Docksway Disposal Site, Newport

Conceptual Model and Hydrogeological Risk Assessment for Area 2 – Landfill Extension

Project Ref: 14739/014/A2/002 – CBH/DA/RHT

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Report Re-issue to Address Schedule 4 Notice

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1 Introduction

1.1 This Issue of the Hydrogeological Risk Assessment Report

This report was issued to the EA for comment in November 2004 as part of the IPPC application for Area 2. In February 2004 the EA issued a Schedule 4 Notice requesting further information on the application site. This report has been reissued in response to the Notice and addresses the additional hydrogeological information requested.

38 Revised or additional text present within this version of the report which is required in order to satisfy the Schedule 4 Notice has been labelled in order to assist the EA in the review of new information. Such text has been given a number (in grey bold italic font) to its left. This number refers to the item number of the Schedule 4 Notice in which the information was requested. In the case of this paragraph, item no. 38 of the Schedule 4 Notice has been indicated for demonstration purposes.

1.2 Background

The Docksway Disposal Site is located 3km south of Newport Town Centre, Gwent and is centred on National Grid Reference ST 305 853 (Figure 1). It is operated by Newport City Council, referred to hereafter as NCC.

The disposal site is located on a peninsula of land between the tidal River Ebbw and River Usk. It is bordered immediately to the west by the River Ebbw and to the east and south by Newport Docks on the western bank of the River Usk.

43 The site is split into a northern half (Area 1) and a southern half (Area 2). Area 1 of the site has been used intermittently for waste disposal operations since 1939 and will reach capacity in early 2005. There is no artificial containment of potential contaminants at Area 1. Area 2 comprises land reclaimed in 1990 following a diversion of the River Ebbw. Up until recently Area 2 was partially flooded with a large oxbow lake. Dewatering of the oxbow lake is currently being undertaken in preparation for the engineering of Area 2 to form a containment landfill. This proposed extension to Docksway Disposal site will increase the life of the landfill until approximately 2025.

NCC requires a hydrogeological risk assessment to be carried out at Docksway Disposal Site in order to comply with the EC Groundwater Directive (80/68/EEC) and the Landfill Directive (99/31/EC) (as stipulated in condition 48.3 of the site waste management licence), and to support an IPPC application for the 'installation'. The EC Groundwater Directive has been implemented in the UK via the Waste Management Licensing Regulations, 1994 and the Groundwater Regulations, 1998. A hydrogeological risk assessment is required by these Regulations before a licence or permit can be granted for the disposal of waste to land where that waste may contain certain polluting substances. This risk assessment will investigate the risks to groundwater by the proposed engineered landfill extension. The ultimate design of the proposed extension may be modified following the findings of the hydrogeological risk assessment. The completed assessment will be submitted to the Environment Agency (EA) for approval.

A hydrogeological risk assessment has also been undertaken for Area 1 of the landfill and this has been reported separately to the EA (see PBA, 2004c) as part of a separate IPPC application.

A review of available historical investigation reports has been undertaken to complement the hydrogeological risk assessment along with the results of recent PBA intrusive investigations and environmental monitoring.

1.3 Scope of Work

The scope of work for this assessment was outlined in the Peter Brett Associates (PBA) proposal Reference 11938/001/TAU/DA/GLA dated July 2001.

Guidance on the approach to be taken for hydrogeological risk assessment for landfills has been provided by the EA (EA, 2003a) and the standard approach to risk assessment is given by the DETR in their Waste Management Paper 26B, Appendix E (DETR, 1995).

The approach is to ascertain the contaminative "***source term***" for a site and the "***receptors***" that could be at risk as a result of "***pathways***" between the two. All three aspects have to be present for a risk to exist. For landfills the source term is the leachate produced by the reaction between water which enters the waste (usually rainfall but also percolating groundwater or liquid waste if present) and the waste itself. In order to define the pathways and targets it is necessary to understand the geology, hydrogeology and hydrology of the site area.

The guidance recommends collecting together all relevant information to characterise the site and the surrounding area. This includes a review of available data on the site history, topography, geology, hydrogeology, hydrology, waste input, leachate level and leachate quality. All the information on the above aspects available to date is summarised and any shortfalls in data requirements are highlighted.

1.4 Legislative Framework

An IPPC permit is required to allow the commencement of waste disposal at Area 2 of the Docksway Disposal Site. For the permit to be issued an authorisation to discharge Listed substances under the Groundwater Regulations, 1998 is required. The hydrogeological risk assessment is required to demonstrate that these discharges will be acceptable in terms of the Groundwater Regulations,

The Groundwater Regulations, 1998 transpose the EC Groundwater Directive (80/68/EEC) into UK law. The general purpose of the Groundwater Directive is:

- to prevent substances in List I from entering groundwater; and
- to limit the introduction of List II substances so as to avoid pollution.

Listed substances are defined by the EC Directive (80/68/EEC). List I substances are defined as substances that have very significant carcinogenicity, toxicity, persistence and/or bio-accumulation. List II substances are defined as all other potentially polluting substances. Substances designated as either List I or List II are given in JAGDAG, 2001 and EA, 2004b.

1.5 Sources of Information

A full reference list for all the documentation consulted as part of this work is provided in Section 16.

Some data have been obtained directly as a result of recent investigation and monitoring work commissioned by PBA. In addition, some data have been obtained through external archives and data providers, such as the Environment Agency, Associated British Ports and the Centre for Ecology and Hydrology (CEH).

A full Envirocheck report including historical Ordnance Survey Mapping was obtained by PBA from Landmark Information Services Limited in 2001 which has provided information on for example, local licensed groundwater abstractions.

A number of historical investigation reports have been provided by NCC, many of which have been used to assist in the production of a conceptual model for the site. In particular the borehole records included in such reports have been used to assist in understanding the geology of the site.

No guarantee can be given for the accuracy or completeness of the third party information which has been used in the compilation of this report. It must be noted that there may be conditions pertaining to the site which were not disclosed by any of the investigative work carried out and which, therefore, could not be taken into consideration.

The interpretation carried out in this report is based on scientific and engineering appraisal. We have not taken into account the perceptions of, for example banks, insurers, lay people etc.

1.6 Complexity of Risk Assessment

EA guidance stipulates that hydrogeological risk assessments can be undertaken by means of a risk screen, a simple risk assessment or a complex risk assessment dependant on the nature of the site setting and the type of landfill under consideration. It is considered that a complex risk assessment is the most suitable method for evaluating the risks posed by Docksway Disposal site, based on the fact that it will take municipal waste and is in close proximity to a river. Consequently a complex assessment has been undertaken which includes a comprehensive site characterisation. This approach has been agreed with the EA.

2 Site Description

2.1 Location and Setting

The Docksway Disposal Site lies 3km south of Newport Town Centre between the River Ebbw and Newport Docks (Figure 1). The site is centred on NGR ST 305 853 and occupies a total area of approximately 50 hectares. Area 2 is centred on NGR ST 305 850 and occupies just under half of the total site area.

Area 1 (which lies to the north of Area 2) is a dilute and disperse landfill which has been operated by the local authority since the 1980s. The area to the west of the site (across the River Ebbw) is grassland and is known to have been used historically for landfilling. The Newport Docks lie to the east of the site and contain a number of industrial units including a timber treatment works and a fertiliser manufacturer. The River Ebbw forms the southern boundary of the site.

2.2 Site Geometry

Area 2 comprises low lying land reclaimed in 1990 following the straightening of the River Ebbw. It is intended that the area will be engineered for landfilling in five cells as depicted in Figure 2A. The surface areas of each cell are provided in Table 2.1. The total area that will be used for waste disposal in Area 2 is approximately 15.4 ha.

Table 2.2 Approximate Percentages of Each Waste Type Accepted

Cell No.	Surface Area (m^2)
1	47495
2	33710
3	25173
4	29514
5	18196
Total	*154088*

The IPPC boundary for the site is shown in Figure 3.

2.3 Topography

Docksway Disposal site is located on the alluvial plain of the River Severn Estuary. Prior to all filling activities, the site would have had a low-lying relief cut into by various meanders of the River Ebbw. As a result of landfilling activities, Area 1 now rests at between approximately 15m and 40m AOD.

The northwestern part of Area 2 has been raised using waste materials, see Section 2.4. In other locations the alluvial clay has been won from Area 2 for use in Area 1 (as temporary daily cover material for example) and this has reduced the ground level across some parts of Area 2. The edge of Area 2 adjacent to the Ebbw has been raised for flood protection. Topographic lows are present where the Ebbw formerly meandered through Area 2 (see Figure 3 for the location of the former Ebbw meander).

Area 2 now typically varies between approximately 6.5 and 9.5m AOD with the floor of the former oxbow lake/river meander at approximately 2.5m AOD.

2.4 Site History

2.4.1 Recent History

Docksway Disposal Site (Area 1) has been operated by Newport City Council or its predecessors since 3 June 1987 under waste management licence number EAWML30058. During this time filling has generally only taken place in Area 1. The site licence permits the acceptance of inert, household, commercial and industrial wastes. Table 2.2 details the breakdown of individual waste types currently accepted at the site (in Area 1 South).

Table 2.2 Approximate Percentages of Each Waste Type Accepted

Waste Type	Percent of Total (%)
Domestic/Household	54
Commercial	35
Inert Waste	11

2.4.2 Early History

Available 1:10,000 scale historical Ordnance Survey (OS) maps for the site do not indicate that the site was used for waste disposal until between 1981 and 1994 (Appendix 1). However, the 1968:1972 1:2,500 map labels Area 1 as a 'council tip' on the 1972 part of the map.

On the 1992, 1994, 1996, 1972 1:10,000 OS map, refuse disposal is indicated to have taken place largely on Area 1, but also on Area 2 to the north and west of the then oxbow lake (former River Ebbw meander). GW03/14 is located on this part of the Area 2 and records refuse in the Made Ground.

Land to the west of the site on the opposite side of the Ebbw is also known to be a landfill.

Available borehole logs indicate that Made Ground is present across much of Area 2. This provides evidence that early (pre-1980s) landfilling took place in Area 2. In general the Made Ground does not have the appearance of waste and this early fill placement may is expected to have been undertaken to raise the land and reclaim it from the flood plain of the River Severn.

2.4.3 *History of the Ebbw Meander*

Work to straighten the meander of the Ebbw which flowed through Area 2 was completed in 1990. The Ebbw was dammed at two points using clay with demolition arisings (Figure 2B). This work initially created an oxbow lake. The lake was dewatered in 2000 in order to undertake geotechnical investigations of the suitability of the area for development as a containment landfill. The lake was subsequently allowed to refill.

Two internal clay dams were installed subsequent to the oxbow lake formation (Figure 2B). These dams split the oxbow lake into three separate lakes.

The lakes of Area 2 have recently been dewatered in preparation for the construction of the Docksway landfill extension. Three smaller residual water bodies now remain in Area 2 (see Figure 2B). Figure 3 shows the locations of both of the former Ebbw meanders which were present on the Docksway Disposal site prior to the two separate river straightening operations.

2.5 *Principal Drainage*

Drainage from Area 1 runs towards and into Area 2 to the lowest point on the site (the former oxbow lake/Ebbw meander). Because the land has been raised for flood defence along the southern and western margins of Area 2, an effective basin is formed which collects precipitation and surface water runoff from several directions. Following recent dewatering work in preparation for construction, three lakes remain within the former Ebbw meander (Figure 2B). The principal drainage at Area 2 is towards these three residual water bodies.

One further surface water feature is present to the northeast of the Area 2 IPPC boundary. This is a ditch which runs close to the eastern boundary of the site (i.e. the waste management licence boundary). However, the ditch acts as a minor surface water storage area and no flow has been observed within this ditch to date.

A 1.2m diameter storm drain taking runoff from the ABP docks formerly discharged into the oxbow lake. This was diverted in 1995 and now runs along the eastern edge of Area 2 and outflows into the Ebbw to the south of the site (monitoring point SW15).

The Maes Glas Pill was formerly culverted in a dog leg along the eastern edge of Area 1 and east-west north of the boundary between Area 1 and Area 2. Following a stability assessment it was concluded that the load-bearing capacity of the culvert was not sufficient to support the estimated loading which would result from future landfilling at the site. A new 1.8m diameter concrete pipeline was installed in 2001 which runs through the northern part of Area 1 and the dog leg culvert was decommissioned.

Historically, this redundant culvert had had problems with the rapid transmittal of groundwater and/or contaminants. In the 1994 Working Plan for the site, it is noted that leachate-contaminated groundwater (presumably from the Area 1 tip) was discharging to the Ebbw in the vicinity of the now redundant Maes Glas Pill culvert (LG Mouchel, 1994). It was suggested that voids in the backfill surrounding the culvert were likely to have formed preferential pathways for the leachate.

26 Artificial site drainage is depicted on Figure 2B.

2.6 Engineering Design Philosophy

2.6.1 Outline Details

38 The design of the future Area 2 landfill has been discussed in detail in the engineering design philosophy report (PBA, 2004e). However, outline details have been provided here in order to comply with the Schedule 4 Notice.

The geology of the site has been discussed in detail in Section 3. The natural geology at the site comprises of alluvial clays (approximately 2.5m to 8m thick) over gravel deposits (approximately 5 to 8m thick) over the Mercia Mudstone.

7,8,34 Limited Made Ground is present over the natural strata in some parts of Area 2. However, where present this material will be removed prior to construction of the landfill. Consequently both the base and the sides of the artificial landfill liner will rest on alluvial clay following construction. Moreover, the top 2m of the exposed alluvial clay will be cement stabilised to form part of the EBS for the landfill.

2.6.2 Engineered Barrier System

Leakage from the site and the associated transport of contaminants will be impeded by the presence of an engineered barrier and a natural geological barrier (the natural alluvial clays present beneath the site). The engineered barrier system (or EBS) will comprise 3 components; two clay barriers separated by a load transfer blanket (numbers 2. to 4. in Table 2.3).

The upper clay barrier will comprise 1.2m of imported clay engineered to have a maximum permeability of 10^{-9} m/s. The lower barrier will comprise 2m of in-situ alluvial clay which will undergo stabilisation using cement columns. Details of the input parameters used to represent the EBS in the LandSim modelling are included in Table 9.1.

Table 2.3 Area 2 EBS Design

Material	Thickness (mm)	Hydraulic Conductivity (m/s)
1. Granular drainage blanket	500	10^{-3}
2. Engineered imported Clay Barrier	1200	$< 10^{-9}$
3. Load transfer blanket	300	10^{-3}
4. Cement stabilised in-situ Alluvium	2000	$< 10^{-9}$
Note: Numbers 2 to 4 are termed the engineered barrier system (EBS) throughout this report.		

Table 2.3 indicates the EBS design over the majority of the site. It is not quite correct for the EBS design over the deepest parts of the former Ebbw channel which meanders beneath Area 2. In the deepest part of the river channel the top of the alluvium is lower than elsewhere across the site and in order to reach the construction level required an additional layer of imported engineered clay will have to be added. At its lowest point the top of the alluvium is present at +1.5m AOD. At such locations an additional 1.5m of engineered clay will be added and the total

imported engineered clay used in the design will be up to 2.7m thick. This is represented pictorially in Figure 2D.

2.6.3 Minimum Alluvial Clay Thickness Beneath the Landfill

35 Beneath the future Area 2 landfill, the base of the alluvial clay/top of the Gravel Deposits rests at between approximately -1.0m AOD and-2.5m AOD, Figure 4E).

The most recent (March 2005) topographic survey of the site has confirmed that the top of the alluvial clay has a minimum height of 1.5m AOD in the former Ebbw river channel, giving the alluvium a minimum thickness of 2.5m.

The top 2m of the alluvial clay deposit is to be stabilised with cement to form part of the engineered barrier system for the landfill. Consequently a minimum thickness of 0.5m of 'unengineered' alluvium will remain beneath the landfill site following the EBS construction. At such locations additional clay will be added above the top of the alluvium in order to achieve the required construction platform height (see discussion in Section 2.6.2).

8,10 Away from the former river channel, the maximum height of the top of the alluvial clay will rest at 3.8m AOD following preparation of the surface for the construction of the upper (imported clay) barrier/liner. Consequently, away from the river meander the 'unengineered' alluvium will have a minimum thickness of 2.8m. The worst case and best case thickness of the 'unengineered' alluvial clay beneath the landfill is represented pictorially in Figure 2D.

2.6.4 Groundwater Levels

35 Beneath the future Area 2 landfill, the base of the EBS will rest at between 1.8m AOD and 0.3m AOD. The top of the EBS will rest at between 4.5m and 5.3m AOD (see Figure 2D).

Sub-artesian groundwater is present in the gravel deposits which in general has a piezometric surface within the Alluvial Clays at a level of between approximately +1.3 m AOD and +3.7 m AOD (see Figures 8A to 8J for the piezometric surface of the Gravel groundwater at various states of the tide). At some locations the piezometric surface of the Gravel groundwater will lie within the lower part of the EBS (see Figure 2D).

6,35 At no point will the future landfill be below the piezometric surface of the Gravel groundwater, i.e. sub-water table (see Figure 2D). During high tide however, the sub-artesian piezometric surface may rise into the basal clay liner (i.e. the stabilised alluvium) in the north-western part of the landfill (i.e. where groundwater levels are higher). Also at the very lowest points of the EBS the piezometric surface is expected to generally be present just above the base of the EBS.

As the tide rises and falls the proportion of the natural alluvial clay which forms the vertical pathway (i.e. that which is fully saturated) will theoretically change. As the vertical pathway increases the unsaturated pathway will decrease and vice-versa. This has implications for the LandSim modelling work which are discussed further in Section 9.5.

2.6.5 *Stability of the EBS*

64 An assessment of the hydrogeological stability of the engineered lining system (i.e. the risk of hydraulic uplift caused by the piezometric surface) has been undertaken in the Stability Assessment report for Area 2 (PBA, 2004a). The findings of this assessment are that there should be at least 3.64m of strata between the top of the gravel and the underside of the upper engineered clay barrier to ensure a minimum factor of safety (1.5) against hydraulic uplift. Figure 2D shows that at the sump of Cell 1A this distance is 4.4m, i.e. considerably in excess of the minimum requirement.

2.6.6 *Drainage Blanket Details*

Full details of the drainage blanket specification and performance are presented in the design philosophy report (PBA, 2004e). However, outline details have been provided here in order to comply with the Schedule 4 Notice.

The drainage blanket for the landfill will comprise 500mm of '40mm single size', (to BS882 grading requirements), clean non-calcareous gravel or crushed rock with a 10% fines value of greater than 100kN.

Using Hazen's formula the inferred permeability of this material (with a D_{10} minimum particle size of 11mm) is 1.21 m/s. In accordance with EA guidance a landfill drainage blanket requires a minimum permeability of $1x10^{-4}$ m/s and the performance assessment for the drainage blanket is based on the assumption that it will have this minimum permeability.

14 It has been calculated (assuming a $1x10^{-4}$ m/s permeability value) that the maximum head of leachate that will be present above the base of the drainage blanket will be 120mm, which is considerably lower than the design head, and less than the blanket thickness of 500mm (PBA, 2004e).

44 The actual permeability of the proposed drainage stone is considered to be some four orders of magnitude greater than the design value, thus allowing for a significant degree of clogging and bio-fouling to occur before the leachate management system would be incapable of maintaining the maximum leachate head proposed.

Details of the drainage parameters which have been entered into the LandSim model are given in Table 9.1.

3 Geology and Ground Conditions

3.1 *Data Available*

The geology of Area 1 is described in detail in the Area 1 hydrogeological risk assessment (PBA 2004c). The ground conditions at Area 2 are described here. Geological data are available as a result of:

- Work undertaken in 1994 to investigate the potential suitability of the alluvial clays beneath the southern part of the site for use as capping material and/or for the containment of waste (Structural Soils, 1994).
- Work undertaken in 1996 to investigate the engineering properties of the strata underlying the southern extension area (Exploration Associates, 1996):
- Boreholes drilled around the former Maes Glas Pill culvert in August 1999 (Gwent Consultancy, 1999a and 1999b).
- Groundwater and gas monitoring well installation work in 2003 (CJ Associates, 2003 and 2004a).
- Borehole investigation work in 2004 (CJ Associates, 2004b).

All the boreholes used to compile a 3D conceptual model of the site geology are included on Figure 3. Schematic geological cross sections through Area 2 are presented in Figure 5. The borehole logs used to generate Figure 5 are presented in Appendix 3.

3.2 *Main Stratigraphic Units*

Four main geological horizons are recognised. The natural succession comprises superficial deposits (Alluvial Clays over Gravels) over the Triassic bedrock. The Triassic bedrock is generally considered to comprise the Mercia Mudstone Group beneath the entire site (e.g. LG Mouchel, 1996a).

The 1:50,000 scale geological map of Newport, (BGS 1986a), indicates that the north western-most part of Area 1 of the site lies on bedrock which is younger than the Mercia Mudstone, i.e. rocks of the Rhaetic Cotham and Westbury beds and the Jurassic Blue Lias Group (see Figure 4A).

However, all of the deeper boreholes drilled on the Docksway Disposal Site to date have identified red-brown mudstone bedrock which is assumed to be the Mercia Mudstone and hence it has been assumed for this risk assessment that the Mercia Mudstone Group underlies the entire site area.

Recently, GW03/28 was drilled outside the application boundary to the north west of the site. This borehole encountered grey calcareous mudstone and hard limestone below 4m bgl which is considered likely to represent part of the Blue Lias Group.

Made Ground is present overlying the superficial deposits over some of the site. Due to the extent of the landfilling activity at the site and the local topography, the thicknesses of each of these strata vary significantly between Area 1 and Area 2.

3.3 Made Ground

In Area 1 the Made Ground can be summarised as a mixture of domestic refuse, building rubble and reworked natural deposits. In Area 2, the Made Ground is generally less extensive and contains less in the way of waste materials. Typically Made Ground located in Area 2 comprises clay with gravel and cobbles.

For the most part the horizon comprises reworked natural deposits. However, locally, especially around the edges of Area 2, builder's waste-type material is included in the fill. For example, concrete is present at GW03/09 and GW03/10A and in the Ebbw dams.

The Made Ground has been described as dark grey-black coal-derived ash with coal at borehole EA7 (to 2.1m bgl). Occasional ash was also noted during the drilling of SS94-8, SS94-9 and SS94-10 (Structural Soils, 1994).

Investigations undertaken to date have not been able to establish a lateral limit to fill placement and fill materials are present beyond the Area 2 IPPC application boundary towards the east, and to the west and south where fill materials 'outcrop' on the bank of the Ebbw.

Fill materials have been used to construct four dams in Area 2. Two largely clay dams have been placed to cut off the Ebbw initially forming an oxbow lake. The clay dams include some demolition materials such as concrete boulders. Two internal dams have also been placed which at the time, divided the oxbow lake into three separate water bodies. These dams also comprise clay with demolition rubble.

To the north (i.e. in Area 1), considerable thicknesses of fill (and in particular waste) have been placed to create the landform present. The highest part of Area 1 has been termed the central raised area or CRA (see also PBA, 2004c).

3.4 Alluvial Clays

The Alluvial Clays generally comprise grey, grey-brown or grey-black organic-rich clays or clay-silts with traces of peat. They are generally firm to stiff with a desiccated 'crust' for the top 1 to 2m of the strata. Below this depth they are soft or very soft.

Atterberg Limit testing on the alluvial deposits shows them to comprise generally high to very high plasticity clays (Structural Soils, 1994). In general the maximum liquid limit measured is approximately 80% whilst the maximum plasticity index measured is approximately 50%. Recent studies (based on the testing of 45 samples), have shown the liquid limit of the clays to vary between 40% and 106% with a mean value of 62%, and the plasticity index of the clays to vary between 12% and 63% with a mean value of 25% (CJ Associates, 2003).

A study of 135 moisture content measurements from the Alluvial Clays has demonstrated a range between 13 and 85% with a mean of 48%.

Particle size distribution tests have shown that the Alluvial Clays contain a clay fraction of between 41 and 55% with the remaining grains largely silt-sized (Structural Soils, 1994).

Consolidation tests on the Alluvial Clays recorded coefficient of volume compressibility values of between 2.0 m^2/MN for a pressure range of 25 to 50 kNm^2 and 1.0 m^2/MN for a pressure range of 50 to 100 kNm^2. These values are representative of high compressibility soils.

40 Recent cation exchange coefficient (CEC) testing has indicated that the Alluvial Clays have a CEC value of between 140 and 230 meq/kg. This range is fairly typical for a clay soil (EA, 2001a). Organic carbon content testing indicated that the Alluvial Clay has between 0.6 and 14% organic carbon. The analytical certificates for the CEC and organic carbon testing are presented in Appendix 7.

The upper crust of the alluvium has been removed over a large part of the site and has exposed very soft clay in these areas. Where the crust remains the alluvial clay forming the crust tends to be soft to firm.

24,25 The alluvial clay deposits contain occasional depositional sub-horizontal silt partings and laminae. The presence of these partings is expected to contribute to the higher observed horizontal permeability of the alluvium in comparison with its vertical permeability (see Appendix 4). No discrete peat layers have been recorded in any of the boreholes sunk although traces of peaty and organic matter are recorded in places but present as disseminated fragments within the clay.

In general the alluvial clay deposits are very soft or soft with a relatively high natural moisture content (mean of 48%) and no observations of discontinuities have been made in the clays at any significant depth. The top 1 to 2m of the alluvial clay has been noted to generally form a desiccated crust where micro-fissures have been occasionally observed. However, such conditions are much less common in Area 2 since at the majority of locations the top few meters of the clay has been won for use as daily cover material on the Area 1 landfill. Below the "crust" the lithology, depositional history, unconsolidated nature and geotechnical properties of the alluvial clay are such that vertical discontinuities will not be present. Importantly, where the alluvium is at its thinnest beneath the former river meander, the presence of surface water above the clay will have kept it softened and hence fissures will not have developed.

In general, vertical discontinuities are not considered to be of significance in the alluvium beneath Area 2. However, in case of their presence a very conservative value for the vertical permeability of the alluvial clays has been used in the modelling (see Appendix 4, Table 9.1 and Section 13. 9).

3.5 *Gravel Deposits*

The Gravel Deposits generally comprise pale brown-grey medium dense to dense sandy and sometimes silty or clayey gravel of sandstone and quartz with occasional cobbles of sandstone.

Particle size distribution tests have shown that the Gravel Deposits contain a fine to coarse gravel fraction of between 55 and 97% and a fines (silt and clay) content of up to 15%. The remaining grains (up to 30%) comprise fine to coarse sand (Exploration Associates, 1996).

3.6 Mercia Mudstone Group

The Mercia Mudstone Group comprises red and brown weak blocky mudstones with occasional siltstones. The Group is observed to be weathered at the top and comprises gravel-sized fragments of mudstone bound in a red clay matrix or stiff red-brown clay with gravel (Exploration Associates, 1996, LG Mouchel, 1996a and NCBC, 2000). During recent investigation work (CJ Associates, 2003), the Mercia Mudstone was encountered in four boreholes where it was described as a stiff or very stiff red-brown clay with silt.

The Mercia Mudstone has been proven to a maximum thickness of 11.7m as a result of the various investigations undertaken to date. The mudstones of the Mercia Mudstone Group are known to be between 130m thick (BGS and EA, 2000) and 190m (BGS, 1986b) in the region. The Mercia Mudstone is referred to by its former name (Keuper Marl) on the geological map for the site (Figure 4A).

3.7 Thicknesses of Deposits

3.7.1 Made Ground Thickness and Occurrence

Made Ground generally varies between about 0.5m and 3m thick across Area 2. However, locally the Made Ground thins or is absent, e.g. beneath the former oxbow lake at borehole EA1. Also, locally the Made Ground increases substantially in thickness.

In the northeastern part of Area 2 the Made Ground increases to up to 6.5m thick e.g. at GW03/14 and domestic refuse is included in the Made Ground. Landfilling with refuse on this part of the site is indicated on the 1992, 1994, 1996, 1972 OS map for the area (see also Section 2.4).

The Made Ground is slightly thicker around GW03/13 and SS94-8 on the south western edge of the site.

The Made Ground also increases in thickness where dams have been placed (see Figure 2B). Made Ground is 6.3m thick at the internal dam on the western side of the former oxbow lake. Made Ground is 7m thick at the internal dam on the eastern of the former oxbow lake. The Made Ground increases to up to 10.6m thick where the dams have been placed to straighten the Ebbw (borehole GW03/23).

The western-most dam installed to cut off the oxbow lake from the Ebbw extends from approximately 7.5m AOD to -3.3m AOD. The eastern dam extends from approximately 8.8m AOD to approximately -0.5m AOD. The base of the made ground in these locations is lower than the natural top of the Alluvial Clays (approximately 2.5m AOD). This suggests that some clay may have been removed prior to the placement of the dams. Also the clay beneath the dams is likely to have consolidated following dam construction.

Figure 4B shows a plot of Made Ground thickness across the site. Figure 2C shows a schematic geological cross section through one of the Ebbw dams indicating the approximate made ground thickness within the dam.

3.7.2 Natural Deposits Thickness and Occurrence

The thickness of the Alluvial Clay varies considerably beneath Area 2. It ranges between approximately 5.5m in the west (GW03/13) and 8 to 10m in the east (for example SS94-9 and EA7) with thinning to a minimum of 2.5m observed below the former river channel. Figure 4C shows a plot of Alluvial Clay thickness across the site.

Table 3.2 Simplified Generalised Stratigraphic Sequence at Area 2

Stratum	Approximate Depth to base (m bgl)	Approximate Horizon Thickness (m)	Approximate Height of Base (m AOD)
Made Ground (where present)	1.0	1.0	3.5
Alluvial Clays	6.0	5.0	-1.0
Gravels	12.0	6.0	-6.0
Mercia Mudstone		Up to 190	

Note:

Sequence is generalised and figures are only approximate mean values.

The Mercia Mudstone has been proven to a maximum thickness of 11.7m beneath the site (Morgan Vinci, 2002) but is known to be up to 190m thick in the region (BGS, 1986b).

The Gravel Deposits beneath Area 2 vary in thickness between approximately 3.8m at the western end (SS94-5 and SS94-6) and 8.9m at the eastern boundary of the site (EA6 and GW03/09). The base of the gravel horizon/top of the Mercia Mudstone Group is present at between -5.25 and -11.00m AOD. The boundary undulates somewhat but in general it deepens towards the east as the Alluvial Clays and Gravel Deposits above thicken.

A generalised and simplified geological sequence beneath Area 2 is summarised in Table 3.2. The elevations of the bases of each stratigraphic horizon at selected borehole locations in Area 2 are given in Table 3.3. Further details of the height of each stratigraphic horizon at the majority of the boreholes studied as part of this assessment (in both Areas 1 and 2) are presented in Table A3-1 within Appendix 3.

3.8 Site-wide Trends

The base of the Made Ground/top of the Alluvial Clays varies between approximately 8.8m and -3.3 AOD (Table 3.3). The junction is present at greater depth close to the former river channels and where dams have been constructed to straighten the Ebbw. Figure 4D plots the height of this horizon across both Areas 1 and 2. It shows that the junction is particularly deep around the two external Ebbw dams and at GW03/08B. In all three of these areas the top of the Alluvial Clay has probably been reduced at a result of clay extraction.

The base of the Alluvial Clay/top of the Gravels generally lies between approximately -0.5m AOD and -3.5m AOD (Table 3.3). Figure 6F provides contours of the height of this stratigraphic boundary across Area 2. The base of the Alluvial Clay deposits generally deepen in an easterly direction, i.e. towards the River Usk and also in a southerly direction towards the Severn Estuary. The contours show that the base of the alluvium/top of the gravels is typically present at between -1m and -3m AOD beneath the future Area 2 landfill.

Table 3.3 Elevation of the Bases of Various Stratigraphic Horizons

Borehole	**Elevation of base of Made Ground (m AOD)**	**Elevation of base of Alluvial Clays (m AOD)**	**Elevation of base of Gravel Deposits (m AOD)**
GW03/07	5.40	-2.10	Not determined
GW03/08A	5.85	-2.85	Not determined
GW03/09	7.36	-0.64	-8.74
GW03/10a	8.88	-1.47	Not determined
GW03/13	5.31	-0.19	-5.24
GW03/14	3.83	-0.27	-7.77
GW03/17**	0.75	-1.25	-8.65
GW03/19*	1.98	Not determined	Not determined
GW03/21*	-0.56	Not determined	Not determined
GW03/22**	0.7	-1.4	-8.0
GW03/23*	-3.30	Not determined	Not determined
GW03/24*	-2.79	-3.29	Not determined
GW03/25	4.68	-3.32	-7.52
Notes: * = external dam location ** = internal dam location			

The base of the Gravel Deposits varies between approximately -5.2m AOD and approximately -8.7m AOD beneath Area 2 (Table 3.3). Figure 6G provides contours of the height of this horizon across both Areas 1 and 2. In general, the junction deepens towards the east, i.e. towards the River Usk and also towards the south, i.e. towards the Severn Estuary.

3.9 Construction Earthworks

It is noteworthy that the preparation of Area 2 for the construction of the landfill will entail earthworks which will alter the near surface geology. Where it is present, made ground will be removed from areas where the landfill is to be constructed. In addition, where the top of the alluvium is below the required construction platform height, imported, engineered clay will be placed in order to raise ground level prior to construction.

4 Hydrogeology

4.1 *Regional Hydrogeology*

The regional hydrogeology for the site is described in outline on the 1:125,000 hydrogeology map for South Wales (BGS, 1986b). The site is shown to be underlain by 'alluvial deposits and peat'. Groundwater yields from the alluvial deposits are described as low (less than 5 ls^{-1}) and the groundwater is described as liable to saline intrusion.

Beneath the alluvial deposits is 'sand and gravel' from which groundwater yields of 5 to 15 ls^{-1} are reported. The groundwater quality in these deposits is described as similar to that of the river with which they are in hydraulic continuity (i.e. the estuarine Ebbw in the case of gravels beneath the subject site). Iron and manganese concentrations are also reported as undesirably high (BGS, 1986b).

The Mercia Mudstone Group is described as approximately 190m thick across the map area comprising mudstones over a conglomerate layer at the base which is up to 60m thick. The map states that the mudstones act as an impermeable top to the basal conglomerate. This description is echoed in the Policy and Practice for the Protection of Groundwater, Welsh Regional Appendix, (EA, 1995).

Contours of the base of the superficial deposits are shown to deepen towards the Severn (i.e. towards the south east) on the hydrogeology map. Groundwater within the superficial deposits would be expected to flow in this broad direction. This is in agreement with the regional groundwater flow direction indicated in the Environmental Impact Statement for the site (Borough of Newport, 1993).

4.2 *Hydrogeological Sensitivity*

4.2.1 *Groundwater Vulnerability Map*

The 1:100,000 scale groundwater vulnerability map for the site and its vicinity (EA, 1996), indicates that some of the site and the general area around the site is considered as a non-aquifer (Figure 6). This classification relates to the presence of the low permeability alluvial deposits that are present on the northern tidal flats of the Severn Estuary.

However, part of the site has been designated as a minor aquifer on the map. The deposits indicated as a minor aquifer cover a localised area adjacent to the River Ebbw and its former meander (the base plan used for the groundwater vulnerability map does not show the work undertaken in 1990 to straighten the Ebbw in Area 2 of the site). This designation is assumed to relate to the presence of the Gravel Deposits beneath the Docksway site.

Based on the fact that some of the site area is classified as a non-aquifer, and on the fact that the wider area within the Severn flood plain is considered as a non-aquifer (see Figure 6), the site is not considered to be particularly sensitive with respect to groundwater resources. Other evidence which supports this view is the lack of groundwater abstractions in the site vicinity (see Section 4.2.2) and the known poor quality of the Gravel groundwater (see Section 7 and relevant comments in the above Section).

4.2.2 *Groundwater Abstractions*

No groundwater abstraction points within 5km of the site are shown on the hydrogeology map (BGS, 1986b). According to the Envirocheck report commissioned by PBA, there are no licensed groundwater abstractions within a 1000m radius of the site (PBA, 2001). According to the EA, there are no licensed groundwater abstractions within a 2000m radius of the site (EA, pers. comm.). According to the Local Authority (Newport City Council, there are no private water wells located within a 2000m radius of the site (NCC Environmental Health Department, pers. comm., see Appendix 2).

The site does not lie within a source protection zone (SPZ) for any licensed groundwater abstractions (EA, 2004). As indicated in the previous Section, the site is considered to be a low sensitivity location with respect to groundwater resources.

4.3 *Hydraulic Properties of the Made Ground*

4,8 The Made Ground is generally only 0.5m to 3m thick where present over Area 2 and it is absent at many locations. Where made ground is present beneath the proposed landfill site it will be removed and the landfill will be constructed on the alluvial clay, consequently its hydraulic properties are of little significance to this risk assessment.

4,8 Made ground will remain in place at two locations to the south of the landfill at the Ebbw dams (see Figure 2B for approximate dam locations). The top edge of the engineered side slope of the landfill will abut the made ground of the dams at two locations (see Figure 2C for relationship between the landfill edge and the dams). Based on the fact that the dams only border approximately 9% of the perimeter of the landfill, the proximity of these two areas of made ground are not considered to have any hydraulic significance to the presence of the landfill.

In any case, the side liner of the landfill will be thickened to 3m where the landfill abuts these two dams (see Figure 2D).

4.4 *Hydraulic Properties of the Alluvial Clays*

The Alluvial Clays are regarded as an aquitard. Several assessments of their permeability have been carried out previously (see for example Structural Soils, 1994 and Exploration Associates, 1996).

A thorough assessment of all the available data has been undertaken by PBA as part of the geotechnical design of the Area 2 landfill extension (PBA, 2004a). Work which has been undertaken to evaluate the permeability of the Alluvial Clays is presented in Appendix 4.

The mean coefficient of horizontal permeability has been estimated to be of the order of 1.0×10^{-7} ms^{-1} and the mean coefficient of vertical permeability has been estimated at < 8.8×10^{-10} ms^{-1} as a result of this assessment (Appendix 4). For the LandSim modelling work the vertical hydraulic conductivity has been assigned a fixed higher value of 1.0×10^{-9} ms^{-1} in order to be conservative.

32,49d Using the initial void ratio data obtained in the laboratory from recent and historical investigations, the porosity of the alluvium has been estimated at ranging between 0.41 and 0.69. This is typical for a clay deposit (see for example Freeze and Cherry, 1979). The initial void ratio data used to estimate the alluvial clay porosity is presented as Appendix 8.

32 The EA has requested that effective porosity values are provided for the Alluvial Clay however this data is not available. Studies indicate that that the effective porosity of a clay is unlikely to exceed 0.18 (McWorter and Sunada, 1977).

A sensitivity analysis has been carried out on the porosity used in the model to assess the degree of influence that this parameter has on the model output (see Section 13.10). The analysis demonstrated that the model is relatively insensitive to the porosity value used (values for porosity of between 0.05 and 0.7 were modelled).

4.5 *Hydraulic Properties of the Gravel Deposits*

The Gravel Deposits of the Severn Estuary are classified as a minor aquifer by the EA (EA, 1996). Generally these deposits were noted as water bearing when encountered during drilling work. Groundwater was often struck at boundary between the top of the Gravel Deposits and the base of the Alluvial Clays during drilling (Table 4.1).

After 20 minutes, rest water levels generally rose to some 2m or more above the base of the Alluvial Clays suggesting that groundwater within the Gravel Deposits is confined slightly by the overlying clays (Table 4.1).

Table 4.1 Examples of Groundwater Strikes in the Gravel Deposits

Well	Strike depth (m bgl)	Geology	Rest water level after 20 min (m bgl)
GW03/01	10.10	Top of Gravel at 10.00	8.60
GW03/04	16.00	Top of Gravel at 16.10	10.10
GW03/05	15.80	Top of Gravel at 15.80	13.20
GW03/07	11.30	Top of Gravel at 11.30	8.70
GW03/08A	9.00	Top of Gravel at 10.00	8.00
GW03/09	12.00	Top of Gravel at 10.90	9.00
GW03/10A	11.50	Top of Gravel at 11.50	9.00
GW03/14	11.00	Top of Gravel at 10.00	9.00
GW03/15	11.40	Top of Gravel at 11.40	9.90

The in-situ hydraulic conductivity of the Gravel Deposits has been estimated in the field using a series of rising head and constant head permeability tests (CJ Associates, 2003 and CJ Associates, 2004). The results suggest that the hydraulic conductivity falls within the range from 1.9×10^{-7} ms^{-1} to $>9.5 \times 10^{-3}$ ms^{-1}.

Previously, the permeability of the gravel was estimated at between 1.3 x 10^{-8} ms^{-1} and 6.8 x 10^{-4} ms^{-1} based on five field falling head permeability tests (Exploration Associates, 1996).

It is important to note that tests undertaken in borehole standpipes influence only a small volume of soil (which is likely to have been disturbed during the drilling process) and can give rise to misleading results. Variable head tests, particularly those carried out in boreholes during drilling, are prone to silting up and can underestimate the permeability of the horizon being tested. The constant head tests in standpipes are considered the more reliable. Typical permeability values for sand and gravel deposits vary between 10^{-3} and 1 ms^{-1} according to the geotechnical engineering handbook (Carter, 1983) although with the relatively high sand fraction present in the Gravel at the site, values in excess of 10^{-2} $ms^{-1}$are unlikely. It is anticipated that the true permeability of the Gravel Deposits is close to the higher end of the range of values determined in 2003 and 2004.

Ignoring the variable head tests and any spuriously low constant head tests gives a permeability range from 8.3 x 10^{-6} to >9.5 x 10^{-3} ms^{-1} with the actual field value likely to be towards the higher end of this range.

Accordingly a triangular distribution within the range from $1x10^{-5}$ to $1x10^{-2}$ ms^{-1} has been selected for the LandSim model input. The apex of the triangle is set at $5x10^{-3}$ ms^{-1} to skew the value towards the upper end of the range.

4.6 *Hydraulic Properties of the Mercia Mudstone*

The Mercia Mudstone Group comprises a series of low permeability mudstones with occasional thin horizons of fractured siltstone (or skerries), through which minor flows of groundwater can occur (BGS and EA, 2000). The Group is considered a minor aquifer by the EA since small quantities of potable water can be abstracted from its more permeable siltstone horizons and the basal conglomerate layer in some areas.

In general, the mudstones of the Group are viewed as a low permeability horizon which confines groundwater within the basal conglomerate (e.g. BGS, 1986b). Data on the hydrogeological properties of the Mercia Mudstone are extremely rare in the South Wales area (BGS and EA, 2000), which reflects the minor importance of this (minor) aquifer as a groundwater resource in this part of the United Kingdom.

The BGS aquifer properties manual (BGS and EA, 2000) describes the Mercia Mudstone Group as 'predominately impermeable and at best a poor aquifer'. For this reason the Mercia Mudstone Group is treated as a non-aquifer throughout the rest of this assessment.

4.7 *Groundwater Elevation and Flow*

4.7.1 *Preliminary Studies and General Comments*

In 1996, groundwater monitoring by LG Mouchel & Partners over a nine hour period demonstrated that the elevation of the gravel groundwater is subtly affected by tidal forces. It was concluded from this study that the groundwater within the Gravel Deposits is in partial hydraulic continuity with the River Ebbw (LG Mouchel, 1996a).

Table 4.2 shows the results of a round of groundwater elevation monitoring for the whole site (Area 1 and Area 2) undertaken on 20 August 2003 at twelve wells installed into the Gravel Deposits. Crucially, these dip measurements were taken within a short time frame around the high tide time for the Ebbw (11:30am to 1:55pm). The High tide time for the Newport Docks was 11:32 on this date (ABP, 2003). Since the gravel groundwater is influenced by the tides it is important to use dip measurements taken during the same part of the tidal cycle in order to draw conclusions about true groundwater elevations (and hence likely groundwater flow direction).

Table 4.2 shows that the groundwater in the Gravel Deposits was present beneath the site at between approximately 1.3m and 4.4m AOD on this occasion and was present at between 1.3m and 2.7m AOD beneath Area 2. Groundwater is generally at a lower elevation beneath Area 2 than is the case beneath Area 1 providing evidence for groundwater flow from Area 1 to Area 2. This is in line with the expected regional groundwater flow direction towards the Severn Estuary.

Also of note from Table 4.2 is that the typical elevation of the Gravel Deposits piezometric surface is some 1.6 to 4.9m above the top of the horizon. The Gravel Deposits groundwater is hence slightly confined by the Alluvial Clays (GW03/02 is the exception where the groundwater does not appear to be confined).

The results of these early studies indicated that tidal influence is significant and that a more comprehensive programme of tidal and groundwater level monitoring was required.

Table 4.2 Elevation of the Gravel Groundwater on 20/8/03

Well	Dip (m below cover	Height of cover (m AOD)	Groundwater level (m AOD)	Elevation of top of Gravel (m AOD)	Distance of RWL above top of Gravel (m)
GW03/02	10.445	14.814	4.37	4.61	-0.24
GW03/03	11.65	15.382	3.73	1.94	1.79
GW03/06a	7.75	9.918	2.17	-1.59	3.76
GW03/07	7.43	10.229	2.80	-2.1	4.90
GW03/09*	7.8	10.508	2.71	-0.64	3.35
GW03/10A*	8.4	9.704	1.30	-1.47	2.77
GW03/13*	5.93	7.984	2.05	-0.19	2.24
GW03/14*	7.49	9.68	2.19	-0.27	2.46
GW03/15	9.05	11.74	2.69	1.09	1.60
GW03/16	11.125	14.421	3.30	0.42	2.88
Note: * = Well positioned in Area 2					

4.7.2 *Tidal Influence*

Regional groundwater flow in the site vicinity is likely to be towards the south or south east, i.e. in the general direction of the Severn Estuary. However, early work demonstrated that the tidal nature of the Ebbw does locally alter groundwater elevation within the Gravel Deposits and therefore both the hydraulic gradient and groundwater flow direction within the gravels are likely to be subject to localised variations at different states of the tide.

More recently, a comprehensive study of the tidal variations in elevation of the Gravel groundwater has been undertaken. This study includes three main rounds of monitoring which have been undertaken over the duration of full tidal cycles during low spring, high spring and neap tidal events (see Table 4.3). In order to target these tidal events, the National Tidal and Sea Level Facility website (NTSLF, 2004) and the South Wales tide tables booklet (ABP, 2004) were consulted. Additionally, information on the tidal range of the Ebbw at the entrance to Newport Docks has been obtained through ABP (ABP, pers. comm.).

The results of the three main tidal monitoring episodes are depicted in Figures 7A, 7B and 7C and are discussed below.

33,34 Raw groundwater monitoring data collected as part of this study is presented in Appendix 11.

Figure 7A shows groundwater levels in the gravel during the low spring tidal cycle of 13 January 2004. It is apparent from Figure 7A that the groundwater level in some wells is not influenced by the Ebbw tides (e.g. GW03/04, GW03/05 and GW03/06 GW03/09 which are all located to the north and east of Area 1). Groundwater levels in wells located in close proximity to the Ebbw, i.e. less inland, record an obvious tidal response (e.g. GW03/10A, GW03/13, GW03/14, GW03/15 and GW03/16),

Table 4.3 Tidal Monitoring Undertaken at the site

Date	State of Tidal Cycle	Details of Monitoring Undertaken
20/08/03	NR	Monitoring of 10 gravel wells undertaken once around high tide.
13/01/04*	Low Spring	Continuous monitoring of several perched water wells and several gravel groundwater wells over a full cycle (Figure 7A).
26/01/04*	High Spring	Continuous monitoring of several gravel groundwater wells over a full cycle (Figure 7B).
14/07/04*	Neap	Continuous monitoring of several gravel groundwater wells over a full cycle (Figure 7C).
01/09/04	Low Spring	Monitoring of 4 gravels wells twice (once after low tide and once after high tide)
09/09/04	Neap	Monitoring of 5 gravels wells once just before high tide.

Note:
NR = Not recorded
* = Main tidal monitoring rounds comprised measuring groundwater at each monitoring location approximately once every half an hour continuously for between 12 and 13 hours.

Figure 7B shows groundwater levels in the Gravel Deposits during the high spring tidal cycle of 26 January 2004. As with the low spring tidal event (Figure 7A), only selected wells located close to the bank of the Ebbw are influenced by its tides (e.g. at GW03/10A, GW03/13, GW03/14, GW03/15 and GW03/16).

It is interesting to note from Figure 7B that the tides increase the groundwater elevation at selected wells to the point where hydraulic gradients within the Gravel groundwater system are likely to be altered locally for short period of time around the high tide peak. For example, in general, groundwater levels at GW03/13 are lower than those at GW03/05 and consequently groundwater flow would be expected to be broadly from GW03/05 towards GW03/13. However, for a period of about 3 hours around the time of the high tide during a High Spring cycle, the situation is reversed, (Figure 7B). This indicates that local groundwater flow directions are likely to change at high tide (see Section 4.7.3 below).

It is important to note that the typical sea level of the Usk Estuary at the entrance to the Newport Docks ranges between -4.0m and -5.0m AOD during low tide (see Figures 7A and 7B) and that the bed of the river will be below -5m AOD. This is significantly lower than the bed of the River Ebbw adjacent to the site which is approximately 0m AOD according to site surveys and OS maps. The bed level of the River Usk at and around low tide is considered to be what drives the hydraulic gradient of the Gravel groundwater beneath the site. The net flow of groundwater at the site is consistently towards the southeast (i.e. towards the Usk Estuary) as described in Section 4.7.3 below.

4.7.3 Groundwater Flow Direction

Figures 8A to 8J provide interpretive gravel groundwater elevation contour plots on various dates at various stages of the tidal cycle. The likely direction of groundwater flow is indicated as generally towards the south east on all of these plots. This is in line with the general groundwater flow direction indicated on the hydrogeology map for the region (BGS, 1986b)

During low tide times (e.g. Figures 7A and 7D), groundwater contours conform slightly to the shape of the peninsula between the Ebbw and the Usk. Hence whilst flow is generally to the southeast, locally flow can be towards the east, south, west or southwest away from the site. The shape formed by the groundwater elevation contours is described as a bulge in the following text.

During high tide times the increase in head in the Ebbw alters the groundwater head in the Gravel Deposits along the southern and western edges of the site. The contour bulge observed at low tide is effectively widened and shifts slightly to the south west (e.g. Figures 8B and 8E), giving a more southerly component of groundwater flow.

It is important to note that during high tide this shift of the contour bulge means that groundwater can theoretically flow beneath the Ebbw towards the site from the adjacent landfilled area. Consequently groundwater from beneath the former landfill across the Ebbw to the west of the site could potentially influence the hydrochemistry of the site groundwater (for example in the vicinity of GW03/14), (see Figures 8B, 8E and 8G).

Whether at high tide or low tide the net groundwater flow direction has been demonstrated as towards the south east.

4.7.4 Water Level in the Docks

The water level in the Newport Docks to the east of the site is relatively consistent. Information has been supplied by ABP (ABP, pers. comm.) for all occasions when tidal assessments have been undertaken. ABP record the Docks water level once in the morning and once in the afternoon. The water level has varied by a total of 70cm over six monitoring occasions and twelve readings.

The level of the water in the Docks is consistently much higher than groundwater in the Gravel Deposits. The nearest wells to the Docks that are included in the monitoring programme are GW03/26 and GW03/27 situated some 175m from the north Dock (Figure 3). Groundwater in these wells is present at approximately 2.5m AOD regardless of the state of the tide whilst water in the Docks is at more than 6.8m AOD at all times (Table 4.4). This significant difference in head suggests that the water in the Docks is not in hydraulic continuity with the Gravel groundwater.

Evidence for this lack of effective hydraulic continuity is supported by the hydrochemistry (see Section 7.4).

Table 4.4 Water Levels in Newport Docks

Date of Monitoring	**Water level (am)** to Newport Channel chart datum	**Water level (am)** to Newlyn OD	**Water level (am)** to Newport Channel chart datum	**Water level (am)** to Newlyn OD
20/08/03	11.7	7.22	11.7	7.22
13/01/04	12.0	7.52	11.9	7.42
26/01/04	11.7	7.22	11.8	7.32
14/07/04	11.85	7.37	11.8	7.32
01/09/04	11.9	7.42	11.85	7.37
09/09/04	11.45	6.97	11.3	6.82

The North Dock is reported to be 8m deep, (ABP, pers. comm.) which suggests that its base would lie in the Alluvial Clays. The South Dock is reported to be 11m deep (ABP, pers. comm.) which suggests that its base would be more likely to lie in the Gravel Deposits. However, the expected silting up of the base of the Docks would be likely to reduce hydraulic continuity between the dock water and the Gravel groundwater if this was ever the case.

4.7.5 Hydraulic Gradients

Table 4.5 gives a number of potential values for the hydraulic gradient within the Gravel Deposits. Because of the bulge in the groundwater elevation contours formed by the peninsula, groundwater may flow towards the south, east or west at different times and beneath different parts of the site. The values of the hydraulic gradients given in Table 4.5 are all estimated between wells which are at right angles to the groundwater elevation contours.

Table 4.5 Estimate of Hydraulic Gradient in Gravel Deposits

Wells used in calculation	Difference in Head (m)	Distance between wells (m)	Hydraulic Gradient (dimensionless)
GW03/16 & GW03/13 (13/01/04)	1.977	590	0.0034
GW03/14 & GW03/10a (13/01/04	1.496	380	0.0039
GW03/09 & GW03/10a (13/01/04)	1.494	270	0.0055
GW03/14 & GW03/10a (26/01/04)	2.376	380	0.0063
GW03/02 & GW03/16 (26/01/04)	2.276	480	0.0047
GW03/09 & GW03/10a (26/01/04)	1.764	270	0.0065
GW03/03 & GW03/16 (26/01/04)	0.721	130	0.0055
GW03/14 & GW03/25 (14/07/04)	1.39	310	0.0044

The hydraulic gradient for the groundwater in the gravel is estimated at between 0.0034 and 0.0065.

5 Hydrology

5.1 *Introduction*

The main hydrological feature of the site is the River Ebbw which forms the western boundary of the site (see Figure 4). The Ebbw joins the River Usk about 1.3km downstream of the site. The Usk then flows into the Severn Estuary some 3.5km downstream from the site. Other surface water features on the site include:

- A small pond (North Pond) in the north western corner of the site close to the civic amenity centre.
- A number of lakes in the southern half of the site (Area 2) which have formed in an abandoned loop of the River Ebbw before diversion works were completed in 1990. At one time the lakes combined to form one oxbow lake. Area 2 has almost entirely been dewatered in preparation for the groundworks necessary prior to the construction of the southern extension to Docksway Disposal Site.

5.2 *Rainfall*

Rainfall data has been collated from various sources.

Over the twelve year period between 1980 and 1991, NCC reported the average annual Newport rainfall to be 999.89 mm (NCBC, 1992). These data were recorded by the Local Authority-operated weather station at the Newport Civic Centre which is no longer in use. In a letter to the Borough of Newport dated 22 October 1996, the total annual rainfall for the Newport area averaged over the period 1981 to 1996 is given as 987 mm/year (LG Mouchel, 1996b).

Rainfall data from 1978 to 1995 for Cardiff is available on the Met Office website (Met Office, 2004). These data gives the average annual precipitation at 1112.6 mm/yr.

16,23 The data from Cardiff are considered to be the most conservative since the average rainfall presented is higher than that quoted by NCC and LG Mouchel. Consequently, it is the Cardiff data that has been used in the water balance work. Furthermore, the Cardiff rainfall data is given for individual months between 1978 and 1995 with accompanying monthly temperature averages which are required to establish potential evapotranspiration as part of the water balance.

5.3 *Water Balance*

16,18 Pre-restoration and post-restoration water balances have been undertaken for Cell 1 of the future landfill and have been presented in the engineering design philosophy report (PBA, 2004e). The pre-restoration and post restoration water balances are reproduced in this report in Appendices 5 and 6 respectively. The calculations have been undertaken with reference to published authoritative guidance (DoE, 1995).

21i Calculations have been undertaken to estimate the potential infiltration rate to active landfill cells assuming use of daily cover of not greater than 150mm thickness to the waste, and also post restoration assuming a 1.0m thickness clay capping, overlain by

850mm subsoil and 150mm grassed topsoil (see Appendix 5 and PBA, 2004e). The following parameters have been determined:

Table 5.1 Water Balance Input Parameters

	Parameter	Calculated Value
1	Average Rainfall (1978 – 1995)	1113mm per annum
2	Runoff Post restoration (15% assumed) Pre restoration (0% assumed)	 167mm per annum NIL
3	Actual Evapotranspiration AET Post restoration Pre restoration	 584mm per annum 329mm per annum
4	Infiltration to waste Post restoration Pre restoration	 43mm per annum 678mm per annum
5	Rate of waste infilling	90,000 tonnes per annum Decreasing thereafter
6	Placement Density of Waste	0.85 tonne/m^3
7	Absorptive Capacity of Waste	0.06m^3/tonne

The full water balance calculation for Cell 1 is presented in Appendix 5 and PBA, 2004e. Each sub-cell has been shown to have sufficient absorptive capacity to accommodate the estimated amount of leachate likely to be generated. In the event that free leachate does accumulate in the piped system as a result of the generation of preferential pathways, then the leachate will be extracted by pumping. Reference should be made to PBA, 2004e with regard to leachate management details.

Table 5.2 Cell 1 Water Balance Results

Sub Cell No.	Absorptive Capacity (m^3)	Volume of Infiltration (m^3)	Free Leachate
1A	4010	2779	No
1B	4379	3632	No
1C	2023	1679	No
1D	2113	1870	No
1E	3017	2860	No
1F	1565	1399	No

It has been agreed with the EA that at this stage of the IPPC application process that full engineering details are only required for Cell 1. Consequently a sub-cell by sub-cell water balance has not been provided for the cells other than Cell 1. However, based on knowledge of the expected waste volumes in the remaining cells within Area 2, calculations regarding the required number of sub-cells within each cell have been provided (Table 5.3). The subdivision of the remaining cells will provide a theoretical greater absorption capacity for the refuse than the average rainfall, thus minimising the potential for free leachate to arise.

Table 5.3 Area 2 – Approximate Filling Rates

Cell	Lined Area (a) (m^3 approx)	Volume Waste (b) (m^3 approx)	Average Filling Rate (c) (t/annum)
1	39851	335423	88121
2	33710	378010	74037
3	25173	276903	56047
4	29514	442710	48357
5	18196	127372	47214

48b Based on the absorptive capacity of 0.06m^3/tonne for a mixed waste density of 0.85 tonnes/m^3 the subdivision of Area 2 Cells 1 to 5 may be calculated. By applying the subdivision of these Cells, the potential for generation of free leachate will be minimised.

Table 5.4 Area 2 – Cell Subdivision Water Balance Calculation

Cell	Annual absorptive capacity (d) =(c) x 0.06 (m^3/annum)	Infiltration per annum (e) (m)	Optimum Operational Area (d/e) (m^2)	Minimum Number of Sub-cells
1	5287	0.678	7796	5.11 (6 No.)
2	4442	0.678	6550	5.14 (6 No.)
3	3362	0.678	4959	5.07 (6 No.)
4	2901	0.678	5704	6.89 (7 No.)
5	2832	0.678	5569	4.35 (5 No.)

5.4 *River Flow Characteristics*

5.4.1 Ebbw

27 Flow data for the Ebbw have been taken from two volumes of the Hydrometric Register (CEH, 1998 and 2003) and are presented in Table 5.5. The Ebbw flow monitoring point is located at NGR ST 259 889.

The Ebbw is tidal (see also Section 4.8.3 with respect to the influence this has on the water table in the Gravel Deposits). Data from the Environmental Impact Statement for the Proposed Extension of Docksway Disposal Site, (Borough of Newport, 1993) indicates the following predicted tide levels for the Ebbw in this area:

Mean High Water Spring Tide	6.29m AOD
Highest Astronomical Tide	7.69m AOD
1 in 200 Still Water Level	8.50m AOD

Table 5.2 Ebbw Flow Data Published by CEH (Rhiwderyn)

Year	Mean Flow (m^3s^{-1})	Peak Flow (m^3s^{-1})	Minimum Daily Flow (m^3s^{-1})
1991	7.19	105.1	1.27
1992	7.00	171.7	1.25
1993	6.91	122.1	1.15
1994	9.17	113.5	1.22
1995	6.86	69.9	0.82
1996	Not given	Not given	Not given
1997	6.66	Not given	Not given
1998	9.70	248.3	1.49
1999	9.13	121.0	1.33
2000	10.34	402.4	1.12

Actual tidal data for the Ebbw collected as part of the recent tidal studies suggest the following tide levels for the Ebbw at the entrance to Newport Docks (ABP, 2004 and ABP, pers. comm.):

Low Spring Tide High Water Level	5.1m AOD (13/1/04)
Low Spring Tide Low Water Level	-4.1m AOD (13/1/04)

Actual tidal data for the Ebbw collected as part of the recent tidal studies suggest the following high tide level for the Ebbw adjacent to the LL03/01 area of the site:

High Spring Tide High Water Level 6.9m AOD (26/1/04)

The nature of these tides means that the southern part of the site was at risk from flooding until flood defence bunds were placed around the edge of this part of the site at an elevation of approximately 9m AOD. A flood risk assessment using the latest guidelines in TAN 15 (2004) has been completed for Area 2 of the Docksway Disposal Site and will be submitted as part of the IPPC.

5.4.2 Maes Glas Pill

No flow data are available for the Maes Glas Pill since it is such a minor water course. The Pill is slightly influenced by the tidal behaviour of the Ebbw. Recent monitoring has demonstrated that the elevation of the stream water within the Maes Glas Pill increases at higher tide times in the Ebbw. The Maes Glas Pill is isolated from the Ebbw by means of a flat non-return valve fitted at the exit of the new culvert (i.e. at sampling location SW04). The observed increase in the Maes Glas Pill elevation during the Ebbw high tide is hence likely to be largely a result of the backing up of Maes Glas Pill water as opposed to the ingress of estuarine Ebbw water. This theory is not fully supported by the results of salinity testing undertaken at monitoring point SW21 in the Maes Glas Pill during high and low tide (Section 7.5.5). The results of this work show that the salinity of the Maes Glas Pill increases slightly during the high tide of the Ebbw tidal cycle, suggesting that the non-return valve may not stop all of the Ebbw tidal surge (see Table 7.8).

6 Leachate

6.1 Leachate Control Measures

Leachate control measures will be incorporated into the engineering of each Area 2 cell as they are constructed. Leachate pumping wells will be built in sections above the sumps of each of the cells as part of landfilling operation. This will enable leachate levels in each landfill cell to be controlled during the operational and managed phases. Design details of the leachate management wells and their proposed locations are presented in PBA, 2004e and also in PBA, 2005a.

The two main objectives of leachate management are to minimise the rate of leachate generation by minimising rainfall infiltration and water seepage into the waste and secondly to provide a reliable, maintainable means of collecting and removing the leachate quantities that are produced. Prior to the capping being completed the cells of the landfill will operate on the basis of providing a greater absorption capacity by the refuse than the average rainfall infiltration, thus minimising the potential for free leachate to arise.

19,20 Leachate removed from the landfill in order to maintain affixed head will be pumped to a leachate treatment plant. No leachate recirculation is planned for this landfill.

Each phase will be capped at the earliest opportunity to further restrict surface water input. Surface water from capped phases will be directed away from the landfill via the surface water management control ditches constructed along the perimeter of the site.

Details of water balance calculations, anticipated leachate generation and further details of the landfill leachate management plan are presented in PBA, 2004e.

6.2 Leachate Elevation

To date, leachate maintenance levels for the operational and managed phases have not been agreed between the Operator and the EA. However, likely leachate management practices have been considered in order to complete the design and the hydrogeological risk assessment for the landfill.

The engineering design philosophy report for Area 2 (PBA, 2004e), details the leachate management scheme proposed for the site. During the early stages of landfill operation leachate will be controlled such that it lies at an average of 1m above the bases of each cell (if leachate control is required). This measure will ensure that leachate does not overtop the internal bunds between each cell of the landfill. This short term arrangement will be in place until the second stage of filling commences over the tops of the cells. During the second stage of the operational phase and throughout the managed phase, leachate will be controlled such that it averages equal to or less than 2m above the base of the landfill.

For the LandSim modelling undertaken as part of this assessment, an assumed leachate level within the landfill is required as an input parameter for the model. The value used in the modelling work is an average of 2m above the base of the engineered barrier system (EBS) which equates to approximately 5m AOD. This is considered to be the most appropriate value to use throughout the operational and managed phases. Based on the water balance calculations undertaken (Section 5.3) and on the assumed absorption capacity of the waste, it is a conservative assumption that free leachate will reach 2m above the EBS during the operational phase.

6.3 *Leachate Chemistry*

Details of the expected leachate chemistry are required as an input for the LandSim modelling work. The quality of the leachate within the Area 2 landfill is not yet known because the landfill is not yet constructed.

3df It is necessary to estimate the expected leachate chemistry based on scientific judgement whilst taking a conservative approach.

Where an application is for a future landfill, the LandSim guidance stipulates default leachate contaminant concentrations (based on a wide range of UK data) which can be used in the contaminant transport modelling (EA, 2001a). For contaminants for which there are no LandSim default values, other published data are available for guidance on expected leachate chemistry (i.e. DoE, 1995). In the case of Docksway Disposal site, the data collected to date on the leachate chemistry of Area 1 also provides a useful information source.

Information is particularly sparse on expected concentrations of certain contaminants in landfill leachate. Contaminants which fall into this category and are considered as possible priority contaminants at the Docksway site include: phenol, petroleum hydrocarbons and other organic List I substances. The EA guidance suggests that in the absence of published guidance, the public register can be consulted for an indication of likely contaminant concentrations in similar landfills.

3f Whilst much of the tipping at Area 1 pre-dates the current licensing regime, waste within Area 1 represents waste from a largely municipal source from around the Newport area. In particular, waste within the central raised area (CRA) is largely municipal and has largely been placed within the last 15 years. Consequently, whilst there is a possibility that leachate from the CRA in Area 1 could contain substances unlikely to be present in the current Newport municipal waste stream, it does provide a useful guide to the possible future chemistry of the Area 2 leachate.

The Area 1 leachate testing data provides a conservative estimate of the likely future Area 2 source term concentrations since industrial and commercial wastes will not be permitted in the Area 2 facility (as they have been in the past in Area 1).

<u>Selection of Priority Contaminants for which Data are Widely Available</u>

50 Leachate data from Area 1, WMP 26B (DoE, 1995) and the LandSim manual have been compared in Table 6.1 for assessing likely future concentrations of more common contaminants in landfill leachate.

When selecting priority contaminants for use in the LandSim modelling, contaminants which are more elevated in the Area 1 leachate than expected typical values published in WMP 26B and the LandSim manual have been preferentially selected to model a conservative scenario. Whether or not the contaminant has been identified in the Docksway Gravel Deposits groundwater has also been taken into account when selecting priority contaminants (if the contaminant is currently present in the Docksway Gravel groundwater it is considered a higher risk contaminant).

Table 6.1 Determination of Potential Priority Contaminants for which Data on Expected Concentrations in Leachate are Widely Available.

Determinand	**Area 1 spot measurements (uniform)**	**LandSim Default (triangular)**	Mean conc's for methanogenic leachates (WMP 26B) (triangular)	**Conservative range chosen for modelling**
Electrical conductivity (μS/cm)	22100 to 24300		5990, 11502, 19300	Not a priority*
Ammoniacal Nitrogen (mg/l)	1763 to 2439	32.1, 267, 1100	283, 889, 2040	1763 to 2439*
BOD (mg/l)	120 to 804		97, 374, 1770	Not a priority*
COD (mg/l)	421 to 4810		662, 2307, 8000	Not a priority
Chloride (mg/l)	2119 to 2688	227, 997, 2650	570, 2074, 4710	Not a priority*
Arsenic (μg/l)	75 to 143	3.71, 4.85, 10.7	<1, 34, 485	75, 143, 485
Boron (μg/l)	5392 to 14760			Not a priority*
Cadmium (μg/l)	<0.4 to 2.2	1.9, 10.1, 105	<10, 15, 80	Not a priority
Chromium (μg/l)	268 to 600	23.1, 98.1, 416	<30, 90, 560	Not a priority
Copper (μg/l)	9 to 35	12.9, 50.9, 191	<20, 130, 620	Not a priority
Lead (μg/l)	28 to 111	33.7, 111, 340	<40, 200, 1900	Not a priority
Mercury (μg/l)	<0.05	0.0394, 0.0891, 1.95	<0.1, 0.2, 0.8	0.0394, 0.0891, 1.95*
Nickel (μg/l)	271 to 389	34.5, 126, 627	<30, 170, 600	271, 389, 627
Zinc (μg/l)	192 to 294	29.6, 362, 9000	30, 1140, 6700	Not a priority
Potassium (mg/l)	915 to 1215	40.8, 321, 1140	100, 854, 1580	915, 1215, 1580*
Sodium (mg/l)	1312 to 2040		474, 1480, 3650	Not a priority*
Nitrate (mg/l)	0.8 to 9.5		0.2, 0.86, 2.1	Not a priority
Sulphate (mg/l)	<3 to 29		<5, 67, 322	Not a priority
pH	7.9 to 8.4		6.8, 7.5, 8.2	Not a priority
Note: * = Detected in significant quantities in Gravel groundwater.				

In Table 6.1, arsenic, chromium, nickel, potassium and ammoniacal nitrogen are all potential priority contaminants since the concentrations in the Area 1 leachate are significantly higher than the expected or mean concentrations provided in the LandSim documentation and WMP 26B. In addition, potassium and ammoniacal nitrogen have been recorded in significant concentrations in the Gravel deposits groundwater. Chromium and arsenic behave similarly in the environment, i.e. they are both relatively immobile and hence only one of these two contaminants has been selected (i.e. arsenic due to the fact that its concentration in the Area 1 leachate is significantly greater than the default values provided in the LandSim manual).

Whilst mercury has not been detected to date in the Area 1 landfill leachate, it has been sporadically detected in the Gravel groundwater to the north of the site and is therefore considered worthy of study. It also represents an inorganic List I substance.

The highest concentration range identified from the three data sources consulted has been used for the modelling work in order to take the most conservative approach (as agreed with the EA). For arsenic, the lowest and expected concentrations are represented by the lowest and highest measured arsenic concentration in the Area 1 landfill leachate to date. The highest possible arsenic concentration used in the distribution has been taken from WMP 26B. The nickel and potassium expected concentration ranges have been compiled in a similar way. Importantly, the highest, and therefore most conservative realistic concentration ranges have been used in the determination of the input parameters for the modelling.

General discussion on List I Substances in the Area 1 Leachate

Appendix 1 of the EA guidance (EA, 2003a) describes the families of chemicals viewed as List I substances by the EA. These comprise: organohalogen compounds, organophosphorus compounds, organotins, carcinogenic, mutagenic or teratogenic compounds, mercury, cadmium, cyanides and mineral oil/hydrocarbons.

When selecting List I priority contaminants for use in the LandSim modelling, contaminants which have been recorded in the Docksway Area 1 leachate have been preferentially selected. The results of the List I substances testing undertaken to date on the Area 1 leachate are presented in Appendix 9. Observation of the testing certificates supplied indicates that:

- No organohalogen compounds have been identified;
- No organophosphorus compounds have been identified;
- No mercury has been detected;
- Cadmium concentrations are low;
- No cyanide has been detected.
- A number of VOCs including BTEX compounds have been detected;
- Few SVOCs have been detected although PAHs are present;
- Petroleum hydrocarbons/mineral oil are present in the leachate;
- Organotin compounds are low or not detected in the leachate.

Based on the above information, petroleum hydrocarbons are considered the highest priority group of List I substances which require representation in the source term.

When selecting List I priority contaminants for use in the LandSim modelling, whether or not the contaminants have been recorded in the Docksway Gravel Deposits groundwater has also been taken into consideration (see earlier discussion regarding the inclusion of mercury).

Selection of Priority Contaminants for which Data are not Widely Available

Phenol, extractable petroleum hydrocarbons (including mineral oil, see testing certificates in Appendix 9) and a number of aromatic (BTEX and PAH) hydrocarbon compounds have been detected in the Area 1 landfill leachate. All the List I substances detailed in Table 6.2 have also been sporadically detected in the Gravel groundwater.

3abc Data on likely organic substance concentrations in leachate are not widely available. Leachate data from Area 1 and other UK landfills have been compared in Table 6.2 for assessing likely organic substance concentrations in the future Area 2 leachate. It is widely accepted that in general, contaminant concentrations are likely to be higher in containment landfills than they are in dilute and disperse landfills. Consequently the public register was consulted for information on organic substance concentrations in Welsh containment landfills. The EA's EDM was used to search the available records for 14 Welsh containment landfills: Tir John, Nantycaws, Pwllfawatkin, Bryn Pica, Nant Y Gwyddon, Lamby Way, Bryn Posteg, Garden Lodge, Pen Y Bont, Astbury, Standard, Brookhill, Llanddulas and Penhesgyn Gors. Information supplied by the EA detailing the locations and waste management licence numbers of each of these landfills is presented in Appendix 2. Unfortunately the vast majority of these landfills had either no leachate data available for viewing or no information on less common leachate contaminants (such as organic List I substances). Organic substance concentration data was only supplied for Nant Y Gwyddon landfill in Gelli (see Table 6.2). However, PBA have in-house data on organic substance concentrations in the leachate of Pwllfawatkin Landfill in Pontardawe, Bletchley Landfill in Bedfordshire and Stewartby Landfill in Bedfordshire (Table 6.2) and this information has been consulted in order to gauge whether concentrations found in the Docksway Area 1 leachate are high or low.

Table 6.2 Deduction of Potential Organic Priority Contaminants (for which Data on Expected Concentrations in Leachate are not Widely Available)

List I substance identified in Leachate	Area 1 spot measure-ments	Nant Y Gwyddon data*	Pwllfawatkin landfill data**	Stewartby Landfill, data***	Bletchley Landfill Data¥	Conservative range chosen for modelling
Benzene (µg/l)	<1 to 4	<2	<1	6.1	10.6	10.6#
Chlorobenzene (µg/l)	<1 to 5	<2	<1	NT	37.3	#
Ethylbenzene (µg/l)	18 to 77	<2	<1	8.7 to 74.5	12.6	#
Naphthalene (µg/l)	3 to 14	<10	<1	10 to 41.2	5.7 to 7.2	10 to 41.2#
Toluene (µg/l)	<1 to 83	2.0	<1	18.7 to 452	37.8	#
Trimethylbenzene (µg/l)	28 to 100	<2	<1	5.9 to 33.6	9.3 to 16.6	#
m,p-xylene (µg/l)	83 to 148	<2	<1	24.9 to 223	12.1 to 25.5	118 to 311 #†
o-xylene (µg/l)	35 to 53	<2	<1	17.8 to 88.2	10.9 to 11.6	
Phenol (µg/l)	60 to 550	< 150	ND	910	<1 to 20.8	60 to 910#
Extractable petroleum hydrocarbons (C_{10} to C_{40}) (mg/l)	10.1 to 172.6	ND	ND	ND	0.7 to 14.3	10.1 to 172.6#
Mineral oil (mg/l)	0.028 to 82.5	ND	ND	ND	ND	

Notes:
* = Sourced from EA, 2005.
** = Sourced in 'Pwllfawatkin Landfill – Regulation 15 assessment – interim report'. (PBA, 2001b)
*** = Sourced in 'Conceptual model and hydrogeological risk assessment for Stewardtby Landfill site' (ESI, October 2003).
¥ = Sourced in Bletchley Landfill Site – Hydrogeological Risk Assessment (Entec UK Limited, 2003).
# = Detected in Gravel groundwater.
NT = not tested
ND = No data
† = xylene modelled as combination of o- and m,p-xylene in LandSim model

It is noteworthy that all five of the landfills listed in Table 6.2 have taken commercial and industrial waste in the past, and consequently List I substances are likely to be more concentrated in these landfills than they would be in a landfill which accepts only municipal waste (i.e. the future Area 2 facility). Consequently it is a conservative approach to define the future source term for Area 2 using the above data.

Phenol has been selected as a priority contaminant based on the fact that it is found at relatively high concentrations in the Area 1 leachate.

3e Three List I aromatic hydrocarbons (benzene, naphthalene and xylene) have been selected for modelling based on the fact that hydrocarbons are an important constituent of the Area 1 leachate. Each of the selected List I hydrocarbons has a different mobility in aquifer systems and all of them have been detected in the Gravel groundwater in the past.

Mineral oil and extractable petroleum hydrocarbons (also referred to as diesel range organics) represent a range of different hydrocarbons which need to be represented in the source term. Mineral oil comprises, amongst other chemicals, straight chain aliphatic hydrocarbons in the range C_{10} to C_{35} (EA, 2000). Extractable petroleum hydrocarbons (EPH) include straight aliphatics in the range C_{10} to C_{40} and PAHs.

PAHs are represented in the source term in the form of naphthalene. To represent mineral oil/EPH a series of straight chain aliphatics have been entered in the source term, the retardation properties of which have been determined by desk top research. The concentration of aliphatic hydrocarbons entered into the model is that of the full range of extractable petroleum hydrocarbons recorded in the leachate samples.

The highest concentration range identified from the review of Area 1 leachate data and available data from four UK containment landfills has been allocated to each organic contaminant for input into the model in order to take the most conservative approach (as agreed with the EA). Priority contaminants have also been chosen with due regard for representing different environmental behaviour characteristics as is recommended in LFTGN01 (see Section 9.4 for further justification of the choice of priority contaminants modelled).

For xylene, the Area 1 Docksway leachate data had the highest minimum recorded concentration range (of m,p- plus o-xylene) and Stewartby had the highest maximum value. The range used in the model was hence a combination of the Stewartby and Docksway data to provide the highest possible concentration range and therefore to exercise the highest level of conservatism. For naphthalene, data from Stewartby landfill indicated the highest concentration range and hence these data were used for conservatism. For benzene, a single measurement from Bletchley landfill indicated the highest concentration and this was used in the model for conservatism.

Whilst trimethylbenzene and ethyl benzene were relatively elevated in the Area 1 Docksway leachate compared to that of the other landfills reviewed, these contaminants were not modelled on account of their very high degradation rates in the environment. Both ethylbenzene and trimethylbenzene have half lives measured in weeks under anaerobic conditions and days under aerobic conditions (Howard *et al.*, 1991). Consequently it is unlikely that these contaminants would break through the base of an engineered barrier system before they have biodegraded. One high degradation-rate organic substance which is present at a high concentration in the Area 1 leachate has been selected for the modelling (i.e. phenol).

Table 9.1 indicates the assigned chemistry of the Area 2 leachate with respect to ten priority determinands based on most conservative concentration ranges established in Tables 6.1 and 6.2.

47b Where possible, triangular distributions have been used for the input of source term concentrations in LandSim in line with the presentation of leachate quality data in the

LandSim guidance. However, where the Docksway Area 1 leachate testing data has been used directly, (e.g. as is the case for ammoniacal nitrogen), the concentrations have been entered as uniform distributions. Uniform distributions are used because only four spot tests of leachate quality are available at Area 1 and consequently it is not statistically justifiable to average the four results and assume that the mean will be the expected value in a triangular distribution. The concentration of benzene in Stewartby landfill was based on one test result only and hence this has been entered as a single value in the model.

