess overall compliance. Significant amounts of Halon are on site in the Halon fire control drench systems in switch rooms, etc and in the Halon bottle store. Use of selected items are in table 3.

Table 3 Annual Purchases of Selected Environmentally Hazardous Materials

Item	Quantity
Fuel Oil	112,000 litres
Lube Oil	2,870 litres
Grease	300 Kilograms
Cutting Oil	100 litres
Gear Oil	50 litres
Degreaser (88 % Paraffin)	400 litres
Epoxy paint	85 litres
Rubber seal paint	15 litres

(For period 5/5/94 to 4/5/95)

5.7.2 Storage

Environmentally hazardous materials are located in five locations:

- the south bank flammable store, associated oil storage tanks and yard environs;
- the underground store for bulk cleaning and janitorial supplies;
- bulk storage of hydraulic and lubricating oils within the Barrier's hydraulic and generator systems themselves;

- the cleaners cupboards and stores at the Visitors Centre and Cafeteria; and
- the fire extinguishing drench systems and bottle store.

South Bank Flammable Store

This store is kept very tidily, with all containers labelled and drip trays for the 45 gallon drums (see photograph 6). Hydraulic and lubricating oils are stored on one side (approx 20x45 gallon drums), with solvents and paints (including an epoxy paint) on the other. The store doorway has a small lip to contain spills and while no absorbent material was in the store, it was readily available from the adjacent underground janitorial store. An overflow drum store is kept in a large container, equipped with sliding door, racking and drip tray. (Photograph 7) Gas bottle stores eg for oxyacetylene torches, etc are kept in a cage in the yard. These stores are kept locked at all times. No COSHH sheets were kept in the store itself.

Bulk Oil Storage

- **Bulk Oil Tanks** The two bulk diesel oil storage tanks serving the site are located in the workshop building adjacent to the flammable store. The tank provides a refuelling facility for plant and fuel for the generators (a back-up power supply to close the Barrier, in case the power supplies from North and south banks fail). The tanks have a combined capacity of 24,000 litres, but are kept partially empty to evacuate diesel supplies from the daily service tanks in case of fire. The tanks appear to be surrounded by an adequately sized concrete built bund compound. The tank store door bears an NRA oil store sticker. The delivery point is located in a locked cabinet on the exterior wall adjacent to the tanks. It is not within a bunded area. (Photograph 8) Oil absorbents are always available on site and the Storeman is aware of the spill procedure.

A third bulk diesel tank is being installed in the compound, opposite the internal bulk tanks. This will have a 40,000 litre capacity and be directly connected to the existing two tanks. The site staff inform us that the tank has an integral bund and believe that an additional bund is not required. We did not inspect the design of the tank to determine the adequacy of the containment, in particular for the filling arrangements and level gauges. Protection from damage caused by vehicles will be required and the fill point will need adequate containment. Staff seem to be aware of the requirements of PPG2. The new tank is fitted with a sight gauge and prevent oil spills sticker. The drip tray may need extending slightly (Photograph 9).



Photographs 6 & 7 Drums in the Flammables store; showing labels (A), locked outlets (B), and drip trays (C). Excess drums are kept in an overflow storage container (D), incorporating drip tray (E).





Photographs 8 & 9 Bulk oil storage is at present inside the building with unbunded, locked fill point (A). In future an exterior oil tank will be used (B). The new tank is labelled, with overfill alarm (C), level guage (D). The drip tray may need extending to fully collect drips (E).

- **Barrier Hydraulic and Generator Systems** The hydraulic rams that close the Barrier operate in a closed system containing approx. 150,000 litres of hydraulic mineral oil. An estimated 2-3,000 litres pa are lost due to leaks and filter changes. We were unable to fully clarify the refilling procedures. Fill points are located on the North and south banks which, we understand, feed bulk tanks on the abutments. These bulk fill points should be fitted with sumps and surrounded by a lockable kiosk. (Photograph 10) The bulk tanks on each of the major piers (piers 4 to 8 inclusive) are filled from 205 litre drums carried out to the piers on a boat and lifted by crane onto the pier. The oil is transferred by barrel pump. Small patches of leaked hydraulic oil are evident on many of the piers. These appear to come from both the header tanks above each power pack (3 packs per pier) and from the hydraulic rams themselves. Absorbents are at hand in yellow Hazchem buckets but they do not appear to be used for minor spills. Biodegradable alternatives to mineral oil are being investigated. The generators each have lube oil filling lines and waste oil tanks inside the generator houses. Each waste oil tank showed evidence of recent minor leaks (Photograph 11).
- **Compound Environs** Adjacent to the new diesel tank, are stored 14 oil drums (45 gallon size), most partially filled and labelled as hydraulic oil, lube oil or antifreeze. We were advised this is the waste oil store and was emptied twice a year by the same specialist recycling contractor who empties the oil separator. The drums were on standing on brick paving on sloping ground, draining to sewer. There is evidence of oil in the nearest drain and oil contamination to the surface. The bricks and the joints are most probably unsealed and so any escape of oil, etc may cause contamination. (Photograph 12)

Hazardous Material Elsewhere on Main Barrier Site

In the North Generator House, a collection of dryfit A200 batteries is stored in an un-contained area. A number of lube oil drums, unbanded and on a sloping floor draining under the doorway out to sewer via the paved external compound, are also stored here. (Photograph 13) Three 25 litre cans labelled ISCEON trichlorofluoromethane (CFC 11) are stored outside underneath the cooling units south of the control tower, adjacent to the drains. Significant amounts of transformers and switchgear exist throughout the site, containing various silicone and mineral oils with the minimal risk of PCB contamination. Four drums of re-claimed transformer oil are awaiting collection by a specialist contractor, who tests them for PCBs and then destroys or recycles them as appropriate. No absorbent material is readily available either here or in the generator houses in the case of a spill.

Underground Janitorial Store

The store is used for the storage of bulk cleaning materials, general purpose de-greaser, fuel additive, epoxy paint, absorbents and granules, urea crystals (used instead of salt as a de-icer on Barrier



Photographs 10 & 11 Filling point for south abutment bulk hydraulic oil tank (A). It is unbunded in an exposed location. Waste oil tank (B) for one of the generators showing leakage of oil to the floor and thence to the drain (C).





Photograph 12 Drums of waste oils, etc, stored in the open in the compound. They are unbunded on block paving. The drums are labelled.



Photograph 13 Drums of oil stored in the north generator house. Any spill would escape into the compound and then either to surface drain or through the paving to ground.

walkways) and cleaning equipment. The Depot Controller reported that he has COSHH sheets for the materials in this store, although these were not inspected.

Visitors Centre - Cleaners Cupboard

Small quantities of cleaning materials are stored in a walk-in cupboard, which also has a sink facility with plumbed hot and cold water. Materials, which included 5 litre containers of bleach and disinfectant cleaners, are kept tidily on shelves. There was just one aerosol container in the cupboard, graffiti remover.

The cupboard was unlocked. This may present a potential risk to safety and/or spillage of chemicals, given the numbers of children that visit the Centre.

Visitors Centre - Storeroom

Larger quantities of cleaning materials are held in a locked storeroom within one of the Portakabins sited alongside the side of the main building. The materials, in 5 litre containers or smaller plastic dispensers, were stacked neatly on metal shelving.

Cafeteria - Store Cupboard

The franchisees keep stocks of cleaning materials on the floor or on shelves within a walk-in cupboard. The chemicals used include dish washer detergent, floor cleaner and toilet cleaners. Generally no more than ten 5 litre containers of any product are held at any one time.

Education Facility

Small quantities of cleaning materials are held in a cupboard within the building.

Herringham Road

Several oil drums are held in the yard area. Two are part full but unlabelled and six are apparently empty. They are not stored in a contained area. Within Store Shed 1 are old batteries, Alcad and lead - acid, in cardboard boxes on the shed floor.

5.7.3 Halons

Plans indicate that Halons are present on most levels in the Control Tower, the local control rooms on each pier, the switch rooms in the piers, and the generator house and transformers. The plans show a total of over 80 bottles. By examination we determined that these places are still protected by

Halons. All the unmanned areas examined include manual lock-off systems for use when operatives are present. It was reported that there had been three accidental releases since the Barrier was commissioned.

Current best practice is to undertake risk assessments to determine where there is a genuine need for fire protection measures. Where such measures are required Halons should be substituted by inert gas or carbon dioxide systems. Early detection systems may remove the need for fire drench protection. (See annex 5)

5.7.4 Use of Herbicides

Use of Herbicides at the site is limited; weed control within the main Barrier compound is carried out on as "as needs" basis. (See Section 5.3) Any herbicide used is approved prior to use by conservation staff.

5.7.5 COSHH

Several supervisors reported that the Administration Officer is responsible for the COSHH records. The Administration Officer holds a file containing the risk assessment for the various substances that had been submitted by individual supervisors. There is no complete list of COSHH substances available. However, it was stated that a COSHH computer database has been generated for initial analysis, although this is not kept up-to-date. The method of recording COSHH substances should be reviewed.

5.7.6 Conclusions

Generally the site is clean and tidy and stores are well maintained and secure. We identified the following good environmental practices:

- the flammable store is clean and tidy, with all materials clearly labelled;
- all oil drums are labelled with their contents;
- waste oil is recycled;
- PPG2 is being complied with for diesel stores; and
- oil absorbents are held on site.

Several issues are identified for further action. We recommend that:

- the design and installation of the new oil tank is approved by Thames Region pollution prevention staff and fully complies with all the requirements of PPG 2;

- all forms of storage comply with the requirements of our own pollution prevention guidelines, including securing all polluting liquid storage facilities (including separate battery store), and bunding all external oil drum storage;
- the bulk delivery points for hydraulic oil are fitted with sumps in lockable kiosks;
- absorbent materials are available immediately adjacent to all potential sources of liquid pollution;
- compliance with COSHH is reviewed and consideration given to the establishment of a single site register for all COSHH records to supplement local records;
- the site's COSHH system incorporates the Environmental Policy on Toxic and Harmful Substances; and
- a risk assessment is made to determine the current requirements for fire protection. Halons should be progressively removed or replaced with more acceptable alternatives.

5.8 WASTE MANAGEMENT

Audit Criteria. Duty of Care for the Disposal of Waste, Waste Management Licensing Regulations, NRA PINs SC/CC/013 and OP/EM/011, best industry practice for the disposal of waste - reduce, reuse, recycle.

5.8.1 Waste Sources

Wastes arising at the facility were identified in the audit and are given in Table 4.

5.8.2 Disposal Practice and Compliance

There is no overall responsibility for waste disposal on the site. Records are not kept in a specific location. We could not adequately determine where responsibilities for the disposal of specific wastes lie nor where the documentation is held, for example waste transfer notes. Consequently not all waste streams on the site were fully audited.

General Waste - Main Site

General rubbish is deposited in two skips, one on the north bank, one on the south bank. The area around the skips was clean and tidy. The waste is removed by Cleanaway Ltd to landfill. The waste is described as Road Sweepings, Cardboard, Paper and Rags on the contract documents (no individual waste transfer notes are raised) and thus excludes some of the wastes that are currently being disposed of in the two skips. We were advised that the disposal arrangements had not been audited as set out in the Code of Practice on the Duty of Care for the Disposal of Waste.

Table 4 Wastes Arising at Thames Barrier Site

	Waste Description	Source	Storage - on Site	Disposal Route
1	General wastes	Main site	North and South Bank General Waste Skips (Cleanaway)	South bank - to Easyload Ltd waste transfer station, Dartford, Earith Haulage waste transfer Station, Earith, or Cleanaway Tunnel Approach waste transfer station, Dartford. Then to various landfills in South East. North bank - to Shanks McEwan waste transfer station, Canning Town and then landfill, Bedford.
2	Drinks cups	Vending machines		
3	Print cartridges	Offices, Visitors Centre		
4	Pollution control materials	Used on main site for spills		
5	Solid dust	Grit blaster in workshop		
6	Oily rags	Workshop, Barrier		
7	General wastes	Visitors Centre	Visitors Centre - Skip (Biffa Waste)	Easyload Ltd waste transfer station, then landfill at Pitsea or Redhill.
8	General wastes	Education Facility	Education Facility - Greenwich Borough Council wheeled bin	SELCHP - incineration with power generation
9	Food wastes - staff restaurant	Staff restaurant	Greenwich Borough Council wheeled bin (food waste only)	SELCHP - incineration with power generation
10	Paper	Offices, Visitors Centre	Store room in basement	Recycled - Maybank plc
11	Batteries	All of site	N Generator House	Specialist waste contractors for reclamation.
12	Waste oil	From site	Stored within marked drums in un-bunded area	Removed for re-cycling by contractor - Associated Reclaimed Oils
13	Sharps	Light bulbs	Separate sharps bin	Specialist contractor
14	De-greasing solvent (paraffin based)	De-greasing cabinet in workshop	In contained unit in de- greasing machinery	Recycled by specialist contractor (SafetyKleen UK)
15	Paint tins (epoxy paint)	Maintenance of Barrier surface	General Waste Skip	Cleanaway (as above) or by painting contractors
16	Aluminium cans	Cafeteria	Bagged on site	Taken to local school for collection

Drinks Cups, Print Cartridges, Pollution Control Materials, Solid Dust, and Oily Rags

Used drinks cups are disposed of in the general waste stream; the site administration is considering the possibility of recycling. Print cartridges from all the site are similarly disposed of, despite the national contract offering a take-back scheme. Industrial materials (pollution control materials, grit blaster dust, oily rags) are also disposed of in the general skips.

Visitors Centre Wastes

All wastes, except paper, batteries and print cartridges, are placed in a skip which is emptied by Biffa Waste Services Ltd. The waste ends up in landfill.

Education Facility Wastes

All education facility wastes are removed by Greenwich Borough Council. Officers of the Borough stated that the waste is incinerated, with power generation, at SELCHP. The facility is soon to use waste heat for district heating.

Food Wastes - Staff Restaurant

Food wastes are disposed of in the Greenwich Borough Council wheeled bin, on the south bank. Final disposal is as for the Education Facility waste.

Paper

Waste paper is removed from the facility for recycling by Maybank. No waste transfer documentation is raised. White paper is not separated out (Section 4.7.1).

Batteries

Batteries from all of the site are collected in the North Generator House prior to removal by specialist contractors, John Robson Metals at Preston and Vinton Metals at Earith, Kent. The waste is treated as special waste with a five part consignment note raised.

Waste Oil

Waste oil from the site is labelled before removal by specialist contractor (Associated Reclaimed Oils) for recycling. While receipts were on file in Planning, they did not constitute formal WTNs.

Sharps - Fluorescent Tubes

Most fluorescent tubes are crushed before removal from the site. They are stored in a designated waterproof bin in the main site compound. However, we observed one tube in the general waste skip on the south bank. We did not check the documentation for this waste stream.

De-Greasing Solvents

Paraffin based degreasing agent (88 % paraffin) is used in a spray degreaser. Disposal of contaminated solvent is by Safety-Kleen UK Ltd, who reclaim and resupply the solvent.

Used Paint Tins

We could not fully determine the disposal route for waste paints. Cans of the epoxy paint were observed in the general waste skip although we were told that this waste is separated.

Aluminium Cans

Cans from the Cafeteria are collected by the franchisee who has them taken to a local school for disposal. The school uses the proceeds for their funds. Cans from the staff canteen are placed in the general rubbish skip.

5.8.3 Waste Disposal Contractors

Several waste disposal contractors are used at the site. They are selected on the basis of being "reputable". We found specifications for waste disposal contractors for the Visitors Centre only. Site staff have not audited nor checked waste disposal or waste management licences of the contractors.

There is no policy on the type of waste disposal facility to be used by waste contractors.

5.8.4 Conclusions

Waste disposal practices are mixed. We identified the following good environmental practices:

- correct disposal of difficult wastes eg PCB contaminated transformer oil, batteries, sharps; and
- recycling schemes in place for waste oil and paper.

Several issues are identified for further action. We recommend that:

- waste management responsibilities are formally identified and allocated to a single, named manager;
- the handling of waste at the site is reviewed to ensure continuing compliance with waste management licensing and the Duty of Care for waste disposal. Specific items include correctly describing the 'general' waste and raising adequate documentation for waste paper and batteries;
- an approved list of waste disposal contractors is produced for site use; and
- the NRA considers a policy on the final disposal of waste from NRA sites to ensure best environmental practice.

ANNEX 1

SITE GEOLOGY, HYDROGEOLOGY AND HYDROLOGY

AND

SITE HISTORY

Prepared by

Environmental Assessment group Ltd

for NRA

ANNEX 1

SITE GEOLOGY, HYDROGEOLOGY AND HYDROLOGY

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1.0 SITE DESCRIPTION

1.1 SITE SETTING

The site comprises two areas of land, located on the north and south banks of the River Thames, adjacent to the Thames Flood Barrier, Greenwich, London (see Figure 1). For ease of reporting the two sites will be described in isolation, where appropriate, in the following sections.

North Site

The site is accessed via an unnamed road which joins the A1020 North Woolwich Road approximately 230m north of the site. The river wall forms the southern boundary of the site, with vacant land, formerly industrial premises, abutting the remaining site boundaries. A scrap yard is located to the immediate east of the site.

South Site

The site is accessed via Eastmoor Street which joins the A206 Woolwich Road approximately 200m south of the site. The river wall forms the northern boundary of the site with modern, as well as older, industrial premises being adjacent to the remaining site boundaries. The wider area to the north of Woolwich Road is industrial in nature, with residential development comprising the principal land use to the south of Woolwich Road. Parks are located to the south of Woolwich Road which link through to the green areas of the Barrier to form part of the Green Chain Walk.

2.0 GEOLOGY, HYDROGEOLOGY AND HYDROLOGY

2.1 Introduction


Desk-based research of the local geology and hydrogeology was carried out by EAG in order to establish the potential for migration of contaminants (if present) onto the site, from adjacent, potentially contaminated, land, or away from the site onto third party land. In particular, an assessment of the surface water and groundwater sensitivity of the area was carried out.

Figure 1.

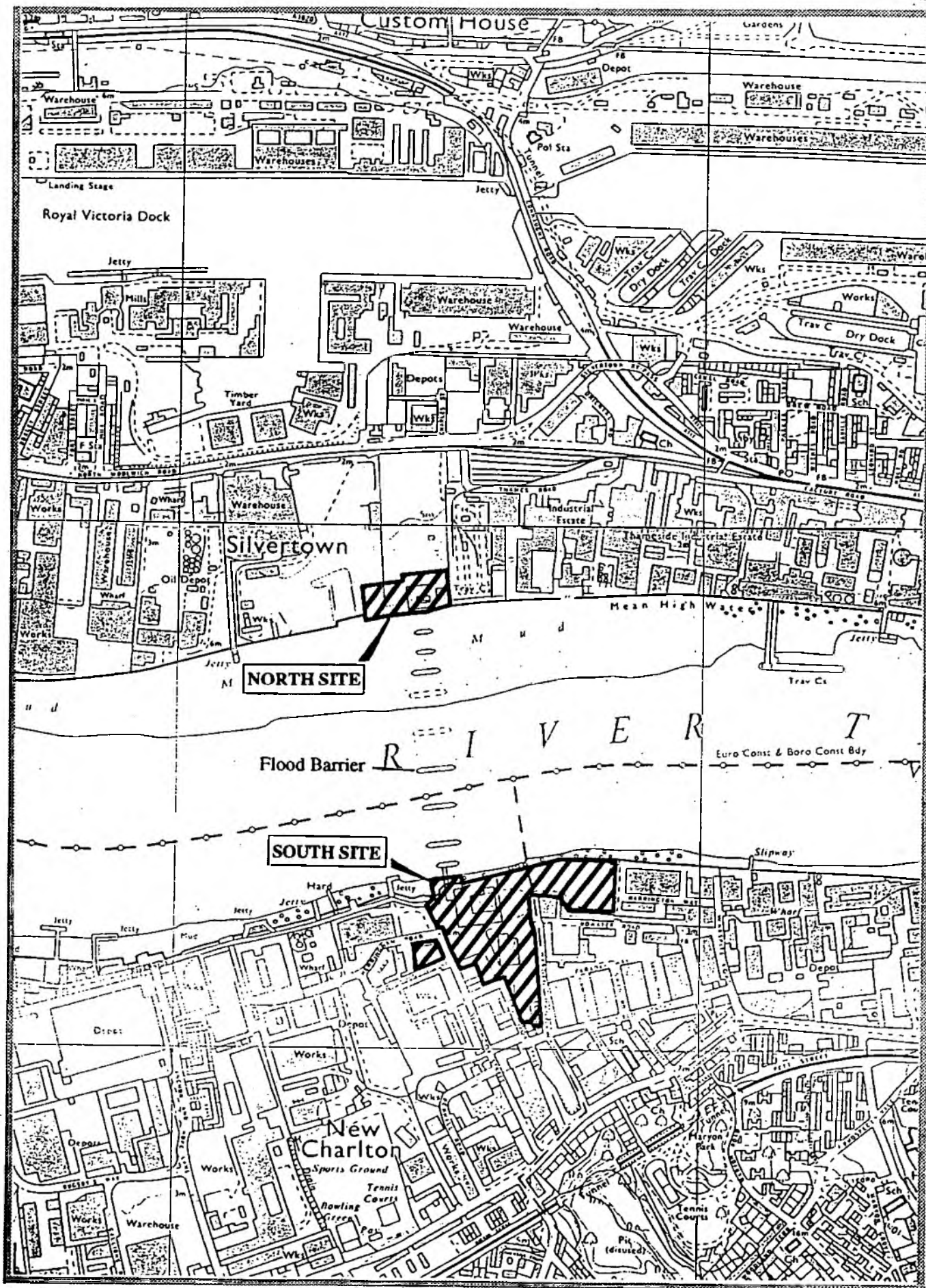
SITE LOCATION.

Scale: 1 : 10,000

Date : November 1995

North 

EAG



2.2 Geology

Information on the geological stratigraphy underlying the site was provided by the NRA namely:

- ▶ geotechnical investigation and report undertaken prior to the construction of the Thames Barrier, published 1978.

Further information on the geological stratigraphy underlying the site was obtained from a number of sources, namely:

- ▶ examination of geological maps and borehole logs published by the British Geological Survey (BGS); and
- ▶ review of the Policy and Practice for the Protection of Groundwater, Thames Regional Appendix, published by the National Rivers Authority (NRA).

North Site

According to BGS Sheet 271 (Dartford), 1:50,000 Series, the site is underlain by alluvial deposits of Alluvium and River Terrace Gravels overlying Thanet Sand, which in turn overlies Upper Chalk. This sequence is confirmed by the report of the geotechnical investigation for the boreholes excavated beneath the in-river barrier piers. However, the geotechnical report does not detail the excavations carried out on either of the north and south banks. From general information on the surrounding area it is considered likely that Woolwich and Reading Beds underlie the alluvial deposits, between the River Terrace Gravels and the underlying Thanet Sand, and that made ground is present beneath much of the surrounding area, typical of former industrial land adjacent to the River Thames.

A borehole log, located 250m north-west of the site at National Grid Reference TQ 412 801, was obtained from the BGS which described the following stratigraphy:

[Note due to the distance of the borehole from the River Thames the depths of shallow strata may not be completely comparable to those beneath the site, particularly with reference to the made ground and alluvial deposits, both of which may be more extensive beneath the site.]

<u>Geological Classification</u>	<u>Strata</u>	<u>Depth (mbgl)</u>
Made Ground	- sand, gravel, bricks and concrete	G.L. - 2.00
Alluvium	- silty, peaty clay	2.00 - 2.30
	- peat	2.30 - 3.75
	- silty very sandy clay	3.75 - 5.40
River Terrace Gravels	- sandy, fine to medium gravel	5.40 - 12.00
Woolwich and Reading Beds	- sandy silty clay with shell fragments	12.00 - 15.00
	- very stiff sandy silty clay	15.00 - 16.10
	- limestone	16.10 - 17.10
	- dense sand with fragments of limestone	17.10 - 18.85
	- very stiff sandy silty clay	18.85 - 19.55
	- gravel with clayey silty sand	19.55 - 20.75
	- clayey very silty fine sand	20.75 - 21.55
Thanet Sand	- very dense silty fine to medium sand	21.55 - 37.90
Upper Chalk	- off-white rubbly chalk with occasional flints	37.90 - 43.50

A second, shallow borehole, was also obtained located 130m north-east of the site and 140m north of the River Thames. The borehole recorded a thin covering of made ground (approximately 1m) overlying 10m of alluvial deposits of Ballast and Sand. Groundwater was encountered at 3m bgl.

In summary, it is considered likely that there will be a variable depth of made ground (fill material) beneath the site. The made ground will be underlain by deposits of Alluvium, including some peat, and River Terrace Gravels. Woolwich and Reading Beds, (sandy silty clays with limestone) are thought to be present beneath the alluvial deposits overlying the Thanet Sands. The Upper Chalk is present at approximately 30m below ground level.

South Site

According to BGS Sheet 271 (Dartford), 1:50,000, the site is underlain by alluvial deposits of Alluvium (including Peat layers) and River Terrace Gravels. These drift deposits are directly underlain by Upper Chalk at a depth of approximately 20m bgl. Sand, Chalk and Gravel deposits have been excavated approximately 300m south of the site (to the south of the Woolwich Road) and in the absence of any evidence to the contrary it is not thought likely that either Woolwich and Reading Beds or Thanet Sand Deposits are present beneath the site. However, due to the riverside location of the site and from anecdotal information provided by Greenwich Borough Council (Environmental Health Department), it is probable that there will be made ground of variable depth beneath the site.

A borehole log, located 80m south of the River Thames adjacent to the east of Hardens Manor Way, i.e. <20m from the centre of the site, was obtained which described the following stratigraphy:

<u>Geological</u> <u>Classification</u>	<u>Strata</u>	<u>Depth (mbgl)</u>
Made Ground	- concrete	G.L. - 0.20
	- not described	0.20 - 2.20
	- concrete floor	2.20 - 2.80
Alluvium	- clay and peat	2.80 - 5.35
	- mottled clay	5.35 - 6.45
	- peat	6.45 - 9.75
	- mottled clay	9.75 - 10.70
	- peat	10.70 - 11.80

	- ballast	11.80 - 13.10
	- running sand	13.10 - 13.70
	- ballast	13.70 - 16.70
Upper Chalk	- chalk with flints	16.70 - 18.20

2.3 *Hydrogeology*

Specific groundwater information was not contained within the geotechnical report provided by the NRA. However, more general information was provided by the NRA Scientific Department, reference to the Policy and Practice for the Protection of Groundwater (Thames Region Appendix) and gained from general experience of the area. At the time of writing, the Groundwater Vulnerability Map for the area was not available to EAG.

North Site

There is no definite classification for the Alluvium deposits beneath the site, but due to their continuity with the underlying River Terrace Gravels, which are classified as a minor aquifer, it is considered that the alluvial deposits as a whole should be considered as a minor aquifer. The alluvial deposits will be water bearing and likely to be in hydraulic continuity with surface water in the River Thames, or groundwater in the saturated zone surrounding the river.

The Woolwich and Reading Beds, if present beneath the site, are classified as a non-aquifer, but may well be locally water bearing. Despite the high silty clay content of these deposits they are not considered to be impermeable and would not act as an effective aquiclude between the shallow groundwater and the underlying chalk aquifer.

The Thanet Sand deposits are classified as a minor aquifer and will be in hydraulic continuity with the Chalk aquifer beneath.

The underlying Chalk deposits are classified as a major aquifer and are the source for potable abstractions in the east London areas of Deptford and East Ham.

In summary, there are likely to be shallow water tables beneath the site, dependent upon made ground conditions, the thickness of Alluvium, River Terrace Gravel and the presence of Woolwich and Reading Beds. The shallow groundwater is likely to be in hydraulic continuity with both the adjacent River Thames and the underlying major aquifer within the Upper Chalk.

South Site

The alluvial deposits are similar to those beneath the north site and would hence be expected to be water bearing, classified as a minor aquifer and in some degree of hydraulic continuity with the River Thames. Additionally in the absence of any other underlying deposits, the shallow groundwater within the Alluvium and River Terrace Gravels will be in direct continuity with the major aquifer in the Chalk deposits below.

Groundwater Abstractions

From consultation with the NRA (Thames Region), there are two licensed groundwater abstractions within 2km of the site. Both abstractions are from the Chalk aquifer on the south side of the River Thames. The first is 2km east of the south site and used for Public Baths and the second 1km west of the south site and used for gravel washing and concrete production.

According to the NRA, neither the north or south sites lie within a Zone 1 or a Zone 2 Groundwater Protection Zone for public purposes.

2.4 Hydrology

Information concerning the surface water regime in the area of the site was provided by the NRA Thames Region.

Both the north and south sites border the River Thames. The river is tidal at this point and has a water quality classification of B (fair) under the scheme for classifying estuaries (1990 River Quality Survey).

There are fourteen consented and fourteen revoked discharges to the River Thames (current and revoked) held within 2km of the site. Table 1 overleaf outlines the details of the discharges:

Surface Water Abstractions

According to information obtained from the NRA, there are three surface water abstractions from the River Thames within 2km of the site. Two of these are located approximately 1km upstream of the site and used for sand/gravel washing and dust suppression. The downstream abstraction is located 800m east of the site and is used for cooling purposes.

TABLE 1.0: DISCHARGE CONSENTS (CURRENT) WITHIN 2KM OF THAMES FLOOD BARRIER		
Grid Reference	Name	Type
Upstream		
TQ4030 7930	St Albans Sand and Gravel Company Ltd	Sewage Effluent
TQ3900 7911	Tunnel Refineries	Trade Effluent, process water (from sugar and starch refining)
TQ3925 8125	Pura Foods Ltd	Trade Effluent, cooling water, and surface water
TQ3900 8100 TQ3944 8131	Docklands Light Railway	Site Drainage
TQ4044 7915	Bardon London Ltd	Site Drainage
TQ4128 7929	Thames Water	Sewage Effluent - Storm Sewage
TQ4060 7920	Murphy and Sons	Trade Effluent (Run-off) cement site
TQ4060 7920	Tarmac Roadstone	Trade Effluent (mineral working effluent)
Downstream		
TQ4240 7980	Tate and Lyle Sugars	Trade Effluent (cooling water)
TQ4373 7980	Thames Water	Sewage Effluent - Stone Sewage
TQ4292 7974	Thames Water	Sewage Effluent - Stone Sewage
TQ4320 7974	Thames Water	Sewage Effluent - Stone Sewage
TQ4330 7930	Woolwich Leisure Centre	Site Drainage
TQ4370 7990	Hastingwood Construction Ltd	Site Drainage

2.5 *Significance of Geology, Hydrogeology and Hydrology*

The site (both sides of the river) is considered to be located in a sensitive groundwater area. The expected hydraulic continuity between the shallow groundwater and the underlying chalk deposits would facilitate the vertical migration of site derived contaminants, if present, into the major Chalk aquifer. Although the site is not located within a groundwater source protection zone, the Chalk aquifer is abstracted within 2km of the site and provides potable supplies to areas of London further to the east. The shallow strata and associated groundwater could also allow horizontal migration of mobile contaminants either beneath the site from off-site sources, or from the site onto third party land.

Similarly the site is considered to be located in a sensitive surface water area, due to the adjacent proximity of the River Thames. Although water quality in the Thames is only classified as B (fair) at present and there are several consented discharges within 2km of the site, the NRA is seeking an improvement in the water quality in the river at this point, to a level *"passable to migratory fish; maintenance of a euryhaline fish population; maintenance of a commercial eel fishery; aesthetically pleasing appearance."* The likely hydraulic continuity between shallow groundwater beneath the site and the surface water in the river, as well as the possibility of surface run-off entering the river directly, would allow the migration of mobile contaminants, if present on or beneath the site, into the river adversely affecting the water quality. However, the presence of the river wall, on both sides of the River Thames may serve to reduce or prevent such migration.

3.0 *POTENTIAL FOR CONTAMINATION*

3.1 *Introduction*

The site history has been researched by reference to Ordnance Survey (County Series and National Grid) maps and by referring to the site's planning history and other archive material, in order to assess the potential for ground contamination from previous industrial land uses. Where distances from the site have been estimated, they represent the distance between the nearest boundary of the site and the closest boundary of the stated land use.

3.2 Historical Development

North Site

County Series First Edition 1869

The site was occupied by a petroleum works, located on the western part of the site, with a second petroleum works located 150m north-west. A wharf was present 130m west of the site beyond which there was an area of marshland adjacent to the river. Land adjacent to the north and east of the site was undeveloped and appeared to be in greenfield use, with drainage ditches present at the surface. North Woolwich Road was present in its current configuration located 230m north of the site. Silvertown station was located 700m east, and a railway line was present, commencing at North Woolwich and the Woolwich Ferry located 2km east, before continuing in a north-westerly direction. A small amount of residential development had taken place 500m east of the site, adjacent to Silvertown Works (Indian Rubber, Gutta Percha and Telegraph Works). Other industry in the surrounding area included:

- ▶ iron works 360m north-west and 500m east;
- ▶ Victoria Dock Gas Works 1km east;
- ▶ paraffin oil stores 1.5km west;
- ▶ manure works 1.7km west-north-west;
- ▶ chemical works 1.6km west-north-west; and
- ▶ sugar refining works 1.6km west-north-west.