46 The priority contaminants selected for modelling will be subject to different types of behaviour in the geosphere in and around the Area 2 landfill. An assessment of uncertainty of the future presence of each of these contaminants is given in Table 6.3.

Table 6.3 Uncertainty Associated with the Presence of the Selected Priority Contaminants

Priority Contaminant	Comment on Uncertainty
Aliphatic hydrocarbons	Aliphatic hydrocarbons are common ingredients in many household products. They are found in lotions, soaps, cosmetics and motor oil and are the main ingredients in many baby care products such as baby oil, baby liquid soap, baby lotions and petroleum jelly. Aliphatic hydrocarbons are also found in most household and motor fuels. Based on this information it is considered highly likely that they will continue to be present in the Newport municipal waste stream.
Ammoniacal nitrogen	It is widely accepted that ammoniacal nitrogen is one of the most common contaminants arising from MSW landfills. Therefore, it is considered very likely that it will be generated in Area 2.
Arsenic	The leachate and Gravel groundwater testing data from Area 1 indicates that arsenic is currently present in the Newport municipal waste stream. As a common ingredient of weed killers and wood preservatives and an additive to textiles, glass and paint it is considered highly likely that arsenic will continue to be present within the Newport MSW stream.
Benzene	Benzene has been identified in the Area 1 leachate and also sporadically in the Gravel groundwater at selected locations. It can be concluded that benzene must be present in the Newport municipal waste stream. The most common application of benzene is as an additive to fuels. In the past it was also extensively used as a solvent. Because of its presence in fuels, it is considered likely that benzene will continue to be present in the Newport municipal waste stream.
Mercury	Mercury is a common trace component of most landfill leachates. It has been sporadically recorded in the Gravel groundwater at selected locations. Mercury is used in thermometers, barometers, diffusion pumps, switches and other electrical apparatus and for making some types of battery cell. It is also used in mercury-vapour lamps and advertising signs and some pesticides and antifouling paints. Based on this information it is considered moderately likely that mercury will be present in the future Newport municipal waste stream.
Naphthalene	Naphthalene has been identified in the Area 1 leachate and also sporadically in the Gravel groundwater at selected locations. It can be concluded that naphthalene must be present in the Newport municipal waste stream. Naphthalene may be found in a wide range of substances, including petroleum products, mothballs, wood preservatives, solvents and dyes. Consequently, it is considered highly likely that naphthalene will continue to be present in the Newport municipal waste stream.

Priority Contaminant	Comment on Uncertainty
Nickel	The leachate and Gravel groundwater testing data from Area 1 indicates that nickel is currently present in the Newport municipal waste stream. As a constituent of stainless steel, coins, colour ceramics and batteries and due to its widespread use in metal plating it is considered likely that nickel will continue to be present within the Newport MSW stream.
Phenol	Phenol is a component of disinfectant and antiseptic and is used widely in industry as a chemical intermediate. As such it is common in landfill leachates. Phenol is currently present in the Newport municipal waste stream and based on the fact that it is a relatively common substance, it is considered likely that it will continue to be present in the Newport municipal waste stream.
Potassium	It is widely accepted that potassium is a common contaminant arising from landfills which is reflected in data for typical landfill leachates provided in the LandSim guidance and in WMP 26B. Potassium is currently present in the Newport municipal waste stream and based on the fact that it is a relatively common element, it is considered likely that it will continue to be present in the Newport municipal waste stream.
Xylene	Xylene is the most elevated List I substance which has been identified in the Area 1 Docksway leachate to date and it can be concluded that it must be present in the Newport municipal waste stream. Xylene is used widely in industry including as a solvent in paints and marker pens and as an additive in insecticides, pharmaceuticals and motor fuel. It is therefore considered highly likely that xylene will continue to be present in the Newport municipal waste stream.

52a A sensitivity analysis has not been undertaken on the source term since the most conservative concentration range has been selected in each case (in excess of the LandSim default values where available). The choice of leachate component concentration ranges used in the modelling is highly conservative and it is considered unlikely the values used will be approached in the future landfill for the reasons outlined below.

Firstly, Stewartby, Bletchley, Pwllfawatkin, Nant Y Gwyddon and the Area 1 Docksway landfills have all taken industrial waste in the past, yet the new Area 2 landfill facility will not be permitted to take industrial waste. Consequently, the assumption that the Area 2 landfill leachate will realise the highest identified organic contaminant concentrations from all five of the above source terms is highly conservative.

Secondly, the WMP 26B and LandSim default leachate data are based on information from landfills which have taken both municipal and industrial wastes. Consequently, the assumption that the Area 2 landfill leachate will realise the highest identified contaminant concentrations from these source terms is highly conservative.

Also of note is that, as waste regulations tighten and recycling targets increase in the future, less more hazardous contaminants are likely to be deposited in municipal waste landfills. This should lead to municipal waste streams providing less contaminated source terms in the future.

7 Hydrochemistry

7.1 *Groundwater Quality Monitoring Programme*

4,8 A discussion of the perched groundwater conditions in Area 1 is provided in the hydrogeological risk assessment report for Area 1 (PBA, 2004c). In Area 2, perched groundwater is not likely to be important due to the limited thickness of made ground (where present) at Area 2 and the fact that it will be removed where it is in place ahead of construction to ensure that the landfill is constructed on the alluvial clay. Consequently this chapter of the report focuses on the quality of the Gravel Deposits groundwater.

Prior to September 2003, very little groundwater quality data were available for the site. Sporadic monitoring had been undertaken in the past, but such monitoring tended to be limited to only a handful of monitoring locations, a limited testing suite and a short time span. Consequently, a comprehensive groundwater and surface water monitoring programme was commenced in September 2003 in order to gain hydrochemical data for the hydrogeological risk assessment. It is intended that this monitoring programme will continue indefinitely on a monthly basis in accordance with the licence conditions of the site and the monitoring plan.

58 The locations of the borehole installations used as part of the current monitoring programme are indicated on Figure 3. The outline design for the Gravel groundwater monitoring boreholes is shown in Figure 14.

Initial baseline data gathering was undertaken during the first and second rounds of groundwater monitoring (which commenced on 30/9/03 and 17/11/03 respectively). For these two rounds of monitoring all of the suitable available Gravel groundwater wells at the site were sampled and tested for various contaminants in order to establish hydrochemical conditions over a large part of the site. Many of the conclusions regarding the hydrochemistry of the site in this Chapter of the report are based on the results from the preliminary baseline monitoring rounds.

Subsequent monitoring data has been passed to the EA in the form of interim monitoring reports on a monthly basis since June 2004 (see for example PBA, 2004b).

The hydrochemistry discussed in Sections 7.4 and 7.6 covers the Docksway Disposal site as a whole, i.e. results are discussed for groundwater and surface water at Area 1 and Area 2. The groundwater beneath Area 1 is likely to flow towards Area 2 and hence provides the baseline hydrochemistry for the groundwater entering the Area 2 IPPC. This is discussed further in Section 7.5.

7.2 *Assessment Criteria*

The significance of the results of the analytical testing undertaken on groundwater and surface waters beneath and around the site should be assessed against available environmental reporting limits (or EALs) according to EA hydrogeological risk assessment guidance (EA, 2003a). Available and appropriate assessment criteria are discussed further in Section 10. As part of the risk assessment procedure, Trigger Levels and Control Levels should be set for between three and ten priority contaminants, and these Levels will provide guidance on the significance of results obtained as part of a site monitoring programme. The guidance stipulates that the Trigger levels for List I substances should be set at the minimum reporting values (MRVs) for each List I priority contaminant where baseline concentrations in the site groundwater are below the MRV. Section 10 deals with setting Control and Trigger Levels for the site groundwater.

7.3 Field Observations and Field Testing of the Gravel Groundwater

In the majority of cases the gravel groundwater was observed to be colourless. In all cases the gravel groundwater was noted as odourless. The majority of the groundwater samples taken from the gravel recorded elevated EC values suggesting that there may be some saline intrusion into the gravel deposits or some impact by landfill leachate. Dissolved oxygen is low in the gravel groundwater (generally between 0 and 3 mg/l), which is typical for confined groundwater.

7.4 Laboratory Results for the Gravel Groundwater Testing

7.4.1 List 1 Substances

None of the Gravel groundwater samples taken from the site to date have recorded cadmium or cyanide at concentrations above the laboratory detection limits for the tests (0.4 µg/l and 0.05 mg/l respectively). Mercury was either not recorded above the detection limit for mercury or was recorded at negligible concentrations in the gravel groundwater (up to 0.13 µg/l compared to the UK Drinking Water Quality Standard of 1 µg/l).

No organotin compounds organochlorine pesticides (OCPs) or organophosphate pesticides (OPPs) have been detected in the gravel groundwater to date.

A few List 1 substances have been identified in the Gravel groundwater as detailed in Table 7.1 beneath Area 1 (i.e. upgradient of Area 2 with respect to the general groundwater flow direction. These are generally the same substances as those identified in the raw leachate within the CRA of Area 1 (See Section 6 of PBA 2004c).

It is noteworthy from Table 7.1 that the occurrence of List I substances is sporadic in the Gravel wells. No one location has consistently recorded the presence of the same List I substances.

The distribution of List 1 substances in the Gravel groundwater suggests that landfill leachate has impacted the groundwater beneath Area 1 (to the north of the proposed landfill extension site).

In general it is the wells GW03/07, GW03/14, GW03/15 and GW03/16 which record most of the List I substances on the most occasions. GW03/14, GW03/15 and GW03/16 are all located on the western side of the site and could potentially receive groundwater flow from the west, i.e. from across the River Ebbw. This implies that the groundwater at these locations could potentially be impacted by contaminants originating from the landfill across the River Ebbw from the site (see Section 4.7.3 and Figures 8B, 8D and 8G).

GW03/14 is located in close proximity to a redundant culvert which used to direct the Maes Glas Pill beneath Area 1 of the site. It has been historically reported that this culvert preferentially transmitted contaminants to the Ebbw (see also Section 2.5). It may be that the presence of List I substances at GW03/14 is associated with the past or current presence of a preferential pathway associated with the original Maes Glas Pill culvert construction.

GW03/07 is considered most likely to receive groundwater flow from beneath the CRA and consequently contaminants identified at this location are likely to have originated in the Area 1 landfill.

Table 7.1 List 1 Substances Recorded in Gravel Groundwater

Substance	**Occurrences**	**Frequency**	**Maximum concentration (μg/l)**	**Assessment Criteria (μg/l)**
4-chloroaniline	GW03/14	1 of 2	2	NG
Benzene	GW03/14	2 of 4	3	30≈, 30*
Chlorobenzene	GW03/14	2 of 4	6	NG
Ethylbenzene	GW03/14 GW03/15	2 of 4 1 of 4	2	150*
Mercury	GW03/01 GW03/02 GW03/03 GW03/04 GW03/05 GW03/06	1 of 3 1 of 3 1 of 3 2 of 2 1 of 3 1 of 2	0.13	0.3*, 1.0†
Naphthalene	GW03/04 GW03/07 GW03/14 GW03/16	1 of 3 1 of 4 2 of 4 1 of 4	6	70*
Toluene	GW03/14	2 of 4	1	50≈, 1000*
Tributyl phosphate	GW03/04 GW03/15	1 of 1 1 of 1	1	NG
Trimethylbenzene	GW03/14 GW03/15 GW03/16	3 of 4 1 of 4 1 of 4	61	NG
Xylene	GW03/07 GW03/09 GW03/14 GW03/16	1 of 4 1 of 3 3 of 4 1 of 4	15	30≈, 70*

Notes:
List 1 substances are as those denoted in JAGDAG, 2001 and EA, 2004b.
Italics indicates a VOC or SVOC
** = MRV presented in EA, 2003a.
NG = No guideline available.
* = Dutch Intervention Guideline for groundwater (Ministerie VROM, 2000)
† = UK Drinking Water Quality Standard (DETR, 2000).
≈= Freshwater EQS (EA, 2001b)≈= Freshwater EQS (EA, 2001b)

The pattern of mercury distribution in the Gravel groundwater is not like any of the other List I chemicals. The slightly elevated mercury concentrations to the northern part of Area 1 of the site may represent background or baseline conditions. Mercury has not been identified in the CRA leachate to date and hence the mercury recorded in the wells to the north of the CRA is not thought to have originated from the CRA.

7.4.2 *Sodium, Chloride and Electrical Conductivity*

Groundwater within the gravel beneath the site is known to be in some degree of hydraulic continuity with the estuarine water of the Ebbw (e.g. LG Mouchel, 1996a) and/or Newport Docks. During high tide, the water in the Newport Docks is known to increase to approximately 5600 mg/l sodium and 15,000 mg/l chloride (recent PBA testing), whilst the water in the Ebbw to the south of the site increases to at least 1500 mg/l sodium and 2400 mg/l chloride (recent PBA testing).

Figures 9 and 10 show the distribution of chloride in the Gravel Deposits groundwater during Round 2 and Round 8 respectively. Figure 11 shows electrical conductivity (EC) measurements in the gravel groundwater during Round 1. The patterns are similar for all of these figures. The highest chloride and EC concentrations are measured to the southeast of the site. This is considered likely to be caused by the influence of the Ebbw estuary water which is more saline at its most south eastern (downstream) extent. It is not considered likely that the saline water in the Newport Docks is in effective hydraulic conductivity with the Gravel groundwater observed beneath the site based on the significant difference between the head of water in the Docks and the Gravel water table. The relatively low chloride concentrations in wells GW03/26 and GW03/27 adjacent to the Docks confirms this viewpoint (see Section 7.5).

7.4.3 *Ammoniacal Nitrogen, BOD and COD*

Many of the Gravel wells in Area 1 (GW03/01, GW03/02, GW03/03, GW03/04, GW03/05, GW03/06, GW03/07, GW03/15 and GW03/16) have recorded elevated ammoniacal nitrogen compared to typical 'unpolluted' groundwater during one or more of the monitoring rounds. In some cases ammoniacal nitrogen has been recorded at concentrations in excess of 300 mg/l in Area 1 (e.g. GW03/04 during Rounds 1 and 2, and GW03/07 during Round 6). It is considered likely that these wells have been impacted to some degree by landfill leachate generated at Area 1. Ammoniacal nitrogen concentrations beneath Area 2 range from approximately 2 to 140 mg/l. They are particularly elevated in GW03/14 which is expected to be impacted by leachate from Area 1 or from leachate from the landfill across the Ebbw from GW03/14 (see Section 4.7.3). Figure 12 indicates ammoniacal nitrogen concentration in the Gravel Deposits groundwater during Round 1.

BOD has generally not been significantly elevated in the Gravel Deposits groundwater. BOD was only recorded as significantly elevated on one occasion (24 mg/l at GW03/14 during Round 2).

COD concentrations in the Gravel Deposits are not atypical for confined groundwater. They range between 12 and 329 mg/l and values are highest beneath Area 1.

7.4.4 *Other Determinands*

A number of other determinands, (e.g. potassium, boron, chromium and nickel) form distribution patterns suggesting that the gravel groundwater directly beneath the CRA of Area 1 has been impacted by landfill leachate. Figure 13 shows the distribution of potassium in the gravel groundwater.

7.5 Quality of Off-site Groundwater

As part of this assessment, PBA have endeavoured to obtain details of the quality of the gravel groundwater in the wider vicinity of Docksway Disposal Site in order to make a broad assessment of its background hydrochemistry.

Local groundwater quality data has been requested from the EA as part of this study but unfortunately none are available (EA, pers. comm.).

It is possible that better quality groundwater may be present in the Gravel Deposits to the north of the site at least with respect to sodium, chloride and electrical conductivity. However, the area of Newport which lies to the north of the site is largely industrial and hence high quality groundwater would not be expected to the north of the site. In any case the groundwater beneath Area 1 flows towards Area 2 and it is the Area 1 groundwater which can be considered representative of off-site conditions in terms of the land within the Area 2 IPPC application boundary. The quality of the Area 1 Gravel groundwater is known to be generally poor (see PBA, 2004c and Table 7.1 of this report).

To the east of the site, the Docks are present. As a result of the on-site industrial activities carried out on the Docks it is not expected that groundwater quality will improve significantly to the east of the site. Landfilling is known to have taken place over part of this land.

Groundwater quality to the west of the site is expected to be poor since the land across the Ebbw from the site to the west has also been used for landfilling.

In essence, groundwater quality is considered likely to be relatively poor to the north, east and west of Area 2.

7.6 Perched Groundwater Quality

4,8 In Area 1, a substantial thickness of made ground is present across the entire site and this material is invariably water-bearing. In Area 2 Made Ground is much less extensive and hence perched groundwater is not particularly important at the Area 2 facility. Where made ground is present at locations where the Area 2 containment landfill is to be constructed, it will be removed and the landfill will be constructed on alluvial clay at all locations (Figure 2C).

To the immediate south of the proposed Area 2 landfill two dams have historically been constructed to divert the course of the River Ebbw (Figure 2B). At these two locations made ground extends to deeper levels than elsewhere on the site and perched groundwater is present in this made ground.

The quality of the perched groundwater has been tested in GW03/12D installed within the western Ebbw dam (see Figure 2B) and the results of this testing are presented in Table 7.2.

The perched groundwater quality in GW03/12D is generally of similar quality to the Area 2 gravel groundwater. There is one exception in that ammoniacal nitrogen is higher than would be expected in the Gravel groundwater at this part of the site. This slightly elevated ammoniacal nitrogen in the perched groundwater may be caused by the presence of occasional fill materials other than reworked clay within the soil used for the dam construction.

Baseline groundwater monitoring and testing is ongoing at the Docksway site (both in the Gravel groundwater and in the perched groundwater where present). Collection of further data from well GW03/12D may clarify the ammoniacal nitrogen concentration in the perched groundwater in this area.

A considerable database of groundwater testing results from Area 2 will have been compiled prior to the commencement of landfilling operations in Area 2. The established baseline data will ensure that potential groundwater quality impacts from the new landfill will be able to be recognised.

Current baseline groundwater conditions have been used in order to assess the Trigger and Control Levels for the site. Collation and assessment of future monitoring results will enable the review of the conceptual model and reassessment of the groundwater compliance levels as appropriate (see Section 11.3).

Table 7.2 Chemistry of the Groundwater in one Ebbw Dam

Determinand	**Concentrations recorded in GW03/12D in May 2004**	**Determinand**	**Concentrations recorded in GW03/12D in May 2004**
Electrical conductivity (µS/cm)	7980	Mercury (µg/l)	< 0.05
Ammoniacal Nitrogen (mg/l)	157	Nickel (µg/l)	4
BOD (mg/l)	4	Zinc (µg/l)	17
COD (mg/l)	78	Potassium (mg/l)	93
Chloride (mg/l)	2319	Sodium (mg/l)	1395
Arsenic (µg/l)	12	Nitrate (mg/l)	< 0.3
Boron (µg/l)	1119	Sulphate (mg/l)	280
Cadmium (µg/l)	< 0.4	pH	8.34
Chromium (µg/l)	2	Phenol (µg/l)	< 0.01
Copper (µg/l)	< 1	Extractable petroleum hydrocarbons (mg/l)	< 10
Lead (µg/l)	< 1	Mineral oil	< 10
OPPs (ng/l)	< 10	OCPs (ng/l)	< 10
SVOCs	3 of 60 compounds detected at the laboratory detection limit of 1 µg/l (naphthalene, phenol and di-n-butyl phthalate)	VOCs	None detected

7.7 *Surface Water Quality Monitoring*

7.7.1 *Historical Data*

Prior to September 2003, little surface water testing data were available for the Docksway Disposal site in general and was particularly sparse for Area 2. It is known that in July 2000 chemical testing of the former oxbow lake was undertaken. The results demonstrated that at the time it was acceptable for the lake to be dewatered into the Ebbw in order for geotechnical investigation work to be undertaken. This dewatering to the Ebbw was approved by the EA.

7.7.2 Current Programme

In order to gain adequate hydrochemical data for the hydrogeological risk assessment, a comprehensive groundwater and surface water monitoring programme was commenced in September 2003. It is intended that this monitoring programme will continue indefinitely on a monthly basis in accordance with the licence conditions of the site.

A number of monitoring points have been used for assessing the surface water quality within the vicinity of the landfill site. Three of the previously used sampling locations in the oxbow lake are no longer in use due to the fact that the lake has been largely dewatered in preparation for the Area 2 landfill construction work. The positions of both the current and historical surface water sampling points used for monitoring to date are illustrated on Figure 2B.

The colour and odour of each water sample taken is recorded during monitoring. In general the surface water samples taken to date at the site have been observed to be colourless and odourless.

Surface water samples have been tested in the field for temperature, electrical conductivity, pH and dissolved oxygen. The results of field testing of the surface water samples have been passed to the EA on a monthly basis since May 2004 within interim monitoring reports as stipulated in the landfill licence (see for example PBA, 2004b).

7.8 Laboratory Results for Surface Water Testing

7.8.1 List 1 Substances

To date, cadmium, cyanide and mercury have not been recorded in any of the surface water samples tested for List I substances.

In addition, no VOCs, SVOCs, organotin compounds, organochlorine pesticides (OCPs) or organophosphate pesticides (OPPs) have been detected at any of the surface water sampling locations tested for List I substances.

7.8.2 Sodium, Chloride and Electrical Conductivity

Many of the surface water sampling locations around the site are (or were) fresh water (e.g. North Pond and the former Oxbow Lake). These sampling locations have consistently recorded low sodium and chloride concentrations and low electrical conductivity values, i.e. values which meet UK drinking water criteria. However, the River Ebbw and Maes Glas Pill are not entirely fresh water and are influenced by the salinity of the Severn Estuary to some degree.

Greater concentrations of sodium, chloride, and electrical conductivity were generally recorded at high tide in the Ebbw and the Maes Glas Pill as a result of the ingress of salt water (see Table 7.3). The most significant increase in these determinands was observed at the downstream Ebbw monitoring point (SW02). The mechanisms for the increase in the salinity in the Maes Glas Pill are discussed further in Section 5.3.2.

Table 7.3 Tidal Effects on Surface Water Quality

Monitoring Point	**Sodium at Low Tide (Round 1)**	**Sodium at High Tide (Round 2)**	**Chloride at Low Tide (Round 1)**	**Chloride at High Tide (Round 2)**	**EC at Low Tide (Round 1)**	**EC at High Tide (Round 2)**
SW01 (Ebbw up)	43.5	135	22	26	737	531
SW02 (Ebbw down)	37.5	1537.5	68	2412	1058	7860
SW03 (Maes Glas Pill up)	33.0	75	62	106	473	929
SW04 (Maes Glas Pill down)	115	135	216	172	1015	1277
Monitoring Point	**Sodium at Low Tide (Round 6)**	**Sodium at High Tide (Round 7)**	**Chloride at Low Tide (Round 6)**	**Chloride at High Tide (Round 7)**	**EC at Low Tide (Round 6)**	**EC at High Tide (Round 7)**
SW01 (Ebbw up)	NT	150	28	226	601	1263
SW02 (Ebbw down)	NT	4575	263	8087	1701	21900

7.8.3 Ammoniacal Nitrogen, BOD and COD

With respect to ammoniacal nitrogen and BOD in the surface water around the site, few samples indicate elevated concentrations. The EA's GQA Scheme for rivers and canals has been used to assess the quality of surface waters at the site. All ten of surface water samples tested during Round 2 are classified as of very good quality (Class A) according to their BOD values.

Eight of the ten samples are classified as good to fairly good quality (Class B to C) based on the ammoniacal nitrogen testing results. Two samples are classed as poor (SW15 which represents drainage from the adjacent Newport Docks) or bad quality (SW04 – the downstream Maes Glas Pill sample) according to their ammoniacal nitrogen testing results. It should be noted that both of these samples represent water discharged from culverts.

Figure 20 shows the variation in ammoniacal nitrogen with time at SW01 and SW02. The water quality at SW01 is fairly consistent whilst that at SW02 is quite variable. SW02 is poorest quality when the tide is low. At higher tides the poorer quality of the downstream aquatic environment is masked by the surge of more saline water.

7.9 Conclusions Regarding the Hydrochemistry of the Site

7.9.1 Hydrochemistry of the Gravel Groundwater

- Ammoniacal nitrogen and BOD results indicate that the gravel groundwater may have been impacted by landfill leachate beneath Area 1 and at GW03/14 in Area 2.
- The gravel groundwater chemistry is influenced to some degree by saline intrusion from the Ebbw Estuary.

- Very few List 1 substances have been identified in the Gravel groundwater, i.e. no cadmium, cyanide, organotin compounds, organophosphates or organochlorines have been identified.

- Trace List I volatile organic compounds have been identified in the Gravel groundwater at five locations. Two of these locations are present in Area 2 (i.e. GW03/14 and GW03/09).

- Mercury has been identified above the laboratory detection limit for the test in selected wells in the northern half of Area 1. Mercury has not been recorded in the Area 1 leachate.

- The presence of List I substances in the Gravel groundwater is sporadic with substances being detected in some monitoring wells but not in others and during some rounds but in not in others. It has not been proven that any List I substance is consistently present in the Gravel groundwater at any one location.

- The presence on occasion of several List I substances in the Gravel groundwater (which were also identified in the Area 1 landfill leachate) indicate that the Area 1 landfill leachate is a potential source of the groundwater contamination.

- The contamination identified at GW03/14, GW03/15 and GW03/16 may have migrated there from the beneath an adjacent landfill located across the Ebbw from GW03/14 (see Section 4.7.3). This is another potential source of List I substances in these wells.

- The List I substances detected in GW03/14 may be related to a past or present localised flow path related to the now redundant Maes Glas Pill culvert and are possibly not indicative of a widespread ubiquitous release of List I substances from the Area 1 landfill.

7.9.2 *Hydrochemistry of the Surface Water*

- No list 1 substances were identified in any of the surface water bodies on or around the site.

- Following on from the above point, it is important to note that according to the chemical testing results reviewed to date, the Docksway Disposal Site is not discharging List I substances to the Ebbw surface water course (either directly or via the Gravel groundwater) to the extent that that is any measurable increase in the concentration of List I substances.

- COD and ammoniacal nitrogen are more concentrated in the downstream Ebbw and Maes Glas Pill samples than they are in the upstream samples.

- Tidal affects mask the reduction in quality recorded in the Ebbw at low tide as it flows downstream.

8 Conceptual Model

8.1 Principles

Guidance on the approach to be taken for hydrogeological risk assessments for landfills, indicates that the "***sources***" of potential contamination from a site and the "***receptors***" that could be at risk as a result of "***pathways***" between the two should be established (EA, 2003a). All three aspects have to be present for a risk to exist.

The site conceptual model has been developed with the objective of quantifying contaminant migration from the source along each possible pathway to an identified receptor. Figure 16 provides a diagrammatic representation of the conceptual model used for the LandSim modelling work. Figure 2C provides a schematic north-south cross-section through the landfill showing its construction design.

8.2 Source Term

The landfill leachate at the study site represents the source term in the conceptual model. Leachate contains a range of potential contaminants that may cause harm if they enter the groundwater or surface water environment.

The key contaminants that are likely to be present in the Area 2 leachate have been discussed in Section 6.3 and the priority contaminants used in the modelling are detailed in Sections 6.3 and 9.3.

There will be a decline in source term concentration with time as infiltrating rainwater continues to pass through the site and dilute the leachate, and as leachate treatment processes take place during the managed phase. Hence, the declining source term option has been used during the LandSim modelling assessment.

8.3 Potential Receptors

A review of the potential receptors to contamination derived from any site should include all the on-site and nearby surface water bodies and all potential groundwater bearing strata. For Docksway Disposal Site Area 2, this kind of preliminary assessment identifies three potential receptors as follows: the River Ebbw, groundwater in the gravel and groundwater in the Mercia Mudstone.

However, as detailed in Table 8.1, not all of these potential receptors are considered significant for the purposes of this risk assessment.

As discussed in Section 7.3, the quality of the gravel groundwater beneath the site is poor with respect to its chloride and sodium content and its electrical conductivity. The observed estuarine hydrochemistry of the gravel groundwater coupled with the absence of known licensed groundwater abstractions or private water wells within at least 2km of the site reduces the sensitivity of the groundwater as a receptor. However, the groundwater within the Gravel Deposits is a controlled water and as such the potential impacts to this water body have been evaluated as part of this assessment.

Table 8.1 Potential Receptors Considered

Potential Receptor	Description of Receptor	To be included in the risk assessment?
River Ebbw	Controlled water.	Yes
Gravel Groundwater	Groundwater within the Gravel is controlled water. It has been agreed with the EA that potential impacts to the Gravel groundwater should be assessed as part of this hydrogeological risk assessment.	Yes
Mercia Mudstone Groundwater	At all locations where the Mercia Mudstone Group has been encountered beneath the site, it has comprised a stiff clay. Hence the bedrock is expected to behave as a non aquifer. This is supported by the absence of any known abstractions from this horizon in the site vicinity and by published documents (e.g. BGS, 1986b).	No

Following a review of the potential receptors within the vicinity of the site, two are considered suitable for consideration in the hydrogeological risk assessment. Namely:

a) The groundwater within the Gravel Deposits.

b) The River Ebbw. This passes the southern boundary of the site, which lies downgradient with respect to the anticipated groundwater flow direction.

Because the groundwater within the Gravel lies directly beneath the landfill (ignoring the finite thickness of Alluvial Clay), this is considered to be the most sensitive receptor to landfill-derived contamination.

8.4 Potential Pathways

Landfill leachate could impact the Gravel groundwater below the site via gradual downward permeation of the leachate through the Alluvial Clays which separate the Gravels from the waste.

There are anticipated to be three pathways via which contamination from Area 2 may enter the Ebbw:

(a) Directly via surface run-off; [considered unlikely due to the design topography of the Area 2 landfill and its surrounds and the implementation of a surface water management plan].

(b) Indirectly by passing through the Made Ground which forms the flood bunds around the edge of Area 2; and/or

(c) Indirectly via baseflow from the Gravel groundwater; [this pathway is considered to be of minor-moderate importance and is of secondary importance to the initial entering of leachate into the Gravel groundwater beneath the Area 2 landfill].

Table 8.2 Significance of Potential Pathways

Potential Pathway	Receptor	Significance
Downward migration of leachate from the landfill through the Alluvial Clays	Groundwater in Gravel Deposits beneath the site.	Major
Runoff of surface water from the tip	Ebbw or Maes Glas Pill	Minor
Lateral transport in Gravel and flow into Ebbw as baseflow	Ebbw	Minor/Moderate
Flow of leachate through the flood bunds to the bank of the Ebbw	Ebbw	Minor

The significance of each of the pathways reviewed as part of this assessment are outlined in Table 8.2. It is the pathway of major significance, i.e. the vertical pathway from the waste to the Gravel which will be considered in the numerical part of this assessment.

8.5 *Transport Fate*

The expected flow path for a typical contaminant in the Phase 2 southern extension of Docksway Disposal Site is outlined below.

a) Downward migration through the waste in the landfill

b) Downward migration through the granular drainage blanket (flow path ≈0.5m).

c) Downward migration through the upper engineered clay barrier (flow path ≈ 1.2m).

d) Downward migration through the load transfer blanket (flow path ≈0.3m).

e) Downward migration through the cement stabilised alluvium immediately below the site. (flow path = 2m).

f) Downward migration through the unengineered Alluvial Clay (flow path ≈1.4m to 4.3m – see Figure 2D). This layer has been modelled as a fixed unsaturated zone of 0.5m and an underlying saturated zone (termed the vertical pathway in the LandSim model) varying between 0.9m and 3.8m thick.

g) Enter the Gravel groundwater beneath Area 2.

h) Travel broadly due south (may be to the southeast of southwest depending on the state of the tide) to the southern site margin where the contaminant may or may not enter the Ebbw as baseflow (flow path = approximately 140m).

The conceptual model above will be used to simulate the transport behaviour of several selected priority contaminants (see Section 9.3) away from the Area 2 landfill. A diagrammatic representation of the conceptual model is presented as Figure 16.

It has been agreed with the EA that potential impacts to the Gravel Deposits groundwater should be considered in the LandSim modelling.

9 Numerical Simulations

9.1 Modelling Software

This risk assessment has been assisted via the use of LandSim2.5 (EA, 2001a) numerical simulations. Following the agreement of the EA, LandSim2.5 has been be used to assess the likely water quality impacts to the Gravel Deposits groundwater that may result from the Docksway Disposal Site operation.

The LandSim modelling work has considered the following:

- The composition of the future landfill leachate;
- The volumes of leachate generated through time;
- The estimated rate of leachate leakage from Area 2;
- The dilution of the leachate by groundwater beneath the site.
- The attenuation of selected contaminants within the leachate as they pass through the engineered barrier system and the Alluvial Clays below (the unsaturated zone and vertical pathway components of the model).

9.2 Future Modelling Predictions

LandSim can model site conditions many years into the future. The LandSim work has been undertaken to predict site conditions during the operational phase, managed phase and the unmanaged phase.

- The landfill operational phase represents the situation between the start of tipping, (2005), and cessation of tipping which is anticipated to be approximately 2020 depending on the rate at which waste is accepted at the new installation. Consequently the year 2025 has been selected for the end of the operational phase for the purposes of the LandSim modelling.
- The managed phase (post-operational phase), represents the situation from 2025 to approximately 2075. Leachate levels will be controlled in Area 2 during this 50 year time period via pumping to a leachate treatment plant in order to restrict leachate to a level agreed with the EA.
- The unmanaged phase (post 2075), represents the time after leachate control measures will have ceased.

For the purposes of the LandSim modelling we have designated that leachate levels will be kept at a maximum of 2m above the EBS for the duration of the operational and managed phases (see Section 6.2). It should be noted that because the bases of each cell will slope slightly towards a sump, the 2m average height above the EBS will vary. Above the sump the leachate will slightly more than 2m above the EBS where as at the edges of each cell the leachate will be significantly less than 2m above the EBS.

Calculations have demonstrated that free leachate (i.e. leachate in excess of the absorptive capacity of the waste) is unlikely to be generated during the operational phase (see Sections 5.3 and 6.2) and hence to fix the head at 2m above the EBS in the model is a conservative approach. Calculations have demonstrated that the drainage blanket is likely to sustain a maximum leachate head of 120mm above the base of the drainage blanket (see Section 2.6.6 and PBA, 2004e). It should be noted that leachate levels have yet to be formally agreed with the EA.

9.3 *Priority Contaminants Considered*

3 Testing of the leachate at Area 2 in order to determine its constituent chemicals will not be possible until the landfill is operational. Consequently for the LandSim modelling work, the source term input required has been taken from a variety of sources as detailed in Section 6.3.

Typical leachate contains a range of potential contaminants which may cause harm if released into the groundwater or surface water environment. It is usually considered unnecessary to consider all such contaminants and selected species typical of the main groups of chemicals present are normally assessed (EA, 2003a). The transport behaviour of the following species have been modelled since they are considered representative of different types of chemical contaminant which are likely to be present in the future leachate of Area 2:

Aliphatic hydrocarbons are considered as List I substances. Mineral oil and EPH have been detected at high concentrations in the Area 1 leachate (up to 173 mg/l). Aliphatic hydrocarbons are generally not as mobile as aromatic hydrocarbons and are only marginally soluble or insoluble in water. Aliphatic hydrocarbons are strongly sorbed to organic carbon (Koc value for the C_{16} to C_{21} fraction given as $6x10^8$ in TPHCWG, 1997). The half life of straight chain aliphatic hydrocarbons in the C_{16} to C_{36} range is estimated at 10 years (MftE, 1999).

Ammoniacal nitrogen is a common component of landfill leachates and is usually the List II substance present at the highest concentration. It is retarded and undergoes decay via oxidation to nitrate and nitrite.

Arsenic is an inorganic List II element which is generally quite strongly sorbed to organic matter and clay particles. Consequently arsenic provides a good indicator for substances of relatively low mobility.

Benzene is an organic List I substance which is used largely as an additive in motor, aviation and other fuels. Benzene is readily biodegraded under aerobic conditions and it has a short half life (days). However, in anaerobic conditions benzene is more persistent and a half life of up to 2 years can be expected (Howard *et al.*, 1991). It is hydrophilic and relatively soluble in water (720 ppm according to WRc, 1999 and up to 1780 ppm according to Fetter, 1994) which increases its mobility within aquifer systems. In addition, benzene is not readily sorbed to soil (a K_{oc} value of 97 is given in Fetter, 1994) and hence benzene is considered to have a relatively high mobility within landfills.

Mercury is a List I metal which is generally found to some degree in most landfill leachates. It has been sporadically detected in the Gravel groundwater but not in the

Docksway leachate to date. It does not decay and hence effectively has an infinite half life. It is generally slightly retarded in aquifer systems.

Naphthalene is an organic List I substance present in the Docksway leachate. It is a non-polar hydrophobic polycyclic aromatic hydrocarbon and has a relatively short half life of up to 258 days under anaerobic conditions (Howard *et al.*, 1991). It is only sparingly soluble in water (approximately 32 ppm according to Fetter, 1994) and has a tendency to adsorb to soil and sediment particles. Consequently, naphthalene represents a substance which is likely to be retarded in aquifer systems.

Nickel is an inorganic List II metal subject to some retardation, but is generally relatively mobile. The metal acts as a good indicator for metal contamination in general.

Phenol is a component of disinfectant and antiseptic and is used widely in industry as a chemical intermediate. Hence it is common in landfill leachates. Phenol is not easily retarded by sorption (low Koc of 27 ml/g according to Fetter, 1994) and is highly soluble in water (up to 82000 ppm, Fetter, 1994) and as such is considered a highly mobile contaminant in soil. However, it is rapidly degraded with a half-life of only 8 to 28 days in anaerobic conditions (Howard *et al.*, 1991). Based on the fact that phenol is likely to have a deleterious effect on the taste and odour of groundwater, it can be considered as a List II substance.

Potassium salts are relatively soluble and hence are usually found to some degree in all landfill leachates. Being inorganic and relatively soluble, the concentration of potassium in a leachate would not normally be particularly affected by passage through the soil. The element thus provides an example of a relatively conservative species via which the impact of leachate can be assessed in an estuarine environment (where chloride is inappropriate for this purpose).

Xylene is an aromatic hydrocarbon and a List I substance. It occurs in three isomeric forms -ortho, -meta and -para xylene, also known as 1,2-dimethylbenzene, 1,3-dimethylbenzene & 1,4-dimethylbenzene respectively. Xylene has found wide use in industry including as a solvent in paints and as an additive in motor and aviation fuel and is therefore a relatively commonly encountered contaminant. Xylene is the most elevated List I substance identified in the Area 1 Docksway leachate it has been recorded in some Gravel groundwater monitoring wells on the site. Due to its moderate solubility in water (up to approximately 200 mg/l), and its low to moderate sediment-water partition coefficient (WRc, 1999 and Fetter, 1994), xylene is likely to have moderate mobility in aquifer systems. It is subject to decay however and is reported to have a half life of approximately 12 months under anaerobic conditions (Howard *et al.*, 1991).

Between them, the ten chosen priority contaminants represent:

- A relatively low mobility hydrophobic organic List I substance (naphthalene)
- Very low mobility organic List I substances (aliphatic hydrocarbons)
- A moderate mobility volatile organic List I substance (xylene)
- A relatively high mobility volatile organic List I substance (benzene)
- An inorganic List I substance (mercury)

- A highly soluble (hydrophilic) organic List II substance (phenol)
- A relatively low mobility persistent List II substance (arsenic)
- A moderately mobile, persistent List II substance (nickel)
- A moderately mobile List II substance which is subject to decay (ammoniacal nitrogen)
- An inorganic non-reactive species (potassium).

9.4 LandSim Inputs

Table 9.1 details the inputs used for the LandSim modelling undertaken as part of this risk assessment. Model parameters have been selected based on site specific data and literature searches. The values, or ranges of values used are given in addition to the justifications for their selection.

Table 9.1 LandSim Input Parameters

Parameter	Value	Distribution	Units	Justification
Approximate dimensions of site	280 (length) by 550 (width)	single	m	Measured from site plan
Infiltration	678.2, 86.4	normal	mm	Based on 18 years of Cardiff rainfall data and water balance (see Section 5.3 and Appendix 5)
Design Cap infiltration	23 to 46	uniform	mm/yr	Based on PBA water balance calculations assuming a cap permeability of between $5x10^{-10}$ and $1x10^{-9}$ m/s. (Appendix 6)
Waste porosity	0.02, 0.07, 0.2	triangular	fraction	Based on information contained in Powrie and Beaven, 1999.
Waste hydraulic conductivity	$3.7e^{-8}$ to $1.5e^{-4}$	uniform	m/s	Based on information contained in Powrie and Beaven, 1999.
Waste density	0.62, 0.87, 1.11	triangular	g/cm^3	Based on information contained in Powrie and Beaven, 1999.
Final waste thickness	5, 13, 20	normal	m	Based on design report. (PBA, 2004a) and site layout and waste deposition drawing 14739/007/203.
Waste field capacity	0.4, 0.425, 0.45	triangular	fraction	Based on information contained in Powrie and Beaven, 1999.
No cells	5	single	-	As proposed design (see Figure 2A)
End of managed phase (from start of filling)	70	single	yrs	2005 to 2075. The managed phase lasts 50 years from 2025 to 2075

Parameter	Value	Distribution	Units	Justification
End of filling	20	single	yrs	2005 to 2025
Total surface area of landfill	15.4	single	ha	Table 2.2
Ave. leachate head above EBS (managed phase)	2.0	single	m	Assumed level maintained by leachate pumping for bulk of operational phase and all of managed phase (Section 6.2). To be agreed with EA.
Leachate head above which surface break-out will occur	2.75	single	m	See discussion in Section 9.5.
Drainage Blanket Properties				
Thickness of blanket	0.5	single	m	As design (see PBA, 2004e)
Blanket hydraulic conductivity	$1.0e^{-4}$ to $1.4e^{-2}$	uniform	m/s	Based on design spec and allowing for biofowling
Basal slope	1 in 50	single		As design (see PBA, 2004e)
Pipe spacing	50	single	m	As design (see PBA, 2004e)
Pipe failure rate	0.2	single	fraction	As in LandSim manual
Leachate Inventory				
Ammoniacal nitrogen	1763 to 2439	uniform	mg/l	See Table 6.1 and Section 6.3
Arsenic	0.075, 0.143, 0.485	triangular	mg/l	See Table 6.1 and Section 6.3
Benzene	0.0106	single	mg/l	See Table 6.2 and Section 6.3
Mercury	3.94×10^{-5}, 8.91×10^{-5}, 0.00195	triangular	mg/l	See Table 6.1 and Section 6.3
Mineral oil (aliphatic hydrocarbons)	10.1 to 172.6	uniform	mg/l	See Table 6.2 and Section 6.3
Naphthalene	0.01 to 0.0412	uniform	mg/l	See Table 6.2 and Section 6.3
Nickel	0.271, 0.389, 0.627	triangular	mg/l	See Table 6.1 and Section 6.3
Phenol	0.060 to 0.910	uniform	mg/l	See Table 6.2 and Section 6.3
Potassium	915, 1215, 1580	triangular	mg/l	See Table 6.1 and Section 6.3
Xylene	0.118 to 0.311	uniform	mg/l	See Table 6.2 and Section 6.3

Parameter	Value	Distribution	Units	Justification
Engineered Barrier System – Double Clay Liner				
Thickness of upper clay liner	1.2	single	m	As design (PBA, 2004a). CQA should ensure minimum thickness of 1.2m
Thickness of lower (cement stabilised) clay liner	2.0	single	m	As design (PBA, 2004a). CQA should ensure minimum 2m thickness is achieved
Permeability of EBS	1.0×10^{-10}, 5.0×10^{-10}, 1.0×10^{-9},	triangular	m/s	Clay liner and cement stabilised alluvium expected to achieve $<10^{-9}$ m/s (PBA, 2004a).
Revised permeability of EBS	1.0×10^{-9}	single	m/s	Revised due to sensitivity analysis (see Section 13.3).
Dispersivity of EBS	0.32	triangular	m	10% of total engineered clay barrier thickness
Organic carbon content of imported clay liner	0.002	single	fraction	Conservative value for clay assigned. NB: This value has been applied to the entire EBS even though two thirds of it comprises higher *f*oc alluvial clay.
Thickness of internal drainage layer	0.3	triangular	m	300mm load transfer blanket will separate two engineered clay barriers
Conductivity of drainage layer	10^{-4} to 10^{-6}	triangular	m/s	Permeability of layer expected to reduce with time due to biofowling
Base slope to sump	1 in 50	single		As design. See PBA, 2004d
Diameter of sump	3	single	m	As design. See PBA, 2004d. (Centrally placed).
Relationship between Lower Liner, Unsaturated Zone and Vertical Pathway				
See Section 2.6, Section 9.5 and Figure 2D for information on the relationship between the lower engineered liner, the unsaturated zone and the vertical pathway.				
Unsaturated Zone – Alluvial Clay				
Unsat zone thickness	0.5	single	m	See Section 9.5
Unsat zone vertical conductivity	$1e^{-9}$	triangular	ms^{-1}	Conservative value. PBA permeability assessment outlined in Appendix 4 suggests $< 8.8e^{-10}$ is more likely.
Moisture content	0.478, 0.15	normal	fraction	Assessment of 135 mc test results from recent and historic investigations
Organic carbon content of alluvium	0.006, 0.008, 0.14	triangular	fraction	Based on alluvial clay testing results (Appendix 7). See also Section 9.5

Parameter	Value	Distribution	Units	Justification
Unsat zone density	1.65 to 2.0	uniform	kg/l	As bulk density for a typical clay
Dispersivity of Unsat zone	0.1	single	m	10% of pathway length
Vertical Pathway – Alluvial Clay				
Thickness of vertical pathway	1.0 to 3.8	uniform	m	See Section 9.5 and Figure 2D
Porosity of vertical pathway	0.41 to 0.69	uniform	fraction	Calculated from 21 measurements of the initial void ratio of the Alluvial Clay. See Appendix 8.
Dispersivity of vertical pathway	0.11 to 0.55	uniform	m	10% of vertical pathway length
Aquifer Properties				
Width of aquifer mixing zone	550	single	m	Width of site perpendicular to groundwater flow direction
Mixing zone thickness	6.12, 1.35	normal	m	Full thickness of Gravel beneath Area 2 based on borehole logs
Hydraulic conductivity	$1e^{-5}$, $5e^{-}3$, $1e^{-2}$	triangular	ms^{-1}	See Section 4.5
Hydraulic gradient	0.0034 to, 0.0065	triangular	fraction	Measured from monitoring results. See Section 4.7.5.
Porosity	0.2 to 0.35	uniform	fraction	Porosity for mixed sand and gravel (Fetter, 1994)
Longitudinal dispersivity	14	single	m	10% of pathway length which is approximately 140m.
Transverse dispersivity	1.4	single	m	1% of pathway length which is approximately 140m.
Organic carbon content of Gravel	0.0	single	fraction	Conservative value for gravel assigned.

9.5 *Justifications for Chosen LandSim Inputs*

'Aquifer' Width

47d The width of 'aquifer' mixing zone has been set at the width of the site perpendicular to the anticipated groundwater flow direction (550m).

Height of Surface Breakout

49a The edges of the landfill cells will be constructed at 7.5m AOD and the base of the landfill cells will vary between 4.5m and 5.3m AOD (see for example Figure 2D). Consequently the leachate head which will be sustainable above the EBS before surface breakout occurs is between 2.2 and 3.0m. This has been set at 2.75m in the model (i.e. between the minimum and maximum likely breakout heights.

Fixed Leachate Head During Managed Phase

14 It has been proposed that leachate will limited to a maximum average value of 2m above the EBS during the managed phase via pumping to a leachate treatment plant. Calculations have been undertaken to demonstrate that even with potential long term clogging, a head of greater than 120mm will not be sustainable on the drainage blanket at the base of the EBS (see PBA, 2004e). The 2m fixed leachate head will hence be achievable in the short, medium and long term regardless of the decreasing performance of the drainage blanket. The location, spacing and specification of the proposed leachate wells in addition to the expected capacity of the leachate management system are presented in PBA, 2004e.

Permeability of the EBS

The permeability of the upper and lower parts of the EBS must be set as the same in LandSim. Both the upper and lower parts of the EBS, (the engineered clay barrier and the cement stabilised alluvium respectively) are likely to have permeability values of less than $1x10^{-9}$ ms^{-1}. Consequently, in the model the permeability of the EBS was initially input as the triangular distribution $1x10^{-10}$, $5x10^{-10}$, $1x10^{-9}$ ms^{-1}. Following the completion of the sensitivity analysis, this value was altered to $1x10^{-9}$ ms^{-1} as a single value for additional conservatism (see Section 13.3).

Thickness of Unsaturated Zone and Vertical Pathway

The alluvial clay horizon can be modelled as one of three pathways in the LandSim model. It either forms the EBS, the unsaturated zone or the vertical pathway depending on its elevation. The 'unengineered' alluvium beneath the landfill EBS will have a thickness ranging between 0.5 and 4.3m thick. This is shown schematically in Figure 2D.

Where the unengineered clay is at its thinnest, additional imported clay will be added above the cement stabilised alluvium in order to achieve the required construction platform height. As a result of this construction requirement, the total thickness of clay beneath the upper clay barrier will always be equal to or greater than 4m (see Figure 2D). 2m is modelled as the lower part of the EBS leaving 2m comprising the vertical pathway and unsaturated zone.

The unsaturated zone and vertical pathway components of the model are never less than 2m thick and range between 2m and 4.3m thick (Figure 2D).

6 In general, groundwater has been shown to vary between 0.5m and 3.7m AOD beneath Area 2 which means that in theory the part of the 'unengineered' clay which acts as the saturated vertical pathway varies considerably during the cycle of the tide. It should be noted that the assessment of the tidal influence on groundwater has been assessed in wells which are open to the atmosphere with their response zones in the gravel (i.e. the water table is not confined by the presence of the clays). In practice, due to the low permeability of the alluvium and the time that it would take to displace porewater within it, it is likely that the piezometric surface of the gravel groundwater stays relatively consistent.

Due to the fact that the piezometric surface of the gravel water is likely to stay relatively constant in the alluvium, the thickness of the unsaturated zone has been fixed in the modelling. It would not be scientifically sound to enter both the unsaturated and saturated part of the 'unengineered' alluvium at their full range of possible values in the model, since LandSim may assign an unrealistic total thickness to the horizon. Consequently the variation in thickness of the 'unengineered' alluvium is allowed for in the thickness range specified for the vertical pathway.

The unsaturated zone has been fixed at 0.5m thick in the model. In reality, the thickness of the unsaturated zone is probably less that 0.5m thick in some locations and more than 0.5m thick in others, but 0.5m is considered to be a reasonable mean value for this parameter. Consequently the remaining thickness available to be assigned to the vertical pathway is 1.5m to 3.8 m. In order to add in additional conservatism to the model we have set the vertical pathway with a lower minimum than that likely to be present in the field. In the model the vertical pathway has been given the uniform distribution of 1.0m to 3.8 m.

Retardation Parameters

51,49 Retardation parameters used in the modelling have been taken from the LandSim guidance where available e.g. the Kd values for common components of leachate such as potassium, nickel and arsenic. Where no default values are available, or where more detailed values were sought, a literature search has been undertaken in order to select appropriate values. The retardation parameters used in the modelling are presented in Table 9.2.

48d,49b For ammoniacal nitrogen, the EBS and sand and gravel Kd value ranges used in the model are presented in NGWCLC, 2003. Both triangular ranges used are given a high degree of confidence by the NGWCLC report authors. For the alluvial clays the default LandSim Kd value range has been used in the absence of site-specific data.

48d,49b The degradation rate of ammoniacal nitrogen has been assumed to be negligible in the EBS and alluvial clays as indicated in the national groundwater and contaminated land centre publication (NGWCLC, 2003), and consequently the half life has been set at 10^9 years in these horizons. In the gravel deposits the ammoniacal nitrogen half life has been set at the range presented in the comprehensive 1 to 6 years national groundwater and contaminated land centre review of ammonium attenuation (NGWCLC, 2003).

48e The Kd values for arsenic, nickel and potassium (used in the modelling) are the default ranges taken from the LandSim user manual. Half lives for each of these species has been set at 10^9 years in all geological horizons since they are not subject to degradation. Default kappa values for potassium are not supplied in the LandSim model. Potassium has been assigned the LandSim default kappa constants for chloride to replicate rapid release from landfill waste. Potassium is known to behave generally as a conservative species. This is a conservative approach and has been agreed with the Environment Agency.

49g For benzene, naphthalene and xylene, the anaerobic half lives presented in Howard et al., 1991 have been used and the Koc values (used to calculate Kd values by the model) are taken from Fetter, 1994.

51 Aliphatic hydrocarbons have been assigned the decay half life of 10 years after information published by the Ministry for the Environment, New Zealand (MftE, 1999). They have been assigned a Koc value of $6x10^8$ l/kg after information published by the

TPH Criteria Working Group (TPHCWG, 1997). Aliphatic hydrocarbons have been assigned the LandSim default kappa constants for chloride to replicate rapid release from landfill waste. This is not likely to be the way that hydrocarbons behave based on their strong affinity for organic carbon. However, it is a conservative approach in the absence of site-specific data or available published data.

40,48c LandSim calculates the Kd value from the user-defined Koc value and organic carbon content of the porous medium under consideration. The organic carbon content of the imported (upper) clay liner has been set at 0.2% which is conservative for a UK clay. In order to be conservative, this value has been applied to the entire EBS even though two thirds of the EBS will comprise alluvial clay and will consequently have a higher foc value (see discussion below).

Laboratory testing of the in-situ alluvial clays at the site has recorded an organic carbon fraction (foc) ranging between 0.6% and 14% (Appendix 7). Whilst two of the three alluvial clay samples tested, recorded <1% organic carbon, the 14% measurement is not considered likely to be an outlier. It is considered likely that the overall carbon content of the alluvial clays is likely to range between 0.6 and 14% based on the knowledge that the deposits contain occasional decayed organic matter and traces of peat and that UK alluvial deposits in general are often rich in organic matter. NCC staff are aware that marsh gas has historically been generated at the site and its surroundings prior to waste placement which supports the view that the alluvial deposits have a relatively high organic content.

48c It is considered likely that the foc of the alluvium has a uniform distribution between 0.6 and 14% in the field. However, in order to be conservative, the foc has been assigned a triangular distribution in the model with the expected value set at 0.8%.

Table 9.2 LandSim Input Parameters (Retardation Factors)

Parameter	Value	Distribution	Units	Justification
Aliphatic hydrocarbons Koc	6.3×10^8	single	l/kg	Value for aliphatics with carbon chain C_{16} to C_{21}. TPHCWG (1997).
Aliphatic hydrocarbons half life	10	single	years	Value for aliphatics with chain length C_{15} to C_{36}. MftE (1999).
Aliphatic hydrocarbons kappa constants	0.2919 (c) 0.0298 (m)	single	kg/l	Allocated LandSim default kappa constants of chloride to simulate rapid release from landfill waste. Whilst unrealistic, this is the most conservative approach
Ammonia Kd (EBS)	0.1, 0.5, 5.0	triangular	l/kg	NGWCLC, 2003
Ammonia Kd (alluvium)	0.5 to 2.0	uniform	l/kg	Default value from Table 5.10 in LandSim user manual
Ammonia Kd (gravel)	0.0	triangular	l/kg	NGWCLC, 2003 gives a range of 0.0, 0.4, 0.9, but a fixed value of zero was used to be conservative.
Ammonia decay rate (gravel)	1 to 6	uniform	years	NGWCLC, 2003

Parameter	Value	Distribution	Units	Justification
Ammonia decay rate (EBS and alluvium)	10^9	single	years	NGWCLC, 2003
Arsenic Kd	500 to 5000	uniform	l/kg	Default value from Table 5.10 in LandSim user manual
Arsenic half life	10^9	single	years	Assumed to be persistent (i.e. not subject to decay)
Benzene Koc	97	single	l/kg	Fetter, 1994.
Benzene half life	0.3 to 2.0	uniform	years	Anaerobic half life given in Howard *et al.*, 1991.
Mercury Kd	450 to 3835	uniform	l/kg	Default value from Table 5.10 in LandSim user manual
Revised Mercury Kd	450	single	l/kg	Conservative value used as a result of sensitivity analysis
Mercury half life	10^9	single	years	Not subject to decay
Naphthalene Koc	1300	single	ml/g	Table 11.3, Fetter (1994)
Naphthalene half life	0.75	single	years	Anaerobic half life given in Howard *et al.*, 1991.
Nickel Kd	20 to 800	uniform	l/kg	Default value from Table 5.10 in LandSim user manual
Revised Nickel Kd	20 to 100	uniform	l/kg	Conservative range used as a result of sensitivity analysis
Nickel half life	10^9	single	years	Assumed to be persistent (i.e. not subject to decay)
Phenol Koc	27	single	l/kg	Table 11.3, Fetter (1994)
Phenol half life	0.02 to 0.08	uniform	years	Anaerobic half life given in Howard *et al.*, 1991.
Potassium Kd	0	single	l/kg	Default value from Table 5.10 in LandSim user manual. Unretarded.
Potassium half life	10^9	single	years	Assumed to be persistent (i.e. not subject to decay)
Potassium kappa constants	0.2919 (c) 0.0298 (m)	single	kg/l	Allocated LandSim default kappa constants of chloride to replicate rapid release from landfill waste. Potassium is know to behave generally as a conservative species
Xylene Koc	552 to 588	uniform	l/kg	Table 11.3, Fetter (1994)
Xylene half life	1	single	years	Anaerobic half life given in Howard *et al.*, 1991.

Note:
For triangular distributions the lowest value, expected value and highest value are given in that order.

9.6 Limitations of the Modelling

53 It is important to note that the LandSim modelling has certain limitations. With all probabilistic models it is possible to set a broad range for parameter values in order to compensate for uncertainty. This avoids the neglect of possible (but unlikely) parameter combinations. The worst-case scenario output from the model will combine extremes in parameter values which in practice are unlikely to be present in nature.

In addition, the LandSim model has been constructed using a number of conservative simplifications to give additional confidence in the protection of the environment. This inevitably leads to unrealistically pessimistic results.

LandSim has to simplify the geometry of the system. In the landfill, each cell is assumed to be of equal size and shape. However, the results are insensitive to size and shape as long as the total base area is correct (15.4 ha in this case).

There is uncertainty associated with all inputs into the model. The majority of input ranges have been selected based on a significant number of field tests or laboratory tests or on established literature values/ranges. In general, e.g. in the consideration of leachate concentration and alluvial clay hydraulic conductivity a conservative value or range of values has been chosen for the model input. A sensitivity analysis has been undertaken for several input parameters in order to gauge which parameters influence the model output the most strongly.

Only selected contaminants can be used to model chemical behaviour in the geosphere. Such contaminants have been selected based on their significance in the Newport municipal waste stream and in order to represent different groups of chemicals which behave differently in the environment. The uncertainty associated with the selection of priority contaminants used in the model is addressed in Table 6.3.

Figure 2D shows schematic cross-sections through the centre and edges of Cell 1 indicating the construction details and the height of the piezometric surface of the groundwater confined in the Gravel Deposits. Potentially the thicknesses of the vertical pathway and unsaturated zone in the LandSim model will constantly change during a tidal cycle. This relationship has to be simplified for input into the model and the unsaturated zone thickness has been fixed at 0.5m.

Despite any limitations in the modelling work, it should be noted that a highly conservative approach to the modelling exercise has been undertaken. In the construction of the conceptual model, highly conservative input has been used including the following:

- The source term input used in the model represents the anticipated worst case scenario based on the composition of several leachate sources which have been influenced by commercial and industrial wastes;
- It has been assumed that the leachate head in the tip will be kept at an average of 2m above the EBS throughout the operational and management phases. This is a conservative assumption since during the operational phase leachate is not likely to be generated to this degree;

- The permeability of the EBS has been set at the probable maximum value it will achieve. In reality much lower permeability values could be the norm;

- A high (worst-case) permeability has been used for the alluvium. In reality much lower average permeability value than that used in the model could dominate;

- A very low minimum thickness for the alluvial clay has been used in the model (see discussion in Section 9.5);

- The impacts of contaminants on the Gravel groundwater has been studied without taking into account background concentrations of the contaminants already present. Breakthrough curves for contaminants such as arsenic, nickel, potassium and ammoniacal nitrogen would be more subdued than that predicted by the model if background concentrations were considered.

- Conservative retardation factors have been used in the EBS and alluvium;

- The organic carbon content of the alluvial clay has been set at a conservative range; and

- All contaminants have been assigned a Kd value of zero in the Gravel 'aquifer' and hence no sorption has been allowed for in the Gravel aquifer.

All of the above points add a considerable factor of safety to the modelling work presented.

9.7 Locations for Assessing Emissions to Groundwater

The EA is required to prevent the pollution of groundwater by the substances listed in the Annex of the Groundwater Directive, namely List I and List II substances. More specifically the EA is required to ensure that necessary steps are taken to *prevent* List I substances from entering groundwater (within the Gravel Deposits in the case of Docksway Disposal Site) and to *limit* the introduction of List II substances to groundwater so as to avoid pollution.

The point of compliance where an assessment of the impacts of List I substances is undertaken as part of the numerical modelling work has been chosen as the base of the Alluvial Clays beneath the tip, since this marks the point of entry into the Gravel groundwater for leachate contaminants.

The potential impacts of the other three priority contaminants (ammoniacal nitrogen, nickel and potassium) have been assessed at a compliance well which is located at the south western edge of the Area 1 landfill (GW03/14).

54,56 Graphical output from the LandSim model is presented as Figures 17 to 20. Tabulated numerical output from the model is provided within Appendix 10 (the sensitivity analysis).

9.8 *Results of the Quantitative Risk Assessment*

9.8.1 Percentiles and Confidence Limits

It is important to note that LandSim uses the Monte Carlo methodology which allows for uncertainty in input parameters. Where parameters have been set as a distribution of likely values (see table 9.1), the model quantitatively assesses uncertainty by running the model with many different assigned values for each parameter.

The results of the quantitative risk assessment have been discussed in terms of the 95th percentile (95%ile) and the 50th percentile (50%ile). The 95%ile is considered to be an appropriate conservative estimate of the risk that might arise as a result of uncertainty of the model input. It represents a result or value which has only been realised 5% of the time and there is therefore 95% confidence that the true result or value will be less than the 95%ile value.

The 50%ile gives an indication of the most likely risk since it is equally as likely that the true result will be higher or lower than this predicted value. The 50%ile value is exceeded in 50% of the model runs and for the other 50% of the runs the result is predicted to be below the 50%ile.

9.8.2 Maximum Head Calculations

14,44 The LandSim model was used to calculate the anticipated maximum head likely to be present on the basal drainage blanket. The output from LandSim is shown in Figure 17A. The maximum likely head predicted by LandSim based on the drainage blanket properties input (Table 9.1) is 50 mm. This is a similar result to that generated by the manual calculations presented in PBA, 2004e (120 mm).

48b Calculations demonstrating the likely performance of the drainage blanket are provided in PBA, 2004e.

9.8.3 Predicted Leachate Heads

Figure 17B presents the expected leachate head in the Area 2 landfill as predicted by LandSim. For the operational and managed phases it has been proposed that the leachate head be set at 2.0m above the EBS (see Section 6.2). This represents the anticipated leachate level that will be agreed with the EA in the future and achieved through pumping from the landfill to a leachate treatment plant.

Figure 17B shows that when the managed phase of the landfill operation ends (70 years from the commencement of tipping), leachate levels will rise slightly to 2.75m above the EBS (based on the 95%ile value). However, the 50%ile predicts a maximum head of about 2.6m above the EBS.

Figure 17C indicates the predicted rate of leachate leakage from the base of the Area 2 landfill. The plot demonstrates how leakage from the base of the tip may reduce once the cap is emplaced (20 years after commencement of tipping) and then is predicted to increase again when leachate management via pumping ceases (70 years after commencement of tipping). A tabular, numerical print out of the leakage predicted by the model is presented in Appendix 12.

Surface breakout of leachate is not predicted to occur during the operational, managed or unmanaged phase according to the 50%ile value (Figure 17D). According to the 95%ile some surface breakout is predicted up to a worst-case value of approximately 9500 litres per day.

The estimate of 2.75m to give surface breakout is based on the height of the cell edges minus the average height of the top of the EBS. It is noteworthy that in reality leachate would probably reach higher than 2.75m above the EBS in the centre of the landfill before any major breakout is observed at the edges.

Estimates of the amounts of leachate that will need to pumped to the leachate treatment plant to maintain the fixed leachate head of 2m during the operational and managed phases are given in Figures 17E and 17F. Two graphs are required owing to the different scales required to show the leachate pumped during the operational and managed phases.

During the operational phase it is predicted that up to $4x10^5$ litres of leachate per day will require removal to maintain the fixed head of 2m above the EBS (based on the 95%ile value) (Figure 17E). Once the cap has been placed on Area 2, the model predicts that based on the 95%ile value, approximately 15,000 litres of leachate per day will need to be pumped to the treatment plant (Figure 17F).

It is recommended that the water balance for the Area 2 landfill is revisited in the future during the managed phase. At this time the leachate levels in the tip will be known as will the volumes being pumped to the treatment plant. It will be more straightforward and verifiable to reassess the water balance and carry out another prediction of the likely leachate levels following the cessation of pumping with this information to hand. If there is an unacceptably high risk of leachate breakout in Area 2 during the unmanaged phase, mitigation or remedial measures can be incorporated into a controlled and monitored cessation of management plan.

9.8.4 Definition of Discernable Concentrations

55 It is important to use the LandSim model to determine whether the discharge of List I substances to groundwater is predicted. LandSim is capable of predicting very dilute output concentrations for contaminants (down to approximately 10^{-20} mg/l) but such discharges would not necessarily be discernable using modern analytical techniques. The EA has defined discernable concentrations for some List I substances as minimum reporting values (MRVs) in LFTGN01.

Where MRVs are not published we have been advised by the EA to use the laboratory detection limit to represent the discernable concentration (see email correspondence from the EA of 1 March 2005 in Appendix 2.

55 Table 9.3 lists the concentrations deemed as 'discernable concentrations' for use in estimating impact from List I substances at the Docksway site. The UKAS and MCERTS accredited analytical laboratory used for this project cannot detect mercury at the MRV specified by the EA. However, when evaluating output from the LandSim model, the EA MRV has been used to determine discernable potential impacts from mercury.

Table 9.3 Discernable Concentrations of List I Substances

List I Substance	Discernable Concentration	Source
Aliphatic hydrocarbons	10 μg/l	Minimum achievable detection limit of UKAS and MCERTS accredited project laboratory**
Benzene	1 μg/l	MRV from LFTGN01
Mercury	0.01 μg/l 0.05 μg/l	MRV from LFTGN01 Minimum achievable detection limit of UKAS and MCERTS accredited project laboratory
Naphthalene	1 μg/l	Minimum achievable detection limit of UKAS and MCERTS accredited project laboratory**
Xylene	3 μg/l	MRV from LFTGN01

Note:
Project analytical testing laboratory is ALControl Chester
** = MRV not published by EA.

9.8.5 Emissions to Groundwater – List I Substances

Figures 18A, 18B, 18C, 18D and 18E indicate the LandSim-predicted concentrations of the List I substances aliphatic hydrocarbons, benzene, mercury, naphthalene and xylene respectively at the base of the vertical pathway.

The figures demonstrate that all five of these List I substances are not predicted to reach the base of the vertical pathway at recordable concentrations (i.e. less than $1x10^{-20}$ mg/l) after 20,000 years.

9.8.6 Emissions to Groundwater – List II Substances

Figures 18F, 18G, 18H and 18I indicate the LandSim-predicted concentrations of the List II substances arsenic, ammoniacal nitrogen, nickel and phenol at the base of the vertical pathway.

Ammoniacal nitrogen is predicted to reach a maximum concentration of approximately 800 mg/l (95%ile) after approximately 1000 years (Figure 18F).

Arsenic is predicted to reach a maximum concentration of approximately 0.04 mg/l (95%ile) after approximately 20,000 years (Figure 18G).

Nickel is predicted to reach a maximum concentration of approximately 0.05 mg/l (95%ile) after approximately 16,000 years (Figure 18H).

Figure 18I shows that phenol is not predicted to reach the base of the vertical pathway after 20,000 years.

Figures 19A, 19B and 19C indicate the LandSim-predicted concentrations of the List II substances arsenic, ammoniacal nitrogen and nickel at a compliance well located at the southern edge of the landfill.

Figure 19A indicates that ammoniacal nitrogen will reach a concentration of up to approximately 2.5 mg/l at a southern compliance well after approximately 1000 years (95%ile). The 50%ile predicts that almost no ammoniacal nitrogen will reach the compliance well. It is very unlikely that ammoniacal nitrogen would breakthrough at the compliance well at a concentration greater than the background ammoniacal nitrogen concentration present within the Gravel groundwater.

Figure 19B shows that arsenic is predicted to reach a maximum concentration of 6.0×10^{-5} mg/l at the compliance well after approximately 20,000 years. The 50%ile predicts a much lower maximum breakthrough concentration of less than 1×10^{-5} mg/l. It is very unlikely that arsenic would breakthrough at the compliance well at a concentration greater than the background arsenic concentration present within the Gravel groundwater.

Figure 19C shows that nickel is predicted to reach a maximum concentration of 9.0×10^{-5} mg/l at the compliance well after approximately 20,000 years. The 50%ile predicts a much lower maximum breakthrough concentration. It is very unlikely that nickel would breakthrough at the compliance well at a concentration greater than the background nickel concentration present within the Gravel groundwater.

9.8.7 Emissions to Groundwater – Potassium

Figure 18J indicates that potassium will reach a concentration of up to approximately 600 mg/l at a the base of the vertical pathway after less than 500 years (95%ile). The 50%ile predicts a maximum breakthrough concentration of approximately 350 mg/l.

Figure 19D indicates that potassium will reach a maximum concentration of approximately 2.5mg/l at a southern compliance well after less than 500 years (95%ile). A more likely value of approximately 0.5 mg/l is modelled as the 50%ile. It is very unlikely that potassium will breakthrough at the compliance well at a concentration detectable above the background potassium concentration within the Gravel groundwater.

10 Control and Trigger Levels

10.1 Introduction

It is a requirement of the EA (EA, 2003a), that assessment criteria (control and trigger levels) are agreed for selected contaminants in order to be able to assess the significance of monitoring results in the future.

Trigger Levels are defined as compliance limits for water quality which if exceeded warrant the instigation of a contingency action plan to be agreed with the EA. Control Levels are set at lower concentrations than the Trigger Level for the same chemical species (for species other than List I substances). The exceedance of a control level provides a potential warning of detrimental trends. It may be appropriate to instigate a contingency action plan (such as increasing the monitoring frequency) when a control level is exceeded.

This section of the report addresses recommended compliance monitoring locations, recommended determinands for which assessment criteria should be set and discusses the derivation of control and trigger levels.

10.2 Monitoring Locations

As discussed in Sections 8.3 and 8.4 the Gravel groundwater is considered the key receptor for potential contamination generated at the site and the vertical pathway through the Alluvial Clay deposits is considered to be the primary pathway via which contamination in the leachate may reach the Gravel groundwater. Consequently, it is proposed that compliance points are considered as wells installed within the Gravel Deposits.

37,58 Suitable boreholes via which groundwater quality in relation to established control and trigger levels could be monitored are GW03/10a, GW03/13 and GW03/25. These wells are all located just outside the southern margin of the Area 2 IPPC boundary (see Figure 2B and Figure 5). These three wells are termed as the 'compliance wells' in this section of the report and are suitable for assessing the potential impacts of List II substances. The outline design of the three compliance monitoring boreholes is presented as Figure 14.

37,59 Discharges of List I substances are assessed at notional points directly beneath the centre of each phase of the landfill at the point of entry into the Gravel groundwater. Monitoring of these substances should be undertaken at GW03/10a, GW03/13 and GW03/25 and GW03/14 in order to provide groundwater quality data upgradient of the Area 2 landfill. It should be noted that groundwater at GW03/14 may have been impacted by the presence of the Area 1 dilute and disperse landfill.

10.3 Chemicals Considered

As part of this assessment, the quality of the Docksway Disposal site leachate and the surrounding groundwaters have been studied. The background quality of the Gravel Deposits groundwater is generally poor and it is not practical to set assessment criteria for all of the chemical determinands that exceed available guidance criteria (e.g. the prescribed concentrations for UK drinking water) or MRVs where available (for List I substances). The rationale behind modelling the behaviour of a selection of chemicals (priority contaminants), during this assessment is discussed in Section 9.3.

Assessment criteria have been derived for aliphatic hydrocarbons, ammoniacal nitrogen, arsenic, benzene, mercury, naphthalene, nickel, phenol, potassium and xylene.

10.4 Derivation of Trigger Levels for List I Substances

59 It is not usual to set Control Levels for List 1 substances. The Trigger Levels for such substances are generally set at very low values since the Groundwater Directive prohibits their entry into groundwater (EA, 2003a). It is preferable to set the Trigger Values for List I substances in groundwater at the minimum reporting value (MRV) for that substance where the substance is not already present in the aquifer. However, at Docksway Disposal site a number of List I substances have been identified in the Gravel Deposits groundwater and hence background conditions need to be considered.

Guidance from the EA (EA, 2003a), stipulates that where baseline concentrations exceed the appropriate MRV for that chemical (List I substance) baseline groundwater conditions should be taken into account when setting Trigger Levels. In this case, Trigger Levels should be set at the concentration of the current baseline quality such that the landfill is not permitted to cause a discernable increase to the baseline contamination.

59 For the priority List I contaminants that have been detected in the Gravel groundwater (benzene, naphthalene and xylene) it is proposed that the Trigger Levels for Gravel groundwater are set are the maximum concentration recorded in the groundwater to date plus 25%. This is a technique adopted in one of the case studies cited in Appendix 11 of LFTGN01 (EA, 2003a). Using this method, the trigger levels derived for benzene, naphthalene and total xylene are 3.8, 7.5 and 22.5 µg/l respectively (Table 10.1).

10.5 Derivation of Assessment Criteria for Other Contaminants

Where possible, it is recommended by the EA that Trigger Levels for List II substances are set at a relevant environmental assessment level (EAL) for that contaminant (EA, 2003a). However, where baseline concentrations exceed appropriate EALs for that chemical, the guidance stipulates that baseline groundwater conditions should be taken into account when setting Trigger Levels.

For ammoniacal nitrogen, arsenic, nickel and potassium, we propose that Trigger Levels for the Gravel groundwater are initially set at the highest concentration of each contaminant recorded in Gravel groundwater to date plus 25%. This is a technique adopted in one of the case studies cited in Appendix 11 of LFTGN01 (EA, 2003a). Similarly, we propose that Control Levels for the Gravel groundwater are initially set at the maximum concentrations of each contaminant recorded in the Gravel groundwater to date plus 10%.

59 . Using this approach, the Trigger Levels derived for ammoniacal nitrogen, arsenic nickel, and potassium are 580mg/l, 48.8µg/l, 30µg/l and 431mg/l respectively and the control levels are 510mg/l, 42.9µg/l, 26.4µg/l, and 380mg/l respectively (Table 10.1).

Table 10.1 Derivation of Control and Trigger Levels

Determinand	Highest concentration measured to date in Gravel wells	MRV or EAL	Proposed Control Level – max conc +10%	Proposed Trigger Level – max conc +25%
Ammoniacal nitrogen (mg/l)	463.8	0.021***, 0.5†	510	580
Arsenic (µg/l)	39	25***, 50†	42.9	48.8
Benzene(µg/l)	3	1*	Not relevant – List I	3.8
Mercury (µg/l)	0.13	0.01*	Not relevant – List I	0.16
Extractable petroleum hydrocarbons C_{10}-C_{40} (mg/l)	4.6	NG	Not relevant – List I	5.8
Naphthalene (µg/l)	6	1**	Not relevant – List I	7.5
Nickel (µg/l)	24	30***, 20†	26.4	30
Phenol (µg/l)	1	30***	1.1	1.25
Potassium (mg/l)	345	12†	380	431
Total xylene (µg/l)	18	3*	Not relevant – List I	22.5

Notes
It is not practical to set control and trigger values for all the contaminants present in the source term and it is acceptable to set a few such levels for selected contaminants of differing chemical properties.
* = minimum reporting value taken from Appendix 7 of LFTGN01 (EA, 2003a)
** = Assumed minimum reporting value based on UK laboratory VOC detection limit in water.
*** = Saltwater EQS
† = Prescribed concentration for UK drinking water (DETR, 2000)
NG = no EAL available.

10.6 Predicted Contaminant Concentrations

The assessment criteria detailed in Table 10.1 have been compared with the results of the numerical modelling to ensure that predicted concentrations of contaminants in the Gravel groundwater are not likely to exceed the assessment criteria proposed. Figures 18A to 18J provide LandSim-predicted concentration breakthrough curves for all of the priority contaminants at the base of the vertical pathway. For six of the ten priority contaminants the predicted concentrations in the Gravel groundwater do not exceed the Trigger or Control Levels presented in Table 10.1 and hence they are considered as appropriate assessment criteria at this time.

Ammoniacal nitrogen, arsenic, nickel and potassium concentrations at the base of the vertical pathway (point of entry into the Gravel groundwater), are predicted to almost reach or exceed the proposed trigger levels (according to the 95%ile values). However, at the GW03/25 compliance well their respective concentrations are significantly below the suggested control levels. Hence the proposed Trigger and

Control Levels for all ten priority contaminants are considered appropriate at this time.

10.7 Compliance Monitoring Frequency and Methods

It is proposed that monitoring of the compliance wells should be undertaken monthly and that the exceedance of an assessment criterion (Control or Trigger Level) on three monitoring occasions out of twelve (i.e. three times per year) at any one well should be considered a breach of that assessment criterion and would necessitate consideration of contingency action at that specific monitoring location. Table 10.2 outlines details of each Trigger and Control Level and proposed contingency actions following a breach in the line with the guidance provided in EA, 2003b.