Graving Dock and Victoria Dock were present 400m north-west and 650m north respectively.

County Series Second Edition 1897

The site had been redeveloped as a chemical works and considerable industrial and residential development had taken place in the surrounding area. Prince Regents Wharf Chemical Works was located adjacent to the west of the site and included a reservoir situated on the previously marshy area now reclaimed land. A number of tanks were located on or adjacent to the western part of the site. A railway had been constructed on the southern side of North Woolwich Road, and a

number of rail lines were present on the site itself. The wharf to the west remained in its previous configuration on-site, and two jetties were present extending into the River Thames from the site.

A colour works was present 70m to the north-west of the site which included several ponds. The land to the immediate east of the site remained largely in greenfield use, with the exception of one building (not identified) present 100m north of the site, adjacent to the east of which were rail sidings, on the southern side of North Woolwich Road.

Other industry in the surrounding area was concentrated on the banks of the river and included the following:

- ▶ Crescent Wharf 400m west;
- ▶ varnish works 520m west;
- ▶ Indian Rubber, Gutta Percha and Telegraph Works 500m east;
- ▶ sugar refinery 650m east and 1.2km west;
- ▶ gas works 1km east;
- ▶ sewage works 1km east;
- ▶ chemical works 1.3km east;
- ▶ composition works 550m north-east;
- ▶ chemical manure works 1.2km west;
- ▶ chemical works 1.2km west;
- ▶ Peruvian Guano works 1.2km west;
- ▶ soap works 1.3km west; and
- ▶ oil works 1.2km west.

A number of warehouses were present 700m north-west of the site on the southern side of Royal Victoria Dock. Residential properties had been constructed 250m north of the site, on the northern side of North Woolwich Road.

County Series Third Edition 1920

The site itself remained in a similar configuration to that shown in 1897. Prince Regents Wharf remained to the west of the site, and a number of tanks and travelling cranes were present on the site and on land adjacent to the west of the site. The reservoirs present to the west of the site were

smaller than in 1897. Pitch beds had been constructed on or adjacent to the western part of the site, next to Princes wharf.

Considerable industrial development had taken place in the immediate vicinity of the site, including Wards Wharf immediately east of the site, a radiator works 120m east, a jam factory 300m east, and a sack factory 250m north-west. The rail sidings located to the south of North Woolwich Road, 150m north-east of the site were identified as a goods and coal depot. The colour works present 70m to the north-west of the site was identified as the British Alizarine Works. The land 300m west of the site was occupied by a number of buildings and tanks (and would appear to have been an oil depot). A timber yard was located 400m north of the site. Industry in the surrounding area remained approximately in the same configuration as in 1897. Gasometers were still present 1km east, though the gas works was no longer identified as such.

County Series Revised Edition 1935

The site and surroundings were in similar configuration to that in 1920.

National Grid Edition 1959

The site remained occupied by a works, including several buildings and tanks, and an on-site rail system. Land to the west of the site was also occupied by a works, with an extensive rail system, and what appeared to be a tank farm. One building was marked as a ruin. The reservoirs previously located to the west of the site had been infilled, and buildings had been constructed in their place. Prince Regents Wharf was still present but was not marked as such. The pitch beds previously located on or adjacent to the western part of the site were no longer present.

A works and a tank farm were present 250m west of the site. Land uses to the immediate east of the site were unchanged, comprising a works and rail sidings. A factory was located 300m to the west of the site, on part of the site of the former "British Alizarine Works".

The surrounding area remained predominantly industrial, and residential properties previously located 500m east had been replaced by a depot and works. Part of Pontoon Dock (previously named Graving Dock) located 400m north-west had been infilled, and a depot was present on the site of a former sack factory located 250m north-west.

National Grid Edition of 1968

The site appeared to be in a similar configuration to that in 1959, being occupied by a chemical works with Prince Regents Wharf adjacent to the west occupied by a works and a tank farm.

A cake mill (animal foods) factory was on the site of the former Alizarine works, 300m west of the site. Rail sidings remained to the north-east of the site. The surrounding area was occupied almost entirely by industrial premises, and included the following:

- ▶ timber yard 250m north-north-west;
- ▶ joinery works 280m north;
- ▶ flour mill 420m north;
- ▶ depot 300m north;
- ▶ warehousing 450m north; and
- ▶ corn mill 350m north-north-west.

National Grid Edition of 1973/74

The site and much of the adjacent surrounding land was undeveloped, with the exception of a small works located 100m west of the site. No railway lines were present on the site itself. The wharf remained in its previous configuration to the west of the site.

A scrap yard was present to the immediate east of the site, beyond which several warehouses were located.

Minoco Wharf (an oil depot) was present 250m to the west of the site. The wider area appeared to remain in industrial use, including the following:

- ▶ aluminium foil works 480m west;
- ▶ timber yard 240m north;
- ▶ transport depot 400m west; and
- ▶ varnish works 670m west.

National Grid Edition of 1983

The Thames Flood Barrier had been constructed, and a small building was present on site adjacent to the barrier. The wharf to the west was no longer present, and appeared to have been in-filled. A building was present 200m to the west of the site, to the north of where ponds were previously located. A car park was located to the north of the site.

The scrap yard present to the immediate east of the site was identified as a works, and a travelling crane was also present. A warehouse was present 150m to the north-west of the site, on the site of the former animal food stuffs factory. The rail sidings remained 150m north-east, and the railway was still present along the southern side of North Woolwich Road.

The wider area remained predominantly industrial, with the exception of new residential development which had taken place 1.6km north-east.

National Grid Edition of 1989

The site remained unchanged from the plan of 1983. A car park was present to the north-east of the site.

A works (and travelling crane) remained to the immediate east of the site. The railway was no longer present along North Woolwich Road, although some rail sidings were still present 150m north-east of the site. A warehouse remained 150m north-west of the site.

Considerable redevelopment had taken place in the wider area. Warehouses previously located 260m north, alongside Royal Victoria Dock, had been demolished. Considerable residential development had taken place 1.6km north-east. London City Airport had been constructed, with the runway present 800m east-north-east on the strip of land between Royal Albert Dock and King George V Dock.

South Site

County Series 1st Edition 1869

The site was occupied by a number of differing land uses, namely:- a telegraph works located adjacent to the River Thames, mid-way along the bankside area of the site; Harrington Saw Mill located adjacent and to the south of the telegraph works; Nightingale Dairy located at the eastern end of the site, south of Harrington Road; terraced residential properties covering the majority of the southern part of the site. Vacant land occupied the remainder (majority) of the bankside area of the site and extended along the river to the east and west. Berths for the Marine Society were present on-site adjacent to the telegraph works.

The surrounding area was occupied by residential properties and vacant land. Saw Pits were present 220m south-east of most easterly part of the site and a pumping station 240m south of the site. Greenwich and Woolwich Lower Road (present day A206 Woolwich Road) was present 200m south of the site. Sand and Chalk pits were located to the South of the Greenwich and Woolwich Lower Road, beginning 220m south of the site and extending south-eastwards. The remains of a Roman Camp were shown 300m south of the site. The South-Eastern Railway line was located 290m south of the site, passing underground in places.

County Series 2nd Edition 1894-1896

The north-eastern part of the site was wholly occupied by an extensive telegraph works, which extended to the east, adjacent to the River Thames, for a further 200m. The saw mill, dairy, Marine Society Berths and original telegraph works, formerly on this part of site, were no longer present. The north-western part of the site remained as vacant land, except for a timber yard located across north-western boundary. The remainder of the site (southern part) was occupied by residential properties, which continued to the south of the site. Land to the west of the site was largely unoccupied except for a few small areas of residential development. To the west of the site, on the bank of the River Thames was Telegraph Wharf, 130m west, and Silicate Paint Works, 260m west, with vacant land in between. An iron foundry was present 100m west of the southern part of the site with vacant land beyond. A school was present 330m south-east of the site. To the south of Woolwich Road some of the former sand and chalk pits were shown as Maryon Park,

whilst others were still shown as pits 230m south-east of the site. Two churches were located 220m south-east and 250m south of the site.

County Series 3rd Edition 1916 (Partial Coverage Only)

The telegraph works remained on the north-west part of the site, and had expanded to the south over formerly vacant land adjacent to the east of the southern part of the site. A school as present 150m south-east of the site and allotment gardens were shown 100m to the west. The site and the remainder of the surrounding area (where covered) appeared to be largely unchanged from the second edition plans.

County Series Revised Edition 1935

The former telegraph works present on-site was shown as an Electrical Engineering Works and had expanded further to the south, east, and also to the west, occupying the north-western part of the site adjacent to the River Thames. The works extended further to the west across the former Timber Yard and Telegraph Wharf. A petrol storage depot, including several above ground storage tanks was present 170m west of the site, between the electrical engineering works and the silicate paint works. Residential properties remained on the southern part of the site, with two Public Houses situated close to the centre of the site. Engineering works were present 20m to the west and south-east of the site, with the former iron foundry to the west of the site no longer shown. Land further to the west remained undeveloped, but was no longer shown as allotment gardens. Industrial buildings were present 200m east of the southern part of the site, and the Commonwealth Buildings were shown approximately 400m east of the site. Industrial buildings were also present 200m south-south-east of the site. The area to the south of Woolwich Road remained largely unchanged.

National Grid Editions 1954-55

The site was largely occupied by Siemens Electrical works as shown on the County Series Revised Edition. The residential properties, formerly covering the majority of the southern part of the site, had been demolished to a great extent, the area being occupied by vacant land and a few remaining residential properties. Adjacent to the west of the site, alongside the River Thames, was Thames Wharf, occupied by a Flint Glass Works (formerly part of the electrical engineering

works). The petrol storage depot and silicate part works remained to the west of the flint glass works. Two iron foundries were present 250m and 300m west of the site, with a large slag heap located 250m west of the southern part of the site. Adjacent to the western boundary of the southern part of the site were a garage, two engineering works, a furniture works and a Jam Factory. The bankside area to the east of the site was shown as Pepper and Spice Wharf and included ruins (possibly of the power electrical engineering works located on this area), an electrical sub station and Asphalt Wharf further to the east.

National Grid Edition 1962

The northern part of the site was wholly occupied by a works which extended to the south and east, adjacent to the east of the southern part of the site, which was occupied by vacant land and residential properties. Surrounding adjacent land uses to the south and west were mainly industrial and appeared not to have altered markedly from the 1954-55 editions. A sports ground was present 300m west-south-west of the site. The former sand and chalk pits to the south of Woolwich Road appeared to no longer be in use and partially infilled. In the wider area industrial development dominated the land use between Woolwich Road and the River Thames to the east and west of the site.

National Grid Editions 1968-76

Siemens electrical works was no longer labelled and some buildings were no longer present. However, the majority of the buildings remained on site. Five large above ground tanks were present on the north-east corner of the site. The southern part of the site was occupied by industrial buildings and vacant land. Alongside the River Thames to the west of the site were the flint glass works (adjacent), Riverside (petroleum) Wharf (200m west), depot (300m west) and a foundry (350m west). The silicate part works was no longer shown. Several works were present to the south of these premises i.e. to the west of the site. Adjacent to the west of the site were a works, warehouse and a factory. To the south of the site (<20m) was a cable yard. An engineering works remained 20m south-east of the site. The former slag heap to the west of the site was no longer shown. Maryon Park to the south of Woolwich Road, had extended westwards over some of the former sand and chalk pits.

National Grid Editions 1982-1985

The Thames Flood Barrier had been constructed and the site was occupied by associated buildings and car parks. The industrial area to the east of the site had been redeveloped and included several new light industrial or warehouse units. The former engineering works south east of the site had also been redeveloped. The former cable yard to the south of the site remained unoccupied. Land to the west of the site remained in industrial use as works and warehouses. Reservoirs were present 500m south-west of the site adjacent and to the south of the Sports Ground.

National Grid Editions 1988-1995

The site remained occupied by buildings associated with the Thames Flood Barrier. The area to the east of the site continued to be redeveloped for light industrial or warehouse use. The former cable yard south of the site remained unoccupied and land to the west of the site was unchanged. In the wider area the land to the north of Woolwich Road and remained in industrial use with residential properties continuing south of the road. Maryon Park and disused pits also remained to the south of Woolwich Road.

3.3 Local Authority Research

The planning departments of Greenwich Borough Council (GBC - South Site) and the London Docklands Development Corporation (LDDC - North Site) were contacted to establish a planning history for the site.

North Site

LDDC, the planning authority for the site area since 1981, confirmed that there were no planning applications on record, relevant to the site. The planning department, however, noted that they were expecting an application to be made, early in 1996, for the restoration to parkland of part of the site and the surrounding area to the north and west.

South Site

GBC supplied details of a number of planning applications made at the site since 1985 (the earliest record). The applications concern mainly minor alterations and additions to the existing NRA facilities, for example road surfacing, temporary car parking, temporary exhibitions, pedestrian access gates, signs, Hallets Panorama. However, three of these applications, dated 1988, 1991 and 1993, have included provisions for earthmounding and landscaping. The most recent of these applications (1993) included the removal of contaminated soil. A number of other applications concern the installation and subsequent alterations to the telecom Securicor Radio for Cellnet Antenna also on-site.

London Waste Regulation Authority (LWRA) was requested to carry out a search for current and previously licensed landfills within 500m of the site. These records do not include landfills operated prior to 1974. No records of licensed landfills within 500m of the site were found.

3.4 Other Issues

North Site

A request for information concerning the site and nearby properties was made to the Environmental Health Department (EHD) of Newham Borough Council.

The site has no authorisations to operate Part A or B scheduled processes. In addition, there have been no complaints made to the Local Authority, about the site, relating to nuisance caused to neighbouring premises (e.g. noise, dust, smoke). There are three Part B prescribed processes within 500m of the site. These are listed below.

Brett Fairlops Concrete
Unit 8, Thames Industrial Estate
Thames Road
Silvertown
E16 4AV

G&G Powder Coatings Limited
Unit 2a, Thames Road Industrial Estate
Thames Road
Silvertown
E16 2EZ

Tarmack Topmix Limited
Site 12
Thames Road
Silvertown
E16

The EHD was not aware of any private (unlicensed) water abstractions within 2km of the site or of any licensed landfill operations having taken place within 500m of the site. However, in-filling of most of the bankside area is known to have taken place historically (circa 1870 onwards), notably the in-filling of the former Graving Dock to the west of the site.

Much of the land surrounding the site, and beneath the site, was described as being 'grossly contaminated' following a prolonged history of industrial development. The land adjacent to the north and west of the site is owned by the London Docklands Development Corporation (LDDC) who are understood to wish to develop the area for residential and open space (parkland) use, including part of the NRA site. This area is at present covered by a layer of crushed concrete.

It was noted that an unexploded wartime bomb is known to be present beneath the LDDC land, the position of which remains undiscovered despite several attempts to locate it.

South Site

Discussions were held, concerning the site, with an officer at the Environmental Health Department (EHD) of Greenwich Borough Council, who has specialist knowledge of the site area. The EHD provided the following information.

The site has no authorisations to operate Part A or B scheduled processes. In addition, there have been no complaints made to the Local Authority about the site relating to nuisance caused to neighbouring premises (e.g. noise, dust, smoke).

The nearest registered Air Pollution Control (APC) authorised process is at Essex Replica Car Ltd, located approximately 250m south-south-west of the site, adjacent to Woolwich Road and Westmoor Street. The premises operates a furnace in connection with on-site iron foundry. The EHD were not aware of any unlicensed private water abstractions in the vicinity of the site.

The EHD confirmed that the site was operated by as a Telegraph Works by Siemens Ltd (cable manufacturers) from at least the early 1900s until 1968. The site produced a range of cables, including military cabling during World War Two. The manufacturing process involved the use of large quantities of metal, especially copper, but also the use of lead baths, and bitumen coating processes. The former cable yard to the south of the site was subject to a contaminated land investigation, undertaken by the Greater London Council (GLC), prior to development of the area as a greenfield site (park) in the 1980's. The investigation was limited to shallow trial pitting techniques, but highlighted significantly elevated metal concentrations within the surface layers. The area was subsequently classified a derelict land and received a derelict land grant in July 1988. The area was capped with 'clean' topsoil in order to allow vegetation growth.

The underlying geology for the area was confirmed as sandy alluvial drift directly overlying the chalk beneath. It is known that land near to the river wall was historically marshy and subject to Victorian in-filling operations prior to initial development. The marshy deposits in the area are known to produce methane which is actively venting from the Commonwealth Buildings approximately 300m east of the site. However, although initial methane concentrations and flow rates are normally high when recorded via installed wells, they are known to drop off to safe levels in a relatively short space of time.

The EHD were not aware of any licensed landfilling operations within 500m of the site, but as mentioned above, suggested that Victorian in-filling would be likely to have taken place behind the river wall. It is also possible that minor filling operations have taken place more recently in the area, for instance by the GLC.

3.5 Summary of the Potential for Contamination

North Site

The site history research has shown the site to have been put to a number of uses which could have led to significant soil and groundwater contamination, namely; a petroleum works (approximately 1869-1897); chemical works (approximately 1897-1973/4) which included several above ground storage tanks; pitch beds.

The site appears to have been undeveloped from the early 1970s to the early 1980s, during which time the site and surrounding area are thought to have been used as a construction site for the Thames Flood Barrier.

In the surrounding area there has been a diverse range of industrial land uses including, in close proximity to the site; a petroleum works, chemical works, colour works, Alizarine works, oil depot, scrap yard, timber yard, varnish works, coal depot.

Anecdotal evidence provided by Newham Borough Council EHD, and from map evidence, would suggest that the area surrounding the site suffered from wartime bomb damage. Land filling operations are also known to have taken place alongside the River Thames, notable to the west of the site at the Former Graving Dock and the former marshy area further to the west of the site.

Consequently there is considerable potential for soil and groundwater contamination to have occurred, beneath the site and neighbouring properties, via a range of organic and inorganic compounds. These may include; coal tar, phenols, hydrocarbons, cyanide, sulphate, sulphide, elemental sulphur, volatile aromatic compounds, asbestos, polychlorinated biphenyls, ammonia and elevated acidity. There is also the potential for there to be elevated concentrations of landfill gases in the ground beneath the site, derived from natural peat deposits or from historical landfilling operations.

South Site

The site history research has shown the site to have been occupied by a Telegraph Works and subsequently an Electrical Engineering works from at least 1869 to 1968. Part of the site was occupied by a saw mill in 1869, and five above ground storage tanks were shown on site in 1968. The site was redeveloped to its current user associated with the Thames Flood Barrier, by 1982.

In the surrounding area a variety of industrial uses have been present since the late 1800's, notably; timber yard; Silicate paint works; petroleum storage depot, various engineering works; iron foundries; glass works; Asphalt Wharf; slag heap; electrical sub-station.

The EHD of Greenwich Borough Council highlighted the known metal contamination of land adjacent to the south of the site, a former cable yard. The possibility of elevated landfill gas levels in the area, which have been recorded on nearby sites, was also raised.

There is consequently the potential for both soil and groundwater contamination to be present beneath the site and in the surrounding area. The range of potential contaminants would be similar to that suggested at the north site, with the additional likelihood of elevated metal concentrations also being present beneath the site. Again, similarly to the north site there is also the potential for there to be elevated concentrations of landfill gases in the ground beneath the site, derived from natural peat deposits or from historical landfilling operations.

3.6 Recommendations

Given that there is considered to be considerable potential for soil and groundwater contamination beneath the site, and the identified sensitive environmental setting of the area, it is recommended that further intrusive site investigations are carried out in order to quantify the actual levels of contamination, if any, present beneath the site.

ANNEX 2

**CONTAMINATED LAND PROPOSAL FOR
PHASE II INVESTIGATION**

Prepared by

Environmental Assessment group Ltd

for NRA

THAMES BARRIER SITE INVESTIGATION PROPOSALS

NORTH SITE

Sources of Contamination

Main sources of potentially significant contamination identified off-site, adjacent to the site:

- ▶ north and west - major former chemical/gas works;
- ▶ north-east and east - scrapyard.

A portion of the site itself previously formed part of the chemical works.

Potential Contaminants

Potential contaminants include:

- ▶ solvents;
- ▶ semi-volatile organics (including Polynuclear Aromatic Hydrocarbons (PAHs), Phenols);
- ▶ Polychlorinated Biphenyls (PCBs);
- ▶ cyanides;
- ▶ ammonia, sulphates, sulphides;
- ▶ toxic and phytotoxic metals;
- ▶ acids and alkalis;
- ▶ land gases (methane, carbon dioxide and other volatiles).

Many of these are mobile in the environment and could therefore be migrating beneath the site.

Possible Risks

Although there is some potential for part of the site to be contaminated due to previous on-site activities, the main concern is over migration onto the site from off-site sources.

Possible risks include migration into River Thames via the NRA site and health risks to workers in subterranean voids/tunnels.

Recommended Investigation

Focus on groundwater and land gas monitoring with some soil analysis:

The suggested investigation is as follows:

- ▶ installation of 4 permanent ground/water/gas monitoring wells to depths of approximately 10m bgl;
- ▶ excavations of 6 power auger holes to depth of approximately 3m;
- ▶ analysis of 4 groundwater samples and 18 soil samples for the contaminants listed above. (Not every sample would be analysed for every parameter).
- ▶ repeat land gas monitoring on four separate occasions.

SOUTH SITE

Sources of Contamination

On and off-site sources of potentially significant contamination identified, as follows:

- ▶ the site itself was previously used as a telegraph (or cable) works and later as an engineering works;
- ▶ off-site sources include, nearby sawpits, paints works; iron foundry; petrol storage depot; glass works; furniture works.

Potential Contaminants

Potential contaminants include:

- ▶ toxic and phytotoxic metals;
- ▶ bitumen;
- ▶ semi-volatile organics (including PAHs);
- ▶ volatile organics (petroleum products and solvents);
- ▶ PCBs;
- ▶ cyanides, sulphates;
- ▶ acids and alkalis;
- ▶ land gases.

As with the North Site, several of these contaminants may be mobile in the environment and thus there is the potential for on and off-site migration.

Possible Risks

The South Site differs from the North Site in that in addition to the potential for contaminants from off-site source, there is also a strong potential for the site to have been affected by contamination due to previous on-site activities. There is thus the possibility for mobile contaminants from the site to migrate off-site, towards the River Thames or onto third party land. In addition, there are potential health risks to on-site workers, particularly those in subterranean tunnels.

Recommended Investigation

Focus on groundwater and land gas monitoring but, given that the site is relatively large and that on-site sources of contamination may be present, more soil sampling and analysis is proposed compared with the North Site.

The suggested investigation is as follows:

- ▶ installation of 4 permanent groundwater/gas monitoring well to depths of 10m bgl;
- ▶ excavation of 15 power auger holes in part of the site where the potential for historic ground contamination has been identified;
- ▶ analysis of 4 groundwater and 30 soil sample for the potential contamination identified above (not every sample would be analysed for each parameter);
- ▶ analysis of selected soil samples for leachable contaminants (mainly non-organic parameters) using the NRA leach test method; and
- ▶ repeat land gas monitoring in four occasions.

ANNEX 3

ENERGY USE REPORT

THAMES BARRIER

Prepared by

Environmental Assessment group Ltd

for NRA

**Energy Survey, Thames Barrier, Operational Area
Eastmore Street, Charlton, London**

National Rivers Authority

EAG
Environmental Assessment Group Limited
January 1996

Project No:

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Report Status:

FINAL DRAFT

Project Manager/Author
(signature):

D. Denley.

Approved
(signature):

Date:

16.1.96.

This report has been prepared by Environmental Assessment Group Limited (EAG) with all reasonable skill, care and diligence, and taking account of the manpower and resources devoted to it by agreement with the client. This report is confidential to the client, and Environmental Assessment Group Limited accepts no responsibility whatsoever to third parties to whom this report, or any part thereof, is made known, unless formally agreed by EAG beforehand. Any such party relies upon the report at their own risk.

EAG disclaims any responsibility to the client and others in respect of any matters outside the agreed scope of the work.

CONTENTS

	Page
1.0 INTRODUCTION	1
2.0 SITE INFORMATION	2
2.1 Site Location	2
2.2 Barrier Description	2
2.3 Floor Areas	2
3.0 MANAGEMENT SUMMARY	3
3.1 Summary of Energy Savings	3
3.2 Major Conclusions and Recommendations	4
3.3 Management Summary	8
4.0 SURVEY FINDINGS	13
4.1 Energy Consumption	13
4.2 Energy Intakes	16
4.3 Building Performance Indicators	17
4.5 Electrical Distribution	18
4.6 Lighting Installations	19
4.7 Heating and Ventilation Systems	22
4.8 Combined Heat and Power	25
4.9 Building Management Systems (BMS)	26
4.10 Building Condition Survey	26

APPENDIX 1 - Floor Plans

APPENDIX 2 - Energy Calculations

APPENDIX 3 - Thames Barrier Electricity Consumption

APPENDIX 4 - Electrical Maximum Demand

APPENDIX 5 - Energy Efficiency Office Performance Criteria

APPENDIX 6 - Thames Barrier Operational Parameters

APPENDIX 7 - Electric vs Gas Fired Boilers

APPENDIX 8 - London Electricity Invoices

1.0 INTRODUCTION

Environmental Assessment Group Limited (EAG) was commissioned by the National Rivers Authority (Environmental Policy Unit) to undertake an energy survey at the Thames Barrier, Operational Area, Eastmore Street, Charlton, SE7 5LX.

The objective of the survey was to provide an audit of site energy usage, identify areas of potential cost savings, provide estimates of potential annual energy savings with implementation costs and payback periods and identify how methods of energy management should be developed to achieve, maintain and recognise further potential savings.

This report presents the results of EAG's investigation. The survey comprised the following:

- ▶ research of existing site documentation, drawings, operating manuals, previous survey reports, energy billing and tariff documentation and documented energy management procedures;
- ▶ site visits¹;
- ▶ interviews/discussions with site operational representatives²;

EAG reviewed the documents necessary to reach conclusions regarding the site's energy consumption and identify potential cost saving areas. While EAG did not identify anything that contradicted the information provided, and EAG has no reason to doubt the information provided to us, this report is complete and accurate only to the extent the information provided to us was complete and accurate.

¹ By David Denley, John Harvey and Roger Meads.

² Trevor Noyes, Peter Hull and Rex Bobc.

Figure 1.

SITE LOCATION.

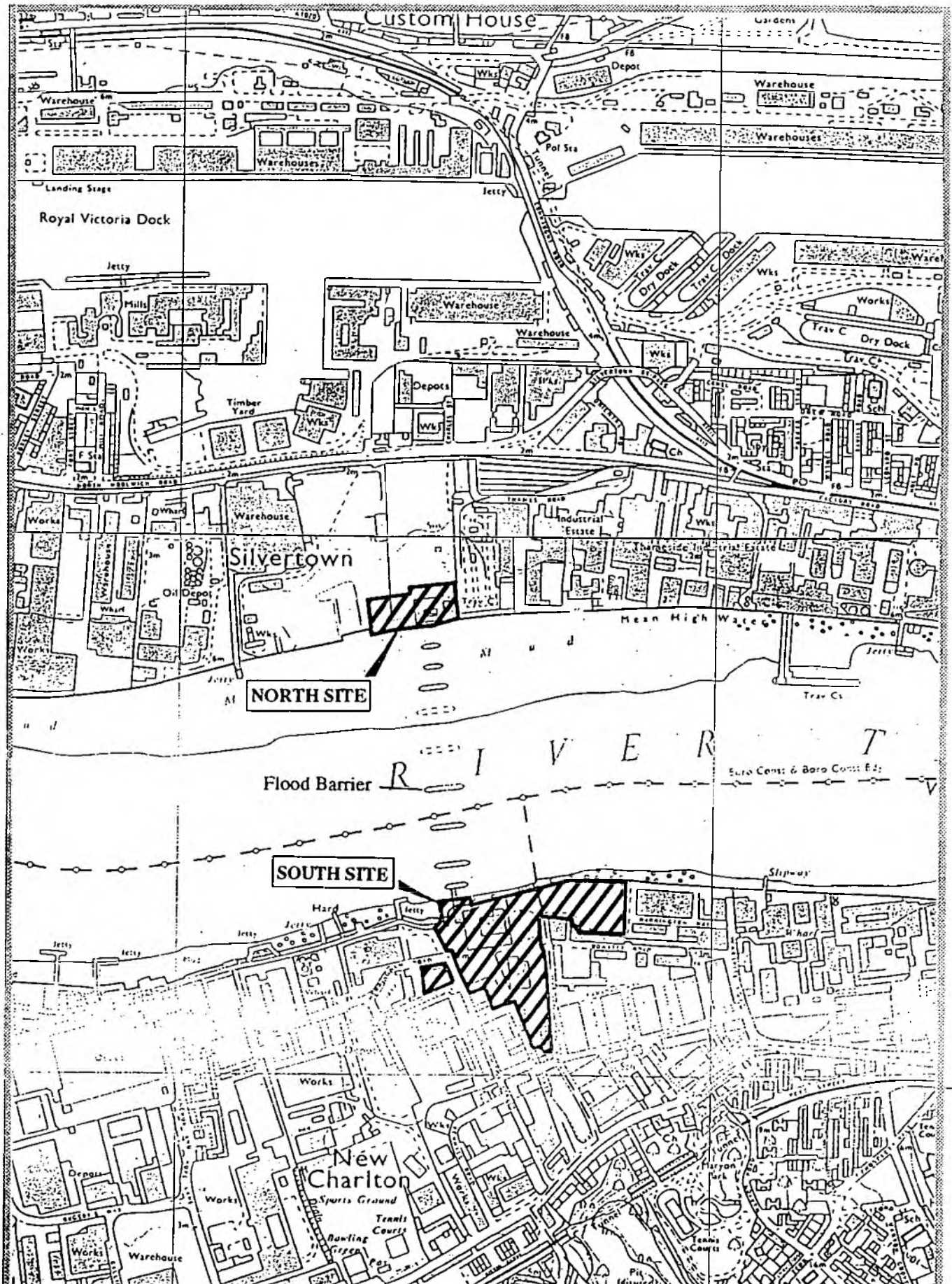
Scale: 1 : 10,000

Date : November 1995

North



EAG



2.0 SITE INFORMATION

2.1 SITE LOCATION

The site comprises two areas of land, located on the north and south banks of the River Thames, adjacent to the Thames Flood Barrier, Greenwich, London (Figure 1).

The Thames Barrier area office and support buildings are located south of the river at the northern end of Eastmore Street, and include a control tower, workshop/offices, generator house and sub-stations. There is also an educational building fronting Eastmore Street, two warehouses to the west fronting Herringham Road, a visitors centre/cafeteria located to the east and a detached residential hostel located to the north of Herringham Road.

A sub-station is located on the northern site.

The energy audit addresses the control tower, workshop/offices, generator house and sub-stations.

2.2 BARRIER DESCRIPTION

The Thames Barrier officially opened in May 1984 and is part of the flood defence scheme to protect London against rising water levels and tidal surges. The total defence also includes raised river embankments and additional flood gates at strategic points including the Barking Barrier.

2.2 FLOOR AREAS

A breakdown of the building floor areas is provided in Appendix 2 (clause 3.0).

3.0 MANAGEMENT SUMMARY

This section summarises the report recommendations and details estimated net annual savings (cost and energy), implementation costs and simple payback (years). The format includes provision for adding applicable additional study/design costs, which can be developed following agreement on the project implementation priorities and contractual arrangements.

3.1 SUMMARY OF ENERGY SAVINGS

The following is a summary of the key findings and recommendations from the energy survey.

SUMMARY OF ENERGY SAVINGS				
Report Reference	Description	Savings		
		kWh	CO ₂ Tonnes	£
4.5.3	Transformer Isolation	157,680	110	7,000
4.6	General Lighting	134,980	95	6,000
	- high efficiency luminaires			
	- continue BMS strategy for piers and abutments	649,728 ³	455	29,234
	- reduce pier and abutment lighting to 50%	267,696	187	12,047
4.7.1	Complete heating and ventilation upgrades	636,000 ³	445	28,620
4.7.2.1	Control Tower heating improvements	26,296	18	1,183
	Control Tower and Workshops - replace electrode boilers with gas fired units		262	17,800
4.7.2.3	Control tower air conditioning improvements	110,376	77	5,000
4.7.2.4	Workshop/offices improve heating controls	10,800	8	500
4.7.2.6	Generator room - improve heating controls and reduce air infiltration	36,000	25	1,800
Total		2,029,556	1,682	109,186
% savings against current energy usage and cost (1994/95)		40.3%	47.7%	48.2%

³ Energy improvements implemented by the site.

- ▶ procedures to monitor energy usage and conservation achievements using "real time" data to confirm actual savings achieved.

3.2.3 Electricity Tariff Arrangements (report reference 4.2.2)

A full tariff analysis was not part of the energy audit.

Electricity is currently being purchased from the 'pool' at an average rate of 4.5p/kWh. This compares favourably with electricity charges for other similar office/operational facilities.

EAG recommends that the electricity contract be competitively tendered to establish whether further cost savings could be achieved.

3.2.4 Transformer Isolation (report reference 4.5.3)

The piers, abutments and substations generally have duplicate transformers installed as part of the security of supply strategy. Isolating 50% of the transformers would achieve energy and cost savings of approximately 157,680kWh and £7,000 per year.

EAG recommends that senior management review the present operational strategy to establish the viability of transformer isolation.

3.2.5 Lighting

3.2.5.1 General Office Areas (report reference 4.6.3)

Lighting levels were generally in accordance with the CIBSE guidelines apart from the Control Tower (recently refurbished areas) and the Planning Office which were measure at 750/800 and 1,000 lux.

EAG recommends the establishment of a Site Asset Management Plan to include:

- ▶ on-going replacement of office luminaires with "state of the art" fittings. Potential annual energy savings 134,980kWh and £6,000 based on all the fluorescent luminaires being replaced and a 15% improvement in fitting efficiency;

3.2 MAJOR CONCLUSIONS AND RECOMMENDATIONS

3.2.1 Energy Management Strategy (report reference 4.1)

The Thames Barrier engineering services design and operational strategy has been based on providing a high level of reliability and security to ensure availability of service at all times. This philosophy has resulted in an operational culture which tends toward leaving equipment "switched on". The review identified several opportunities where a change in this approach would result in significant energy savings being achieved as lighting, transformers, pier heating and ventilation systems etc.

EAG recommends that senior management review the present site strategy to consider whether a change in operational approach could be implemented without comprising health and safety and the security of the Thames Barrier.

3.2.2 Energy Records and Monitoring (report reference 4.1.1, 4.1.2, 4.3.1, 4.3.2)

A detailed energy analysis over an appropriate time frame (minimum 12 months) was not possible due to absence of accurate and consistent data (electricity company invoices, site measurements, load profiles) and the limited local metering arrangements for individual facilities (control tower, workshop/offices etc).

EAG recommends that the site develops a formal energy management programme to include:

- ▶ the installation of local metering to monitor energy consumption;
- ▶ the collection and collation of monthly energy data including: kWh, kVAh, maximum demand (kVA), power factor and load profile information for a summer and winter period (month);
- ▶ a comprehensive review of one years energy data to establish an accurate picture of the sites energy performance and identify the primary targets for energy reduction and effective load management;
- ▶ regular senior management energy performance reviews; and

- ▶ provisions to ensure that all new and refurbished office lighting installations comply with the EC Directive for workstation VDUs;
- ▶ the introduction of individual luminaire switching and PIR control in low occupancy areas and the establishment of a lighting "switch-off" strategy through the work card system.

3.2.5.2 Piers, Abutment and Tunnel Lighting (report reference 4.7.1)

The pier, abutment and tunnel lighting represent a significant electrical load (230.4KW) amounting to approximately 33% of the sites total energy consumption. The ongoing upgrades to the sites Building Management System (BMS) will achieve considerable energy savings (649,728kWh and £29,237) when completed.

EAG recommends that subject to health and safety requirements the site management considers; the potential for additional energy savings by a further reduction in the pier lighting, eg, a reduction by say 50% would achieve energy savings of 267,696kWh and £12,046.

3.2.6 Heating, Ventilation and Air Conditioning Systems

3.2.6.1 Piers and Abutments (report reference 4.7.1)

The pier and abutment heating and ventilation systems are being modified in accordance with a series of recommendations by Oscar Faber. These proposals were reviewed and are considered an effective solution to meet the present operational criteria whilst achieving effective energy management. The savings resulting from the proposed changes when implemented for all the piers and abutments are estimated at approximately £28,620 and £636,000kWh, based on a 50% energy saving.

EAG recommends continuation of upgrade programme.

3.2.6.2 Electrode Boiler Replacement (report reference 4.7.2.1 and 4.7.2.4)

Replacement of the existing electrode boilers would result in annual energy cost savings of £17,800 and a reduction in indirect CO₂ emissions of approximately 262 tonnes. The capital cost of replacing the boilers was estimated at £43,000 giving a simple payback period of 2.4 years.

EAG recommends that the existing boilers be changed to gas fired units subject to confirmation of the savings (through on-site metering) and capital plant estimates (competitive tendering).

TABLE 3.3: MANAGEMENT SUMMARY RECOMMENDATIONS

Report Reference	Location	Description of Recommendations	Fuel Type E (electricity) G (gas) W (water)	Net Annual Savings		Implementation Costs £		Simple Payback (Years)
				£	kWh	Extra Study and Design if Applicable	Total	
4.1 4.1.1	-	Improve energy records and undertake analysis of consumption and trends.	E					
4.1.2		Develop procedures to collect and analyse maximum demand (MD) load profile.	E					
		Develop strategy for economical load management.	E					
4.1.3	Substations	Determine site power factor and establish business case.	E			(subject to detailed calculation and measurements)	£1,000.00	
		Install recording instrumentation.	E					
		Obtain KVAR readings from LEB	E					
Totals (Any Overall Payback Period)								

TABLE 3.3: MANAGEMENT SUMMARY RECOMMENDATIONS								
Report Reference	Location	Description of Recommendations	Fuel Type E (electricity) G (gas) W (water)	Net Annual Savings		Implementation Costs £		Simple Payback (Years)
				£	kWh	Extra Study and Design if Applicable	Total	
4.2.2		Review existing LEB tariff arrangements and consider competitive tendering.	E					
4.3.1		Develop procedures to monitor energy performance.	E					
4.3.2		Develop plan and energy saving targets.	E					
4.3.3		Install kWh meters to the support buildings.	E				3,500	
4.5.3	Piers and substations	Review power supply strategy and consider 50% transformer isolation.	E	7,000	157,680			
Totals (Any Overall Payback Period)								

TABLE 3.3: MANAGEMENT SUMMARY RECOMMENDATIONS

Report Reference	Location	Description of Recommendations	Fuel Type E (electricity) G (gas) W (water)	Net Annual Savings		Implementation Costs £		Simple Payback (Years)
				£	kWh	Extra Study and Design if Applicable	Total	
4.6.1	General lighting	Design new and re-furbished lighting installations to comply with VDU workstation EC Directive.	E	(minor	savings)	(based on 15% luminaire efficiency improvement)		
		Improve light switching control.						
		New lighting to be state of the art high efficiency.	E	6,000	134,980			
		Continue BMS lighting control strategy (PIERS).	E	29,237	649,728kWh			
		Consider potential for further energy savings (PIERS).	E	12,046	267,696kWh			
4.7.1	Piers and abutments	Complete heating and ventilation system upgrades.	M	28,620	636,000	(Assumption 50% saving)		
		Introduce energy management reviews.	E/M					
Totals (Any Overall Payback Period)								

TABLE 3.3: MANAGEMENT SUMMARY RECOMMENDATIONS

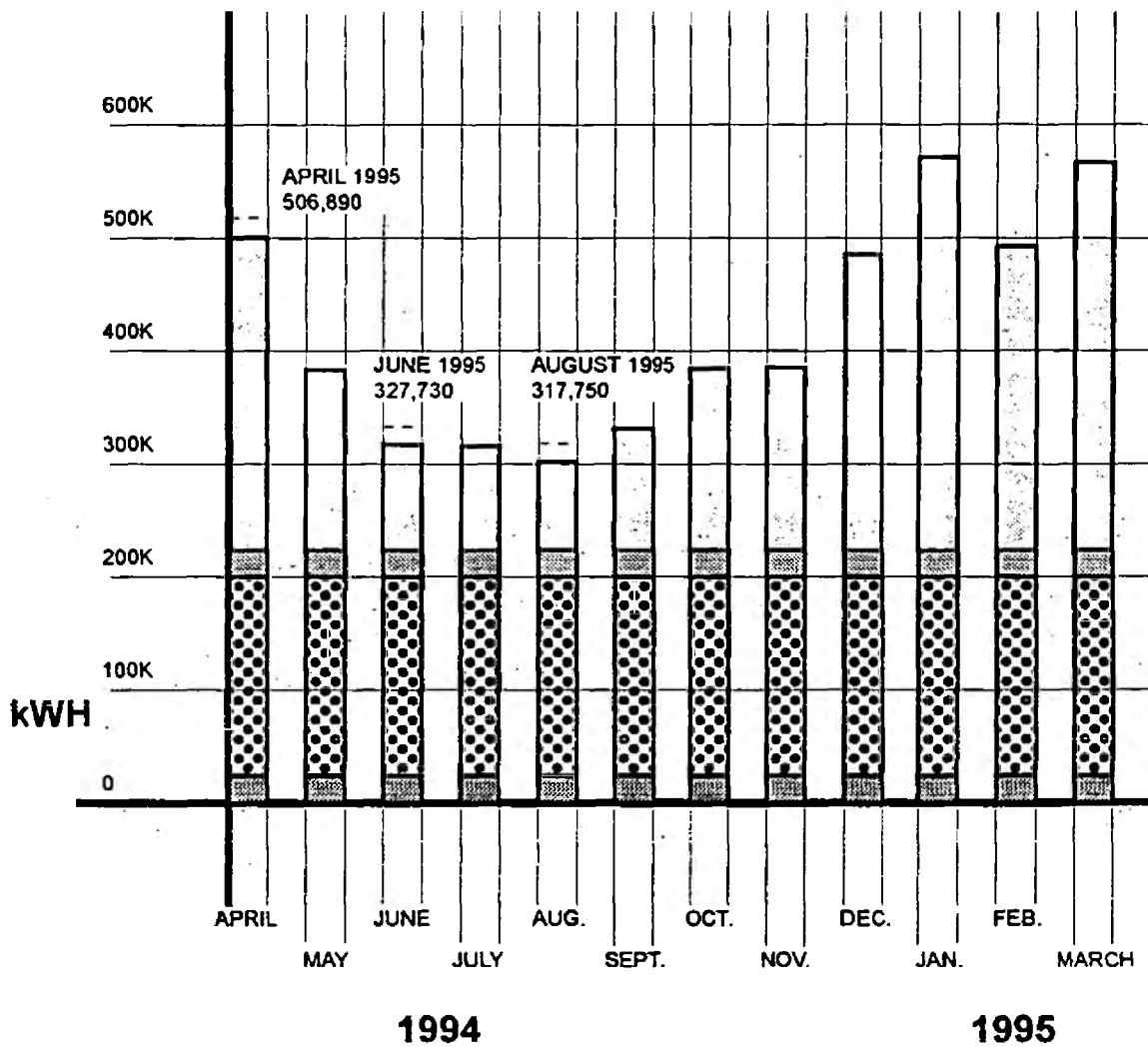
Report Reference	Location	Description of Recommendations	Fuel Type E (electricity) G (gas) W (water)	Net Annual Savings		Implementation Costs £		Simple Payback (Years)
				£	kWh	Extra Study and Design if Applicable	Total	
4.7.2.1	Control Tower	Undertake survey of heating systems.	M	1,183	26,296	£5,000.00	£25,000 (subject to detailed survey)	2.4
4.7.2.1 4.7.2.4	Control Tower and Workshops	Investigate electrode boiler replacement.	E	17,800			£43,000.00	
4.7.2.3	Control Tower	Undertake detailed survey of air conditioning systems.	M					
		Evaluate air conditioning options.	M	5,000	110,376	£5,000.00	£45,000	
4.7.2.4	Workshops/ Offices	Undertake detailed survey of heating system.	M					
		Develop improvement scheme for heating system control.	M	500	10,800	£4,000.00	£2,000	
Totals (Any Overall Payback Period)								

TABLE 3.3: MANAGEMENT SUMMARY RECOMMENDATIONS								
Report Reference	Location	Description of Recommendations	Fuel Type E (electricity) G (gas) W (water)	Net Annual Savings		Implementation Costs £		Simple Payback (Years)
				£	kWh	Extra Study and Design if Applicable	Total	
4.7.2.6	Generator Room	Install thermostatic control for wall panel radiators.	E	300	6,000		£3,000.00	
		Check temperature set points for fan heaters.	M					
		Reduce air infiltration through dampers and grilles.	M	1,500	30,000		£2,000.00	
4.9	All	Continue implementation of BMS strategy.	E/M		see 4.6 and 4.7.1 savings			
4.10	All	Investigate construction defects. Implement remedial work programme.						
	Generator Buildings	Install water collection and disposal arrangement in generator room basement.						
	Workshop	Implement remedial work to valley roof.						
Totals (Any Overall Payback Period)								

Figure 2
ENERGY 1994 / 1995.



INTERNAL LIGHTING $1,817,736 / 12 = 151,478 \text{ KWH / MONTH}$
EXTERNAL LIGHTING $173,100 / 12 = 14,425 \text{ KWH / MONTH}$



EXTERNAL LIGHTING
AVERAGE / MONTH

INTERNAL LIGHTING
AVERAGE / MONTH

TRANSFORMER LOSSES
26,280 KWH / MONTH



4.0 SURVEY FINDINGS

4.1 ENERGY CONSUMPTION

Electricity is the primary source of energy for the site with the exception of the emergency generators which use 35 second diesel oil. The emergency generators are used for test purposes and to export power to the UK National Grid System.

Utility information was provided by the National Rivers Authority (NRA) for electrical energy consumption April 1994 - March 1995 (Appendix 3). Discussions with the site operational representatives confirmed that the London Electricity Board (LEB) invoicing was inconsistent and not in a format suitable for energy analysis. Three LEB invoices provided by the NRA dated April, June and August 1995 (Appendix 8) were used for comparison with the 1994/95 data. The energy information was analysed and recorded in the form of a graph (Figure 2) and tables (Appendix 3).

Recommendations

- ▶ develop accurate and consistent energy records and undertake detailed analysis of energy consumption trends.

4.1.1 Total Energy Usage

The electrical kWh consumption figures for April, June and August 1995 (Figure 2) show a small increase in total energy over 1994. This could be explained through changes in climatic conditions over the period. A detailed energy analysis is required to establish energy consumption trends based on consistent and accurate LEB data, and site meter readings over a 1/2 year period.

Recommendations

- ▶ develop accurate and consistent energy records and undertake detailed analysis of energy consumption trends.

Figure 3
BASE LOAD 25th - 26th NOVEMBER 1995.

EAG

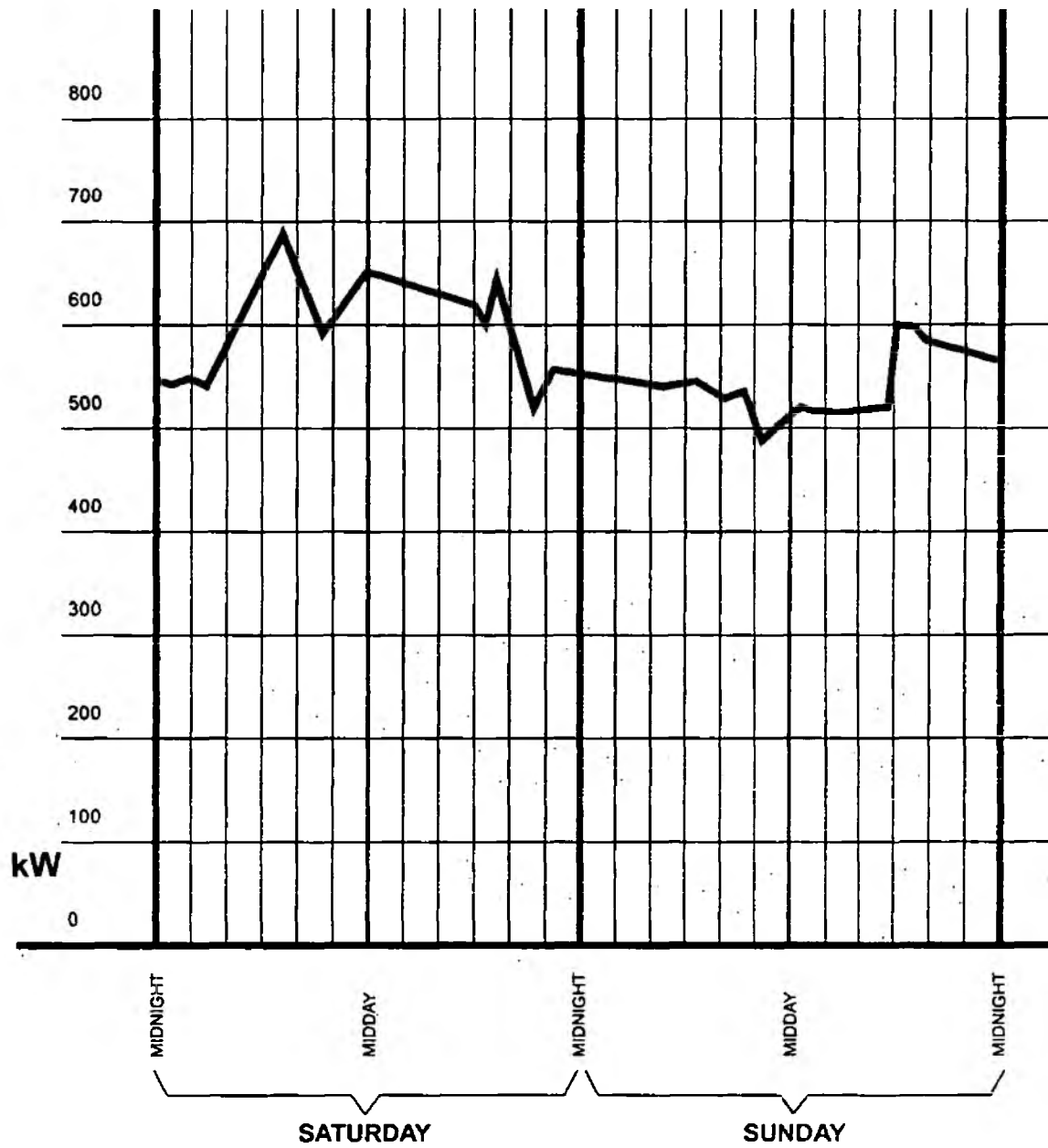
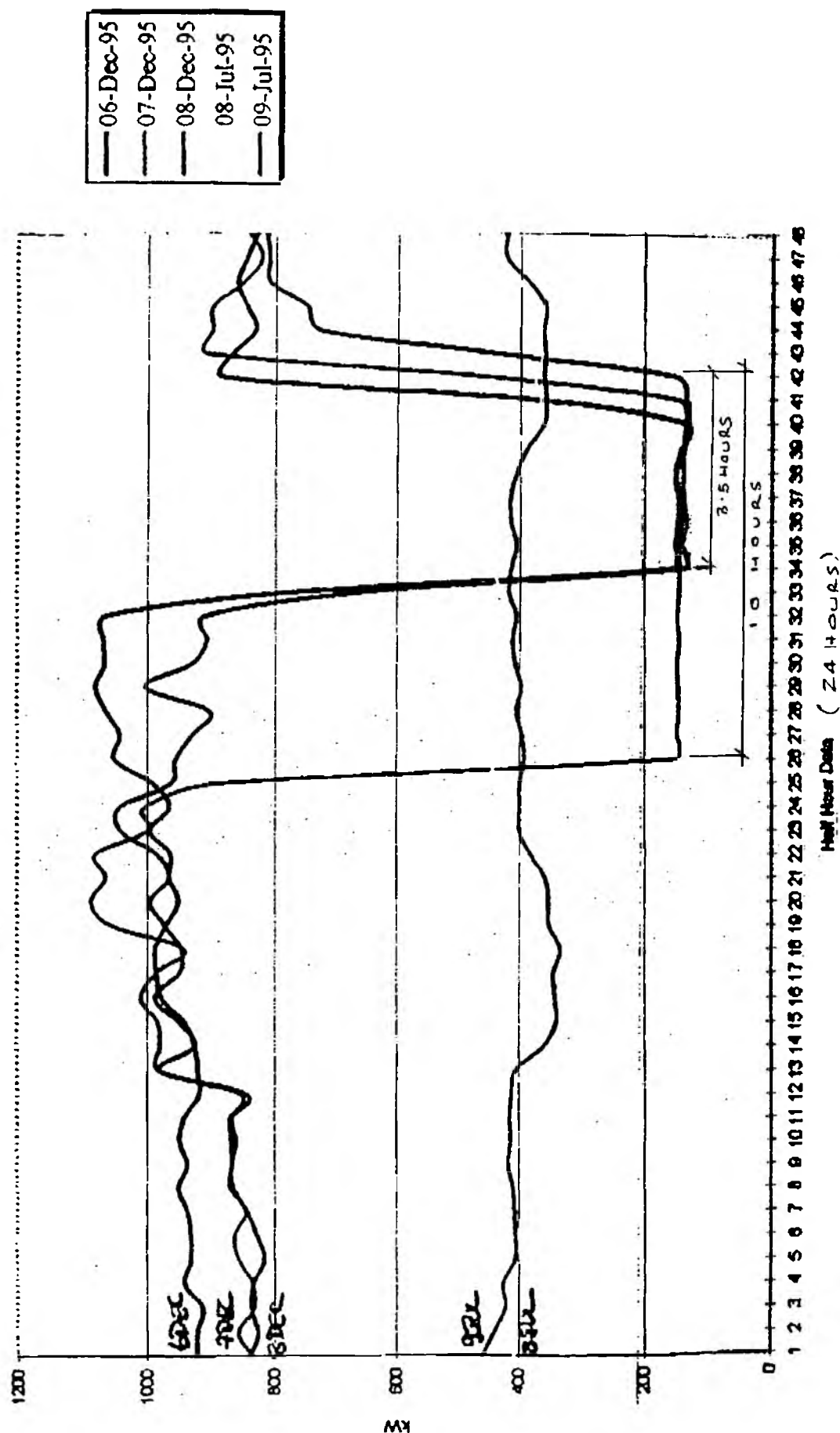


Figure 4: Comparison of Summer/Winter 1995

Comparison of Summer/Winter 1995



4.1.2 Electricity Maximum Demand (Figure 3 and 4)

The maximum demand (KW) profiles (Figures 3 and 4) for the periods 25-26 November 1995 (weekend) and 6-8 December 1995 (weekdays) and 8-9 July 1995 (weekend) demonstrate the following characteristics:

► *25-26 November 1995 (weekend)*

The profile shows an average maximum demand of 550KW and a peak demand of 700KW. During this period weather conditions were mild with a day time temperature of 12°C. The 550KW compares favourably with the 575KW maximum demand assessment (Appendix 2, Section 8.0) calculated for a period without heating.

The peak demand of 700KW indicates a period when the electrode boilers were operating. This was supported during the site audit, conducted during relatively mild weather conditions, when the boilers were observed to be operating and compares favourably with the maximum demand assessment (Appendix 2, Section 8.0) calculated for a winter mild weather condition.

► *6-8 December 1995 (weekdays)*

The profile shows an average maximum demand of approximately 900KW with a peak demand of 1100KW. The electrical load dropped to approximately 150KW between 3.5 and 10 hours over the period.

The average maximum demand of 900KW and peak demand of 1100KW occurred during mild weather similar to the November 95 conditions and compares favourably with the 1046KW maximum demand assessment (Appendix 2, Section 8.1.2) calculated for a winter low heating demand period.

The significant drop in maximum demand of approximately 850KW for a 3.5 to 10 hour period could be due to the generators being used for peak lopping or substantial load shedding for operational reasons. The profile information was provided post-audit and further discussions with the site engineers will be necessary to rationalise the significant load deviation.

► 5 and 9 July 1995 (weekend)

The profile shows a relatively consistent maximum demand of 400KW and a minimum demand of 350KW over the period. The maximum demand assessment (Appendix 2, Section 8.3) indicates a demand of approximately 350KW, comprising mainly pier lighting, ventilation, transformer losses and control tower building loads over typical building operation and occupancy patterns.

The profile information was provided post-audit and has no time of day reference. Further discussions with the site engineers will be necessary to rationalise the data.

Recommendations

- develop management procedures to collect and analyse load profile information.
- based on accurate profile information and operational considerations develop strategy for the most economic method of load management.

4.1.3 Power Factor Correction

To obtain the best possible economic advantage from electrical power both the supply company and consumer's plants should be operated at high efficiency. To achieve this it is essential to have a good power factor throughout the system. Where tariffs are based on a basic standing charge per kVA plus a charge for each unit (kWh) supplied, the most economical degree of correction is achieved when the power factor is corrected to approximately 0.98. The return on investment is best when improving from a low value to a moderate value, say from 0.8 to 0.93, and diminishes as unity is approached.

The average site power factor was calculated at approximately 0.94 using LEB invoice data (estimated readings).

The current LEB kWh tariff charging arrangements do not support the installation of power factor correction equipment.

Recommendations

- ▶ Establish site power factor through data obtained from the LEB and on-site recording instruments.
- ▶ Determine viability of business case for installation of power factor correction equipment.

4.2 ENERGY INTAKES**4.2.1 Meter Provisions**

There are two LEB high voltage incoming feeders supplying the north sub-station and one LEB incoming feeder supplying the south sub-station. These feeders are metered at 11KV and provide maximum demand (KW), kWh and KVArh readings. The main MV (11KV) and LV (415V) switchboards in the substation buildings are fitted with ammeters which provide instantaneous load readings. LV switchboards in the south and north abutments are also fitted with ammeters as are the main LV switchboards on the piers.

The generator building has two LV switchboards supplying lighting and general power services and each is fitted with ammeters. The workshop LV switchboard was not inspected.

4.2.2 Electricity Tariff Arrangements

A full tariff analysis was not part of the energy audit. From the information provided the cost of electricity purchased from the "pool" (average 4.5p/kWh) compares favourably with other major energy users.

The site was unable to provide a comprehensive and consistent set of electricity consumption data over a sufficient time period (1/2 years) to enable a provisional tariff analysis to be undertaken.

Recommendations

- ▶ Review LEB billing information to establish cost performance of contract arrangements.
- ▶ Consider competitive tendering.

4.3 BUILDING PERFORMANCE INDICATORS

4.3.1 Electricity

The support buildings (control tower, workshops and offices) are not separately metered and comparison of electricity performance (kWh/m²) against the criteria published by the Energy Efficiency Office (EEO)(Appendix 5) was not possible.

The Thames Barrier is a unique structure and performance against other facilities is not practical.

Recommendations

- ▶ Develop and implement management procedures to regularly monitor energy performance.
- ▶ Develop and implement an energy management plan to place the Barrier Support Buildings in the low EEO energy performance category (Appendix 5) for electricity consumption.
- ▶ Install independent kWh meters for the control building, workshops and generator house.

4.3.2 CO₂ Performance

Comparison of CO₂ performance (kg/m²) against the criteria published by the EEO (Appendix 5) was not possible due to limited metering arrangements.

Recommendations

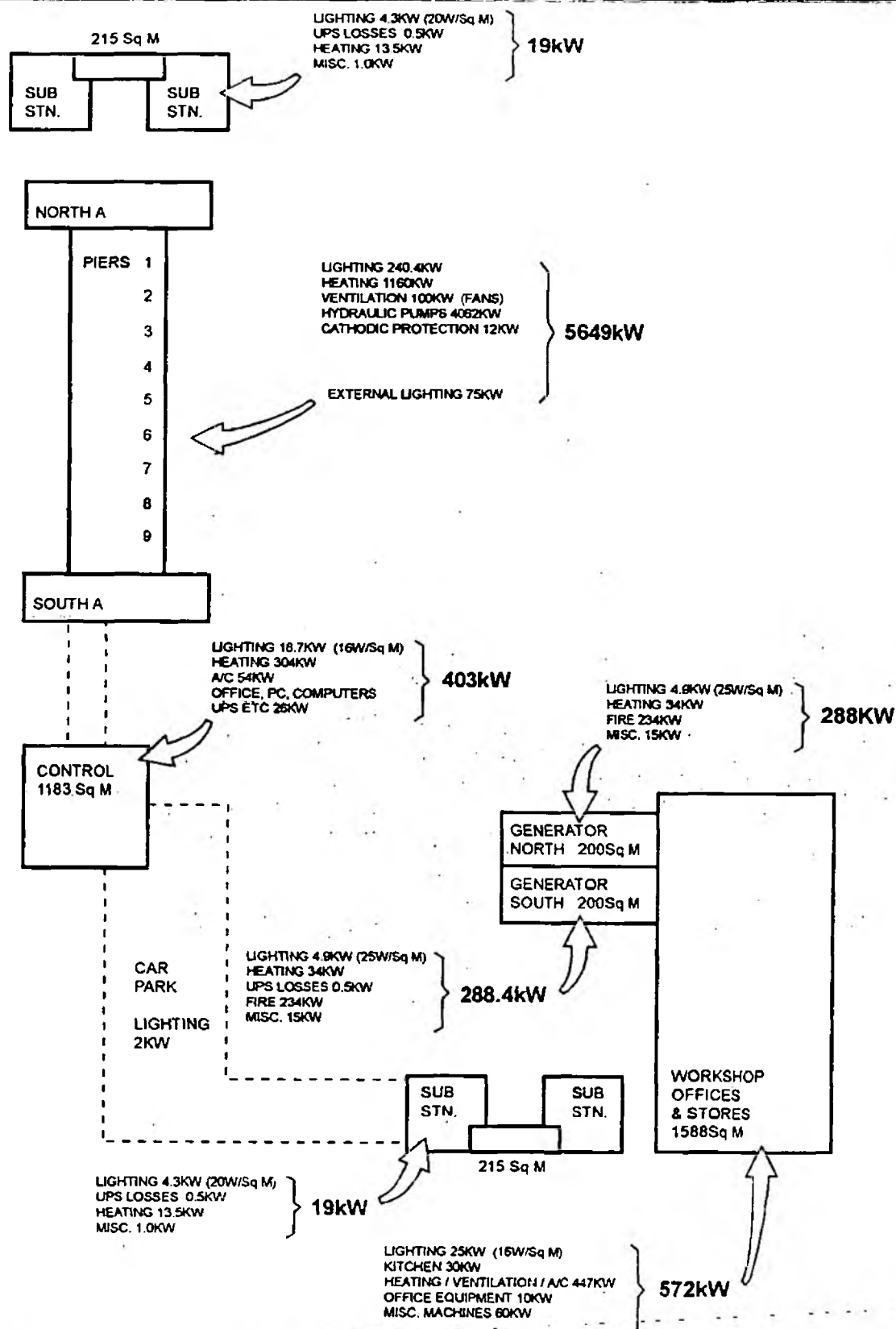
- ▶ Develop and implement energy management plan to place the barrier support building in the EEO low CO₂ performance category.

4.3.3 Cost Performance

Comparison of cost performance £/m² against criteria published by the EEO was not possible due to limited metering arrangements.

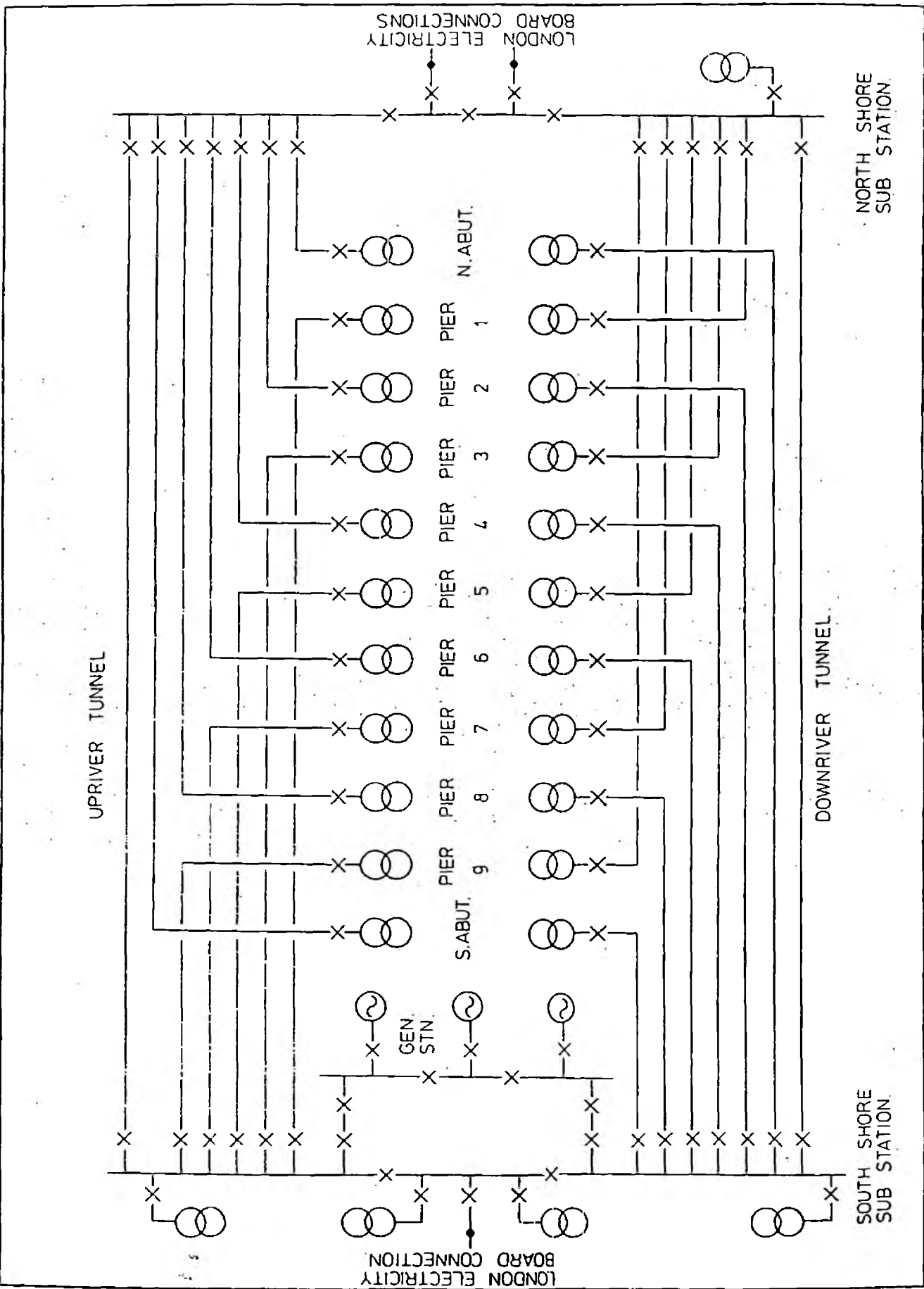
Figure 5
CONNECTED LOADS.