Table 10.2 Trigger and Control Level Monitoring and Contingency Requirements

Assessment Criteria	Trigger Levels	Control Levels
Contaminant for which levels have been set	EPH C_{10}-C_{40} (5.8 mg/l) Ammoniacal nitrogen (580 mg/l), Arsenic (48.8 μg/l) Benzene (3.8 μg/l) Mercury (0.16 μg/l) Naphthalene (7.5 μg/l) Nickel (30 μg/l), Phenol (1.1 μg/l) Potassium (431 mg/l), Total xylene (22.5 μg/l)	Ammoniacal nitrogen (510 mg/l), Arsenic (42.9 μg/l), Nickel (26.4 μg/l), Phenol (1.25 μg/l) Potassium (380 mg/l)
Criterion Objective	To ensure that quality of groundwater does not deteriorate	To ensure that quality of groundwater does not deteriorate
Monitoring points covered by criterion	GW03/14, GW03/10a, GW03/13 and GW03/25 or alternative suitable wells to be agreed with EA.	
Measurement technique	Lab test for ammoniacal nitrogen using Kone analyser. VOC lab test by GC-MS headspace (benzene, naphthalene, xylene). Lab test for potassium using flame photometer. Lab test for arsenic and nickel using ICP-MS. Lab test for mercury using Emission Spectrometry - ICP. Lab test for aliphatic hydrocarbons using EPH C_{10} to C_{40} by GC-FID. Lab test for phenol as part of an SVOC suite using GC-MS.	
Frequency of measurement	Monthly	Monthly
Assessment of breach	3 times per year	3 times per year
Response time	Within 1 month of breach	Within 1 month of breach
Contingency action	• Advise EA • Increased frequency of testing to fortnightly • Re-appraise risks and report to EA • Re-evaluate assessment criterion if risks are acceptable • Implement corrective measures if risks are deemed unacceptable	• Advise EA • Increased frequency of testing to fortnightly • Re-appraise risks and report to EA

11 Completion Criteria

11.1 Definition

22,57 As part of the hydrogeological risk assessment, completion criteria need to be proposed based on the predictions of the reducing leachate quality with time and the predicted transport and decay behaviour of contaminants (EA, 2003a). Completion criteria may take the form of contaminant concentrations at selected distances from the landfill and/or calculated time periods at which such concentrations will be met. When these completion criteria are met, it is assumed that the landfill will not pose an unacceptable risk to the environment. Completion criteria can be used to assist formulating the landfill closure and aftercare plan (EA, 2003a).

11.2 Contaminant Concentrations

The fate and transport behaviour of seven of the ten priority contaminants have been studied in order to provide completion criteria. Between the seven priority contaminants discussed, those forming short term, medium term and long term risks are present. The declining source term of the landfill is presented in Figures 21A to 21G.

Table 11.1 Completion Criteria

Measurable Variable	Recommended Completion Criterion	Measured At Location	Likely time-scale required to reach the proposed criterion
Ammoniacal Nitrogen concentration	1 mg/l 50 mg/l	Compliance well Source term well	4000 years
Potassium concentration	1 mg/l 100 mg/l	Compliance well Source term well	2000 years
Arsenic concentration	25 µg/l	Source term well	10000 years
Nickel concentration	25 µg/l	Source term well	3000 years
Benzene concentration	1 µg/l (MRV)	Source term well	25 years
Naphthalene concentration	1 µg/l	Source term well	50 years
Xylene concentration	3 µg/l (MRV)	Source term well	5 years

Within 70 years, benzene, xylene and naphthalene have all disappeared from the source term. These List I substances are hence viewed as posing relatively short term risks to the environment. It has been demonstrated that at the concentrations in which they have been entered into the model, benzene, naphthalene and xylene do not reach the Gravel groundwater at discernable concentrations. Hence at their highest likely concentrations, benzene, naphthalene and xylene do not pose significant harm to the environment assuming that the landfill functions as designed. Nevertheless, we would recommend that concentrations equal to the relevant MRVs (where available) measured in the leachate are as used as completion criteria for these List I contaminants.

Figure 18F shows the breakthrough of ammoniacal nitrogen at the base of the vertical pathway. It shows that after 4000 years, ammoniacal nitrogen is still predicted to be discharging to groundwater at concentrations in excess of 100 mg/l (95%ile). Consequently, ammoniacal nitrogen poses a medium term risk to groundwater. In practice the 50%ile predicts the concentrations most likely to be realised and after 4000 years this is approximately 30 mg/l which is not considered to represent an unacceptable risk. At 4000 years the source term ammoniacal nitrogen concentration is predicted to be zero or close to zero (Figure 20B) and the compliance well ammoniacal nitrogen concentration is predicted to be less than 1 mg/l (Figure 19A).

The ammoniacal nitrogen compliance criteria can be set at either the source term (50 mg/l is suggested) or the compliance well (1 mg/l is suggested) see Table 11.1.

Figure 18G shows the breakthrough of arsenic at the base of the vertical pathway. It is not certain from Figure 18G whether or not the peak of the arsenic breakthrough has occurred within the maximum runtime of the model (20,000 years). Consequently, arsenic poses a relatively long term risk to groundwater. However, it is noteworthy that the predicted maximum breakthrough concentrations of arsenic are low. The 95%ile after 20,000 years is 0.05 mg/l which is equal to the freshwater EQS of 0.05 mg/l. The more likely 50^{th} %ile predicts breakthrough at less than 0.01 mg/l after 20,000 years which is less than the saltwater EQS for arsenic of 0.025 mg/l.

Arsenic breakthrough is predicted to be negligible at the nearest compliance well to the site (GW03/25). At this location the 95^{t}%ile prediction is less than $1.6x10^{-4}$ mg/l after 20,000 years (see Figure 19B) and consequently arsenic not considered to represent an unacceptable risk to the environment at any time.

Due to the fact that arsenic concentrations in the compliance well steadily increase with time up to the 20,000 year modelling limit, it is not practical to set completion criteria for arsenic in the Gravel groundwater. However, the decline of arsenic from the source term can be monitored and based on the model output (Figure 20C), arsenic should reach about 25 μg/l after 10,000 years. This figure is suggested as a compliance criterion for arsenic (see Table 11.1).

Figure 18J shows the breakthrough of potassium at the base of the vertical pathway. It shows that after 2000 years, potassium discharges to the Gravel groundwater are predicted to be lower than 150 mg/l (95%ile). Based on the fact that the Gravel groundwater is brackish due to saline intrusion from the Ebbw, an input of 150 mg/l of potassium into the groundwater would not be considered to pose unacceptable risk. At 2000 years the source term potassium concentration is predicted to be less than 50 mg/l (Figure 20I) and the compliance well potassium concentration is predicted to be less than 1 mg/l (Figure 19D).

The potassium compliance criteria can be set at either the source term (100 mg/l is suggested) or the compliance well (1 mg/l is suggested) see Table 11.1. It should be noted that background potassium concentrations in the Gravel groundwater are likely to be greater than 1 mg/l and consequently it is likely that the completion criterion for this contaminant will be more easily monitored in the source term.

Figure 18H shows the breakthrough of nickel at the base of the vertical pathway. It shows that the peak of the nickel breakthrough does not occur until at least 16000 years. Consequently, nickel poses a relatively long term risk to groundwater. However, it is noteworthy that the predicted maximum breakthrough concentrations of nickel are low. Whilst the 95%ile exceeds the saltwater EQS of 0.03 mg/l the more likely 50%ile predicts breakthrough at or just below this EAL. Breakthrough is predicted to be negligible (up to $3x10^{-4}$ mg/l) at the nearest compliance well to the site (see Figure 19C) and consequently nickel not considered to represent an unacceptable risk to the environment at any time.

Due to the trace concentrations predicted, and the fact that nickel concentrations in the compliance well steadily increase with time up to at least 16,000 years, it is not practical to set a compliance limit for nickel in the Gravel groundwater. However, the decline of nickel from the source term can be monitored and based on the model output (Figure 20G), nickel should reach about 0.025 mg/l after 3000 years. This figure is suggested as a compliance criterion for nickel (see Table 11.1).

11.3 Ongoing Review of the Risk Assessment

It is stipulated in the guidance (EA, 2003a), that hydrogeological risk assessments should be reviewed every four years after the submission of the PCC application. Environmental monitoring and ongoing risk assessment requirements will be laid out in the PPC landfill permit.

The review of the risk assessment should take into account changes in the baseline conditions or model input parameters which will potentially alter the conceptual model and alter the degree of risk presented by the landfill. Table 11.2 includes some parameters which should be reviewed and fed into the conceptual model.

Table 11.2 Risk Assessment Review Criteria

Measurable Variable	Comments on Significance of Variation
Rainfall	Annual rainfall should be compared to the range input in the model to ensure that water balance calculations remain realistic.
Average Leachate Head	Average leachate levels in the landfill should be monitored to ensure that leachate head does not exceed 2.75m above its base in order to minimise the risk of surface breakout.
Leachate Chemistry	Monitor landfill leachate quality to ensure that it does not contain priority contaminants at concentrations in excess of those used in the model input. The true declining source term concentrations can be compared to predicted concentrations.
Groundwater levels	Based on current and historical monitoring data the landfill is not sub-water table at any locations. Groundwater levels should be monitored in the future to ensure that this situation remains constant.
Groundwater quality	Groundwater quality should be monitored throughout the life of the landfill. Groundwater quality upgradient of the site which is out of the influence of Area 2 (but within the influence of Area 1) is of key importance.
Observations of surface breakout	Observations of surface breakout should be recorded and details of the corresponding leachate head in the tip. This will clarify the true leachate head which gives rise to surface breakout.

12 Conclusions

The results of this risk assessment can be viewed in terms of the Groundwater Regulations (1998). These regulations prohibit the discharge of List I substances to groundwater and stipulate that the introduction of List II substances should be limited so as to avoid pollution.

The output graphs from the LandSim modelling, (Figures 18A to 18F), predict that the proposed extension to Docksway Disposal Site (Area 2) will be compliant with the Groundwater Regulations using the design proposed.

The potential impacts of the List I substances aliphatic hydrocarbons, benzene, mercury, naphthalene and xylene have been assessed at the base of the vertical pathway (i.e. at the point of entry into the Gravel groundwater system). These contaminants are not predicted to reach the Gravel groundwater at concentrations in excess of the relevant MRVs or other discernable concentrations (see Table 9.3) for these contaminants based on the 95%ile LandSim output.

The potential impacts of the List II substances ammoniacal nitrogen, arsenic nickel and phenol and the conservative species potassium have been assessed at a base of the vertical pathway and also at a compliance well situated at the southern edge of Area 2. Phenol is not predicted to reach the base of the vertical pathway during the 20,000 year maximum model run time. The breakthrough concentrations of ammoniacal nitrogen, arsenic, nickel and potassium have been shown to be negligible at a compliance well located on the southern boundary of the landfill.

LandSim modelling has demonstrated that none of the priority contaminants are predicted to reach the compliance well at significant concentrations. It should be stressed that the modelling undertaken is considered to be highly conservative for the following reasons:

- The source term input used in the model represents the anticipated worst case scenario based on the composition of several leachate sources which have been influenced by commercial and industrial wastes;

- It has been assumed that the leachate head in the tip will be kept at an average of 2m above the EBS throughout the operational and management phases. This is a conservative assumption since during the operational phase leachate is not likely to be generated to this degree;

- The permeability of the EBS has been set at the probable maximum value it will achieve. In reality much lower permeability values could prevail;

- A high (worst-case) permeability has been used for the alluvium. In reality much lower average permeability value than that used in the model could prevail;

- A very low minimum thickness for the alluvial clay has been used in the model;

- The impacts of contaminants on the Gravel groundwater has been studied without taking into account background concentrations of the contaminants already present. Breakthrough curves for contaminants such as arsenic, nickel, potassium and ammoniacal nitrogen would be more subdued than that predicted by the model if background concentrations were considered.

- Conservative retardation factors have been used in the EBS and alluvium;

- The organic carbon content of the alluvial clay has been set at a conservative range; and

- All contaminants have been assigned a Kd value of zero in the Gravel 'aquifer' and hence no potential retardation by sorption has been allowed for in the Gravel aquifer.

List I substances have been identified in the Gravel groundwater within Area 2 (in particular at GW03/14), and leachate leakage from the base of the current Area 1 landfill could be a potential source for these substances. The contaminants identified in the groundwater at GW03/14 could alternatively be present as a result of; (1) migration along a current or historical localised preferential pathway associated with the now redundant Maes Glas Pill culvert; or (2) groundwater flowing from the west beneath the Ebbw carrying contaminants which have originated at the landfill to the west of the site. Possible origins for the contaminants which have been identified in the Gravel groundwater are discussed in more detail in the hydrogeological risk assessment for Area 1 which has been reported to the EA as part of a separate IPPC application for that Area (PBA, 2004c).

Two failure scenarios have been modelled to demonstrate the performance of the landfill if either the cap or the basal EBS should catastrophically fail (see Section 14).

Completion criteria have been set for the landfill based on the outcome of the predictive modelling (see Section 11).

13 Sensitivity Analysis

13.1 Introduction

42,52 A sensitivity analysis has been undertaken in order to establish parameters which apply the most significant control to the outcome of the model. The amount of leakage from the base of the tip is controlled by:

a) the infiltration rate;
b) the permeability of the EBS; and
c) the fixed leachate head level during the managed phase.

The amount of leakage leaving the base of the landfill will directly influence the leachate head predicted by the model during the unmanaged phase.

The times of the peak breakthrough of modelled contaminants and the maximum concentrations recorded are controlled partly by the amount of leakage leaving the tip (and hence on the factors listed above), and also on the following parameters:

d) the concentration at the source term
e) retardation factors for individual contaminants
f) the organic carbon content of the EBS and alluvial clay (organic species only)
g) the thickness of the in-situ alluvial clay
h) the permeability of the alluvial clay; and
i) the porosity of the vertical pathway.

Sensitivity runs have been carried out for each of these parameters or justifications have been given for why such an analysis has not been undertaken. For most sensitivity runs, the model was run with 201 iterations and two priority contaminants only (potassium and ammoniacal nitrogen) in order to speed up the run time of the model. This was also done because ammoniacal nitrogen and potassium have marked breakthrough curves in the model submitted whilst other contaminants have negligible or no breakthrough (and hence changes to these outputs would be less readily observable following modifications to the model).

13.2 Infiltration Rate

The initial infiltration rate input into the model is a mean of 678.2mm with a standard deviation of 86.4. This is considered to be a reliable value since it is based on 18 years of rainfall data and a detailed water balance. The infiltration rate (based on the climate) only affects the output of the model for the first 20 years of the simulation. This is because following cessation of tipping the landfill cap is paced, and infiltration to the tip is then governed by the cap design infiltration rate regardless of the amount of rainfall. Consequently it is the cap design infiltration that has been varied to observe its influence on leachate head and leakage.

The cap design infiltration (cdi) rate has been input into the model as a range between 23mm/yr and 46mm/yr. These figures have been derived based on seepage velocity calculations through a 1m thick cap with a permeability value ranging between $5x10^{-10}$ and $1x10^{-9}$ ms^{-1} respectively. It is anticipated that the average permeability of the cap will be $7.5x10^{-10}$ ms^{-1} (equivalent to a cdi of 34.5 mm/yr).

Because the clay cap will be engineered with construction quality assurance (CQA) it is considered unlikely that the anticipated average cdi of 34.5 mm/yr will be exceeded. However, a sensitivity run has been undertaken setting the cdi at 46mm/yr to assess the significance.

The results of this analysis are shown in Section 2 of Appendix 10. With the cdi set at 46mm/yr, leakage and head on the EBS increases fractionally over the submitted model. Crucially, some surface breakout is predicted by the 50th percentile (4000 litres per day) when the cap design infiltration is fixed at this higher limit. Consequently, cdi is considered to be a fairly sensitive parameter and the CQA applied to the cap construction will need to be rigorous.

Comparison of the 23mm/yr cap design infiltration run versus the 46mm/yr cap infiltration design run shows that EBS leakage approximately doubles in the latter (as would be expected). A run with the cap design infiltration set at 92mm/yr was undertaken to demonstrate that predicted leakage from the EBS does not increase significantly compared with the 23mm/yr run, but surface breakout more than doubles from approximately 11000 litres per day to approximately 28,000 litres per day (90%ile values).

13.3 Hydraulic Conductivity of the EBS

The permeability values for both clay barriers must be set as the same distribution in LandSim. In the model we have set this distribution as triangular ($1x10^{-10}$, $5x10^{-10}$, $1x10^{-9}$ ms^{-1}). As with the clay cap it is considered that this permeability range is likely to be achieved based on the fact that a CQA programme will be in place.

In any case model runs have been undertaken with the EBS permeability set at $1x10^{-9}$ ms^{-1} and $1x10^{-8}$ ms^{-1} in order to assess the significance of this parameter.

If the EBS conductivity is increased to $1x10^{-9}$ ms^{-1}, little difference is made to the output of the model compared to that submitted with the application. Head on the EBS reduces slightly and no surface breakout is predicted. Leakage remains approximately the same as in the submitted model and the breakthrough curves for ammonium and potassium are similar.

If the EBS conductivity is increased to $1x10^{-8}$ ms^{-1}, marked differences are apparent in the model output. Firstly no significant head of leachate is sustained on the EBS and hence no surface breakout occurs. Secondly, ammoniacal nitrogen and potassium breakthrough at far greater concentrations than those observed at lower hydraulic conductivity values and they breakthrough more quickly.

The hydraulic conductivity values of the clay barriers are a particularly sensitive input in the model. If the EBS permeability increases, the breakthrough of contaminants is more rapid and at higher concentrations. In order to be conservative the hydraulic conductivity for the EBS was revised to $1x10^{-9}$ ms^{-1} (as compared with the range specified above (see also Table 9.1).

The graphical and numerical output for this work is presented in Section 3 of Appendix 10. The graphical output from the revised model is provided in Section 4 of Appendix 10.

13.4 Fixed Leachate Head During the Managed Phase

52,17,42 The leachate head will be restricted to 2m above the EBS during the managed phase via pumping to a leachate treatment plant. Figure 18D shows a LandSim plot indicating the predicted leachate volumes which will need to be pumped to the treatment plant in order to maintain the 2m head.

In order to assess the sensitivity of the fixed leachate head parameter to the model output, the model has also been run with 0.5m and 2.75m fixed heads for the duration of the managed phase. Both sensitivity runs demonstrated no differences in the chemical breakthrough curves of potassium and ammoniacal nitrogen (Section 10 of Appendix 10).

The flow to leachate treatment plant graph produced in each case was similar to the submitted model although inevitably slightly more or less leachate is predicted to be removed during the managed phase.

13.5 Concentration of the Source Term

A sensitivity analysis has not been undertaken on the source term since the worst case source term has been entered into the model. For ammoniacal nitrogen, arsenic, mercury, nickel and potassium, the worst case probability density function (pdf), composed after reference to Area 1 leachate data, WMP 26B and the LandSim manual has been entered as the source term. For the List I organic contaminants aliphatic hydrocarbons, benzene, naphthalene and xylene, and the List II substance phenol, the worst case source term pdf has been arrived at by comparison of Area 1 leachate data with leachate data from four UK containment landfills which have accepted industrial and commercial wastes. In the case of all ten priority contaminants, the worst case pdf was used (see Section 6.3) and consequently the model predictions are unlikely to be realised in actuality.

13.6 Retardation Factors

52 A sensitivity analysis has been undertaken to determine how critical selected retardation factors of certain priority contaminants are. Graphical and spreadsheet output for this work is presented in Section 4 of Appendix 10.

Ammoniacal Nitrogen

Ammoniacal nitrogen has been assigned a decay half life of 10^9 years in the EBS and alluvial clay and 1 to 6 years in the gravels based on information published in NGWCLC, 2003. This is a well-researched EA publication and because there is little uncertainty associated with these values, it is not considered necessary undertake a sensitivity analysis.

Ammoniacal nitrogen has been assigned a Kd value of 0.1, 0.5, 5 l/kg (triangular) in the EBS based on information published in NGWCLC, 2003. This is a well-researched EA publication and because there is little uncertainty associated with this pdf, it is not considered necessary to undertake a sensitivity analysis.

Ammoniacal nitrogen has been assigned the LandSim default Kd value of 0.5 to 2.0 l/kg as a uniform distribution in the alluvial clay unsaturated zone and the alluvial clay vertical pathway. In order to assess the sensitivity of this parameter, the model was ran assigning the minimum LandSim value of 0.5 l/kg. Breakthrough behaviour was compared with that in the submitted model.

The run shows that with a Kd value of 0.5 l/kg in the alluvium, an almost identical ammoniacal nitrogen breakthrough curve to that from the submitted model is predicted. That is to say that the ammoniacal nitrogen Kd value in the alluvium is not a particularly sensitive parameter within the model.

The model was also run with the ammoniacal nitrogen Kd value set at zero in the EBS, unsaturated zone and vertical pathway, i.e. representing no possible retardation. Ammoniacal nitrogen is predicted to peak at a maximum concentration of 1250 mg/l at the base of the vertical pathway after less than 1000 years (95%ile) under these conditions (Section 11, Appendix 10).

Arsenic

Arsenic has been assigned a decay half life of 10^9 years in all horizons since it does not decay and this value does not require a sensitivity analysis. Arsenic has been assigned the LandSim default Kd value of 25 to 250 l/kg as a uniform distribution in the EBS, the alluvial clay unsaturated zone and the alluvial clay vertical pathway. In order to assess the sensitivity of this parameter, the model was ran with arsenic only in the source term assigning the minimum LandSim value of 25 l/kg. Breakthrough behaviour was compared with output from the submitted model in Section 4 of the sensitivity analysis appendix (Appendix 10).

This work demonstrates that the breakthrough behaviour of arsenic is altered by the Kd value used. In the submitted model, arsenic reaches almost 0.007 mg/l after some 18,000 years. With the Kd value reduced to 25 l/kg, arsenic reaches 0.05 mg/l in 10,000 years.

It is noteworthy that at the compliance well (where the impacts of List II substances are assessed), arsenic does not reach significant concentrations with the reduced Kd value. A maximum value of 2×10^{-4} mg/l or 0.2 μg/l is predicted after 13,000 years (see Section 5 of Appendix 10).

The model was also run with the arsenic Kd value set at zero in the EBS, unsaturated zone and vertical pathway, i.e. representing no possible arsenic retardation. It is predicted to peak at a maximum concentration of 0.3 mg/l at the base of the vertical pathway after less than 1000 years (95%ile) under these conditions (Section 11, Appendix 10).

Mercury

Mercury has been assigned a decay half life of 10^9 years in all horizons since it does not decay and this value does not require a sensitivity analysis. Mercury has been assigned the LandSim default Kd value of 450 to 3585 l/kg as a uniform distribution in the EBS, the alluvial clay unsaturated zone and the alluvial clay vertical pathway. In order to assess the sensitivity of this parameter, the model was ran with mercury only in the source term assigning the minimum LandSim value of 450 l/kg. Breakthrough behaviour was compared with output from the submitted model (Appendix 10).

This work demonstrates that the breakthrough behaviour of mercury is altered by the Kd value used. In the submitted model, mercury does not reach the base of the vertical pathway at a recordable concentration after some 20,000 years. With the Kd value reduced to 450 l/kg, it reaches the base of the vertical pathway at 10^{-10} mg/l after 20,000 years. This is still significantly below the MRV for mercury (10^{-5} mg/l).

In order to be conservative, the minimum LandSim mercury Kd value of 450 l/kg has been used in the revised model submitted.

The model was also run with the mercury Kd value set at zero in the EBS, unsaturated zone and vertical pathway, i.e. representing no possible mercury retardation. In this case, mercury is predicted to enter the Gravel groundwater at concentrations exceeding the MRV for mercury. It is predicted to peak at a maximum concentration of 7×10^{-4} mg/l after less than 1000 years (95%ile) under these conditions (Section 11, Appendix 10).

Nickel

Nickel has been assigned a decay half life of 10^9 years in all horizons since it does not decay and this value does not require a sensitivity analysis. Nickel has been assigned the LandSim default Kd value of 20 to 800 l/kg as a uniform distribution in the EBS, the alluvial clay unsaturated zone and the alluvial clay vertical pathway. In order to assess the sensitivity of this parameter, the model was ran with nickel only in the source term assigning the minimum LandSim value of 20 l/kg. Breakthrough behaviour was compared with output from the submitted model (Appendix 10).

This work demonstrates that the breakthrough behaviour of nickel is significantly altered by the Kd value used. In the submitted model, nickel only reaches $3x10^{-6}$ mg/l after some 16,000 years. With the Kd value reduced to 20 l/kg, nickel reaches $3x10^{-2}$ mg/l in approximately 7,500 years.

It is noteworthy that at the compliance well (where the impacts of List II substances are assessed), nickel does not reach significant concentrations if the reduced Kd value is used. A maximum value of $7x10^{-5}$ mg/l or 0.07 μg/l is predicted after approximately 8,000 years (see Section 5 of Appendix 10).

In order to be conservative, and in order that nickel can be used to assess the behaviour of the more mobile List II metals, the Kd value of nickel has been reduced from the value presented in the LandSim manual. A range of 20 to 100 l/kg has been used in place of the default range of 20 to 800 l/kg.

The model was also run with the nickel Kd value set at zero in the EBS, unsaturated zone and vertical pathway, i.e. representing no possible nickel retardation. Nickel is predicted to peak at a maximum concentration of 0.3 mg/l at the base of the vertical pathway after less than 1000 years (95%ile) under these conditions (Section 11, Appendix 10).

Potassium

Potassium has been assigned a Kd value of 0 and a decay half life of 10^9 years to represent truly conservative behaviour. This is in agreement with the approach for modelling potassium in the LandSim manual and does not require a sensitivity analysis.

Aliphatic Hydrocarbons

The straight chain aliphatic hydrocarbons used to represent mineral oil and EPH in the source term have been assigned a decay half life of 10 years after MftE, 1999. No measurable breakthrough of aliphatic hydrocarbons is predicted at the base of vertical pathway by the LandSim model using this half life. Two sensitivity runs were undertaken increasing the aliphatics half life to 100 years and 1000 years to observe the differing breakthrough behaviour at the base of the vertical pathway. These runs demonstrated no difference in predicted output and consequently the half life of aliphatic hydrocarbons is not considered to be a sensitive input parameter.

The aliphatic hydrocarbons in the source term have been assigned a Koc value of $6x10^8$ ml/g (TPHCWG, 1999). A sensitivity run was undertaken reducing the Koc by 3 orders of magnitude to 10^{-5} ml/g and no difference in output was predicted by the model. Consequently the Koc value of the aliphatic hydrocarbons is not considered to be a particularly sensitive parameter in the LandSim model.

Benzene

A sensitivity analysis has been undertaken on benzene in order to assess the likely affects on the general breakthrough behaviour of the three aromatic List I substances modelled (benzene, xylene, naphthalene) when altering the retardation factors. Benzene has been chosen because it is potentially the most mobile organic List I substance present in the model. Consequently, if the alteration of the decay half life and Koc value of benzene show little or no change to the breakthrough behaviour of benzene, then little or no change would be expected to the behaviour of the less mobile aromatic contaminants modelled (naphthalene and xylene) if their retardation parameters were changed.

Benzene has been assigned an anaerobic decay half life of between 0.3 and 2 years after Howard *et al.*, 1991 and no measurable breakthrough of benzene is predicted at the base of vertical pathway by the LandSim model. Two sensitivity runs were undertaken doubling the maximum possible benzene half life to 4 years and then again to 8 years to observe the differing breakthrough behaviour at the base of the vertical pathway. These runs demonstrated a measurable difference in the breakthrough behaviour of benzene but bezene remained at insignificant concentrations. If a 4 year half life is used benzene reaches a maximum concentration of approximately $1x10^{-17}$ mg/l. If an 8 year half life is used benzene reaches a maximum concentration of approximately $1x10^{-12}$ mg/ at the base of the vertical pathway (Section 5 of Appendix 10). Although the half life of the most mobile organic List I substance does have an impact on breakthrough behaviour, output is still significantly below the minimum reporting value (10^{-3} mg/l) given in the EA guidance on producing hydrogeological risk assessments.

Benzene has been assigned a Koc value of 97 ml/g (Fetter, 1994). A sensitivity run was undertaken setting the benzene Koc value at 0 (which assumes the contaminant has no affinity for organic carbon and is hence the most conservative possible situation) to observe the resulting breakthrough behaviour at the base of the vertical pathway. This run shows that a negligible breakthrough of benzene is still observed when the Koc is set to zero. Consequently the Koc value of benzene is not considered to be a particularly sensitive parameter in the LandSim model.

Phenol

It is widely accepted that phenol has a low Koc and has little affinity for adsorption to carbon (see for example ATSDR, 1998). The Koc for carbon has been set at the low value of 27 ml/g (after Fetter, 1994) and a sensitivity analysis is not considered to be required for this parameter (reducing the value to zero is not likely to alter the output from the model).

It is widely accepted that phenol is readily degradable in the environment (see for example ATSDR, 1998) and the expected half life of this substance is measured in days whether under aerobic or anaerobic conditions. The half life of phenol has been set at 0.02 to 0.08 years (after Howard *et al.*, 1991). A model run with the half life set at 1 year (i.e. more than an order of magnitude greater that the maximum expected value) demonstrated a negligible difference in the breakthrough behaviour of phenol at the base of the vertical pathway (see Section 5 of Appendix 10).

13.7 Organic Carbon Content

Conservative values for the organic carbon content (foc) of the landfill barriers and the alluvial clay have been input into the model. The EBS as a whole can only be assigned one value for foc. As a conservative approach, the entire EBS has been assigned the lower imported clay foc value rather than the higher alluvial clay value, despite the fact that two thirds of the EBS is constructed of stabilised alluvial clay.

The alluvial clay has been assigned a conservative foc as detailed in Section 9.5. Due to the fact that such conservative foc values have been used in the model it is not considered necessary to assess the sensitivity of this parameter.

13.8 Alluvial Clay Thickness

The inter-relationship between the alluvial clay thickness, the vertical pathway length and the unsaturated zone thickness has been discussed at length in Sections 2.6 and 9.5.

The alluvial clay beneath the stabilised alluvium his has been modelled as a 0.5m thick unsaturated zone overlying a vertical pathway which varies between 1.0m and 3.8m thick. The minimum value for the vertical pathway thickness has been set lower than that anticipated from measurements of the alluvium thickness across the site and knowledge of the clay importation required to raise the construction platform. Hence a conservative approach has been taken in modelling the alluvial clay thickness.

In order to assess the sensitivity of this parameter, the model has been run with the vertical pathway fixed at the very low thickness of 1.6 m under the entire landfill.

Using a fixed 1.6m vertical pathway thickness, the leakage from the base of the landfill is approximately the same as when the vertical pathway is assigned a thickness range of 1.0 to 3.8m. However, the 50%ile prediction of leachate head drops slightly from above 2.5m to below 2.5m when comparing both models and predicted surface breakout is marginally less with the reduced vertical pathway.

The breakthrough behaviour of ammoniacal nitrogen and potassium has been shown to be almost identical whether the vertical pathway is fixed at 1.6m thick or assigned a thickness range of 1.0 to 3.8m.

It is concluded that the model is not considered to be particularly sensitive to moderate changes in the thickness of the vertical pathway.

13.9 Hydraulic Conductivity of the Unsaturated Zone

The alluvial clay beneath the stabilised alluvium his has been assigned a hydraulic conductivity of $1x10^{-9}$ ms^{-1} (a conservative value based on the fact that the expected vertical hydraulic conductivity of the alluvium is $5x10^{-10}$ ms^{-1} according to a review undertaken of the testing data available. The model was also run with a fixed alluvium hydraulic conductivity of $1x10^{-8}$ ms^{-1} and $1x10^{-7}$ ms^{-1} in order to assess the sensitivity of this parameter.

The breakthrough behaviour of both ammoniacal nitrogen and potassium has been shown to be almost identical comparing models with the hydraulic conductivity of the alluvium set at $1x10^{-9}$ ms^{-1} and $1x10^{-7}$. Consequently, it is concluded that the model is not considered to be particularly sensitive to changes in the hydraulic conductivity of the alluvial clay unsaturated pathway. This is to be expected since the unsaturated zone is relatively thin (0.5m) in the conceptual model.

13.10 Porosity of the Alluvium (Vertical Pathway)

32,49d The alluvial clay beneath the stabilised alluvium his has been assigned a porosity of 0.41 to 0.69 based on the initial void ratio testing results from the on-site alluvium. In order to assess the sensitivity of this parameter, the model was also run with a fixed porosity of 0.7, 0.2 and 0.05 (see Section 9 of Appendix 10).

The breakthrough behaviour of both ammoniacal nitrogen and potassium has been shown to be almost identical comparing models with the porosity of the vertical pathway set at 0.2 and 0.7.

Also the ammoniacal nitrogen and potassium breakthrough curves are similar comparing the 0.05 alluvium porosity run against the 0.7 porosity run. Consequently, it is concluded that the model output is not particularly sensitive to changes in the porosity of the vertical pathway.

13.11 Outcome of Sensitivity Analysis

The sensitivity analysis has determined five high sensitivity parameters which significantly alter the model predictions when they are varied (Table 13.1). Implementation of a strict CQA programme during construction should ensure that the design cap infiltration and the hydraulic conductivity of the EBS are as (or more favourable than) the inputs used in the LandSim model.

A conservative value for the Kd of nickel and mercury which are less than the LandSim default values have been used in the revised model submitted with this report in recognition of the fact that these are sensitive parameters.

Whilst the sensitivity analysis has shown that the arsenic Kd value is a sensitive parameter, it has been demonstrated that arsenic does not reach significant concentrations at the nearest compliance well to the site (GW03/25).

Table 13.1 Relative Sensitivity of Model Input Parameters

High Sensitivity Parameters	Low Sensitivity Parameters
Design cap infiltration	Fixed leachate head (managed phase)
Hydraulic conductivity of EBS	Ammoniacal nitrogen Kd in alluvium
Arsenic Kd value	Vertical pathway porosity
Mercury Kd value	Hydraulic conductivity of unsaturated pathway.
Nickel Kd value	Koc of benzene
Half life of benzene	Half Life of phenol
	Half life of aliphatic hydrocarbons
	Koc of aliphatic hydrocarbons

40 Sensitivity runs with Kd values for nickel, mercury, arsenic and ammoniacal nitrogen set at zero have been provided to demonstrate breakthrough behaviour of these inorganic contaminants in the complete absence of retardation. In the view of the EA, this exercise provides information on the possible worst case discharges from the landfill where site-specific Kd values are not available.

14 Accidents and Failure Scenarios

14.1 Accidents and their Impacts

45 A qualitative assessment of the likely impacts of site accidents on the landfill is discussed in PBA, 2005b. This document includes likely impacts of accident scenarios on the leachate management system.

14.2 Failure Scenarios

41 The site basal lining system and cap do not include any form of geosynthetic membrane. Consequently the failure of such membranes has not been considered as part of this work.

The likelihood for potential base failure as a result of uplift of the soft alluvial clays beneath the landfill has been discussed in the stability assessment report for Area 2 (PBA, 2004a) and it is not proposed that this is discussed any further as part of the hydrogeological risk assessment.

During the operational and managed phases, leachate control occurs. The potential failure of the leachate management system and its consequences are discussed in PBA, 2005b.

As a result of the sensitivity analysis (see Section 13), the design cap infiltration and the EBS hydraulic conductivity have been assessed to be two high sensitivity input parameters. A failure within the cap would lead to greater leachate generation and either an increase in leakage from the site or surface breakout of leachate or both.

A catastrophic failure in the EBS would cause a decrease in leachate head within the tip and a reduction in the likelihood of surface breakout of leachate. However, it would significantly increase leakage from the landfill and significantly alter the breakthrough behaviour of all source term components.

The two failure scenarios described above have been modelled using LandSim and the results are presented in Sections 12 and 13 of Appendix 10.

<u>Cap Failure</u>

41 A seepage calculation was undertaken which demonstrated that if the cap permeability reduced catastrophically to 10^{-4} ms^{-1}, the cap design infiltration (cdi) could be as high as 4575874 mm/yr. If this was the case, the infiltration would be limited to the pre-restoration infiltration for the site (678 mm/yr) (see Table 5.1). This value for the cap design infiltration was put into the model and it was rerun to demonstrate the outcome of a catastrophic cap failure.

This exercise demonstrated that as soon as leachate management ceases (70 years after the commencement of tipping), the leachate head in the tip rises to the maximum possible level (2.75m) and stays at this level.

Surface breakout of leachate is predicted to be continuous following cessation of leachate management at approximately $2.7x10^5$ l/day or 270 m^3/day. The LandSim output shows that the same quantity (approximately $2.7x10^5$ l/day) of leachate would have to be pumped to the leachate treatment plant during the managed phase in order to maintain the fixed leachate head of 2m above the EBS.

The breakthrough curves for all the List I substances (aliphatics, benzene, mercury, naphthalene, xylene) and phenol show no breakthrough at the base of the vertical pathway (as is the case in the submitted model accompanying this report).

The breakthrough curves of ammoniacal nitrogen, nickel, potassium and arsenic are significantly different comparing the cap failure run with the submitted model. Ammoniacal nitrogen, potassium, nickel and arsenic breakthrough in a much reduced timescale in the cap failure run, and at reduced concentrations.

Instinctively, the reduced contaminant concentrations beneath the landfill could be presumed to be caused by the model allowing for some contaminant release via the surface breakout of leachate. Alternatively, a more rapid contaminant reduction in the source term could result from the increased leachate removal during the managed phase (required to maintain the fixed leachate head of 2m). Study of the source term decline output graphs from LandSim (included in Section 12 of Appendix 10) identifies which of these mechanisms is important.

The source term decline output graphs show that at the end of the operational phase (20 years) the source term components are predicted to rapidly decline to zero. The rapid source term decline is hence not predicted to be as a result of surface breakout since surface breakout is only allowed to occur after 70 years. The concentrations of contaminants predicted at the base of the vertical pathway are lower in the cap failure scenario because the source term decline is predicted to accelerate due to increased leachate removal during the managed phase.

<u>Basal EBS Failure</u>

41 It is considered highly unlikely that the basal EBS of the landfill will catastrophically fail. Calculations have been undertaken to demonstrate that there is no significant risk present from uplift of the EBS caused by sub-artesian groundwater pressures (PBA, 2004a). However, in order to demonstrate catastrophic failure of the basal EBS for example as a result of a Newport earthquake, the LandSim model has been run with the hydraulic conductivity of the EBS set at 10^{-4} ms^{-1}.

The output from this modelling is presented in Section 13 of Appendix 10. The leachate head is shown to be maintained at 2m above the EBS until the end of the managed phase when it drops to zero. The post-managed head of 0m indicates that with the hydraulic conductivity of the base set so high (10^{-4} ms^{-1}), the landfill cannot maintain any leachate and any leachate generated is lost via leakage.

The operational and managed phase leachate head output is unrealistic in that the model forces the head to remain at 2m (as specified by the user) even though the hydraulics make this head unsustainable. The leakage output graphs show that significant leakage is generated prior to 20 years when the cap is constructed. After the placement of the cap, leakage reduces to the approximate volumes indicated by the submitted model. This is expected since the same infiltration rate into the landfill is used by both models (i.e. the submitted model and the basal EBS failure model).

The surface breakout plot shows that no surface breakout is predicted when the landfill EBS hydraulic conductivity is so high (10^{-4} ms^{-1}).

The 'flow leachate treatment plant' plot shows that no artificial leachate removal is required since the leachate losses via the base are so substantial early on in the operational phase. The fact that all the leachate generated passes vertically downwards into the geosphere has a marked impact on the breakthrough behaviour of many source term components.

The breakthrough curves for all the List I substances (aliphatics, benzene, mercury, naphthalene, xylene) and phenol show no breakthrough at the base of the vertical pathway (as is the case in the submitted model accompanying this report).

The breakthrough curves for ammoniacal nitrogen, arsenic, nickel, and potassium indicate more rapid and more concentrated breakthrough than is predicted in the submitted model. This is to be expected since in this example no source term reduction takes place via leachate pumping to a treatment plant.

15 Glossary of Terms

cdi	cap design infiltration
Compliance point	Location at which the input of List I or List II substances to the receptor are assessed.
Control Level	Set lower than the Trigger Level, the control level marks a value above which monitoring frequency may be increased in order to assess detrimental trends. Control levels are not applicable to List I substances.
CRA	Central raised area'. The highest part of Area 1, filled largely between the late 1980s and 2004. Waste is of the order of 30m deep in this area.
EAL	Environmental assessment level, e.g. freshwater and saltwater EQSs.
EBS	Acronym used for the engineered barrier system or engineered liner of a landfill in the LandSim documentation. In this case the EBS comprises 1.2m of imported engineered clay (the upper barrier), and 2m of cement-stabilised alluvium separated by a 300mm thick load transfer blanket.
Effective rainfall	Total precipitation minus evapotranspiration = infiltration plus runoff.
*f*oc	Organic carbon content fraction.
kappa	A constant, unique to each chemical species which is related to the rate of release of the chemical species from the solid phase (the waste) to the liquid phase (the leachate) within the landfill. A chemical with a high value of kappa (e.g. chloride) will decline from the source term more rapidly than one with a low value of kappa (e.g. arsenic).
K_d	Solid:liquid distribution coefficient calculated from laboratory batch sorption experiments. $K_d = C_s/C_{aq}$ where C_s = concentration of the contaminant sorbed to the soil and C_{aq} = the concentration of the contaminant which remains in solution, i.e. in the groundwater. Higher K_d values imply less mobile contaminants.
K_{oc}	Organic carbon:liquid distribution coefficient calculated from laboratory batch sorption experiments. Higher K_{oc} values imply less mobile contaminants. K_{oc} values can be converted to K_d values for any specific material if the foc of that material is known.
Made Ground	A general term to describe fill material in Area 1. Much of the made ground contains refuse.
MRV	Minimum reporting value for a List I substance given in the EA guidance on production of hydrogeological risk assessments.

NCC	Newport City Council – the landfill operator.
pdf	Probability density function; the range of values entered for any one parameter in the LandSim model.
Perched groundwater	Groundwater within the made ground around the CRA of Area 1.
Priority Contaminants	Several species used to model contaminant behaviour in the geosphere. Each contaminant chosen for the modelling has different chemical and/or physical properties.
SDR	Southern Distributor Road of Newport
Trigger Level	A compliance limit for water quality. If the trigger level is exceeded a contingency action plan will be adopted.

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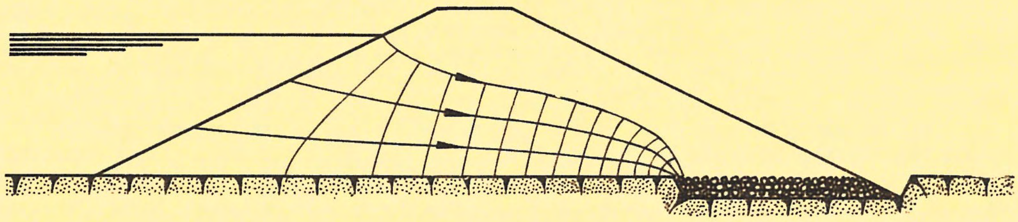

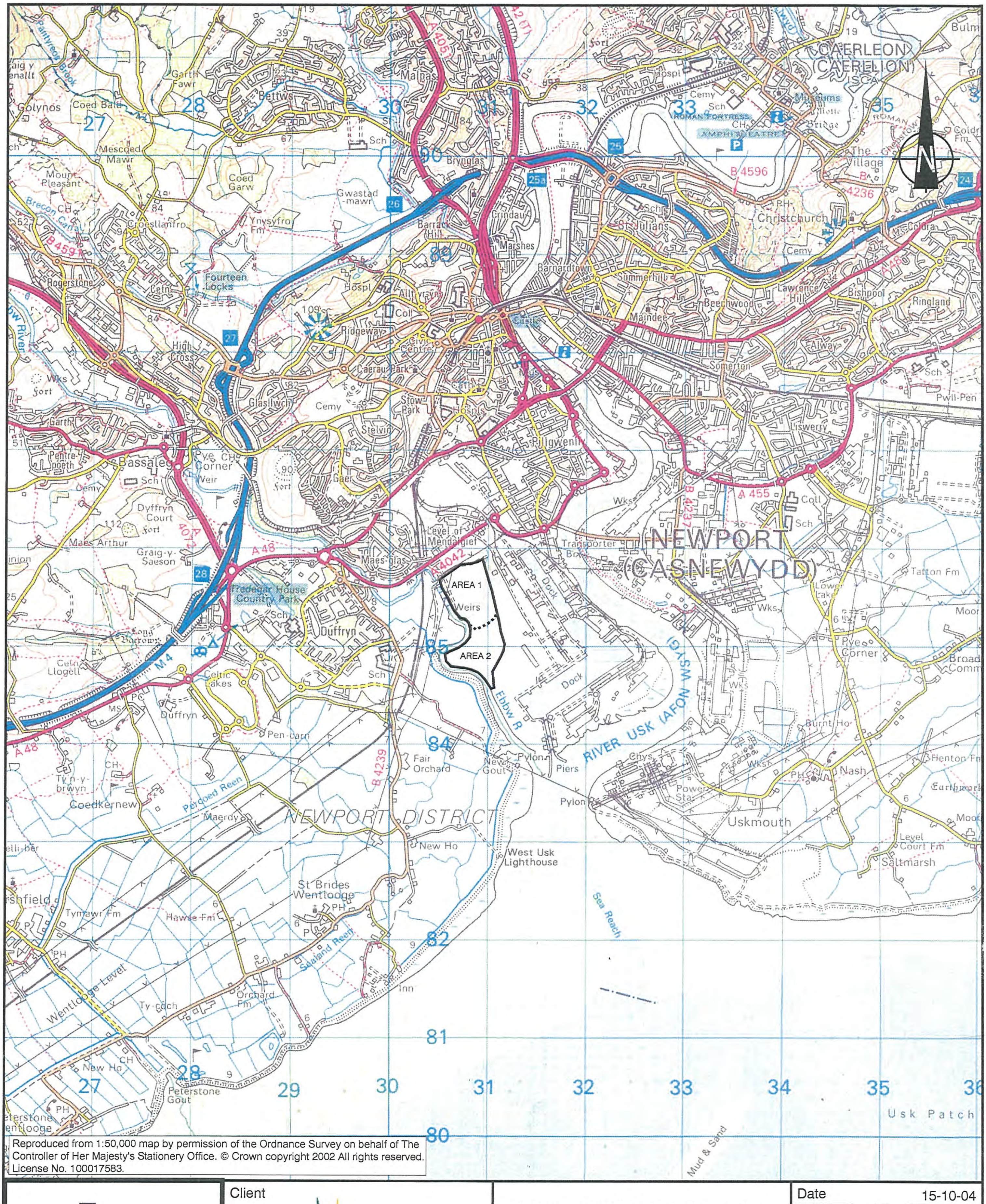

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Cyngor Dinas Casnewydd

DOCKSWAY DISPOSAL SITE

SITE LOCATION

Date	15-10-04
A4 Scale	1:50,000
Drawn	BDA
Checked	AOD
Figure Number	1

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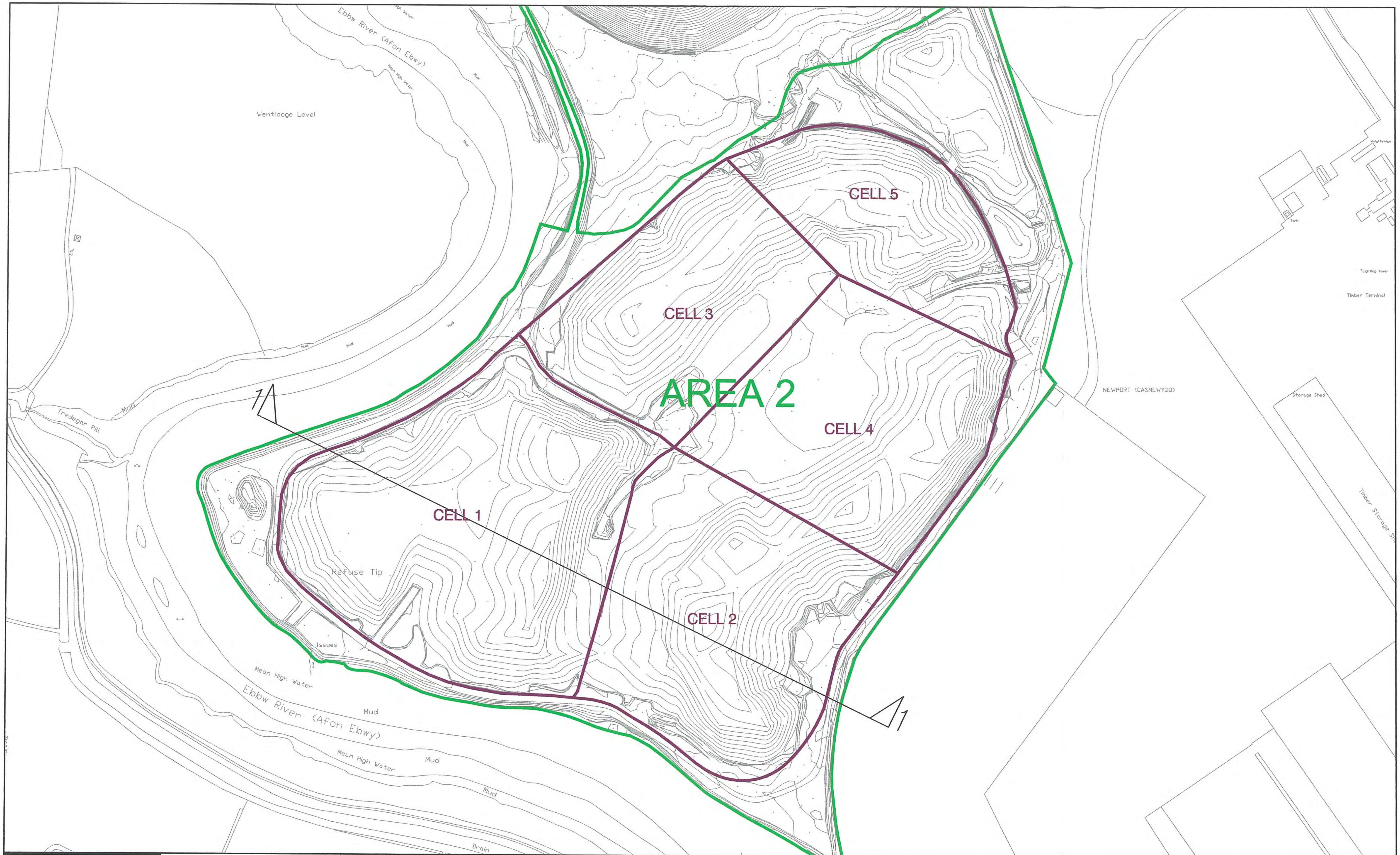

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DOCKSWAY DISPOSAL SITE

PROPOSED SITE LAYOUT AND FILLING PHASES

Date	15-10-04
A3 Scale	1:2500
Drawn	BDA
Checked	DW
Figure Number	2A

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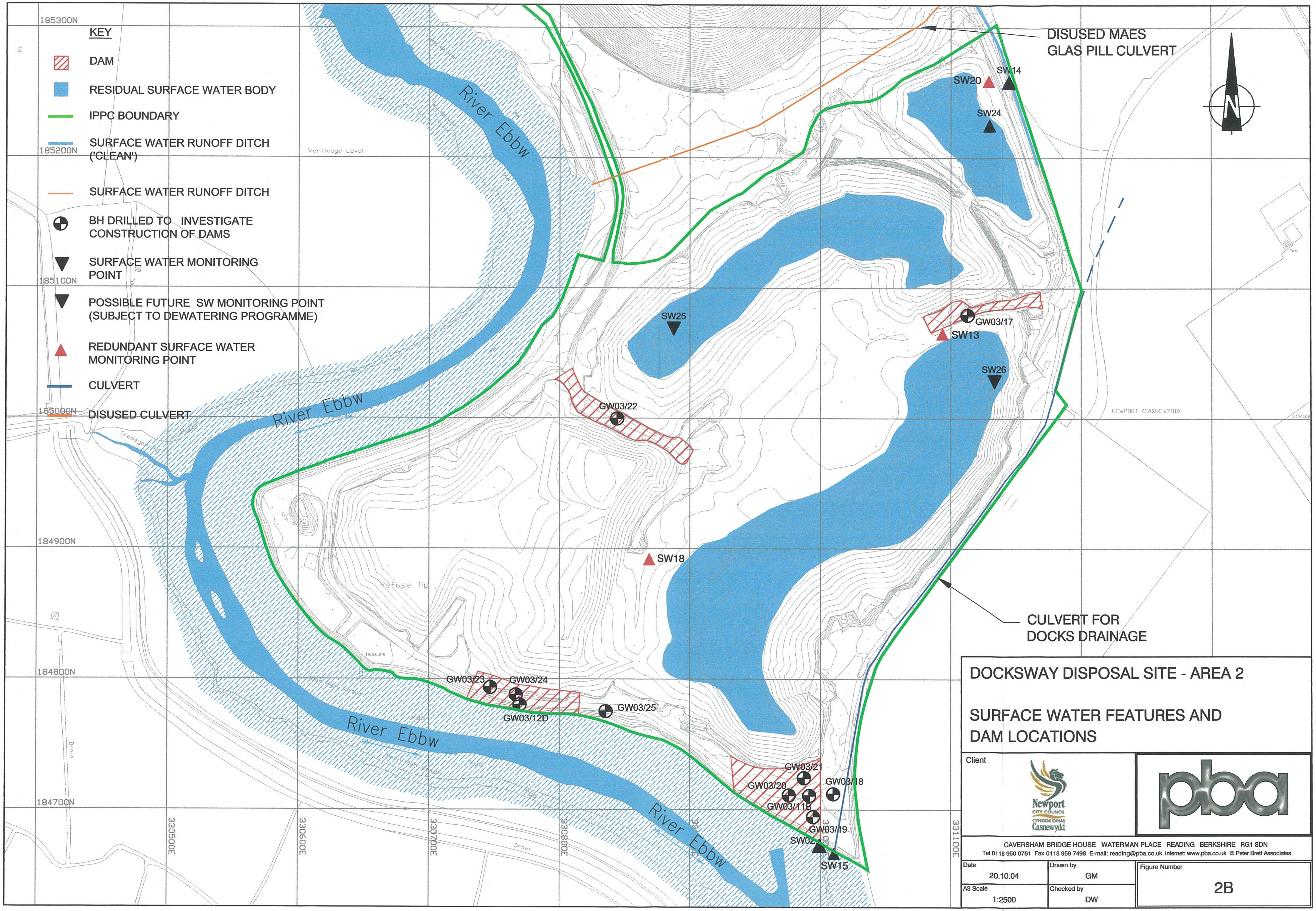

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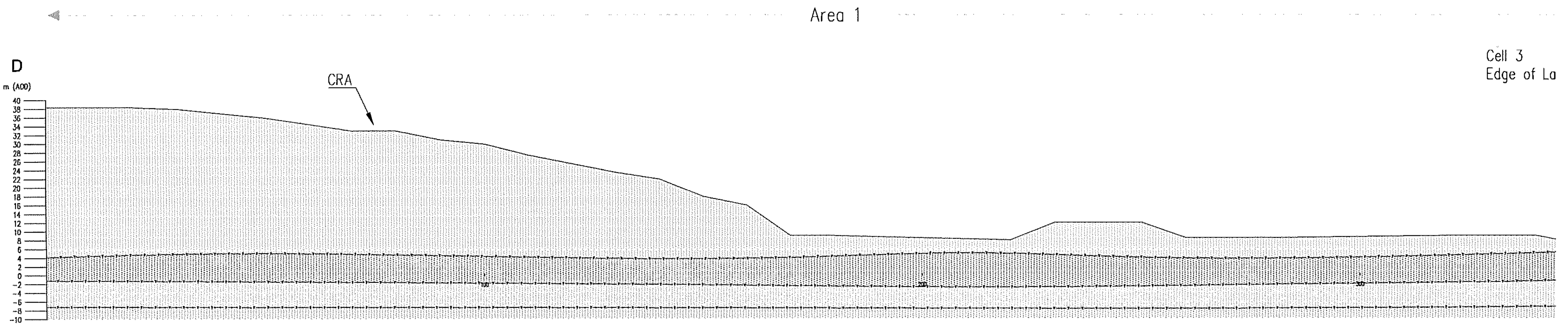
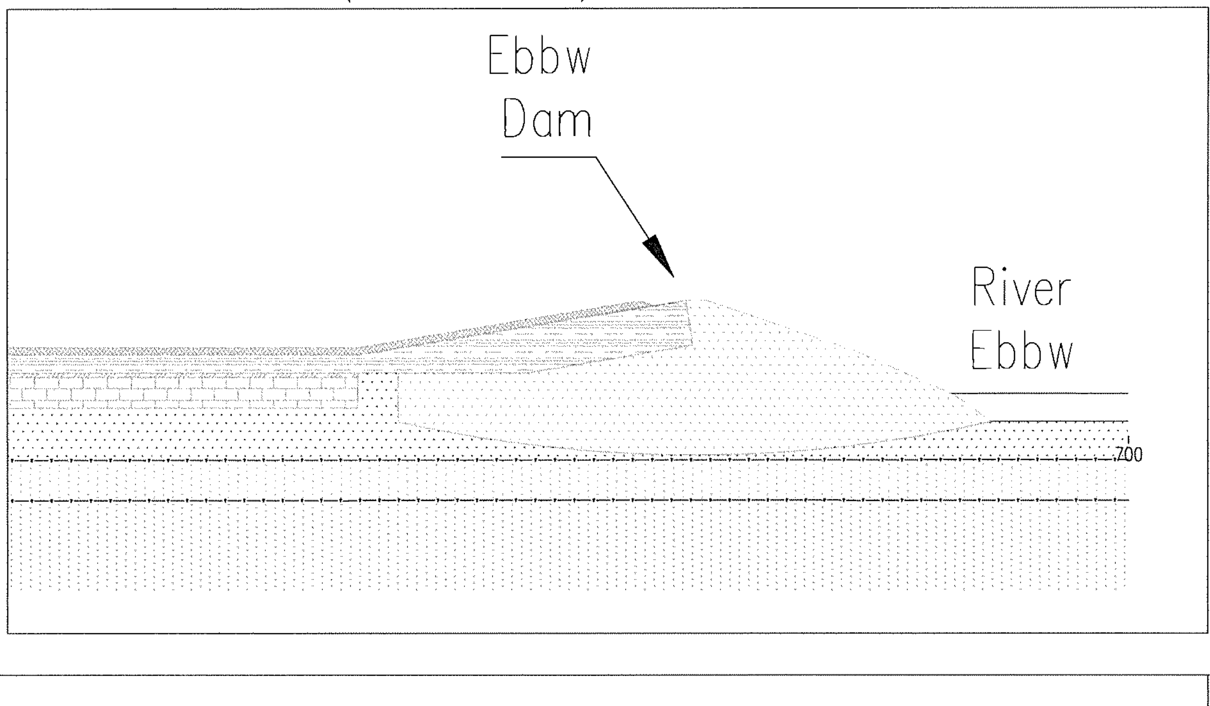
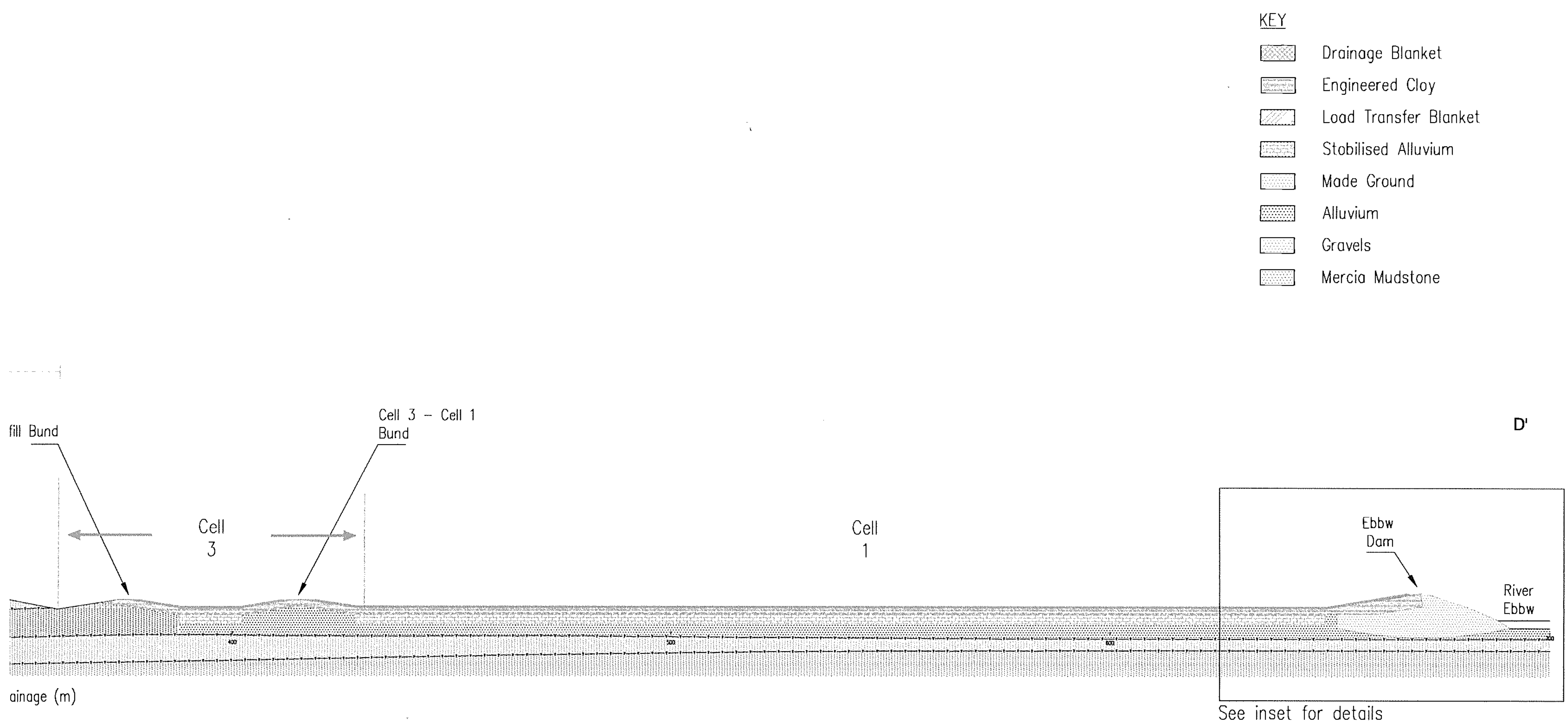


INSET OF EBBW DAM (Scale – 1:500)





Docksway Disposal Site - Area 2
Schematic Geological N-S Cross Section Showing Northern Dam & Liner Characteristics

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Date	Drawn by	Figure Number
March 2005	DJM	2C
A2 Scale: 1:1250	Checked by: JEM	

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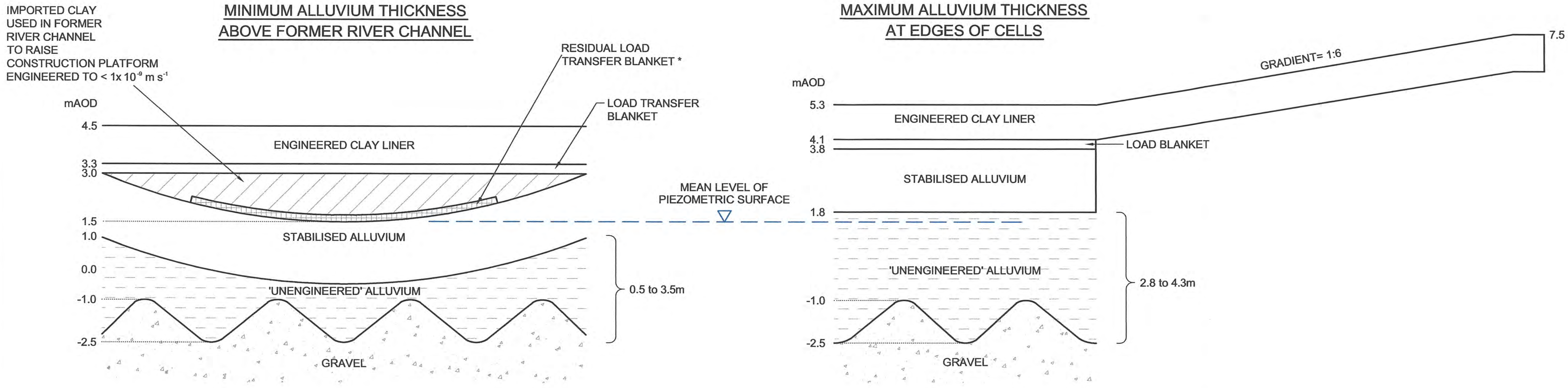

* Temporary load transfer blanket used in the former river channel prior to infilling of the channel with engineered clay in order to raise construction platform.

Client		
NEWPORT CITY COUNCIL	DOCKSWAY DISPOSAL SITE	Date: MAR. 2005
	LINER DESIGN AND ELEVATION SCHEMATIC SECTION (CELL 1)	A3 Scale: 1:125
		Drawn: DJM
		Checked: DW
		Figure Number: 2D

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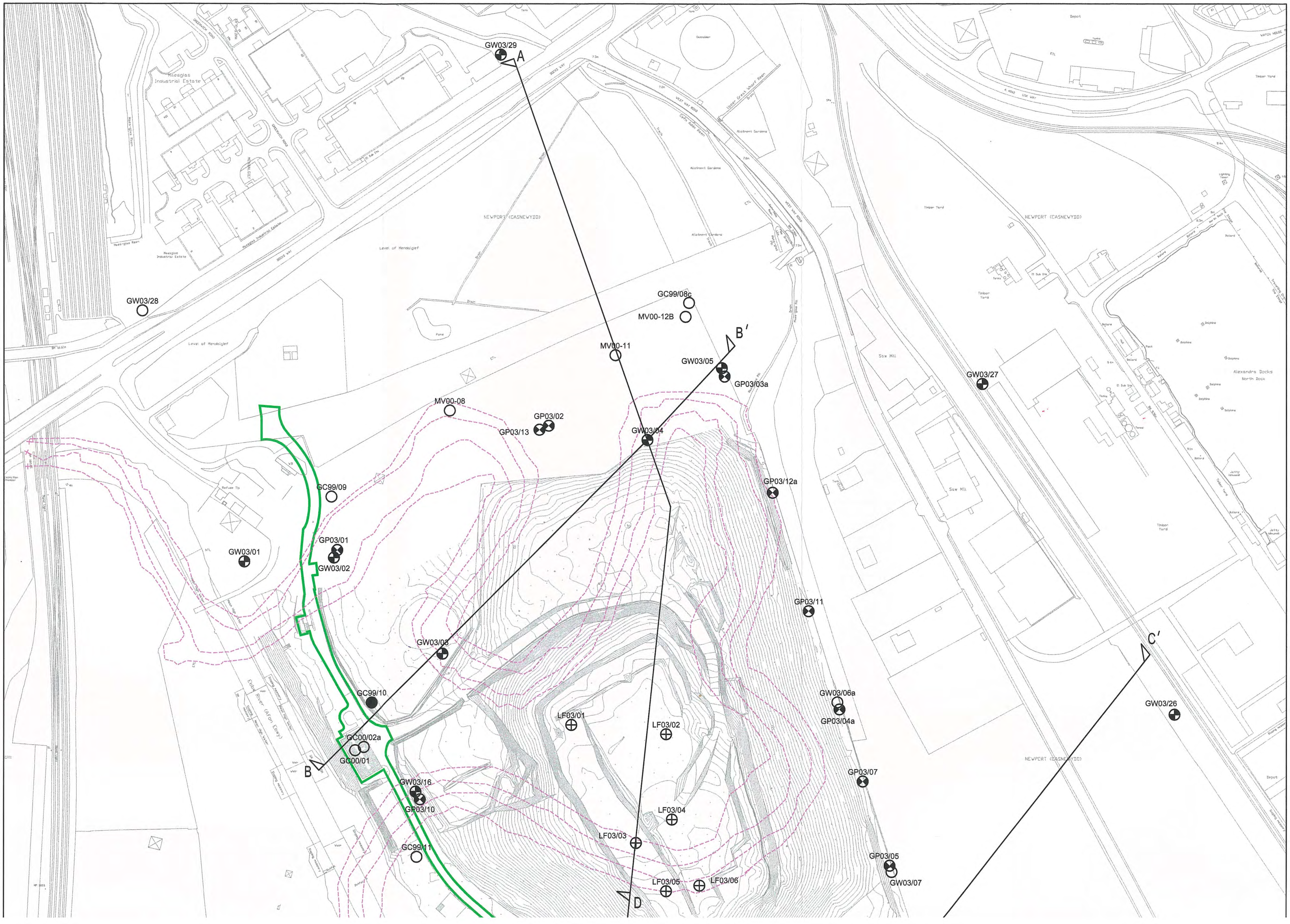
GW03/29
A
GW03/28
GC99/08c
MV00-12B
B'
MV00-11
GW03/05
GP03/03a
GW03/27
MV00-08
GP03/02
GP03/13
GW03/04
GC99/09
GP03/12a
GP03/01
GW03/01
GW03/02
GP03/11
GW03/03
C'
GC99/10
GW03/06a
GP03/04a
GW03/26
LF03/01
LF03/02
GC00/02a
GC00/01
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GW03/16
GP03/10
LF03/04
LF03/03
GC99/11
GP03/05
GW03/07
LF03/05
LF03/06
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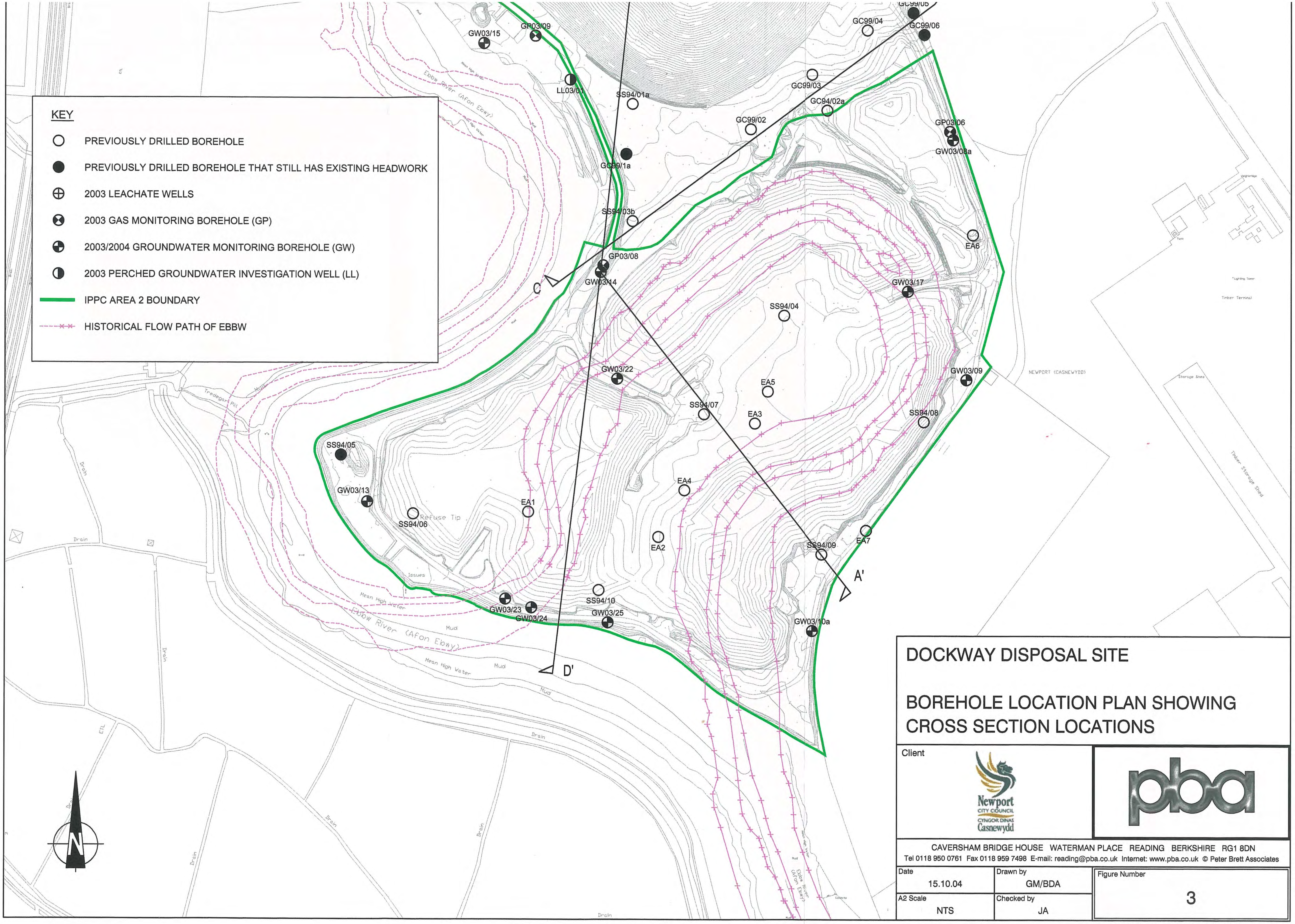
NEWPORT (CASNEWYDD)
Maesglas Industrial Estate
Level of Mendalgief
Alexandra Docks North Dock
Saw Mill
Timber Yard
Allotment Gardens
Depot



DOCKWAY DISPOSAL SITE

BOREHOLE LOCATION PLAN SHOWING CROSS SECTION LOCATIONS

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Date	Drawn by	Figure Number
15.10.04	GM/BDA	3
A2 Scale	Checked by	
NTS	JA	

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EXPLANATION OF GEOLOGICAL SYMBOLS AND COLOURS

DRIFT
Not drawn to scale

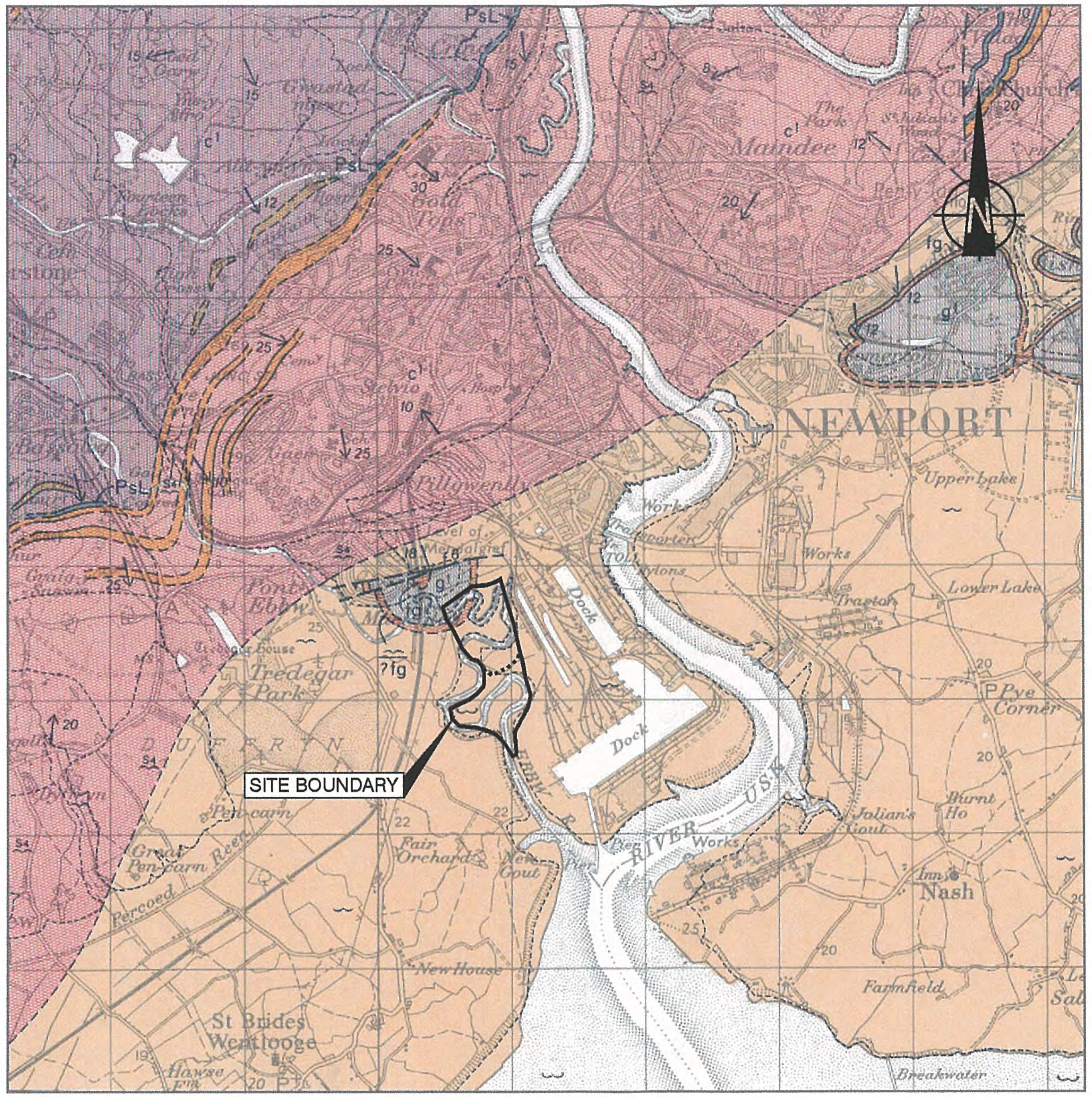
PLEISTOCENE AND RECENT

- *Peat*
- *Alluvium*
- *Alluvial Fan*
- *River Terrace Deposits, undifferentiated*
- *River Terrace Deposits correlated with Fourth (Kidderminster) Terrace of River Severn* (S4)
- *Llangibby Terrace* (Lg)
- *Marine Beach Deposits, present day or Tidal Flat*
- *Marine or Estuarine Alluvium*

SOLID
GENERALIZED VERTICAL SECTIONS
Scale: 1 cm to 40 metres

- Lower Lias Clay — g¹
- Blue Lias — g¹
- Cotham *and* Westbury beds — fg
- Keuper Marl *with* Tea Green Marl *at top* — f⁶

Unconformity



Scale: 1cm to 100 metres

Symbol	Lithology	Group	Series	System
d²	*Limestone*	Main Limestone	CARBONIFEROUS LIMESTONE SERIES	CARBONIFEROUS
d¹ᵇ⁻²	*Dolomite*	Main Limestone	CARBONIFEROUS LIMESTONE SERIES	CARBONIFEROUS
d¹ᵇ / d¹ᵃ	*Mudstone* / *Limestone*	Lower Limestone Shale	CARBONIFEROUS LIMESTONE SERIES	CARBONIFEROUS
c³	*Quartz conglomerate*		UPPER	OLD RED SANDSTONE
	Unconformity			
c¹	*Sandstone*	Brownstone Group	LOWER	OLD RED SANDSTONE
	Ruperra Limestone (RuL)	St. Maughan's Group	DITTON SERIES	OLD RED SANDSTONE
c¹	*Sandstone*	St. Maughan's Group	DITTON SERIES	OLD RED SANDSTONE
	Sandstone	St. Maughan's Group	DITTON SERIES	OLD RED SANDSTONE
	'Psammosteus' Limestone (PsL)			OLD RED SANDSTONE
	Limestone	Raglan Marl Group	DOWNTON SERIES	OLD RED SANDSTONE
c¹	*Sandstone*	Raglan Marl Group	DOWNTON SERIES	OLD RED SANDSTONE
	Sandstone	Raglan Marl Group	DOWNTON SERIES	OLD RED SANDSTONE
c⁰	Downton Castle Sandstone *with* Ludlow Bone Bed *at base*		DOWNTON SERIES	OLD RED SANDSTONE
b⁷ᶜ	Whitcliffe *and* Leintwardine beds		LUDLOW SERIES	SILURIAN
b⁷ᵇ	Upper Bringewood Beds (Aymestry Limestone)		LUDLOW SERIES	SILURIAN
b⁷ᵃ	Lower Bringewood Beds *and* Elton Beds		LUDLOW SERIES	SILURIAN
b⁶ᶜ	Wenlock Limestone		WENLOCK SERIES	SILURIAN
b⁶ᵇ	Wenlock Shale		WENLOCK SERIES	SILURIAN