EAG



TOTAL CONNECTED LOAD = 7,213kW
AVAILABLE TRANSFORMER CAPACITY = 20,500kVA

Figure 6: Electrical Distribution



Recommendations

- ▶ Monitor energy costs and implement measures to further improve cost performance and place the barrier support buildings in the EEO low cost performance category (Appendix 5).

4.5 ELECTRICAL DISTRIBUTION

4.5.1 Electrical Loads

An assessment of the electrical system was undertaken to establish the connected and maximum demand loads for the barrier and its support facilities. Details of this assessment are provided in Appendix 2 and summarised in Figure 5. The assessment was based on information provided by the site engineers and through visual inspection during the audit. **The information presented in Appendix 2 and Figure 5 represents a best estimate of the installed equipment loads to identify the general load distribution and evaluate these against current design criteria for energy efficient buildings.**

4.5.2 Electrical Design

The electrical design of the barrier (Figure 6) was based on achieving maximum reliability and the electrical systems are generally duplicated (on-site diesel generators, three LEB supplies and duplicate transformers on each pier). The electrical supplies are available at all the times other than when essential maintenance is being undertaken.

The system duplication needed to meet the operational reliability and safety criteria has a higher than normal operating cost eg, maintained pier and tunnel emergency lighting and transformer losses.

The barrier reliability and security provisions for the support facilities meet normally acceptable design criteria apart from a few specific instances which have been highlighted in the report eg, heating distribution and controls and lighting levels in refurbished areas (control building).

4.5.3 Transformer Losses - Barrier Piers and Substations

The piers, abutments and substations generally have duplicate transformers installed as part of the security of supply strategy provided under the original Barrier design concept.

Total transformer iron losses (no load losses) are approximately 36KW (Appendix 2, Section 5.0). A strategy of isolating 50% of the transformers would achieve energy and cost savings of approximately 157,680kWh and £7,000 per year. The specific switching regimes would need to be agreed based on operational and maintenance requirements. This may not be acceptable due to the potential for moisture absorption under certain weather conditions into the cooling medium, switching arrangements and a reduction in security of supply.

Recommendations

- ▶ review security of supply strategy and consider 50% transformer isolation to achieve energy savings.

4.6 LIGHTING INSTALLATIONS

4.6.1 General

Fluorescent luminaries are installed throughout the piers, abutments, tunnels, control tower, maintenance, generator buildings and substations. High pressure discharge lamps are installed for high bay lighting in the workshops and generator buildings and also for security and flood lighting.

Measured lighting levels were generally in accordance with the Chartered Institution of Building Services Engineers (CIBSE) recommendations apart from where highlighted in the report.

Internal lighting is controlled by standard light switches in most areas with the exception of piers 5, 6 and 7 which are contactor controlled by the Trend BMS systems.

4.6.2 Control Tower Lighting

Fluorescent luminaries are installed throughout the control tower offices and ancilliary spaces. Lighting levels were generally in accordance with recommended CIBSE design criteria with the exception of the recently refurbished control tower areas. Lighting levels of between 750 and 800

lux were measured in these areas which exceed the recommended CIBSE guidance levels (300 lux for VDU and 500 lux office work).

Internal lighting is controlled by manual switching in the majority of office and ancilliary areas.

4.6.3 Workshop, Offices and Stores

Fluorescent luminaries are installed throughout all areas with high bay discharge fittings installed in the workshop area. Internal lighting is generally controlled by manual switching with passive infra red (PIR) control provided in a number of the store areas.

Lighting levels in the planning offices were measured at 1,000 lux against a recommended CIBSE recommended design level of 750 lux.

4.6.4 Generator House

Fluorescent and high bay discharge lighting installed throughout all areas with manual lighting switching.

4.6.5 External Lighting

External security and floodlighting comprises sodium and mercury luminaires with time clock and photocell control. Further details are provided in Appendix 2, Section 4.0.

4.6.6 Pier and Tunnel Lighting

Fluorescent luminaries installed throughout all pier and tunnel areas.

Safety and security lighting is supplied by uninterruptable power supplies (UPS) and comprises 20% of the total installed lighting. The safety and security lighting is operational 24 hours per day, 365 days per year.

Piers 5, 6 and 7 are switched by the BMS control. The lighting is operational 12 hours per day and 5 days per week. Lighting in Piers 1,2,3,4,8,9 and the north and south abutments is operated continuously (24 hours per day, 365 days per year).

A new BMS system is being installed and the lighting controls in Piers 1,2,3,4,8,9 and the north and south abutments is being revised in accordance with the switching regime in piers 5,6 and 7.

A breakdown of the connected and operation of loads is provided in Appendix 2, Section 2.0.

4.6.7 VDT Workstation Lighting

Because of health and safety concerns when using display screen equipment, EEC Directive 90/270/EEC 29 May, 1992 and the UK 'Health and Safety' (Display Screen Equipment) Regulations 1992 was implemented. The Regulations require that existing work stations comply with the scheduled technical requirements by the 31st December 1996.

The Regulations specify the following schedule of technical requirements: adequate lighting, adequate contrast, no glare or distracting reflections; distracting noise minimised; leg room and clearances to allow for postural change; window covering; software appropriate to task, adapted to user, provide feedback on system status, no undisclosed monitoring; screen: stable image, adjustable, readable, glare and reflection free; keyboard: usable, adjustable, detachable, legible; workplace: allow flexible arrangements, spacious, glare free; work chair: adjustable; and foot rest.

With regard to adequate lighting the HSE guidance note Lighting at Work (HS(G)38) refers to CIBSE Lighting Guide 3 for lighting design criteria at VDT workstations.

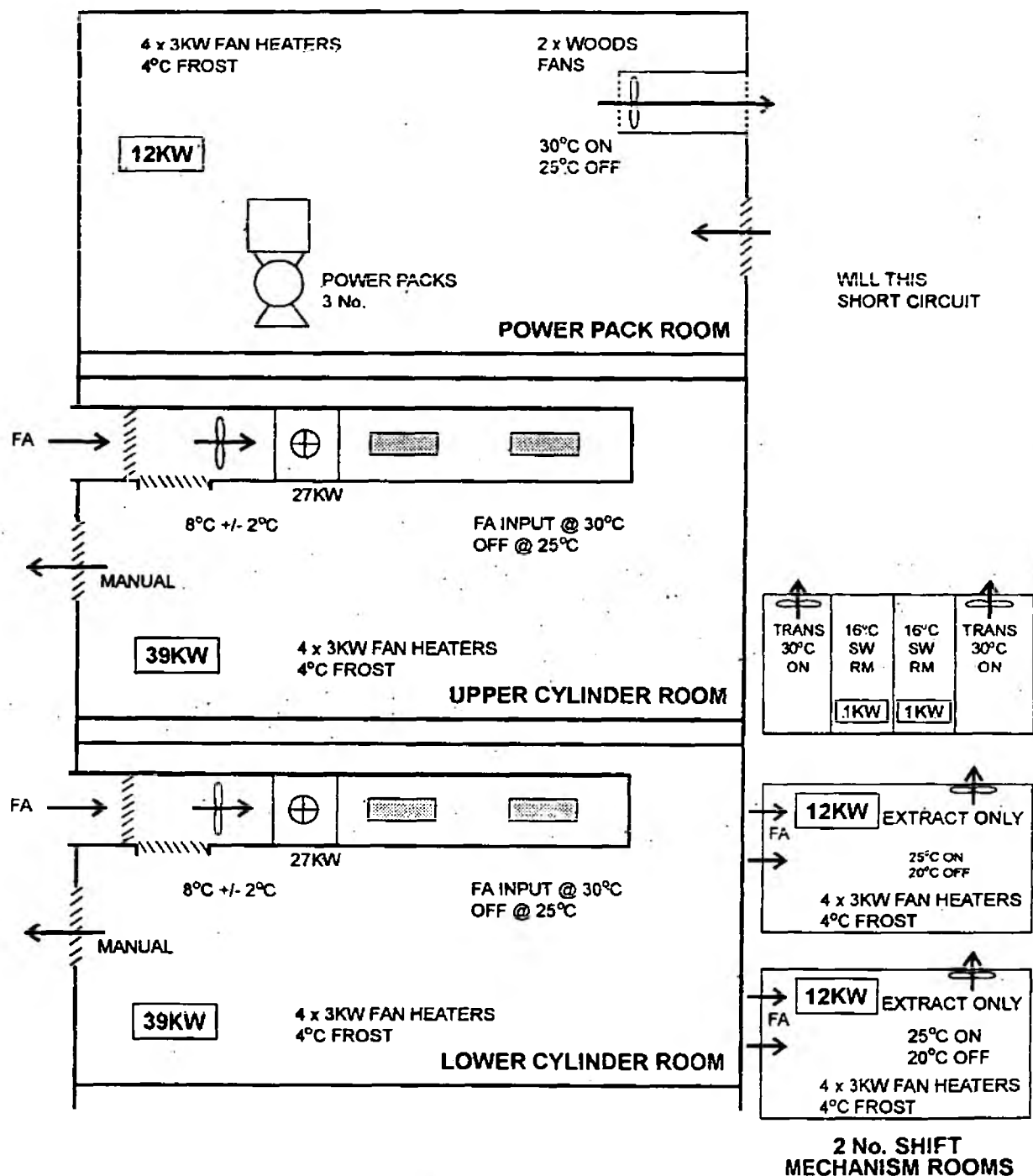
Recommendations

- ▶ all new or replacement lighting installations should be designed to comply with CIBSE criteria and EEC Directive 90/270/EEC and the UK Health and Safety Regulations 1992;
- ▶ for new or refurbished areas consider providing individual luminaire switching and PIR control in low occupancy areas eg, toilets, stores, generator buildings etc.
- ▶ when replacing luminaries install where possible state-of-art high efficiency fittings;
- ▶ continue implementation of BMS switching controls on piers and abutments as installed for piers 5,6 and 7;

Figure 7

PIERS HEATING & VENTILATION, NEW SYSTEM.

EAG



TOTAL CONNECTED HEATING PER PIER = 116KW
VENTILATION FANS (INC. TUNNELS) = 10KW

- ▶ review pier and tunnel lighting switching strategy to ascertain potential for further energy/cost savings against operational and health and safety considerations. (Appendix 2, Section 2 details further opportunities for energy and cost savings);
- ▶ consider introduction of a 'switch-off' instruction strategy for low occupancy areas using permit to work system.

4.7 HEATING, VENTILATION AND AIR CONDITIONING SYSTEMS

4.7.1 Piers and Abutments

The pier and abutment heating and ventilation systems are currently being modified as shown in Figure 7 and detailed in Oscar Faber proposals dated October 1994. The Oscar Faber proposals were reviewed and are considered an appropriate solution to meet the operational criteria whilst achieving effective energy management. The proposed operational criteria is detailed in Appendix 6, Section 1.0.

Ventilation and heating control set points will eventually be under BMS control which will allow the areas to be continuously monitored with remote set point control.

Recommendations

- ▶ Complete heating and ventilation system upgrade for all piers and abutments.
- ▶ Introduce formal management reviews to establish scope for further energy management improvements.

4.7.2 Control Tower Building

4.7.2.1 Heating

Central Plant

Heating to the control tower building is provided by 2 x 145KW electrode boilers located in the basement plant room. An assessment of the building heating requirements was undertaken (Appendix 2, Section 7.0) which indicated that one boiler has sufficient capacity to meet the total

building heating winter demand. It is assumed that the second boiler is provided for standby only.

Distribution

Heating is distributed via duplicate pump sets, pipework, risers and branch circuits with panel radiators at each floor level.

From observation the boiler flow and return temperatures were controlled by thermostats located in pipework adjacent to the boilers (no detailed schematic control drawings and manuals were made available for inspection during the audit). Boiler and circulation pumps operate continuously and distribute water to each floor. A limited number of thermostatic regulating valves are provided. No control valves are provided for zone or floor control.

Recommendations

- ▶ Undertake detailed survey of the heating systems.
- ▶ Investigate replacement of electrode boilers with gas to reduce indirect CO₂ emissions (Appendix 7).

4.7.2.2 Hot Water Services

Domestic hot water is provided by two electrically heated storage calorifiers (2 x 6KW) with duplicate circulation pumps. The emersion heaters are controlled by locally installed thermostats (no detailed schematic drawings were made available for inspection during the audit).

4.7.2.3 Air Conditioning Systems

Air conditioning systems include:

Level 7 control room: supplied by two air handling units (level 9) and chilled water units located externally at ground floor level.

Levels 5 and 6 computer/equipment rooms: fan coil units supplied by chilled water from chiller units located at ground floor level.

Miscellaneous: small air handling unit at level 3 possibly to supply conference room ventilation/comfort cooling on level 2.

From observation it would appear that the chiller units could provide a total of approximately 130 KW (cooling) including provision for standby.

The assessed control building cooling load was estimated at approximately 95 KW (80 watts/m²) indicating adequate availability of chilled water to meet the office, control room and equipment loads.

No detailed drawings or manuals were made available for inspection during the audit.

Recommendations

- ▶ Undertake detailed survey of air conditioning systems.

4.7.2.4 Workshop and First Floor Offices

Heating

Heating to the workshops and offices is provided by electrode boilers (1 x 275 KW and 1 x 144 KW) located in the workshop plant room. An assessment was carried out of the workshop/office heating load requirements (Appendix 2, Section 7.0) which indicate that a boiler capacity of approximately 190 KW would support the workshop and office requirements. The installed boiler capacity is therefore considered adequate.

No control valves installed on branch distribution circuits. Unit fan heaters (workshop) under manual control. Thermostatic regulating valves installed to all panel radiators (office areas).

Air Conditioning and Ventilation

Air conditioning systems include:

- ▶ Two air-conditioning units - planning office.
- ▶ One small air conditioning unit supporting the hydraulics workshop.

- ▶ One ventilation unit supporting the electronics/controls workshop.

Recommendations

- ▶ undertake detailed survey of workshop/office heating and air conditioning systems to establish and quantify improvements for more effective control and energy saving opportunities.

4.7.2.5 Sub-Stations Heating

Heating is provided by 1.5 KW oil filled panel radiators with individual local thermostatic control. Electrical switch boards provided with internal anti-condensation heaters.

Recommendations

- ▶ Retain as installed.

4.7.2.6 Generator Room Heating

Heating is provided by wall mounted electric panel radiators (9 x 3 KW) and fan heaters (2 x 3 KW) (pump well) and one oil filled panel radiator (electrical switchroom).

Recommendations

- ▶ Install thermostatic control for electric panel radiators.
- ▶ Check fan heaters temperature set points.
- ▶ Reduce air infiltration through dampers and open mesh grills.

4.8 COMBINED HEAT AND POWER

4.8.1 Introduction

A CHP unit consists of five basic components: an engine, an electricity generator; a heat recovery system; a control system and an exhaust system. CHP units make use of a relatively low-cost fuel,

usually natural gas, to generate both heat, that would normally be produced by conventional boiler plant, and electricity that would otherwise be purchased from the electricity supply company. CHP systems are generally less efficient than boilers but this disadvantage is offset by savings in electricity unit costs and maximum demand charges. CHP installations are most cost effective when operating for the maximum number of hours during heating demand periods and when electricity tariffs are most beneficial.

To maximise CHP operation and hence savings it is necessary to have a year round heat demand (not necessarily 24 hours per day). In practice it is unlikely that units operating for less than 3,000 hours per year would be cost effective.

4.8.2 *Thames Barrier*

The Barrier does not have a year round heat demand and would therefore not be able to provide the year round heating load needed to optimise the effective use of a CHP scheme.

4.9 *BUILDING MANAGEMENT SYSTEM (BMS)*

The new BMS currently being installed should provide adequate facilities for building services control and energy management. Future completion will be essential to the achievement of energy service targets and objectives.

Recommendations

- ▶ Continue implementation of BMS strategy for barrier and support facilities.

4.10 *BUILDING CONDITION SURVEY*

4.10.1 *General*

The survey was carried out on 24 November 1995 and comprised a visual inspection of the following areas:

- Control Building
- Maintenance Workshop

- Generator and Transformer Compound
- Underground Stores and Cableways.

The weather at the time of the survey was dull, overcast and windy with occasional light rain.

The roofs of the buildings are of a somewhat unique architectural design and a main feature of the complex. This theme has been incorporated into the design of the piers.

For ease of reference the report is sectioned into the areas scheduled above together with a section on the feature roofs and a summary.

4.10.2 Control Building

Concrete framed building of 9 storeys with one basement level, two roof levels and undercover car-parking.

The external surfaces have been designed and constructed so as to require minimum maintenance by the use of stainless steel and concrete with exposed aggregate for the elevational treatments.

The roof complex is readily accessed via a series of catwalks and ladderways with egress onto the roof by a hatchway. Externally the roof is in a satisfactory condition. None of the areas inspected required any remedial works to be undertaken.

The roof void houses services plant and equipment. The roof has been fully lined with either a fire or thermal cladding and an inspection of the structure was not possible. There were no signs of external water penetration or dampness.

At the time of the survey the lift service was suspended due to maintenance work and no inspection of this area of the building was possible. The condition of the lift shaft etc. should be assessed from the maintenance records, or through a report commissioned from the lift company.

Access between all levels is provided by two stair wells, one designated as a fire escape route. From windows set in the external walls of the shaft it was possible to carry out a limited inspection of the external surfaces and comment on these are referenced to in the summary section.

The seals to the windows were in satisfactory condition and there were no signs of penetration of water or dampness.

Egress at balcony level allowed an inspection of some of the external elements of the building. Weathering detailing and construction was satisfactory and no remedial or maintenance work was required.

An inspection was carried out at each floor level. Window and other openings were inspected for signs of penetration of water and dampness and the building fabric was inspected for signs of deterioration.

Seals and mastics are intact and all surfaces appear generally satisfactory except at level 8 where there are signs of staining to the concrete columns.

4.10.3 Maintenance Workshop

An open-plan framed building accessed primarily from the dock area and comprising a workshop/maintenance area, stores general offices at entrance level with a mezzanine level accommodating further offices and a staff canteen.

The roof has been designed to provide natural lighting to the workshop through a series of glazed roof panels around the central flat roofed area set in a 'valley' of the main feature roof.

Access to the 'valley' is gained via catwalks and ladderways and through a glazed doorway in the roof panels.

The roof is laid to fall to rainwater disposal points set in the roof covering. Silt has built up around these drainage points and restricts the free flow of water.

A layer of pebbles cover the roof, it is presumed to protect the roof surface from UV. but these have drifted and are not evenly distributed leaving areas of the roof covering exposed.

Areas of the roof covering are 'spongy' underfoot. It was not apparent whether this is due to the penetration of water or for other reasons.

Seams to the roof felt upstands have opened.

One of the glazing panels is cracked. At the time of the survey this had not caused any deterioration of the building.

The roof structure was readily accessible for inspection by the use of the walkways set at eaves level. The timber boarding fixed to the steel frame of the roof and acting as backing/support for the stainless steel cladding is covered with a white dry deposit which can be readily brushed off.

The steelwork roof structure appears satisfactory and its protective coating is intact. There are no signs of corrosion or damage.

Windows and other openings at mezzanine level and ground level were inspected for signs of penetration of water and dampness and the building fabric was inspected for signs of deterioration. Seals and mastics are intact and all surfaces appear generally satisfactory.

4.10.4 Generator and Transformer Compound

Transformer Room

A single storey building accessed from deck level.

The roof of the Transformer Room was inspected from the fire escape staircase to the mezzanine offices. Distortion of the roof covering was preventing the full discharge of the surface water. There were no internal signs of water penetration to indicate that the integrity of the roof has been compromised.

Windows and other openings were inspected for signs of penetration of water and dampness and the building fabric was inspected for signs of deterioration. Seals and mastics were intact and all surfaces appeared generally satisfactory.

Rainwater from the roof is carried by a series of rainwater pipes through the transformer room. Caulking to the joints is intact with no signs of seepage or other staining of the pipes.

Generator Room

A single storey building comprising of two separate areas accessed from deck level incorporating various basement levels accessed from the entrance level floor.

An inspection was carried out of both areas but as the findings of each room were identical only one description/report has been prepared.

An internal inspection of the roof structure was carried out from the gantry/overhead crane. Both ends of the roof have been lined with a thermal cladding prohibiting an inspection of the structure although with was possible in the middle section.

The roof steelwork appears satisfactory and its protective coating is intact. There are no signs of corrosion or damage.

At entrance level windows and other openings were inspected for signs of penetration of water and dampness and the building fabric was inspected for signs of deterioration. Seals and mastics are intact and all surfaces appear generally satisfactory.

An inspection was carried out of the cableway basement area. There were no signs of water penetration or dampness and all surfaces appeared satisfactory.

An inspection of the basement at the eastern end of the building was generally satisfactory except:

- water is discharging from the surface duct in the floor above and runs down the face of the basement wall. Excessive staining and deterioration of the concrete surface has occurred. It is understood that this water is condensation emanating from compressors.
- a horizontal line of staining has occurred to the perimeter wall along the line of a construction joint in the wall.

4.10.5 Underground Stores and Cableways

The stores are situated and extend under the Maintenance Workshop and are accessed from ground level. The cable-ways extend from the store to level 1 of the Control Building.

The building fabric was inspected for signs of deterioration and found to be generally satisfactory with no signs of penetration of water or dampness except:

- the perimeter walls in the north-east corner of the store area are displaying signs of excessive water staining.

Rain water and soil pipes pass through this basement level. Caulking to the joints was intact with no signs of seepage or other staining of the pipes.

4.10.6 Roofs and External Elevations

With the exception of the 'valley' roof to the Maintenance Workshop and the roof complex to the Control Building a full external inspection could not be made of the roof although a general inspection was made from various vantage points.

The roof covering appears to be intact with no obvious signs of detached or loose cladding and with the exception of the roof to the Transformer Room is allowing for the proper discharge of surface water.

The vertical elevations are of a concrete finish mainly featuring 'exposed-aggregate'. All of the elevations are displaying various degrees of staining usually associated with the corrosion of reinforcement.

4.10.7 Summary and Recommendations

The complex is subject to a planned maintenance programme and is generally in a satisfactory condition.

The following points should be the subject of further investigation or remedial work:

- a specialist concrete firm should be commissioned to carry out an investigation of the staining to the exposed aggregate wall finishes, the staining to the construction joint in the basement to the generator room and the staining to the walls in the north-east corner of the underground stores. The findings of the report should then be assessed and if necessary a programme of remedial work implemented.

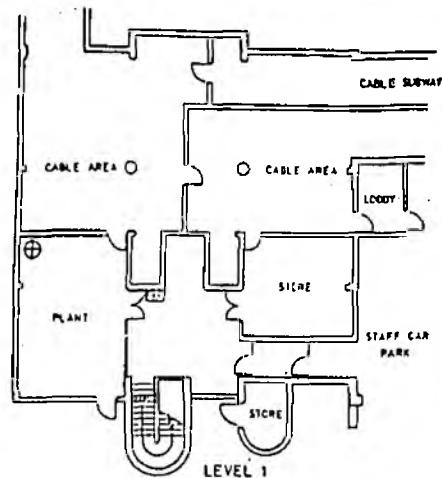
- a system of controlled water collection and disposal installed in the basement to the generator room to prevent further deterioration of the concrete and repairs carried out to the concrete and reinforcement as necessary.

- the flat roof covering to the 'valley' roof over the maintenance workshop should be repaired and reinstated and upstands treated with a UV reflective paint. A regular inspection/maintenance programme should be implemented for this area of the building.

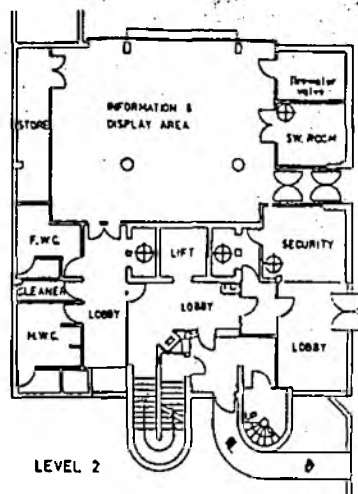
Appendices

Appendix 1

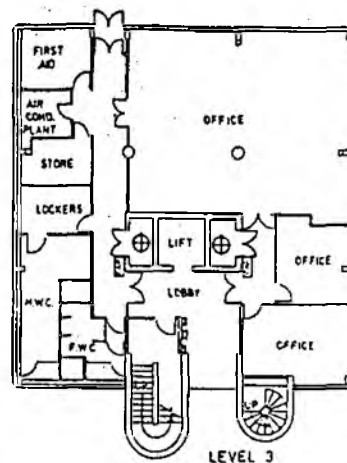
Floor Plans



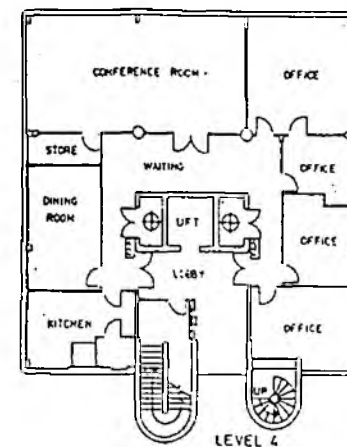
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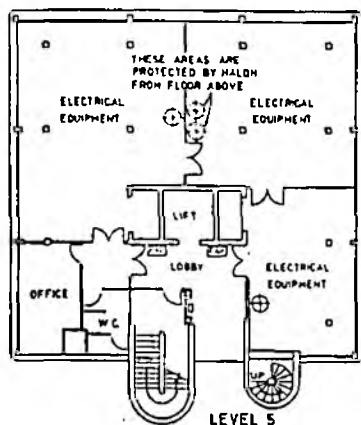
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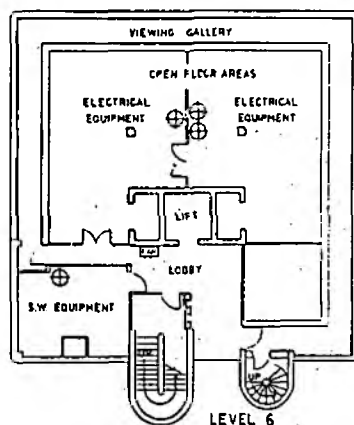
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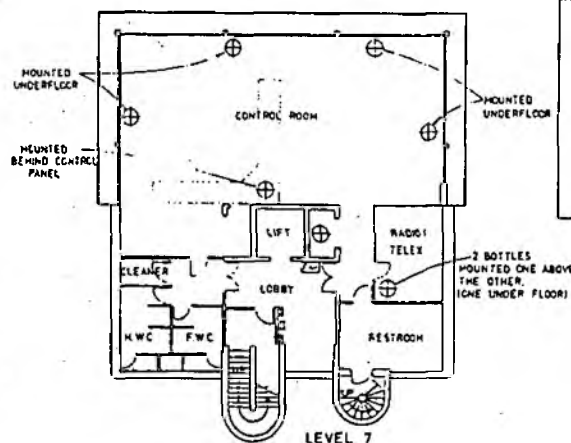
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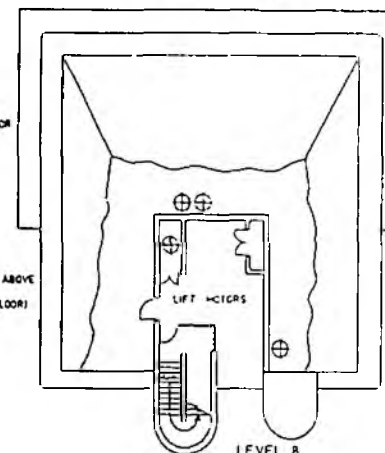
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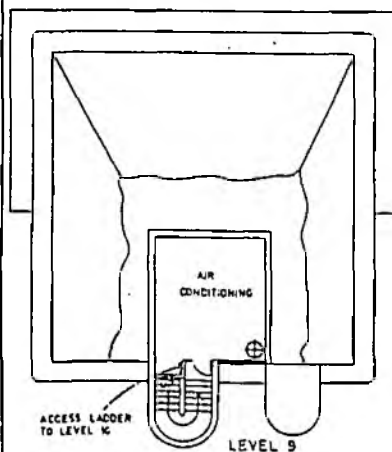
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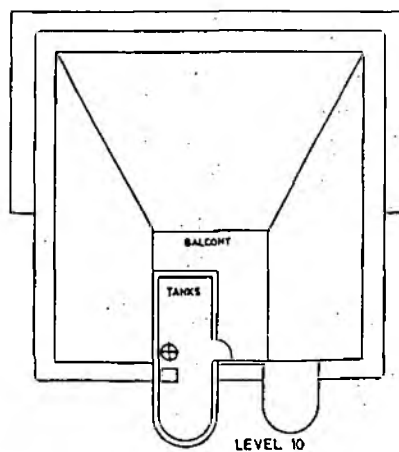
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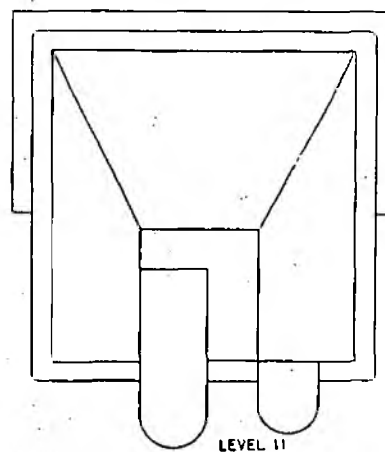
LEVEL 8



LEVEL 9



LEVEL 10



LEVEL 11

⊕ HALON BOTTLE
 ⊞ FIRE ALARM PANEL
 □ PASSAGE

REEL 172/441

REV BY DATE

THAMES BARRIER PROJECT	
FIREMANS ACCESS PLANS	
CONTROL TOWER	
DRAWN BY: SA	APPROVED: J. P. H.
CHECKED BY: J	DATE: 1 AUG 88
	DRAWING NO:
	TB / V0008

PALLADIUM
CONTAINER

WASTE
PAPER

STAFF CAR PARK

SOUTH ABUTMENT

PUBLIC
FOOTPATH

CABLE SUBWAY 1

CABLE SUBWAY 2

SUBSTATION 4

SUBSTATION 5

FILL

SUBSTATION 6

FILL

SOUTH GENERATOR
HOUSE

NORTH GENERATOR
HOUSE

PUMPWELL

PUMPWELL

DIESEL FUEL TANKS

DIESEL FUEL TANKS

INFLAMMABLE STORE

SOUTH STORE

WATER TANKS

NORTH STORE

- PF PREMIX FOAM
- CD CARBON DIOXIDE BOTTLE
- MR HOSE REEL
- SC SAFETY EQUIPMENT CABINET
- FA FIRE ALARM PANEL

REEL 172/442

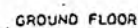
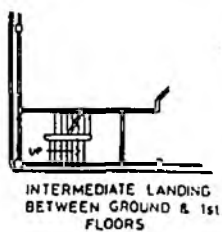
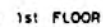
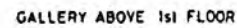
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THAMES BARRIER PROJECT

FIREMANS ACCESS PLANS
BASEMENT STORES & CAR PARK

DRAWN BY 578 APPROVED 578 G
CHECKED BY DATE 1

TB/V0009



⊕ MALON C-LINDER
 111 MOSE RE:.

REEL 172 / 443

REVISED OCTOBER 1978

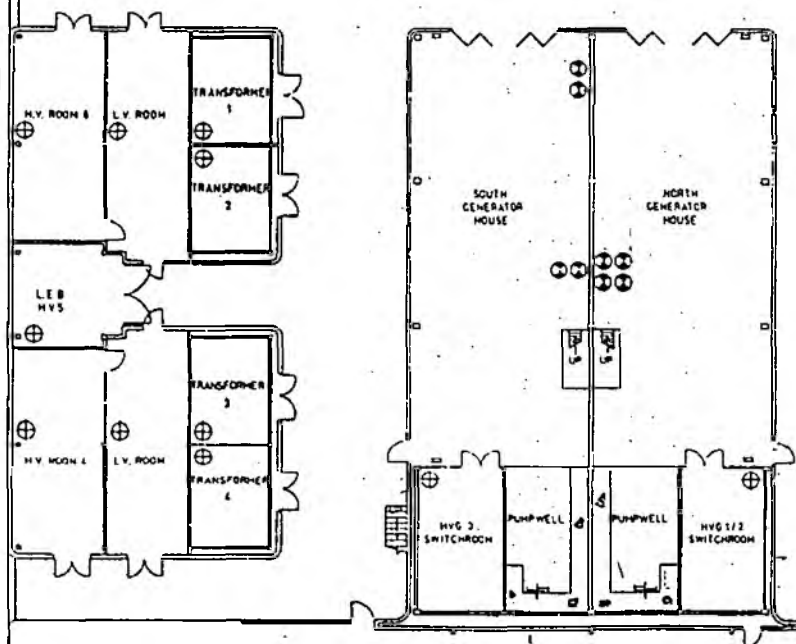
THAMES BARRIER PROJECT
FIREMAN'S ACCESS PLANS
WORKSHOP AREA AND OFFICES

NAME	578	ADDRESS	222
DATE		DATE	

TB/Y0010

RAMP UP →

CAR PARK



SEE WORKSHOP GROUND FLOOR PLAN
SEE DRS. N° 18/V0010/REEL 132/1661

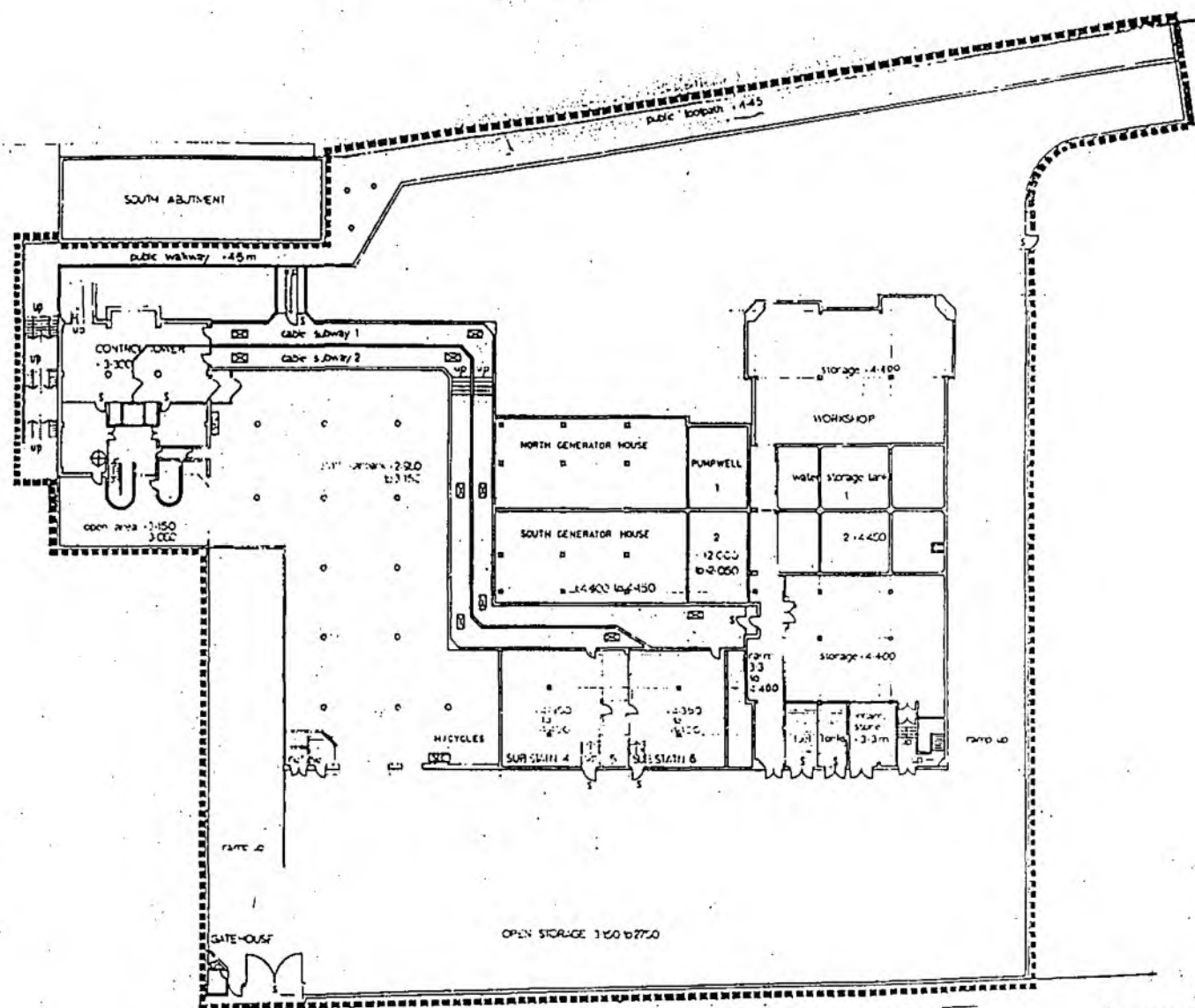
COOLER BASE



THE V.I.T.
COC APPROVAL

FIREMAN'S ACCESS PLANS
SUB-STATIONS & GENERATOR HOUSE

TB / YOOH



- ☒ HALON CYLINDER
☒ SAFETY EQUIPMENT CABINET
 5 - SECURITY DOORS
☒ SHORE OUTLETS

GREATER LONDON COUNCIL -
DEPARTMENT OF PUBLIC HEALTH ENGINEERING
SHANKS PLOD PREVENTION

THAMIS BARRIER PROJECT

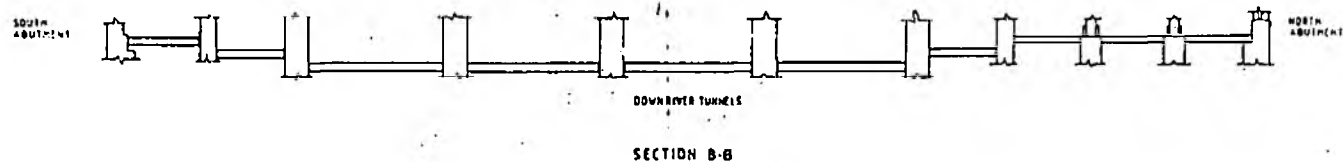
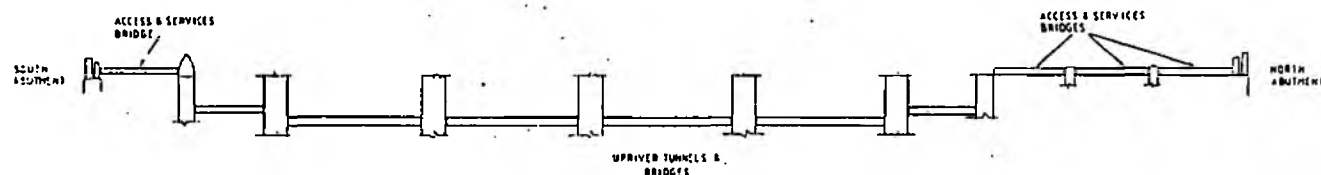
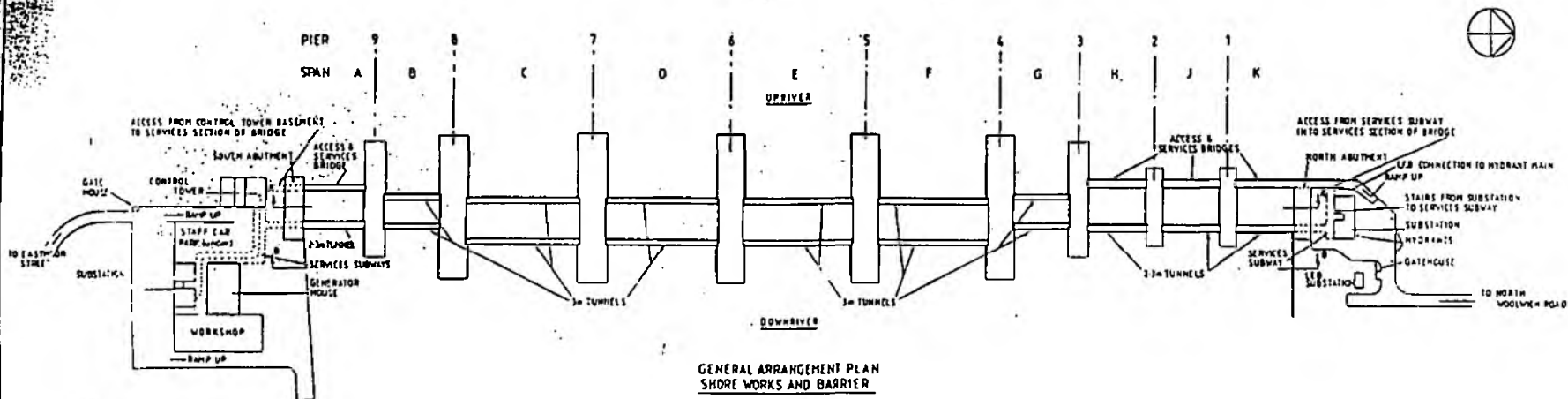
FIREMAN'S ACCESS PLANS
SITE LAYOUT BASEMENT LEVEL

6-10-66	APPROVED	J. AUST
EX-100-100	DATE	
DRAWING No.		
REVISIONS	SL1	
EX-100-100	07467/4531A	

REEL 172 / 445

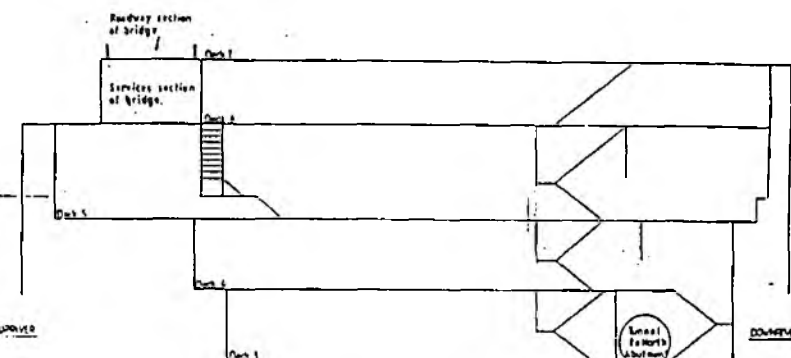
B	S/E		JUL 90	HALON CYLINDERS ADDED	
			OCT 89		
				GROUP CAL	

SCALE 1.201

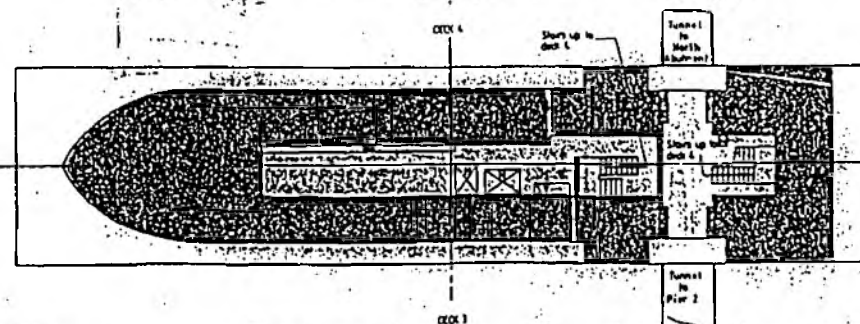









REEL 172 / 417

GREATER LONDON COUNCIL			
DEPARTMENT OF PUBLIC HEALTH ENGINEERING			
THAMES FLOOD PREVENTION			
THAMES BARRIER PROJECT			
FIREMANS ACCESS PLANS			
KEY PLAN			
DESIGNED BY	ENGINEER	DATE	PROJECT
DRAWN BY	CHECKED	DATE	PROJECT
DRAWING NO.			K1
REVISIONS			07/10/75



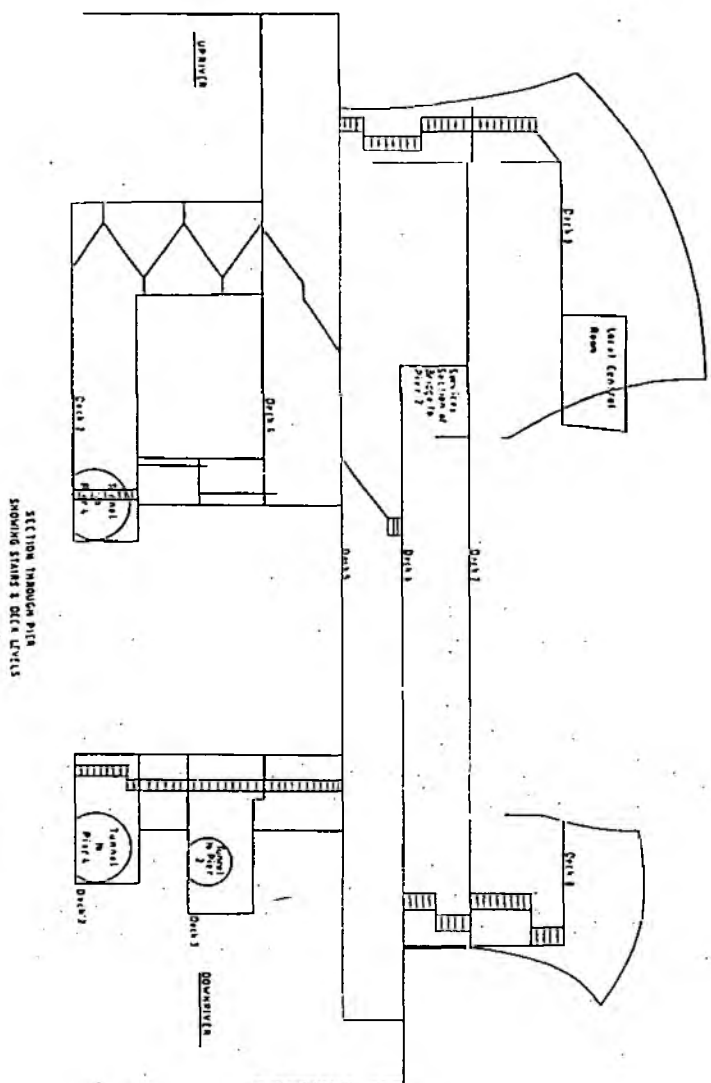
SECTION THROUGH P(2)
SHOWING STARS & DEER UNITS



-  Safety Equipment Cabinet
 Main Battery
 Freshwater Tank 5M
 Fire Alarm Panel
 Hatch
 1/2" Inboard
 5/8" Fire water zone stop valve

Single 1-1029					
B	LWB	DONOR	CHECK	58	(+) ADDED
A	SEC	NOV	27	Stop values & F&P add me.	
MT	NO	PTM	OFF	LWR	
GREATER LONDON COUNCIL DEPARTMENT OF PUBLIC HEALTH ENGINEERS THAMES FLOOD PREVENTION THAMES BARRIER PROJECT FIREMAN'S ACCESS PLANS PERTH DECKS 5, 6, 7 PERTH BRIDGE					
DRAWN BY		CHECKED BY		APPROVED	
ENGINEER				MANAGER	

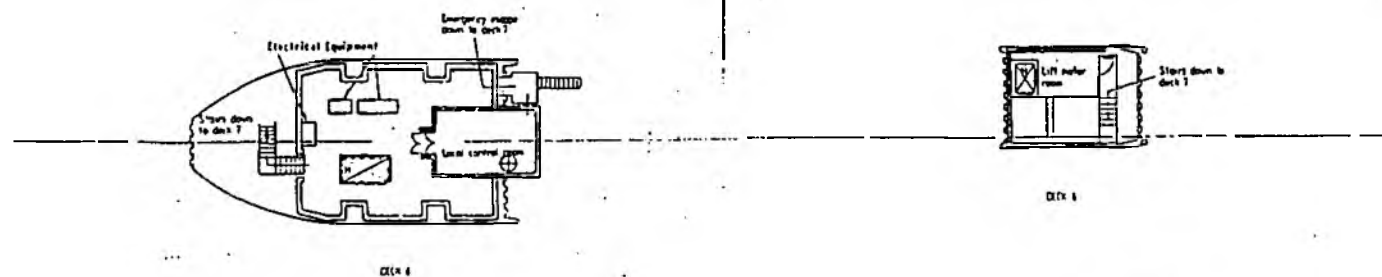
REEL 172/438



REEL 1721436.

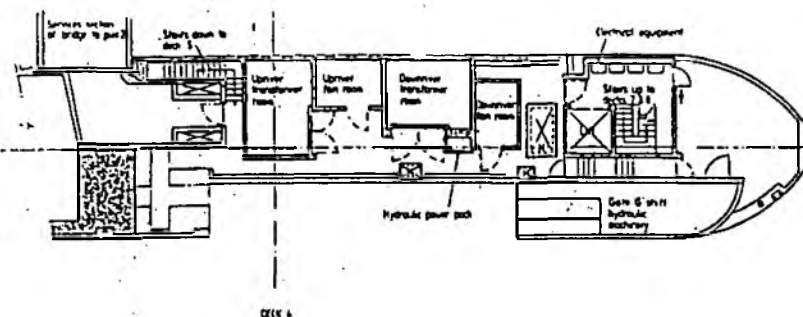
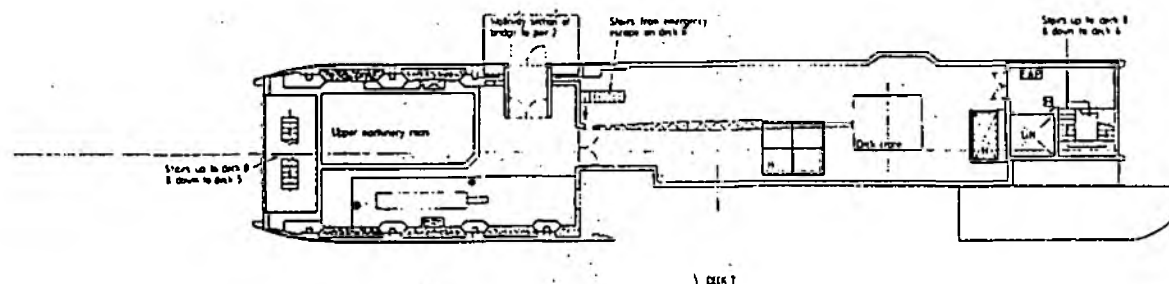
[illegible]

GALSTER, LONDON COUNCIL
INSTALLATION OF PUBLIC HEALTH BOARD
THIRD FLOOR RECEPTION



UPPER

DOWNER



REEL 172/435

- ⊕ Helon Bellis
- Fireman Vent SW
- ⊞ Fire Alarm Panel
- Hatch
- ↑ Hydrant

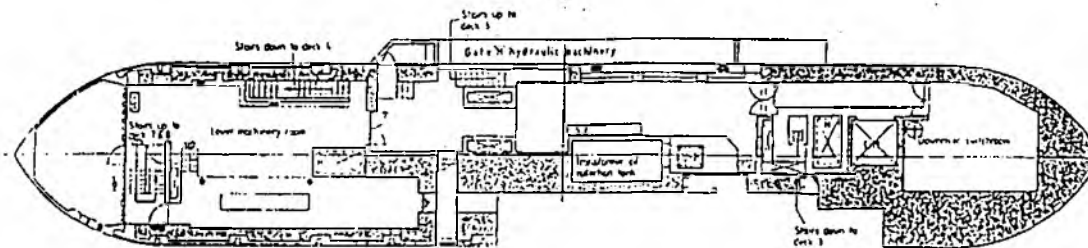
Scale 1:100

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7	7	7	7
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9	9	9	9
10	10	10	10

GREATER LONDON COUNCIL
DEPARTMENT OF PUBLIC HEALTH ENGINEERING
THAMES FLOOD PREVENTION

THAMES BARRIER PROJECT
FIREMANS ACCESS PLANS
PIER 3 - DECKS 6, 7 & 8

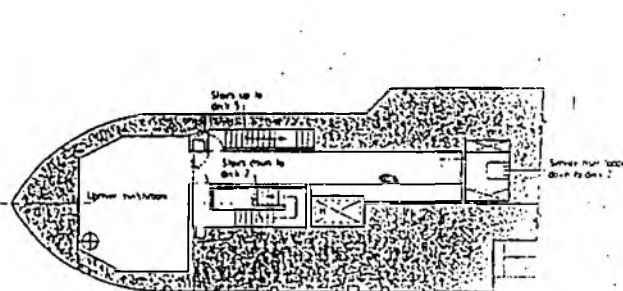
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DESIGNED BY	1/1/73	CHECKED	
DRAWING NO.		P3-2	
6164/16311 0			



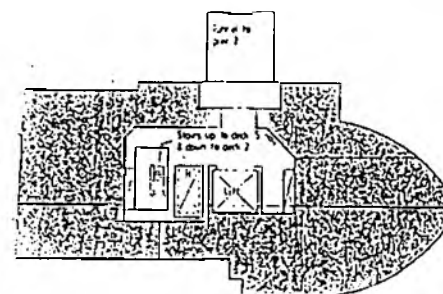
170018

DECK 5

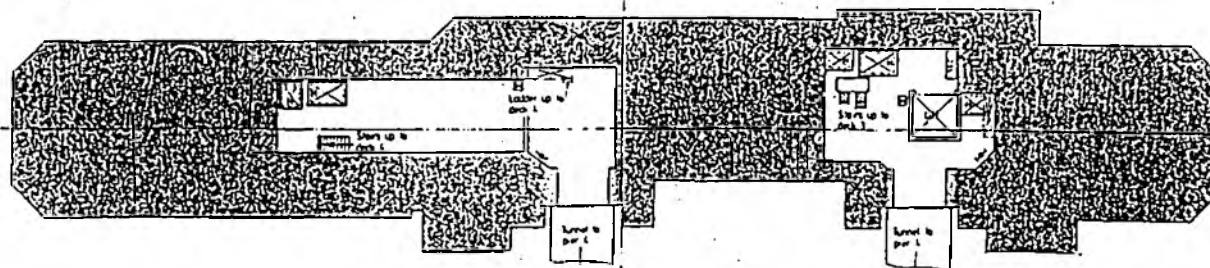
DOCK RIVER



DECK 4



DECK 3



DECK 2



REEL 172/434

EE Firemans Access Plan

SAFETY EQUIPMENT CABINET

HEAVY GATE

PIER

PIER

PIER WATER ZONE STOP VALVES

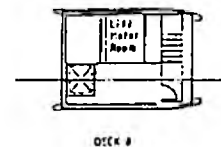
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GREATER LONDON COUNCIL
DEPARTMENT OF PUBLIC HEALTH ENGINEERING
THAMES FLOOD PREVENTION

THAMES BARRIER PROJECT
FIREMANS ACCESS PLANS
PIER 3 - DECKS 2,3,4,5

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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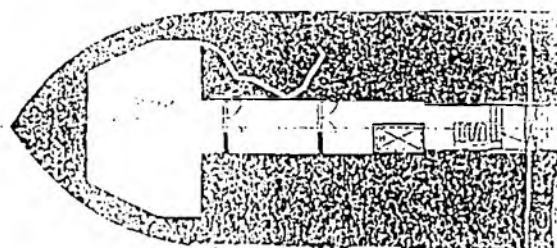
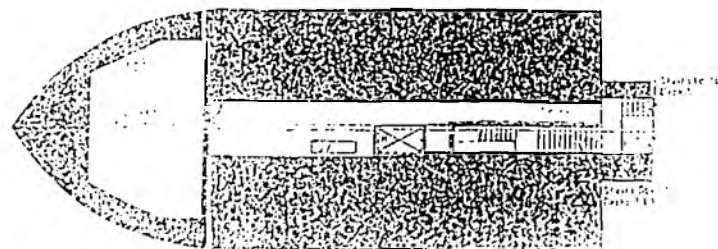
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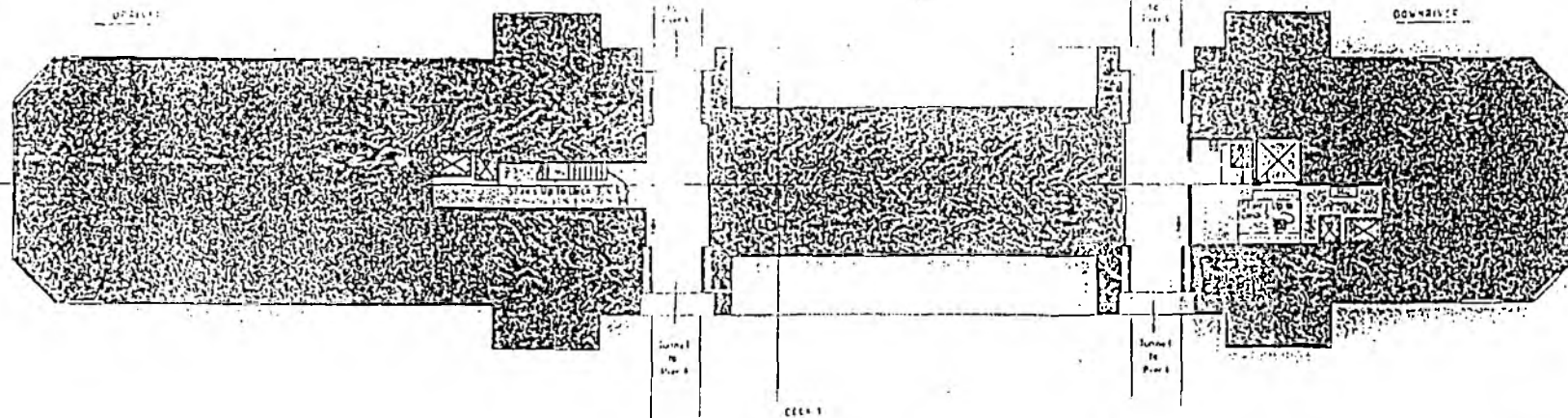
00W-21V(2)



NAME	DATE
CIRCLE	NO.
GROUP NAME & ADDRESS COMMUNITY CENTER 10000 100th Street Everett, WA 98203	DATE 11/11/81 11/11/81



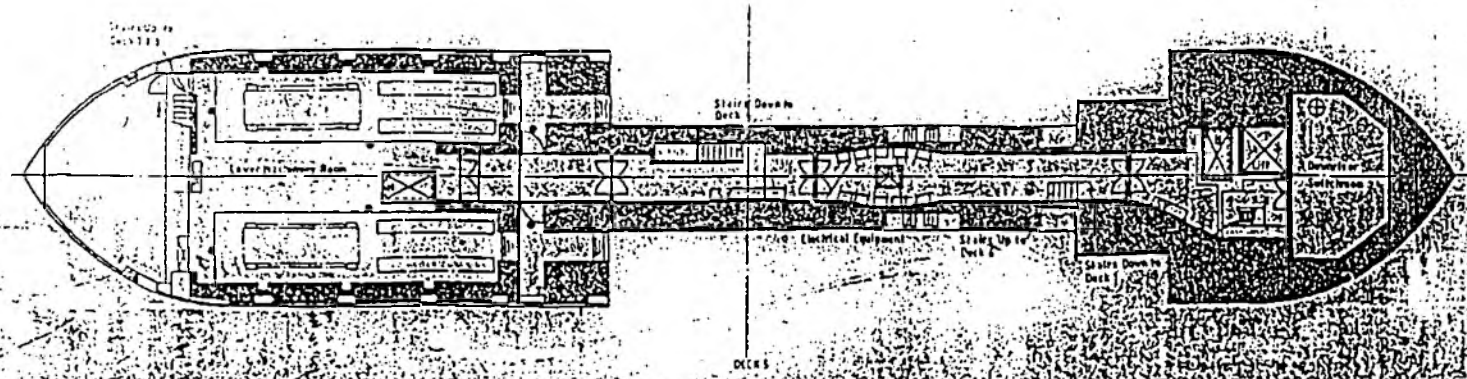
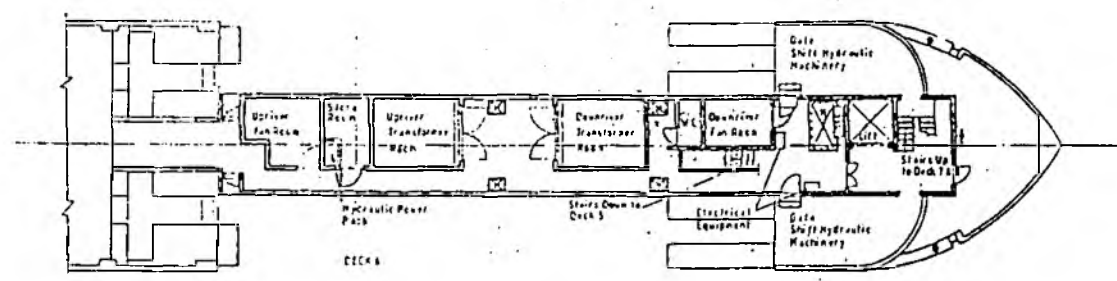
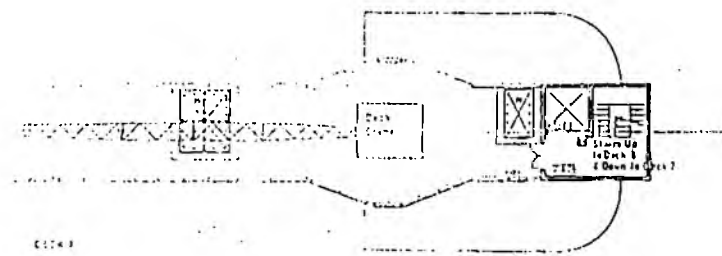
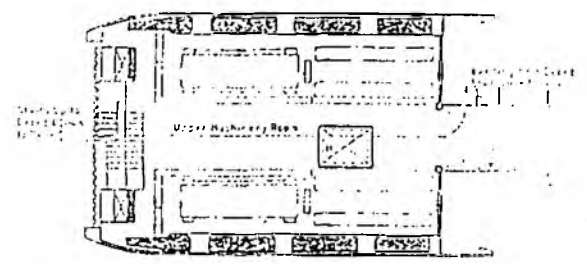
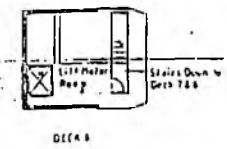
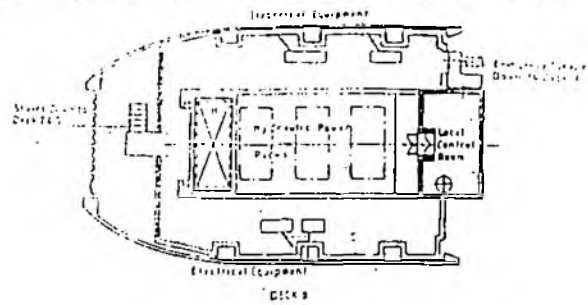
SECTION THROUGH PIER
SHOWING STAIRS & DECK LEVELS



- 1. Pier 5 Plans
- 2. Pier 5 Equipment Layout
- 3. Pier 5 Access Route
- 4. Pier 5 Stairs
- 5. Pier 5 Deck Levels
- 6. Pier 5 Fireman's Access

THAMES BARJER PROJECT	
FIREMAN'S ACCESS PLANS	
PIERS 5- DECKS 1, 3 & 4	
DATE	1972/4/29
BY	PS-1
CHECKED BY	PS-1
APPROVED BY	PS-1