Client

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DOCKSWAY DISPOSAL SITE

EXTRACT OF GEOLOGICAL MAP

Date	15-10-04
A3 Scale	1:50,000
Drawn	BDA
Checked	DW
Figure Number	4A

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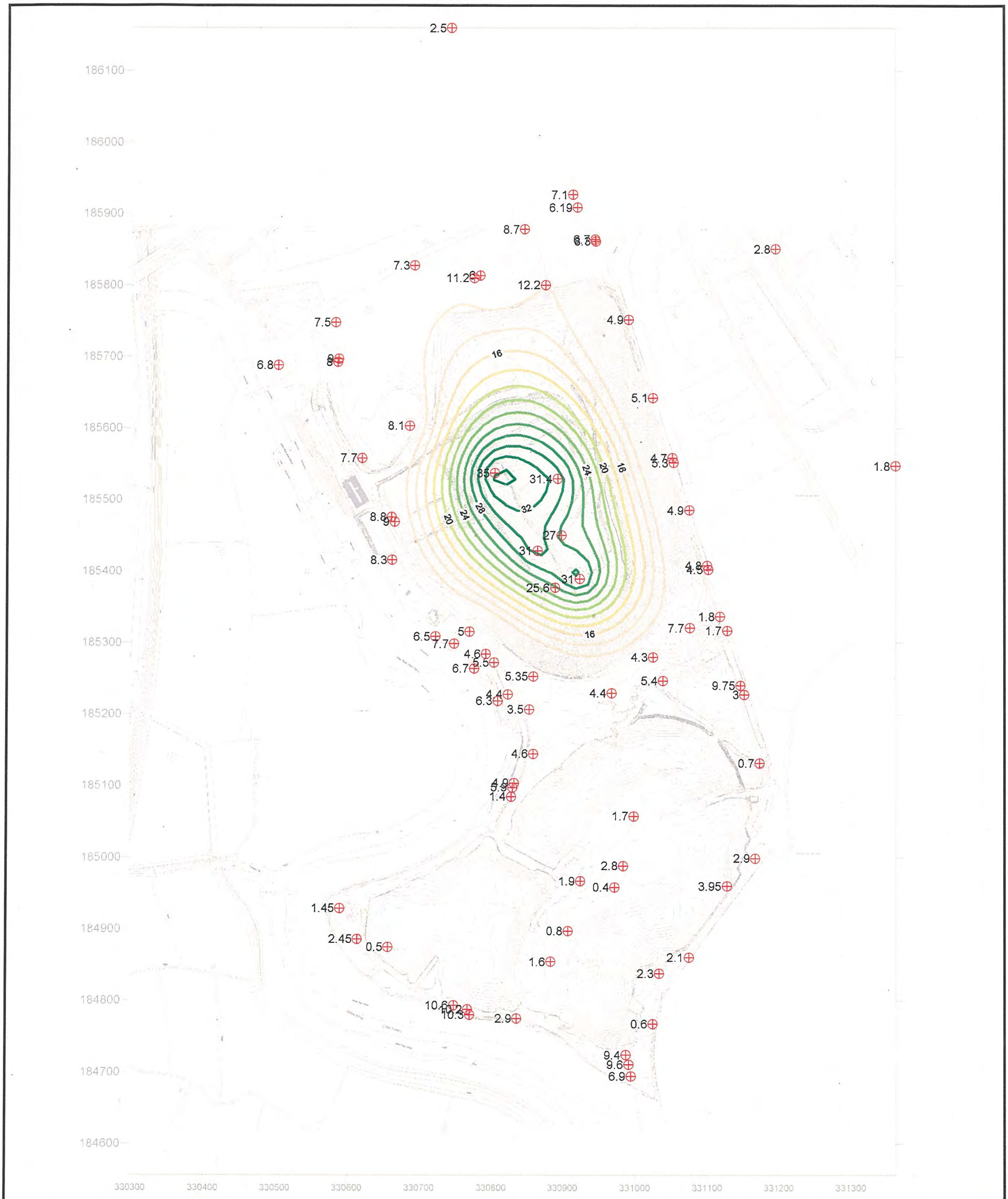

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Cyngor Dinas Casnewydd

DOCKSWAY DISPOSAL SITE

PLOT SHOWING THICKNESS OF MADE GROUND

Date	15-10-04
A4 Scale	NTS
Drawn	BDA
Checked	DW
Figure Number	4B

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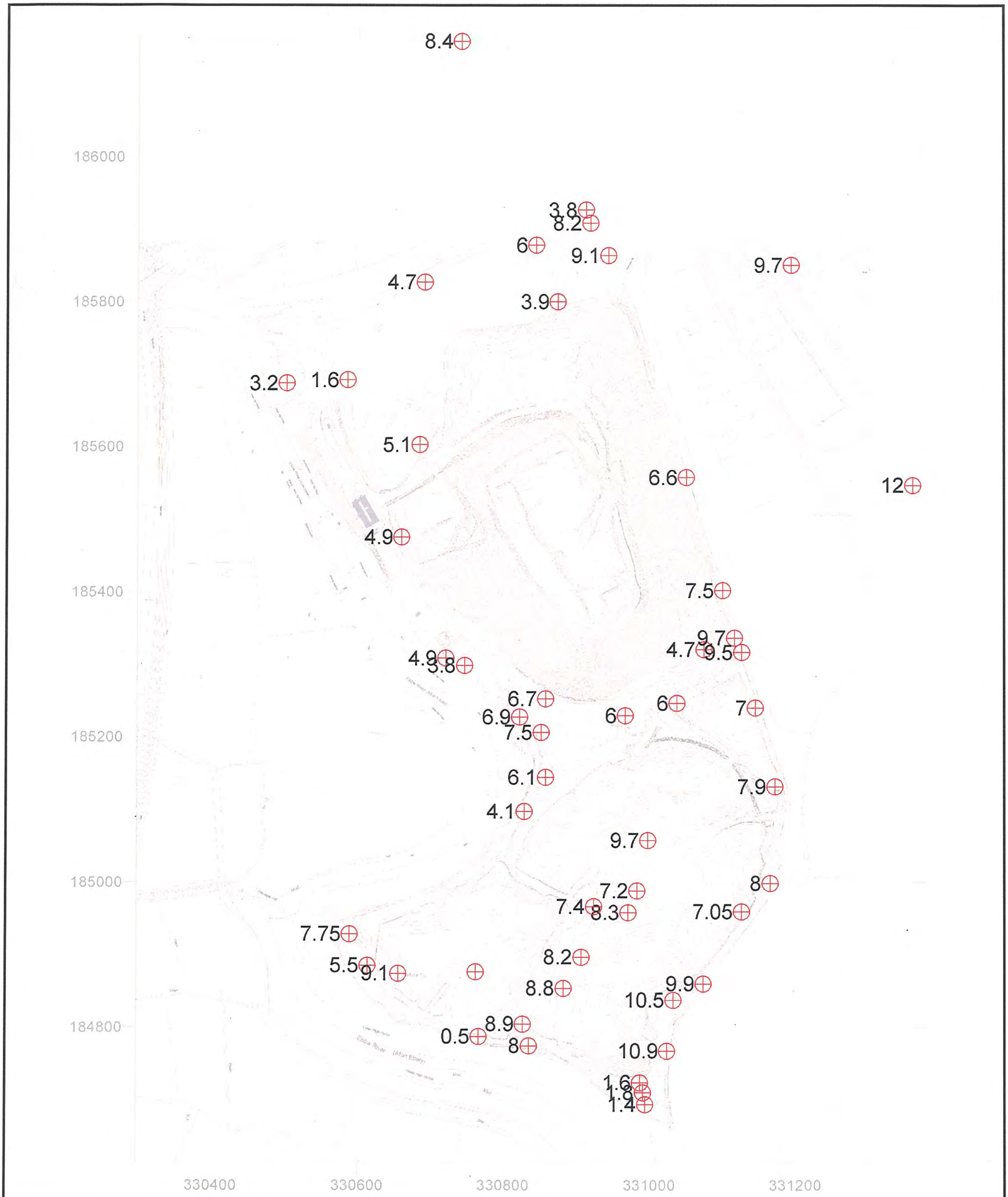

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CITY COUNCIL
CYNGOR DINAS
Casnewydd

DOCKSWAY DISPOSAL SITE

PLOT SHOWING THICKNESS OF ALLUVIAL CLAYS

Date	15-10-04
A4 Scale	NTS
Drawn	BDA
Checked	DW
Figure Number	4C

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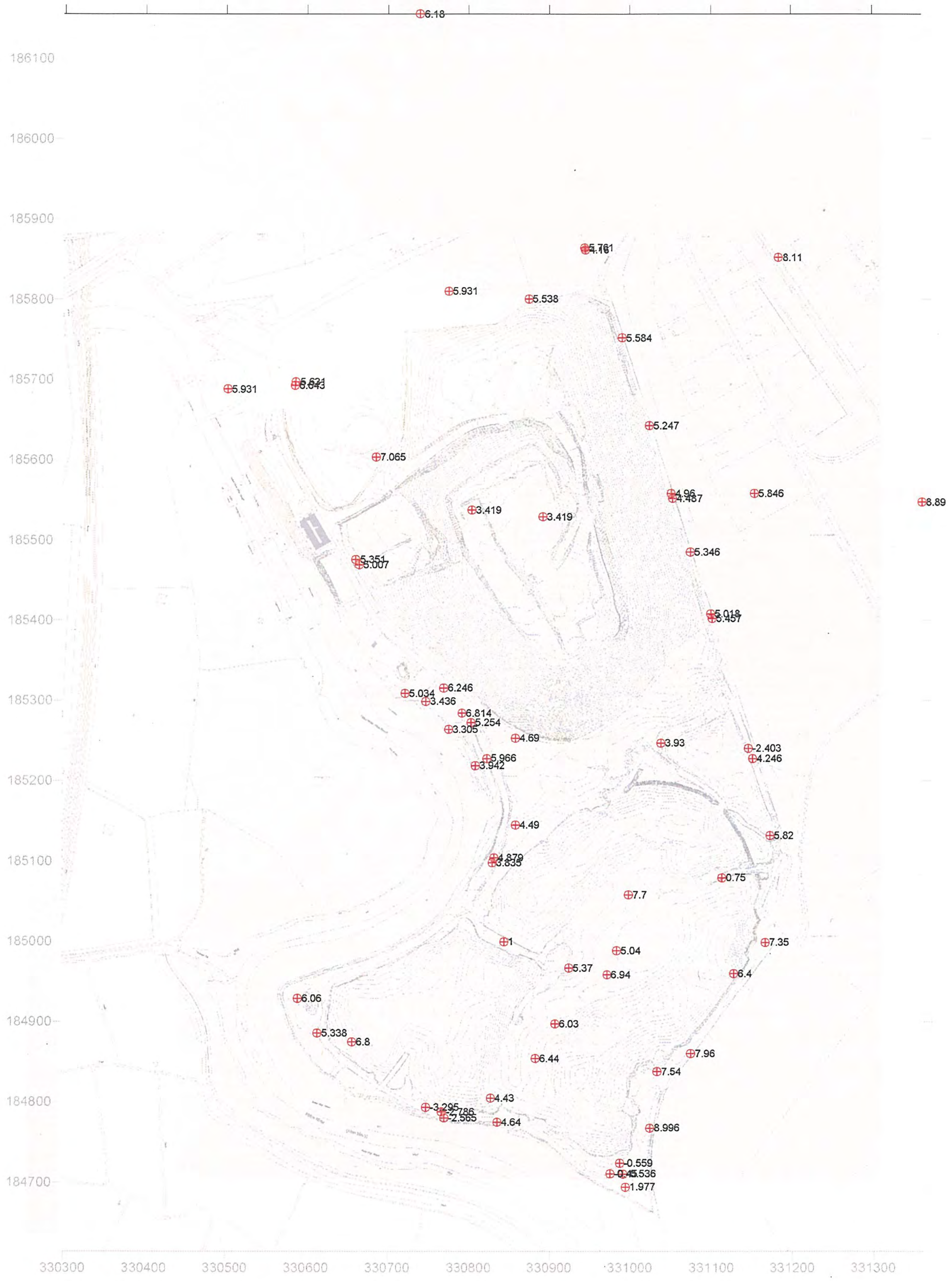

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DOCKSWAY DISPOSAL SITE

SPOT HEIGHTS FOR ELEVATION OF BASE OF MADE GROUND

Date	15-10-04
A4 Scale	NTS
Drawn	BDA
Checked	DW
Figure Number	4D

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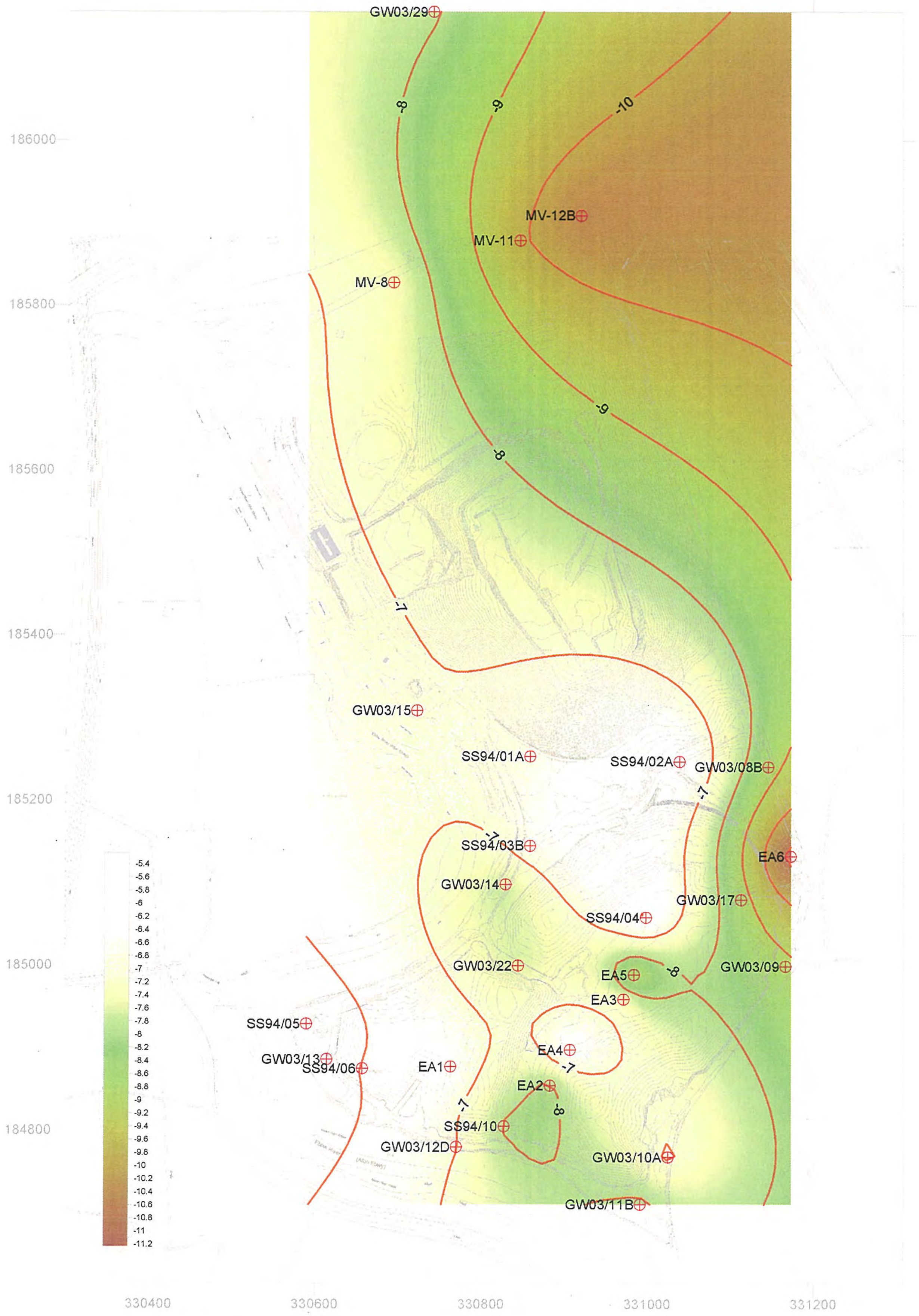

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DOCKSWAY DISPOSAL SITE

INTERPRETIVE CONTOUR PLOT SHOWING ELEVATION OF BASE OF GRAVEL DEPOSITS

Date	15-10-04
A4 Scale	NTS
Drawn	BDA
Checked	DW
Figure Number	4F

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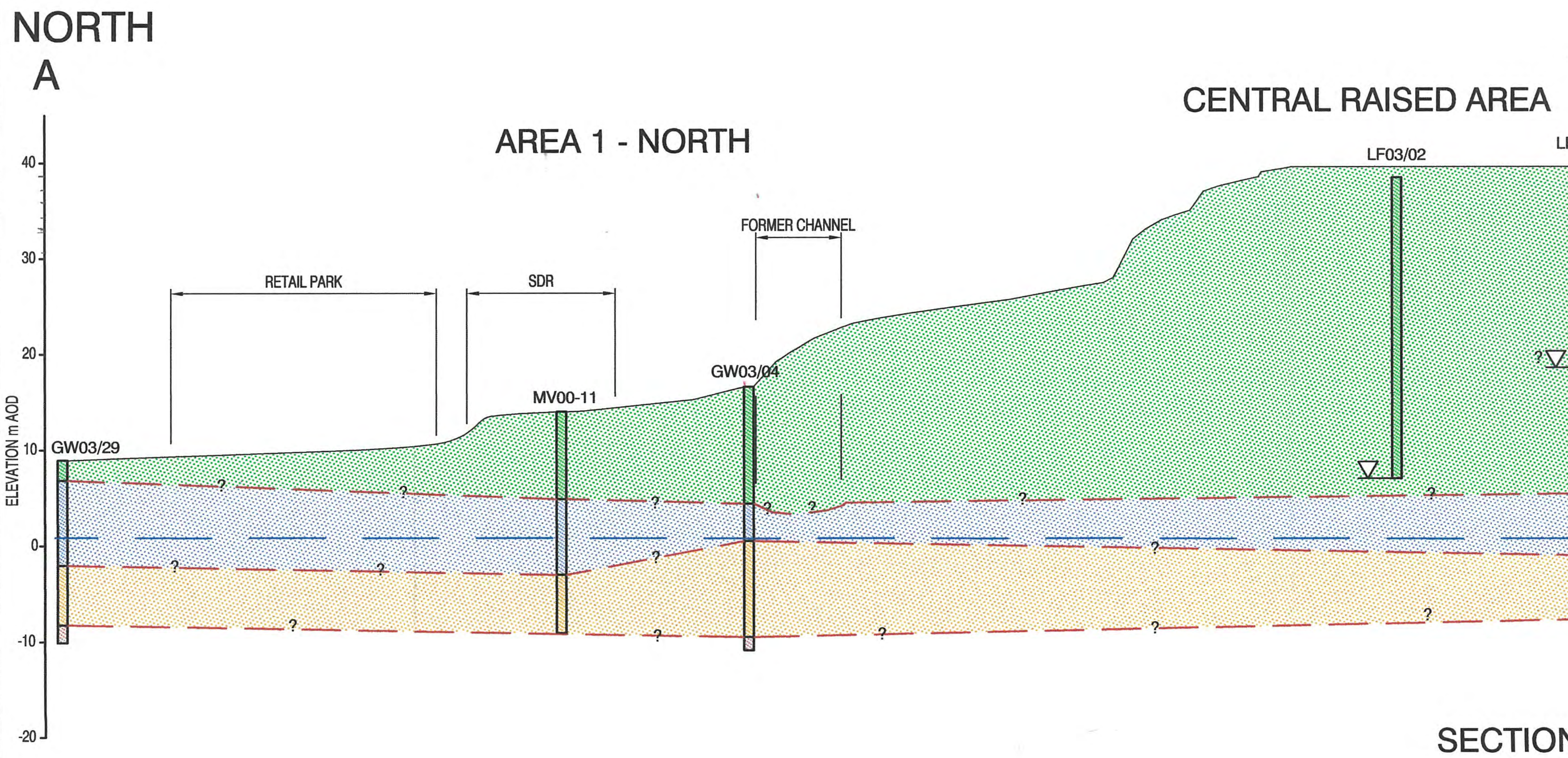
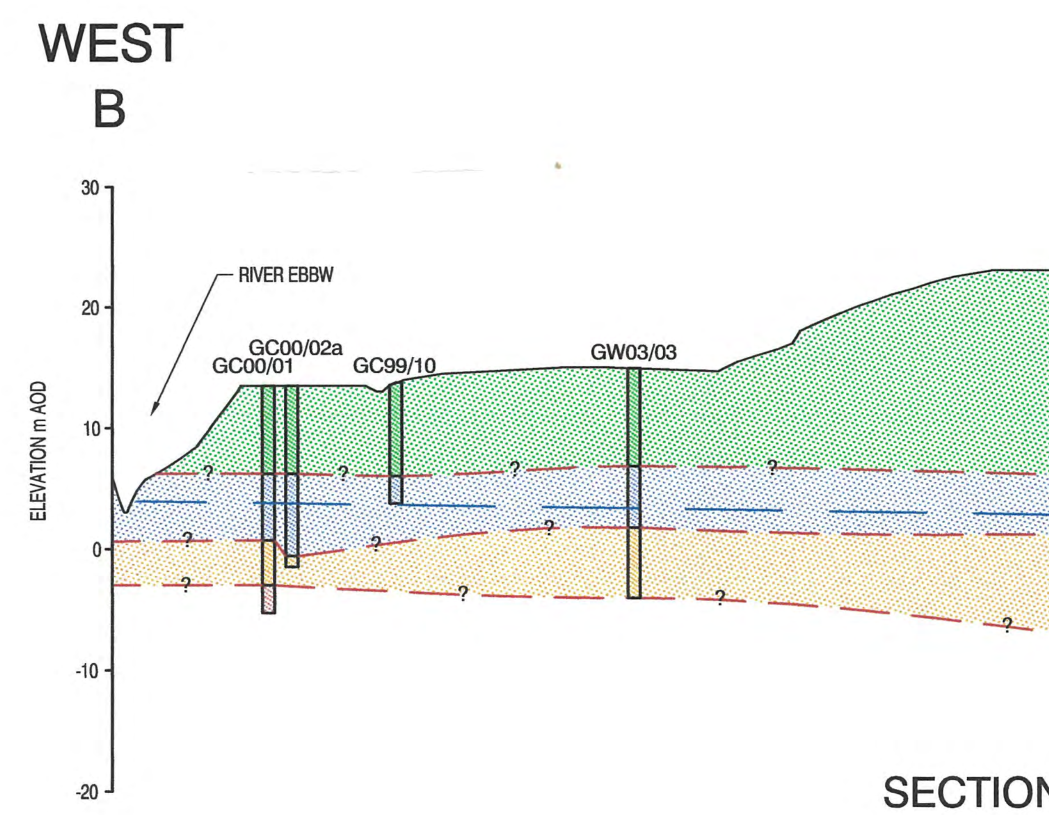
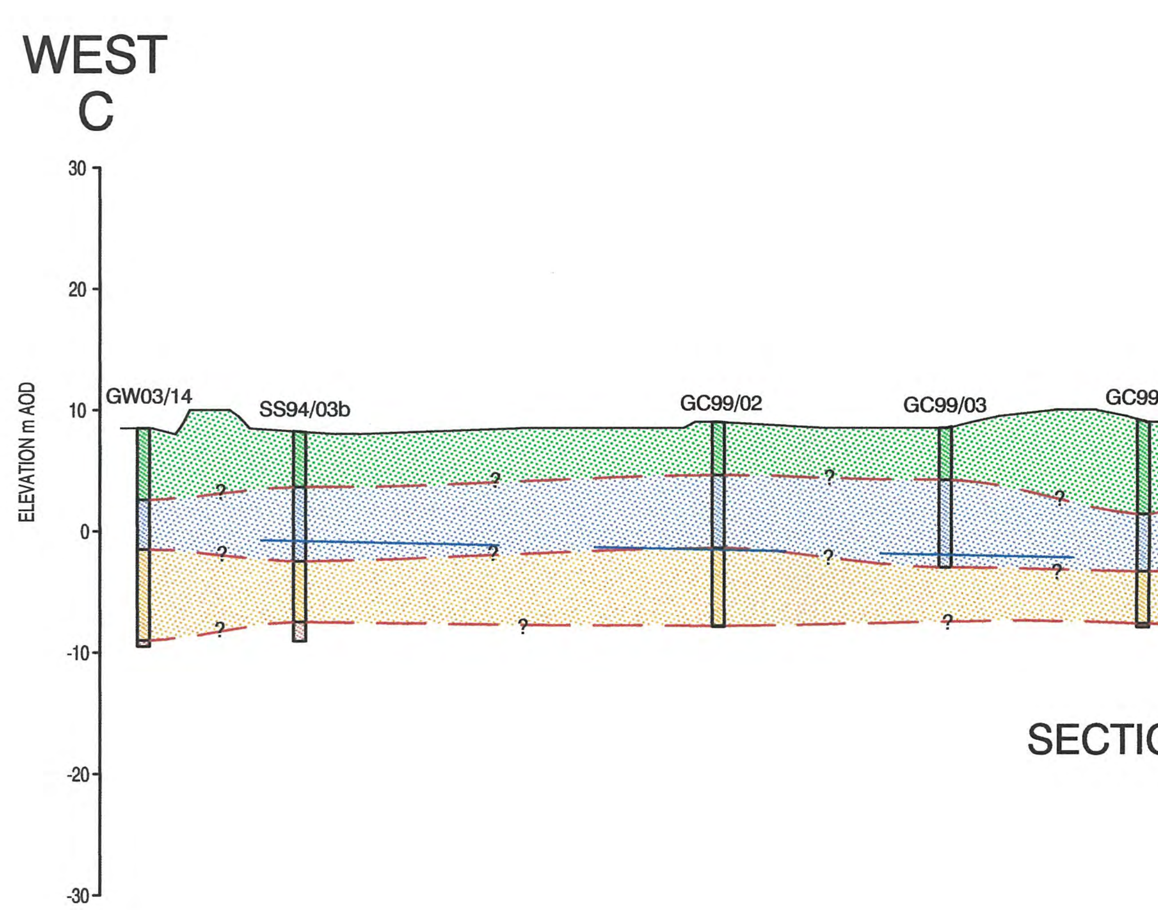

NORTH
A
AREA 1 - NORTH
CENTRAL RAISED AREA
ELEVATION m AOD
40
30
20
10
0
-10
-20
RETAIL PARK
SDR
FORMER CHANNEL
GW03/29
MV00-11
GW03/04
LF03/02
SECTION


WEST
B
ELEVATION m AOD
30
20
10
0
-10
-20
RIVER EBBW
GC00/02a
GC00/01
GC99/10
GW03/03
SECTION


WEST
C
ELEVATION m AOD
30
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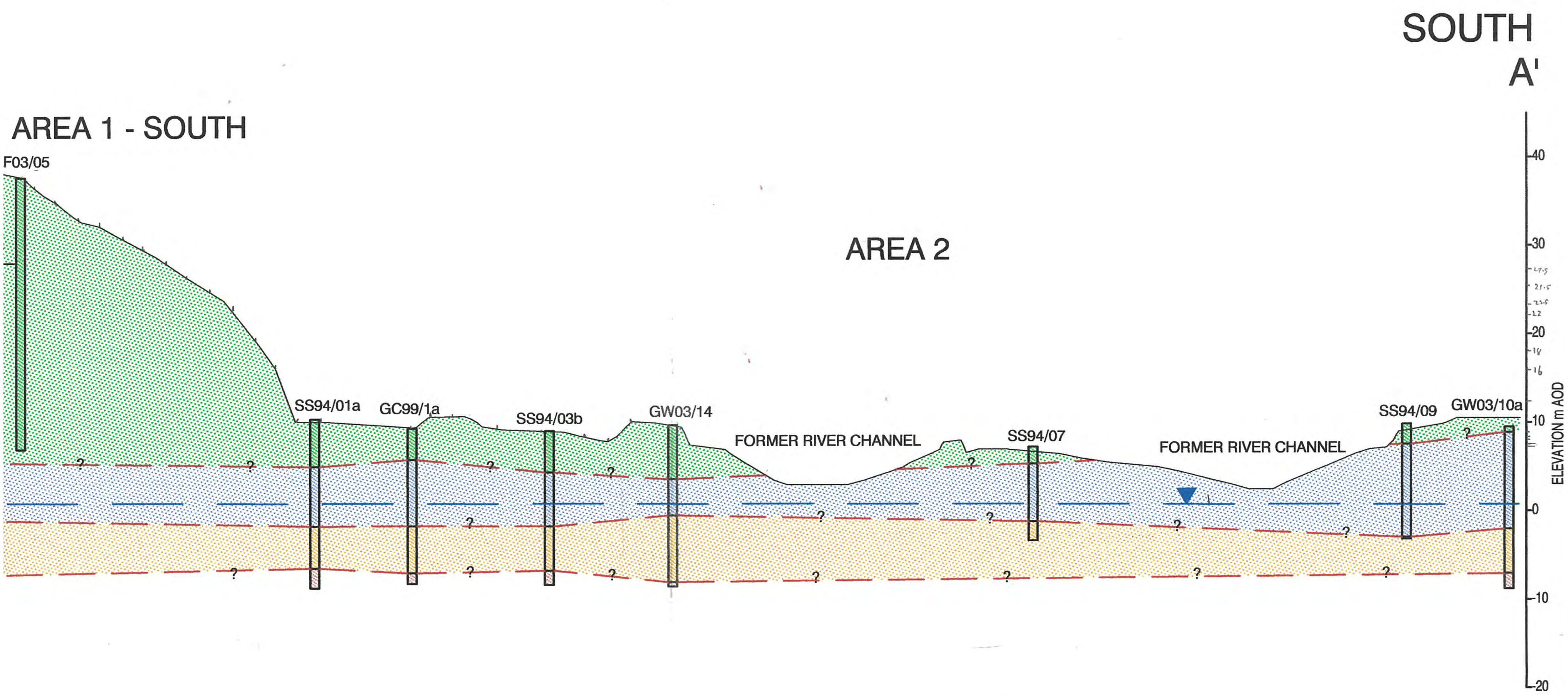
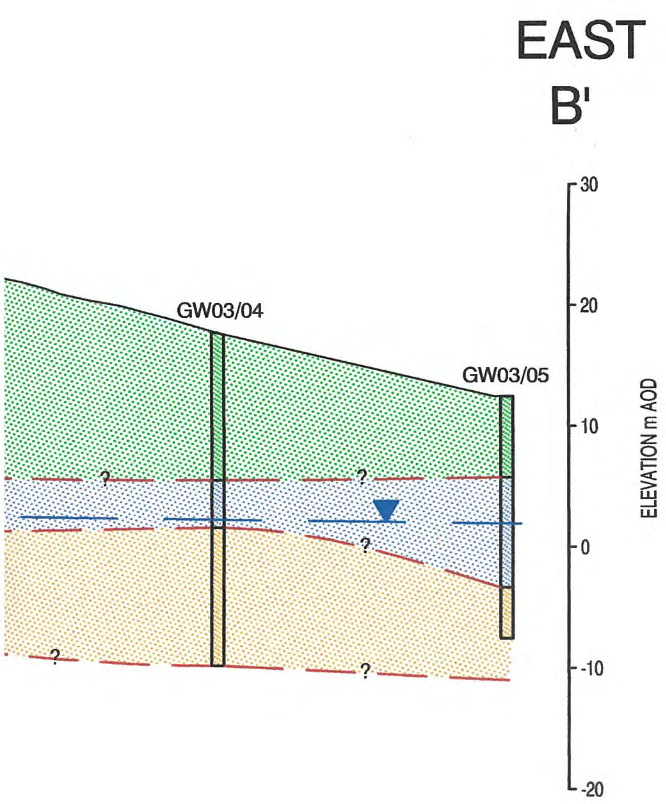
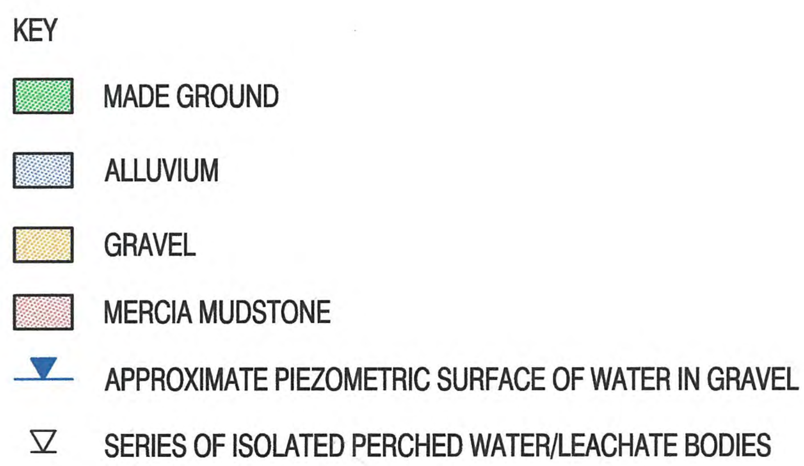
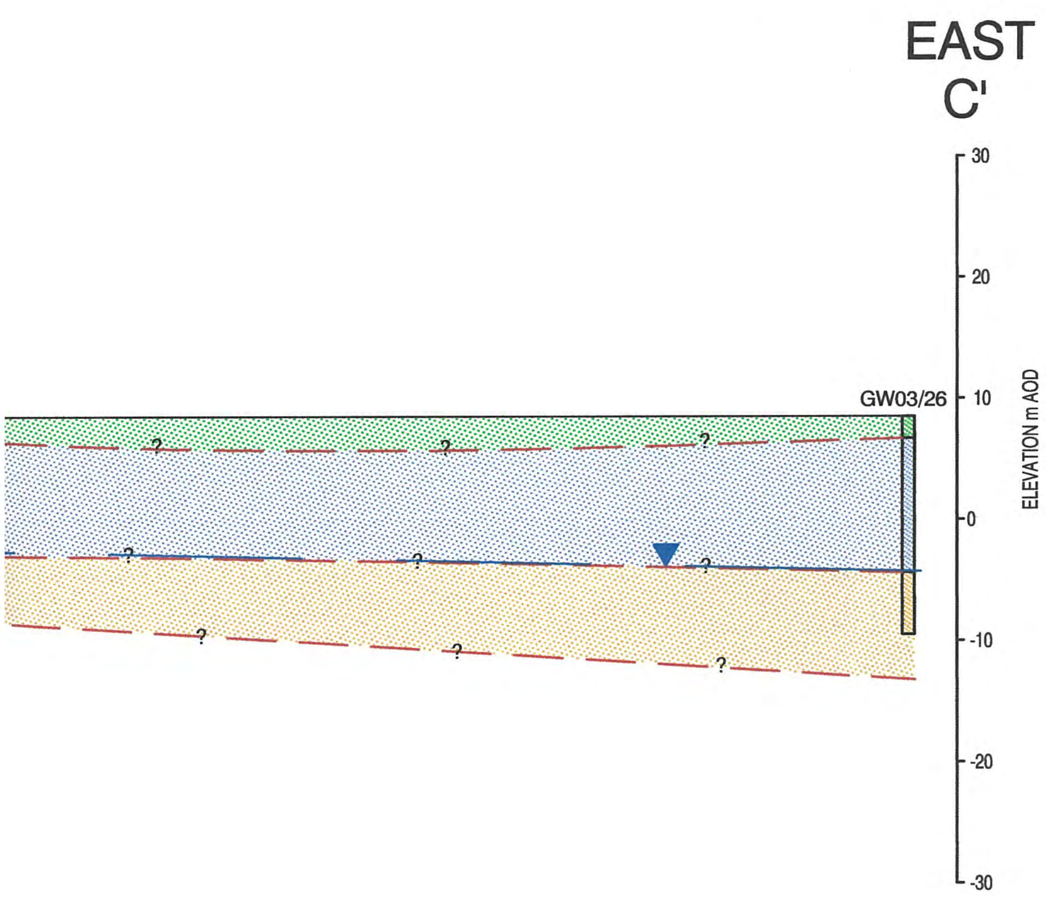
-20
-30
GW03/14
SS94/03b
GC99/02
GC99/03
SECTIO









DOCKSWAY DISPOSAL SITE
NEWPORT
SCHEMATIC GEOLOGICAL CROSS SECTIONS

Client: Newport City Council / Cyngor Dinas Casnewydd

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Date	Drawn by	Figure Number
15-10-04	BDA	5
A2 Scale: H = 1:2500 V = 1:625	Checked by: DW	

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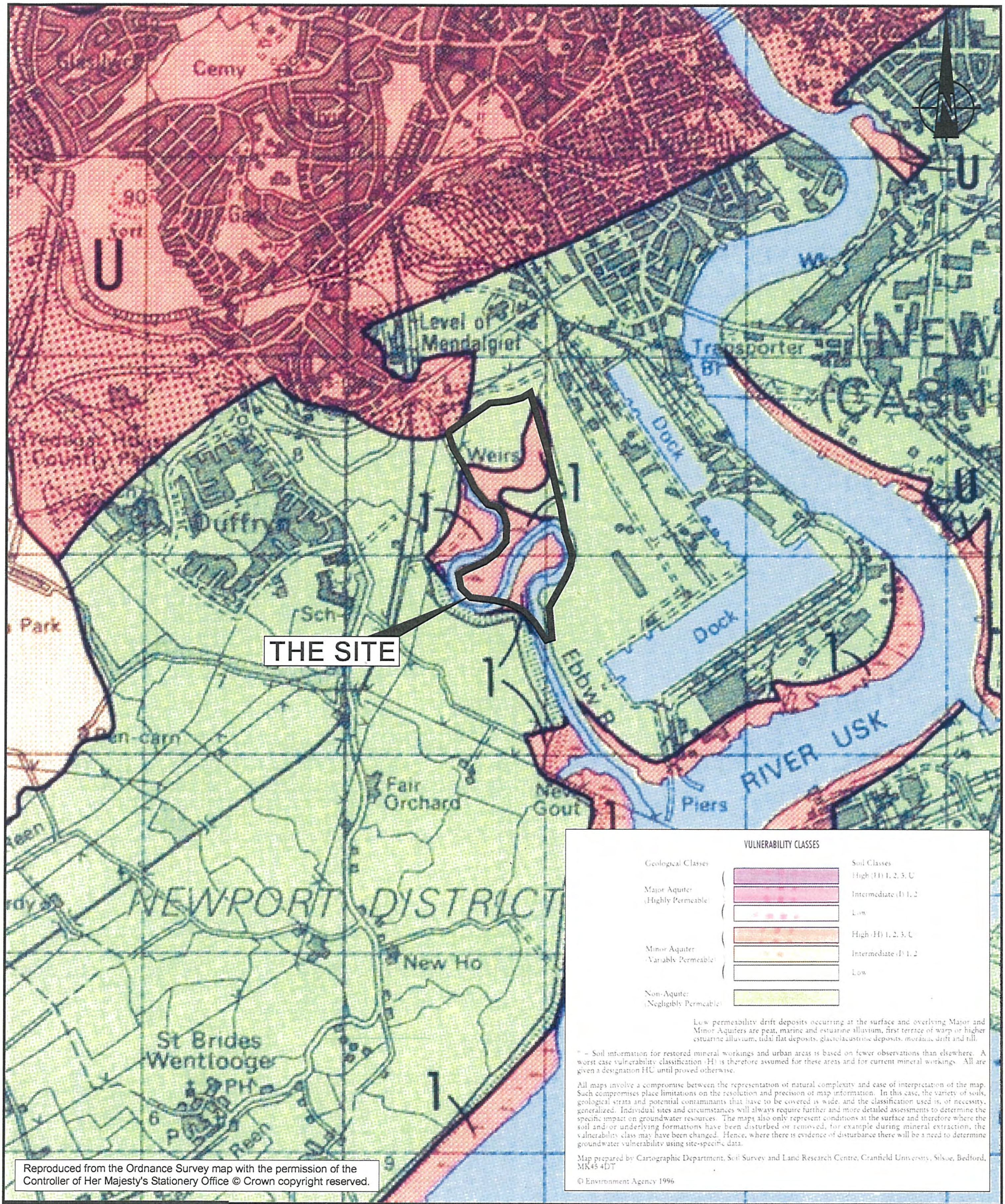

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DOCKSWAY DISPOSAL SITE, NEWPORT

EXTRACT OF GROUNDWATER VULNERABILITY MAP

Date	15-10-04
A4 Scale	1:25,000
Drawn	BDA
Checked	DW
Figure Number	6

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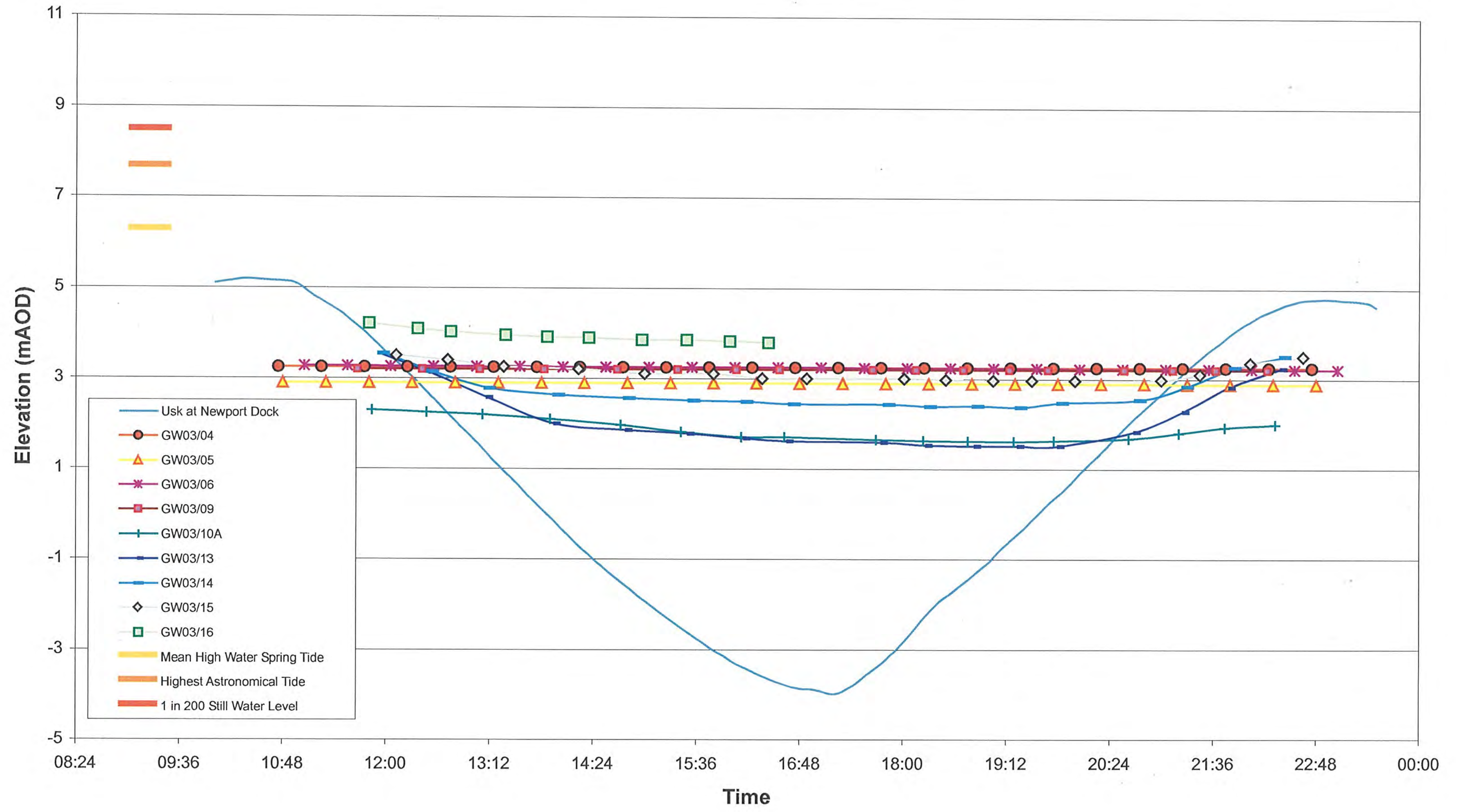

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Docksway Disposal Site,
Newport

Tidal Monitoring - Gravel Groundwater Levels on 13/01/04
(Low Spring Tidal Cycle)

Date	OCT. 04
A4 Scale	AS SHOWN
Drawn	GM
Checked	JA
Figure Number	7A

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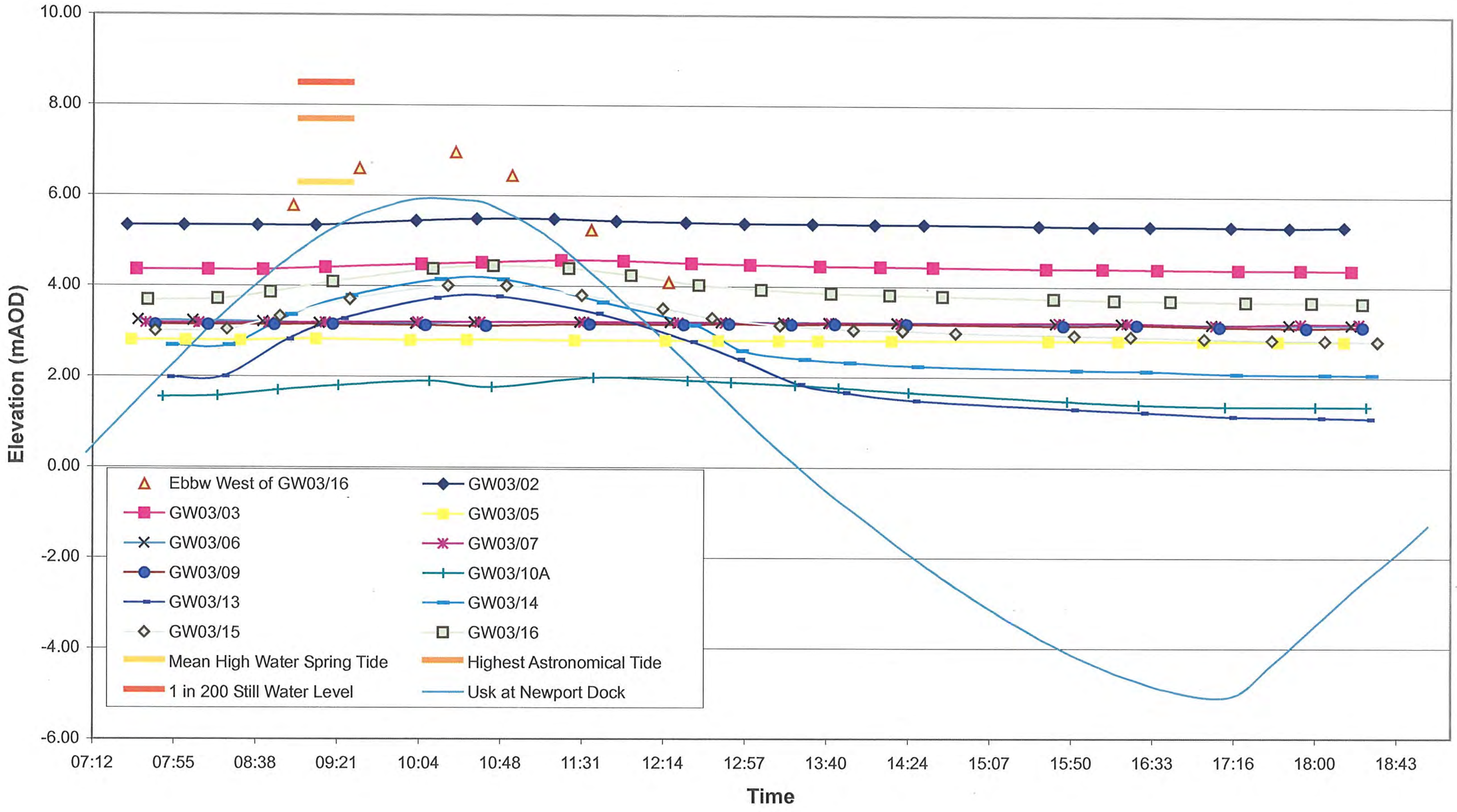

pba	Client: Newport City Council / Cyngor Dinas Casnewydd	Date: OCT. 04
		A4 Scale: AS SHOWN
		Drawn: GM
		Checked: JA

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Docksway Disposal Site,
Newport

Tidal Monitoring - Gravel Groundwater Levels on 26/01/04
(High Spring Tidal Cycle)

Figure Number
7B

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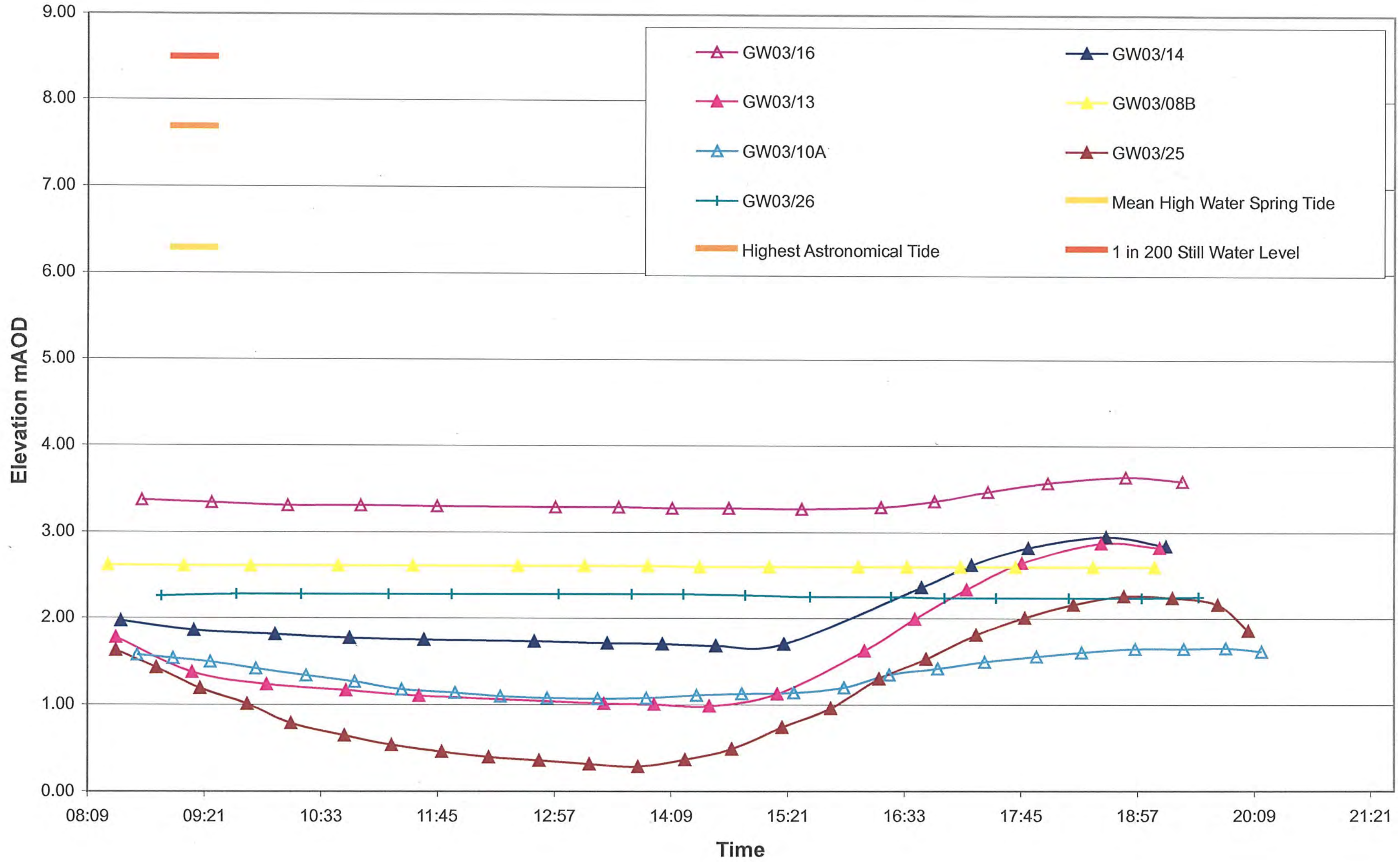

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Docksway Disposal Site,
Newport

Tidal Monitoring - Groundwater Levels on 14/07/04
(Neap Tidal Cycle)

Date	OCT. 04
A4 Scale	AS SHOWN
Drawn	GM
Checked	JA
Figure Number	7C

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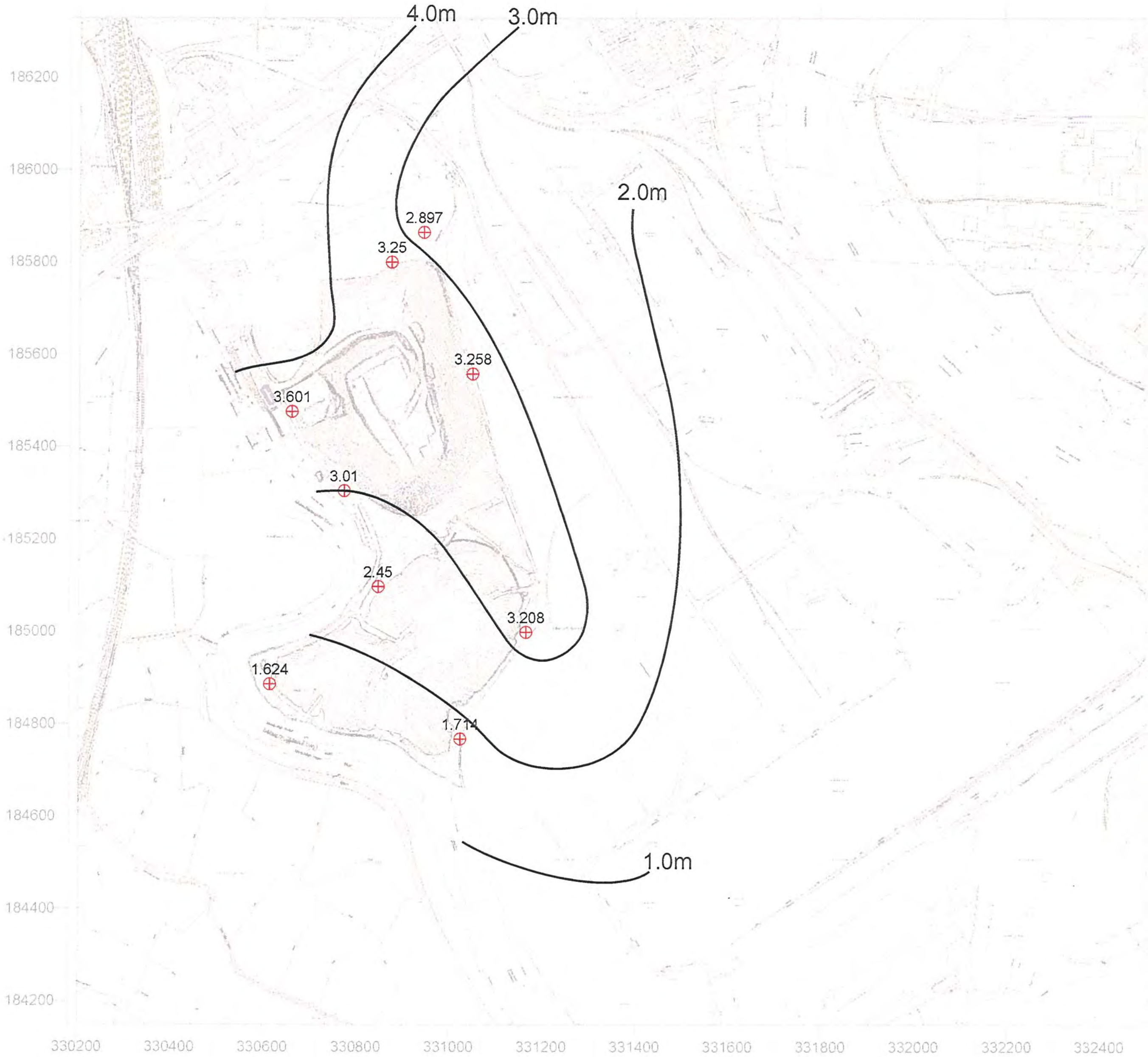

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Docksway Disposal Site

Interpretive Groundwater Elevation Contour Plot for Gravel Deposits - 13/01/2004 (Low Tide) [Low Spring Tidal Cycle]

Date	15-10-04
A4 Scale	N/A
Drawn	BDA
Checked	JA
Figure Number	8A

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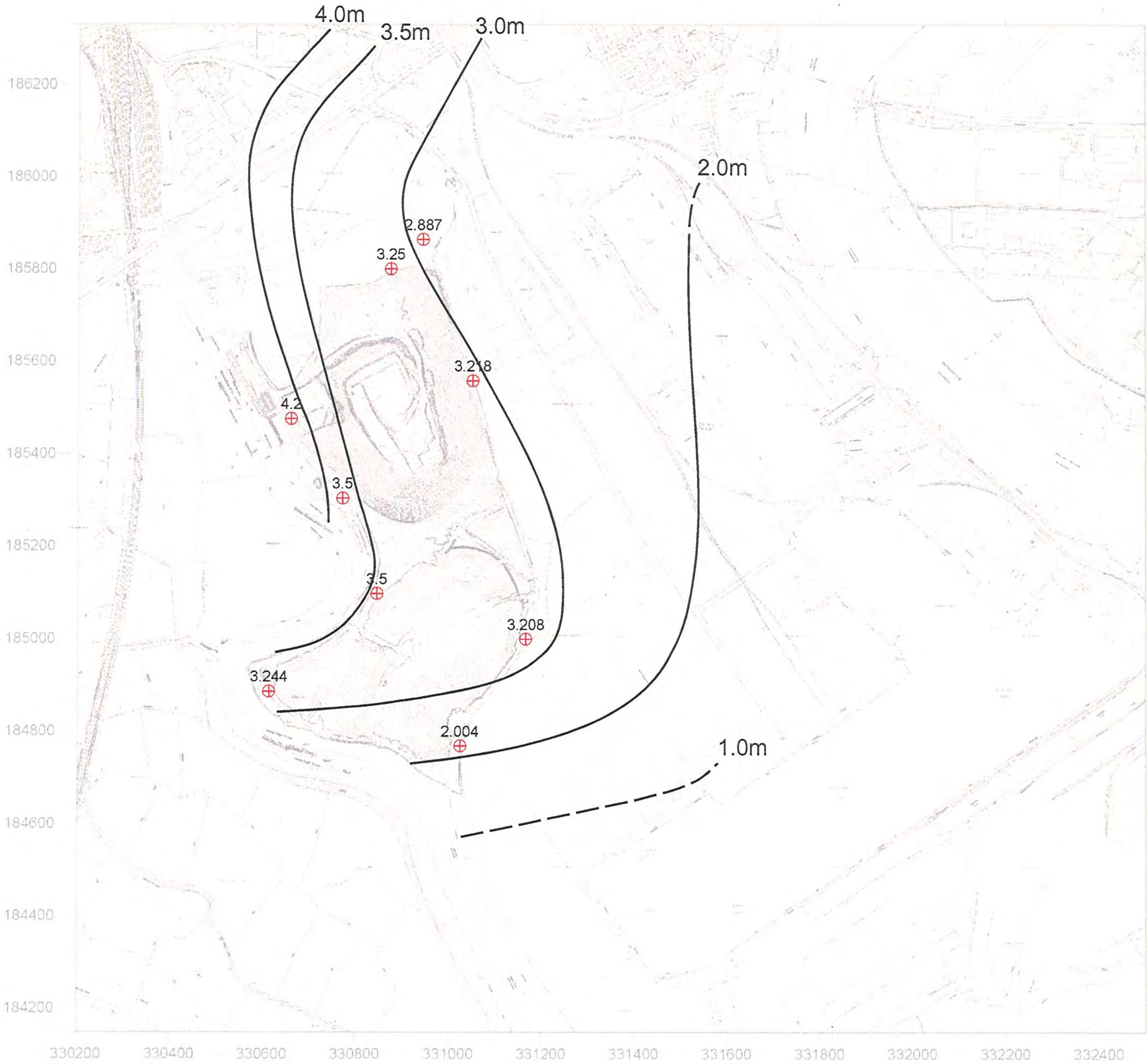

Client

Newport City Council
Cyngor Dinas Casnewydd

Docksway Disposal Site

Interpretive Groundwater Elevation Contour Plot for Gravel Deposits - 13/01/2004 (High Tide) [Low Spring Tidal Cycle]

Date	15-10-04
A4 Scale	N/A
Drawn	BDA
Checked	JA
Figure Number	8B

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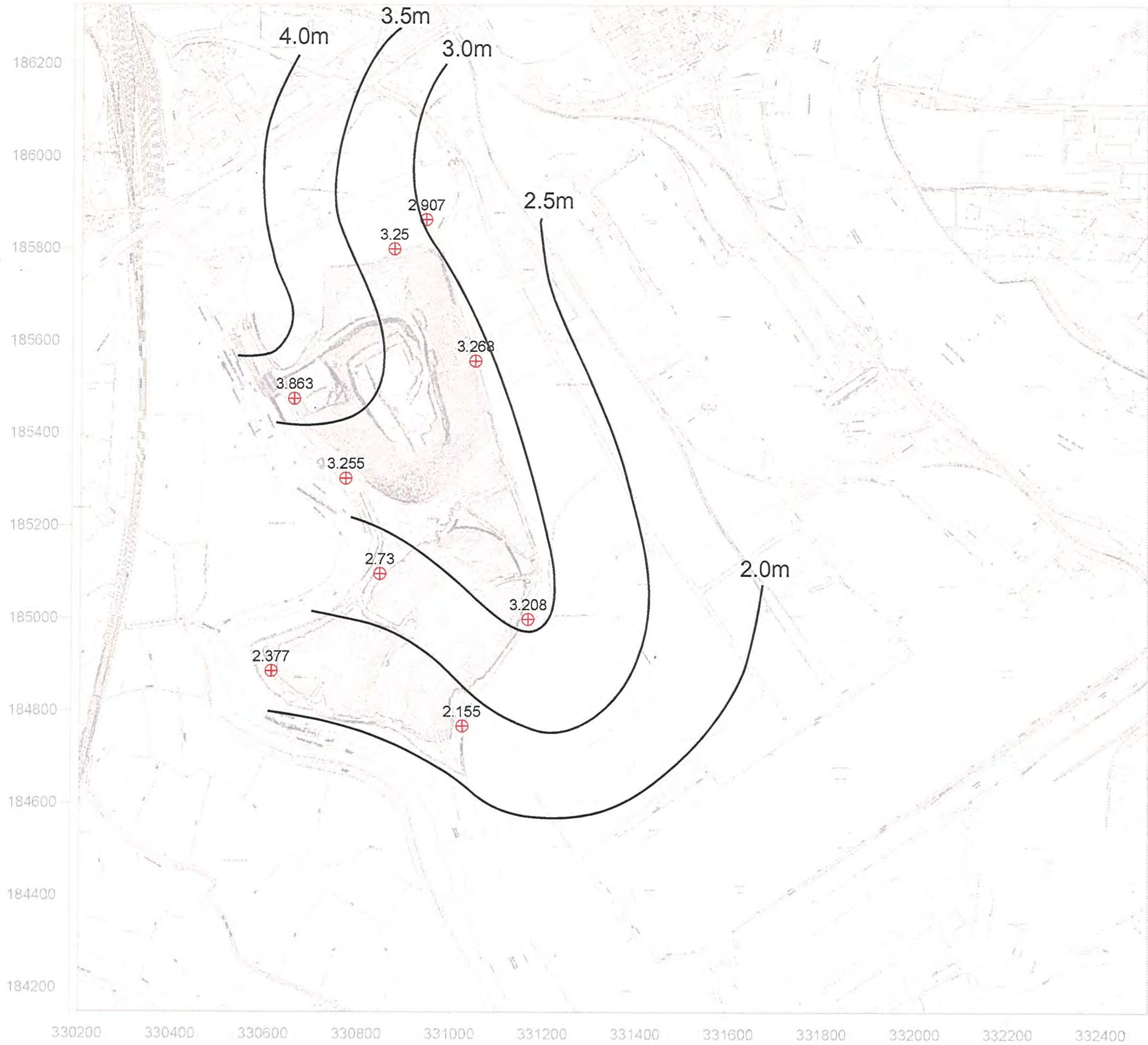
email: reading@pba.co.uk internet: www.pba.co.uk



pba

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email: reading@pba.co.uk internet: www.pba.co.uk

Client

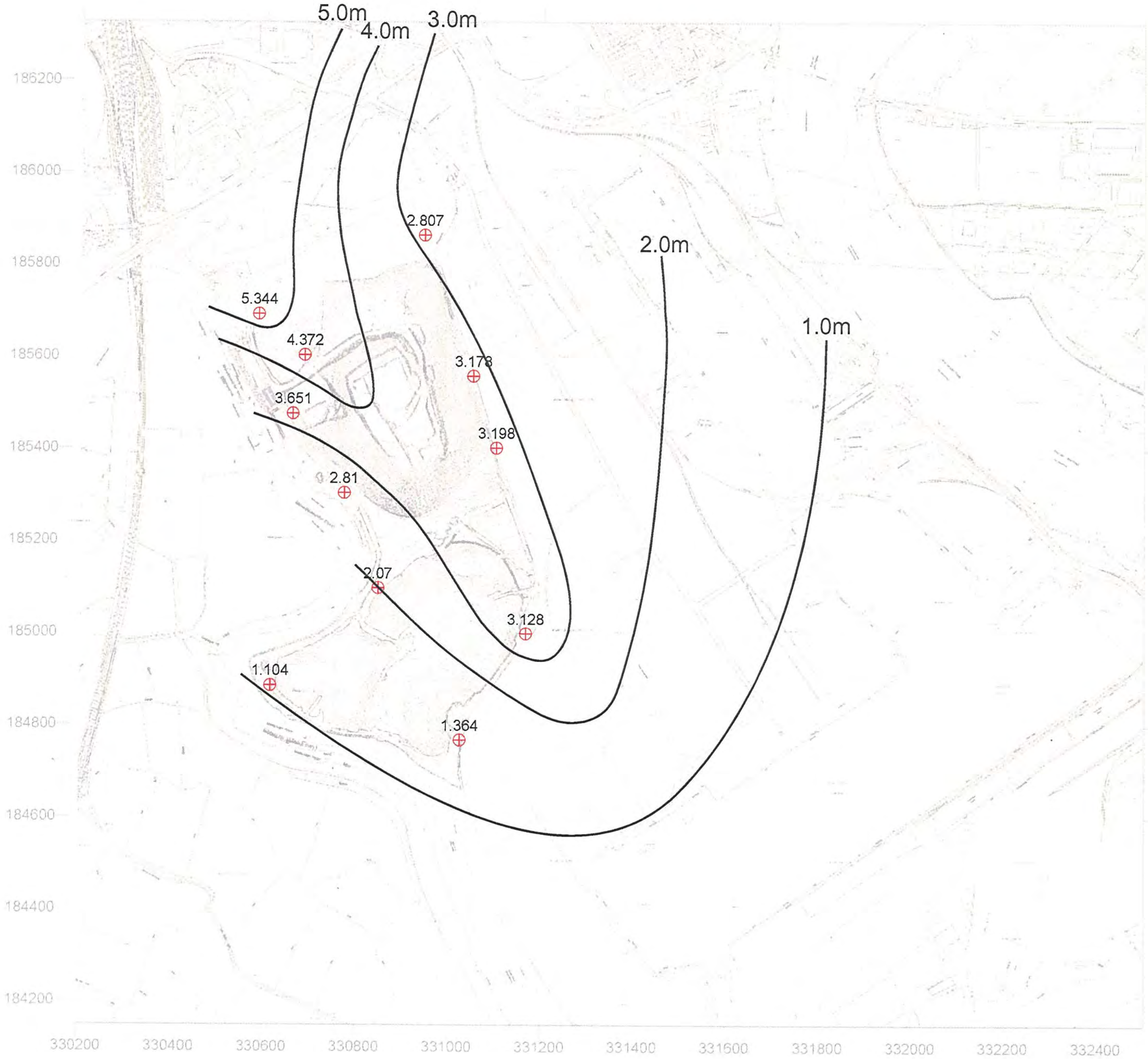
Newport City Council
Cyngor Dinas Casnewydd

Docksway Disposal Site

Interpretive Groundwater Elevation Contour Plot for Gravel Deposits - 13/01/2004 (Mid Point) [Low Spring Tidal Cycle]

Date	15-10-04
A4 Scale	N/A
Drawn	BDA
Checked	JA
Figure Number	8C

J:\14000series\14739\014-HRA\Figures\Area 2



pba

Client

Newport City Council
Cyngor Dinas Casnewydd

Docksway Disposal Site

Interpretive Groundwater Elevation Contour Plot for Gravel Deposits - 26/01/2004 (Low Tide) [High Spring Tidal Cycle]

Date	15-10-04
A4 Scale	N/A
Drawn	BDA
Checked	JA
Figure Number	8D

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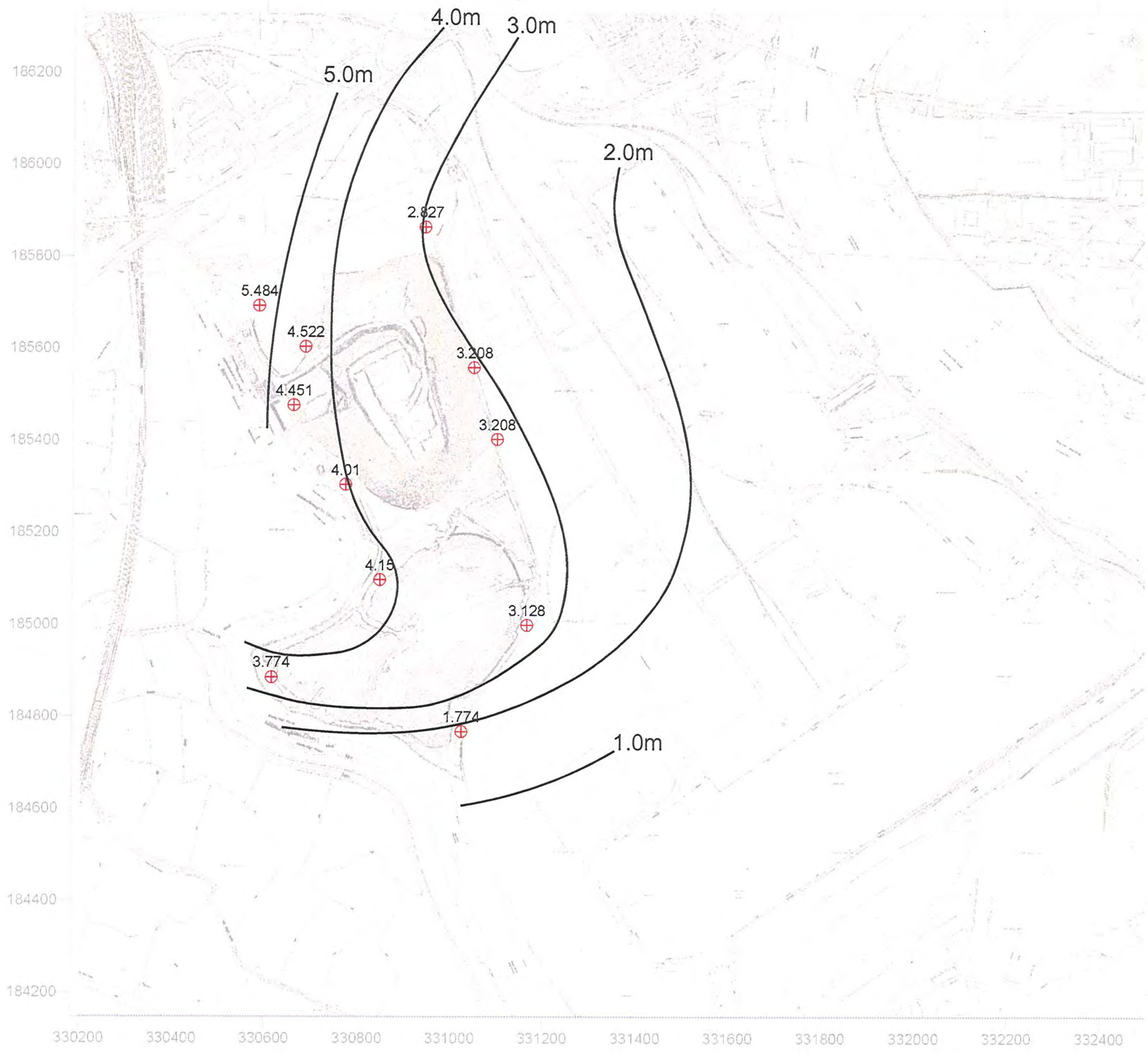


Client

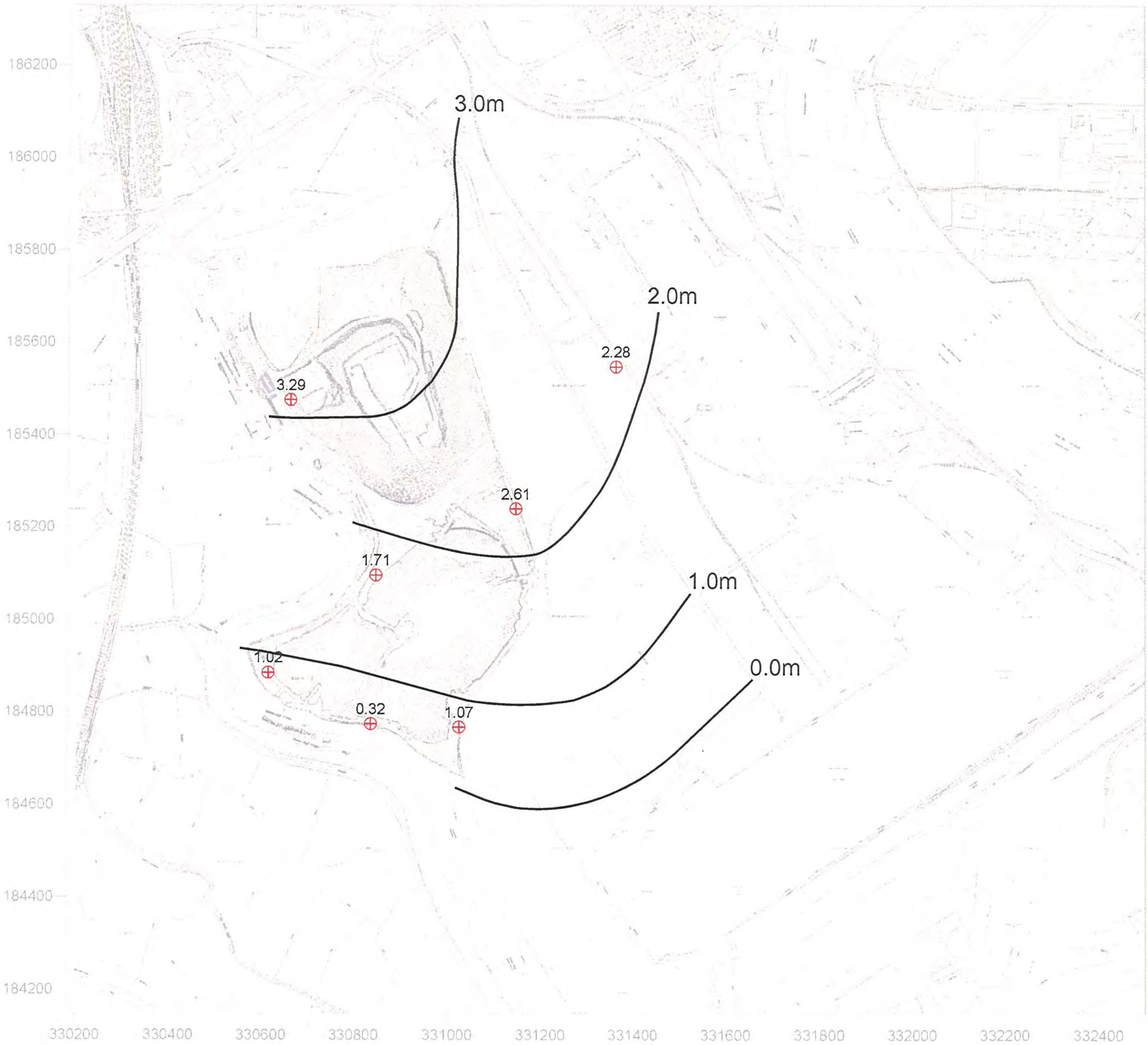
Newport City Council
Cyngor Dinas Casnewydd

Docksway Disposal Site

Interpretive Groundwater Elevation Contour Plot for Gravel Deposits - 26/01/2004 (High Tide) [High Spring Tidal Cycle]

Date	15-10-04
A4 Scale	N/A
Drawn	BDA
Checked	JA
Figure Number	8E

CAVERSHAM BRIDGE HOUSE, WATERMAN PLACE, READING, BERKSHIRE TEL 0118 950 0761 FAX 0118 959 7498
email: reading@pba.co.uk internet: www.pba.co.uk



pba	Client: Newport City Council / Cyngor Dinas Casnewydd	Docksway Disposal Site Interpretive Groundwater Elevation Contour Plot for Gravel Deposits - 14/07/2004 (Low Tide) [Neap Cycle]	Date: 15-10-04 A4 Scale: N/A Drawn: BDA Checked: JA Figure Number: 8F

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email: reading@pba.co.uk internet: www.pba.co.uk