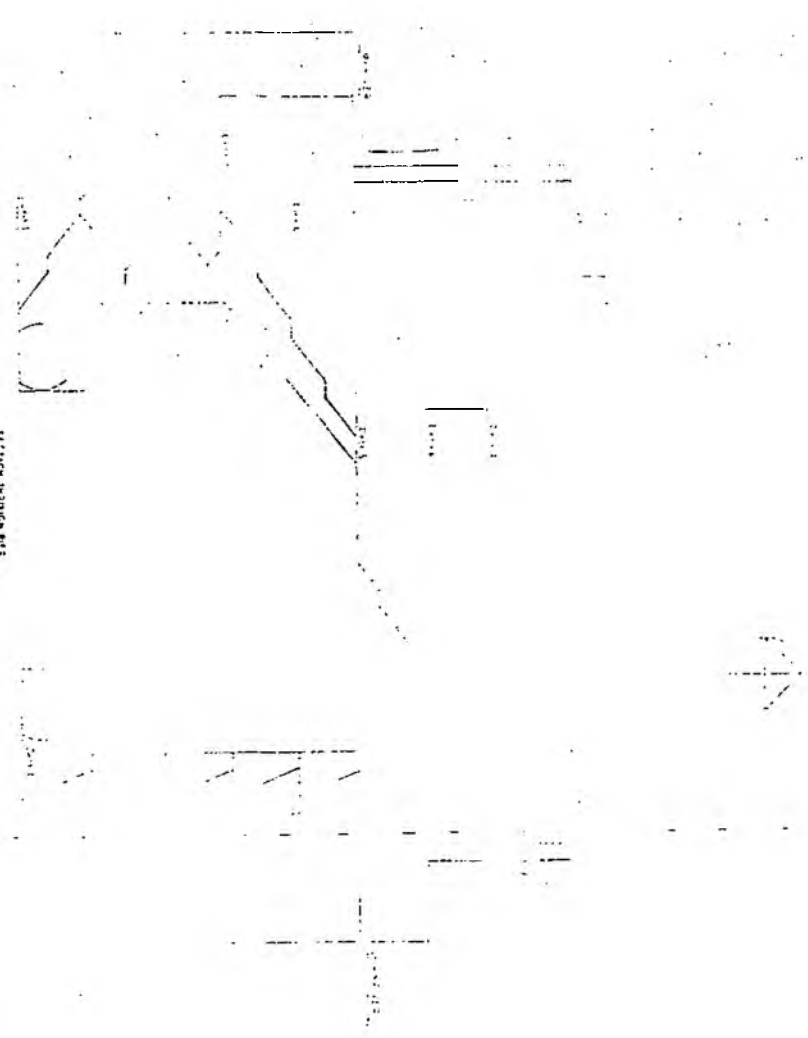
REEL 172/429



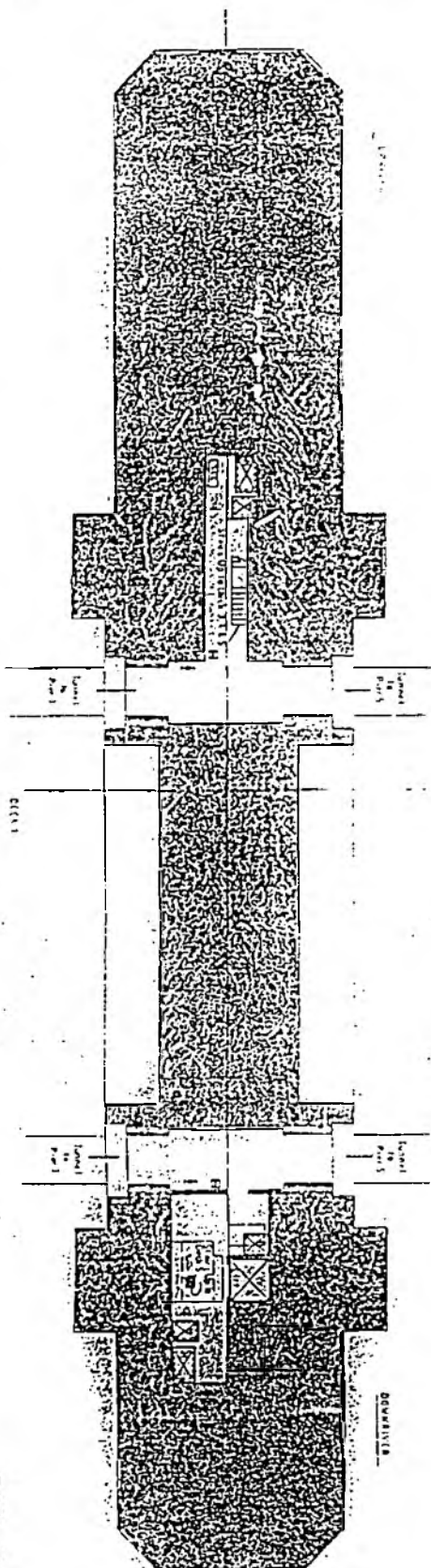
REEL 172/428

- Safety Equipment Cabinet
- Fireman's Vest Sign
- ⊕ Helon Butte
- Fire Alarm Panel
- Hatch
- Hydrant
- 1000 Motor (some ship select)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
<p>GREATER LONDON COUNCIL DEPARTMENT OF PUBLIC HEALTH FIREHANS ACCESS PLANS PIER 6 DECKS 5 & 6</p>																																																																																																			



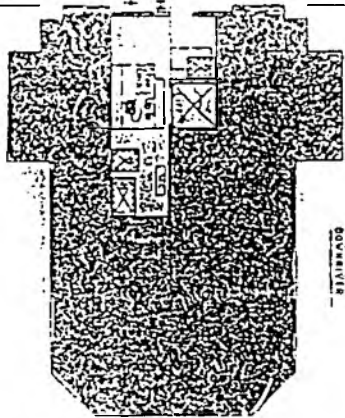
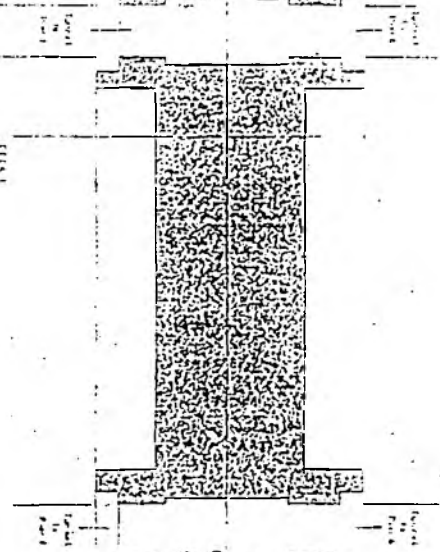
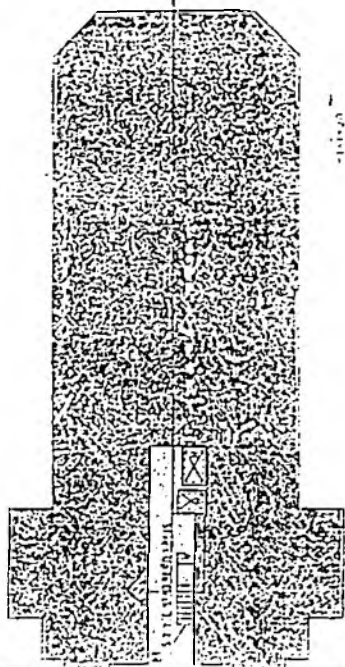
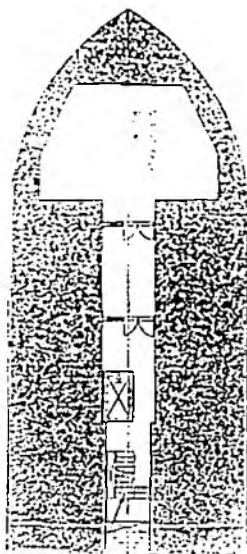
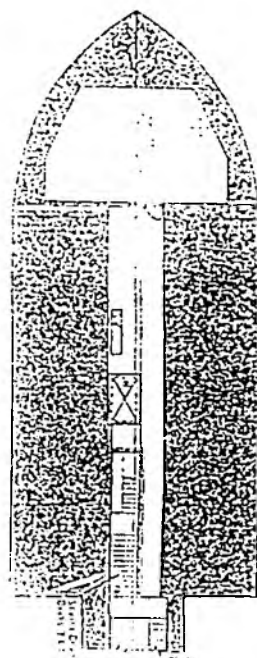
SHOWING STATUS & DATE



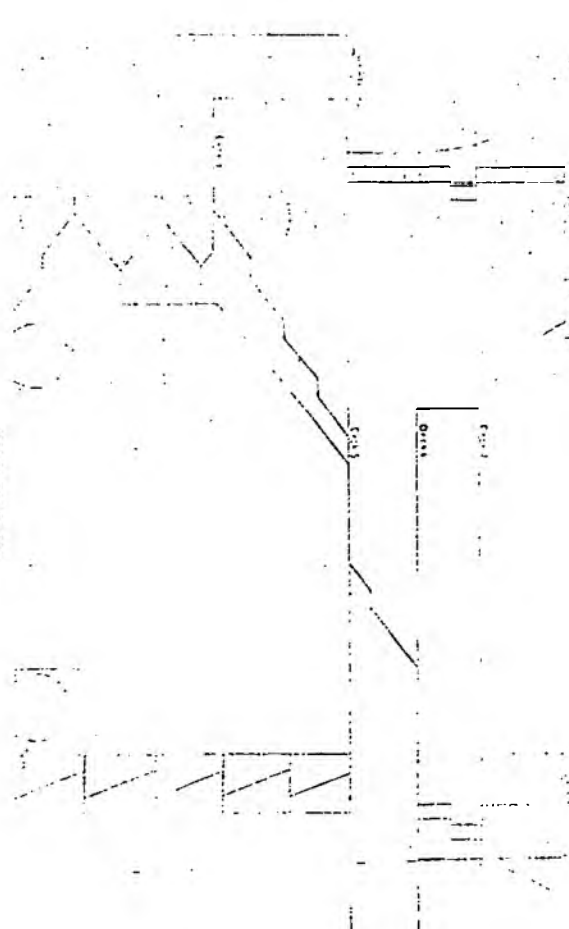
REEL 1721427

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[illegible]

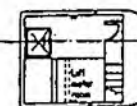


SECTION THROUGH PIA
SHOWING STAIRS & ELEV. LEVELS



REEL 1721425

GENERAL INFORMATION	
PROJECT NAME	THURGOOD & LOVELL COUNCIL
PROJECT NO.	1721425
DATE	1965-7-1
BY	ARCHITECT
CHECKED BY	ARCHITECT
APPROVED BY	ARCHITECT
DATE	1965-7-1
PROJECT NAME	THURGOOD & LOVELL COUNCIL
PROJECT NO.	1721425
DATE	1965-7-1
BY	ARCHITECT
CHECKED BY	ARCHITECT
APPROVED BY	ARCHITECT
DATE	1965-7-1

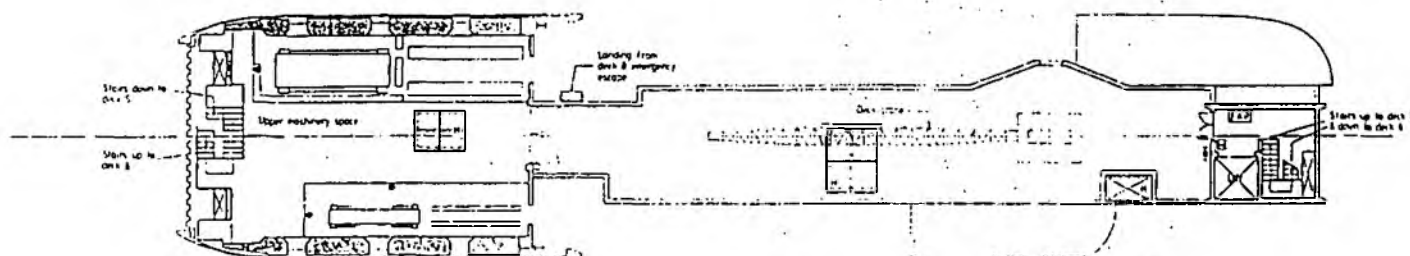


528

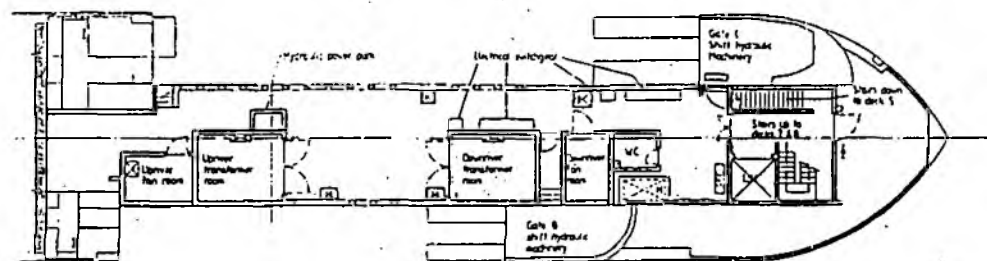
(b)(2)(v)

Q11 = 4

22-5000



241



Click on



- Flags** - 8 fragments used SW
- Globe** - Motion Battle
- Safety Equipment** - CBRN
- Life Alarm Panel**
- Map**

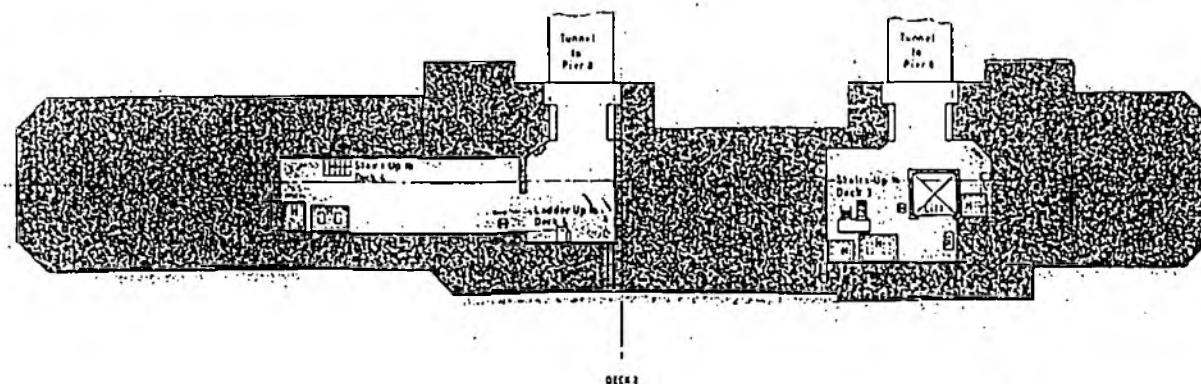
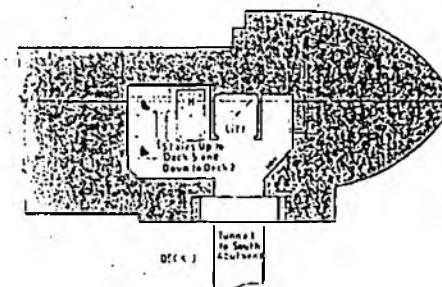
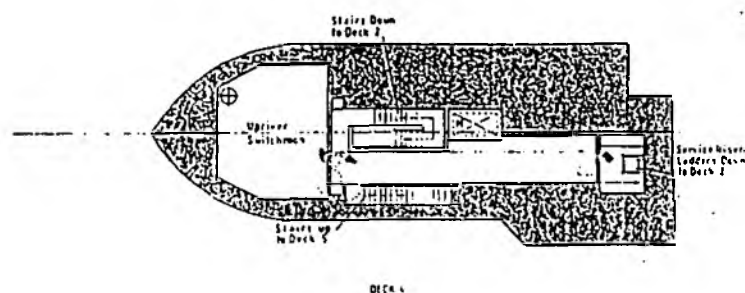
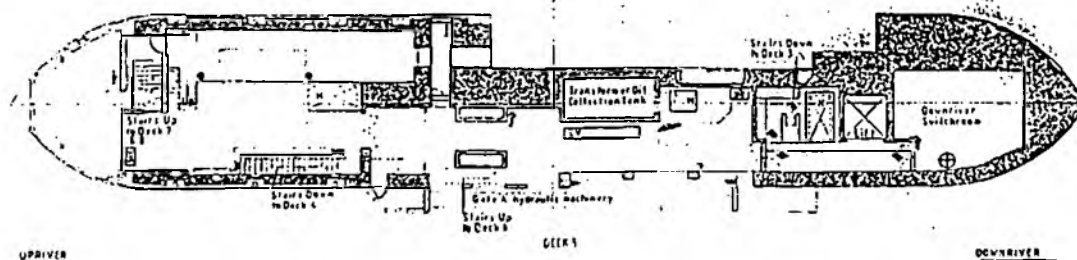
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A	JCE PFA		PBI	FAP Add-d	
M	N	KRM	WFF	HIR	







FIREMAN'S ACCESS PLANS
PIER 8 - DECKS 4, 7 & 8

DATE	10/10/10	TIME	10:10
BY	10/10/10	TIME	10:10
DRAWING NO.		P8-3	
10/10/10		10/10/10	

PA-3

07667/4503



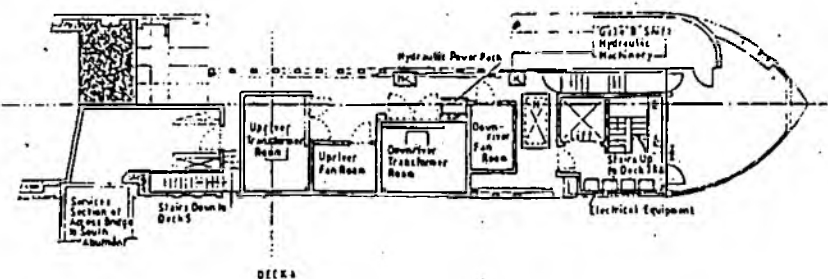
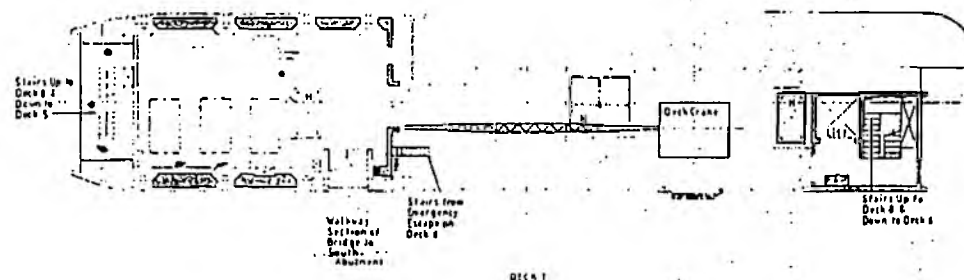
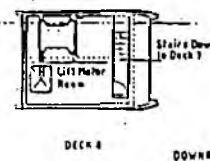
-  Halon Bulb
-  Safety Equipment Cabinet
-  Fireman's Tool
-  Match
-  Hydrant
-  Fire water hose nozzle




B	L.S.	TAG	ADD(+) CTS. B ADDED		
A	KC		SIX Six values added:		
0.1	R	CY	OFF	WRT	

GREATER LONDON COUNCIL
DEPARTMENT OF PUBLIC HEALTH (ENGINEERING)
FLOOD PREVENTION

THAMES BARRIER PROJECT
FIREFIGHTERS ACCESS PLANS
PIER 1-4 DECKS: 2, 3, 4, 5

NAME OF	SITE NO.	SPRING NO.	DATE
LOCATION OF			
		DRAWING NO.	
		29-1	



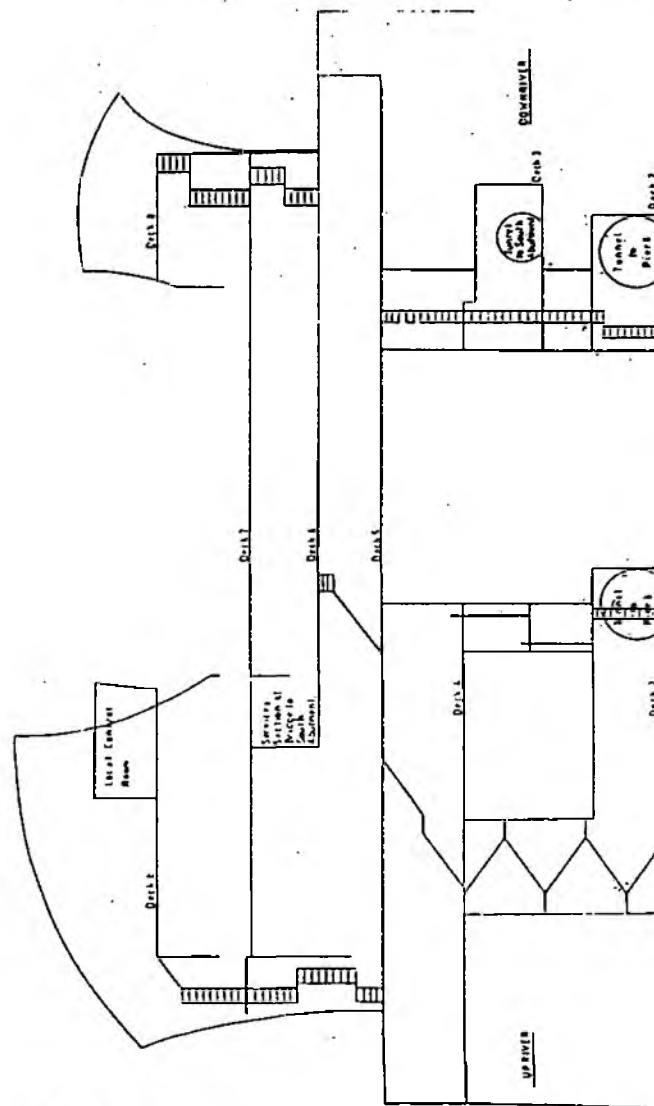
- ◆ Helen Cylinder
-  Fire Alarm Panel
-  Watch
-  Widow

B	SJB		7/04	7/07	Master Cylinder 00000
A	CC	2/76		7/03	PAP Addm
W	W	2/76	0/00	2/76	

GREATER LONDON COUNCIL
DEPARTMENT OF PUBLIC HEALTH ENGINEERS
THAMES FLOOD PREVENTION

THAMES BARRIER PROJECT
FIREMANS ACCESS PLANS
PIER 9 - DECKS 6,7 & 8

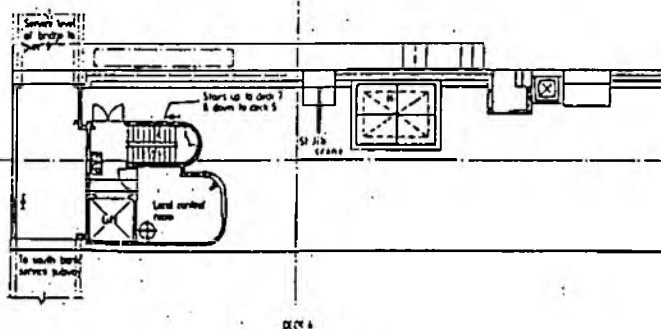
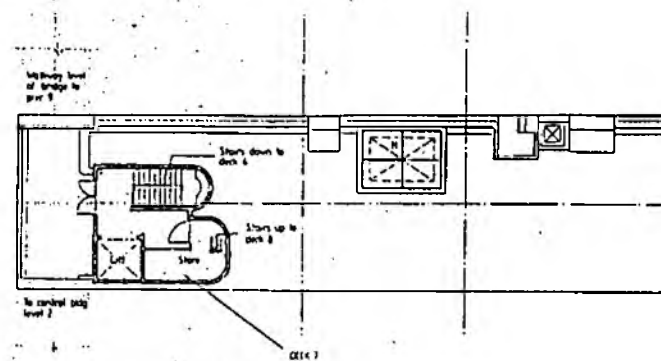
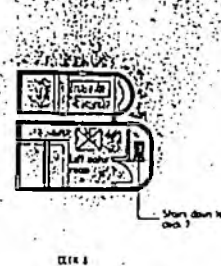
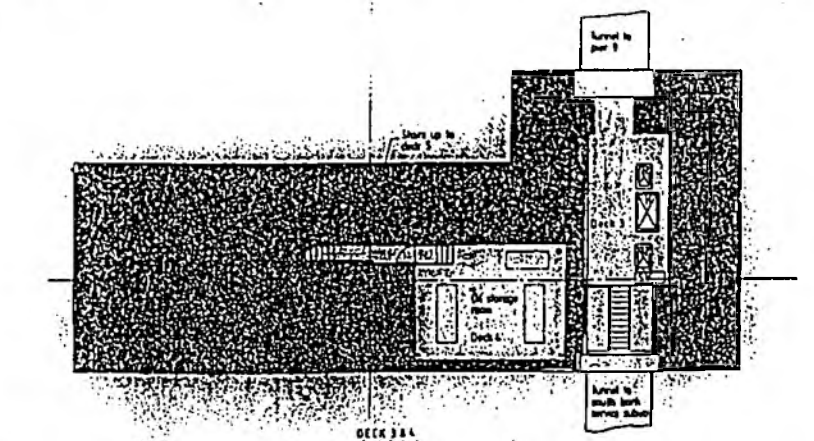
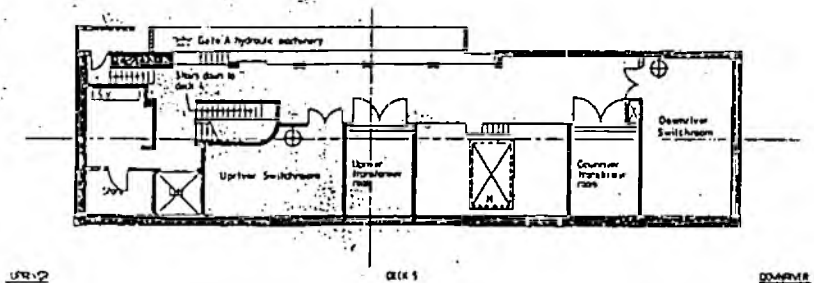
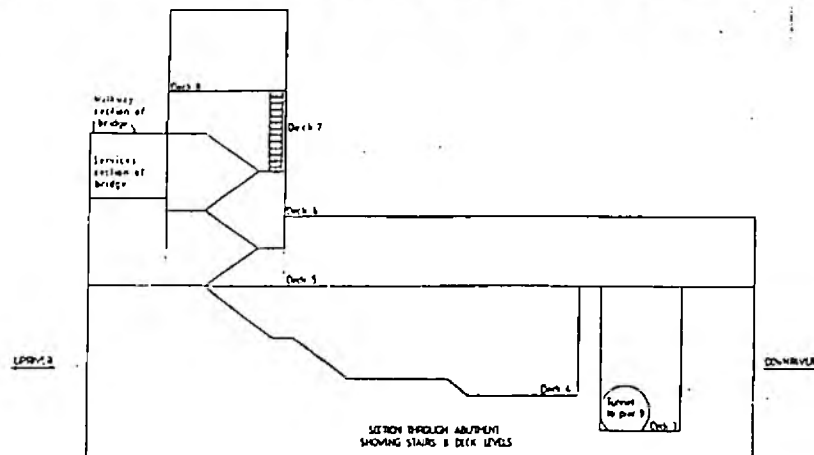
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CITY	STATE
SPECIAL AGENT U.S. DEPARTMENT OF JUSTICE FEDERAL BUREAU OF INVESTIGATION WASHINGTON, D.C. 20535	
DRAWING P9-2	



SECTION THROUGH PIER
SHOWING STAIRS & DECK LEVELS

REEL 172 / 421

GALATHEA LONDON COUNCIL	
DEPARTMENT OF PUBLIC RELATIONS & COMMUNICATIONS	
THAMES RIVER PROJECT	
FIREHARMS ACCESS PLANS	
PIER 9-SECTION	
DATE	27.11.83
BY	PLANNING
NO.	88-3
THAMES RIVER PROJECT	
FIREHARMS ACCESS PLANS	
PIER 9-SECTION	



REEL 172/418

- ⊕ Manhole
- ⊗ Fire alarm panel
- ⊗ Hatch
- ⊗ Hydrant
- ⊗ Fire water pump stop valves

Scale 1:100											
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385	386	387	388	389	390	391	392	393	394	395	396
397	398	399	400	401	402	403	404	405	406	407	408
409	410	411	412	413	414	415	416	417	418	419	420
421	422	423	424	425	426	427	428	429	430	431	432
433	434	435	436	437	438	439	440	441	442	443	444
445	446	447	448	449	450	451	452	453	454	455	456
457	458	459	460	461	462	463	464	465	466	467	468
469	470	471	472	473	474	475	476	477	478	479	480
481	482	483	484	485	486	487	488	489	490	491	492
493	494	495	496	497	498	499	500	501	502	503	504
505	506	507	508	509	510	511	512	513	514	515	516
517	518	519	520	521	522	523	524	525	526	527	528
529	530	531	532	533	534	535	536	537	538	539	540
541	542	543	544	545	546	547	548	549	550	551	552
553	554	555	556	557	558	559	560	561	562	563	564
565	566	567	568	569	570	571	572	573	574	575	576
577	578	579	580	581	582	583	584	585	586	587	588
589	590	591	592	593	594	595	596	597	598	599	600
601	602	603	604	605	606	607	608	609	610	611	612
613	614	615	616	617	618	619	620	621	622	623	624
625	626	627	628	629	630	631	632	633	634	635	636
637	638	639	640	641	642	643	644	645	646	647	648
649	650	651	652	653	654	655	656	657	658	659	660
661	662	663	664	665	666	667	668	669	670	671	672
673	674	675	676	677	678	679	680	681	682	683	684
685	686	687	688	689	690	691	692	693	694	695	696
697	698	699	700	701	702	703	704	705	706	707	708
709	710	711	712	713	714	715	716	717	718	719	720
721	722	723	724	725	726	727	728	729	730	731	732
733	734	735	736	737	738	739	740	741	742	743	744
745	746	747	748	749	750	751	752	753	754	755	756
757	758	759	760	761	762	763	764	765	766	767	768
769	770	771	772	773	774	775	776	777	778	779	780
781	782	783	784	785	786	787	788	789	790	791	792
793	794	795	796	797	798	799	800	801	802	803	804
805	806	807	808	809	810	811	812	813	814	815	816
817	818	819	820	821	822	823	824	825	826	827	828
829	830	831	832	833	834	835	836	837	838	839	840
841	842	843	844	845	846	847	848	849	850	851	852
853	854	855	856	857	858	859	860	861	862	863	864
865	866	867	868	869	870	871	872	873	874	875	876
877	878	879	880	881	882	883	884	885	886	887	888
889	890	891	892	893	894	895	896	897	898	899	900
901	902	903	904	905	906	907	908	909	910	911	912
913	914	915	916	917	918	919	920	921	922	923	924
925	926	927	928	929	930	931	932	933	934	935	936
937	938	939	940	941	942	943	944	945	946	947	948
949	950	951	952	953	954	955	956	957	958	959	960
961	962	963	964	965	966	967	968	969	970	971	972
973	974	975	976	977	978	979	980	981	982	983	984
985	986	987	988	989	990	991	992	993	994	995	996
997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008
1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020
1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032
1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044
1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056
1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068
1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080
1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092
1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104
1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116
1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128
1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140
1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152
1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164
1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176
1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188
1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200
1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212
1213	1214	1215	1216	1217	1218	1219	1220	1221	1222	1223	1224
1225	1226	1227	1228	1229	1230	1231	1232	1233	1234	1235	1236
1237	1238	1239	1240	1241	1242	1243	1244	1245	1246	1247	1248
1249	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260
1261	1262	1263	1264	1265	1266	1267	1268	1269	1270	1271	1272
1273	1274	1275	1276	1277	1278	1279	1280	1281	1282	1283	1284
1285	1286	1287	1288	1289	1290	1291	1292	1293	1294	1295	1296
1297	1298	1299	1300	1301	1302	1303	1304	1305	1306	1307	1308
1309	1310	1311	1312	1313	1314	1315	1316	1317	1318	1319	1320
1321	1322	1323	1324	1325	1326	1327	1328	1329	1330	1331	1332
1333	1334	1335	1336	1337	1338	1339	1340	1341	1342	1343	1344
1345	1346	1347	1348	1349	1350	1351	1352	1353	1354	1355	1356
1357	1358	1359	1360	1361	1362	1363	1364	1365	1366	1367	1368
1369	1370	1371	1372	1373	1374	1375	1376	1377	1378	1379	1380
1381	1382	1383	1384	1385	1386	1387	1388	1389	1390	1391	1392

Appendix 2

Energy Calculations

1.0 CONNECTED LOADS

1.1 NORTH SUBSTATION AND SOUTH SUBSTATION

Lighting

14 x 5ft 80 watt = 1,120 watts

32 x 6ft 80 watt = 3,200 watts

Total Lighting = 4,320 watts (4.3 kW)

Emergency Lighting/UPS 5 kVA diversity factor 0.75 = 3 kW input load
(losses 0.5kW)

Oil filled panel heaters 9 x 1.5 kW = 13.5 kW

Miscellaneous:	100 volt 3 kVA/transformer	}	
	Switchgear cubicle heaters	}	1.0 kW
	Tripping battery chargers	}	
	Ventilation dampers/fans	}	

Total connected load = 19 kW/substation

1.2 GENERATOR HOUSE NORTH (2 x 1.5mw enclosures)

Lighting:	3 x 250w MBIF	=	750 watts
	8 x 80w fluorescents	=	640 watts
	11 x 100w fluorescents	=	640 watts
	8 x 140w fluorescents	=	1,100 watts
	8 x 140w fluorescents	=	1,120 watts
	8 x 160w fluorescents	=	1,280 watts

Total lighting = 4.9 kW

Heating:	9 x wall mounted panel radiators @ 3kW	=	27 kW
	2 x wall mounted fan heaters @ 3kW	=	6 kW
	1 x oil filled radiator @ 1.5kW	=	1.5 kW

= 34.5 kW

Fire Protection:	Hydrant pump	150 kW	}	
	Sprinklers	45 kW	}	234 kW
	Jockey pumps	17 kW	}	
	Compressor	22 kW	}	

Miscellaneous: 110 v 3 KVA transformer, 2 x 5 kW
 Compressor motors
 Trace heating, vent fans and water tank
 Immersion heaters 15 kW

Total connected load = 288.4 kW

1.3 GENERATOR HOUSE SOUTH (1 x 1.5mw enclosure)

Lighting:	as North	=	4.9 kW
UPS emergency lighting		=	7.0 kW (input)
UPS Losses		=	1.0 kW

Heating:	as North	=	34.5 kW
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Fire Protection:	as North	=	234 kW
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Miscellaneous:	as North	=	15 kW
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Total Connected Load = 289.4 kW
 (includes UPS losses)

1.4 WORKSHOP/STORES/OFFICES

Lighting:	10 x 6ft 180 watt	=	1.8 kW
	38 x 6ft 100 watt	=	3.8 kW
	38 x 5ft 160 watt	=	6.0 kW
	24 x 5ft 80 watt	=	2.0 kW
	6 x 5ft 320 watt	=	2.0 kW
	9 x 4ft 120 watt	=	1.0 kW
	2 x 4ft 80 watt	=	0.2 kW
	12 x MBIF 250 watt	=	2.5 kW
		=	20.3 kw

Add say 12 miscellaneous fittings, eg. toilets, corridors, etc. at 100 watts

(20.3 + 1.2)kW

161 fittings = 21.5 kw

Add lower level stores (PIR control)

= 3.5 kw

Total Lighting

= 25 kw

Kitchen: Oven, hotplates, fridge, microwave;
fryers, water heaters etc

= (allow) 30 kw.