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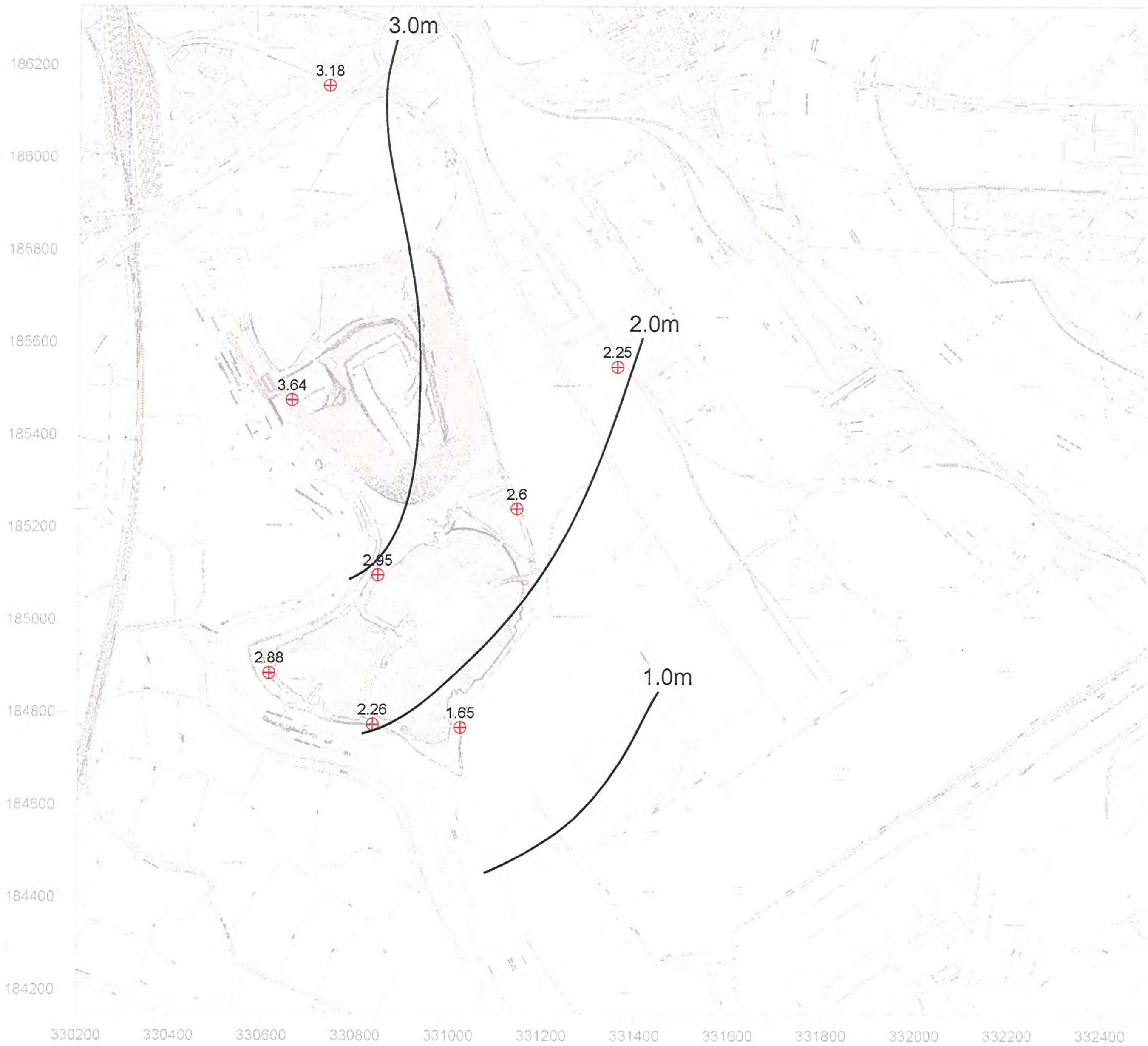

pba

Client

Newport City Council
Cyngor Dinas Casnewydd

Docksway Disposal Site

Interpretive Groundwater Elevation Contour Plot for Gravel Deposits - 14/07/2004 (High Tide) [Neap Cycle]

Date	15-10-04
A4 Scale	N/A
Drawn	BDA
Checked	JA
Figure Number	8G

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Client	Docksway Disposal Site	Date	15-10-04
Newport City Council / Cyngor Dinas Casnewydd	Interpretive Groundwater Elevation Contour Plot for Gravel Deposits - 01/09/2004 (Low Tide) [Low Spring Tide Cycle]	A4 Scale	N/A
		Drawn	BDA
		Checked	JA
		Figure Number	8H

CAVERSHAM BRIDGE HOUSE, WATERMAN PLACE, READING, BERKSHIRE TEL 0118 950 0761 FAX 0118 959 7498
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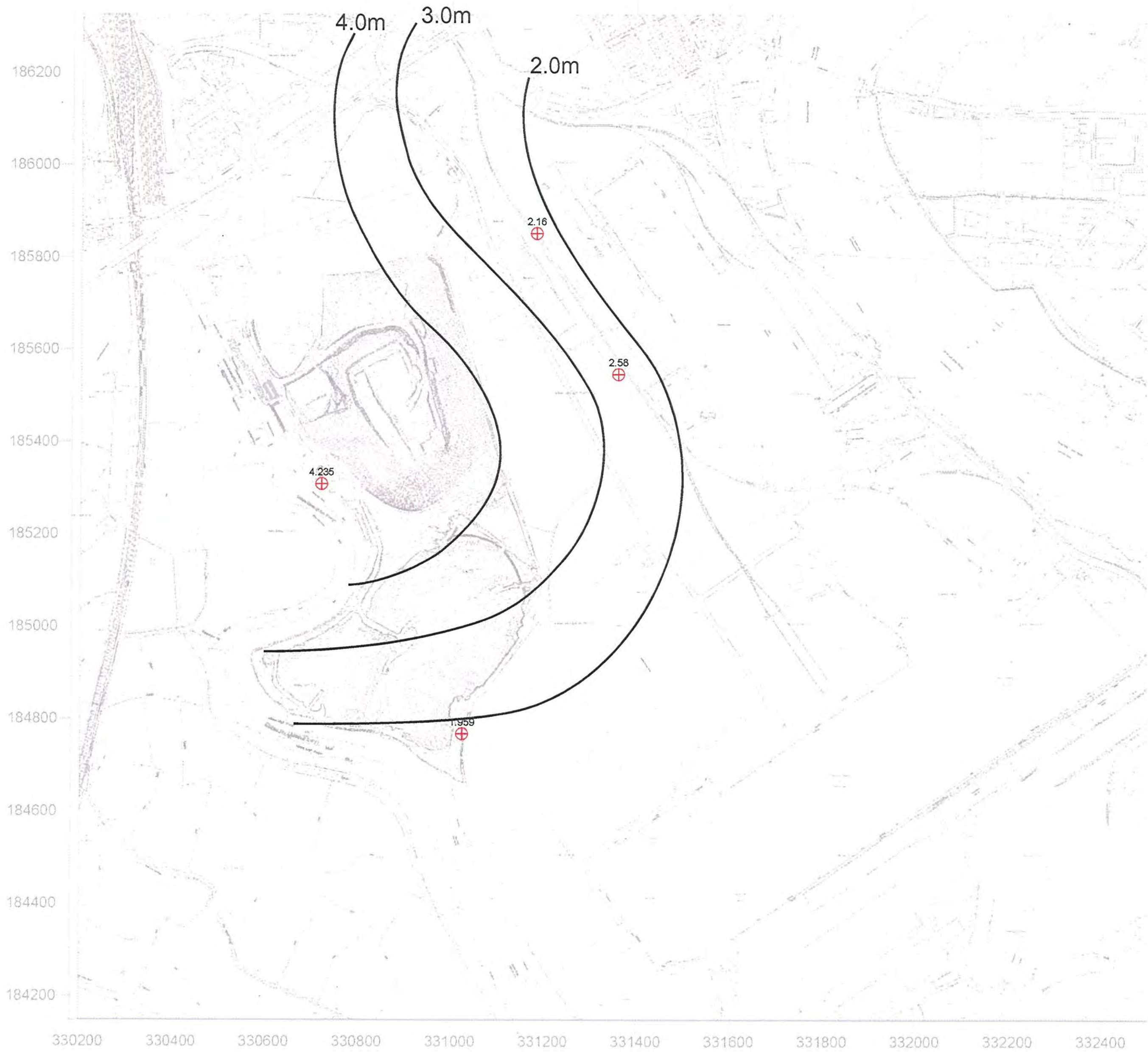

pba	Client: Newport City Council / Cyngor Dinas Casnewydd	Docksway Disposal Site Interpretive Groundwater Elevation Contour Plot for Gravel Deposits - 01/09/2004 (High Tide) [Low Spring Tide Cycle]	Date 15-10-04 A4 Scale N/A Drawn BDA Checked JA Figure Number 8I

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email: reading@pba.co.uk internet: www.pba.co.uk

Client

Newport City Council
Cyngor Dinas Casnewydd

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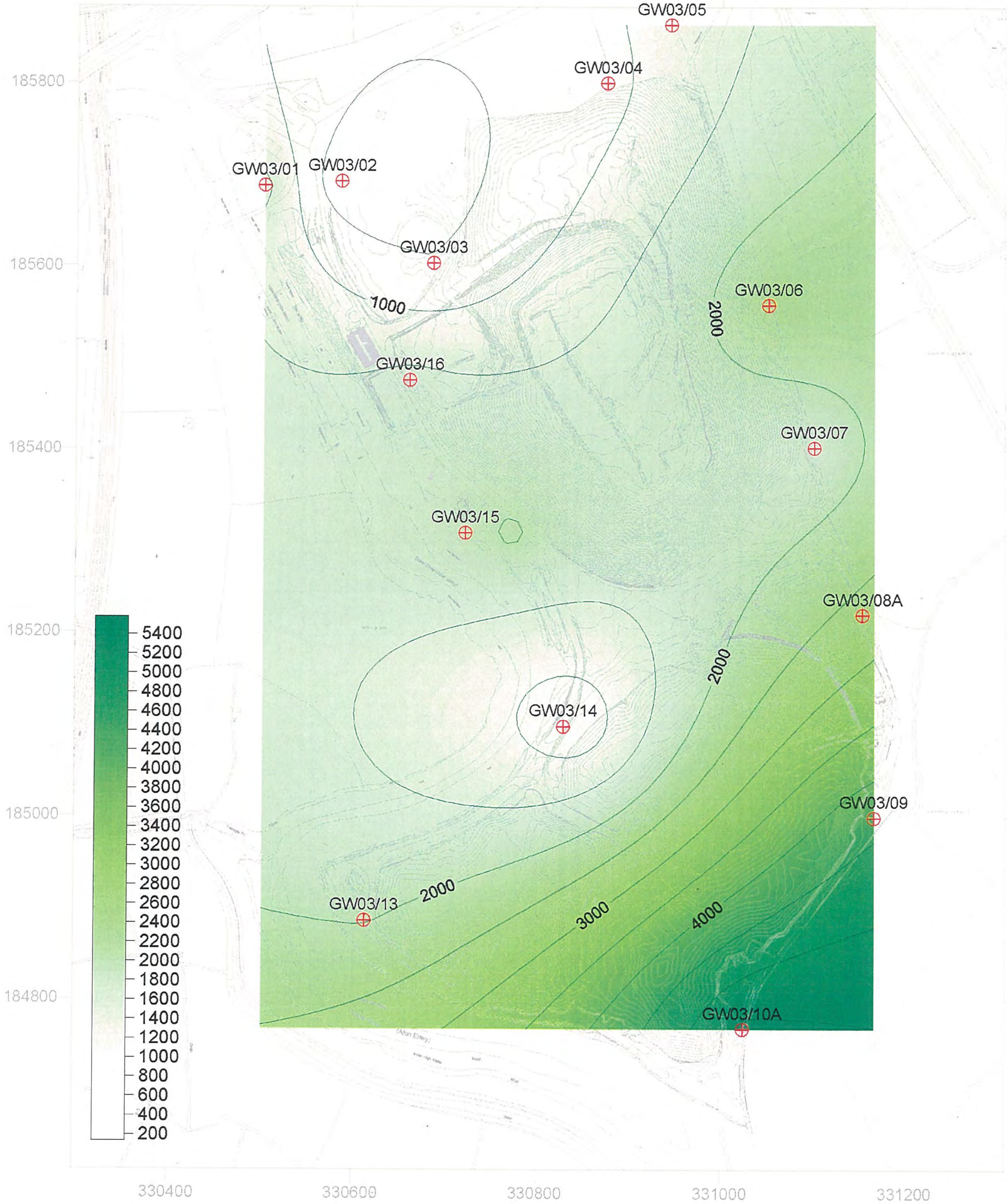
email: reading@pba.co.uk internet: www.pba.co.uk

Docksway Disposal Site

Interpretive Groundwater Elevation Contour Plot for Gravel Deposits - 09/09/2004 at 1330 hours (High at 1450 hours)

Date	15-10-04
A4 Scale	N/A
Drawn	BDA
Checked	JA
Figure Number	8J

J:\14000series\14739\014-HRA\Figures\Area 2



pba

Client

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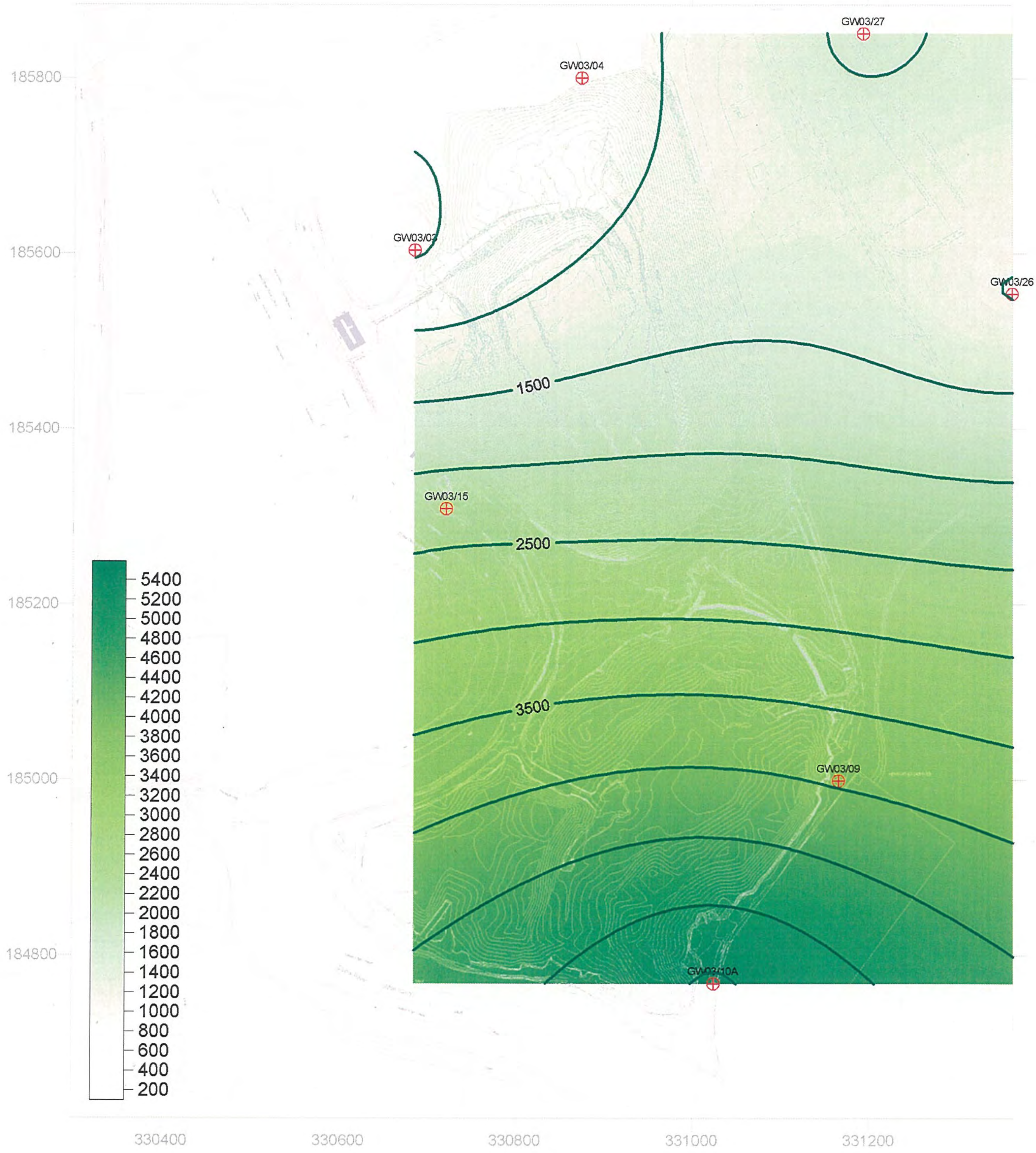
Docksway Disposal Site, Newport

Chloride in mg/l in Gravel Groundwater during Round 1,

Date	OCT. 04
A4 Scale	AS SHOWN
Drawn	GM
Checked	JA
Figure Number	9

J:\14000series\14739\014-HRA\Figures\Area 2



Client: Newport City Council / Cyngor Dinas Casnewydd

Docksway Disposal Site, Newport

Chloride in mg/l in Gravel Groundwater during Round 8

Date	OCT. 04
A4 Scale	AS SHOWN
Drawn	GM
Checked	JA
Figure Number	10

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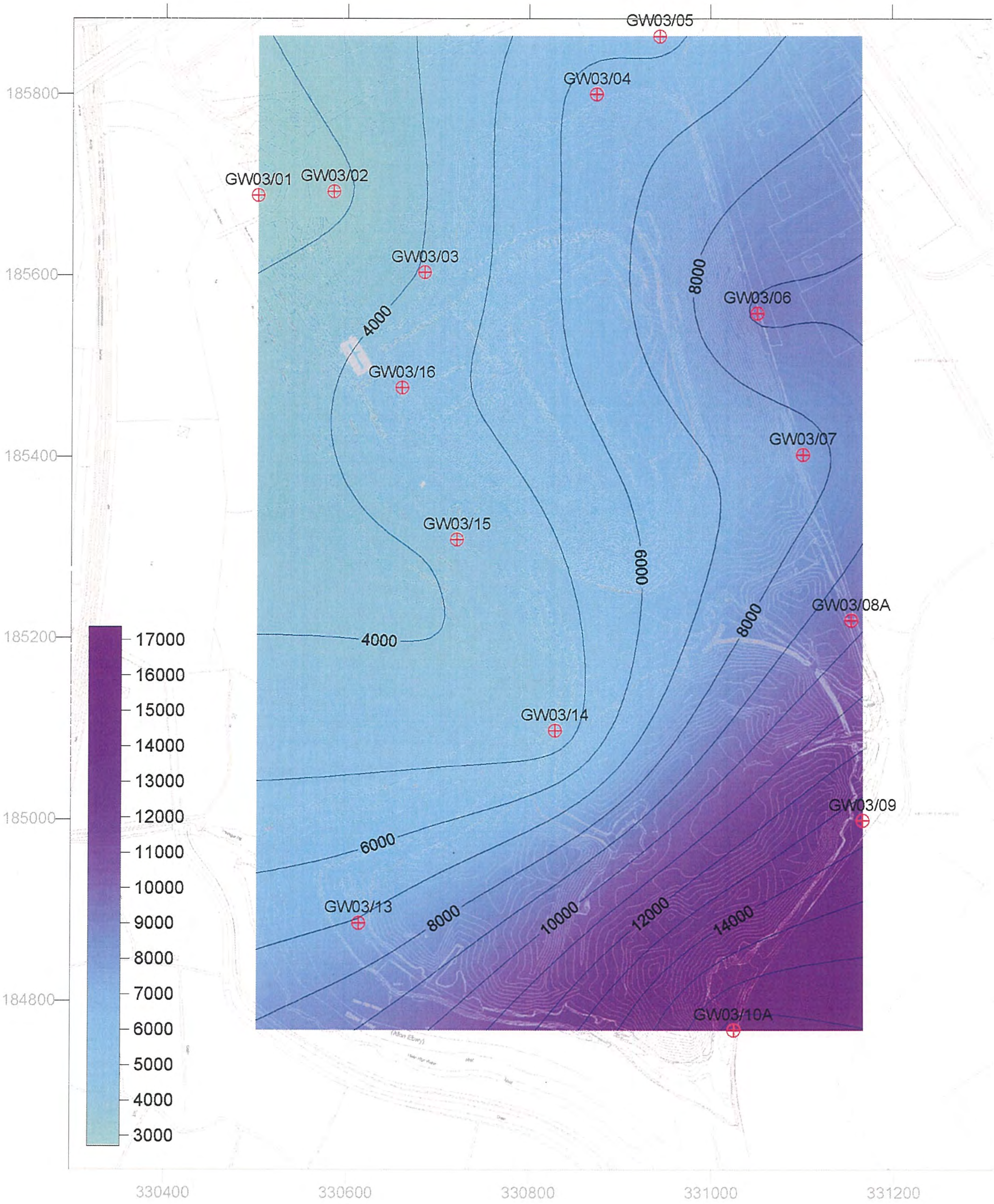

pba	Client: Newport City Council / Cyngor Dinas Casnewydd	Dockway Disposal Site, Newport Electrical Conductivity in uScm/cm in Gravel Groundwater during Round 2	Date: OCT. 04 A4 Scale: AS SHOWN Drawn: GM Checked: JA Figure Number: 11

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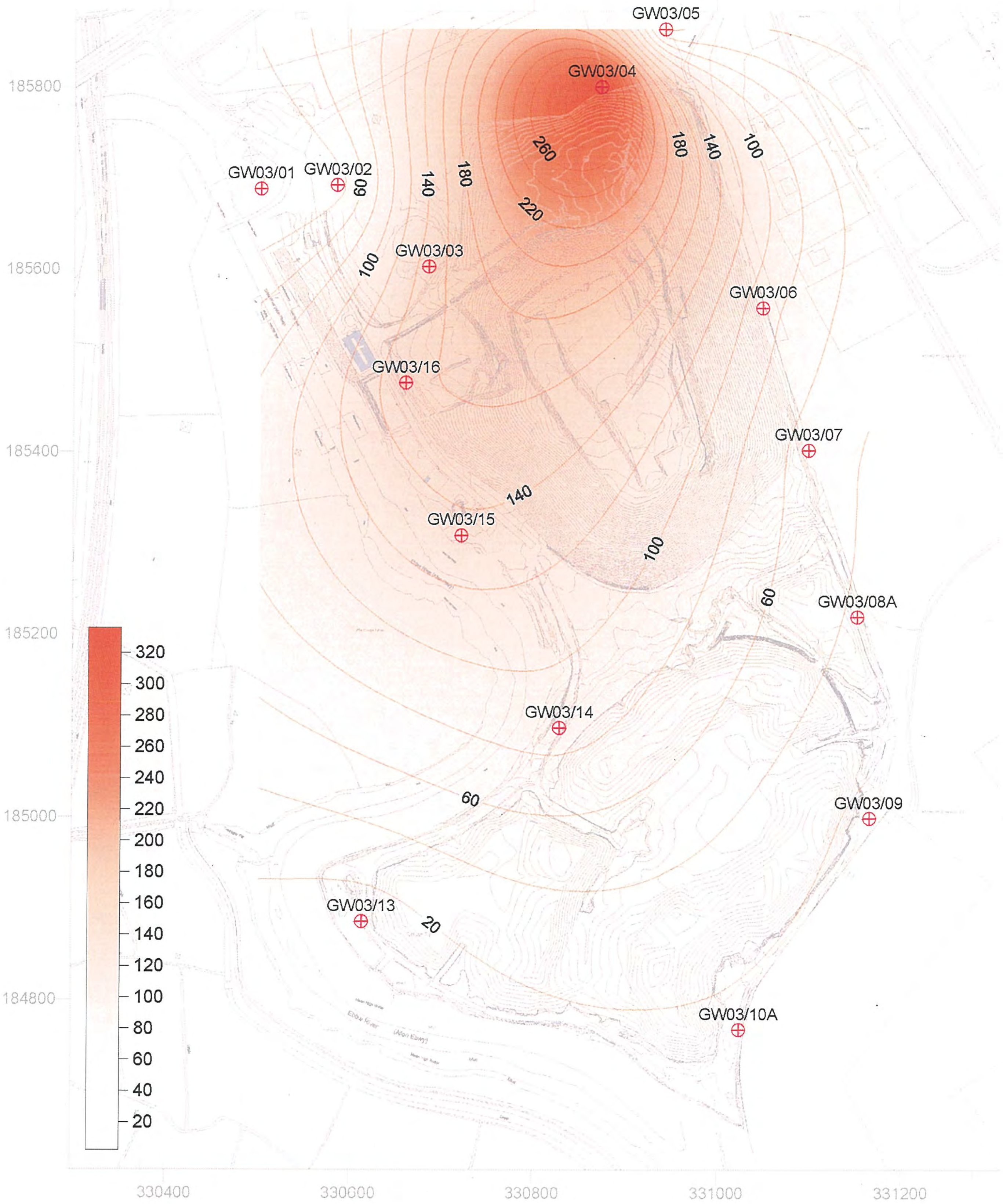

Client

Newport City Council
Cyngor Dinas Casnewydd

Docksway Disposal Site, Newport
Ammoniacal Nitrogen in mg/l in Gravel Groundwater during Round 1

Date	OCT. 04
A4 Scale	AS SHOWN
Drawn	GM
Checked	JA
Figure Number	12

pba
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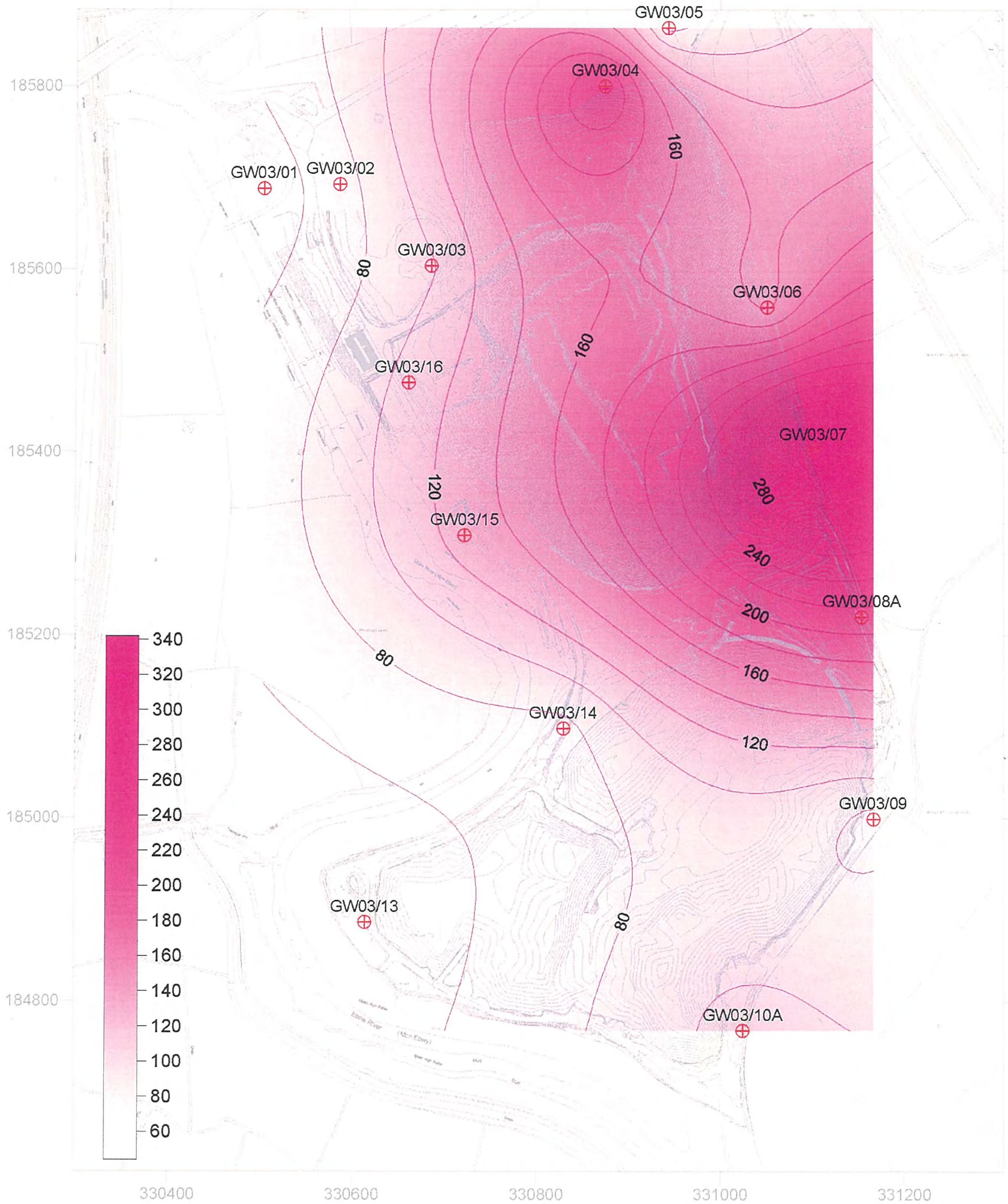

Client

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Dockway Disposal Site, Newport

Potassium in mg/l in Gravel Groundwater during Round 2

Date	OCT. 04
A4 Scale	AS SHOWN
Drawn	GM
Checked	JA
Figure Number	13

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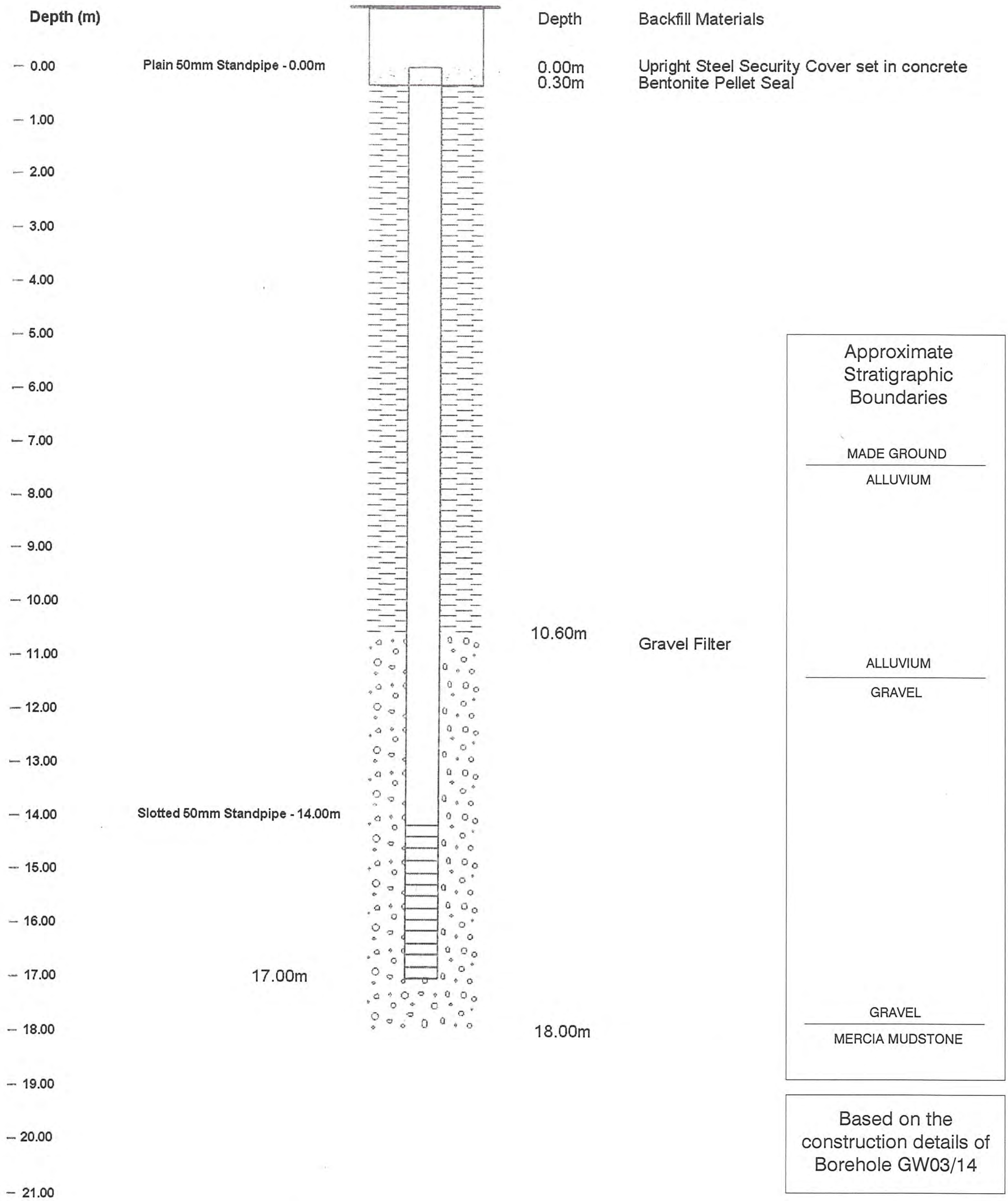

pba	Client: Newport City Council / Cyngor Dinas Casnewydd	Docksway Disposal Site Newport, Gwent Outline Design of Groundwater Monitoring Borehole

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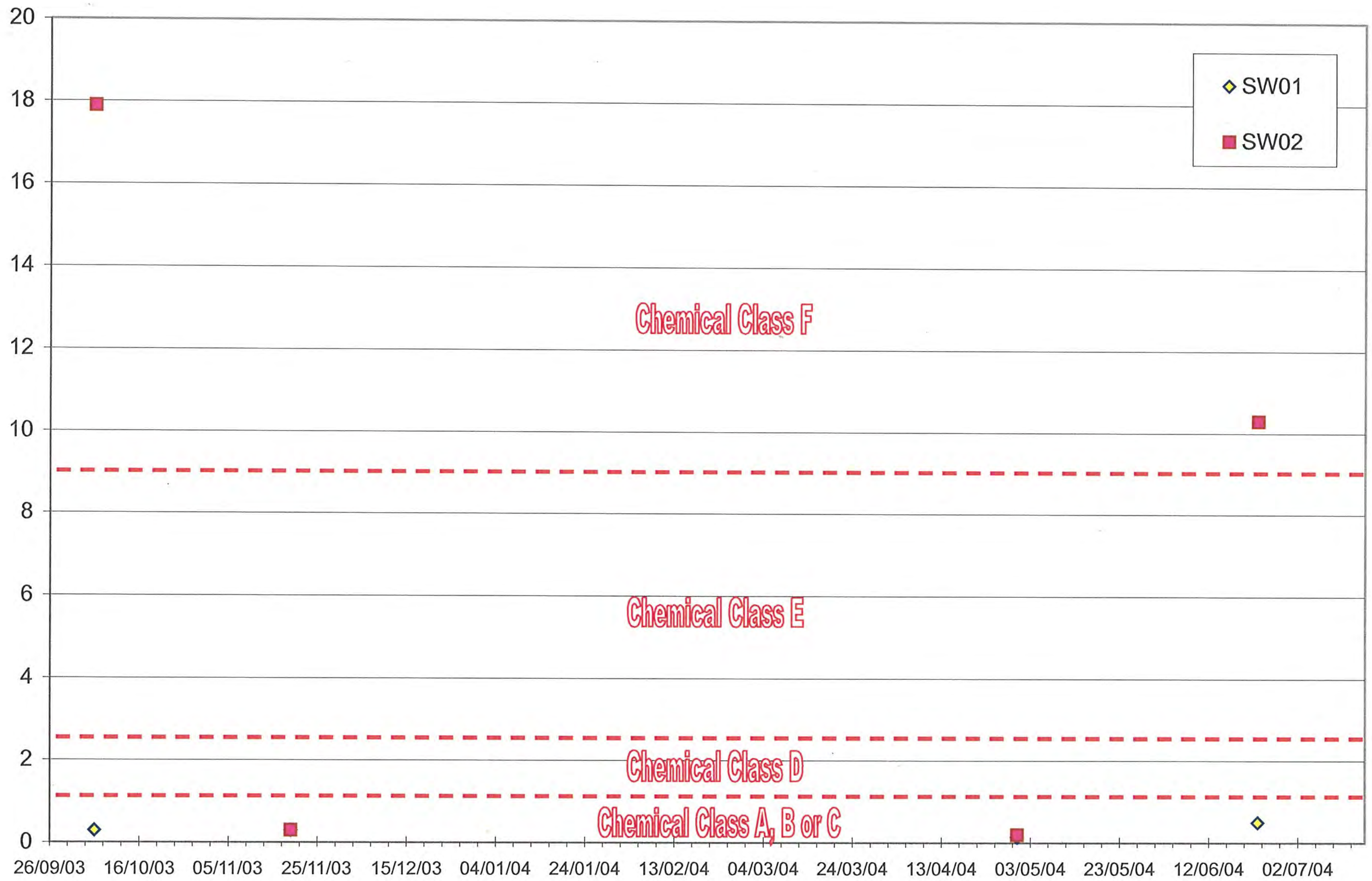
Date	March 2005
A4 Scale	NTS
Drawn	DJM
Checked	DW
Figure Number	14

J:\14000series\14739\014-HRA\Figures\Area 2



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email: reading@pba.co.uk internet: www.pba.co.uk

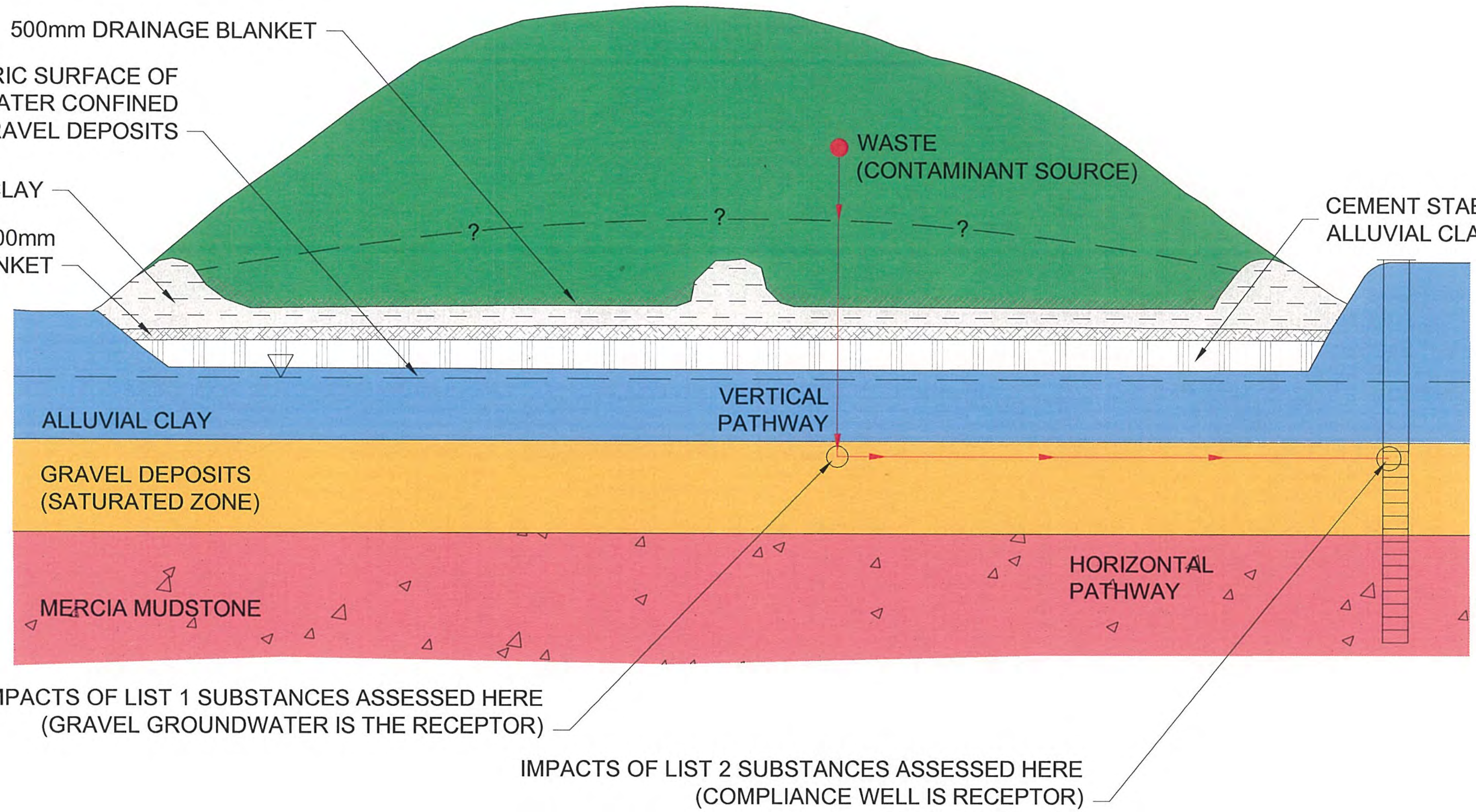
Client: Newport City Council / Cyngor Dinas Casnewydd

Docksway Disposal Site,
Newport

Ammoniacal Nitrogen concentration
(in mg/l) in the River Ebbw

Date	OCT. 04
A4 Scale	AS SHOWN
Drawn	GM
Checked	JA
Figure Number	15

J:\14000series\14739\014-HRA\Figures\Area 2



NOTE
INFILLING/MAKING UP CLAY IN FORMER RIVER CHANNEL, CAPPING AND BASAL ENGINEERING DETAILS INCLUDING LEACHATE DRAINAGE/SUMPS ETC ARE NOT SHOWN FOR CLARITY

Client: Newport City Council / Cyngor Dinas Casnewydd

CAVERSHAM BRIDGE HOUSE WATERMAN PLACE READING BERKSHIRE RG1 8DN
Tel 0118 950 0761 Fax 0118 959 7498 E-mail: reading@pba.co.uk Internet: www.pba.co.uk

DOCKSWAY DISPOSAL SITE
AREA 2 - SCHEMATIC PICTORIAL REPRESENTATION OF SOURCE, PATHWAYS AND RECEPTORS

Date	15-10-04
A4 Scale	NTS
Drawn	BDA
Checked	DW
Figure Number	16

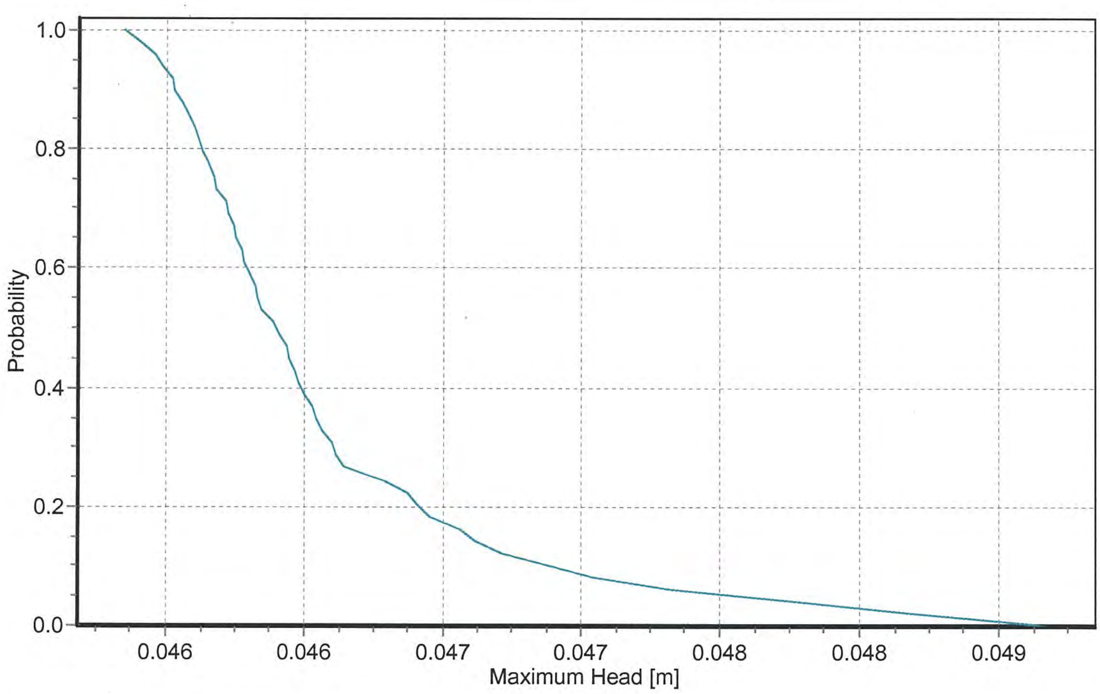
LandSim Version 2.5

FIGURE 17A

Project Name: Docksway Area 2

Customer:Newport City Council

Results: Area 2, Maximum Head [m]



\Area2-DrftJ-Master-drainage.sim

11/04/2005 12:58:24

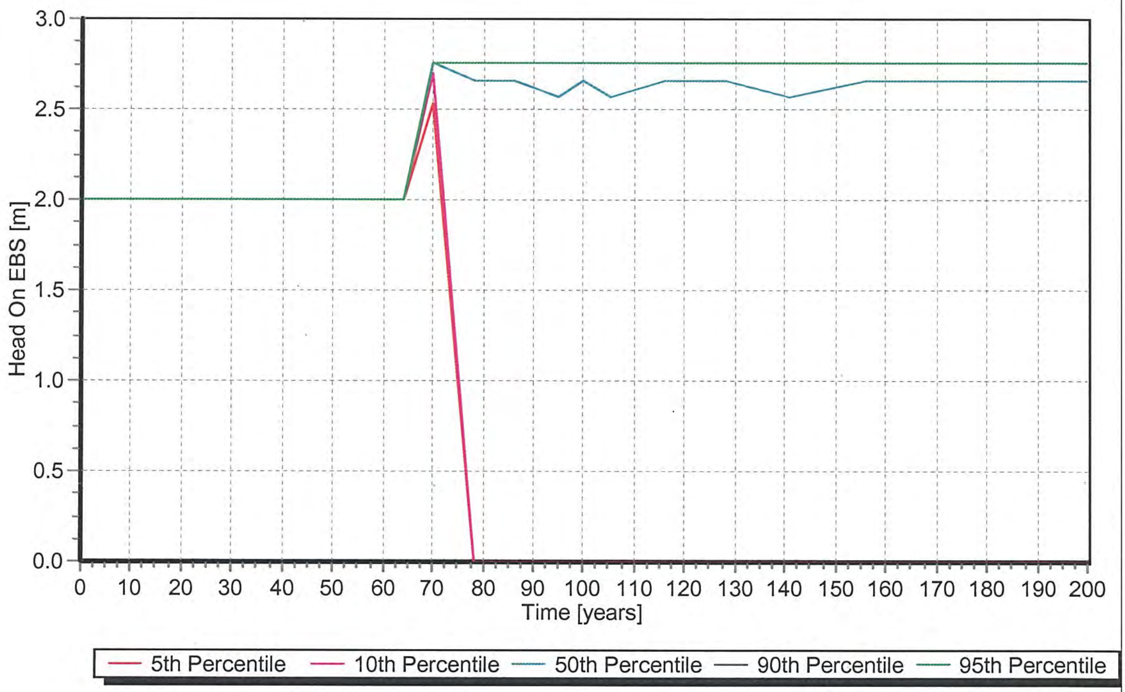
LandSim Version 2.5

FIGURE 17B

Project Name: Docksway Area 2

Customer:Newport City Council

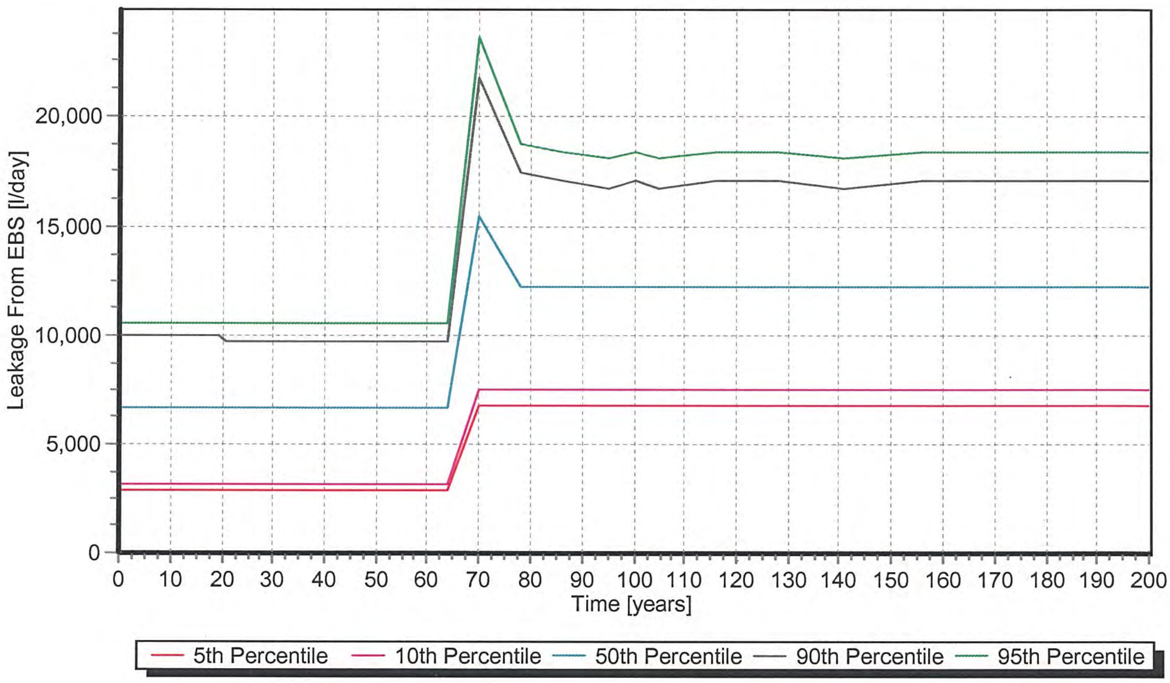
Results: Area 2, Head On EBS [m]



\Area2-DrftJ-Master.sim

11/04/2005 08:37:34

LandSim Version 2.5	**FIGURE 17C**
Project Name: Docksway Area 2 Customer:Newport City Council	
Results: Area 2, Leakage From EBS [l/day]	



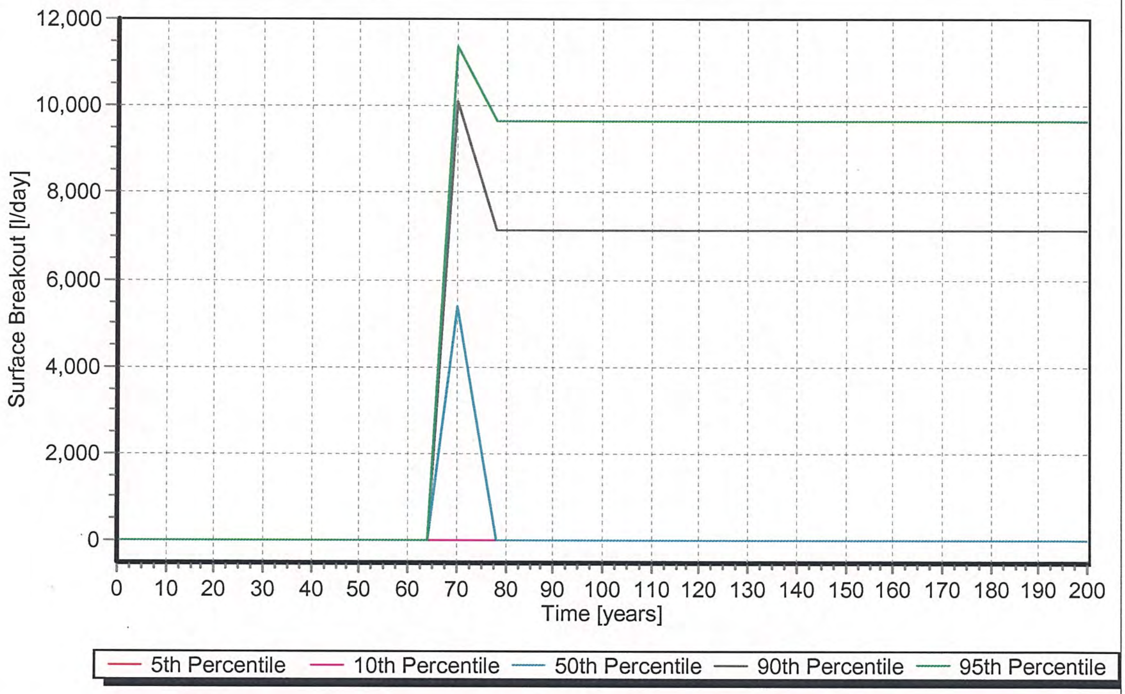
\Area2-DrftJ-Master.sim	11/04/2005 08:37:34

LandSim Version 2.5	**FIGURE 17D**

Project Name: Docksway Area 2

Customer:Newport City Council

Results: Area 2, Surface Breakout [l/day]



\Area2-DrftJ-Master.sim	11/04/2005 08:37:34

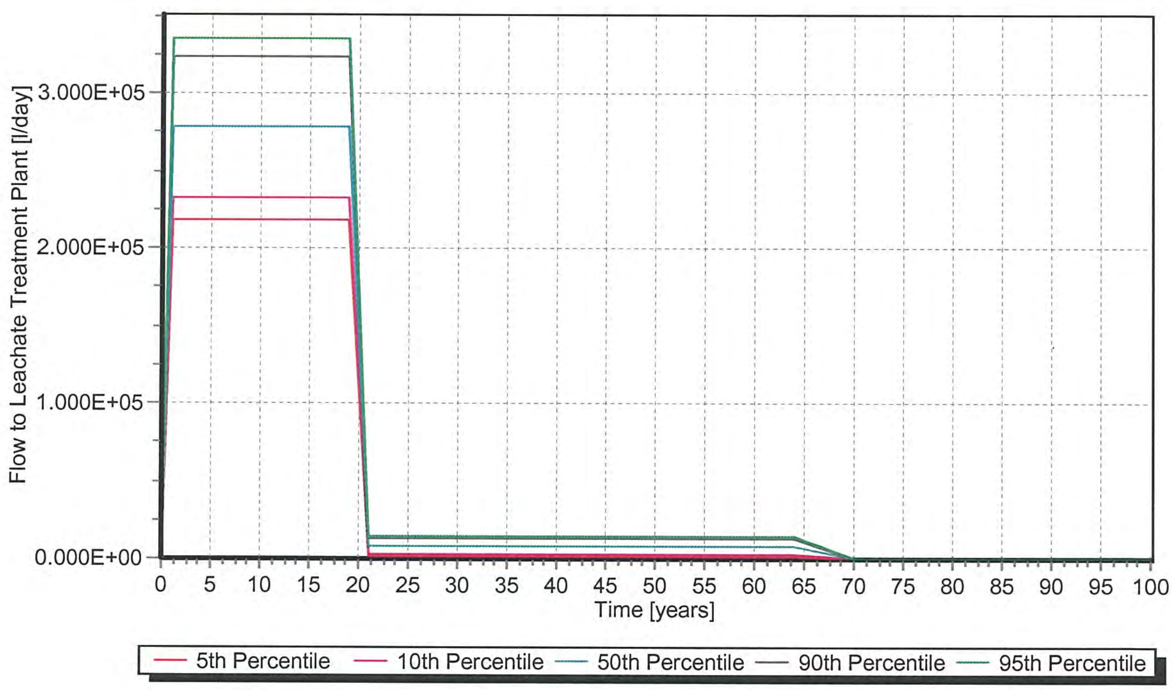
LandSim Version 2.5

FIGURE 17E

Project Name: Docksway Area 2

Customer:Newport City Council

Results: Area 2, Flow to Leachate Treatment Plant [l/day]



\Area2-DrftJ-Master.sim

11/04/2005 08:37:34

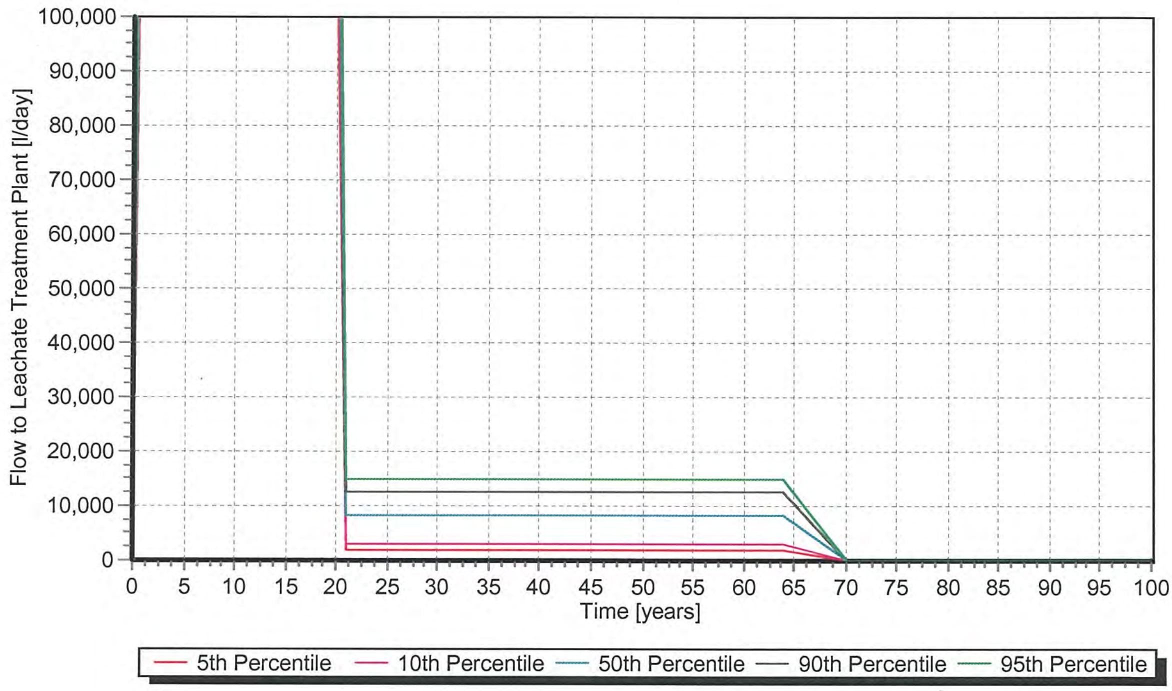
LandSim Version 2.5

FIGURE 17F

Project Name: Docksway Area 2

Customer:Newport City Council

Results: Area 2, Flow to Leachate Treatment Plant [l/day]



\Area2-DrftJ-Master.sim

11/04/2005 08:37:34

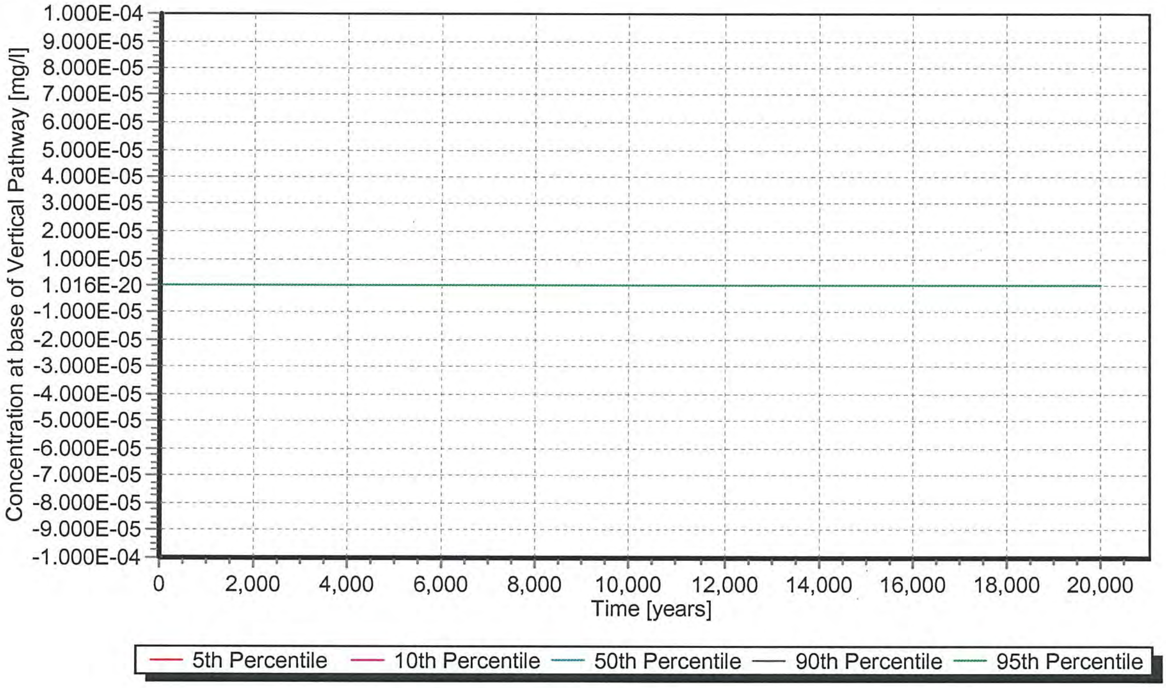
LandSim Version 2.5

FIGURE 18A

Project Name: Docksway Area 2

Customer:Newport City Council

Results: Area 2, Mineral Oil (aliphatic hydrocarbons) Concentration at base of Vertical Pathway [mg/l]



\Area2-DrftJ-Master.sim

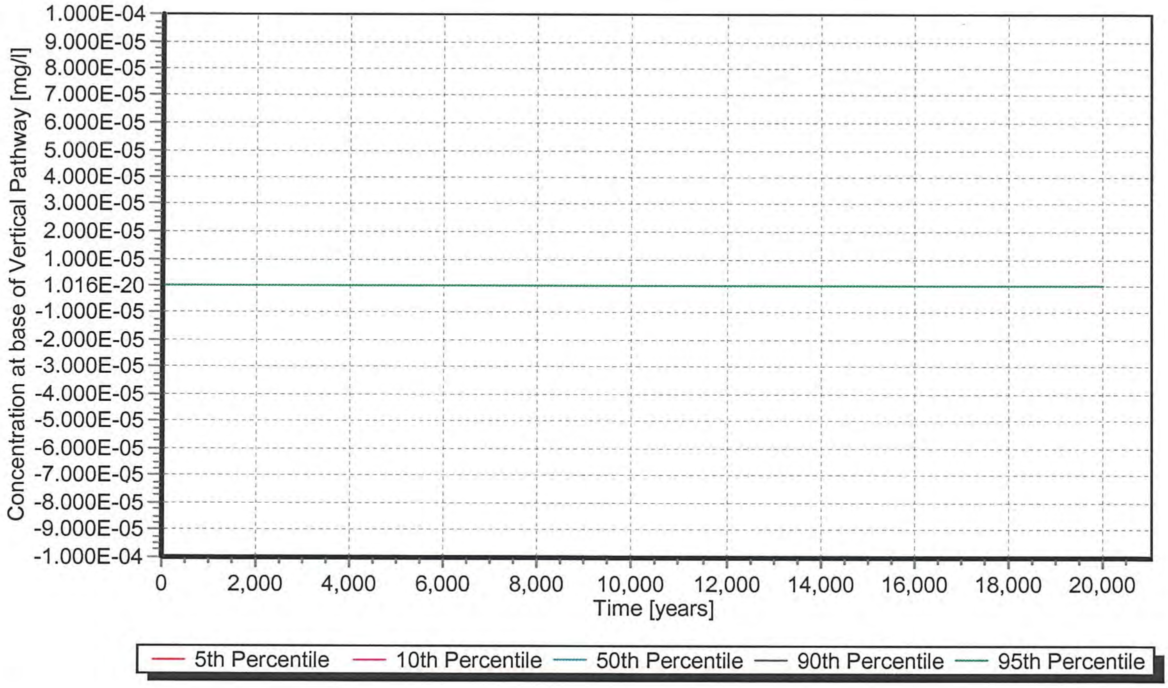
11/04/2005 08:37:34

LandSim Version 2.5	**FIGURE 18B**

Project Name: Docksway Area 2

Customer:Newport City Council

Results: Area 2, Benzene Concentration at base of Vertical Pathway [mg/l]



\Area2-DrftJ-Master.sim	11/04/2005 08:37:34

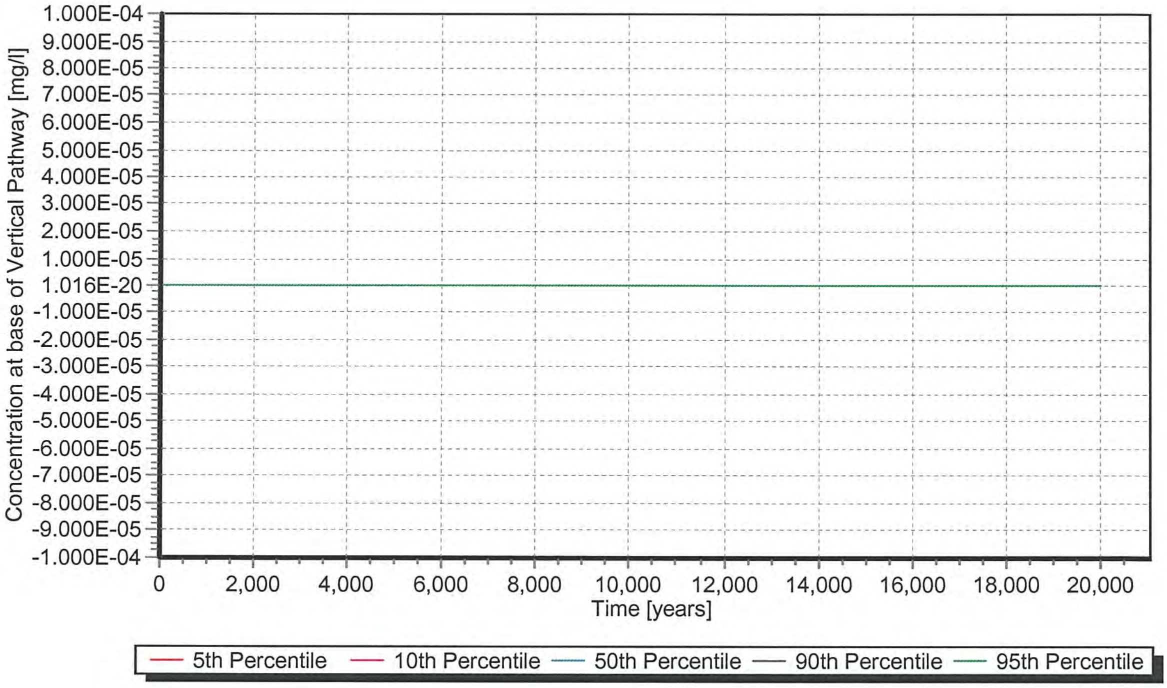
LandSim Version 2.5

FIGURE 18C

Project Name: Docksway Area 2

Customer:Newport City Council

Results: Area 2, Mercury Concentration at base of Vertical Pathway [mg/l]



\Area2-DrftJ-Master.sim

11/04/2005 08:37:34

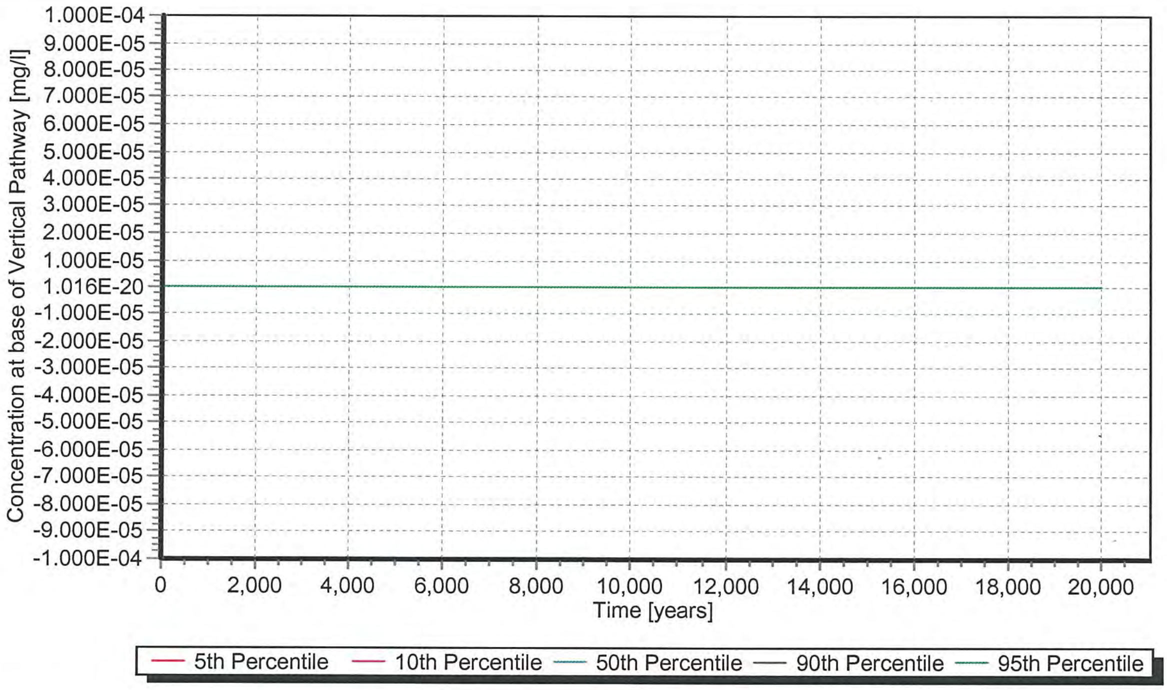
LandSim Version 2.5

FIGURE 18D

Project Name: Docksway Area 2

Customer:Newport City Council

Results: Area 2, Naphthalene Concentration at base of Vertical Pathway [mg/l]



\Area2-DrftJ-Master.sim

11/04/2005 08:37:34

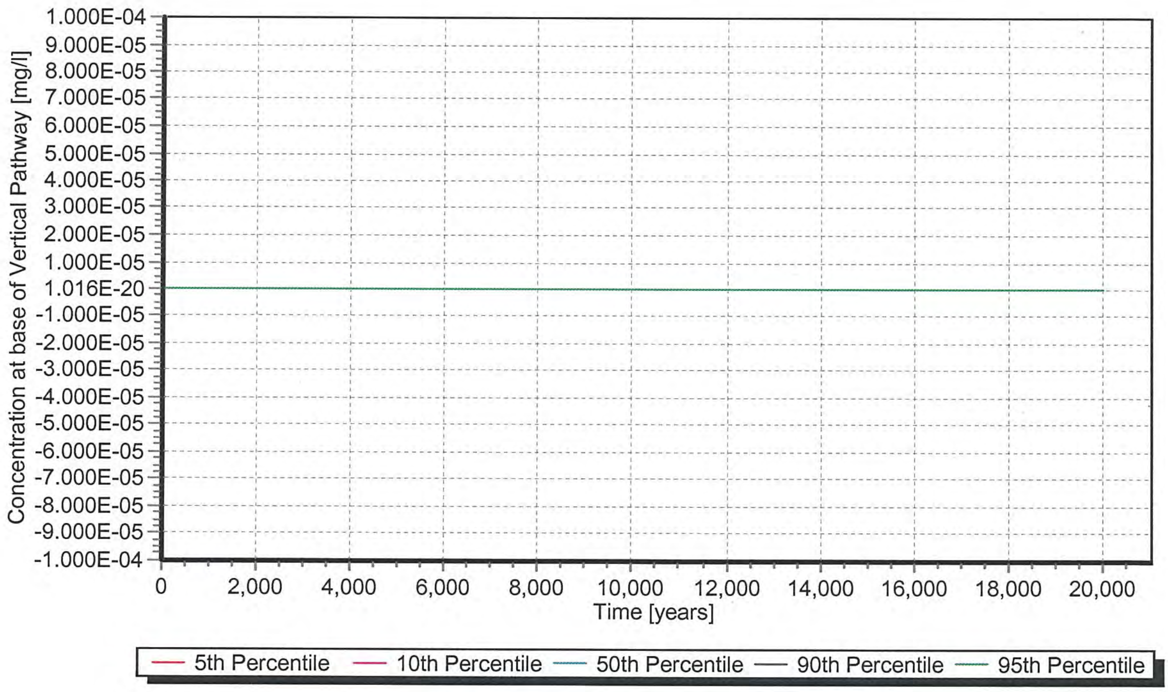
LandSim Version 2.5

FIGURE 18E

Project Name: Docksway Area 2

Customer:Newport City Council

Results: Area 2, Xylene Concentration at base of Vertical Pathway [mg/l]



\Area2-DrftJ-Master.sim

11/04/2005 08:37:34

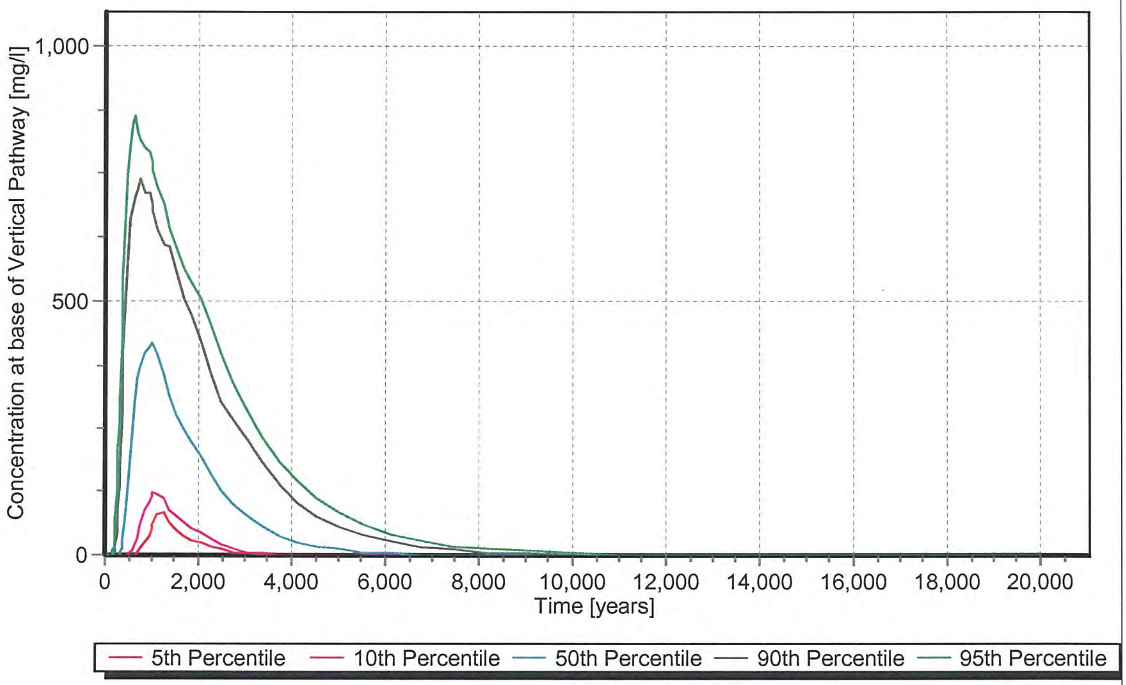
LandSim Version 2.5

FIGURE 18F

Project Name: Docksway Area 2

Customer:Newport City Council

Results: Area 2, Ammoniacal_N Concentration at base of Vertical Pathway [mg/l]



\Area2-DrftJ-Master.sim

11/04/2005 08:37:34

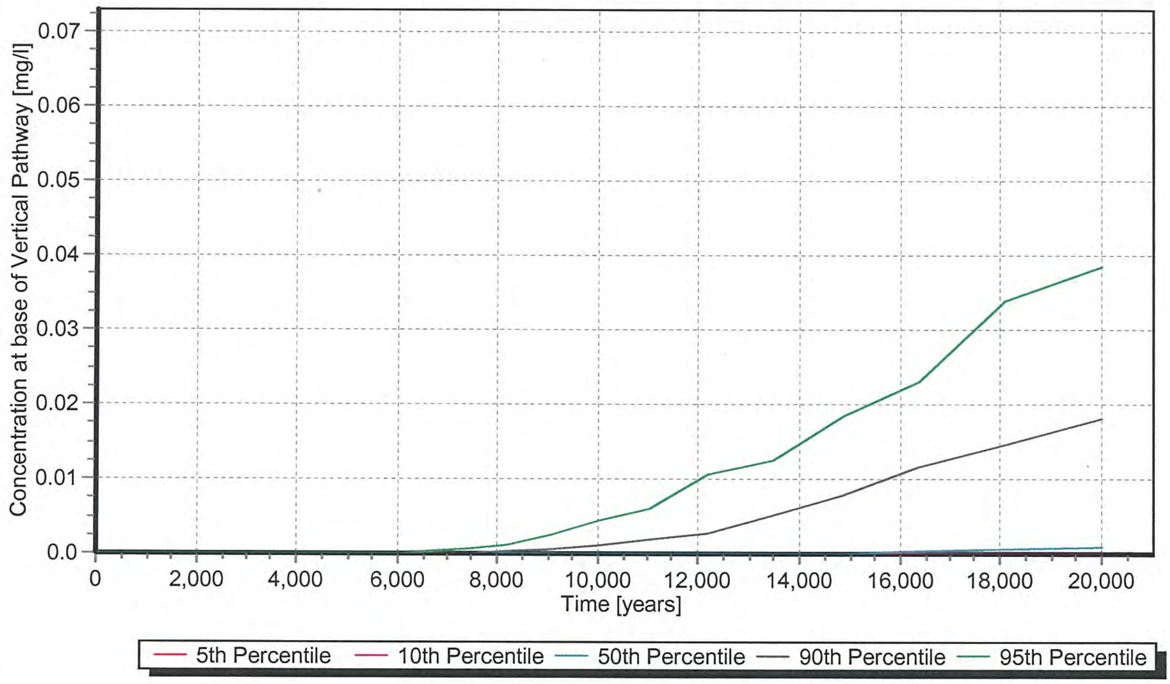
LandSim Version 2.5

FIGURE 18G

Project Name: Docksway Area 2

Customer:Newport City Council

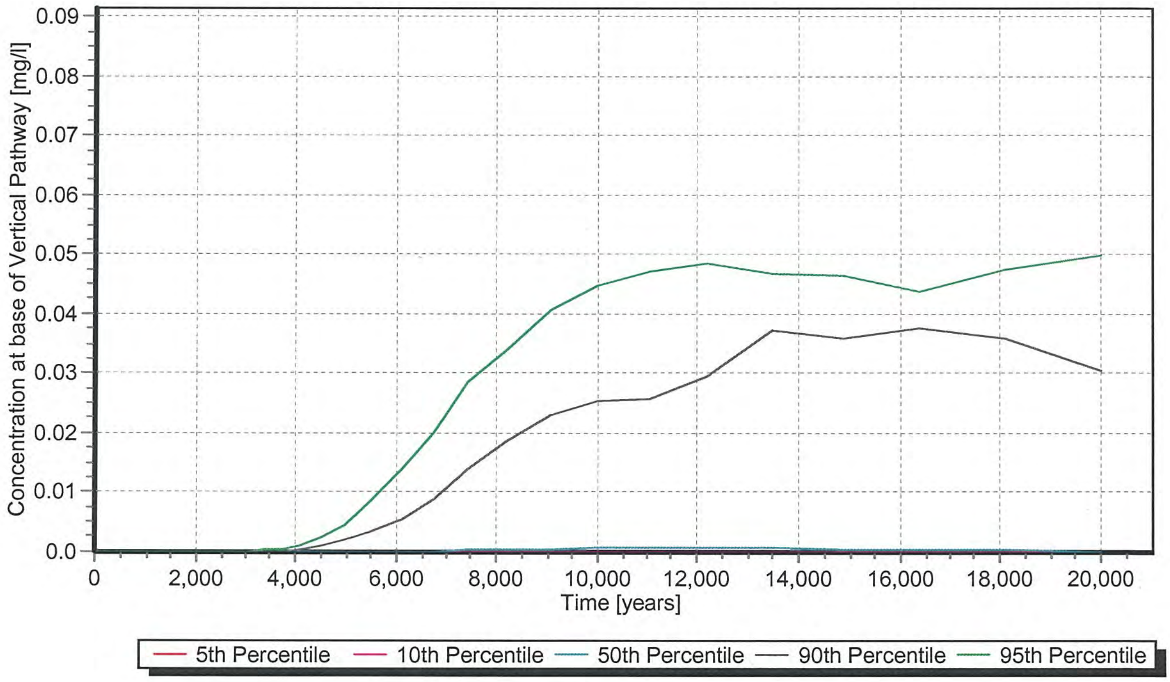
Results: Area 2, Arsenic Concentration at base of Vertical Pathway [mg/l]