Heating/Ventilation/Air Conditioning:

Electrode boilers 144 kW + 275kW = 419 kW

Clean room AC unit = 3 kW

Planning office AC unit = 7 kW

Pumps 2 x 1.1 kW (run/standby) = 1.1 kW

DHWS calorifiers 2 x 6kW = 12 kW

Fan coil heaters (4 x 0.75kW) + (4 x 0.5kW) = 5 kW

Total = 447 kW

Office equipment:

Copiers/PC's/printers/file servers = 10 kW

Miscellaneous/other:

Roof vent compressor = 1 kW

Pneumatic tool comp = 18 kW

Lathes, grinders, milling, etc. = 30-40 kW

Total = 60 kW

1.5 CONTROL TOWER

Lighting

Level 7 (inc. roof/plant) General = 2.5 kW
 Mimic Panel = 1.0 kW
 = 3.5 kW

Level 6 = 2.6 kW

Level 5 = 1.7 kW

Level 4 = 2.8 kW

Level 3 = 2.0 kW

Level 2 = 3.6 kW

Level 1 = 1.5 kW

Other areas, circulation, wc's etc. = 1.0 kW
= 18.7 kW

Heating: 2 x 145 kw electrode boilers = 290 kW
 2 x 6 kw calorifiers = 12 kW
 Circulation pumps = 2 kW
 = 304 kW

Air Conditioning:

Chiller - 2 x 4 kW electrical (11 kW cooling) = 8 kW

Chiller - 2 x 20 kW electrical (55kW cooling) = 40 kW

Fans/fan coil units/AHU's = 6 kW

= 54 kW

Miscellaneous Loads:

	Microwave cooker, cooker, TV, fridge	=	5 kW
Level 5/6	computer equipment/PABX	=	5 kW
	Mawdsley UPS	=	4 kW
	2 Best UPS	=	6 kW
Level 7	PC's, BMS, comms, etc.	=	3 kW
Level 3	PC's, copiers, printers	=	3.5 kW

1.6 EXTERNAL STORE 1

Lighting	=	12 kW
Heating	=	15 kW
	=	27 kW

1.7 EXTERNAL STORE 2

Lighting	=	4 kW
Heating	=	18 kW
	=	22 kW

1.8 PIERS AND TUNNELS (connected electrical loads)

	Size	Heating	kW		
			Vent	80% ltg	20% UPS ltg
North abutment	Small	58	5	8.8	2.2
Pier 1	Medium	116	10	18.0	4.5
Pier 2	Medium	116	10	18.0	4.5
Pier 3	Medium	116	10	18.8	4.7
Pier 4	Large	116	10	18.8	4.7
Pier 5	Large	116	10	18.8	4.7
Pier 6	Large	116	10	18.8	4.7
Pier 7	Large	116	10	18.8	4.7
Pier 8	Large	116	10	18.8	4.7
Pier 9	Medium	116	10	18.8	4.5
South abutment	Small	58	5	8.8	2.2
Totals		1,160	100	184.4	46
UPS losses will reduce to approx 5 kW when the new 'Best' units are installed					10 (losses) 56
TOTAL LIGHTING LOAD					240.4 kW

Hydraulic pump motors	-	12 @ 148 kW = 1,776 kW
	-	12 @ 78 kW = 936 kW
	-	10 @ 45 kW = 450 kW
Shift mechanisms	-	20 @ 45 kW = 900 kW

Maximum operating power to raise one large gate = 300 kW for a period of say 15 minutes.

1.9 TOTAL CONNECTED LIGHTING LOAD

Building	kW	Diversity		Operating Load	
		Winter	Summer	Winter	Summer
North Substation	4.3	0.1	0.1	0.4	0.4
South Substation	4.3	0.1	0.1	0.4	0.4
Generator House North	4.9	0.5	0.5	2.5	2.5
Generator House South	4.9	0.5	0.5	2.5	2.5
Workshop/Offices/stores	25	0.9	0.7	22.5	17.5
Control Tower	18.7	0.85	0.4	15.9	7.5
Car Park	2.0	1.0	1.0	2.0	2.0
Totals	64.1			46.2	32.8
Piers/tunnels	230.4				
UPS losses	10				
Other UPS losses	5				
External Lighting	75				
Total	384.5 kW				
Shed 1	12 kW				
Shed 2	4 kW				

2.0 INTERNAL LIGHTING

2.1 ESTIMATED ANNUAL OPERATING COSTS/LOADS

Operating Period

Summer period 22 weeks

Winter period 30 weeks (7 months)

Support Buildings

Summer $22 \times 5 \times 12 \times (32.8 + 5) = 49,896 \text{ kWh}$

Winter $30 \times 5 \times 12 \times (46.2 + 5) = 92,160 \text{ kWh}$

Piers/Tunnels

20% of all lighting (supplied from UPS) is on for 24 hours per day for 365 days per year

= 8760 hours/year

therefore $8760 \times 56 \text{ kW} = 490,560 \text{ kWh}$

Piers 5, 6 & 7 normal lighting (80% of total) is only switched on for 12 hours per day for 5 days per week:

Lighting load = $3 \times 18.8 \text{ kW} = 56.4 \text{ kW}$

therefore $12 \times 5 \times 52 \times 56.4 = 175,968 \text{ kWh}$

10% of the normal lighting (ie. 10% of 80%) is off all the time (Piers 1, 2, 3, 4, 8 and 9, North and South abutments), therefore the lighting load is $128 \text{ kW} \times 0.9 = 115.2 \text{ kW}$. This lighting is on for 24 hours per day for 365 days per year = $115.2 \text{ kW} \times 8760 = 1,009,152 \text{ kWh}$.

Total annual operating load internal lighting = 1,817, 736 kWh @ 4.5p/kWh
= £81,798.12

Total for pier/tunnels = 1,675,680 kWh/years @ 4.5p
= £75,405.60

2.2 **ESTIMATED LIGHTING OPERATING COSTS AND ENERGY CONSUMPTION - PIERS AND TUNNELS**

A	PRESENT SITUATION (Stage 1)	kWh	£	CO₂ Tonnes
	Emergency lighting 20% lighting 'on' 24 hours per day, 365 days per year (load 56KW)	490,560	22,075	
	PIERS 5, 6, 7 - Normal lighting 12 hours per day, 5 days per week (load 56.4 KW)	175,968	7,918	
	OTHER PIERS AND ABUTMENTS - 1,2,3,4,8 and 9, N & S abutments. Normal lighting 24 hours per day, 365 days per year (load 115.2 KW)	1,009,152	45,412	
	TOTAL (Stage 1)	1,676,580	75,406	1,173
B	UNDER IMPLEMENTATION (Stage 2)			
	Emergency lighting 20% lighting 'on' 24 hours per day, 365 days per year (load 56 KW)	490,560	22,075	
	PIERS 5, 6, 7 - Normal lighting 12 hours per day, 5 days per week (load 56.4 KW)	175,968	7,918	
	PIER 1, 2, 3, 4, 8 AND 9, N & S ABUTMENTS - Normal lighting 'on' 12 hours per day, 5 days per week (load 115.2 KW)	359,424	16,174	
	TOTAL STAGE 2	1,025,952	46,167	718
C	POTENTIAL (STAGE 3)			
	Emergency lighting 20% lighting 'on' 24 hours per day, 365 days per year	490,560	22,075	
	PIERS 1,2,3,4,5,6,7,8,9 AND N & S ABUTMENT - Say reduce lighting 'on' to 50% 12 hours per day 5 days per week Load (115.2KW + 56.4 KW) = 171.6 KW/2 = 85.8 KW	267,256	12,046	
	TOTAL (STAGE 3)	758,256	34,121	530

3.0 *BUILDING AREAS*

Substation North	215m ²		
Substation South	215m ²		
Generators total footprint (16m x 25m)	400m ²		
Workshop footprint (44m x 18m)	792m ²]	
Workshop offices inc. planning (44 x 4) + (10 x 12)m ²	296m ²]	1588m ² NU
Mezzanine stores	-]	
Low level stores	500m ²]	
Control footprint. 13 x 13 NU (169m ²)	1,183m ²		
Level 7 to level 1 inc. (7 x 169m ²)			

4.0 EXTERNAL LIGHTING

4.1 CONNECTED LOAD

External lighting (Photo electric and time clock control - two thirds off at 12.30am).

70w SON	75 off x 83	=	6.2KW
80w MBI	41 off x 90	=	3.7KW
150w SON & SONT	122 off x 200	=	24.4KW
250w MBI & SONT	82 off x 228	=	23.6KW
400w SONT	6 off x 450	=	2.7KW
400w MBI	12 off x 450	=	5.4KW
400w SONT (high mast)	20 off x 450	=	9.0KW
Total			75KW

4.2 OPERATING HOURS

THAMES BARRIER - EXTERNAL LIGHTING				
Available Hours of Daylight	Average Daylight Hours Per Day	Average Hours of Darkness Per Day	Hours 100% Lighting (to 12.30am)	33 1/3 ltg
Jan 7.30 - 16.30	9	15	8	7
Feb 7.00 - 17.00	10.0	14	7	7
Mar 5.30 - 18.30	13.0	11	6	5
Apr 5.00 - 19.00	14.0	10	4	6
May 4.00 - 21.00	16.0	8	3	5
June 4.00 - 21.00	16.0	8	3	5
July 4.00 - 21.00	16.0	8	3	5
Aug 4.00 - 21.00	16.0	8	3	5
Sept 5.00 - 19.00	14.0	10	4	6
Oct 5.30 - 18.00	13.0	11	6	5
Nov 6.30 - 17.00	10.0	14	7	7
Dec 7.30 - 16.30	9.0	15	8	7

4.3 ENERGY CONSUMPTION

THAMES BARRIER - EXTERNAL LIGHTING			
External lighting load 75kw on until 12.30am $\frac{1}{3}$ = 15kw on from 12.30am			
Month	Calculations	KWH	Total KWH Per Month
January	31 days x 8 = 248 hrs x 75kw 31 days x 7 = 217 hrs x 15kw	18,600 3,255	21,855
February	28 days x 7 = 196 hrs x 75kw 28 days x 7 = 196 hrs x 15kw	14,700 2,940	17,640
March	31 days x 6 = 186 hrs x 75kw 31 days x 5 = 155 hrs x 15kw	13,950 2,325	16,275
April	30 days x 4 = 120 hrs x 75kw 30 days x 6 = 180 hrs x 15kw	9,000 2,700	11,700
May	31 days x 3 = 93 hrs x 75kw 31 days x 5 = 155 hrs x 15kw	6,975 2,325	9,300
June	30 days x 3 = 90 hrs x 75kw 30 days x 5 = 150 hrs x 15kw	6,750 2,250	9,000
July	31 days x 3 = 93 hrs x 75kw 31 days x 5 = 155 hrs x 15kw	6,975 2,325	9,300
August	31 days x 3 = 93 hrs x 75kw 31 days x 5 = 155 hrs x 15kw	6,975 2,325	9,300
September	30 days x 4 = 120 hrs x 75kw 30 days x 6 = 180 hrs x 15kw	9,000 2,700	11,700
October	31 days x 6 = 186 hrs x 75kw 31 days x 5 = 155 hrs x 15kw	13,950 2,325	16,275
November	30 days x 7 = 210 hrs x 75kw 30 days x 7 = 210 hrs x 15kw	15,750 3,150	18,900
December	31 days x 8 = 248 hrs x 75kw 31 days x 7 = 217 hrs x 15kw	18,600 3,255	21,855
TOTAL KWH PER YEAR = 173,100 @ 4.5p/unit = £7,789.50			

5.0 TRANSFORMER LOSSES

	Number of Load		
	kVA	Iron Losses kW	Total
North Bank	1 x 500	1 x 1	1
North Abutment	2 x 500	2 x 1	2
Pier 1	2 x 500	2 x 1	2
Pier 2	2 x 500	2 x 1	2
Pier 3	2 x 500	2 x 1	2
Pier 4	2 x 1000	2 x 1.7	3.4
Pier 5	2 x 1000	2 x 1.7	3.4
Pier 6	2 x 1000	2 x 1.7	3.4
Pier 7	2 x 1000	2 x 1.7	3.4
Pier 8	2 x 1000	2 x 1.7	3.4
Pier 9	2 x 500	2 x 1	2
South Abutment	2 x 500	2 x 1	2
South Bank	4 x 1000	4 x 1.7	6.8
Total Losses			36.8kW
kWh losses per year (36 x 365 x 24) = 315,360 kWh/year = 26,280 kWh/month			

6.0 HEATING PIERS/TUNNELS

6.1 HEATING REQUIREMENTS

Cylinder and Power Pack Rooms:

Assumptions:

- ▶ Large Pier
- ▶ Dimensions 8m x 13m x 4m (High)
- ▶ Area 104m², Volume 416m³

Worst case due to high winds and high infiltration

4 air changes per hour. Outside temperature -3°C

Inside temperature 12°C

Ventilation heat loss $Q = N \times V \times S \times \Delta T$ where N = number of air changes per hour; V = volume; S = specific heat of air and ΔT = temperature difference.

$$= 4 \times 416 \times 0.36 \times 15$$

$$= 9 \text{ kW}$$

Fabric losses (Q). Assume losses through walls, floor and roof with an area of 376m² and an average 'u' value of 0.7 w/m²/°C

$$Q = 376 \times 0.7 \times 15$$

$$= 4 \text{ kW}$$

$$\text{Total loss} = 9 + 4 = 13 \text{ kW}$$

Installed heating 4 x 3 kW fan heaters for frost protection and 27 kW (3 x 9 kW stages) for comfort control at 12°C (now 8°C). The heating units normally operate only 2 stages (18 kW).

Therefore, installed heating equipment is adequate to meet the estimated pier heat losses.

6.2 *PIER/TUNNEL ENERGY CONSUMPTION*

Assumptions: 2305 heating degree days per year.

Ventilation loss = hours per day x volume (m³) x specific heat of air x degree days.

$$\begin{aligned}\text{Ventilation loss} &= (4 \times 24) \times 416 \times 0.36 \times 2305 \\ &= 33,138 \text{ kWh per year}\end{aligned}$$

$$\begin{aligned}\text{Fabric loss} &= 'u' \text{ value} \times \text{degree days} \times \text{hours per day} \\ &= 0.7 \times 2305 \times 24 = 38.7 \text{ kWh/year/m}^2 \\ &= 38.7 \times 376 \text{ (m}^2\text{)} = 14,551 \text{ kWh/year}\end{aligned}$$

Total heat loss per room per year = 47,689 kWh/year

$$\begin{aligned}\text{Loss per pier} &= 3 \text{ rooms} \times 47,689 \\ &= 143,067 \text{ kWh/year/pier}\end{aligned}$$

Total loss for 9 piers and 2 abutments.

Assumptions: detailed dimensioned drawings not made available during the audit therefore energy loss calculation for the 9 piers and 2 abutments based upon the data for a large pier and a arbitrary number of piers (9). This is assumed to cover the total energy loss for all piers and abutments.

Total loss = 143,067 (energy loss for large pier) x 9 = 1,287,603 kWh.

7.0 ESTIMATED TOTAL HEATING LOAD (30 weeks heating season)

Substation North $30 \times 7 \times 8 \text{ hrs} = 1680 \text{ hrs} \times 13 \text{ KW}$ = 21,840 kWh

Substation South As North = 21,840 kWh

Generator Building $30 \times 7 \times 8 \times 70 \text{ KW}$ = 117,600 kWh

Workshop/Offices/Stores

275kw boiler ON 06.00 - 16.00 hours Monday to Friday
 OFF Saturday and Sunday

145 kw boiler ON 22.00 - 01.00 hours and 02.00 - 04.00 hours Monday to Friday plus 10.00 -
 12.00 hours and 18.00 - 20.00 hours Saturday and Sunday

Electrode boilers	1 x 275 KW	5 x 30 x 10 x 275 x 0.5	=	206,250}	217,050
	1 x 144 KW	5 x 30 x 5 x 144 x 0.1	=	10,800}	

Estimated heating load = $1588\text{m}^2 @ 120\text{w/m}^2 = 190 \text{ KW}$

Control Tower

One 145 kw boiler ON 24 hours per day, 7 days per week

2 x 145 KW Electrode boilers

$7 \times 30 \times 24 \times 145 \times 0.4$ = 308,875 kWh

Estimated heating load $1,183\text{m}^2 @ 80 \text{ w/m}^2 = 95\text{KW}$

Piers/Tunnels (See calculation 6.0) = 1,287,603 kWh

TOTAL ELECTRICAL ENERGY FOR HEATING = **1,974,808 kWh/year**

8.0 ASSESSMENT OF ELECTRICAL MAXIMUM DEMAND AND CONSUMPTION

8.1 LOAD SCHEDULE

8.1.1 Summer

Building	Load/Type	kW	Duration Hours	kWh/day	Days/ Months	Monthly Total kWh
North Sub Station	Battery Charger, Lighting, Misc	0.5	24	12	31	372
South Sub Station	-	0.5	24	12	31	372
Generators North	Emergency Ltg	1.0	24	24	31	744
	Lighting	1.5	12	18	22	396
	Jockey Pumps} Air Comps}	40	0.25	10	15	150
Generator South	Emergency Ltg	2.0	24	48	31	1488
	Lighting	1.5	12	18	22	396
	Jockey Pumps} Air Comps}	4.0	0.25	10	15	150
Workshop/Of fices Stores	Emergency Ltg	5	24	120	31	3720
	Lighting	12.5	12	150	22	3300
	Kitchen etc	30	4	120	22	2640
	DHWS	12	6	72	22	1584
	Air cond/vent	10	12	120	22	2.640
	Office equipment	10	12	120	22	2640
	Compressors/lathes Machines	30	4	120	22	2.640
Control Tower	Emergency Ltg	3.0	24	72	31	2.232
	Lighting	4.5	12	54	22	1.188
	DHWS	12	6	72	22	1.584
	Air Cond/Vent	30	20	600	31	18.600
	UPS/BMS/PABX	20	24	480	31	14.880
	Computers					
Staff Car Park	Lighting	2	12	24	31	744
Piers/Tunnels	Lighting Inc	240.4	See calculation sheet 1,675, 680 ÷ 12			139.640
	Emergency Ventilation	100	12	1,200	31	37200
External	Lighting Piers General/security	75	(see calculation 4.3)			9300
Sub Stations Piers	Transformers	36	24	864	31	26.784
		719	-	-	-	275,384

8.1.2 Maximum Demand Assessment (Summer)

Maximum Demand (MD) $719 \text{ kW} \times 0.8 \text{ (diversity)} = 575 \text{ KW}$

Monthly MD operating range = $575\text{kW} - 719\text{KW}$.

Peak monthly MD range when operating gates (add 300KW) = $875\text{KW} - 1018\text{KW}$

8.1.3 ASSESSMENT OF WINTER MAXIMUM DEMAND

BASE LOAD	DIVERSITY FACTOR	MAXIMUM DEMAND KW
MAXIMUM DEMAND SUMMER 719 KW	0.8	575
Winter Electrical Loads KW		
▶ North and South Sub-Stations (heating)		27
▶ Generator House		69
▶ Workshop and Offices (electrode boilers)		275
(fan coil heaters)		5
▶ Control Tower (electrode boiler)		145
(pumps)		2
		<hr/> 523
	0.9	471
Piers and Tunnels	0.6	696
ASSESSED MAXIMUM DEMAND (WORST CASE)		1742

8.1.4 Maximum Demand Summary

Maximum Demand Assessment

- ▶ Summer Conditions 575 KW
- ▶ Winter Mild Conditions 1046 KW (excludes piers and tunnels)
- ▶ Winter Severe Conditions 1742 KW
- ▶ Summer Weekend 350 KW

8.3 ENERGY CONSUMPTION (kWh) ASSESSMENT

8.3.1 Barrier Gates

- Assumptions:
- ▶ only two power packs operate simultaneously
 - ▶ ten gate moves per month
 - ▶ each gate move takes 15 minutes (open or close) ie, total 30 mins per gate move
 - ▶ one total barrier closure per month

Energy Usage (worst case):

- ▶ 10 (gates) x 2 power packs (300 KW) x 0.5 hours = 1,500 kWh per month
- ▶ 10 (gates) total closure x 2 power packs (300 KW) x 0.5 hours = 1500 kWh/month

Total Energy Consumption for Operating the Barrier - 3,000 kWh per month

Total Energy Cost for Operating the Barrier - $3,000 \times 4.5p = £135$ per month

8.3.2 Site Support Loads

From table 7.1 monthly energy usage (summer) estimated at 275,384 kWh

Total energy cost per month (summer) = $275,384 \times 4.5p = £12,392$

8.3.3 Total Site and Barrier Loads

Monthly energy usage (summer) = 278,384 kWh

Monthly energy cost (summer) = £12,527

8.3.4 Comparison Between LEB Billed Units (July 1994) and Estimate Usage (7.3.3)

Actual units for July 1994 312,412 kWh

Estimated units for summer months 278,384 kWh

Difference 34,028 kWh

9.0 ESTIMATED ANNUAL ENERGY

9.1 SUMMER ELECTRICAL CONSUMPTION

Monthly summer base operating load (278,384 kWh)		
5 months per year (5 x 278,384)	=	1,391,920 kWh
Add additional hours for lighting (April - August)	=	2,100 kWh
Total summer (April-August)		
electrical consumption	=	1,394,020 kWh

9.2 WINTER ELECTRICAL CONSUMPTION

Summer base operating load (278,384 kWh)		
Total for 7 months = 7 x 278,384 kWh	=	1,948,688
Add for winter lighting	=	59,400
Winter heating load	=	1,974,808
Total winter (Sept-March) Electrical Consumption	=	3,982,896 kWh

9.3 TOTAL ESTIMATED SUMMER AND WINTER ELECTRICAL CONSUMPTION

Summer electrical consumption	=	1,394,020 kWh
Winter electrical consumption	=	3,982,896 kWh
Total estimated electrical consumption	=	5,376,916 kWh

9.4 LEB BILLED UNITS VS ESTIMATED ELECTRICAL CONSUMPTION

1994 - 1995 LEB billed units	=	5,036,273 kWh
Estimated annual electrical consumption	=	5,376,916 kWh
Delta between estimated and billed 1994/95 electrical consumption	=	340,643 kWh

This represents a delta of 7% which is within an acceptable range given the calculation approximations and assumptions.

10.0 CONTROL TOWER AIR CONDITIONING

10.1 EXISTING PLANT

- ▶ 2 X 4KW electrical (11KW cooling) chillers;
- ▶ 2 x 20KW electrical (55KW cooling) chillers;
- ▶ 6KW - fans, fan coil units, air handling plant and pumps.

10.2 ESTIMATED LOADS

▶ Control Tower (control room)(150m ²) Cooling Loads	KW
- Lighting	3
- Computer/control equipment	3
- Solar/fabric	4
- Fresh air	3
- AHH (fans)	<u>3</u>
Total	<u>16KW</u>
▶ Control Tower (levels 5 and 6) cooling load = 18KW (Section 1.5 Appendix 2)	
▶ Total Cooling Load = (16 + 18)KW	
= 34KW	

10.3 SYSTEM OPTIONS

- ▶ Assumption coefficient of performance (COP) for existing chiller plant 1:2
- ▶ Electrical load to provide 34KW cooling = 17KW
- ▶ Estimated operating load of existing chillers, pumps and fans (excluding standby provisions) = 30KW
- ▶ Replacement of existing chilled water system with standalone direct expansion (DX) units (4KW cooling/5KW heating (Heatpumps))
- ▶ Electrical load per unit = 1.6KW

- ▶ Control Towers (control room) would require 4 x 4KW DX units (including standby)
- ▶ Control Tower (levels 5 and 6) would require 6 x 4KW DX units (including standby)

	KW	
▶ Control room electrical operating load 3 units at 1.6KW	= 4.8	
▶ Levels 5 and 6 electrical operating load 4/5 units at 1.6KW	<u>= 7.2</u>	
Total operating load	<u>= 12.0</u>	

▶ **Energy Savings**

Difference between a theoretical chilled water system (on an equivalent basis) and the DX system = (17-12)KW = 5KW

Annual energy saving = 8600 hours x 5KW x 0.7 (operating time factor)
 = 30,660 kWh
 = £1,380 at 4.5p/kWh

Comparison of DX system with the existing connected air conditioning electrical load of 30KW

Annual energy saving = (30-12)KW x 8760 hours x 0.7
 = 110,376 kWh
 = £4,967 at 4.5p/kWh

11.0 REPLACEMENT OF FLUORESCENT LUMINAIRES WITH HIGH EFFICIENCY UNITS

Lighting Consumption

Piers, abutments and tunnels

- ▶ normal operation ($85.8\text{KW} \times 5 \text{ days} \times 12 \text{ hours} \times 52 \text{ weeks} = 267,256\text{kWh}$)
- ▶ emergency ($56.0\text{KW} \times 7 \text{ days} \times 24 \text{ hours} \times 52 \text{ weeks} = 490,560\text{kWh}$)

Support facilities

- ▶ Summer ($47.8\text{KW} \times 5 \text{ days} \times 12 \text{ hours} \times 22 \text{ weeks} = 49,896\text{kWh}$)
- ▶ Winter ($51.2\text{KW} \times 5 \text{ days} \times 12 \text{ hours} \times 30 \text{ weeks} = 92,160\text{kWh}$)

Total 899,872kWh

Efficiency saving say 15% = 134,980kWh/year
 = £6074 @ 4.5p/kWh

12.0 PIER AND ABUTMENT HEATING

- ▶ Total losses (all piers and abutments) = 1,287,603kWh
- ▶ Savings resulting from Oscar Faber recommendations and set point changes (50%) = 636,000kWh

Appendix 3

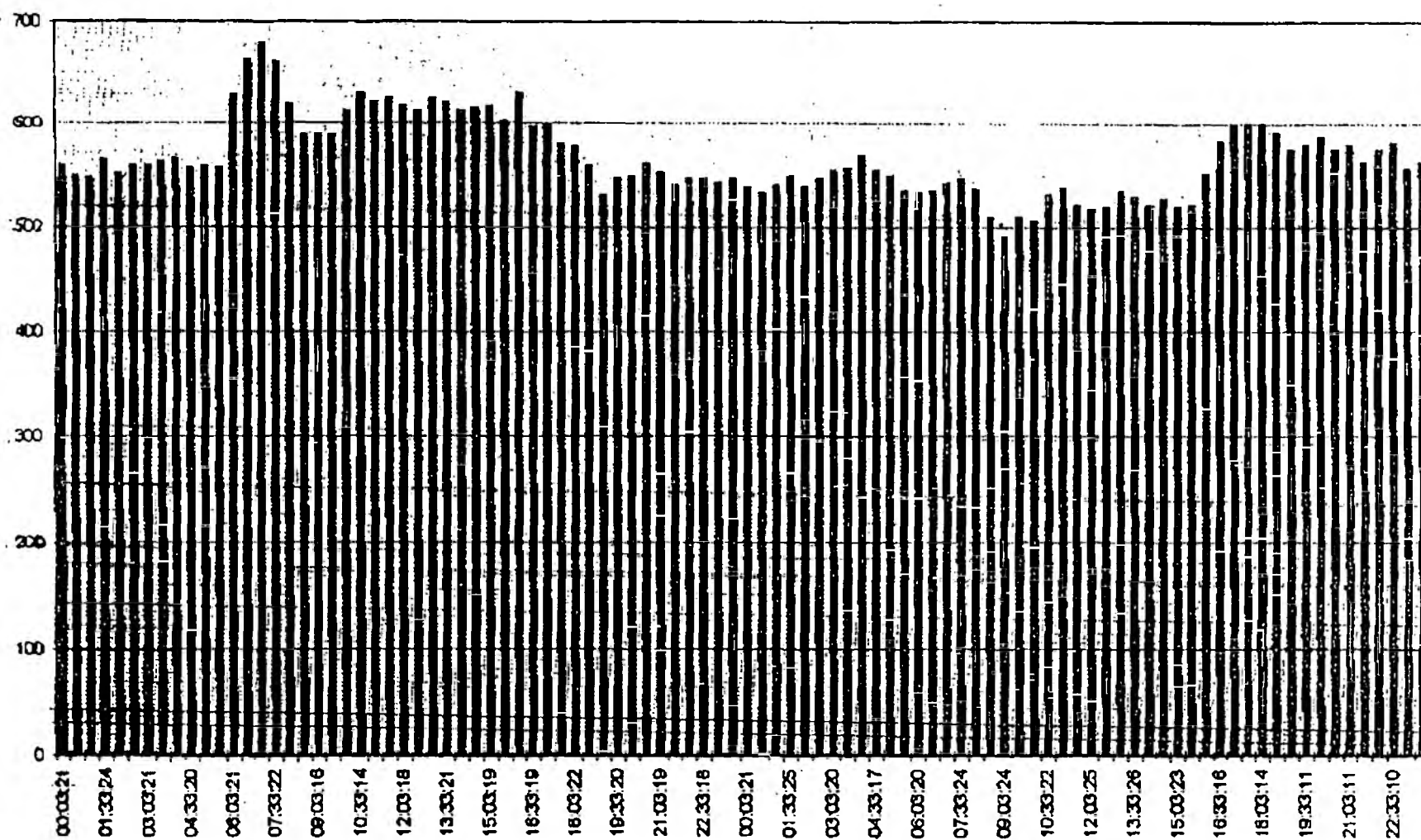
Thames Barrier Electricity Consumption

THAMES BARRIER ELECTRICITY CONSUMPTION					
Month	Total KWH	Total £	P/KWH	CUM M WH	CUM £
Apr 94	507090	22405	4.4	507.1	22405
May 94	375893	15973	4.2	883.0	38378
Jun 94	312693	14846	4.7	1195.7	53224
Jul 94	312412	14348	4.6	1508.1	67572
Aug 94	303431	13205	4.4	1811.5	80777
Sep 94	335347	13529	4.0	2146.9	94306
Oct 94	382817	17649	4.6	2529.7	111955
Nov 94	380958	20656	5.4	2910.6	132611
Dec 94	490093	25810	5.3	3400.7	158421
Jan 95	570829	36463	6.4	3971.6	194884
Feb 95	493810	15370	3.1	4465.4	210254
Mar 95	570900	15476	2.7	5036.3	225730

Appendix 4

Electrical Maximum Demand

Thames Barrier Base Load 25-26 November 1995



Appendix 5

Energy Efficiency Office

Performance Criteria

APPENDIX 6: ENERGY PERFORMANCE INDEX CALCULATION (APRIL 93 - MARCH 94)

Fuel Type	Annual Billed Costs (kwh)	% of Total Energy	Treated Floor Area m ²	Annual kwh/m ²	kwh/m ² Performance Assessment	CO2 Conversion Factors kg/m ²	Annual CO2 Emissions kg/m ²	CO2 Emissions Performance Assessment
Gas						0.2		
Electricity						0.7		
Total								

Energy performance assessment criteria published by the Energy Efficiency Office	Headquarters type facility	Performance	Electricity (Kwh/m ²)	Gas (Kwh/m ²)	CO2 Emissions (electricity and gas kg CO2/m ²)
		Low (L)	<261	<132	<209
		Medium (M)	261 - 361	132 - 273	209 - 307
		High (H)	>361	>273	>307

COST PERFORMANCE INDEX CALCULATION (APRIL 93 - MARCH 94)

Fuel Type	Annual Cost £	% of Total Cost	Treated Floor Area (m ²)	Annual Cost (£/m ²)	Performance Assessment
Gas					
Electricity					
Total					

Cost performance assessment criteria published by Energy Efficiency Office	Headquarters type facility	Cost £/m ²	
		Low Cost (L)	<20
		Medium Cost (M)	20 - 29
		High Cost (H)	>29

Appendix 6

Thames Barrier Operational Parameters

1.0 SETTING OF HEATING THERMOSTATS

The water heaters, space heaters and fan heaters have recommended settings generally as listed below:

3KW pier fan heaters	12°C - piers 5, 6 & 7 controlled from Central Control Room (CCR)	
Switchroom equipment rooms and store rooms thermostats	20°C	
Oil filled radiators	Set to 5	
Frost thermostats (pad type)	5°C	
Trace heating thermostats	3°C to operate	
Transformer room cooling fan	22°C to start fan	- Piers 5, 6 & 7 controlled from CCR
Power pack cooling fans	30°C to start fans	- Piers 5, 6 & 7 controlled from CCR
Shift area cooling fans	25°C to start fans	- Piers 5, 6 & 7 controlled from CCR
Lower and upper cylinder areas	Stage 1 + 6°C Stage 2 - 3°C	- Piers 5, 6 & 7 controlled from CCR

These settings are modified to suit specific operating conditions. In these cases the individual thermostat are changed by reference to the BMS system on Level 7 or local thermostat where BMS is not installed.