\Area2-DrftJ-Master.sim

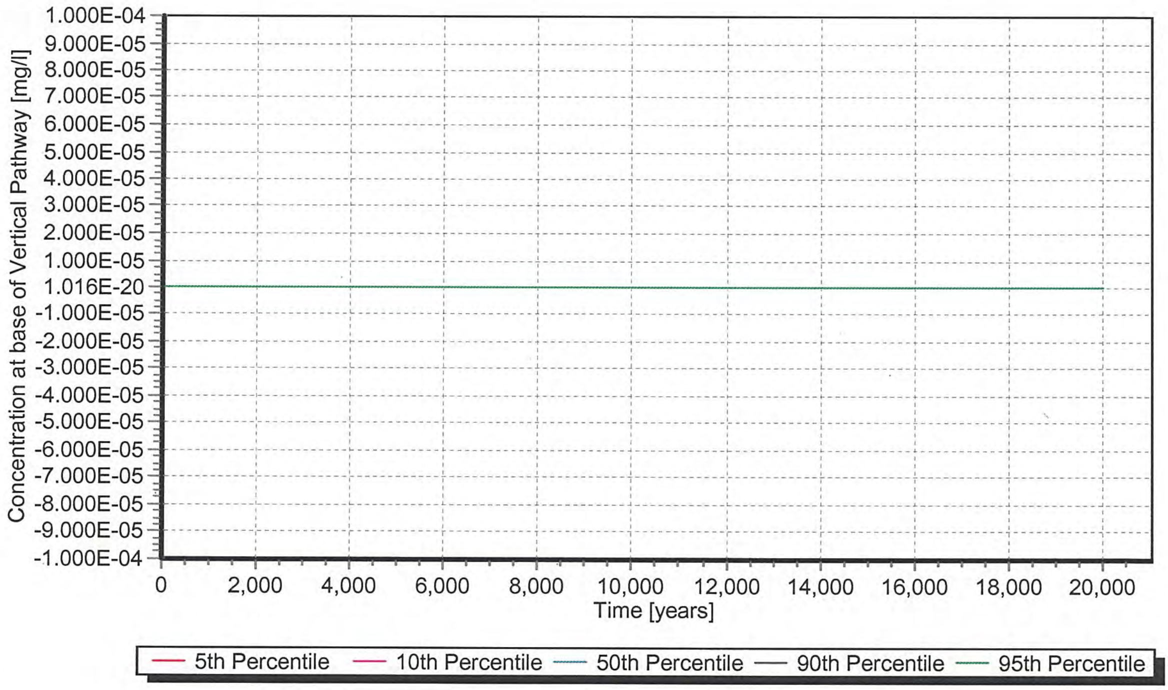
11/04/2005 08:37:34

LandSim Version 2.5	FIGURE 18H
Project Name: Docksway Area 2 Customer:Newport City Council	
Results: Area 2, Nickel Concentration at base of Vertical Pathway [mg/l]	



\Area2-DrftJ-Master.sim	11/04/2005 08:37:34

LandSim Version 2.5	FIGURE 181
Project Name: Docksway Area 2 Customer:Newport City Council	
Results: Area 2, Phenols Concentration at base of Vertical Pathway [mg/l]	



\Area2-DrftJ-Master.sim 11/04/2005 08:37:34

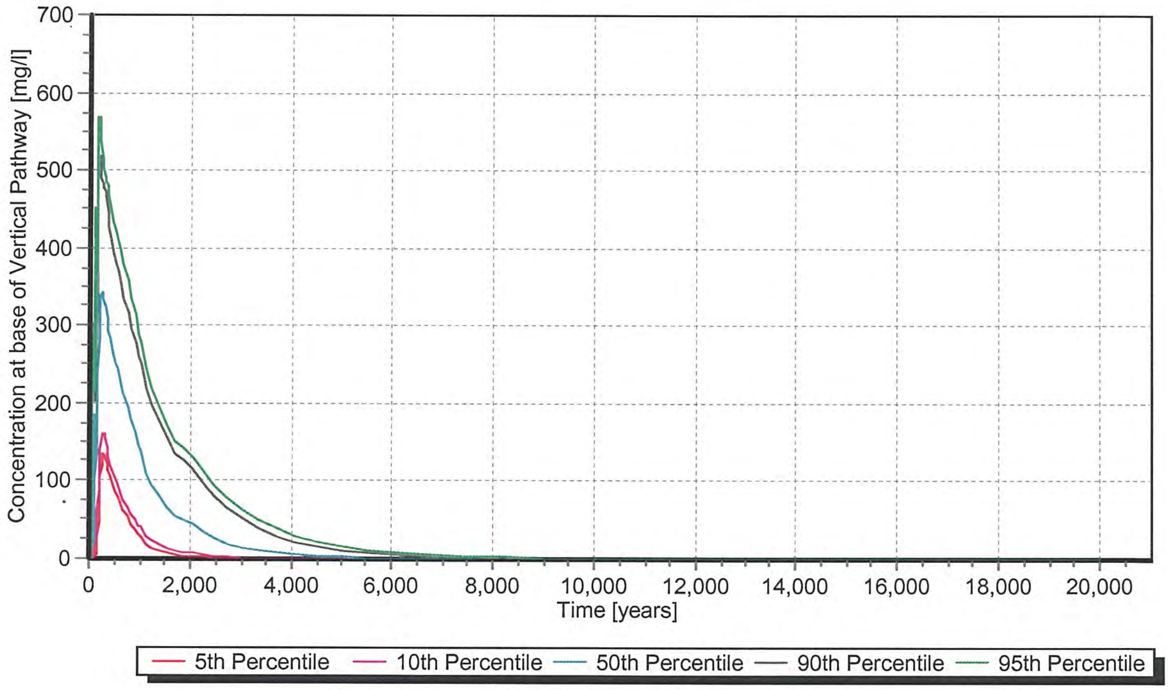
LandSim Version 2.5

FIGURE 18J

Project Name: Docksway Area 2

Customer:Newport City Council

Results: Area 2, Potassium Concentration at base of Vertical Pathway [mg/l]



\Area2-DrftJ-Master.sim

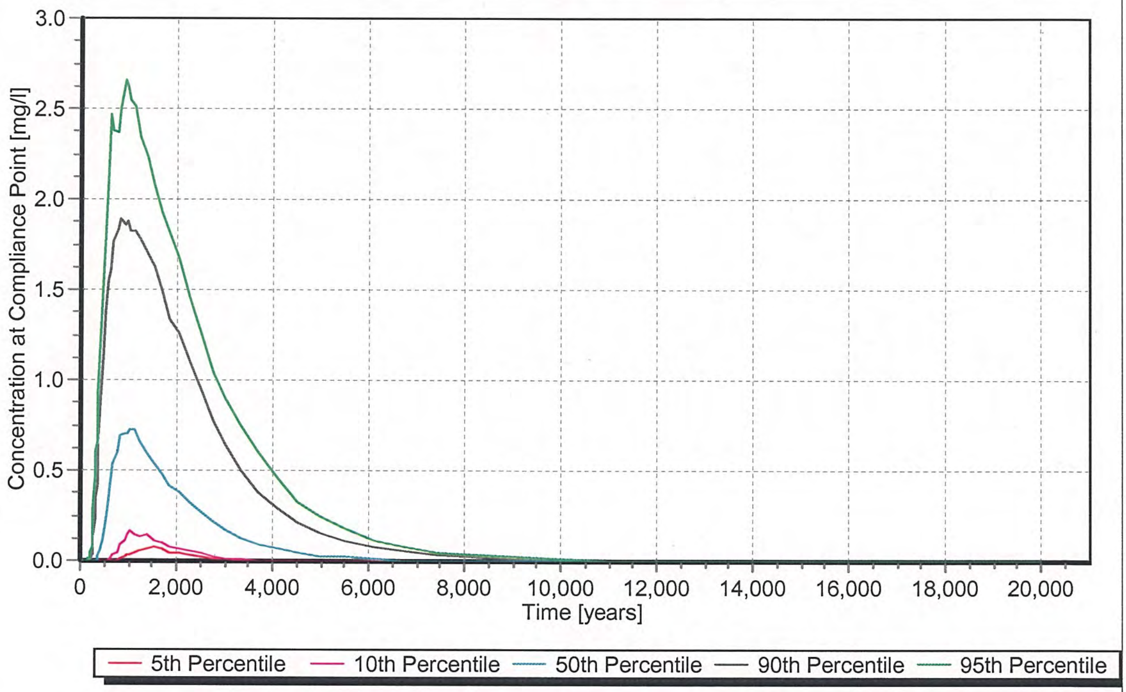
11/04/2005 08:37:34

LandSim Version 2.5	FIGURE 19A

Project Name: Docksway Area 2

Customer:Newport City Council

Results: Ammoniacal_N Concentration at Compliance Point [mg/l]



\Area2-DrftJ-Master.sim 11/04/2005 08:37:34

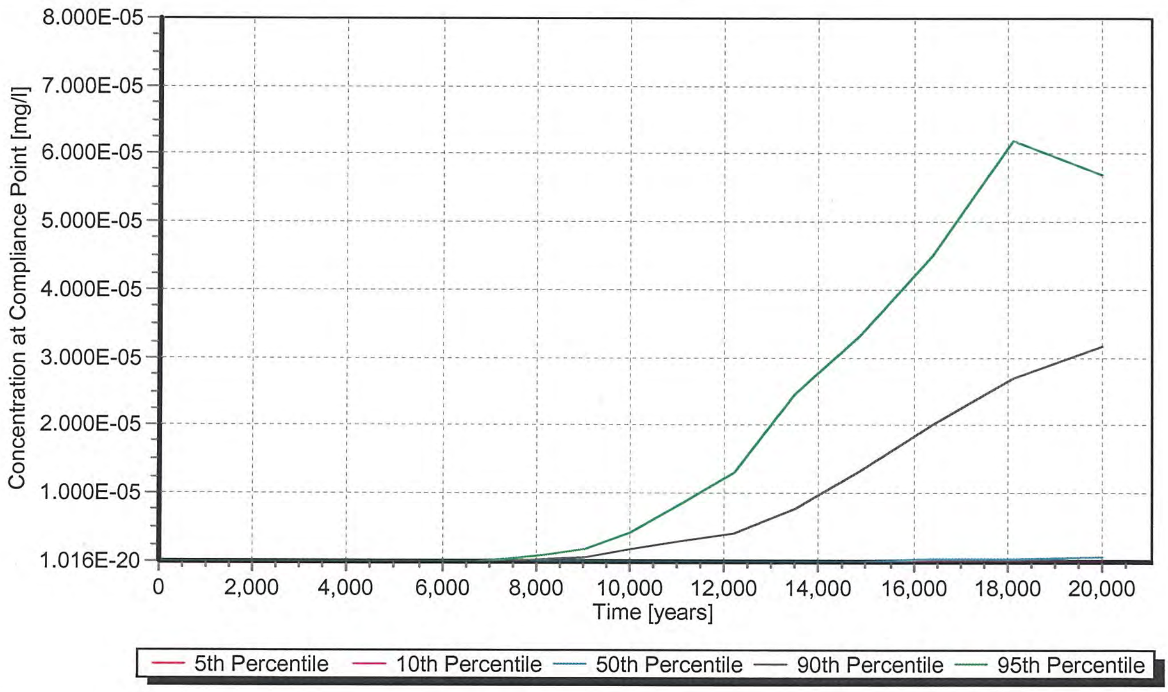
LandSim Version 2.5

FIGURE 19B

Project Name: Docksway Area 2

Customer:Newport City Council

Results: Arsenic Concentration at Compliance Point [mg/l]



\Area2-DrftJ-Master.sim

11/04/2005 08:37:34

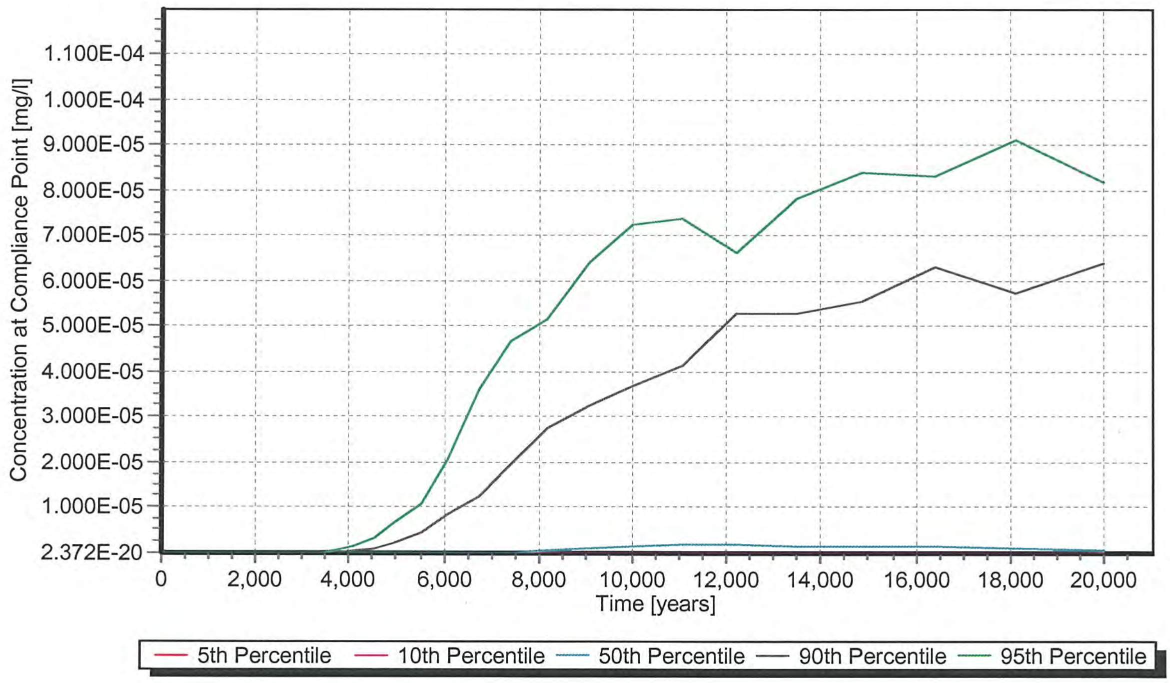
LandSim Version 2.5

FIGURE 19C

Project Name: Docksway Area 2

Customer:Newport City Council

Results: Nickel Concentration at Compliance Point [mg/l]



\Area2-DrftJ-Master.sim

11/04/2005 08:37:34

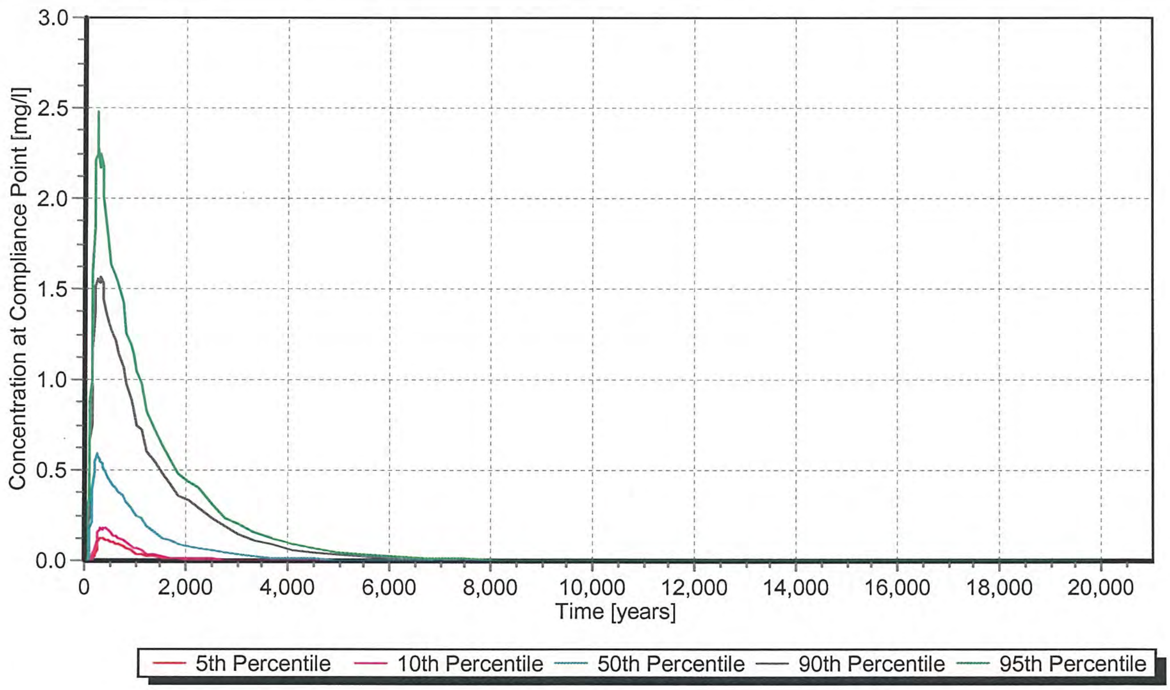
LandSim Version 2.5

FIGURE 19D

Project Name: Docksway Area 2

Customer:Newport City Council

Results: Potassium Concentration at Compliance Point [mg/l]



\Area2-DrftJ-Master.sim

11/04/2005 08:37:34

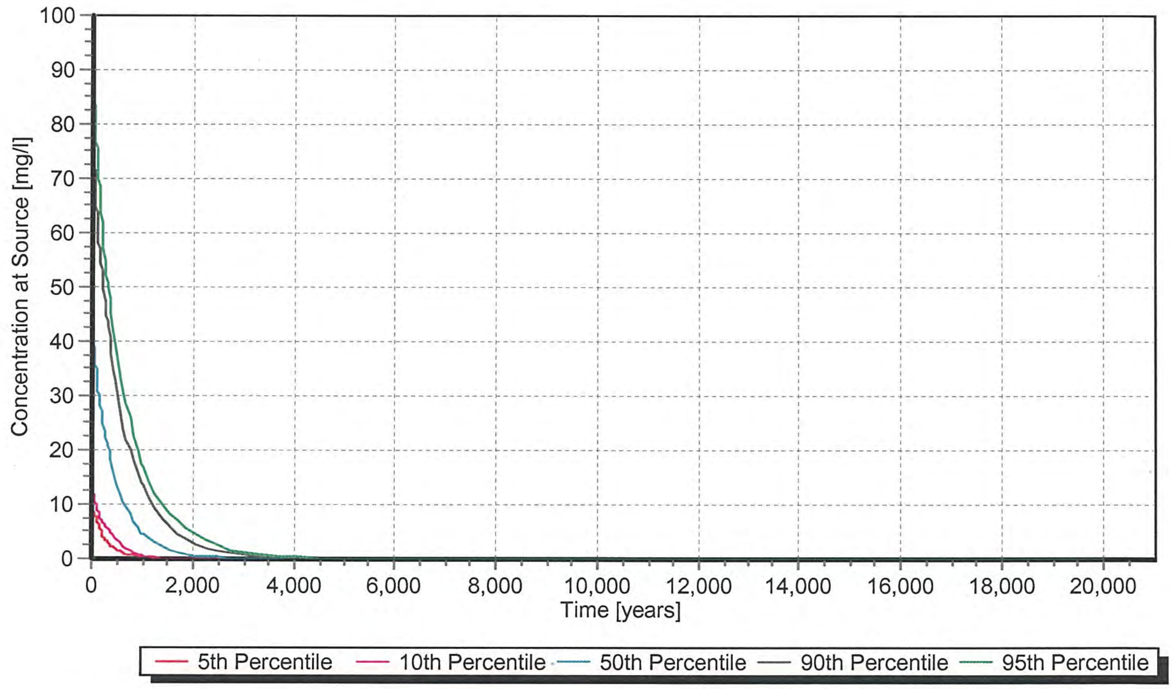
LandSim Version 2.5

FIGURE 20A

Project Name: Docksway Area 2

Customer:Newport City Council

Results: Area 2, Mineral Oil (aliphatic hydrocarbons) Concentration at Source [mg/l]



\Area2-DrftJ-Master.sim

11/04/2005 08:37:34

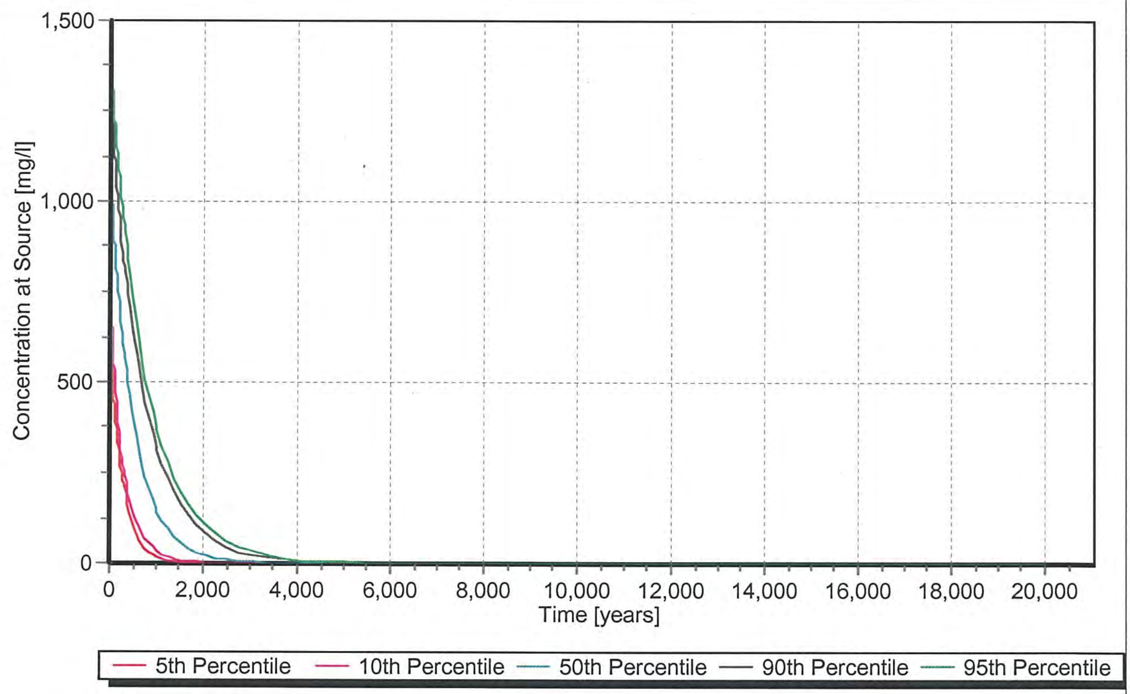
LandSim Version 2.5

FIGURE 20B

Project Name: Docksway Area 2

Customer:Newport City Council

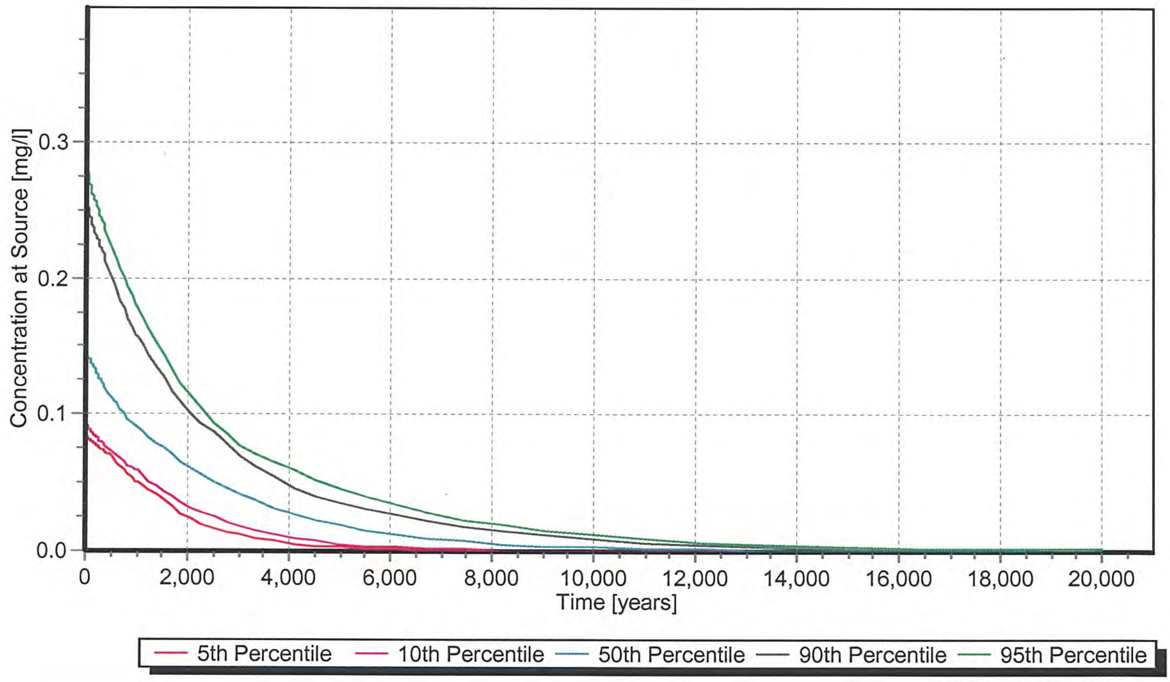
Results: Area 2, Ammoniacal_N Concentration at Source [mg/l]



\Area2-DrftJ-Master.sim

11/04/2005 08:37:34

LandSim Version 2.5	FIGURE 20C
Project Name: Docksway Area 2 Customer:Newport City Council	
Results: Area 2, Arsenic Concentration at Source [mg/l]	



\Area2-DrftJ-Master.sim 11/04/2005 08:37:34

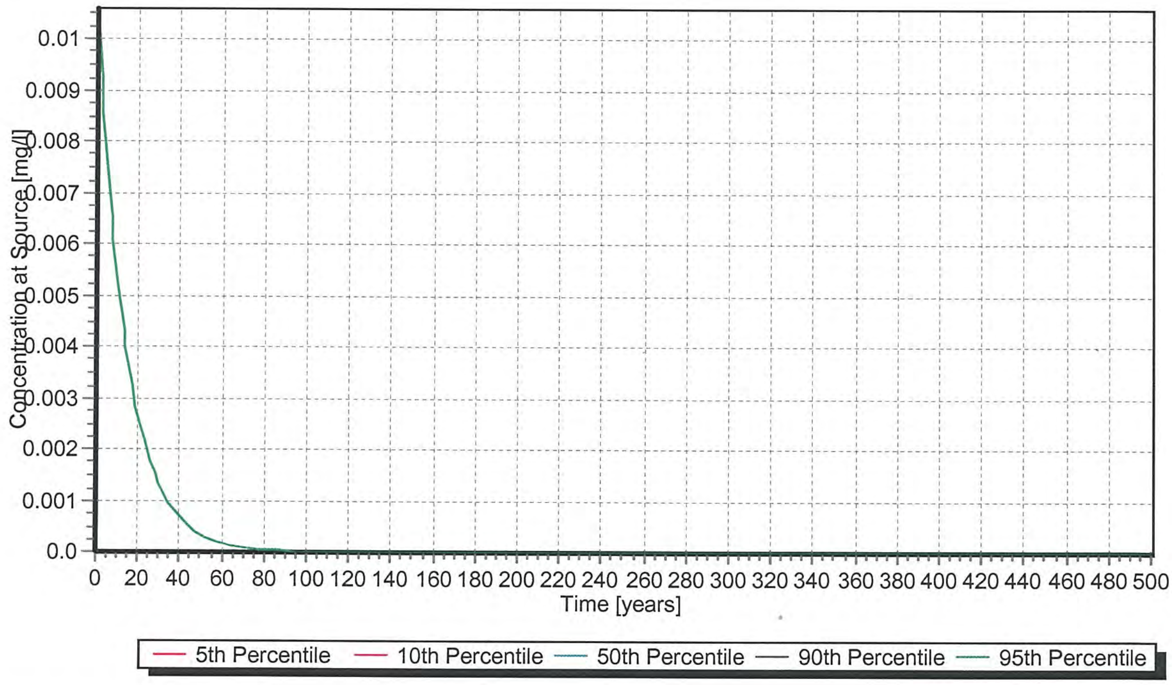
LandSim Version 2.5

FIGURE 20D

Project Name: Docksway Area 2

Customer:Newport City Council

Results: Area 2, Benzene Concentration at Source [mg/l]



\Area2-DrftJ-Master.sim

11/04/2005 08:37:34

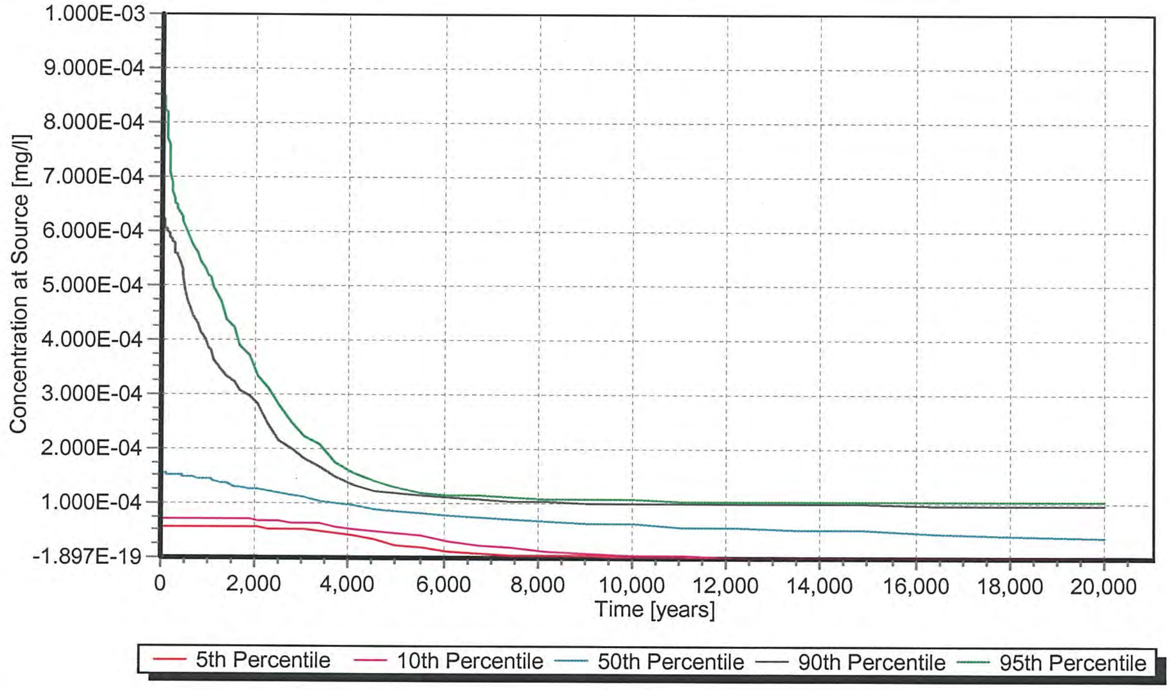
LandSim Version 2.5

FIGURE 20E

Project Name: Docksway Area 2

Customer:Newport City Council

Results: Area 2, Mercury Concentration at Source [mg/l]



\Area2-DrftJ-Master.sim

11/04/2005 08:37:34

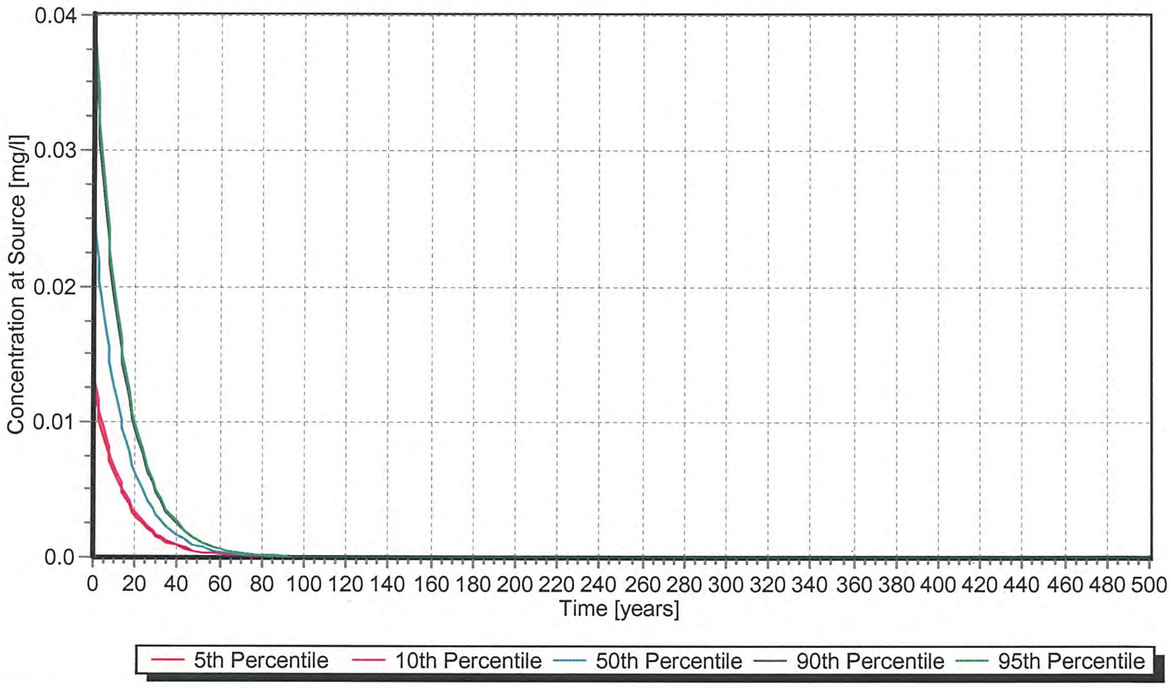
LandSim Version 2.5

FIGURE 20F

Project Name: Docksway Area 2

Customer:Newport City Council

Results: Area 2, Naphthalene Concentration at Source [mg/l]



\Area2-DrftJ-Master.sim

11/04/2005 08:37:34

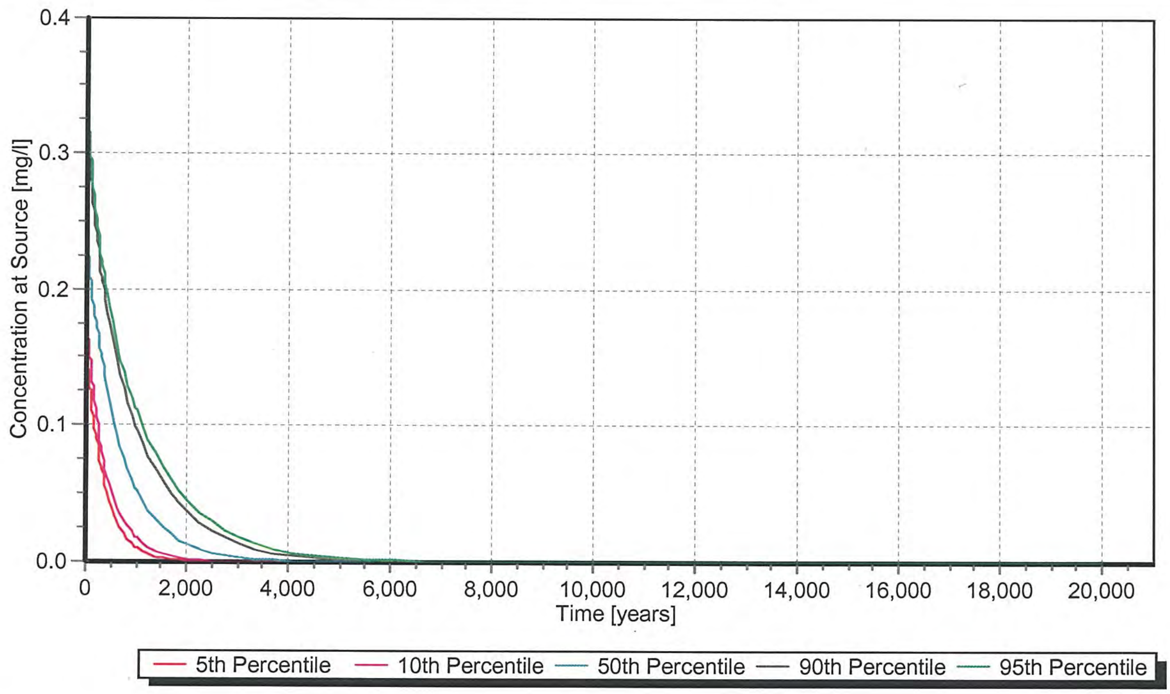
LandSim Version 2.5

FIGURE 20G

Project Name: Docksway Area 2

Customer:Newport City Council

Results: Area 2, Nickel Concentration at Source [mg/l]



\Area2-DrftJ-Master.sim

11/04/2005 08:37:34

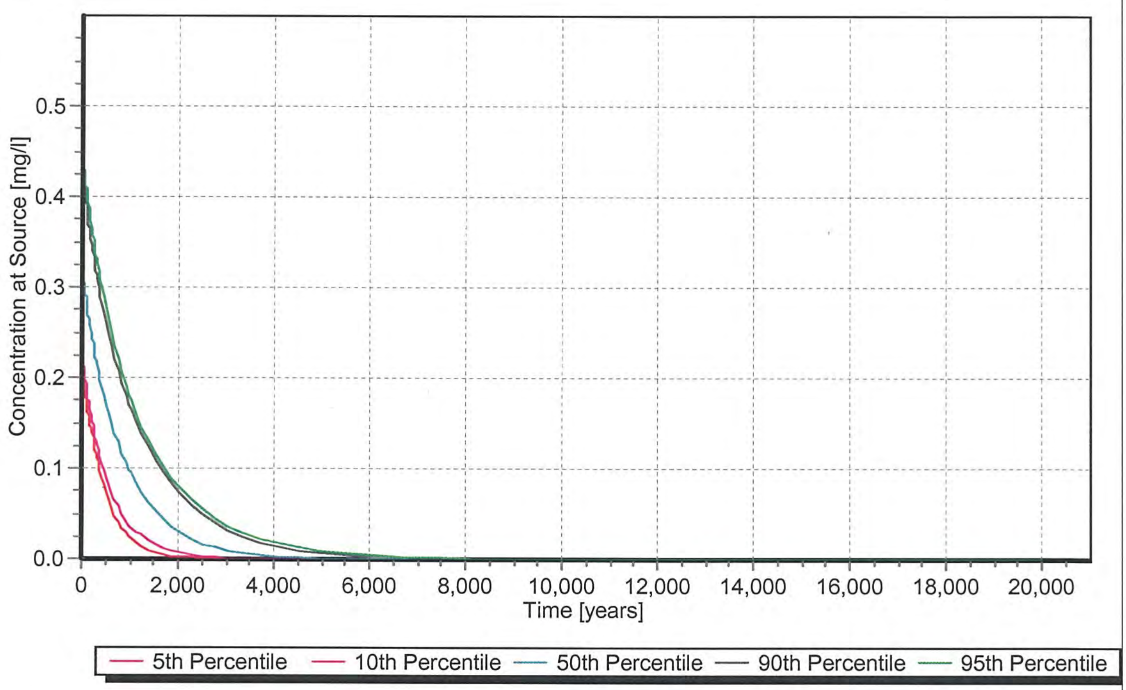
LandSim Version 2.5

FIGURE 20H

Project Name: Docksway Area 2

Customer:Newport City Council

Results: Area 2, Phenols Concentration at Source [mg/l]



\Area2-DrftJ-Master.sim

11/04/2005 08:37:34

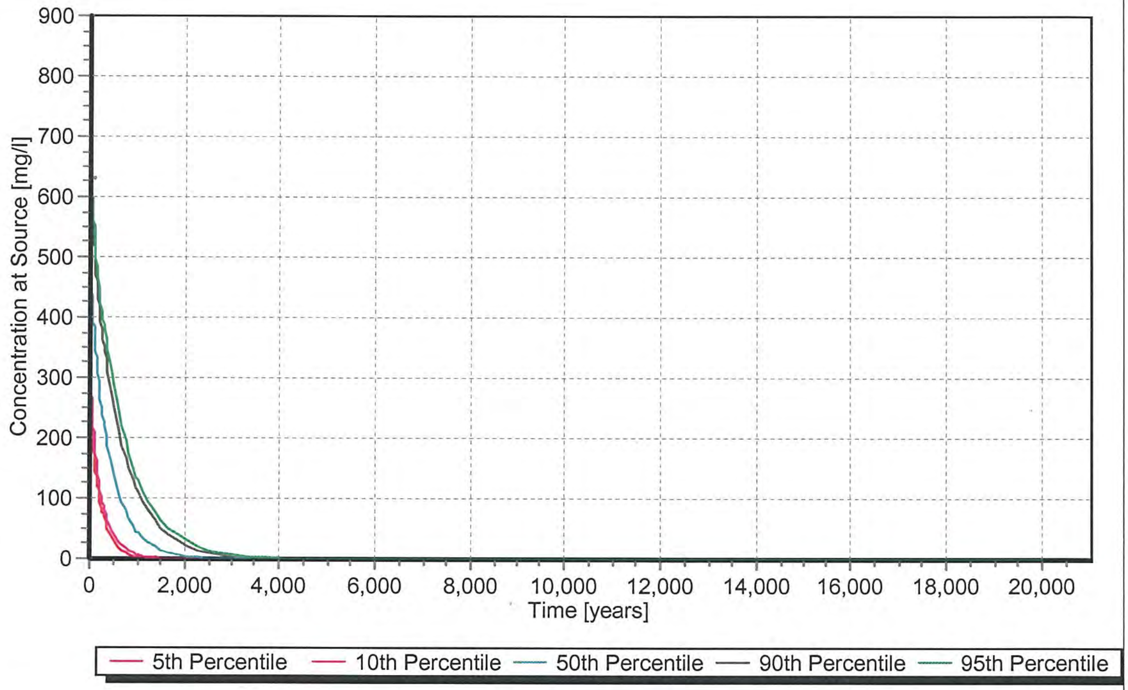
LandSim Version 2.5

FIGURE 201

Project Name: Docksway Area 2

Customer:Newport City Council

Results: Area 2, Potassium Concentration at Source [mg/l]



\Area2-DrftJ-Master.sim

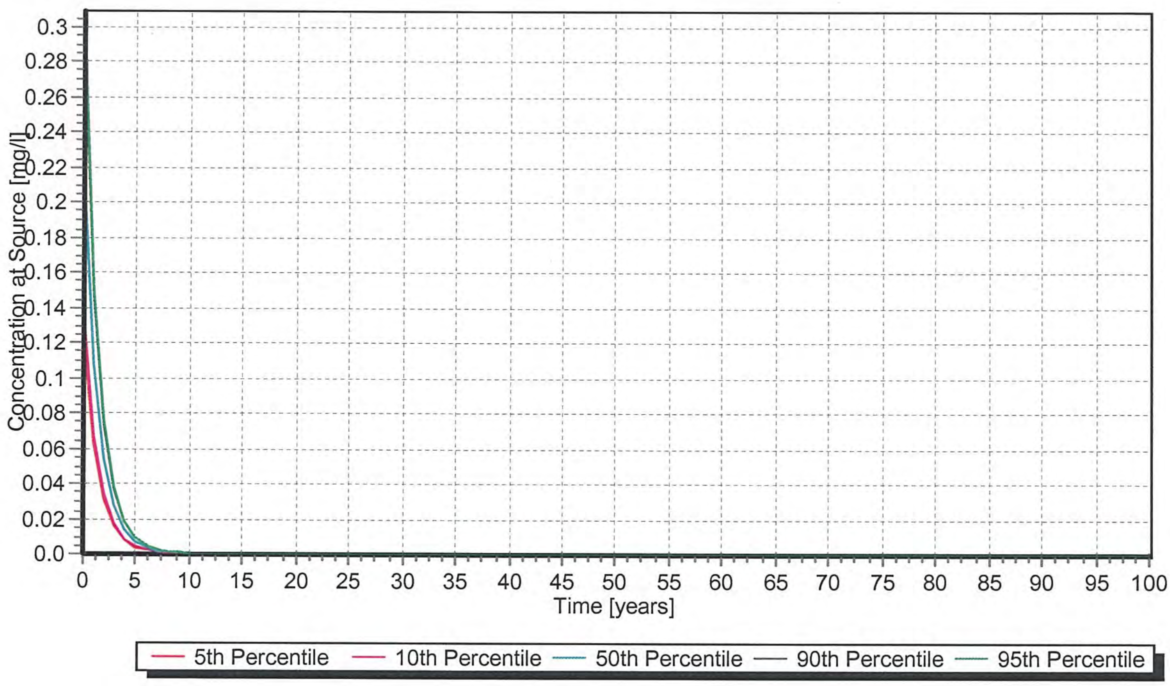
11/04/2005 08:37:34

LandSim Version 2.5	FIGURE 20J

Project Name: Docksway Area 2

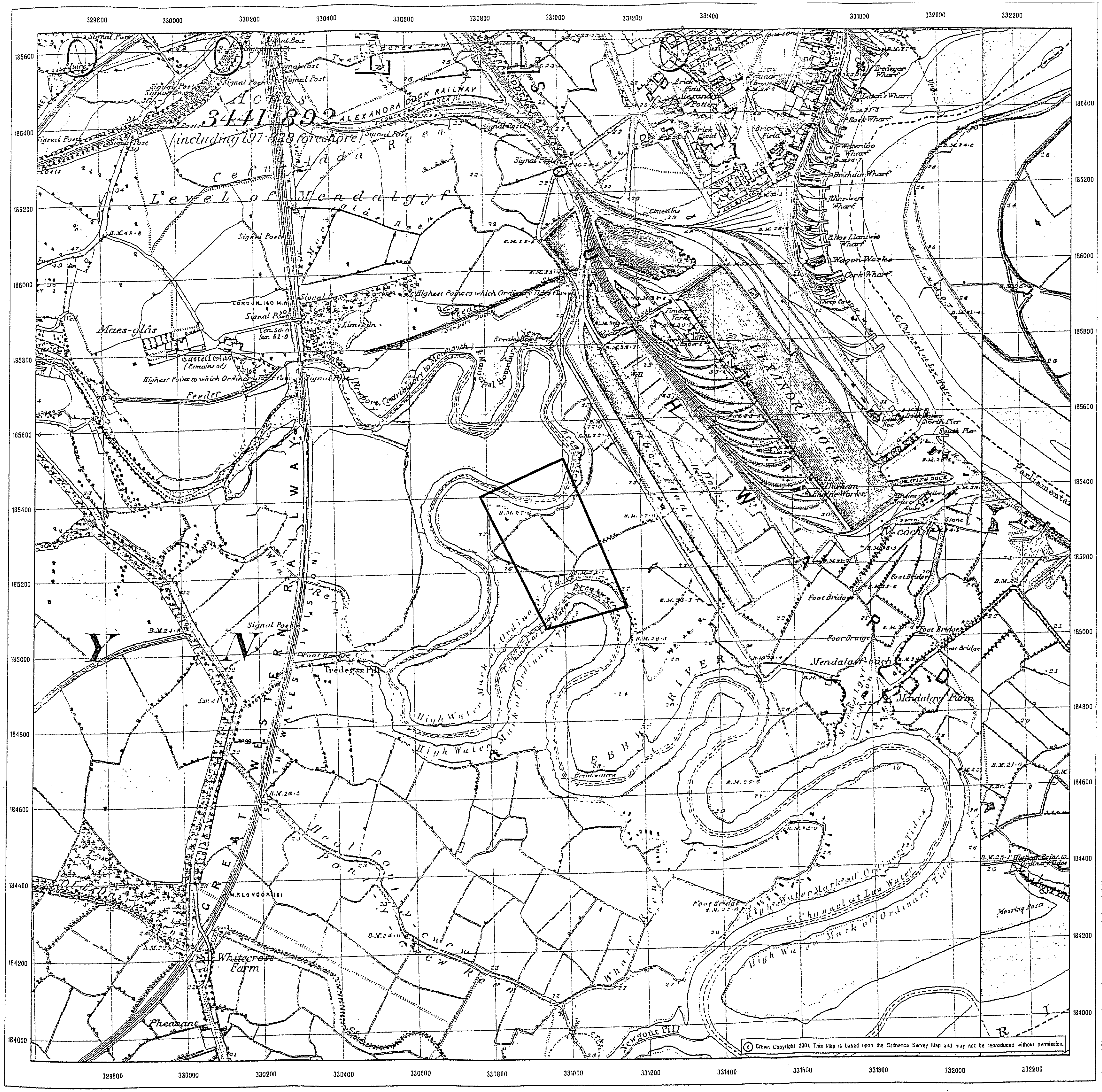
Customer:Newport City Council

Results: Area 2, Xylene Concentration at Source [mg/l]



\Area2-DrftJ-Master.sim	11/04/2005 08:37:34

APPENDIX 1



peter brett associates
CONSULTING ENGINEERS

CLIENT DETAILS

Envirocheck Order No. EC80040_1_1
(19-Sep-2001 10:05)

Customer Ref: .11938/002
Peter Brett Associates'
Snook House 66 Tilehurst Road
READING
Berkshire RG30 2JH

SITE DETAILS

Grid Reference 330970 185270

Docks Way Waste Disposal Site
Newport

Historical Map Legend

Quarry · Shingle · Railway over Road · Road over Railway · Railway over River · Gravel Pit · Sand Pit · Level Crossing · Other Pits · Road over River or Canal · Road over Stream · Mixed Wood · Rough Pasture · Road over Stream · Marsh · Sunken Road · Raised Road · Sketched Contour · Instrumental Contour

Arrow denotes flow of water

MONMOUTHSHIRE

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given on the right therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

In the late 1940's, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

North

Map Scale=1:10,000

1887 | 1887

Date(s) of Publication

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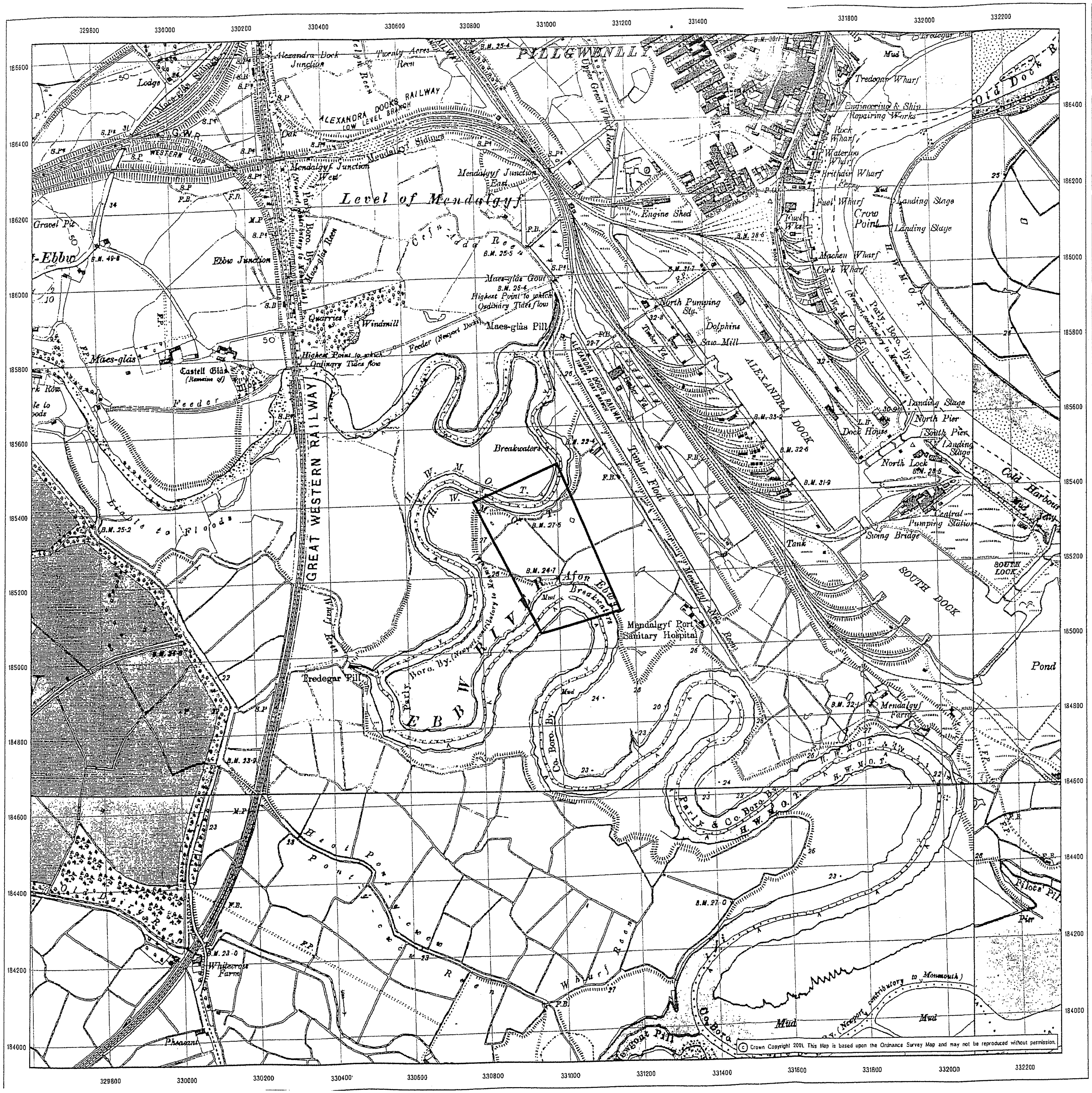
Exeter EX2 7HY
Telephone 01392 441729 Fax 01392 441709



peter brett associates
CONSULTING ENGINEERS

CLIENT DETAILS

Envirocheck Order No. EC80040_1_1
(19-Sep-2001 10:08)

Customer Ref: .11938/002
Peter Brett Associates
Snook House 66 Tilehurst Road
READING
Berkshire RG30 2JH

SITE DETAILS

Grid Reference 330970 185270

Docks Way Waste Disposal Site
Newport

Historical Map Legend

Quarry
Shingle
Railway over Road
Road over Railway
Railway over River
Gravel Pit
Sand Pit
Level Crossing
Other Pits
Road over River or Canal
Road over Stream
Mixed Wood
Rough Pasture
Road over Stream
Marsh
Sunken Road
Raised Road
Sketched Contour
Instrumental Contour
Arrow denotes flow of water

MONMOUTHSHIRE

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given on the right therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

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North

Map Scale=1:10,000

1902	1902
1902	1902

Date(s) of Publication

Ordnance Survey
Licensed Partner

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7 Abbey Court, Eagle Way, Sowton
Exeter EX2 7HY
Telephone 01392 441729 Fax 01392 441709

peter brett associates
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CLIENT DETAILS

Envirocheck Order No. EC80040_1_1 (19-Sep-2001 10:11)

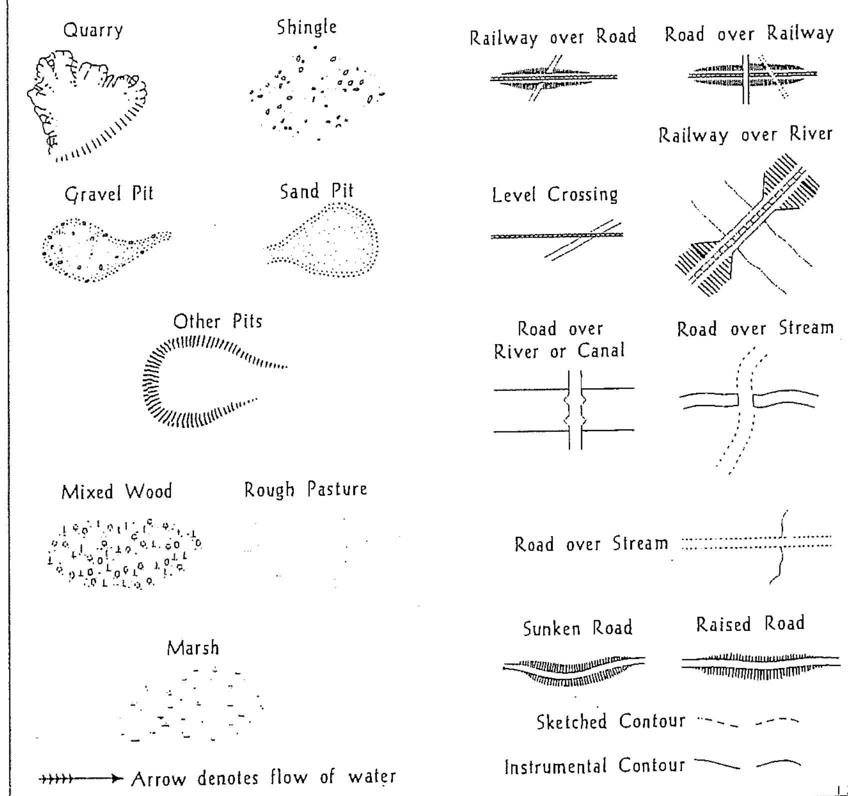
Customer Ref: .11938/002
Peter Brett Associates
Snook House 66 Tilehurst Road
READING
Berkshire RG30 2JH

SITE DETAILS

Grid Reference 330970 185270

Docks Way Waste Disposal Site
Newport

Historical Map Legend



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The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given on the right therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

In the late 1940's, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

North

Map Scale=1:10,000

1922	1922
1922	1922

Date(s) of Publication

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LANDMARK Telephone 01392 441729 Fax 01392 441709

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(19-Sep-2001 10:13)

CLIENT DETAILS

Customer Ref: 11938/002
Peter Brett Associates
Snook House 66 Tilehurst Road
READING
Berkshire RG30 2JH

SITE DETAILS

Grid Reference 330970 185270

Docks Way Waste Disposal Site
Newport

Historical Map Legend

Quarry
Shingle
Railway over Road
Road over Railway
Railway over River
Gravel Pit
Sand Pit
Level Crossing
Other Pits
Road over River or Canal
Road over Stream
Mixed Wood
Rough Pasture
Road over Stream
Marsh
Sunken Road
Raised Road
Sketched Contour
Instrumental Contour
Arrow denotes flow of water

MONMOUTHSHIRE

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given on the right therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

In the late 1940's, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

North

Map Scale=1:10,000

1954	1938
1954	1954

Date(s) of Publication

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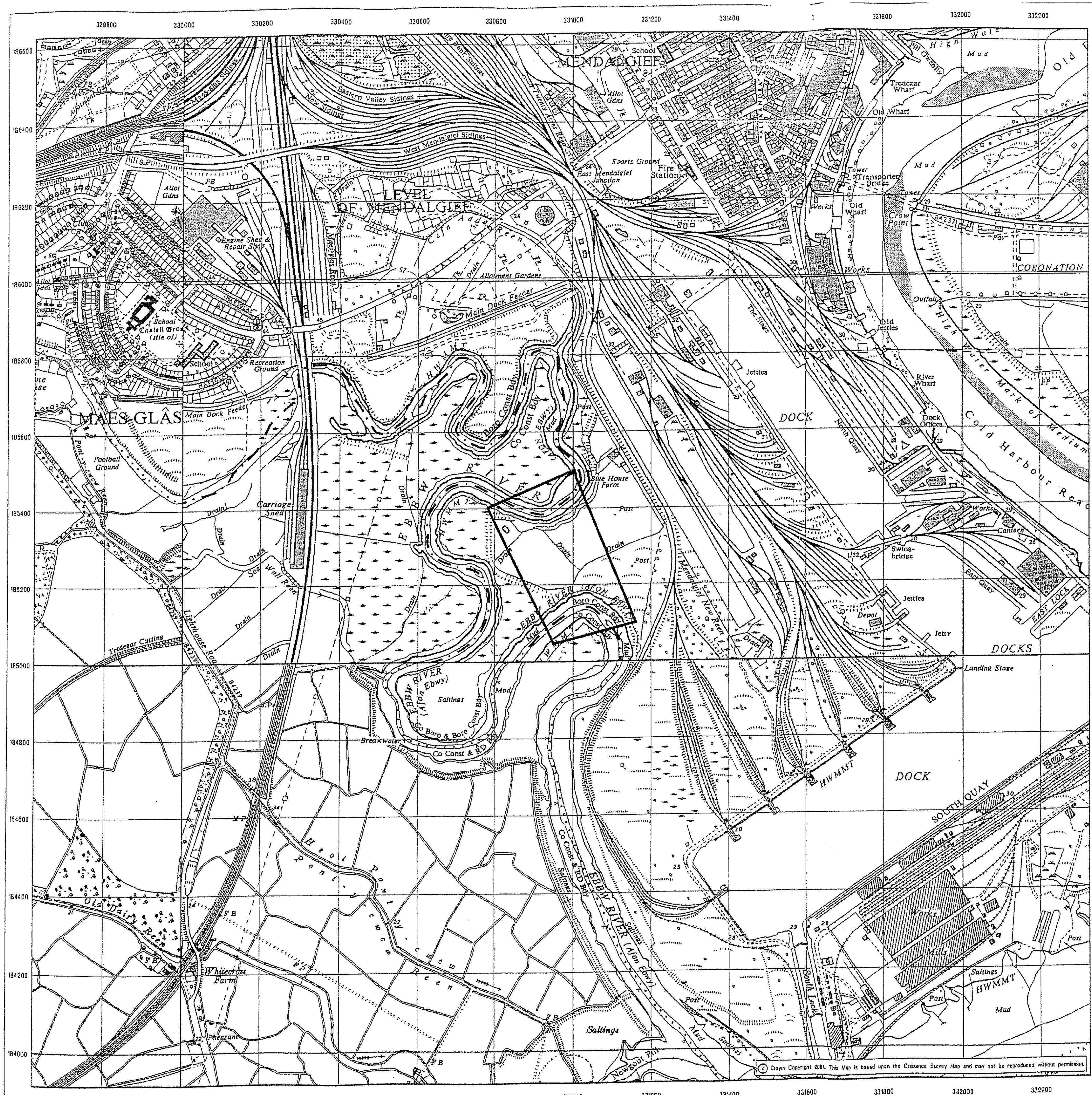
Exeter EX2 7HY
Telephone 01392 441729 Fax 01392 441709



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peter brett associates
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CLIENT DETAILS

Envirocheck Order No. EC80040_1_1
(19-Sep-2001 10:15)

Customer Ref: .11938/002
Peter Brett Associates'
Snook House 66 Tilehurst Road
READING
Berkshire RG30 2JH

SITE DETAILS

Grid Reference 330970 185270

Docks Way Waste Disposal Site
Newport

Historical Map Legend

Quarry
Shingle
Railway over Road
Road over Railway
Railway over River
Gravel Pit
Sand Pit
Level Crossing
Other Pits
Road over River or Canal
Road over Stream
Mixed Wood
Rough Pasture
Road over Stream
Marsh
Sunken Road
Raised Road
Sketched Contour
Instrumental Contour
Arrow denotes flow of water

ORDNANCE SURVEY PLAN

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given on the right therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

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North

Map Scale=1:10,000

1964	1965
1964	1964

Date(s) of Publication

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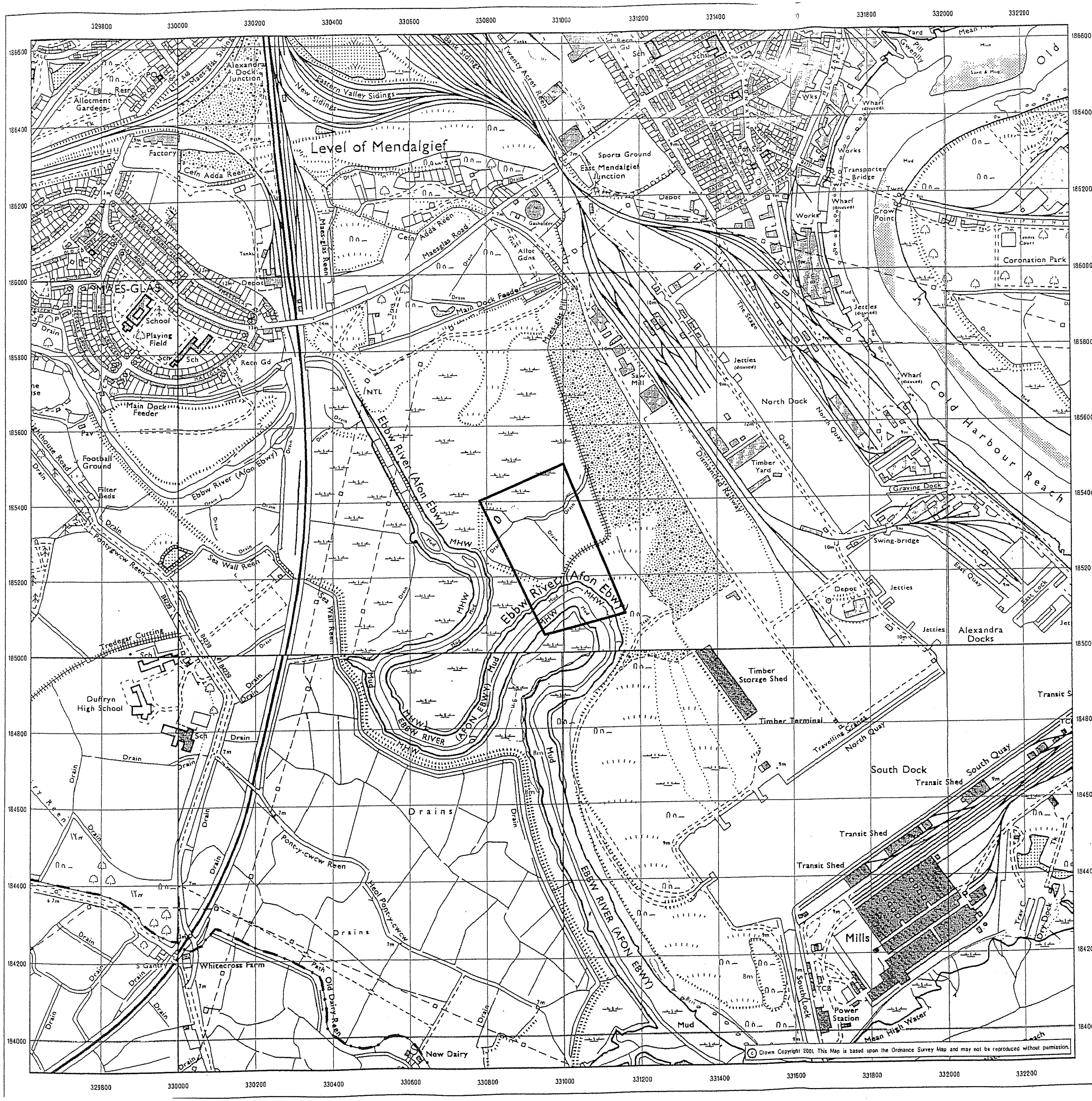
Telephone 01392 441729 Fax 01392 441709



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Envirocheck Order No. EC80040_1_1
(19-Sep-2001 10:19)

Customer Ref: .11938/002
Peter Brett Associates'
Snook House 66 Tilehurst Road
READING
Berkshire RG30 2JH

SITE DETAILS

Grid Reference 330970 185270

Docks Way Waste Disposal Site
Newport

Historical Map Legend

Chalk Pit, Clay Pit or Quarry
Gravel Pit
Sand Pit
Disused Pit or Quarry
Refuse or Slag Heap
Lake, Loch or Pond
Non-Coniferous Trees
Coniferous Trees
Scrub
Pylon
Pole
Electricity Transmission Line
Direction of Flow of Water
Shingle
Sand
Bracken
Heath
Rough Grassland
Reeds
Marsh
Saltings
Cutting
Embankment
Standard Gauge Multiple Track
Road Under
Road Over
Level Crossing
Foot Bridge
Standard Gauge Single Track
Siding, Tramway or Mineral Line
Narrow Gauge

ORDNANCE SURVEY PLAN

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given on the right therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

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North

Map Scale=1:10,000

1972	1973
1970	1972

Date(s) of Publication

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Exeter EX2 7HY
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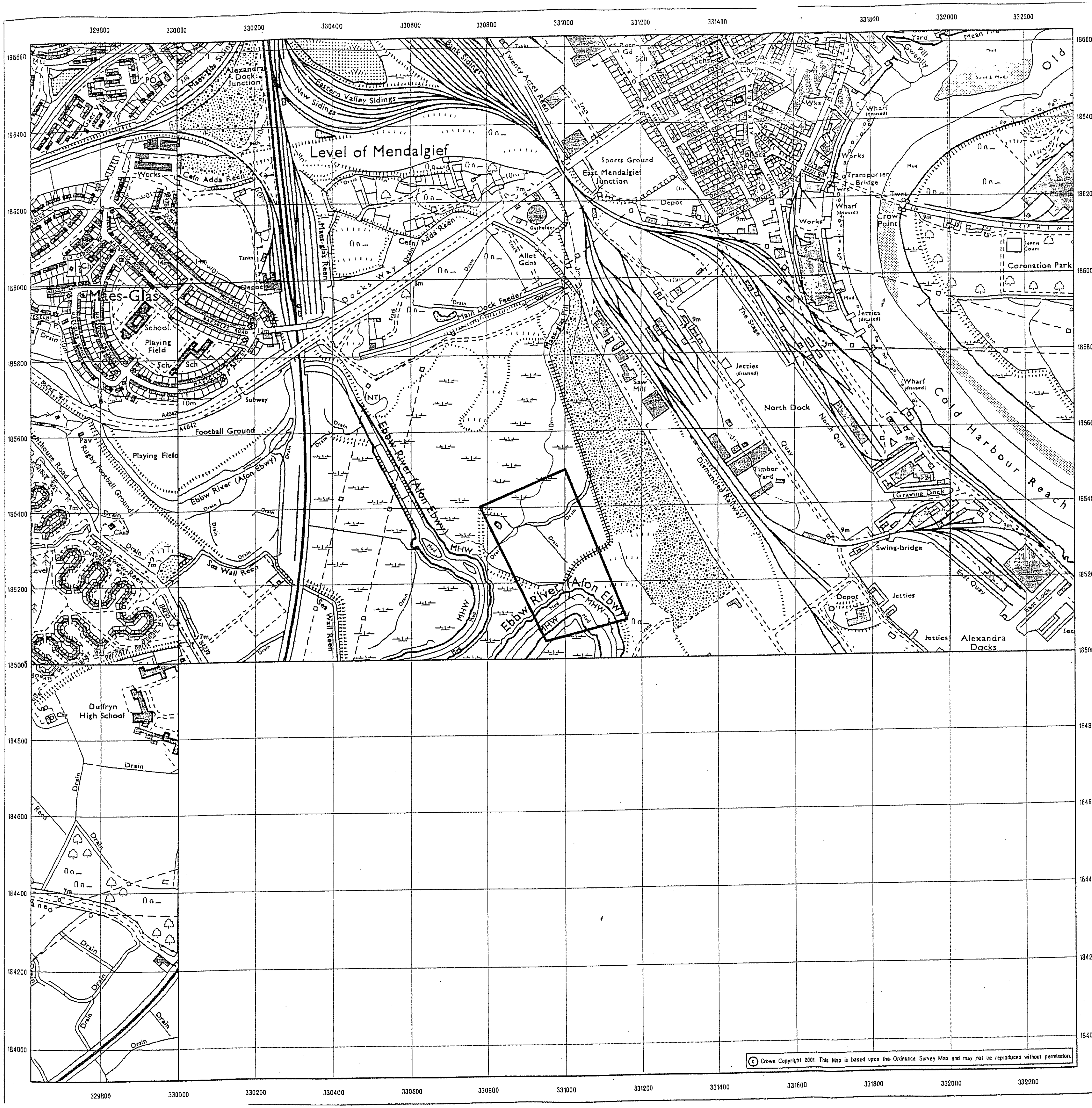

peter brett associates
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CLIENT DETAILS

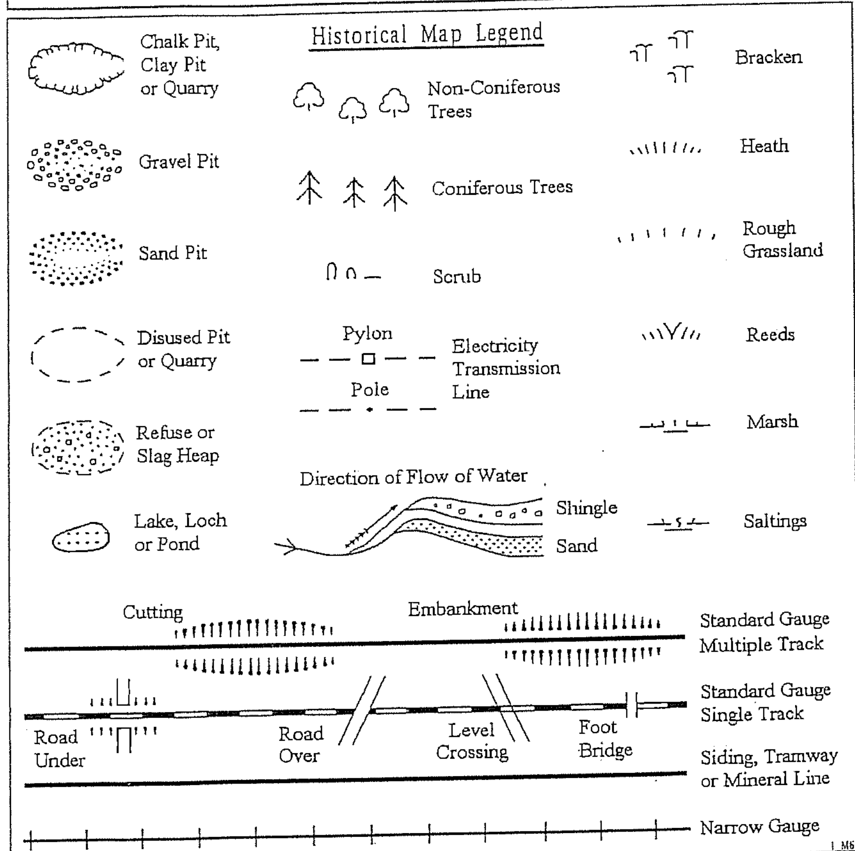
Envirocheck Order No. EC80040_1_1
(19-Sep-2001 10:21)

Customer Ref: 11938/002
Peter Brett Associates
Snook House 66 Tilehurst Road
READING
Berkshire RG30 2JH

SITE DETAILS

Grid Reference 330970 185270

Docks Way Waste Disposal Site
Newport



ORDNANCE SURVEY PLAN

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given on the right therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

In the late 1940's, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

North

Map Scale=1:10,000

1982	1981
1989	

Date(s) of Publication

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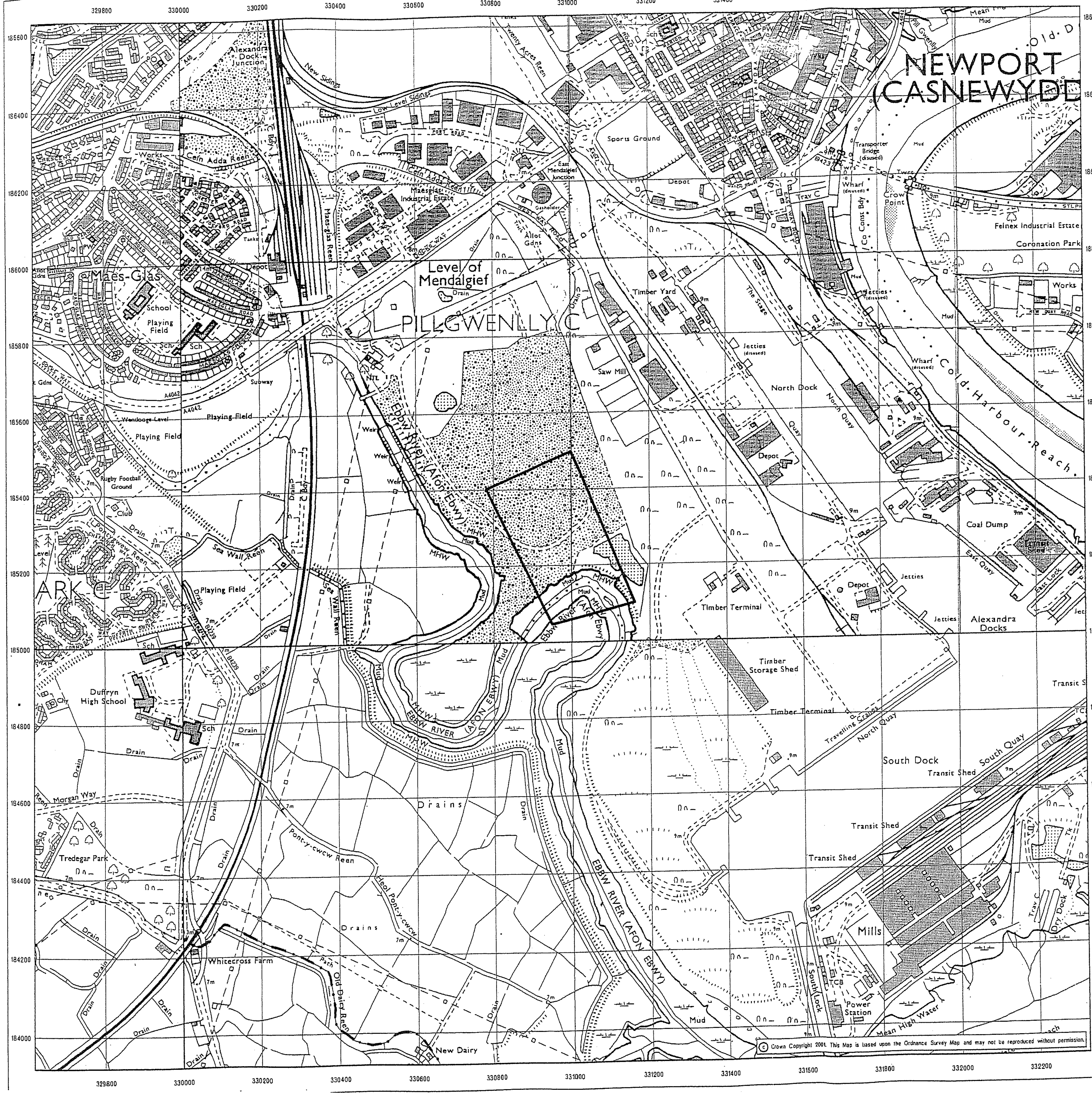
Exeter EX2 7HY
Telephone 01392 441729 Fax 01392 441709



pba peter brett associates CONSULTING ENGINEERS

CLIENT DETAILS

Envirocheck Order No. EC80040_1_1 (19-Sep-2001 10:24)

Customer Ref: .11938/002
Peter Brett Associates'
Snook House 66 Tilehurst Road
READING
Berkshire RG30 2JH

SITE DETAILS

Grid Reference 330970 185270

Docks Way Waste Disposal Site
Newport

Historical Map Legend

- Chalk Pit, Clay Pit or Quarry
- Gravel Pit
- Sand Pit
- Disused Pit or Quarry
- Refuse or Slag Heap
- Lake, Loch or Pond
- Non-Coniferous Trees
- Coniferous Trees
- Scrub
- Pylon / Pole — Electricity Transmission Line
- Direction of Flow of Water
- Shingle
- Sand
- Bracken
- Heath
- Rough Grassland
- Reeds
- Marsh
- Saltings
- Cutting
- Embankment
- Standard Gauge Multiple Track
- Standard Gauge Single Track
- Road Under
- Road Over
- Level Crossing
- Foot Bridge
- Siding, Tramway or Mineral Line
- Narrow Gauge

1 M7

ORDNANCE SURVEY PLAN

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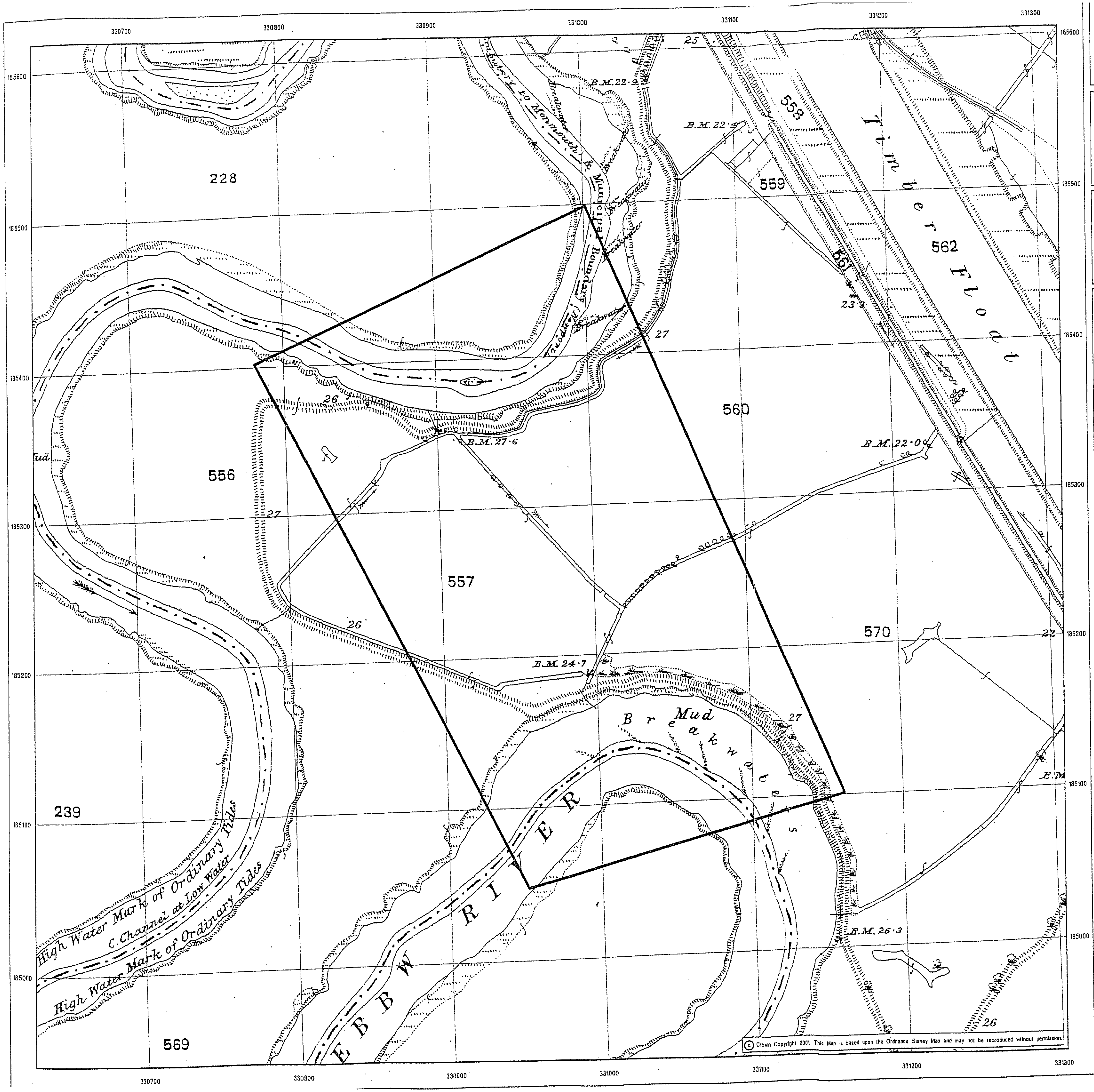
In the late 1940's, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

North

Map Scale=1:10,000

1992	1994
1996	1972

Date(s) of Publication



peter brett associates
CONSULTING ENGINEERS

CLIENT DETAILS

Envirocheck Order No. EC80040_1_1
(19-Sep-2001 09:46)

Customer Ref: 11938/002
Peter Brett Associates
Snook House 66 Tilehurst Road
READING
Berkshire RG30 2JH

SITE DETAILS

Grid Reference 330970 185270

Docks Way Waste Disposal Site
Newport

Historical Map Legend

Quarry, Shingle, Railway over Road, Road over Railway, Railway over River, Gravel Pit, Sand Pit, Level Crossing, Other Pits, Road over River or Canal, Road over Stream, Mixed Wood, Rough Pasture, Road over Stream, Marsh, Sunken Road, Raised Road, Sketched Contour, Instrumental Contour

Arrow denotes flow of water

MONMOUTHSHIRE

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given on the right is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

1884

North

Map Scale=1:2,500

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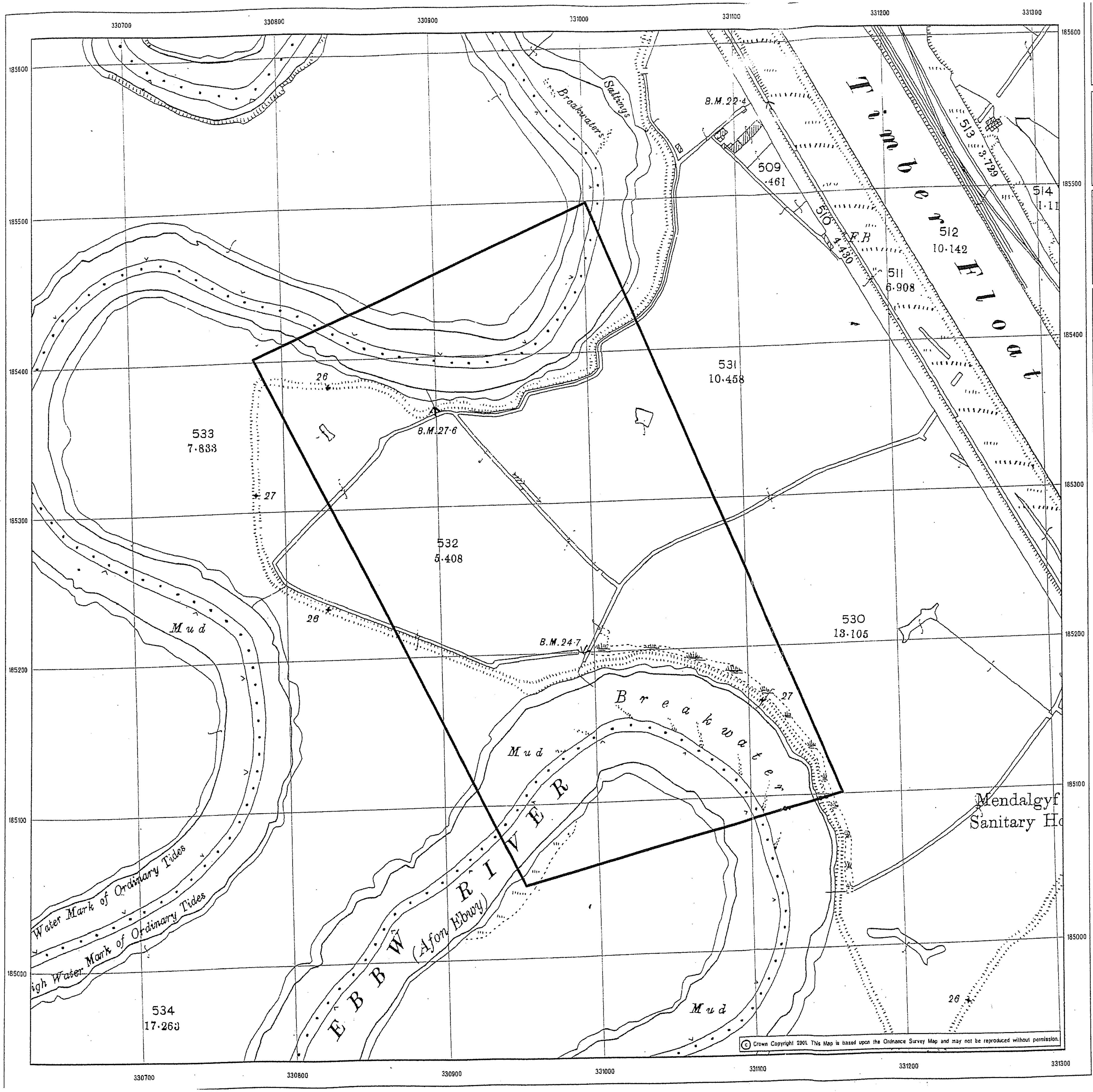

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peter brett associates
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CLIENT DETAILS

Envirocheck Order No. EC80040_1_1
(19-Sep-2001 09:48)

Customer Ref: 11938/002
Peter Brett Associates
Snook House 66 Tilehurst Road
READING
Berkshire RG30 2JH

SITE DETAILS

Grid Reference 330970 185270

Docks Way Waste Disposal Site
Newport

Historical Map Legend

Quarry
Shingle
Railway over Road
Road over Railway
Railway over River
Gravel Pit
Sand Pit
Level Crossing
Other Pits
Road over River or Canal
Road over Stream
Mixed Wood
Rough Pasture
Road over Stream
Marsh
Sunken Road
Raised Road
Sketched Contour
Instrumental Contour
Arrow denotes flow of water

MONMOUTHSHIRE

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given on the right is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

North

Map Scale=1:2,500

1901

Ordnance Survey
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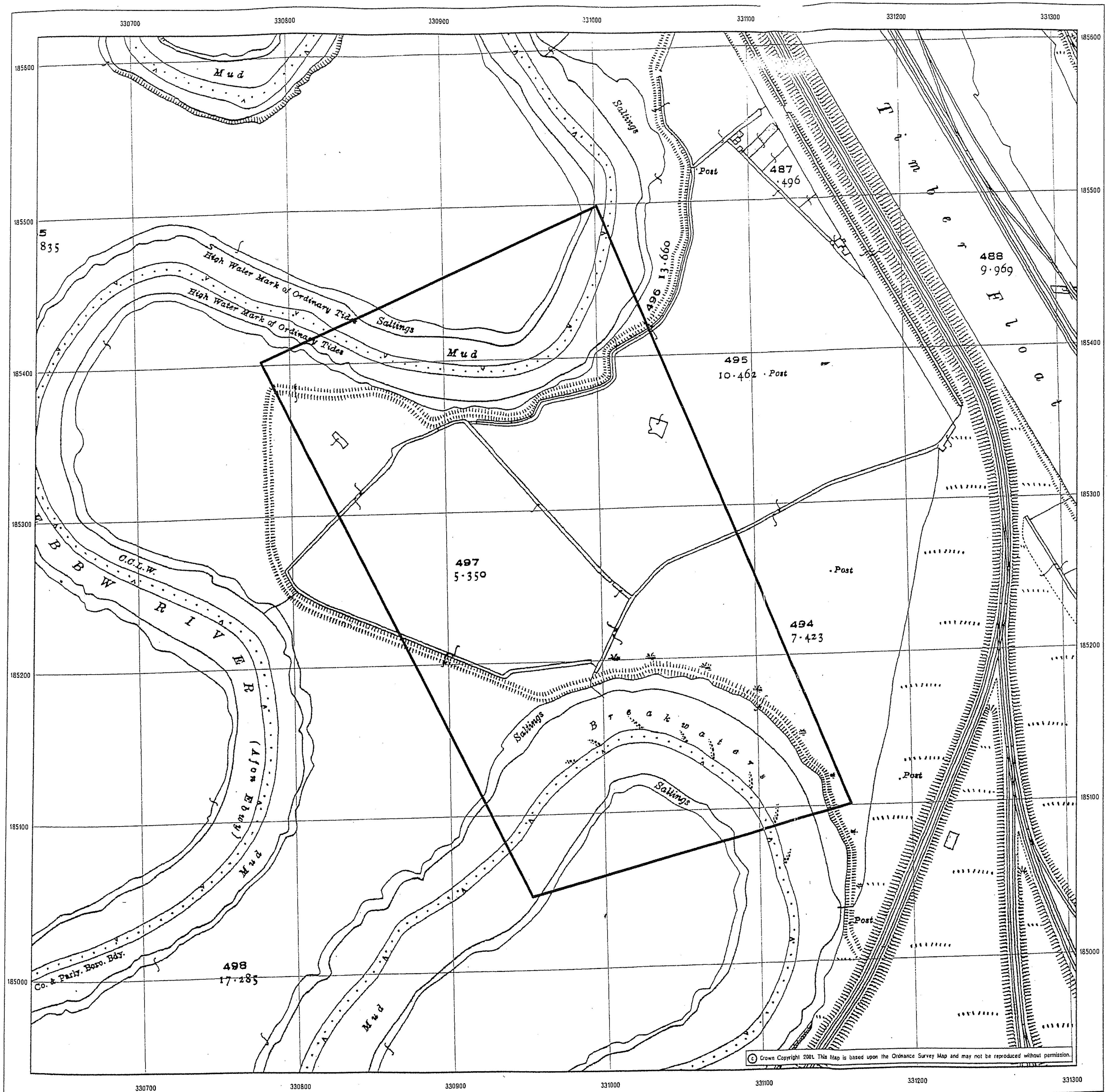
Exeter EX2 7HY
LANDMARK Telephone 01392 441729 Fax 01392 441709



peter brett associates
CONSULTING ENGINEERS

CLIENT DETAILS

Envirocheck Order No. EC80040_1_1
(19-Sep-2001 09:50)

Customer Ref: 11938/002
Peter Brett Associates
Snook House 66 Tilehurst Road
READING
Berkshire RG30 2JH

SITE DETAILS

Grid Reference 330970 185270

Docks Way Waste Disposal Site
Newport

Historical Map Legend

- Quarry
- Shingle
- Railway over Road
- Road over Railway
- Railway over River
- Gravel Pit
- Sand Pit
- Level Crossing
- Other Pits
- Road over River or Canal
- Road over Stream
- Mixed Wood
- Rough Pasture
- Road over Stream
- Marsh
- Sunken Road
- Raised Road
- Sketched Contour
- Instrumental Contour
- Arrow denotes flow of water

MONMOUTHSHIRE

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given on the right is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

North

Map Scale=1:2,500

1921

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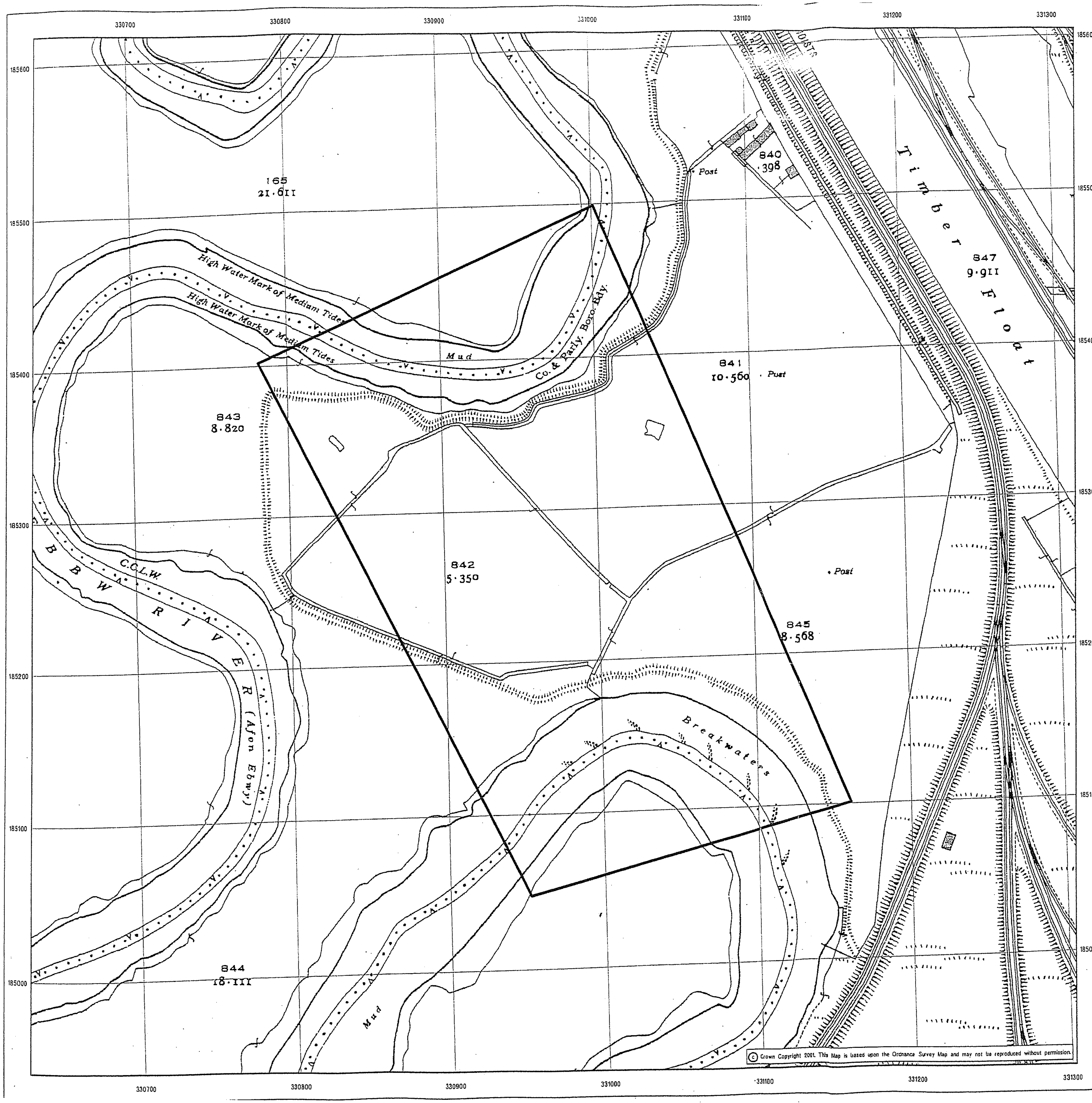
Exeter EX2 7HY
Telephone 01392 441729 Fax 01392 441709



peter brett associates
CONSULTING ENGINEERS

CLIENT DETAILS

Envirocheck Order No. EC80040_1_1
(19-Sep-2001 09:51)

Customer Ref: 11938/002
Peter Brett Associates
Snook House 66 Tilehurst Road
READING
Berkshire RG30 2JH

SITE DETAILS

Grid Reference 330970 185270

Docks Way Waste Disposal Site
Newport

Historical Map Legend

Quarry
Shingle
Railway over Road
Road over Railway
Railway over River
Gravel Pit
Sand Pit
Level Crossing
Other Pits
Road over River or Canal
Road over Stream
Mixed Wood
Rough Pasture
Road over Stream
Marsh
Sunken Road
Raised Road
Sketched Contour
Instrumental Contour
Arrow denotes flow of water

MONMOUTHSHIRE

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given on the right is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

1937

North

Map Scale=1:2,500

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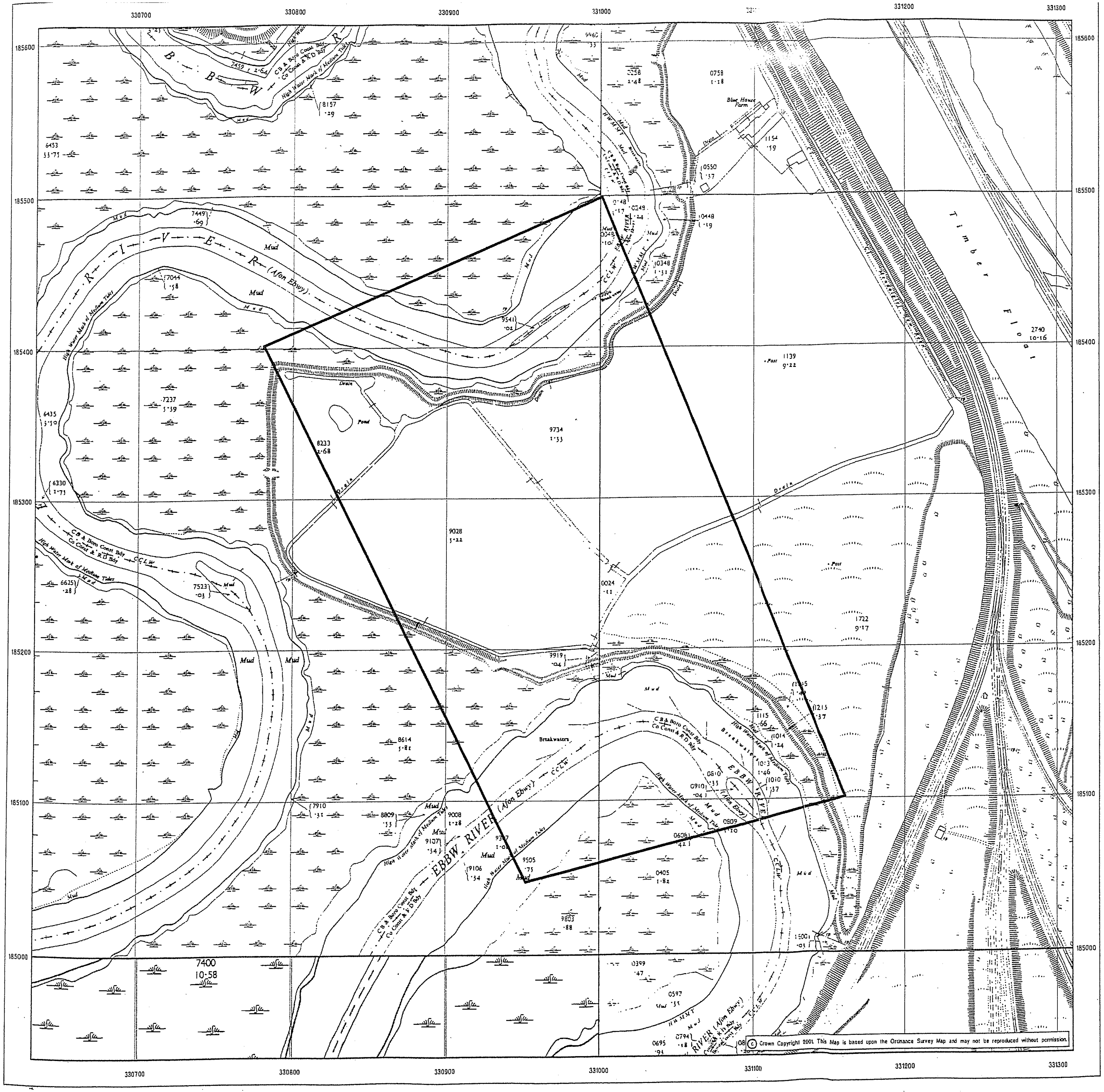
Telephone 01392 441729 Fax 01392 441709



peter brett associates
CONSULTING ENGINEERS

CLIENT DETAILS

Envirocheck Order No. EC80040_1_1
(19-Sep-2001 09:53)

Customer Ref: 11938/002
Peter Brett Associates
Snook House 66 Tilehurst Road
READING
Berkshire RG30 2JH

SITE DETAILS

Grid Reference 330970 185270

Docks Way Waste Disposal Site
Newport

Historical Map Legend

Chalk Pit, Clay Pit or Quarry
Gravel Pit
Sand Pit
Disused Pit or Quarry
Refuse or Slag Heap
Lake, Loch or Pond
Non-Coniferous Trees
Coniferous Trees
Scrub
Pylon
Pole
Electricity Transmission Line
Direction of Flow of Water
Shingle
Sand
Bracken
Heath
Rough Grassland
Reeds
Marsh
Saltings
Cutting
Embankment
Standard Gauge Multiple Track
Road Under
Road Over
Level Crossing
Foot Bridge
Standard Gauge Single Track
Siding, Tramway or Mineral Line
Narrow Gauge

ORDNANCE SURVEY PLAN

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1895 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given on the right is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

1956	1956

North

Map Scale=1:2,500

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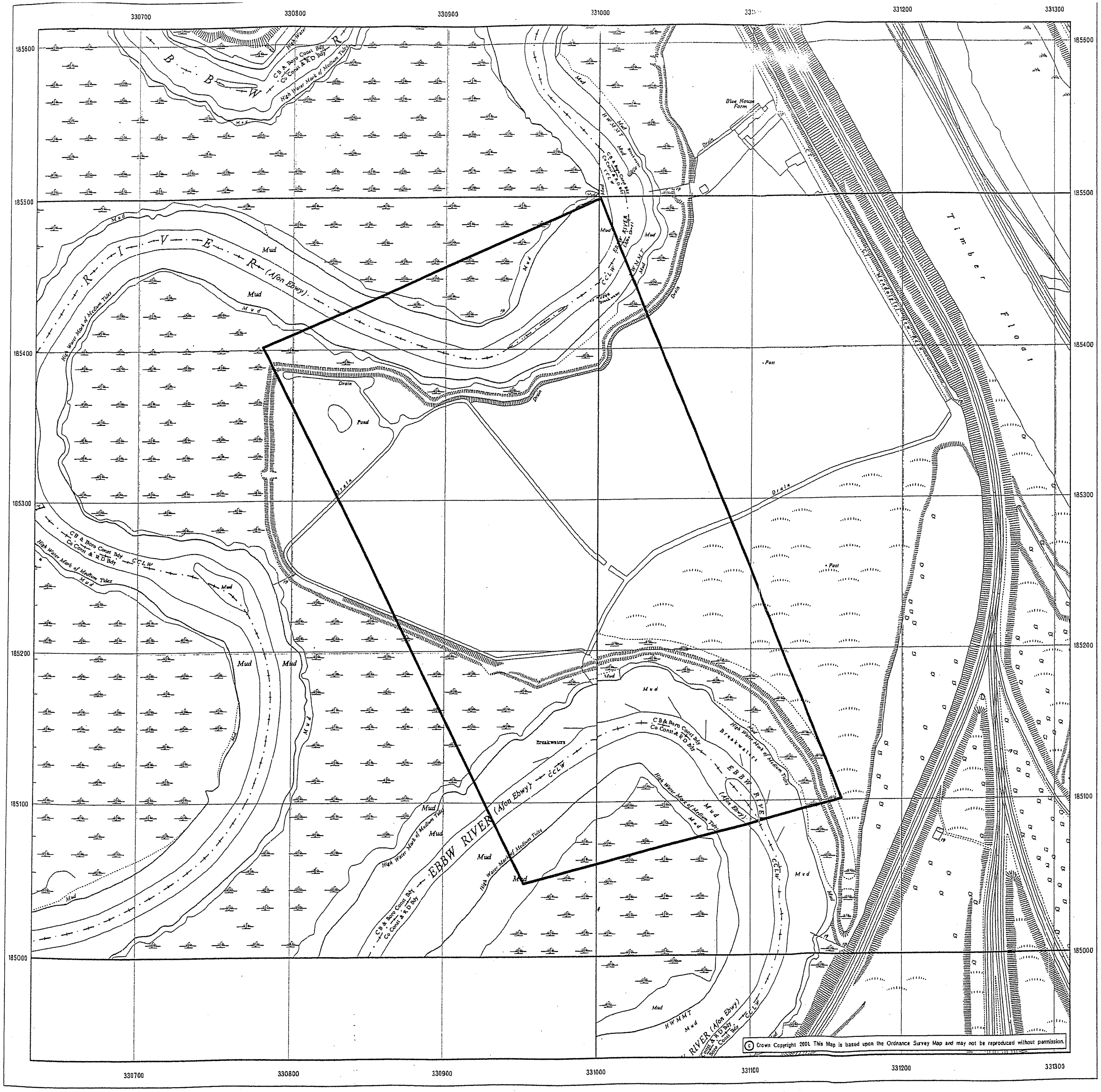

peter brett associates
CONSULTING ENGINEERS

CLIENT DETAILS

Envirocheck Order No. EC80040_1_1
(19-Sep-2001 09:57)

Customer Ref: J1938/002
Peter Brett Associates
Snook House 66 Tilehurst Road
READING
Berkshire RG30 2JH

SITE DETAILS

Grid Reference 330970 185270

Docks Way Waste Disposal Site
Newport

Historical Map Legend

- Chalk Pit, Clay Pit or Quarry
- Gravel Pit
- Sand Pit
- Disused Pit or Quarry
- Refuse or Slag Heap
- Lake, Loch or Pond
- Non-Coniferous Trees
- Coniferous Trees
- Scrub
- Pylon / Pole — Electricity Transmission Line
- Direction of Flow of Water
- Shingle
- Sand
- Bracken
- Heath
- Rough Grassland
- Reeds
- Marsh
- Saltings
- Cutting / Embankment — Standard Gauge Multiple Track
- Road Under / Road Over / Level Crossing / Foot Bridge — Standard Gauge Single Track
- Siding, Tramway or Mineral Line
- Narrow Gauge

ORDNANCE SURVEY PLAN

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given on the right is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

1956	1956
1956	1956

North

Map Scale=1:2,500

Ordnance Survey
Licensed Partner

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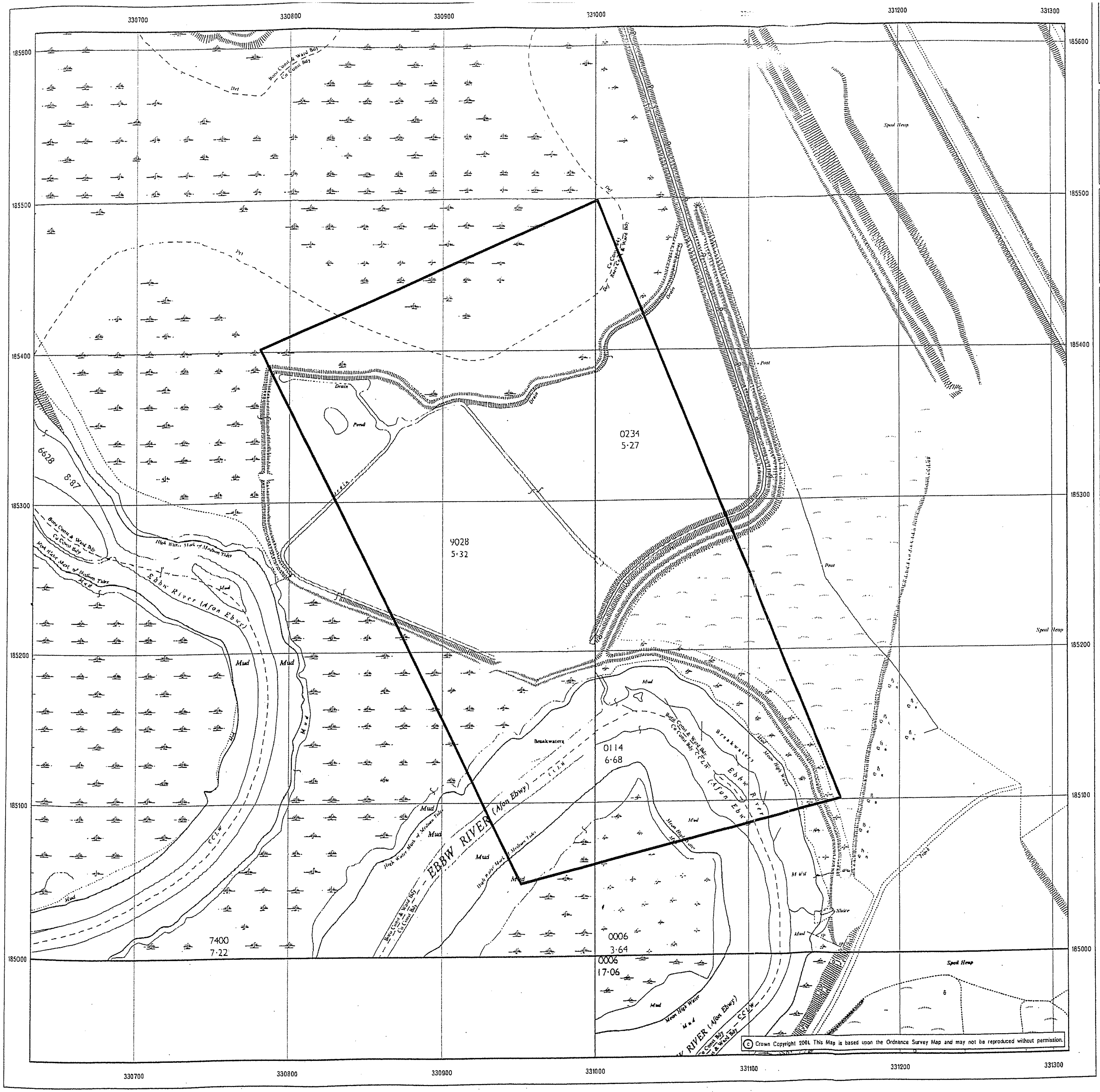
Exeter EX2 7HY
Telephone 01392 441729 Fax 01392 441709



peter brett associates
CONSULTING ENGINEERS

CLIENT DETAILS

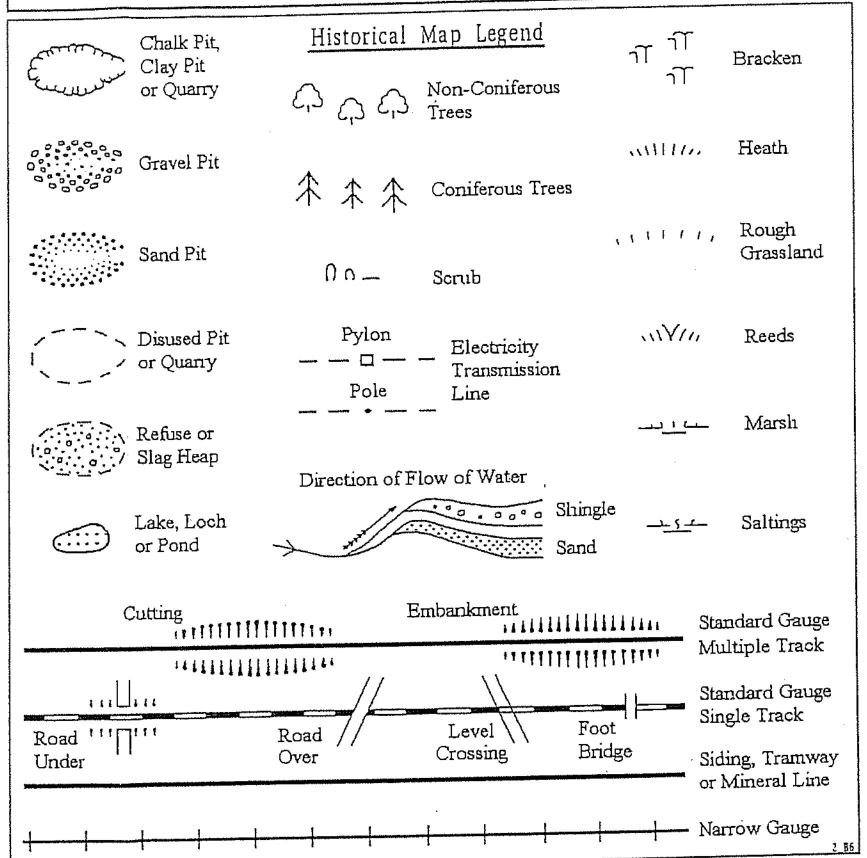
Envirocheck Order No. EC80040_1_1
(19-Sep-2001 09:55)

Customer Ref: 11938/002
Peter Brett Associates
Snook House 66 Tilehurst Road
READING
Berkshire RG30 2JH

SITE DETAILS

Grid Reference 330970 185270

Docks Way Waste Disposal Site
Newport



ORDNANCE SURVEY PLAN

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given on the right is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

1971	1971

North

Map Scale=1:2,500

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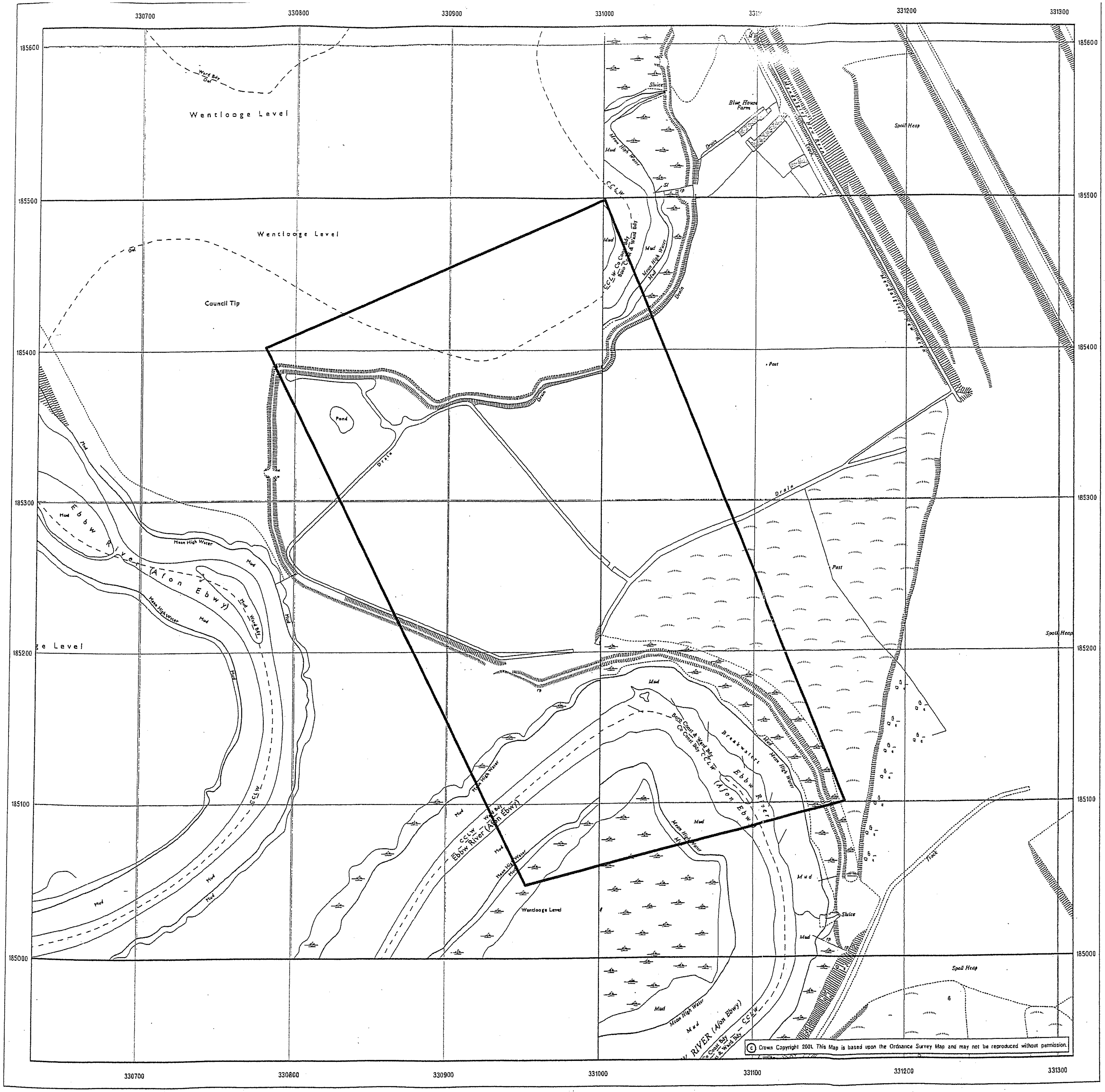


pba
peter brett associates
CONSULTING ENGINEERS

CLIENT DETAILS

Envirocheck Order No. EC80040_1_1

(19-Sep-2001 10:00)

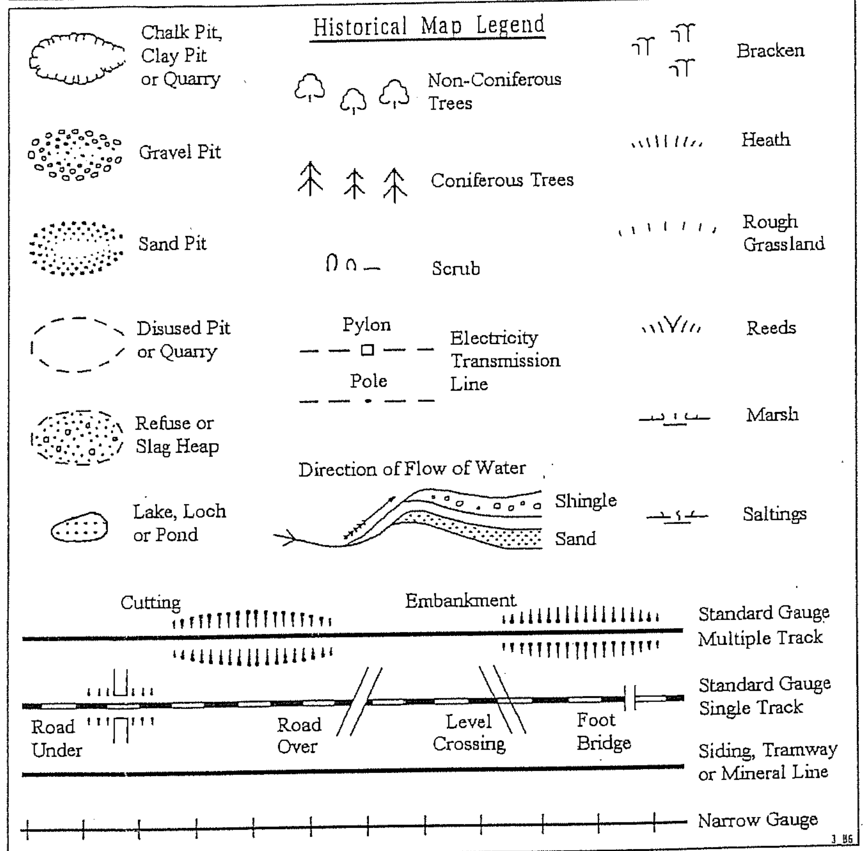
Customer Ref: 11938/002
Peter Brett Associates
Snook House 66 Tilehurst Road
READING
Berkshire RG30 2JH

SITE DETAILS

Grid Reference 330970 185270

Docks Way Waste Disposal Site
Newport

Historical Map Legend



ORDNANCE SURVEY PLAN

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given on the right is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

1972	1968
1972	1968

North

Map Scale=1:2,500

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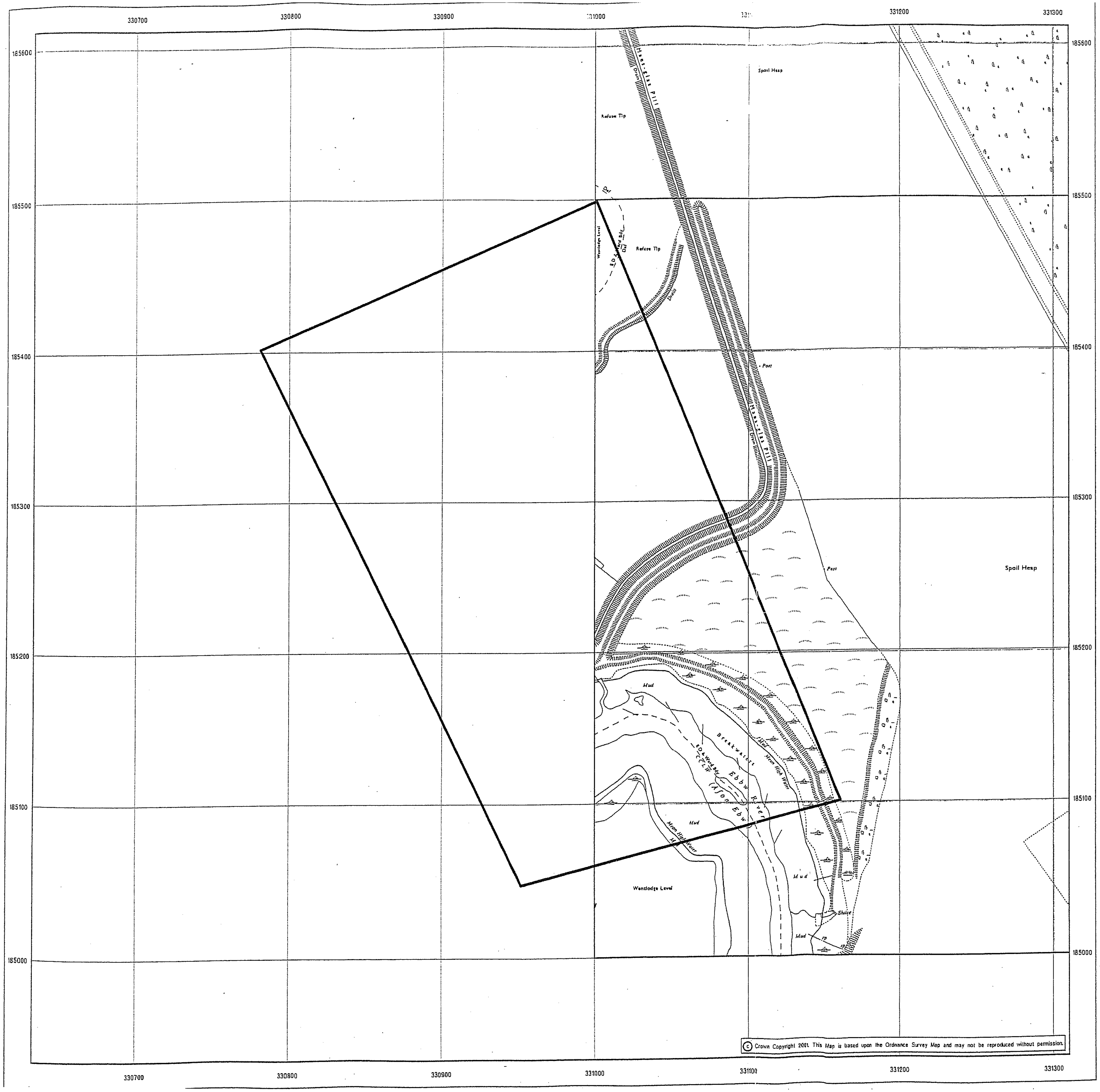
Exeter EX2 7HY
Telephone 01392 441729 Fax 01392 441709



peter brett associates
CONSULTING ENGINEERS

CLIENT DETAILS

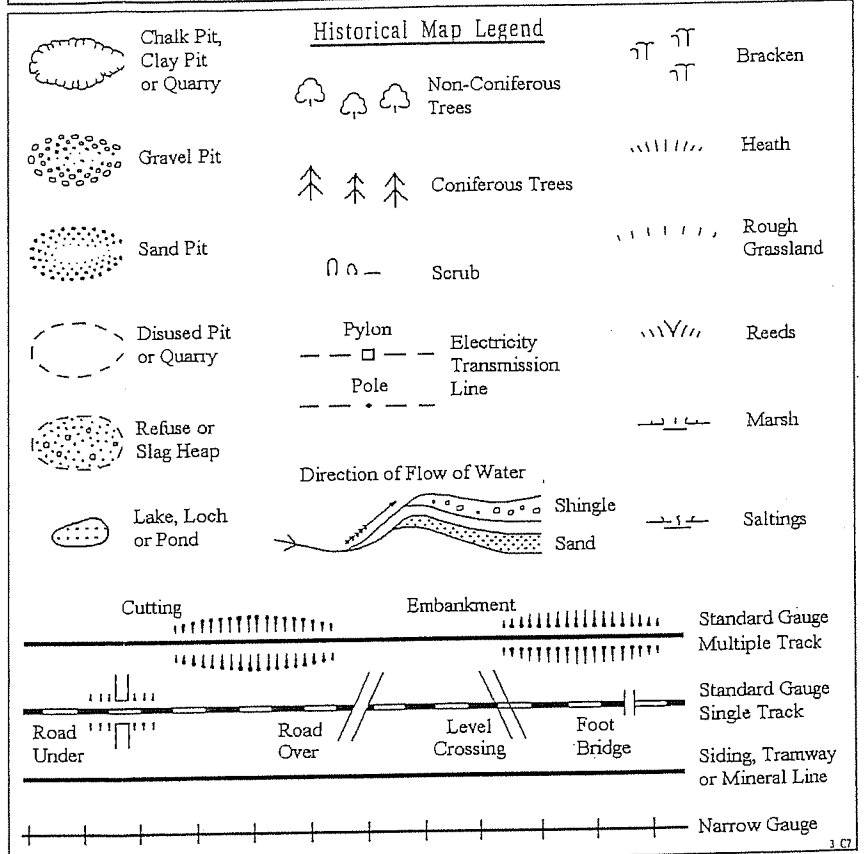
Envirocheck Order No. EC80040_1_1
(19-Sep-2001 10:03)

Customer Ref: .11938/002
Peter Brett Associates*
Snook House 66 Tilehurst Road
READING
Berkshire RG30 2JH

SITE DETAILS

Grid Reference 330970 185270

Docks Way Waste Disposal Site
Newport



ORDNANCE SURVEY PLAN

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given on the right is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

North

Map Scale=1:2,500

1976
1976

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Exeter EX2 7HY
LANDMARK Telephone 01392 441729 Fax 01392 441709

peter brett associates
CONSULTING ENGINEERS

CLIENT DETAILS

Envirocheck Order No. EC80040_1_1
(19-Sep-2001 10:19)

Customer Ref: .11938/002
Peter Brett Associates'
Snook House 66 Tilehurst Road
READING
Berkshire RG30 2JH

SITE DETAILS

Grid Reference 330970 185270

Docks Way Waste Disposal Site
Newport

FIGURE 2

Historical Map Legend

- Chalk Pit, Clay Pit or Quarry
- Gravel Pit
- Sand Pit
- Disused Pit or Quarry
- Refuse or Slag Heap
- Lake, Loch or Pond
- Non-Coniferous Trees
- Coniferous Trees
- Scrub
- Pylon / Pole — Electricity Transmission Line
- Direction of Flow of Water
- Shingle
- Sand
- Bracken
- Heath
- Rough Grassland
- Reeds
- Marsh
- Saltings
- Cutting
- Embankment
- Standard Gauge Multiple Track
- Road Under
- Road Over
- Level Crossing
- Foot Bridge
- Standard Gauge Single Track
- Siding, Tramway or Mineral Line
- Narrow Gauge

ORDNANCE SURVEY PLAN

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given on the right therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

In the late 1940's, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

North

Map Scale=1:10,000

1972	1973
1970	1972

Date(s) of Publication

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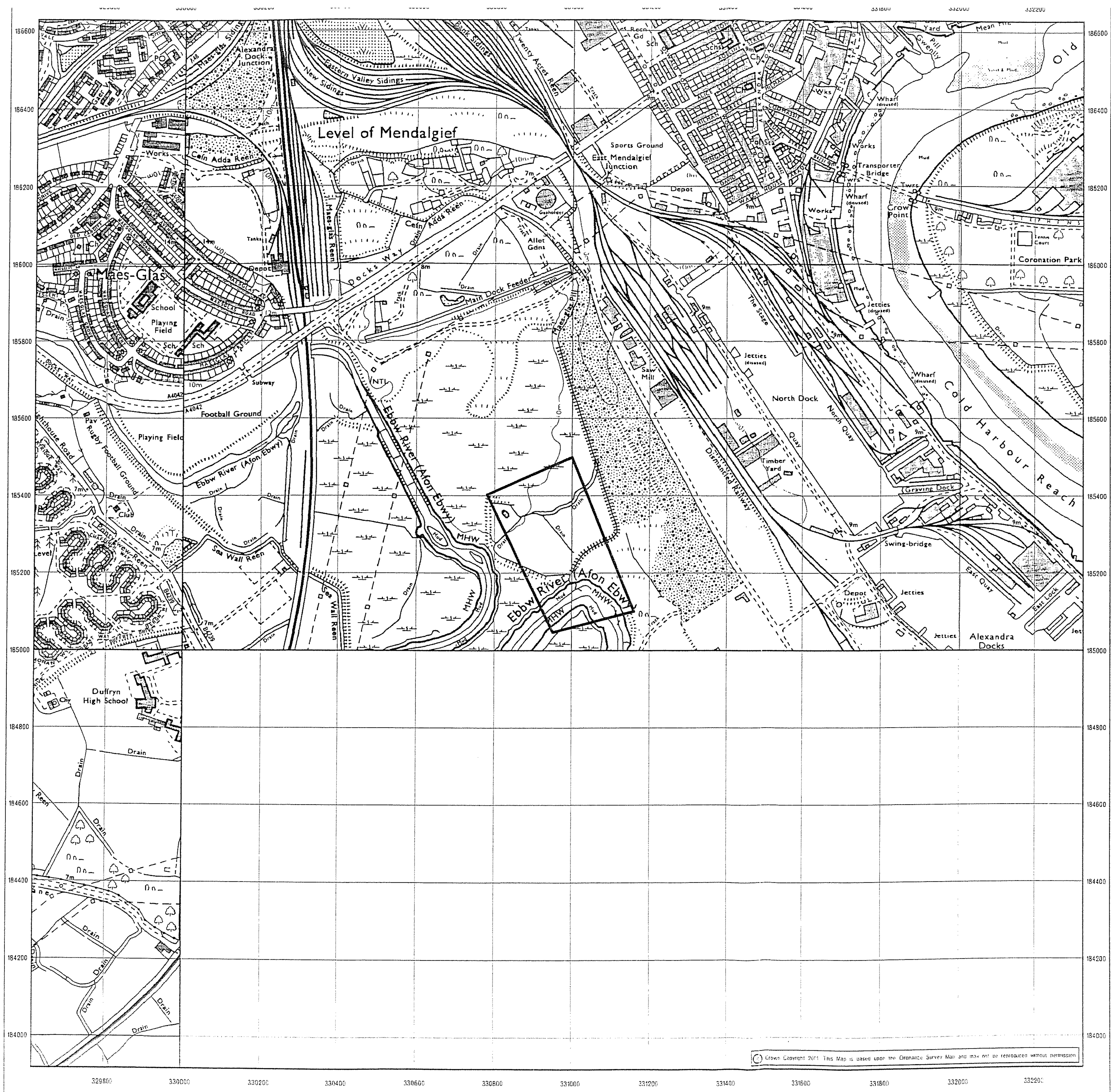

peter brett associates
CONSULTING ENGINEERS

CLIENT DETAILS

Envirocheck Order No. EC80040_1_1

(19-Sep-2001 10:21)

Customer Ref: J1938/002
Peter Brett Associates'
Snook House 66 Tilehurst Road
READING
Berkshire RG30 2JH

SITE DETAILS

Grid Reference 330970 185270

Docks Way Waste Disposal Site
Newport

FIGURE 3

Historical Map Legend

- Chalk Pit, Clay Pit or Quarry
- Gravel Pit
- Sand Pit
- Disused Pit or Quarry
- Refuse or Slag Heap
- Lake, Loch or Pond
- Non-Coniferous Trees
- Coniferous Trees
- Scrub
- Pylon / Pole — Electricity Transmission Line
- Direction of Flow of Water
- Shingle
- Sand
- Bracken
- Heath
- Rough Grassland
- Reeds
- Marsh
- Saltings
- Cutting
- Embankment
- Standard Gauge Multiple Track
- Standard Gauge Single Track
- Road Under
- Road Over
- Level Crossing
- Foot Bridge
- Siding, Tramway or Mineral Line
- Narrow Gauge

ORDNANCE SURVEY PLAN

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North

Map Scale=1:10,000

1982	1981
1989	

Date(s) of Publication

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7 Abbey Court, Eagle Way, Sowton
Exeter EX2 7HY
Telephone 01392 441725 Fax 01392 441709

APPENDIX 2

Eich cyf/Your ref. 11938/SNK/JA/DW/RHT
Ein cyf/Our ref. ACSC/SE/lp/Ei7082

Dyddiad/Date: 13 January 2004

ASIANTAETH YR AMGYLCHEDD CYMRU
ENVIRONMENT AGENCY WALES

...ciates
11938
JA
J. Amos

Mr James Amos
Peter Brett Associates
16 Westcote Road,
Reading
Berkshire
RG30 2DE

Dear Mr Amos,

RE: Docksway Disposal Site - Property at 330975185267.

Thank you for your letter which we received on 5th January 2003 regarding the above. The Agency's response is as follows:

Please find attached a report showing all the licensed abstractions found within 2 km of NGR ST 30975 85267 as required. This report confirms that there is 1 active licensed abstraction within this radius: license number 20/56/11/0013 under the name of Corus UK Ltd. It is a surface water abstraction.

For your information Abstraction license listed (20/56/11/22) was revoked in 1999.

Unfortunately we do not have Agency monitoring boreholes in this area and therefore have no records on groundwater quality as requested by you.

The information provided is based on that currently available to the Agency. The Agency and its officers are not able to offer any warranty as to the accuracy or completeness of the information provided nor can it accept any liability whatsoever for any loss or damage resulting from the interpretation or use of the information.

If you require any further information please do not hesitate to contact Lucy Prisk at this office.

Yours sincerely

G Inight

GARY INIGHT
Team Leader Customer Contact

Asiantaeth yr Amgylchedd Cymru
Plas-yr-Afon, Parc Busnes Llaneirwg, Llaneirwg, Caerdydd, CF3 0EY
Ffon: 029 20770088 Ffacs: 029 20798555

Environment Agency Wales
Rivers House, St Mellons Business Park, St Mellons, Cardiff, CF3 0EY
Tel: 029 20770088 Fax: 029 20798555

Facsimile Message
Neges Ffacs

Civic Centre/Canolfan Ddinesig
Newport/Casnewydd
South Wales/De Cymru
NP20 4UR

Newport CITY COUNCIL
CYNGOR DINAS Casnewydd

To/I: Kate Riley

At/Yn: PBA

From/Gan: Lisa Elliott

Dept/Adran: Environmental Health

Tel/Ffôn: 01633 232433

Fax/Ffacs: 01633 232622

Date/Dyddiad: 29/01/04

Email address wasn't responding.

Total number of pages including the header sheet: 2
Nifer o dudalennau yn cynnwys hon

Darren Wilcox

From: Gerard Edwards
Sent: 01 March 2005 13:31
To: Darren Wilcox; Malcolm Lane
Subject: FW: Docks Way Landfill Area/Phase 2

-----Original Message-----
From: Kerry Paulson [mailto:kerry.paulson@environment-agency.wales.gov.uk]
Sent: 01 March 2005 12:46
To: Gerard Edwards
Subject: Docks Way Landfill Area/Phase 2

Gerard,

Further to the meeting held on 15 February 2005 at The Civic Centre, Newport a response to the following question has been obtained as follows:

With respect to List I substances, where a minimum reporting value (MRV) exists this is defined as the discernible concentration (Appendix 7, Hydrogeological RA guidance). How is a discernible concentration of a List I substance defined for those substances for which no MRV exist?

The limit of detection should be used.

I trust that this response addresses your concerns.

Yours sincerely

Kerry Paulson
Regulatory (Waste) Specialist

From: Lisa Elliott
To: Zkriley@pba.co.uk
Subject: PRIVATE WATER WELLS - AREA OF DOCKSWAY DISPOSAL SITE

Kate,

With reference to our telephone conversation this morning, I am writing to confirm that at this time we are not aware of any private water wells within a 2km radius of the Docksway Disposal Site.

Hope this is of help, if you require any further information please let me know.

Regards
Lisa

Date: 08/01/2004
Time: 09:26:42

Report Title: ABSTRACTION LICENCE SUMMARY BY MANAGEMENT UNIT / REPORTING UNIT
EXTERNAL USAGE

Short Name: AR251R

PARAMETERS	VALUES			PARAMETERS	VALUES
USER	EALTON				
REPORT TYPE	DETAIL			SORT BY	LIC_NO
DESTINATION TYPE	Preview			DESTINATION NAME	
REQUIRED DATE FROM	08/01/2004			REQUIRED DATE TO	
MANAGEMENT UNIT				REPORTING UNIT	Environment Agency Wales LEAPS
LICENCE NO	ALL				
LICENCE HOLDER NAME	ALL				
CONDITIONS ON LICENCES	ALL			AGREEMENTS	ALL
SOURCE OF SUPPLY	ALL			SOS TYPE	ALL
				POINT CATEGORY	ALL
PURPOSE	ALL			POINT TYPE	ALL
	ALL				
	ALL				
RANGE SEARCH BY ANNUAL QTY	NONE DEFINED				
RANGE SEARCH BY DAILY QTY	NONE DEFINED				
RADIAL SEARCH	NGR ST 3097 8526	DISTANCE	2.0 km		
SQUARE SEARCH	NONE DEFINED				

Warning: The figures shown on this report do not take account of any authorised quantity restrictions that may exist between linked licences or within a licence (See the conditions section of the report for this information)

...me: 08/01/2004 09:26:42

NALD - Environment Agency Wale
ABSTRACTION LICENCE SUMMARY BY MANAGEMENT UNIT / REPORTING UNIT

Licence No: 20/56/11/0013 Orig Application:

Expiry Date:
Revoked Date:
Lapsed Date:

Issue No	Incr No	Status	Effective Start	Effective End	Returns Req?	Chargeable?
102	0	CURR	17/04/2000		Y	Y

Licence Holder
5527 Corus UK Ltd
5683 15 Great Marlborough Street
London
W1V 2BS

Licence Type: Ordinary Licence

Source: EAW Surface Water
Multiple Lh?: N

Purpose: Industrial, Commercial and Public Services - Metal
General use relating to Secondary Category (Medium Loss)
Abs Period Start:1/1 Abs Period End: 31/12 Time Ltd Start: Time Ltd End:

Conditions Exist: No
Agreements Exist: No

Annual Qty:	136380 m3	Usability: Legal
Daily Qty:	373.7 m3	Usability: Legal
Hourly Qty:	15.58 m3	Usability: Legal
Inst Qty:	l/s	Usability:

Local Name
DOCK FEEDER AT PILLGWENLLY TO WHITEHEAD
NGR1:ST 3080 8610 0.9km NGR2: NGR3: NGR4:

Primary Type	Secondary Type	Category
Surfacewater	River / Stream	Single Point

****
* END OF REPORT *
****

Report Title ABSTRACTION LICENCE SUMMARY BY MANAGEMENT UNIT / REPORTING UNIT

Short Name AR251R

REPORT SUMMARY

Report Summary for report Date : 08/01/2004

Total Number of Licences	Sum of Hourly Quantities	Sum of Daily Quantities	Sum of Annual Quantities
1	15.580 m3	373.700 m3	136380.000 m3

Ein cyf/Our ref. KP/DP3733BK

Dyddiad/Date: 14 March 2005

ASIANTAETH YR AMGYLCHEDD CYMRU
ENVIRONMENT AGENCY WALES

Peter Brett Associates
15 MAR 2005
Authorised:
Distribution:
Darren Wilcox

Peter Brett Associates Limited
Caversham Bridge House
Waterman Place
Reading
Berkshire
RG1 8DN.

For the attention of Mr D Wilcox

Dear Sir

THE WASTE MANAGEMENT LICENSING REGULATIONS 1994, AS AMENDED THE POLLUTION PREVENTION AND CONTROL (ENGLAND AND WALES) REGULATIONS 2000 (SI 2000 No. 1973)

Public Register enquiry:

Further to your faxed public register enquiry, dated 7 March 2005, please find below details of operational and closed containment landfills for the acceptance of municipal waste in Wales:

1. Tir John Landfill, Swansea (EAWML34011)*
2. Nantycaws Phase 2 Landfill, Camarthen (EAWML34144)*
3. Pwllfawatkin Landfill, Pontardawe (EAWML34149)*
4. Bryn Pica Landfill (excluding Phase 1), Aberdare (EAWML30104)
5. Nant Y Gwyddon Landfill, Gelli (EAWML30157)
6. Lamby Way Landfill Eastern Extension, Cardiff (EAWML30235)*
7. Bryn Posteg Landfill (EAWML47065)*
8. Garden Lodge Landfill, Ruabon (EAWML37014 &37109)
9. Pen Y Bont Landfill, Chirk (EAWML37123)*
10. Astbury Landfill, Phase 5 and Cells 1 to 5, Llay (EAWML37116)
11. Standard Landfill, Buckley (EAWML37073)
12. Brookhill Landfill, Buckley (EAWML37207)*
13. Llanddulas Landfill Phases 2 & 3, Llanddulas (EAWML37027 & 37028)*
14. Penhesgyn Gors Landfill Area 3, Llansadwrn (EAWML37083)*

Leachate quality data is available for these sites in the Agency's Electronic Document Management (EDM) System, which you are entitled to view by visiting an Area Agency Office and logging into the system. From our telephone conversation on Friday Wallingford is the closest Area office to Reading. Should you wish to visit the Wallingford office for this purpose arrangements can be made.

Asiantaeth yr Amgylchedd Cymru
Plas Yr Afon, Parc Busnes Llaneirwg, Llaneirwg, Caerdydd, CF3 0EY
Ffon: 02920 245296 Ffacs: 029 20362920

www.environment-agency.gov.uk

Environment Agency Wales
Rivers House, St Mellons Business Park, St Mellons, Cardiff, CF3 0EY
Tel: 02920 245296 Fax: 029 20362920

Furthermore, leachate quality data may be available in PPC Permit applications submitted for the sites marked above with an asterix. These Applications, in paper form, are available on the local public register to the site in question.

The Agency does not guarantee the accuracy or suitability for use of data provided under the public register provisions.

In the meantime, should you wish to discuss any aspect of this letter please do not hesitate to contact me on 02920 245296, or by e-mail at kerry.paulson@environment-agency.gov.uk.

Yours faithfully

K. Paulson

KERRY PAULSON
Regulatory (Waste) Specialist

Asiantaeth yr Amgylchedd Cymru
Plas Yr Afon, Parc Busnes Llaneirwg, Llaneirwg, Caerdydd, CF3 0EY
Ffon: 02920 245296 Ffacs: 029 20362920

www.environment-agency.gov.uk

Environment Agency Wales
Rivers House, St Mellons Business Park, St Mellons, Cardiff, CF3 0EY
Tel: 02920 245296 Fax: 029 20362920

APPENDIX 3

Appendix 3: Table A3-1

BH NUMBER	GROUND LEVEL	OS EAST	OS NORTH	Elevation of Base of Made Ground (mAOD)	Elevation of Base of Alluvial Clays (mAOD)	Elevation of Base of Gravel (mAOD)
GW03/01	12.731	330501.688	185688.086	5.931	2.731	Not determined
GW03/02	14.643	330585.004	185692.641	6.643	4.643	Not determined
GW03/03	15.165	330685.042	185603.368	7.065	1.965	Not determined
GW03/04	17.738	330874.474	185800.486	5.538	1.638	Not determined
GW03/05	12.461	330943.682	185864.298	5.761	-3.339	Not determined
GW03/06	9.66	331050.647	185558.329	4.96	-1.64	Not determined
GW03/07	9.957	331100.874	185402.445	5.457	-2.443	Not determined
GW03/08A	7.146	331153.686	185258.28	5.846	-2.854	Not determined
GW03/08B	7.347	331145.69	185240.501	-2.403	-2.953	-8.653
GW03/09	10.25	331166.168	184998.789	7.35	-0.65	-8.75
GW03/10A	9.596	331024.405	184767.797	8.996	-1.354	-6.904
GW03/11B	9.064	330991.23	184710.656	-0.536	-2.336	-8.136
GW03/12D	7.735	330769.497	184780.191	-2.565	Not determined	-6.965
GW03/13	7.788	330613.485	184886.029	5.338	-0.162	-5.212
GW03/14	9.735	330828.776	185097.983	3.835	-0.265	-7.765
GW03/15	11.534	330721.016	185308.943	5.034	0.134	-6.966
GW03/16	14.151	330660.114	185475.945	5.351	0.451	Not determined
GW03/17	7.75	331112.7	185079.3	0.75	-1.25	-8.65
GW03/19	8.877	330994.198	184694.402	1.977	Not determined	Not determined
GW03/20	8.9	330975.4	184710.9	-0.45	Not determined	Not determined
GW03/21	8.841	330987.233	184724.221	-0.559	-1.459	Not determined
GW03/22	7.3	330843.8	184999.6	1	-1.1	-7.7
GW03/23	7.305	330746.971	184793.481	-3.295	Not determined	Not determined
GW03/24	7.414	330766.563	184787.82	-2.786	-3.286	Not determined
GW03/25	7.54	330835.443	184775.283	4.64	-3.36	Not determined
GW03/26	10.69	331361.576	185547.395	8.89	-2.11	Not determined
GW03/27	10.91	331184.221	185852.195	8.11	-1.59	Not determined
GW03/29	8.68	330739.319	186156.132	6.18	-2.22	-7.92
LF03/01	38.419	330803.893	185537.383	3.419	Not determined	Not determined
LF03/02	38.666	330891.765	185529.268	3.419	Not determined	Not determined
LL03/01	10.754	330803.043	185272.44	5.254	Not determined	Not determined
LL03/02	11.136	330746.805	185298.893	3.436	-0.364	Not determined
LL03/03	11.414	330791.448	185284.377	6.814	Not determined	Not determined
LL03/04	10.005	330774.899	185264.137	3.305	Not determined	Not determined
LL03/05	10.366	330822.321	185228.009	5.966	-0.934	Not determined
LL03/06B	10.242	330808.016	185218.995	3.942	Not determined	Not determined
GP03/01	14.631	330586.258	185696.917	5.631	Not determined	Not determined
GP03/02	17.27	330783.239	185813.695	11.27	Not determined	Not determined
GP03/03A	12.46	330944.547	185861.637	4.16	Not determined	Not determined
GP03/04A	9.787	331052.579	185551.787	4.487	Not determined	Not determined
GP03/05	9.818	331098.931	185408.184	5.018	Not determined	Not determined
GP03/06	7.246	331150.828	185227.606	4.246	Not determined	Not determined
GP03/07	10.246	331074.131	185485.253	5.346	Not determined	Not determined
GP03/08	9.779	330831.096	185104.075	4.879	Not determined	Not determined
GP03/09	11.246	330768.47	185315.771	6.246	Not determined	Not determined
GP03/10	14.007	330664.242	185469.175	5.007	Not determined	Not determined
GP03/11	10.347	331023.969	185642.696	5.247	Not determined	Not determined
GP03/12A	10.484	330990.364	185751.921	5.584	Not determined	Not determined
GP03/13	17.131	330774.636	185810.258	5.931	Not determined	Not determined
EA1	6.61	330762.5	184877.39	No Made Ground	-1.39	-6.39
EA2	8.04	330882.5	184854.46	6.44	-2.36	-8.16
EA3	7.34	330971.21	184958.61	6.94	-1.36	-7.36
EA4	6.83	330906.94	184897.42	6.03	-2.17	-6.17
EA5	7.84	330983.425	184988.467	5.04	-2.16	-8.96
EA6	6.52	331172.44	185132.05	5.82	-2.08	-11.28
EA7	10.06	331074.2	184860.47	7.96	-1.94	Not determined
SS94/01A	10.04	330858	185253	4.69	-2.01	-6.76
SS94/02A	9.33	331038	185247	3.93	-2.07	-5.97
SS94/03B	9.09	330858	185145	4.49	-1.61	-6.61
SS94/04	9.4	330998	184058	7.7	-2	-5.9
SS94/05	7.51	330589	184929	6.06	-1.69	-5.49
SS94/06	7.3	330656	184875	6.8	-2.3	-6.1
SS94/07	7.27	330924	184967	5.37	-2.03	Not determined
SS94/08	10.35	331127	184960	6.4	-0.65	Not determined
SS94/09	9.84	331033	184838	7.54	-2.96	Not determined
SS94/10	5.83	330827	184805	4.43	-4.47	-8.07

Cable Percussion Borehole Log Sheet

Site: **Newport**
Job Number: **R0555**
Client: Newport City Council
Rig Type: Pilcon 1500

BH No: **GW03/29**
Start Date: 09/08/2004
Finish Date: 10/08/2004
Vertical Scale: 1:50
Sheet 1 of 2

C J Associates

Depth (m)	Sample Ref.	Test type	Seat.	Test Drive	N-value	Pen. (mm) Seat	Pen. (mm) Test	U100 Blows / % recovery	Depth (m)	Thickness (m)	Legend	Description of Strata	Reduced Level (m O.D.)
												MADE GROUND (Concrete over ashy fill - drillers description)	
1.00	D1									(2.50)			
2.00	D2												
2.50	D3								2.50			Firm, brown CLAY. (Drillers description)	
3.00	D4												
4.00	D5											Becoming softer, grey CLAY.	
										(4.50)			
5.00	D6												
6.00	D7												
7.00	D8								7.00			Soft, grey silty CLAY. (Drillers description)	
8.00	D9									(3.00)			
9.00	D10												
10.00	D11								10.00			(Continued on next sheet)	

Hole Progress with Time (Depths in m. below G.L.)

Date	Hole depth	Casing depth	Depth to water	Remarks
10/08/2004	7.00	7.00	-	Dry - start of shift

Chiselling

From (m)	To (m)	Time (hrs)
11.80	12.30	1
14.50	14.90	1
16.20	16.60	1.25

Casing Record

Depth (m)	Dia. (mm)
17.60	200

Groundwater Strikes (depths in m. below G.L.)

Strike	Casing	Water (20mins)	Sealed	Remarks
10.90	10.90	10.00	-	Struck

General Remarks:

Drilled By: RD
Logged By:

Cable Percussion Borehole Log Sheet

Site: **Newport**
Job Number: **R0555**
Client: Newport City Council
Rig Type: Pilcon 1500

BH No: **GW03/29**
Start Date: 09/08/2004
Finish Date: 10/08/2004
Vertical Scale: 1:50
Sheet 2 of 2

C J Associates

Depth (m)	Sample Ref.	Test type	Seat.	Test Drive	N-value	Pen. Seat	Pen. Test	U100 Blows / % recovery	Depth (m)	Thickness (m)	Legend	Description of Strata	Reduced Level (m O.D.)
										(0.90)		Firm, grey CLAY. (Drillers description)	
11.00	D12								10.90			Dense GRAVEL, cobbles and coarse SAND. (Drillers description)	
12.00	D13												
13.00	D14												
14.00	D15									(5.70)			
15.00	D16												
16.00	D17												
16.60	D18								16.60	(1.00)		Weathered, red MARL. (Drillers description)	
									17.60			END OF BOREHOLE	

Hole Progress with Time (Depths in m. below G.L.) Date	Hole depth	Casing depth	Depth to water	Remarks	Chiselling From (m)	To (m)	Time (hrs)	Casing Record Depth (m)	Dia. (mm)	Groundwater Strikes (depths in m. below G.L.) Strike	Casing	Water (20mins)	Sealed	Remarks

General Remarks:

Drilled By: RD
Logged By:

Monitoring Pipe Installation Details

BH No: GW03/29

Site: Newport

Job Number: R0555

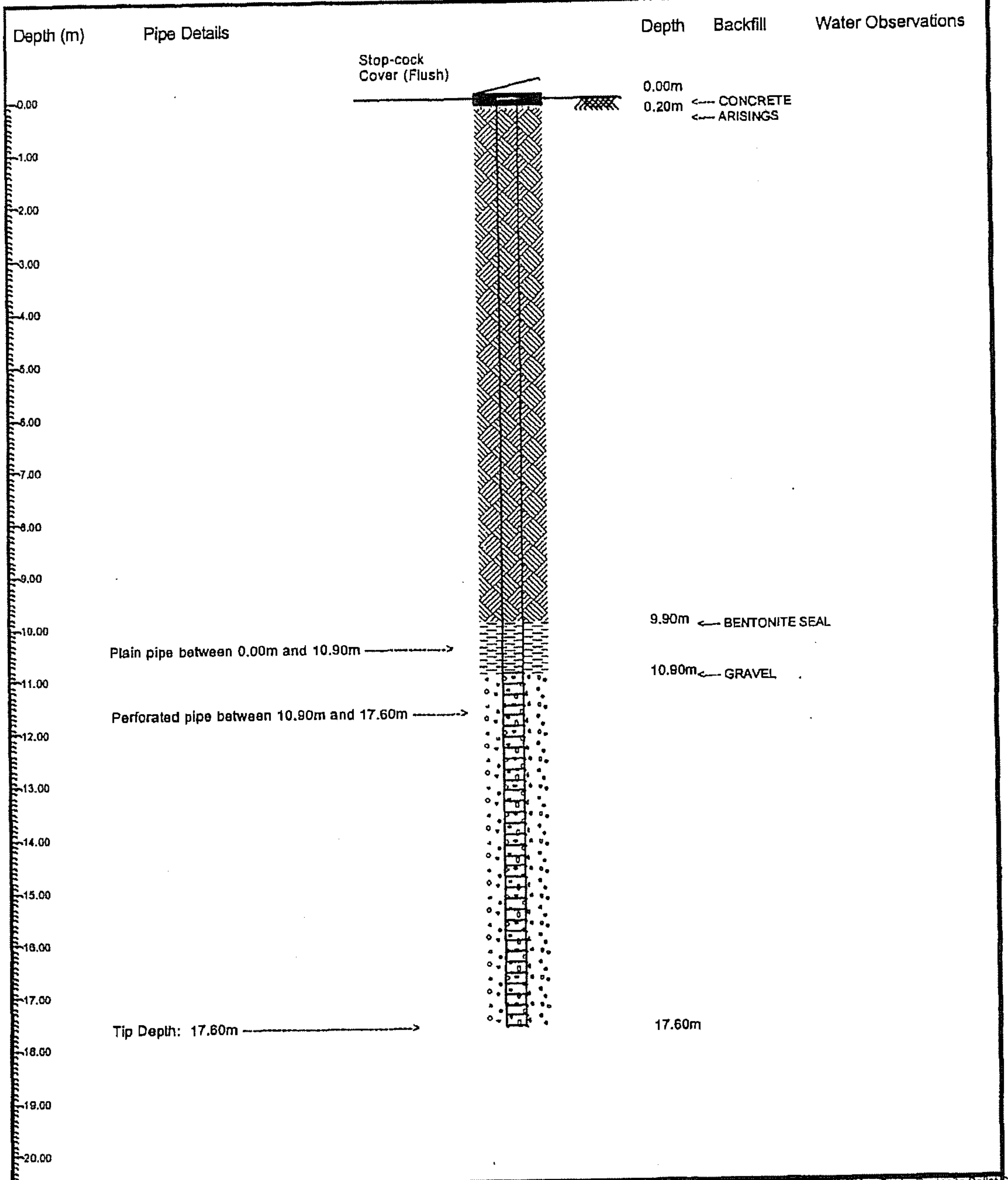
Client: Newport City Council

Engineer:

Vertical Scale: 1:100

Final BH Depth: 17.60m

C.J. associates



Installation Type: 50mm diameter standpipe	Installation Date: 10/08/2004		Note: Seal = Bentonite Pellet Grout = Cement / Bentonite Grout
Co-ordinates:	Ground Level:	Cover Level:	
General Remarks:			

Sampling					Strata			
Depth	Type	Casing Depth	Date/ Water	SPT N (Cu)	Description	Depth (Thickness)	Level	Legend
			19/04 2000		MADE GROUND: Soft to firm brown slightly sandy gravelly clay. Gravel is medium to coarse subrounded to rounded of quartzite. Sand is fine to medium. Material contains plastic bags.	G.L.	14.67	
0.40-0.80	B							
1.00-1.45	C			6		(1.60)		
1.00-1.50	B							
						1.60	13.07	
2.00-2.45	C	1.50		8	MADE GROUND: Soft to firm dark grey to black slightly gravelly sandy clay. Gravel is fine to coarse, angular of various lithologies. Material contains plastic bags, wood chippings and ash with depth.			
2.00-2.50	B							
3.00-3.45	C	3.00		11				
3.00-3.50	B					(3.40)		
4.00-4.45	C	3.80		11				
4.00-4.50	B							
5.00-5.45	C	4.50		22		5.00	9.67	
5.00-5.50	B				MADE GROUND: Medium dense black clayey fine to coarse sand and fine to coarse angular gravel of clinker, sandstone, brick, with some rubber tubing, timber and ash.	(1.10)		
6.00-6.45	C	6.00	6.00	70/ 225		6.10	8.57	
6.00-6.80	B				MADE GROUND: Very dense dark grey slightly clayey slightly sandy medium to coarse angular gravel of limestone with many cobbles, and steel wire. (Brick, wood and metal)**.			
7.00-7.45	C	7.00	6.70	65				
7.50		7.50	6.40 20/04 6.00			(2.60)		
8.00-8.21	C	7.00		40/ 61				
						8.70	5.97	
8.80-9.00	B							
9.00-9.45	U	8.8			Firm to stiff grey mottled orange/ brown slightly sandy CLAY. Sand is fine. Material contains root traces.			
9.50	D							
9.70	D					(1.90)		

Equipment: Light cable percussion

Borehole Dia (mm)	Casing Dia (mm)
200 to 9.00m	200 to 9.00m
150 to 25.00m	150 to 25.00m

Groundwater

No.	Struck	Behaviour	Sealed
1	6.00	Rose to 6.00m in 20 mins 6.00/6.00/6.00 in 5/10/15 mins	8.90
2	12.00	Rose to 12.00m in 20 mins 12.00/12.00/12.00 in 5/10/15 mins	

Ground Level 14.67 m OD
Coordinates 330844.96 mE 185878.70 mN

Drilled by GB
Logged by GN
Checked by NW

Remarks Chiselled from 6.20m to 6.80m (90 mins), 7.10m to 7.50m (80 mins), 7.60m to 8.00m (60 mins), 8.20m to 8.60m (60 mins), 16.30m to 16.90m (100 mins), 17.50m to 18.00m (120 mins), 18.10m to 18.70m (90 mins), 20.00m to 20.40m (90 mins), 21.40m to 21.90m (80 mins), 23.70m to 24.10m (80 mins)
Water added to assist boring from 9.00m to 12.00m
Unable to retrieve 13.50m of 150mm casing from borehole.