2.0 EXTERNAL LIGHTING CONTROLS

South Shore Lighting controlled by photocell and time switches. All lighting on at dusk, time switch control cuts lighting to one third at 12.30am.

North Shore photocell control only, single phase supply to lighting columns stops switching to reduced lighting.

High mast lighting on at all times to meet security requirements.

3.0 BOILER CONTROLS

Large Boiler in Workshop ON 06.00 to 16.00 Mon/Fri OFF Sat/Sun.

Small Boiler in Workshop ON 22.00 to 01.00 and 02.00 to 04.00 Mon/Fri plus 10.00 to 12.00 and 18.00 to 20.00 Sat/Sun.

Control Tower Boilers one on continuously.

All boilers on Trend maximum demand load shedding.

Appendix 7

Electric vs Gas Fired Boilers

ELECTRIC VS GAS FIRED BOILERS

► Cost of fuel

►	Electricity	4.5p/kwh
►	Gas	1.1p/kwh ¹
		3.4p/kwh

► Heating Demand

►	Workshops	217,050 kwh
►	Control Bldg	308,875 kwh
	Total	552,125 kwh

The above figures to be validated using information obtained from on-site meters.

► Potential savings

$$525,925 \text{ kwh} \times 3.4\text{p} = \text{£17,800}$$

CO₂ reduction = 262 tonnes

► Capital costs

Workshops (2x 150KW boilers, pressurisation units, flue dilution, header tanks, controls etc)

= £25,000

Controls Bldg (2x 75KW boilers and equipment)

= £18,000

Total Capital Cost

= £43,000

► Simple pay back

2.4 years

¹ DoE gas contract note.

Appendix 8

London Electricity Invoices

LONDON ELECTRICITY

In case of query contact:
Mr W. Pope
Central Billing, Customer Services
34 - 38 Aybrook Street
London
W1M 3JL
Tel 0171-725-3099



Company name _____

NATIONAL RIVERS AUTHORITY
TIDAL THAMES - AREA MANAGER
THAMES BARRIER
EASTMOOR STREET, LONDON
SE7 8LX

THAMES BARRIER
EASTMOOR STREET
LONDON
SE7 8LX



Invoice

Amount £

Meter no.	Present reading	Previous reading	Constant	Reading type	Reg	Units
Supply point 001						
P90A01891	3285	0	20.00	KWH	HH	65700
	3285	0	20.00	KWH	HH	65700
	994	0	20.00	KWH	HH	19890
	2290	0	20.00	KWH	HH	45810
	2402	2398	100.00	KVARH	26	400
Supply point 002						
P90A01893	2004	0	20.00	KWH	HH	40090
	2004	0	20.00	KWH	HH	40090
	674	0	20.00	KWH	HH	13480
	1330	0	20.00	KWH	HH	26610
	397	395	100.00	KVARH	26	200
Supply point 003						
P90A01824	20055E	0	20.00	KWH	HH	401100
	20055E	0	20.00	KWH	HH	401100
	5919E	0	20.00	KWH	HH	118390
	14135E	0	20.00	KWH	HH	282710
	38681E	37344	100.00	KVARH	26	133700

Charge & rate	Price per unit	Total units	Amount
POPD NIGHT RATE	0.144100P	151760	218.69
POPD NORMAL RATE	0.328900P	355130	1168.02
POPS SINGLE RATE	0.000000	506890	10504.15
REAP SP 001 SINGLE RATE	0.110000P	0	0.00
REAP SP 001 SINGLE RATE	0.165000P	0	0.00
REAP SP 002 SINGLE RATE	0.110000P	0	0.00
REAP SP 002 SINGLE RATE	0.165000P	0	0.00
REAP SP 003 SINGLE RATE	0.110000P	0	0.00
REAP SP 003 SINGLE RATE	0.165000P	0	0.00

Account reference

Invoice no.

Period of supply

Date of invoice

00034694

0075

01 Apr 95 - 30 Apr 95

10 Jun 95

LONDON ELECTRICITY

In case of query contact:
Mr W. Pope
Central Billing, Customer Services
34 - 38 Aybrook Street
London
W1M 3JL
Tel 0171-725-3099



Company name _____

NATIONAL RIVERS AUTHORITY
TIDAL THAMES - AREA MANAGER
THAMES BARRIER
EASTMOOR STREET, LONDON
SE7 8LX

THAMES BARRIER
EASTMOOR STREET
LONDON
SE7 8LX

THAMES BARRIER
RECEIVED
16 AUG 1995

Invoice

Amount £

Meter no.	Present reading	Previous reading	Constant	Reading type	Reg	Units
-----------	-----------------	------------------	----------	--------------	-----	-------

Supply point 001

P90A01891	3285E	0E	20.00 KWH	HH	65700	
	3285E	0E	20.00 KWH	HH	46200	
	994E	0E	20.00 KWH	HH	19890	
	2290E	0E	20.00 KWH	HH	45810	
	2847E	2628E	100.00 KVARH	26	21900	

Supply point 002

P90A01893	2004E	0E	20.00 KWH	HH	40090	
	2004E	0E	20.00 KWH	HH	40090	
	674E	0E	20.00 KWH	HH	13480	
	1330E	0E	20.00 KWH	HH	26610	
	668E	535E	100.00 KVARH	26	13300	

Supply point 003

P90A01824	11097	0	20.00 KWH	HH	221940	
	11097	0	20.00 KWH	HH	221940	
	3121	0	20.00 KWH	HH	62430	
	7975	0	20.00 KWH	HH	159510	
	39830	38926	100.00 KVARH	26	90400	

Charge & rate	Price per unit	Total units	Amount
POPD NIGHT RATE	0.144100P	95800	138.05
POPD NORMAL RATE	0.328900P	231930	762.82
POPS SINGLE RATE	0.000000	327730	8396.17
REAP SP 001 SINGLE RATE	0.110000P	0	0.00
REAP SP 001 SINGLE RATE	0.165000P	0	0.00
REAP SP 002 SINGLE RATE	0.110000P	0	0.00
REAP SP 002 SINGLE RATE	0.165000P	0	0.00
REAP SP 003 SINGLE RATE	0.110000P	16420	18.06
REAP SP 003 SINGLE RATE	0.165000P	0	0.00

Account reference

Invoice no.

Period of supply

Date of invoice

00034694

0077

01 Jun 95 - 30 Jun 95

10 Aug 95

LONDON ELECTRICITY

In case of query contact :
Mr W. Pope
Major Business Services
34 - 38 Aybrook Street
London
W1M 3JL
Tel 0171-725-3099



Awarded for excellence



Company name _____

NATIONAL RIVERS AUTHORITY
TIDAL THAMES - AREA MANAGER
THAMES BARRIER
EASTMOOR STREET, LONDON
SE7 8LX

THAMES BARRIER
EASTMOOR STREET
LONDON
SE7 8LX

THAMES BARRIER
RECEIVED
17 OCT 1995

Billing details

FIXED CHARGES	VAT CODE	Amount £
ADMINISTRATION CHARGE	1	200.00
AVAILABILITY CHARGE 2900.0 @ 1.45 /KVA	1	4210.80
TUOS CHARGE	1	786.50
STANDING CHARGE	1	79.31
TOTAL FIXED CHARGE		5276.61

Meter no.	Present reading	Previous reading	Constant	Reading type	Reg	Units
Supply point 001						
P90A01891	0E	0E	20.00 KWH	HH		67930
	0E	0E	20.00 KWH	HH		67930
	0E	0E	20.00 KWH	HH		20530
	0E	0E	20.00 KWH	HH		47400
	3299E	3073E	100.00 KVARH	26		22600
Supply point 002						
P90A01893	0E	0E	20.00 KWH	HH		41460
	0E	0E	20.00 KWH	HH		41460
	0E	0E	20.00 KWH	HH		13920
	0E	0E	20.00 KWH	HH		27540
	944E	806E	100.00 KVARH	26		13800
Supply point 003						
P90A01824	0E	0	20.00 KWH	HH		208360
	0E	0	20.00 KWH	HH		208360
	0E	0	20.00 KWH	HH		57230
	0E	0	20.00 KWH	HH		151130
	41476E	40782	100.00 KVARH	26		69400

Charge & rate	Price per unit	Total units	VAT code	Amount
POPD NIGHT RATE	0.144100P	91680	1	132.11
POPD NORMAL RATE	0.328900P	226070	1	743.54
				317.750

Account reference

Invoice number Period of supply

Date of invoice

00034694

0079

01 Aug 95 - 31 Aug 95

10 Oct 95

ANNEX 4

ENERGY USE REPORT

VISITORS CENTRE, CAFETERIA

AND EDUCATION FACILITY

1.0 INTRODUCTION

The Visitors Centre is located in Unity Way approximately two hundred and fifty metres east of the main Thames Barrier site. The site is about four acres and the principal accommodation comprises two buildings; the Visitors Centre (774m²) and the Cafeteria (367m²). In addition there are three small portable buildings sited immediately adjacent to the south side of the Visitors Centre.

There is also an off site building, in Eastmoor Street, which serves as an education facility, and is managed under the Visitors Centre umbrella. This building provides accommodation totalling 695m².

Visitors Centre Building

The Visitors Centre is housed within a detached steel frame building with profile cladding and comprises an exhibition foyer, auditorium, shop, office, first aid room, and male and female WCs. The portable buildings are used to provide a staff messroom, an office, storage, and WCs/shower facilities. (Photograph 3)

Cafeteria

The Cafeteria is operated by a third party under a franchise arrangement and occupies a riverside location. Built on the flood embankment, it has two levels: the main facilities comprise the cafeteria on the top level and function room/bar on the lower level. Public WCs, are also housed within the building on the lower level. The cafeteria is constructed of part cavity and block wall at ground floor level with profile cladding at first floor level. The cafeteria seating area has extensive double glazing to two walls. (Photograph 4)

Education Facility

The Education Facility comprises a two storey office building, originally provided to house engineers working on the construction of the Thames Barrier. It is designed to a very basic standard and is constructed of pre cast concrete panels under a mineral felt flat roof. The windows are single glazed galvanised steel. (Photograph 5)

2.0 ENERGY MANAGEMENT

2.1 Heating Installations

Visitors Centre

The Centre is connected to electricity and gas supplies. Space heating is provided as shown below:

External Ticket Booth	-	Electric floor standing convector heater.
Foyer Area	-	Electric blown air units in ceiling void. Hot air fan units heated from gas fired system.
Auditorium	-	Forced heating/cooled air (roof plant) from gas fired system.
Shop	-	Electric blown air units in ceiling void. Hot air fan units heated from gas fired system. Electric heaters mounted above external doors.
Office/First Aid/WCs	-	Gas fired boiler fed radiators.
Water Tank Room	-	8kw electric heater.
Portakabins	-	Wall mounted electric convector heaters.

Cafeteria

The Cafeteria shares the electricity and gas supply connections with the Visitors Centre Building. The electricity and gas meters are located at the Cafeteria site. Space heating to the Cafeteria is provided as follows:

Kitchen/Hallway/WCs	-	Gas fired boiler fed radiators. (Designed for wider use but cafeteria seating area not connected).
Cafeteria Seating Area	-	Electric heater mounted over entry/exit door. Oil filled radiator (installed by franchisee).
Function Room	-	Electric Blown Air Heaters.

The option to connect the gas fired central heating system in the cafeteria area should be investigated, to avoid the need for a supplementary oil filled radiator which is less energy efficient. Such action should be integrated with the commercial management of the facility so that benefits will be received by the NRA to offset adaptation costs.

Education Facility

The Education Facility building occupies a separate site to the Visitors Centre complex. For theory it is considered to be a satellite of the Visitors Centre. In practice, while it serves to accommodate

mainly schoolchildren in programmes managed by the Visitors Centre, the building management is undertaken by Barrier Operations staff.

Use of the building is sporadic. At the time of the audit visit it was not in use. The internal ceiling mounted lighting units are in need of updating if the building is to meet modern low energy demand lighting standards. There is evidence of a recent programme to replace oil filled electric radiators with modern wall mounted electric convector heaters. We noted one remaining oil filled radiator, located in a kitchen area.

2.2 Energy Consumption

Figures for energy use are derived from billing information.

Electricity - October 1994 to September 1995 = £5,428
Units consumed range between 1,000 and 13,000 per month but availability charges for KVAs represent a high element of the charge; up to 60%.

Gas - October 1994 to September 1995 = 193,623 kWh

(Total budget for power, Code E650 Visitors Centre, is £11,400pa. For budget purposes this is split 50/50 by the Visitors Centre Manager.)

2.3 Energy Tariffs

We were not made aware that management has taken tangible measures to confirm that current electricity tariffs are the most appropriate ones for the Visitors Centre. Such action should be an integral part of energy management for the site.

2.4 Energy Conservation Action

Lighting

Type T8 low energy fluorescent tubes have been installed to provide lighting to office, first aid, and WC areas. There are numerous spotlights in the foyer and shop areas of the complex. The bulbs used in these lights have recently been replaced with a longer life, lower energy type.

Heating

The gas fired central heating boiler is controlled by monitoring the temperature of extracted air output. Timing controls are set to shut down the boiler overnight. Temperature settings are set higher than

standard to compensate for frequent opening of outside doors. However, other parts of the total heating system, such as electric heaters and radiator thermostats (not present on all radiators), are individually controlled to maintain a comfortable environment.

Monitoring

The Visitors Centre Building and the Cafeteria are on shared electricity and gas meters. This makes it difficult to monitor consumption. There is no formal recorded monitoring of electricity consumption to evaluate the effects of the lower energy lighting regime. While the achievement of energy saving is an underlying aim, targets and results are not made visible within any formal management controlled process.

3.0 CONCLUSIONS

Energy usage is considered by Visitors Centre staff. However, energy management is hampered by the diverse nature of the Visitors Centre complex and the inability to monitor specific buildings. The benefits derived from any changes in heating or lighting regimes would be difficult to monitor. Problems associated with heat loss as a result of frequently opening exterior doors, and safety lighting considerations are equally relevant to operational efficiency as they are to environmental policy considerations. Whilst the operation of the Cafeteria is franchised, the NRA retains overall responsibility for its environmental integrity.

We recommend that:

- the feasibility of obtaining discrete electricity and gas metering for the Visitors Centre Building should be investigated;
- energy usage should be suitably recorded and monitored, linked to the setting of energy savings targets;
- current electricity tariffs are investigated to confirm they are the most appropriate ones for the Visitors Centre;
- the feasibility of connecting the gas fired central heating system in the upper level seating area of the Cafeteria is investigated;
- when the lighting units in the Education Facility building are replaced, a suitable low energy type should be installed; and
- the single oil filled electric radiator which remains in one of the Education Facility kitchen areas is included within the heater replacement programme.

ANNEX 5

**FIRE PROTECTION SYSTEMS
A REPLACEMENT FOR HALON**

NRA Environmental Management Unit

November 1995

FIRE PROTECTION SYSTEMS - A REPLACEMENT FOR HALON

INTRODUCTION

The EMU has conducted an environmental audit on the Thames Barrier, which is the only major remaining location within the NRA continuing to use Halon as a fire extinguishant.

It is understood that at present there are over 80 cylinders at the site. There is a lock-off facility generally available which prevents accidental discharge of Halon while the area is occupied. The main risks protected by the gas are transformers, switch rooms, control rooms and other areas containing electrical equipment.

Before the discovery that the protective ozone layer around the earth was being depleted (1) and that Halons were partially responsible, Halon extinguishing agents were considered to be the answer to many fire protection problems. Under the Montreal Protocol, production of Halons ceased from 1st January 1994. In view of this an alternative system needs to be identified which is effective, environmentally acceptable, clean, non-conducting and of low toxicity.

Users of ozone depleting substances are under no legal requirement to stop using them (1). However Halon will eventually become more difficult to obtain and may increase in price. 'Halon banking' will ensure that existing stocks are available for cases where they are still essential. It should be noted that the DoE in its Advisory Notes on CFC's and Halons (2) does not regard computer and electronic applications as essential use of Halons in fire fighting equipment. As one of the leading statutory authorities for environmental protection the NRA should rigorously pursue elimination of these substances. In fire fighting systems it should be ensured that any replacement is as environmentally benign as possible. We understand that there have already been three inadvertent releases of the gas since commissioning. The NRA should therefore produce a plan to replace Halon as soon as possible.

Considerations for a Halon Alternative

When selecting an alternative it should be borne in mind that no *one* system will completely replace Halons. It should be noted that in a properly maintained system Halon should not escape to the atmosphere and thus will not contribute to global warming or ozone depletion unless released to extinguish a fire. In selecting a new system one should first question whether a dedicated fire extinguishant is needed at all for a particular area. It may be more appropriate to install a very early smoke detector system backed up with assistance from outside. This report will discuss the options available.

Considerations that will need to be given to alternative systems include toxicity - both in the original state and the by-products which may be produced in the fire - and the physical constraints. All of the alternatives require a greater storage volume than Halons, some considerably more. Not all of the alternatives will be able to use the existing pipework and some may also need changes to the detection system. Consideration may also need to be given as to how an extinguishing agent can be removed from the protected area. For example, after discharge, powder extinguishants leave a considerable deposit.

Consideration also needs to be taken of the manufacturing processes involved in producing the fire fighting substances. Carbon dioxide is a by-product of industry and the inert gases are extracted from the atmosphere. The halocarbons are manufactured by the chemicals industry, with the associated by-products. FE13 is actually a by-product for another chemical process. The processes tend to be energy intensive with a range of pollutants produced during manufacture.

Environmental Impact

Indications are that having addressed the problem of ozone depletion by controlling ozone depleting substances, the next target by Governments may be substances that contribute to global warming, thus selection of alternative fire-fighting systems should take this factor into consideration. Table 1 shows the relative impacts on the atmosphere of alternative fire extinguishant gases.

TABLE 1

Fire extinguishing substance	GWP 100yr (CO ₂ = 1)	ODP CFC11 = 1)	Atmospheric Lifetime (yrs)	Storage Volume Relative to Halon Halon 1301 = 1
Halon 1301	4900	16	77	1
FM200	2050	0	30 - 40	1.7
FE13	11000	0	400	1.7
NAF SIII HCFC22 HCFC123 HCFC124	1600 90 440	0.04	16 2 7	1
Argonite	0	0	NA	10
INERGEN	0	0	NA	10
Carbon Dioxide	1	0	50 - 200	4
Water Fog	0	0	NA	

Where:

GWP = Global Warming Potential

ODP = Ozone Depleting Potential

As none of the viable alternatives to Halon provide a "drop-in" replacement system additional costs may be incurred in installation. Costs associated with replacement will depend on the specific requirement at the location coupled with any changes necessary to the existing installed system. These may be partially off set by the sale of Halon. Appendix (1) gives information on disposal, although it is no longer manufactured a bank exists for users to recycle the recovered gas.

Current Practice

The main risks protected by the gas at the Thames Barrier are transformers, switch rooms, control rooms and other areas containing electrical equipment within cabinets. The current practise for electrical equipment within cabinets is to install an in-cabinet fire system (14). Although this is as expensive to install as a drench system it has the advantage that less material is used and it can respond more rapidly to a fire. If the detector is connected to the power supply for that unit then cutting the supply will usually stop the fire. In both these ways fire damage will be reduced.

Advice from the Fire Brigade and fire companies is that when replacing Halons, transformers are now protected by carbon dioxide, which was originally developed for oil fires. Foam or dry powder could also be used but the latter could cause permanent damage to the equipment.

ALTERNATIVES TO HALON

Halon (CF_3Br) itself when used as an extinguishant produces the combustion products hydrogen bromide and hydrogen fluoride gases which combine with moisture to form acids(3). These acids may have a corrosive effect, particularly on delicate electrical circuitry. However it is a fast, effective extinguishant, has low toxicity, is clean, non-conductive and able to penetrate shielded areas effectively. It is an expensive substance, for use where there are no budgetary constraints. Where there are budgetary constraints then alternatives need to be considered which match some or nearly all the properties of Halons, depending on the nature of the risk to be protected, but without the impact on ozone depletion or global warming that Halon has.

Alternatives generally take three forms:

1. Those that reduce the oxygen level to such a point (typically 14 - 15 %) that flaming combustion can no longer be supported. These substances include the inert gases and carbon dioxide.
2. Those that react chemically with the combustion process to produce rapid flame extinguishment. These are generally the halocarbons and may produce toxic by-products in decomposition.
3. Agents that smother the fire and reduce the temperature of combustion. These include foams, powders water mists and water sprays. They leave some form of deposit that will need cleaning up afterwards.

The inert gases require a design concentration in the order of 35 % of the room volume to be effective. Halocarbon agents are more powerful at extinguishing flaming combustion and typically require a concentration of typically 7 %.

A number of alternatives are discussed below for their suitability in a fire drench system to protect mainly electrical equipment.

Inert Gases

The two readily available products are blends of the inert gases nitrogen, argon and mixed in varying proportions. These are:

- INERGEN
- Argonite

INERGEN(4) is a blend of nitrogen, argon and carbon dioxide the proportions 52/40/8 of respectively. Argonite(5) is a 50/50 blend of nitrogen and argon. They work by flooding the room and reducing the oxygen level to about 12 - 13 %. This is too low to sustain flame combustion but high enough to allow personnel already in the room

to breathe. With INERGEN the carbon dioxide level in the room after discharge rises to about 3 %, the additional levels are claimed by the manufacturer to induce raised breathing rates to compensate for the lower oxygen levels. The raised respiration levels, however, may allow an individual to breathe in more of the fumes from a fire, but generally the medical evidence provided by the sales companies does not suggest that breathing faster for short periods of time is detrimental to an individual. On safety, INERGEN has been safely tested with personnel present. When discharged there is no fogging and so escape routes are not obscured.

The inert gases are stored as a gas and as such can be piped relatively long distances. As they are stored as a gas it means that considerably more storage space is required than for Halons. To counteract this bottles can be stored remote from the risk. In this way it will not be necessary to have large amounts of the gas to cover each risk individually. Enough bottles can be stored for the largest risk and then be directed to areas of need using diverter valves. In this way costs may be kept to a minimum. As considerably more bottles will be needed for inert gases than for Halon structural checks will need to be made to ensure the floors where the bottles are to be stored can support the additional weight. Vents will need to be installed to relieve pressure, allowing the

ambient atmosphere to be expelled. If this does not happen there is the danger that the oxygen level will not be reduced sufficiently to extinguish a fire. It would be expected that the existing detection system could be re-used.

Retro-fitting of inert gases may be able to use existing halon pipework. However the extra storage bottles and pipework that will be required may mean that installation of the hardware may possibly be relatively expensive. This is balanced by the relatively inexpensive cost of the gas so that refills will be relatively.

The gases have a similar density to air and consequently will hold in a room nearly three times longer than Halogen or halocarbons. However as discharge time is in the order of 60 seconds any fire will have time to grow. After discharge the room can be vented using ordinary air conditioning providing that no recirculation takes place.

They are not corrosive and, as they do not react with the products of combustion, no toxic decomposition products are formed. They comprise gases found naturally in the atmosphere and consequently do not contribute to either global warming or ozone depletion. They provide the most environmentally friendly fire extinguishant option.

Carbon Dioxide

Carbon dioxide is heavier than many of the other gaseous alternatives and as a result more nozzles and pipework are needed to distribute the gas effectively(6). The gas has good penetration into screened areas and it is safe to use on live electrical equipment. Originally it was developed for use on oil fires but obviously has a much wider application. Advice from the Cambridgeshire Fire Brigade(14) is that it is suitable for protecting transformers.

It is stored in steel cylinders as a liquid, under pressure. When it is applied to a fire it produces a blanket of heavy gas that reduces the oxygen content of the ambient atmosphere to a level below which combustion cannot be sustained. It also produces a cooling effect.

Carbon dioxide is produced as a by-product of industries such as brewing and thus, in effect, does not contribute to global warming as this gas would otherwise be vented off to the atmosphere.

The most serious disadvantage is that in a manned room it can be potentially lethal in the concentrations required to extinguish a fire. In the event of a fire a concentration of 29 - 30% by volume is released which will reduce the oxygen level of the atmosphere from 21% to 15%. This level will extinguish most fires but will cause an immediate risk of asphyxiation if personnel are present. For electrical risks the concentration is increased to 50 - 52%, reducing the oxygen level to 10%. The UK Health and Safety Executive for the UK have set a maximum CO₂ level of 6% for a room that continues to be occupied. Unconsciousness in humans occurs at concentrations of 10% and above. Even with a discharge time of 60 seconds the toxic level will be reached in 10 - 15 seconds. Thus carbon dioxide systems must be "locked off" while personnel are present to prevent an accidental discharge. Personnel must be trained in carbon dioxide systems before working in areas protected by the gas.

Vents will need to be installed to relieve pressure, allowing the ambient atmosphere to be expelled. If this does not happen there is the danger that the oxygen level will not be reduced sufficiently to extinguish a fire. After discharge ventilation should be via a dedicated extractor connected directly to fresh air.

It is clean efficient, leaves no residue and produces no decomposition products. It is a by-product of industry and so it does not contribute to global warming. Indications are that it is the cheapest option available as a Halon replacement. Although it is potentially toxic the lock-off facility that is available at the Thames Barrier can be utilised to prevent accidental discharge while an area is manned

FM200

FM200 is a halocarbon (C₃HF₇)(8) which is being promoted by the fire fighting companies as the main alternative to Halons. It has a global warming potential no ozone depleting potential (see Table 1) and is similar

in density and design concentration to halon. As it is stored as a liquid the storage area requirements are also similar. As such it is probably the least disruptive to install retrospectively. The existing detector system will be reusable and so will much of the existing pipework. It is considered to be the most effective of the *proposed HFC substitutes* for Halon 1301. It is used at a minimum design concentration of 7% and acts as a physical extinguishant. As with Halon, when discharged, visibility is reduced for a few seconds. Discharge time is rapid, in the order of 10 seconds. Its holding time in a room is similar to Halons and oxygen level depletion is small due to the low concentration of extinguishant used. After discharge ventilation should be via a dedicated extractor connected directly to fresh air.

In a fire situation FM200 decomposes to produce hydrogen fluoride (HF) gas(9) which is a severe irritant (about 6.4 times as much HF is produced by FM200 than is produced by Halons). During tests typical HF concentrations were 100 - 300ppm. A concentration of 32ppm is all that can be tolerated for 3 minutes, with irritation to eyes, nose and respiratory tract. However electrical equipment appears not to be affected at these levels. Other toxic gases such as perfluoroisobutene and hexafluoropropene are also formed when FM200 reacts with combustion products.

FM200 is probably the most expensive of the options (a cylinder of FM200 is more expensive than one of Halon). It is fast acting and requires little more storage space than Halon. However whilst it may not damage the ozone layer it appears to have other unpleasant effects and contributes to global warming.

Water Fog

Water fog(12) (as opposed to water sprinklers) is applied as a very fine water spray which has a small droplet size (in the order of 1 - 10 microns). In this form the water behaves more as a gas than a liquid. Research has shown that water fog does not conduct electricity in the same way as a solid stream of water and so sprays can be considered for use on live electrical equipment. However unlike gases water fog will not diffuse into shielded compartments(13). For this reason the design of water fog systems will have to differ from those used for gases.

As water fog will not easily penetrate into shielded areas the nozzle pattern needs to be designed to anticipate where the fire might occur for effective control. This will lead to considerable extra costs for the hardware as the pipework will have to be designed so that the spray heads direct the water fog at the risk. In control rooms and switch rooms this will probably mean that they will have to be installed into each of the electrical cabinets individually, thus adding to the cost considerably. This requirement may make the system unsuitable for use with electrical systems currently protected by Halon. Discharge times for these systems is in the order of five minutes, which can allow a fire to significantly take hold. The rapid cooling action of the water on circuit boards present may harm them and add to the damage already caused by the fire.

However water is environmentally benign, inexpensive, and easily available. Water mist needs little cleanup after discharge and systems can be brought back into use quite quickly.

Powders

Dry powders comprise a powder aerosol of small particle size and can incorporate flame inhibitors into their make-up(1). They are capable of effecting very rapid fire extinguishment but are ineffective once the powder has settled. If the fire is not fully covered by powder it may start burning again. They could be used to protect transformers but the powder is likely to cause permanent damage to the equipment. Powders cannot cope with 3-D fires.

They are unsuitable for use in areas which are likely to be manned as visibility is seriously reduced, thus obscuring the exit, and are unpleasant to breathe. Clean-up afterwards will need to be completed before work can be resumed.

Foams

Foam acts by forming a barrier between the fire and the supply of oxygen(1). They are most suited to liquid pool fires and not generally effective against running or spray fires. They may be ~~suited for use on~~

transformers(14). To be effective they must fill the protected space, however care is needed in areas that may be occupied as there is a risk of suffocation. Unlike other systems foam systems do not have an in built fire detection capability and need to have a separate detection system.

NAF SIII

NAF SIII is a blend of the HCFC22, HCFC123 and HCFC124(10), and is very similar to Halons in its physical properties. It is the only "drop-in" replacement for Halons and can use existing hardware and pipework from a Halon system. However it is a blend of HCFC's with a high global warming potential and a (low) ozone depleting potential. It will be phased out by the year 2030, if not earlier and thus can only be considered as an intermediate substance after halons. The contribution to ozone depletion means that it is not environmentally acceptable.

FE 13

FE 13 (CHF_3) is also a HCFC(11) and is produced as a by-product of HCFC-22, the latter is a feed stock for the manufacture of other products such as Teflon. Thus, although HCFC-22 will be phased out by the year 2030 FE 13 is still likely to be manufactured.

Of all the alternatives to Halon it has the highest global warming potential - 11000 (see Table 1). It also operates at a high vapour pressure which means that a new system will have to be installed that is sufficiently robust enough to withstand these pressures. It is generally for specialist uses only and is likely to remain so in the foreseeable future. It is not considered environmentally acceptable as it is a HCFC.

CONCLUSION

The Thames Barrier is the last major NRA site to still use Halon as a fire extinguishant. The gas is a major ozone depleting substance and contributes to global warming. These adverse effects means that on environmental grounds Halon should be replaced.

A full risk assessment should be undertaken to determine which risks actually need an extinguishant system. Those areas which do not could be protected by a very early smoke detector system backed up by assistance from outside (i.e. the fire brigade). Where an extinguishant system is still needed the nature of the risk will determine the type of system that will replace the existing Halon system.

Halocarbons are not considered suitable options on environmental grounds as they make a major contribution to global warming and in some cases also contribute slightly to ozone depletion. Foams, powders and water mist are not appropriate as they are generally not suitable for the type of electrical risks found at the site.

There two serious options considered viable on environmental grounds for replacing Halon with a non ozone depleting substance. These are the inert gases and carbon dioxide.

Carbon dioxide gas seems to be the cheapest option and requires less storage space than the inert gases. It still requires considerably more storage space than Halon and has a slower discharge time, in the order of 60 seconds or so. It is also toxic and is really only suitable for areas which are generally unmanned or where the system can be "locked off" when personnel are in the area. Carbon dioxide is the most appropriate system to protect transformers.

The inert gases, Argonite and INERGEN, are stored as gases and require the most storage space. They are a little more expensive than carbon dioxide, but cheaper than FM200, and also require a discharge time of 60 seconds or more. Storage space requirements can be reduced by using one bank of bottles to protect several risks close together such as in the control tower of the Thames Barrier, although the weight of the bottles may cause structural problems. The gases occur naturally in the atmosphere and are not toxic to humans. They also have no environmental impact on the atmosphere. These gases would be most appropriate for protecting electrical equipment.

The NRA should take the approach of installing, appropriate to the risk, the most environmentally benign and least toxic fire extinguishant system available. This would be the inert gases for most risks except for transformers where carbon dioxide would be more appropriate. The most cost effective option for Halon replacement at the Thames Barrier would be phased approach. This should be based on a planned phased replacement of Halon sets during refurbishing or when replacing existing equipment, subject to budgetary constraints.

APPENDIX 1**HALON DISPOSAL**

There are a number of authorised companies who will take Halon away. It may be possible to sell the Halon but payment should not need to be made for its removal. Recovered halon is presently (Nov 1995) selling at £7.5 - £8 per kilo but this could change downwards if at the next Montreal Convention it is decided to bring forward the phase out date. A 5% loss can be expected when Halon is decanted from its original bottles at a specialist recovery centre (although this loss is recovered), so that only 95% of the value will be received. Alternatively Halon can be destroyed by burning at high temperatures.

The Halon Users National Consortium (HUNC) can be approached. HUNC is an association formed by a number of Halon users and the fire industry with the support of the government. Its long term aim is to ensure that existing stocks of Halon in the UK can be managed down to zero in a responsible manner. They have details of surplus Halon supplies in the UK and can give advice on how to dispose of Halons in an environmentally responsible manner. It will also act as a clearing house for sales of recovered Halons and provides a list of companies who will recycle them to a recognised specification.

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(01483) 414147

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