See key sheet and appendices for explanations.

Form 1/0

Borehole Record

Exploration Associates

Project Newport Southern Distributor Road
Newport County Borough Council

Contract 150069

Borehole 11(1 of 3)

Sampling

Depth	Type	Casing Depth	Date/ Water	SPT N (Cu)
10.00-10.45	S	9.00	20/04	6
10.70	D			
11.00-11.45	U	9.00		
11.50	D			
11.70	D			
12.00-12.45	S	9	12	3
12.00	W			
12.70	D			
13.00-13.45	U	12.50	12.80	
13.50	D			
13.70	D			
14.00-14.45	S	13.5	13.6	1
15.00-15.45	C	15.00	14.10	8
15.00-15.50	B			
16.00-16.45	C	16.00	12.00	74
		16.00	12.90	
16.00			21/04 12.00	
16.00-16.30	B			
17.00-17.45	C	17.00	13.90	29
17.00-17.50	B			
18.00-18.25	C	18.00	8.60	51/ 101
		18.00	18.00	
18.00			25/04 8.60	
18.70-19.00	B			
19.00-19.45	C	19.00	10.10	35
19.00-19.50	B			

Strata

Description	Depth (Thickness)	Level
	10.60	4.07
Very soft to soft brownish grey locally slightly sandy CLAY. Sand is fine. with black amorphous plant remains.	(4.10)	
	14.70	-0.03
Soft grey to dark grey slightly sandy gravelly CLAY. Gravel is fine to medium, subrounded to rounded of quartzite. Sand is fine. Driller noted presence of cobbles.	(1.60)	
	16.30	-1.63
Large cobbles**	(0.60)	
	16.90	-2.23
Medium dense grey clayey sandy fine to coarse, sub rounded to rounded quartzite GRAVEL with some cobbles. Sand is fine to coarse.	(0.60)	
	17.50	-2.83
Dense to very dense greyish brown slightly silty slightly sandy fine to coarse, subrounded to rounded GRAVEL with some cobbles.	(5.00)	

Equipment: Light cable percussion

Borehole Dia (mm)
200 to 9.00m
150 to 25.00m

Casing Dia (mm)
200 to 9.00m
150 to 25.00m

Groundwater
No. Struck Behaviour Sealed

Ground Level 14.67 m OD
Coordinates 330844.96 mE
185878.70 mN

Drilled by GB
Logged by GN
Checked by NW

Remarks

See key sheet and appendices for explanations.

Form 1/0

Borehole Record

Exploration Associates

Project
Newport Southern Distributor Road
Newport County Borough Council

Contract 150069

Borehole 11(2 of 3)

Sampling Depth	Type	Casing Depth	Date/ Water	SPT N (Cu)	Strata Description	Depth (Thickness)	Level
20.00	C	20.00	25/04 10.90	50/ 47			
20.50-20.80	B						
21.00-21.45	C	21.00	11.60	36			
21.00-21.30	B						
22.00-22.45	C	22.00	12.80	25			
22.00-22.50	B						
		22.50	13.40			22.50	-7.83
22.50			26/04 12.60		Firm reddish brown slightly gravelly sandy CLAY. Gravel is fine subangular of mudstone. Sand is fine.	(0.70)	
22.90	D						
23.00-23.45	U	22.90	13.10			23.20	-8.53
					Red silty clay(Alluvium)**	23.40	-8.73
23.50	D						
23.50-23.95	C	23.50	13.90	12			
23.50-24.00	B				Medium dense reddish brown slightly silty fine to coarse SAND and fine to coarse, rounded to subrounded quartzite GRAVEL.	(1.20)	
24.20-24.50	B						
24.50-24.95	C	24.50	14.60	63		24.60	-9.93
					Very dense reddish brown slightly sandy fine to coarse, rounded to subrounded GRAVEL. ('marl').**	(0.40) 25.00	-10.33
25.00			14.60				
					End of Borehole.		

Equipment: Light cable percussion

Borehole Dia (mm)	Casing Dia (mm)
200 to 9.00m	200 to 9.00m
150 to 25.00m	150 to 25.00m

Groundwater
No. Struck Behaviour Sealed

Ground Level 14.67 m OD
Coordinates 330844.96 mE 185878.70 mN

Drilled by GB
Logged by GN
Checked by NW

Remarks

See key sheet and appendices for explanations.

Form 1/0

Borehole Record

Exploration Associates

Project: Newport Southern Distributor Road, Newport County Borough Council

Contract: 150069

Borehole: 11 (3 of 3)

Cable Percussion Borehole Log Sheet

BH No: GW03/04

C J Associates

Site:	**Docksway Waste Disposal Site, Newport**	Start Date:	12/06/2003
Job Number:	**P0514**	Finish Date:	18/06/2003
Client:	Peter Brett Associates	Vertical Scale:	1:50
Rig Type:	Dando 2000	Sheet 1 of 3	

Depth (m)	Sample Ref.	Standard Penetration Tests (SPT's) Test type	Blow Counts Seat.	Blow Counts Test Drive	N-value	Pen. (mm) Seat	Pen. (mm) Test	U100 Blows / % recovery	Depth (m)	Thickness (m)	Legend	Description of Strata	Reduced Level (m. O.D.) 17.78
										(1.10)		MADE GROUND (Soft to firm, grey-black, ashy, clay, with brick fragments).	
1.00	D1								1.10			MADE GROUND (Refuse, occasionally slightly clayey).	16.68
2.00	D2												
3.00	D3												
4.00	D4												
5.00	D5												
6.00	D6									(11.10)			
7.00	D7												
8.00	D8												
9.00	D9												
10.00	D10												

(Continued on next sheet)

Hole Progress with Time (Depths in m. below G.L.) Date	Hole depth	Casing depth	Depth to water	Remarks
18/06/2003	13.50	13.50	9.00	Start of shift

Chiselling From (m)	To (m)	Time (hrs)
1.00	2.00	1.5
2.00	4.00	3
4.60	5.00	0.50
5.50	6.00	1
6.40	7.00	1.5

Casing Record Depth (m)	Dia. (mm)
13.50	200
27.50	150

Groundwater Strikes (depths in m. below G.L.) Strike	Casing	Water (20mins)	Sealed	Remarks
9.00	9.00	9.00	-	Struck
16.00	16.00	10.10	-	Struck

General Remarks:

Co-ordinates: 185800.43E - 330874.45N

Drilled By: PK
Logged By: IH

Cable Percussion Borehole Log Sheet

Site:	**Docksway Waste Disposal Site, Newport**	BH No:	**GW03/04**
Job Number:	**P0514**	Start Date:	12/06/2003
Client:	Peter Brett Associates	Finish Date:	18/06/2003
Rig Type:	Dando 2000	Vertical Scale:	1:50
		Sheet 2 of 3	

C J Associates

Depth (m)	Sample Ref.	SPT Test type	SPT Blow Counts Seat.	SPT Blow Counts Test Drive	SPT N-value	SPT Pen. (mm) Seat	SPT Pen. (mm) Test	U100 Blows / % recovery
10.10	D20							
11.00	D11							
12.00	D12							
12.50	D13							
13.80	D14							
14.80	D15							
16.00	D16							
17.10	D17							
18.00	D18							
19.00	D19							

Depth (m)	Thickness (m)	Legend	Description of Strata	Reduced Level (m. O.D.)
			MADE GROUND (Refuse, occasionally slightly clayey).	5.58
12.20	(0.80)		Firm to stiff, grey SILT.	4.78
13.00	(2.00)		Soft to firm, grey SILT.	2.78
15.00	(1.10)		Soft, grey, CLAY, with some fine medium and coarse subrounded gravel.	1.68
16.10	(1.40)		Grey-brown-black, fine medium and coarse subangular GRAVEL.	0.28
17.50	(1.00)		Grey, clayey, fine medium and coarse subangular GRAVEL.	-0.72
18.50			Grey, fine medium and coarse, subangular to subrounded GRAVEL and COBBLES.	

(Continued on next sheet)

Hole Progress with Time (Depths in m. below G.L.) Date	Hole depth	Casing depth	Depth to water	Remarks	Chiselling From (m)	To (m)	Time (hrs)	Casing Record Depth (m)	Dia. (mm)	Groundwater Strikes (depths in m. below G.L.) Strike	Casing	Water (20mins)	Sealed	Remarks

General Remarks:

Co-ordinates: 185800.43E - 330874.45N

Drilled By: PK
Logged By: IH

Cable Percussion Borehole Log Sheet

Site:	**Dockway Waste Disposal Site, Newport**	BH No:	**GW03/04**
Job Number:	**P0514**	Start Date:	12/06/2003
Client:	Peter Brett Associates	Finish Date:	18/06/2003
Rig Type:	Dando 2000	Vertical Scale:	1:50
		Sheet 3 of 3	

C J Associates

Depth (m)	Sample Ref.	SPT Test type	SPT Blow Counts Seat.	SPT Blow Counts Test Drive	SPT N-value	SPT Pen. (mm) Seat	SPT Pen. (mm) Test	U100 Blows / % recovery	Depth (m)	Thickness (m)	Legend	Description of Strata	Reduced Level (m. O.D.)
												Grey, fine medium and coarse, subangular to subrounded GRAVEL and COBBLES.	
21.70	D21												
										(7.60)			
23.00	D22												
24.00	D23												
25.00	D24												
26.00	D25								26.10				-8.32
												Red-brown, sandy, fine medium and coarse subrounded GRAVEL.	
										(1.40)			
27.00	D26												
									27.50			END OF BOREHOLE	-9.72

Hole Progress with Time (Depths in m. below G.L.) Date	Hole depth	Casing depth	Depth to water	Remarks	Chiselling From (m)	To (m)	Time (hrs)	Casing Record Depth (m)	Dia. (mm)	Groundwater Strikes (depths in m. below G.L.) Strike	Casing	Water (20mins)	Sealed	Remarks

General Remarks:

Co-ordinates: 185800.43E - 330874.45N

Drilled By: PK
Logged By: IH

Fugro Engineering Services Limited

Rotary Landfill Drilling Daily Report

Serial No: 5394

Project:	DOCKSWAY L/FILL	Foreman:	W GILL	Gas/ Leachate/ Water Well No.:	LF2
Contract No.:	L39726	Assistant:	K HONEY	Day and Date:	THURSDAY 23/10/03
Client:	NEWPORT BRO COUNCIL	Assistant:		Type of Drilling:	BARREL AUGER
Client's Project No.:		Rig No:	L822		
Weather:	FINE	Vehicle No:	NL ST VOD	Flush:	NIL

DRILLING RECORD

Casing Depth (m)	Casing Dia. (m)	From (m)	To (m)	Time (mins)	Dia. (mm)	Depth to Water (m)	DESCRIPTION OF STRATA
		GL	11.00				DRYWASTE
		11.00	13.00				DAMPWASTE
		13.00	31.40	Gravel Shut.			VERY WET WASTE
							1HR BALING. 1 hour Item 2-10
							1HR. TRACKING RIG TO BH.
							1HR. TRACKING RIG BACK TO
							SITE OFFICE Standing Time
							due to security issues.

Borehole Complete/ Incomplete

INSTALLATION/ BACKFILL

Diagram	From (m)	To (m)	Description
	GL	1.00	PLAIN PIPE STICK UP
	1.00	GL	BENTONITE SEAL
	28.00	1.90	SLOTTED PIPE
	28.00	1.00	STONE

Installation/ Backfilling Time: hrs

REMARKS

1 X MOVE SET UP BH LF2

Signed: W Gill .... Driller

Signed: .... Client's Rep.

MOVES BETWEEN HOLES

Distance (approx.):		m
Time:		hrs

DAYWORKS

Removing waste:	15 MINS	hrs
Collecting materials:	15 MINS	hrs
Breakdowns:		hrs
Other (detail):		

OBSTRUCTIONS

From (m)	To (m)	Time (hrs)
		✓

WORKING HOURS

From	To	Total (hrs)
5.00	18.00	11

PLANT CONDITION (in need of attention)

		clock readings
Rig	y / n	
Tractor	y / n	
Trailer	y / n	
Dumper	y / n	
Compressor	y / n	
Grout mixer/ pump	y / n	
Fuel Bowser	y / n	
Water Bowser	y / n	
Jet Washer	y / n	
Other (detail)		

Fugro Engineering Services Limited

Rotary Landfill Drilling Daily Report

Serial No: 5401

Project:	DOCKSWAY L/FILL	Foreman:	W GILL	Gas/ Leachate/ Water Well No.:	LF 3
Contract No.:	L32726	Assistant:	K HONEY	Day and Date:	TUESDAY 28/10/03
Client:	NEWPORT BRO COUNCIL	Assistant:		Type of Drilling:	BARRELAUGER
Client's Project No.:		Rig No:	L827		
Weather:	FINE	Vehicle No:	NL 51 VDO	Flush:	NIL

DRILLING RECORD / DESCRIPTION OF STRATA

Casing Depth (m)	Casing Dia. (m)	From (m)	To (m)	Time (mins)	Dia. (mm)	Depth to Water (m)	DESCRIPTION OF STRATA
		1500	2700				VERY WET WASTE
							OBSTRUTION AT 2700m.
							NEVER PICKED UP WASTE
							FROM. 2440m.
							1 HR BALING 1 hour Item 2.10
							1 HR. TRACKING RIG TO
							OFFICE. 1 hour Standing Time
							for Security reasons.

Borehole Complete/ Incomplete

INSTALLATION/ BACKFILL

Diagram	From (m)	To (m)	Description
	GL	1.70	PLAIN PIPE STICKUP
	1.00	GL	BENTONITE SEAL
	2440	120	SLOTTED PIPE
	2440	1.00	STONE

Installation/ Backfilling Time: hrs

REMARKS

Signed: W Gill .... Driller

Signed: .... Client's Rep.

MOVES BETWEEN HOLES

Distance (approx.):		m
Time:		hrs

DAYWORKS

Removing waste:	15MINS	hrs
Collecting materials:	15MINS	hrs
Breakdowns:	5HRS.	hrs
Other (detail):		

OBSTRUCTIONS

From (m)	To (m)	Time (hrs)
2700	27.00	1 HR.
1 hour Obstructions at Dayworks.		

WORKING HOURS

From	To	Total (hrs)
300	1800	15.

PLANT CONDITION (in need of attention)

		clock readings
Rig	y / n	
Tractor	y / n	
Trailer	y / n	
Dumper	y / n	
Compressor	y / n	
Grout mixer/ pump	y / n	
Fuel Bowser	y / n	
Water Bowser	y / n	
Jet Washer	y / n	
Other (detail)		

STRUCTURAL SOILS

BOREHOLE LOG

Contract	Client	Borehole No
Newport	Borough of Newport	1A

Job No	Start / End	Ground Level (m AOD)	Co-Ordinates	Sheet
40222	Start 28/02/94 End 01/03/94	10.04	E 330,858 N 185,253	1 of 3

Depth	No	Type	Blows	Description of Strata	Depth (Thickness)
				MADE GROUND: Very soft reddish brown clayey marl and hardcore	(0.40) 0.40
				MADE GROUND: Household refuse	(4.80) 5.20
5.35	5	D		MADE GROUND: Very soft light grey silty clay with abundant brick, wood and household refuse	5.35
5.50-5.95	6	U	18	Very soft light brownish grey silty CLAY (Estuarine Alluvium)	
5.95-6.10	7	D		... from 5.95 to 6.10m depth becoming a grey silty clay mottled with abundant orangish brown clayey sand pockets	
6.50	8	D			
7.40-7.65	9	U	13		(3.65)
7.85-8.00	10	D			
8.55	11	D			9.00

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Casing Diameter	Water Depth
28.2.94		0.70	-	-	0.70
28.2.94		10.00	9.30	150	6.90
1.3.94	07:30	10.00	9.30	150	7.00
1.3.94	PM	19.05	17.10	150	9.70

Chiselling

From	To	Hours
12.05	16.80	1.25 hrs

General Remarks

Falling head test at 5.0-6.0m depth. 50mm diameter methane monitoring pipe installed.

All dimensions in metres Scale	Method	Logged By	Checked By
1:50	Cable Percussion	SMA	

STRUCTURAL SOILS

BOREHOLE LOG

Contract	Client	Borehole No
Newport	Borough of Newport	1A

Job No	Start / End	Ground Level (m AOD)	Co-Ordinates	Sheet
40222	Start 28/02/94 End 01/03/94	10.04	E 330,858 N 185,253	2 of 3

Depth	No	Type	Blows	Water	Description of Strata	Depth (Thickness)
					Very soft light grey locally thinly laminated closely fissured silty CLAY (Estuarine Alluvium)	
9.55-10.00	12	SPT	3	4 ▽		(1.00)
9.56-10.00	13	B				10.00
					Soft dark grey weathering brown thinly laminated slightly silty CLAY with occasional dark grey lenticles (Estuarine Alluvium)	
10.50	14	D				(2.05)
11.30-11.75	15	U	11			
11.75-11.90	16	D				
12.05-13.00	17	B				12.05
					Medium dense brown medium to coarse subrounded GRAVEL and COBBLES in a slightly sandy slightly silty fine angular gravelly clay (River Terrace Deposits)	
13.00	18	W				(4.75)
						16.80
					Very stiff dark brownish red with small grey green pockets locally thinly laminated slightly sandy slightly silty CLAY with some rounded lithorelicts and pockets of coarse sand and fine gravel (Mercia Mudstone Group)	
17.00	19	D				(1.20)
17.60-18.05	20	SPT	53			18.00

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Casing Diameter	Water Depth
28.2.94		0.70	-	-	0.70
28.2.94		10.00	9.30	150	6.90
1.3.94	07:30	10.00	9.30	150	7.00
1.3.94	PM	19.05	17.10	150	9.70

Chiselling

From	To	Hours
12.05	16.80	1.25 hrs

General Remarks

Falling head test at 5.0-6.0m depth. 50mm diameter methane monitoring pipe installed.

All dimensions in metres Scale	Method	Logged By	Checked By
1:50	Cable Percussion	SMA	

STRUCTURAL SOILS

BOREHOLE LOG

Contract	Client	Borehole No
Newport	Borough of Newport	1A

Job No	Start / End	Ground Level (m AOD)	Co-Ordinates	Sheet
40222	Start 28/02/94 End 01/03/94	10.04	E 330,858 N 185,253	3 of 3

Samples and In-situ Tests: Depth	No	Type	Blows	Water	Instrumentation	Description of Strata	Depth (Thickness)	Legend
18.75-19.05	21	CPT	53/ 150mm			Dark brownish red with small grey green pockets locally thinly laminated sandy silty weathered MUDSTONE (Mercia Mudstone Group)	(1.05) 19.05	
						Borehole terminated at 19.05m depth		

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Casing Diameter	Water Depth
28.2.94		0.70	-	-	0.70
28.2.94		10.00	9.30	150	6.90
1.3.94	07:30	10.00	9.30	150	7.00
1.3.94	PM	19.05	17.10	150	9.70

Chiselling

From	To	Hours
12.05	16.80	1.25 hrs

General Remarks

Falling head test at 5.0-6.0m depth. 50mm diameter methane monitoring pipe installed.

All dimensions in metres Scale	Method	Logged By	Checked By
1:50	Cable Percussion	SMA	

SITE: Docksway Landfill Site		LOGGED BY: I.C.L.	BOREHOLE No. 1A
LOCATION: E, N.		REFERENCE No.: 1	SHEET No. 1 of 2
BORING METHOD: Light Cable Percussion Boring			GROUND LEVEL 9.344 m.AOD
BORING EQUIPMENT: PILCON 150			COMMENCED 17/08/99

BORING DIAMETER (mm)	BORING DIAMETER TO (m)	CASING DIAMETER (mm)	CASING DIAMETER TO (m)
150	17.70	150	17.70

DATE & DRILLING DEPTH (m)	WATER LEVEL & SEEPAGE (m)	Date & CASING DEPTH (m)	DETAIL OF PIEZO/INCLO. INST.	SAMPLE DEPTH (m)	SOIL SAMPLE No. / ROCK CORE TCR (SCR) [RQD]	SOIL SAMPLE TYPE / ROCK CORE Fracture Index	CHANGE OF STRATA DEPTH (m)	LEGEND	O.D. LEVEL (m)	DESCRIPTION OF STRATA
/08		17/08	Plain pipe				0.20		9.144	MADE GROUND - Firm red brown gravelly very silty Clay.
				0.5-1.0		B				MADE GROUND - Dense light brown silty clayey fine to coarse sand with much gravel, comprising foam, paper, brick, tinfoil, plastic, cloth, wood.
				1.0-1.45 1.0-2.0		S(38) B				
		1.5		2.0 2.0-3.0		C(25 for 20mm) B				
		3.0		3.0-3.45 3.0-4.0		S(3) B	3.00		6.344	MADE GROUND - Soft red grey brown very silty Clay with some gravel of plastic, brick and ash.
							3.50		5.844	Firm grey brown very silty CLAY.
		3.0		4.0-4.45		U(70)				
08	(WL 4.2m)	18/08	Slotted pipe, geowrapped 12.0 to 1.0m Gravel filter 12.0 to 1.0m	4.45-4.6 4.6-5.0		D B				
		4.5		5.0-5.45		U(20)	5.00		4.344	Soft blue grey very silty CLAY.
				5.45-5.5 5.5-6.5		D B				
		4.5		6.5-6.95		U(15)	6.50		2.844	Soft to firm blue grey very silty CLAY.
				6.95-7.1		D				
				7.1-8.0		B				At 7.1m with very thin laminations of silt and fine sand.
		8.0		8.0-8.45 8.45-8.6		U(5) D				
				8.6-9.5		B				
		9.0		9.5-9.95		U(10)				
				9.95-10.1		D				

CHISELLING FROM (m)	CHISELLING TO	HOURS	WATER ADDED FROM	WATER ADDED TO
	2.5	3/4		
	12.8	1		
	14.5	1		

REMARKS:

Gwent consultancy

SITE: Docksway Landfill Site		LOGGED BY: I.C.L.	BOREHOLE No. 1A
LOCATION: E, N.	REFERENCE No.: 1		
BORING METHOD: Light Cable Percussion Boring	BORING DIAMETER	CASING DIAMETER	SHEET No. 2 of 2
BORING EQUIPMENT: PILCON 150	(mm) 150 / TO (m) 17.70	(mm) 150 / TO (m) 17.70	GROUND LEVEL m.AOD
			COMMENCED

DATE & DRILLING DEPTH (m)	WATER LEVEL & SEEPAGE (m)	Date & CASING DEPTH (m)	DETAIL OF PIEZO./ INCLO. INST.	SAMPLE DEPTH (m)	SOIL SAMPLE No. / ROCK CORE TCR (SCR) (RQD)	SOIL SAMPLE TYPE / ROCK CORE Fracture Index	CHANGE OF STRATA DEPTH (m)	LEGEND	O.D. LEVEL (m)	DESCRIPTION OF STRATA
			Slotted pipe 12.0 to 1.0m	10.5-11.0		B	10.5		-1.156	As previous description.
				11.0-11.45 11.0-12.0		S(11) B	11.0		-1.656	Soft blue grey very silty CLAY with occasional sub-rounded gravel and fine blue black laminations of silt / fine sand.
			Bentonite	12.5 12.5-12.6 12.5-13.5		W S(50 for 115mm) D	12.5		-3.156	Medium dense to dense grey silty clayey very sandy fine to coarse sub-rounded GRAVEL of sandstone with occasional cobbles.
				14.0-14.3 14.0-15.0		S(50 for 145mm) B				
18/08		18/08	Arisings							
				15.5 15.5-16.0		C(50 for 125mm) B	15.5		-6.156	Dense to very dense grey sandy fine to coarse sub-rounded to sub-angular GRAVEL of sandstone and quartz with some cobbles.
				16.3-16.6		B	16.3		-6.956	Dense to very dense grey fine to coarse SAND and fine to coarse sub-rounded GRAVEL of sandstone, quartz, with some to many cobbles.
	8.5	16.6		16.6-17.05		U(20)				
				17.05-17.2		D	17.05		-7.706	Stiff red brown very silty CLAY with some sand sized lithorelics of mudstone (MMG IVa).
				17.5-17.7		S(50 for 145mm)	17.5		-8.156	Stiff red brown very silty CLAY with many gravel sized lithorelics of mudstone (MMG III).
										END OF BOREHOLE

CHISELLING FROM	TO	HOURS	WATER ADDED FROM	TO
	2.5	3/4		
	12.8	1		
	14.5	1		

REMARKS:

Gwent consultancy

STRUCTURAL SOILS

BOREHOLE LOG

Contract	Client	Borehole No
Newport	Borough of Newport	3B

Job No	Start / End	Ground Level (m AOD)	Co-Ordinates	Sheet
40222	Start 02/03/94 End 02/03/94	9.09	E 330,858 N 185,145	1 of 2

Depth	No	Type	Blows	Water	Description of Strata	Depth (Thickness)
					MADE GROUND: Household refuse	(4.60)
1.70	1	W		1		
						4.60
4.70	2	D			Soft dark grey weathering brown thinly laminated silty CLAY with occasional peat traces (Estuarine Alluvium) ... strong refuse odour from 4.70m to 7.65m depth	(6.10)
4.90-5.35	3	U	11			
5.35-5.50	4	D				
6.00	5	D				
7.05-7.50	6	U	9	2		
7.50-7.65	7	D				
8.00	8	D				

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Casing Diameter	Water Depth
2.3.94		1.70	-		1.70
2.3.94		17.00	16.10	150	7.30
3.3.94		17.00	16.10	150	7.30

Chiselling

From	To	Hours
12.00	15.70	1 hr

General Remarks

Falling head test at 8.0-8.95m depth.

All dimensions in metres Scale 1:50	Method Cable Percussion	Drilled By	Logged By SMA	Checked By

STRUCTURAL SOILS

BOREHOLE LOG

Contract	Client	Borehole No
Newport	Borough of Newport	3B

Job No	Start / End	Ground Level (m AOD)	Co-Ordinates	Sheet
40222	Start 02/03/94 End 02/03/94	9.09	E 330,858 N 185,145	2 of 2

Depth	No	Type	Blows	Description of Strata	Depth (Thickness)
9.15-9.60	9	SPT	1	... becoming very soft dark grey weathering brown thinly laminated silty clay with occasional peat traces	
9.16-9.80	10	B			
10.50	11	D			10.70
10.70-12.00	12	B		Medium dense brownish grey fine to coarse angular to subrounded sandstone GRAVEL with occasional cobbles in a grey sandy silty clay matrix (River Terrace Deposits)	
12.00	13	W		... with many large cobbles from 12.00 to 15.70m depth	(5.00)
.80	14	D			15.70
.20-16.65	15	SPT	50/ 220mm	Dark reddish brown highly weathered MUDSTONE, very weak (Mercia Mudstone Group)	(1.60)
.00-17.30	16	CPT	50/ 140mm		17.30
				Borehole terminated at 17.30m depth	

Boring Progress and Water Observations

ate	Time	Borehole Depth	Casing Depth	Casing Diameter	Water Depth
.94		1.70	-		1.70
.94		17.00	16.10	150	7.30
.94		17.00	16.10	150	7.30

Chiselling

From	To	Hours
12.00	15.70	1 hr

General Remarks

Falling head test at 8.0-8.95m depth.

All dimensions in metres	Method	Drilled By	Logged By	Checked By
1:50	Cable Percussion		SMA	

Cable Percussion Borehole Log Sheet

BH No: GW03/14

C J Associates

Site:	**Dockway Waste Disposal Site, Newport**	Start Date:	27/05/2003
Job Number:	**P0514**	Finish Date:	28/05/2003
Client:	Peter Brett Associates	Vertical Scale:	1:50
Rig Type:	Dando 2000	Sheet 1 of 2	

Depth (m)	Sample Ref.	Standard Penetration Tests (SPT's) Test type	Blow Counts Seat.	Blow Counts Test Drive	N-value	Pen. (mm) Seat	Pen. (mm) Test	U100 Blows / % recovery	Depth (m)	Thickness (m)	Legend	Description of Strata	Reduced Level (m. O.D.) 9.73
												MADE GROUND (Grey-brown-black, slightly clayey, angular to subangular gravel and cobbles).	
1.00	D1												
1.90	D2												
										(4.80)			
2.80	D3												
3.60	D4												
4.80	D5								4.80				4.93
										(1.10)		MADE GROUND (Paper and plastic, with some grey-black-brown clayey matrix).	
5.90	D6								5.90				3.83
										(1.10)		Soft to firm, brown CLAY/SILT.	
7.00	D7								7.00				2.73
												Soft, brown SILT.	
8.00	D8												
										(3.00)			
9.00	D9												
10.00	D10								10.00				-0.27

(Continued on next sheet)

Hole Progress with Time (Depths in m. below G.L.) Date	Hole depth	Casing depth	Depth to water	Remarks
27/05/2003	10.50	10.50	-	
28/05/2003	18.00	17.50	9.00	

Chiselling From (m)	To (m)	Time (hrs)
1.30	1.50	0.50
2.90	3.10	0.50
12.50	12.80	0.50
15.50	16.00	1.00
16.80	17.20	1.00

Casing Record Depth (m)	Dia. (mm)
17.50	150

Groundwater Strikes (depths in m. below G.L.) Strike	Casing	Water (20mins)	Sealed	Remarks
11.00	11.00	9.00	-	med

General Remarks: Transport to site - 1hr waiting to be shown bhs. Set up on bh 1hr. Return to yard for extra casing 1/2hr transporting extra casing - Co-ordinates: 185097.91E - 330828.69N

Drilled By: PK
Logged By: IH

Cable Percussion Borehole Log Sheet

BH No: GW03/14

Site:	**Docksway Waste Disposal Site, Newport**	Start Date:	27/05/2003
Job Number:	**P0514**	Finish Date:	28/05/2003
Client:	Peter Brett Associates	Vertical Scale:	1:50
Rig Type:	Dando 2000	Sheet 2 of 2	

C J Associates

Depth (m)	Sample Ref.	Standard Penetration Tests (SPT's): Test type	Blow Counts: Seat.	Blow Counts: Test Drive	N-value	Pen. (mm): Seat	Pen. (mm): Test	U100 Blows / % recovery	Depth (m)	Thickness (m)	Legend	Description of Strata	Reduced Level (m O.D.)
												Grey, subangular to subrounded, fine to coarse GRAVEL and COBBLES.	
11.00	D11												
12.00	D12												
13.00	D13												
										(7.50)			
14.00	D14												
15.00	D15												
16.00	D16												
17.00	D17												
17.50	D18								17.50			Stiff, red-brown CLAY/SILT.	-7.77
										(0.50)			
									18.00			END OF BOREHOLE	-8.27

Hole Progress with Time (Depths in m. below G.L.): Date	Hole depth	Casing depth	Depth to water	Remarks	Chiselling: From (m)	To (m)	Time (hrs)	Casing Record: Depth (m)	Dia. (mm)	Groundwater Strikes (depths in m. below G.L.): Strike	Casing	Water (20mins)	Sealed	Remarks

General Remarks: 1.50hr perm test

Co-ordinates: 185097.91E - 330828.69N

Drilled By: PK
Logged By: IH

STRUCTURAL SOILS

BOREHOLE LOG

Contract	Client	Borehole No
Newport	Borough of Newport	7

Job No	Start / End	Ground Level (m AOD)	Co-Ordinates	Sheet
40222	Start 03/03/94 End 03/03/94	7.27	E 330,924 N 184,967	1 of 2

Depth	No	Type	Blows	Description of Strata	Depth (Thickness)
0.40	1	W		MADE GROUND: Compacted brown sandy gravel with brick, tarmacadam, reinforced concrete and boulders	(1.90) 1.90
2.00	2	D		Soft and very soft dark grey thinly laminated silty CLAY with occasional to some fine to medium gravel, occasional cobbles and pockets of peat, locally slightly sandy (Estuarine Alluvium)	(2.15) 4.05
2.30-2.75	3	U+	17		
2.31-2.90		B			
3.00-3.45	4	U	11		
3.45-3.60	5	D			
4.05	6	D		Very soft dark grey thinly laminated fissured silty CLAY, locally slightly sandy and with occasional peat traces (Estuarine Alluvium)	(5.25)
5.10-5.55	7	U	9		
5.55-5.70	8	D			
6.00	9	D			
7.10-7.55	10	S+	2		
7.11-7.60	11	B			
8.00	12	D			
8.90-9.35	13	U	38		

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Casing Diameter	Water Depth
3.3.94		0.40	-	-	0.40
3.3.94		10.60	10.50	150	7.10

Chiselling

From	To	Hours
0.0	1.9	0.75 hrs
10.50	10.60	2.5 hrs

General Remarks

Falling head test at 3.95-4.0m depth.

All dimensions in metres

Scale 1:50

Method	Drilled By	Logged By	Checked By
Cable Percussion		SMA	

STRUCTURAL SOILS

BOREHOLE LOG

Contract	Client	Borehole No
Newport	Borough of Newport	7

Job No	Start / End	Ground Level (m AOD)	Co-Ordinates	Sheet
40222	Start 03/03/94 End 03/03/94	7.27	E 330,924 N 184,967	2 of 2

Samples and In-situ Tests: Depth	No	Type	Blows	Water	Instrumentation	Description of Strata	Depth (Thickness)	Legend
9.35-9.50	14	D				Soft and very soft dark grey thinly laminated fissured silty CLAY, locally slightly sandy and with occasional peat traces (Estuarine Alluvium)	9.30	
9.50-10.50	15	B				Medium dense brown and grey fine to coarse subrounded sandstone GRAVEL with many cobbles in a grey sandy silty clay matrix (River Terrace Deposits)	(1.30)	
10.50	16	W					10.60	
						Borehole terminated on boulder at 10.60m depth		

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Casing Diameter	Water Depth
3.3.94		0.40	-	-	0.40
3.3.94		10.60	10.50	150	7.10

Chiselling

From	To	Hours
0.0	1.9	0.75 hrs
10.50	10.60	2.5 hrs

General Remarks

Falling head test at 3.95-4.0m depth.

All dimensions in metres Scale	Method	Drilled By	Logged By	Checked By
1:50	Cable Percussion		SMA	

STRUCTURAL SOILS

BOREHOLE LOG

Contract	Client	Borehole No
Newport	Borough of Newport	9

Job No	Start / End	Ground Level (m AOD)	Co-Ordinates	Sheet
40222	Start 16/03/94 End 16/03/94	9.84	E 331,033 N 184,838	1 of 2

Depth	No	Type	Blows	Water	Instrumentation	Description of Strata	Depth (Thickness)	Legend
0.25	1	D				MADE GROUND: Medium dense brown silty gravelly clayey sand with ash, brick and concrete fragments		
0.55-1.00	2	CPT/B	20				(2.10)	
1.25	3	D						
1.50-1.95	4	CPT/B	10				2.10	
2.20	5	D				MADE GROUND: Firm dark brown silty clay with occasional peat traces and brick fragments	2.30	
2.45	6	D	23			Stiff brownish grey mottled orange silty CLAY becoming softer with depth (Estuarine Alluvium)		
2.50-2.95	7	U						
2.95-3.10	8	D						
3.55	9	D					(3.20)	
4.05-4.50	10	U	14					
4.50-4.65	11	D						
5.00	12	D						
5.50-5.95	13	U	12			Soft becoming very soft dark grey very silty CLAY with occasional peat traces (Estuarine Alluvium)	5.50 (4.34)	
5.95-6.10	14	D						
6.60	15	D						
7.00-7.45	16	U	13					
7.45-7.60	17	D						
8.00	18	D						
8.50-8.95	19	U	9					

Elev

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Casing Diameter	Water Depth
16.3.94		12.80	3.20	150	10.30
16.3.94		13.20	3.20	150	10.25

Chiselling

From	To	Hours

General Remarks

All dimensions in metres Scale 1:50	Method Cable Percussion	Drilled By	Logged By AHJ	Checked By

STRUCTURAL SOILS

BOREHOLE LOG

Contract	Client	Borehole No
Newport	Borough of Newport	9

Job No	Start / End	Ground Level (m AOD)	Co-Ordinates	Sheet
40222	Start 16/03/94 End 16/03/94	9.84	E 331,033 N 184,838	2 of 2

Samples and In-situ Tests: Depth	No	Type	Blows	Water	Description of Strata	Depth (Thickness)
8.95-9.10	20	D			Soft dark grey very silty CLAY with occasional peat traces (Estuarine Alluvium)	(7.30)
9.50	21	D				
10.00-10.45	22	U	8	2		
11.00	23	D				
11.50-11.95	24	U	10			
12.80	25	W		1		12.80
					Dense grey GRAVEL with occasional cobbles in a sandy silty clay (River Terrace Deposits)	13.00
					Borehole terminated at 13.00m depth	

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Casing Diameter	Water Depth
16.3.94		12.80	3.20	150	10.30
16.3.94		13.20	3.20	150	10.25

Chiselling

From	To	Hours

General Remarks

All dimensions in metres Scale 1:50	Method Cable Percussion	Drilled By	Logged By AHJ	Checked By

SITE: Docks Way Landfill - Waste Transfer Station	LOGGED BY: ICL	BOREHOLE No. BH1
LOCATION: Newport	REFERENCE No.: 72846	SHEET No. 1 of 2
BORING METHOD: LIGHT CABLE PERCUSSIVE		
BORING EQUIPMENT: Pilcon 150 and 250mm diameter tools and casing		GROUND LEVEL mAOD

BORING DIAMETER (mm)	TO (m)	CASING DIAMETER (mm)	TO (m)
250	19.4	250	18.9

COMMENCED: 10/05/2000

DATE & DRILLING DEPTH (m)	WATER LEVEL & SEEPAGE (m)	Date & CASING DEPTH (m)	DETAIL OF PIEZO./ INCLO. INST.	SAMPLE DEPTH (m)	SOIL SAMPLE No. / TYPE (ROCK CORE TCR (SCR) (RQD) / Fracture Index)	CHANGE OF STRATA DEPTH (m)	LEGEND	O.D. LEVEL (m)	DESCRIPTION OF STRATA
10/05/00		10/05/00	Grout, Plain Pipe	1.0- 1.5 1.0- 1.45	B C 20 (1,2,4,4,5,7)	1.60			MADE GROUND...Stiff red brown mottled black and yellow slightly sandy gravelly very silty Clay with some fragments of plastic and organic matter.
				2.0- 2.5 2.0- 2.45 3.0- 3.5 3.0- 3.45	B C 7 (3,2,1,1,1,4) B C 7 (1,-,1,1,2,3)	3.70			MADE GROUND...Soft to firm blue grey and light brown gravelly very silty Clay with some fragments of paper, wood, glass, plastic and metal.
						4.20			MADE GROUND...Loose grey fine to coarse angular Gravel and cobbles of paper wood plastic metal (compressible).
				4.0- 4.5 4.0- 4.45 4.8- 5.0 5.0- 5.2 5.4 5.8	B C 55 (3,4,5,5,19,26) B C 55 for 134mm (9,12,20,33/59) W W	6.00			MADE GROUND...Medium dense to Dense dark brown slightly silty sandy very clayey fine to coarse angular Gravel of brick and slag (organic odour)
11/05/00	seepage	11/05/00	Bentonite, Seal	6.0- 6.2 6.0- 6.18 7.0- 7.5 7.0- 7.45	B C 50 for 37mm (6,11,50/37mm) B C 12 (7,4,3,1,3,5)	7.30			MADE GROUND...Medium dense to dense black brown slightly silty sandy fine to coarse angular Gravel of hair, wood, plastic, brick, with some cobbles of brick, wood, cloth, metal, and a washing up bottle.
				7.5- 7.95 8.0	U (24) D	8.40			Stiff brown grey very silty CLAY with some rootlets and thin laminae of silt.
				8.5- 8.95 9.5- 9.95	S 11 (1,2,2,3,3,3) U (13)				Soft to firm blue grey very silty CLAY with occasional organic material.

CHISELLING FROM	TO	HOURS	WATER ADDED FROM	TO
4.40	4.70	1		
5.20	5.60	1		
6.20	6.90	2		

REMARKS:
* Includes seating blows

Gwent consultancy

SITE:	Docks Way Landfill - Waste Transfer Station
LOGGED BY:	ICL
BOREHOLE No.	BH1
LOCATION:	Newport
REFERENCE No.:	72846
SHEET No.	2 of 2
BORING METHOD:	LIGHT CABLE PERCUSSIVE
BORING EQUIPMENT:	Pilcon 150 and 250mm diameter tools and casing
GROUND LEVEL	mAOD
COMMENCED	10/05/2000

BORING DIAMETER (mm)	TO (m)	CASING DIAMETER (mm)	TO (m)
250	19.4	250	18.9

DATE & DRILLING DEPTH (m)	Date & CASING DEPTH (m)	DETAIL OF PIEZO./INCLO. INST.	SAMPLE DEPTH (m)	SOIL SAMPLE No. / TYPE
			10.4	D
			10.5 - 10.95	S 7 (1,-,1,1,2,3)
			11.5 - 11.95	U (9)
			12.0	D
		Bentonite Seal	12.5 - 12.95	S 25 (1,2,3,5,8,9)
		Bentonite Seal	13.0 - 13.45	C 51 (2,4,7,7,10,27)
		Bentonite Seal	13.0 - 13.50	B
			14.0 - 14.45	C 42 (1,3,8,10,13,11)
			14.0 - 14.50	B
	12/05/00	ARISINGS	15.0	C 50 for 41mm *
		ARISINGS	16.0 - 16.45	C 60 (11,17,26,18,10,6)
		ARISINGS	17.0 - 17.45	C 22 (3,5,7,6,4,5)
		ARISINGS	17.0 - 17.50	B
		ARISINGS	18.0	C 50 for 61mm *
16/05/00	16/05/00	ARISINGS	18.0 - 18.80	
		Bentonite	18.8 - 19.00	
		Bentonite	19.0 - 19.37	S 63 for 225mm (3,11,15,20,28)
		Bentonite	19.40	

CHANGE OF STRATA DEPTH (m)	DESCRIPTION OF STRATA
10.1 – 12.0	Firm to stiff dark blue very silty CLAY with some rootlets and thin laminations of fine sand and silt.
12.0 –	Firm blue grey slightly sandy very silty CLAY with some to much medium to coarse gravel of sandstone.
– 13.4	Dense grey brown silty sandy fine to coarse sub rounded GRAVEL of sandstone and quartz with some cobbls of sandstone.
13.4 – 14.5	Dense to very dense dark grey, grey slightly silty very sandy fine to coarse sub-rounded GRAVEL of sandstone and quartz with some cobbles and occasional boulders of sandstone.
14.5 – 16.3	Medium dense grey slightly silty very sandy fine to coarse sub-rounded GRAVEL of sandstone and quartz with some cobbles and occasional boulders of sandstone.
16.3 – 17.7	Dense to very dense light grey and brown slightly sandy fine to coarse sub-rounded GRAVEL with many cobbles and some boulders of sandstone.
17.7 – 18.8	Stiff red brown very silty CLAY with many fine to medium gravel sized lithorelics of mudstone (III).
18.8	END OF BOREHOLE

CHISELLING FROM	TO	HOURS	WATER ADDED FROM	TO
15.4	16.3	2		
17.7	18.0	1		
18.0	18.8	4.5		
19.1	19.4	1		

REMARKS:
* Includes seating blows

Gwent consultancy

SITE: Docks Way Landfill - Waste Transfer Station	LOGGED BY: ICL	BOREHOLE No. BH2A
LOCATION: Newport	REFERENCE No.: 72846	SHEET No. 1 of 2
BORING METHOD: LIGHT CABLE PERCUSSIVE		GROUND LEVEL m.AOD
BORING EQUIPMENT: Pilcon 150 and 250mm dia tools and casing		COMMENCED 10/05/2000

BORING DIAMETER (mm)	TO (m)	CASING DIAMETER (mm)	TO (m)
250	15.0	250	14.5

DATE & DRILLING DEPTH (m)	WATER LEVEL & SEEPAGE (m)	Date & CASING DEPTH (m)	DETAIL OF PIEZO./INCLO. INST.	SAMPLE DEPTH (m)	SOIL SAMPLE No. / ROCK CORE TCR (SCR) [RQD]	TYPE / Fracture Index	CHANGE OF STRATA DEPTH (m)	LEGEND	O.D. LEVEL (m)	DESCRIPTION OF STRATA
17/05/00		17/05/00	Concrete							MADE GROUND...Aggregate tarmac and concrete (Drillers Description).
			Bentonite	1.0	C 50 for 27mm		1.00			MADE GROUND...Reinforced concrete (Drillers Description).
							1.80			MADE GROUND...Tarmac (Drillers Description).
							2.10			MADE GROUND...Clay cap (Drillers Description).
							2.70			MADE GROUND...Firm to stiff, grey and brown very silty Clay with much paper, cloth, plastic, glass and a boulder of quartz conglomerate.
				3.0-3.2 3.0-3.45	B C 60 (1,2,4,13,19,24)		3.00			MADE GROUND...Medium Dense brown silty very sandy very clayey fine to coarse angular Gravel of paper hardboard, glass, brick, plastic, cloth and occasional cobbles of brick (organic odour).
				4.0-4.5 4.0-4.45	B C 25 (4,7,8,6,6,5)					
				5.0-5.5 5.0-5.45	B C 25 (6,5,7,7,4,7)		5.00			MADE GROUND...Medium dense to very dense grey silty gravelly very sandy Cobbles of brick, sandstone, metal, cloth, paper, glass fragments.
	1 Seep			5.8	W					
				6.0-6.4 6.0-6.45	B C 51 (2,4,4,7,10,30)		6.20			MADE GROUND...Medium dense to dense brown silty very clayey fine to coarse angular Gravel with fragments of plastic, wood, sandstone, and occasional cobbles and boulders of sandstone and brick.
				7.0-7.5 7.0-7.45	B C15 (3,2,3,3,4,5)		7.30			Firm to stiff brown grey/blue grey slightly sandy very silty CLAY with some organic fragments.
			Bentonite	7.5-7.95	U (28)					
				8.0	D					
				8.5-8.95	S 14 (1,2,3,3,4,4)					
				9.5-9.95	U (18)		9.30			Soft grey and blue grey slightly sandy very silty CLAY with some thin silt laminations
				10.0	D					

CHISELLING FROM	TO	HOURS	WATER ADDED FROM	TO
3.2	3.8	2.0		
6.4	6.9	2.0		
14.5	15.0	1.5		

REMARKS:
Obstructions obsreved at 1.0m depth in BH2. Driller instructed to move to next Borehole. Small area excavated to remove obstructions - Drillers observations during excavation of BH2A noted above.
Medium water inflow at 14.1m.

Gwent consultancy

SITE: Docks Way Landfill - Waste Transfer Station	LOGGED BY: ICL	BOREHOLE No. BH2A
LOCATION: Newport	REFERENCE No.: 72846	
BORING METHOD: LIGHT CABLE PERCUSSIVE		SHEET No. 2 of 2
BORING EQUIPMENT: Pilcon 150 and 250mm dia tools and casing		GROUND LEVEL m.AOD
		COMMENCED 10/05/2000

BORING DIAMETER (mm)	TO (m)	CASING DIAMETER (mm)	TO (m)
250	15.0	250	14.5

DATE & DRILLING DEPTH (m)	WATER LEVEL & SEEPAGE (m)	Date & CASING DEPTH (m)	DETAIL OF PIEZO./ INCLO. INST.	SAMPLE DEPTH (m)	SOIL SAMPLE No. / TYPE; ROCK CORE TCR (SCR) [RQD] / Fracture Index	CHANGE OF STRATA DEPTH (m)	LEGEND	O.D. LEVEL (m)	DESCRIPTION OF STRATA
	▼2		ARISINGS						Soft grey and blue grey slightly sandy very silty CLAY with some thin silt laminations.
				10.5 - 10.95	S 3 (1,-,1,-,1,1)				
				11.5 - 11.95	U (9)				
				12.0	D				Below 12m with some rootlets.
				12.5 - 12.95	S 4 (1,-,1,1,2,2)				
				13.5 - 14.0	C 34 (4,7,10,10,8,6)	13.4			Firm blue grey slightly sandy very silty CLAY with some to much medium to coarse gravel of sandstone.
				13.5 - 13.95					
	▽2					14.1			Dense to very dense dark grey/ grey slightly silty very sandy fine to coarse sub-rounded GRAVEL of sandstone and quartz fragments with some to many cobbles and occasional boulders of sandstone.
				14.5 - 14.875	C 60 (9,15,18,19,23)				
				15.00		15.0			

END OF BOREHOLE

CHISELLING FROM	TO	HOURS	WATER ADDED FROM	TO
3.2	3.8	2.0		
6.4	6.9	2.0		
14.5	15.0	1.5		

REMARKS:
Obstructions obsreved at 1.0m depth in BH2. Driller instructed to move to next Borehole. Small area excavated to remove obstructions - Drillers observations during excavation of BH2A noted above.
Medium water inflow at 14.1m.

Gwent consultancy

SITE: Docksway Landfill Site	LOGGED BY: I.C.L.	BOREHOLE No. 10
LOCATION: E, N.	REFERENCE No.: 1	
BORING METHOD: Light Cable Percussion Boring		SHEET No. 1 of 1
BORING EQUIPMENT: PILCON 150		GROUND LEVEL mAOD
		COMMENCED 23/08/1999

BORING DIAMETER (mm)	TO (m)	CASING DIAMETER (mm)	TO (m)
150	10.0	150	10.0

DATE & DRILLING DEPTH (m)	WATER LEVEL & SEEPAGE (m)	Date & CASING DEPTH (m)	DETAIL OF PIEZO/INCLO. INST.	SAMPLE DEPTH (m)	SOIL SAMPLE No. / ROCK CORE TCR (SCR) [RQD]	TYPE / Fracture Index	CHANGE OF STRATA DEPTH (m)	LEGEND	O.D. LEVEL (m)	DESCRIPTION OF STRATA
23/08			Plain Pipe 0.7 to +0.3m in concrete				0.10			TOPSOIL
				0.7		J	0.70			MADE GROUND - Soft to firm dark brown slightly gravelly very silty Clay with much plastic, paper and brick.
				2.0		J				MADE GROUND - Dark grey slightly silty clayey very sandy fine to coarse angular Gravel of plastic, paper, red brick and occasional glass, ash and concrete with pockets of soft to firm clay.
	▽		Slotted Pipe 9.7 to 0.7m Gravel 10.0 to 0.7m	6.0		J				
				8.0		J	7.70			Firm brown grey very silty CLAY.
				10.00		J	10.0			END OF BOREHOLE

CHISELLING FROM	TO	HOURS	WATER ADDED FROM	TO	REMARKS:

Gwent consultancy

Cable Percussion Borehole Log Sheet

Site:	**Docksway Waste Disposal Site, Newport**	BH No:	**GW03/03**
Job Number:	**P0514**	Start Date:	10/06/2003
Client:	Peter Brett Associates	Finish Date:	11/06/2003
Rig Type:	Dando 2000	Vertical Scale:	1:50
		Sheet 1 of 2	

C J Associates

Depth (m)	Sample Ref.	Standard Penetration Tests (SPT's): Test type	Blow Counts: Seat.	Blow Counts: Test Drive	Blow Counts: N-value	Pen. (mm): Seat	Pen. (mm): Test	U100 Blows / % recovery	Depth (m)	Thickness (m)	Legend	Description of Strata	Reduced Level (m. O.D.) 15.14
0.90	D1								1.00	(1.00)		MADE GROUND (Soft to firm, brown clay, with occasional fine to medium subrounded gravel).	14.14
2.00	D2												
3.00	D3												
4.00	D4								4.10	(3.10)		MADE GROUND (Refuse).	11.04
5.00	D5								5.10	(1.00)		MADE GROUND (Firm, brown-red clay, with occasional fine medium and coarse subangular gravel).	10.04
5.80	D6												
7.00	D7								7.10	(2.00)		MADE GROUND (Refuse).	8.04
8.00	D8								8.10	(1.00)		MADE GROUND (Brown-red,clay, with brick fragments).	7.04
9.00	D9												
10.00	D10								10.00	(1.90)		Soft to firm, grey-brown CLAY, with occasional fine medium and coarse subangular gravel.	5.14

(Continued on next sheet)

Hole Progress with Time (Depths in m. below G.L.): Date	Hole depth	Casing depth	Depth to water	Remarks

Chiselling: From (m)	To (m)	Time (hrs)
2.30	2.50	0.5
5.80	6.00	0.5
17.50	18.00	1
18.00	19.00	2

Casing Record: Depth (m)	Dia. (mm)
9.00	200
19.00	150

Groundwater Strikes (depths in m. below G.L.): Strike	Casing	Water (20mins)	Sealed	Remarks
15.50	15.50	14.00	-	Struck

General Remarks:

Co-ordinates: 185603.33E - 330685.03N

Drilled By: PK
Logged By: IH

Cable Percussion Borehole Log Sheet

Site:	**Docksway Waste Disposal Site, Newport**	Start Date:	10/06/2003
Job Number:	**P0514**	Finish Date:	11/06/2003
Client:	Peter Brett Associates	Vertical Scale:	1:50
Rig Type:	Dando 2000	Sheet 2 of 2	

BH No: **GW03/03**

C J Associates

Depth (m)	Sample Ref.	SPT Test type	SPT Blow Counts Seat.	SPT Blow Counts Test Drive	SPT N-value	SPT Pen. (mm) Seat	SPT Pen. (mm) Test	U100 Blows / % recovery	Depth (m)	Thickness (m)	Legend	Description of Strata	Reduced Level (m. O.D.)
										(1.00)	× × ×	Firm to stiff, grey SILT.	
11.00	U11							30b / 100%	11.00				4.14
										(0.70)	× × ×	Very soft, grey SILT.	
11.50	D12												
									11.70				3.44
										(1.50)	× × ×	Firm, grey SILT, with much subrounded to subangular gravel.	
12.50	U13							50b / 90%					
12.95	D14												
									13.20				1.94
										(5.80)	∴∴	Dense becoming very dense, grey, fine medium and coarse subrounded GRAVEL.	
13.50	D15	C	6,7	7,6,7,8	N=28	150	300						
14.00	D16												
15.00	D17	C	6,8	10,10,14,14	N=48	150	300						
15.50	D18												
16.50	D19												
17.50	D20												
18.50	D21												
									19.00			END OF BOREHOLE	-3.86

Hole Progress with Time: Date	Hole depth	Casing depth	Depth to water	Remarks	Chiselling: From (m)	To (m)	Time (hrs)	Casing Record: Depth (m)	Dia. (mm)	Groundwater Strikes: Strike	Casing	Water (20mins)	Sealed	Remarks

Hole Progress with Time (Depths in m. below G.L.); Groundwater Strikes (depths in m. below G.L.)

General Remarks:

Co-ordinates: 185603.33E - 330685.03N

Drilled By: PK
Logged By: IH

Cable Percussion Borehole Log Sheet

BH No: GW03/05

Site:	**Docksway Waste Disposal Site, Newport**	Start Date:	17/06/2003
Job Number:	**P0514**	Finish Date:	18/06/2003
Client:	Peter Brett Associates	Vertical Scale:	1:50
Rig Type:	Dando 150	Sheet 1 of 2	

C J Associates

Depth (m)	Sample Ref.	SPT Test type	SPT Blow Counts Seat	SPT Blow Counts Test Drive	SPT N-value	SPT Pen. (mm) Seat	SPT Pen. (mm) Test	U100 Blows / % recovery	Depth (m)	Thickness (m)	Legend	Description of Strata	Reduced Level (m. O.D.) 12.44
										(1.10)		MADE GROUND (Concrete and brick fragments).	
									1.10	(4.20)		MADE GROUND (Refuse).	11.34
									5.30	(0.50)		MADE GROUND (Grey-black, clayey ash).	7.14
6.00	D1								5.80	(0.90)		MADE GROUND (Soft, grey clay, with some refuse).	6.64
7.00	D2								6.70	(1.00)		Firm to stiff, grey SILT.	5.74
8.00	D3								7.70			Soft, grey SILT.	4.74
9.00	D4												
10.00	D5												

(Continued on next sheet)

Hole Progress with Time (Depths in m. below G.L.) Date	Hole depth	Casing depth	Depth to water	Remarks	Chiselling From (m)	Chiselling To (m)	Chiselling Time (hrs)	Casing Record Depth (m)	Casing Record Dia. (mm)	Groundwater Strikes (depths in m. below G.L.) Strike	Casing	Water (20mins)	Sealed	Remarks
					0.10 16.50 19.60	1.10 17.20 20.00	2.50 1.5 1.5	0.00	-	15.60	15.50	13.20	-	Struck

General Remarks:

Co-ordinates: 185864.23E - 330943.69N

Drilled By: GW
Logged By: IH

Cable Percussion Borehole Log Sheet

BH No: GW03/05

Site:	**Docksway Waste Disposal Site, Newport**	Start Date:	17/06/2003
Job Number:	**P0514**	Finish Date:	18/06/2003
Client:	Peter Brett Associates	Vertical Scale:	1:50
Rig Type:	Dando 150	Sheet 2 of 2	

C J Associates

Depth (m)	Sample Ref.	SPT Test type	SPT Blow Counts Seat.	SPT Blow Counts Test Drive	SPT N-value	SPT Pen. (mm) Seat	SPT Pen. (mm) Test	U100 Blows / % recovery	Depth (m)	Thickness (m)	Legend	Description of Strata	Reduced Level (m. O.D.)
												Soft, grey SILT.	
11.00	D6												
										(8.10)			
12.00	D7												
13.00	D8												
14.00	D9												
15.00	D10												
									15.80				-3.36
												Grey, fine medium and coarse subrounded GRAVEL, with some cobbles and boulders.	
16.00	D11												
17.00	D12												
										(4.20)			
18.00	D13												
19.00	D14												
									20.00			END OF BOREHOLE	-7.56

Hole Progress with Time (Depths in m. below G.L.)					Chiselling			Casing Record		Groundwater Strikes (depths in m. below G.L.)				
Date	Hole depth	Casing depth	Depth to water	Remarks	From (m)	To (m)	Time (hrs)	Depth (m)	Dia. (mm)	Strike	Casing	Water (20mins)	Sealed	Remarks

General Remarks:

Co-ordinates: 185864.23E - 330943.69N

Drilled By: GW
Logged By: IH

SITE: **Docksway Landfill Site**		LOGGED BY: I.C.L.	BOREHOLE No. 2
LOCATION:	E, N.	REFERENCE No.: 1	SHEET No. 1 of 2
BORING METHOD: Light Cable Percussion Boring			GROUND LEVEL 10.108 m.AOD
BORING EQUIPMENT: PILCON 150			COMMENCED 17/08/1999

BORING DIAMETER (mm)	TO (m)	CASING DIAMETER (mm)	TO (m)
150	17.05	150	17.05

DATE & DRILLING DEPTH (m)	WATER LEVEL & SEEPAGE (m)	Date & CASING DEPTH (m)	DETAIL OF PIEZO./INCLO. INST.	SAMPLE DEPTH (m)	SOIL SAMPLE No. / ROCK CORE TCR (SCR) [RQD]	TYPE / Fracture Index
17/08		17/08	Plain pipe 1.0 to +0.3	0.5		D
				0.5-1.0		B
				1.05-1.5		S(3)
			Slotted standpipe 7.0 to 1.0m	1.5		D
				1.5-2.0		B
				2.05-2.5		S(3)
				2.5		D
				2.5-3.0		B
	1 ▽ / 1 ▼			3.05-3.59		S(37)
				3.4		D
				3.5-4.0		B
	▽			4.05-4.5		C(25)
				4.5		D
				4.5-5.0		B
				5.05-5.5		U(11)
				5.5-5.7		D
				5.9-6.3		B
				6.55-7.0		U(N/R)
			Bentonite Seal 9 to 7m	7.6		D
				8.05-8.5		U(N/R)
				8.7		D
				8.9-9.3		B
				9.55-10.0		U(N/R)

CHANGE OF STRATA DEPTH (m)	O.D. LEVEL (m)	DESCRIPTION OF STRATA
0.30	9.808	MADE GROUND - Brown sandy Clay with brick concrete, plastic, paper and occasional timber.
3.20	6.908	MADE GROUND - Soft grey blue brown slightly sandy very silty Clay with some to much fine to coarse angular gravel of brick, glass, concrete, cloth, plastic.
4.40	5.708	MADE GROUND - Medium dense to dense dark grey sandy fine to coarse angular Gravel of brick, glass, cloth, plastic, and cobbles of wood.
5.90	4.208	Soft to very soft blue grey brown very silty CLAY.
		Very soft blueish grey very silty CLAY with some very thinly laminated silts and fine sands.

CHISELLING FROM	TO	HOURS	WATER ADDED FROM	TO
0	12.45	1		
0	16.10	1		
0	17.00	1		

REMARKS:
At 16.90m casing pushing cobbles into the marl (Driller's description).

Gwent consultancy

SITE: **Docksway Landfill Site**		LOGGED BY: I.C.L.	BOREHOLE No. 2
LOCATION: E, N.	REFERENCE No.: 1		
BORING METHOD: Light Cable Percussion Boring			SHEET No. 2 of 2
BORING EQUIPMENT: PILCON 150			GROUND LEVEL mAOD

BORING DIAMETER (mm)	TO (m)	CASING DIAMETER (mm)	TO (m)
150	17.05	150	17.05

COMMENCED 17/08/1999

DATE & DRILLING DEPTH (m)	WATER LEVEL & SEEPAGE (m)	Date & CASING DEPTH (m)	DETAIL OF PIEZO./ INCLO. INST.	SAMPLE DEPTH (m)	SOIL SAMPLE No. / ROCK CORE TCR (SCR) (RQD)	TYPE / Fracture Index	CHANGE OF STRATA DEPTH (m)	O.D. LEVEL (m)	DESCRIPTION OF STRATA
									As previous description.
							10.4	-0.292	
				10.5-11.0		B			Medium dense to dense blueish grey very clayey fine to coarse sub-rounded GRAVEL.
				11.05-11.5		C(44)	11.0	-0.892	Dense grey very sandy medium to coarse sub-rounded to rounded GRAVEL with occasional to some cobbles of sandstone.
				11.75-11.15		B			
							12.3	-2.192	COBBLES (Driller's description).
18/8		18/8 12.5					12.4	-2.292	
				12.55-13.0		C(50 for 131mm)			Dense to very dense grey very sandy medium to coarse sub-rounded to rounded GRAVEL with some to many cobbles of sandstone.
				13.25-13.75		B			
		14.0		14.05-14.5		C(32)			
			Arisings	14.75-15.25		B			
		15.0		15.55-16.0		C(50 for 156mm)			
				16.25-16.75		B			
							16.8	-6.692	
		16.95		17.0-17.05		C(50 for 3mm)	16.9	-6.792	Stiff Marl (Driller's description)
									END OF BOREHOLE

CHISELLING FROM	TO	HOURS	WATER ADDED FROM	TO
.30	12.45	1		
.90	16.10	1		
.90	17.00	1		

REMARKS:
At 16.90m casing pushing cobbles into the marl (Driller's description).

Gwent consultancy

SITE: Docksway Landfill Site		LOGGED BY: I.C.L.	BOREHOLE No. 3
LOCATION: E, N.		REFERENCE No.: 1	
BORING METHOD: Light Cable Percussion Boring			SHEET No. 1 of 2
BORING EQUIPMENT: PILCON 150			GROUND LEVEL 10.585 mAOD
			COMMENCED 19/08/1999

BORING DIAMETER (mm)	BORING DIAMETER TO (m)	CASING DIAMETER (mm)	CASING DIAMETER TO (m)
150	11.5	150	11.5

DATE & DRILLING DEPTH (m)	WATER LEVEL & SEEPAGE (m)	Date & CASING DEPTH (m)	DETAIL OF PIEZO./ INCLO. INST.	SAMPLE DEPTH (m)	SOIL SAMPLE No. / ROCK CORE TCR (SCR) [RQD]	SOIL SAMPLE TYPE / ROCK CORE Fracture Index	CHANGE OF STRATA DEPTH (m)	LEGEND	O.D. LEVEL (m)	DESCRIPTION OF STRATA
19/8/99		19/8/99	Plain Pipe 0.7 to +0.3m	0.5-1.0 1.0-1.45		B S(3)	0.50		10.085	MADE GROUND - Stiff red brown sandy very silty Clay with some gravel and cobbles.
				1.0-2.0		B				MADE GROUND - Firm to stiff brown sandy very silty Clay with some gravel of wood, plastic, cloth and paper.
		1.5		2.0-2.45 2.0-3.0		S(14) B	2.00		8.585	MADE GROUND - Firm to soft brown and red brown silty very gravelly Clay with fragments of glass, paper, cloth, plastic and wood.
	1 ▽ 1 ▼	3.0	Slotted standpipe 6.7 to 0.7m Gravel 7.0 to 0.7m	3.0-3.45 3.0-4.0		S(8) B				
		3.0		4.0-4.45 4.0-5.0		S(8) B	4.30		6.285	Firm blueish grey mottled brown, very silty CLAY with occasional gravel.
		4.5		5.0-5.45		U(25)				
				5.45-5.6 5.6-6.5		D B				
		6.0		6.5-6.95		U(20)	6.50		4.085	Very soft to soft blueish grey slightly sandy very silty CLAY.
				6.95-7.1 7.1-8.0		D B				
		8.0		8.0-8.45		U(13)				
			Bentonite 7.0 to 11.5m	8.45-8.6 8.6-9.5		D B				Below 8.45m with very thin laminations of silt and fine sand.
		9.0		9.5-9.95		U(15)				
				9.95-10.1		D				

CHISELLING FROM	CHISELLING TO	CHISELLING HOURS	WATER ADDED FROM	WATER ADDED TO

REMARKS:
At 11.50m bubbling of water in the borehole was heard.
Borehole stopped due to potential gas hazard.

Gwent consultancy

SITE: DockswDocksway Landfill Site		LOGGED BY: I.C.L.	BOREHOLE No. 3
LOCATION: E, N.	REFERENCE No.: 1		

BORING METHOD: Light Cable Percussion Boring

BORING EQUIPMENT: PILCON 150

BORING DIAMETER (mm)	TO (m)	CASING DIAMETER (mm)	TO (m)	SHEET No.
150	11.5	150	11.5	2 of 2

GROUND LEVEL: mAOD

COMMENCED: 19/08/1999

DATE & DRILLING DEPTH (m)	WATER LEVEL & SEEPAGE (m)	Date & CASING DEPTH (m)	DETAIL OF PIEZO./ INCLO. INST.	SAMPLE DEPTH (m)	SOIL SAMPLE No. / ROCK CORE TCR (SCR) [RQD]	TYPE / Fracture Index	CHANGE OF STRATA DEPTH (m)	LEGEND	O.D. LEVEL (m)	DESCRIPTION OF STRATA
			Bentonite 7.0 to 11.5	10.1-11		B				As previous.
				11-11.1		U(95)				
				11.1-11.5		B	11.1		-0.515	Very soft grey silty sandy CLAY with much fine to coarse sub-rounded gravel of sandstone.
				11.5		W	11.5		-0.915	
										END OF BOREHOLE

CHISELLING FROM	TO	HOURS	WATER ADDED FROM	TO

REMARKS:
At 11.50m bubbling of water in the borehole was heard.
Borehole stopped due to potential gas hazard.

Gwent consultancy

SITE: Docksway Landfill Site		LOGGED BY: I.C.L.	BOREHOLE No. 4
LOCATION: Newport E, N.	REFERENCE No : 4		SHEET No. 1 of 2
BORING METHOD: Light Cable Percussive Boring			
BORING EQUIPMENT: DANDO 150			GROUND LEVEL 11.03 m.AOD
			COMMENCED 18/08/1999

BORING DIAMETER (mm)	TO (m)	CASING DIAMETER (mm)	TO (m)
150	17.05	150	16.75

DATE & DRILLING DEPTH (m)	WATER LEVEL & SEEPAGE (m)	Date & CASING DEPTH (m)	DETAIL OF PIEZO/ INCLO. INST.	SAMPLE DEPTH (m)	SOIL SAMPLE No. / ROCK CORE TCR (SCR) [RQD]	TYPE / Fracture Index	CHANGE OF STRATA DEPTH (m)	LEGEND	O.D. LEVEL (m)	DESCRIPTION OF STRATA
			GROUT	0.5 - 1.0		B				MADE GROUND - Soft to firm brown slightly gravelly very silty Clay with some plastic, paper, wood, polystyrene and sub-rounded to sub-angular fine to coarse gravel of sandstone.
				1.05 - 1.5		D				
				1.05 - 1.5		S (17)				
				1.5 - 2.0		B				
				2.05 - 2.5		D				
				2.05 - 2.5		S (13)				
				2.5 - 3.0		B				
	1 ▼ ▽ 1			2.9		W	2.90		8.13	
				3.05 - 3.5		C (30)				MADE GROUND - Soft to firm grey silty Clay with much plastic, paper, metal and cloth.
				3.5 - 4.0		B				
				4.05 - 4.5		C (34)				
				4.5 - 5.0		B				
	▽			5.05 - 5.5		C (39)				
				5.75 - 6.25		B				
				6.55 - 7.0		C (2)				
				7.25 - 7.75		B				
				7.7 - 7.8		D	7.70		3.13	
			GROUT	8.05 - 8.5		U (5)				Very soft to soft blue-grey, grey very silty CLAY.
				8.75 - 9.25		B				
				9.55 - 10.0		U (7)				

CHISELLING FROM	TO	HOURS	WATER ADDED FROM	TO
13.8	14.0	1		
15.8	16.0	1		
16.1	16.3	0.5		

REMARKS:

Gwent consultancy

SITE: **Docksway Landfill Site** | LOGGED BY: I.C.L. | BOREHOLE No. 4

LOCATION: Newport E, N. | REFERENCE No.: 1

BORING METHOD: Light Cable Percussive Boring

BORING EQUIPMENT: DANDO 150

BORING DIAMETER (mm)	TO (m)	CASING DIAMETER (mm)	TO (m)

SHEET No. 2 of 2

GROUND LEVEL mAOD

COMMENCED 18/08/1999

DATE & DRILLING DEPTH (m)	WATER LEVEL & SEEPAGE (m)	Date & CASING DEPTH (m)	DETAIL OF PIEZO./ INCLO. INST.	SAMPLE DEPTH (m)	SOIL SAMPLE No. / ROCK CORE TCR (SCR) [RQD]	SOIL SAMPLE TYPE / ROCK CORE Fracture Index	CHANGE OF STRATA DEPTH (m)	LEGEND	O.D. LEVEL (m)	DESCRIPTION OF STRATA
			GROUT	10.25 - 10.75		B	10.2		0.83	Very soft grey, blue-grey slightly sandy very silty CLAY.
				11.05 - 11.5		U (6)NR				
				11.75 - 12.25		B				
				12.55 - 13.0		C (39)	12.4		-1.37	Dense to very dense grey slightly sandy medium to coarse sub-rounded to rounded GRAVEL with some cobbles.
19/08		19/08		13.25 - 13.75		B				
				14.05 - 14.5		C (50 for 226mm)				
				14.75 - 15.25		B				
				15.55 - 16.0		C (50 for 78mm)	15.4		-4.37	Very dense grey brown slightly silty sandy fine to coarse sub-rounded to sub-angular GRAVEL with occasional cobbles.
				16.0 - 16.1		C (50 for 6mm)				
				16.3 - 16.6		B				
				16.8 - 17.05		D	16.7		-5.67	Firm to stiff red brown very silty CLAY with some lithorelies (Grade III to IVa).
				16.8 - 17.05		S (50 for 77mm)	17.0		-5.97	END OF BOREHOLE

CHISELLING FROM	CHISELLING TO	HOURS	WATER ADDED FROM	WATER ADDED TO

REMARKS:

Gwent consultancy

SITE: Docksway Landfill Site		LOGGED BY: I.C.L.	BOREHOLE No.
LOCATION: E, N.	REFERENCE No.: 1		5
BORING METHOD: Light Cable Percussion Boring			SHEET No. 1 of 2
BORING EQUIPMENT: PILCON 150			GROUND LEVEL 8.953 mAOD
			COMMENCED 20/08/1999

BORING DIAMETER (mm)	TO (m)	CASING DIAMETER (mm)	TO (m)
150	12.0	150	12.3

DATE & DRILLING DEPTH (m)	WATER LEVEL & SEEPAGE (m)	Date & CASING DEPTH (m)	DETAIL OF PIEZO/ INCLO. INST.	SAMPLE DEPTH (m)	SOIL SAMPLE No. / ROCK CORE TCR (SCR) [RQD]	TYPE / Fracture Index
20/8	▽		Plain pipe 0.7 to +0.3m in concrete	0.0		W
				0.5-1.0		B
	▽		Slotted pipe 6.7 to 0.7m Gravel filter 6.7 to 0.7m	1.0-1.45		S(4)
				1.0-2.0		B
		1.5		2.0-2.45		S(14)
				2.0-3.0		B
		3.0		3.0-3.45		U(35)
				3.45-3.6		D
				3.6-4.0		B
		3.0		4.0-4.45		U(20)
				4.45-4.6		D
				4.6-5.0		B
		4.5		5.0-5.45		U(20)
				5.45-5.6		D
				5.6-6.0		B
		6.0		6.5-6.95		U(12)
			Bentonite 7.0 to 12.3m	6.95-7.1		D
				7.1-8.0		B
		8.0		8.0-8.45		U(10)
				8.45-8.6		D
				8.6-9.5		B
		9.0		9.5-9.95		U(5)
				9.95-10.1		D

CHANGE OF STRATA DEPTH (m)	LEGEND	O.D. LEVEL (m)	DESCRIPTION OF STRATA
0.00 – 1.00		7.953	MADE GROUND - Stiff red brown mottled yellow, grey and blue, sandy Clay with much gravel of siltstone and mudstone.
1.00 – 1.80		7.153	MADE GROUND - Soft red brown mottled yellow, grey and blue sandy very gravelly Clay with pottery fragments.
1.80 – 2.30		6.653	Firm to stiff blue grey mottled brown slightly gravelly very silty CLAY.
2.30 – 3.00		5.953	Soft to firm blueish grey mottled brown very silty CLAY.
3.00 – 6.00		2.953	Firm blue grey very silty CLAY.
6.00 –			Soft to very soft, blue grey very silty CLAY with very thin laminae of silt and fine sand.

CHISELLING FROM	TO	HOURS	WATER ADDED FROM	TO
12.0	12.3	1/2		

REMARKS:

Gwent consultancy

SITE: Docksway Landfill Site		LOGGED BY: I.C.L.	BOREHOLE No. 5
LOCATION: E, N.		REFERENCE No.: 1	
BORING METHOD: Light Cable Percussion Boring			SHEET No. 2 of 2
BORING EQUIPMENT: PILCON 150			

BORING DIAMETER (mm)	TO (m)	CASING DIAMETER (mm)	TO (m)	
150	12.0	150	12.3	GROUND LEVEL m.AOD
				COMMENCED 20/08/1999

DATE & DRILLING DEPTH (m)	WATER LEVEL & SEEPAGE (m)	Date & CASING DEPTH (m)	DETAIL OF PIEZO./INCLO. INST.	SAMPLE DEPTH (m)	SOIL SAMPLE No. / ROCK CORE TCR (SCR) (RQD)	TYPE / Fracture Index	CHANGE OF STRATA DEPTH (m)	LEGEND	O.D. LEVEL (m)	DESCRIPTION OF STRATA
				10.1-11.0		B				As previous
		10.5		11-11.45		U(55)				
							11.3		-2.347	
							11.5		-2.547	Soft blue grey very silty CLAY with some gravel.
				11.45-11.6		D				Dense to very dense grey very sandy fine to coarse subrounded to rounded GRAVEL with some cobbles of sandstone.
				11.6-12.0		B				
		12.0		12.0-12.3	C(50 for 150mm)		12.3		-3.347	
										END OF BOREHOLE

CHISELLING FROM	TO	HOURS	WATER ADDED FROM	TO
12.0	12.3	1/2		

REMARKS:

Gwent consultancy

SITE: Docksway Landfill Site	LOGGED BY: I.C.L.	BOREHOLE No. 6
LOCATION: E, N.	REFERENCE No.: 1	SHEET No. 1 of 2
BORING METHOD: Light Cable Percussion Boring		
BORING EQUIPMENT: Dando 150		GROUND LEVEL 8.285 mAOD
		COMMENCED 20/08/1999

BORING DIAMETER (mm)	TO (m)	CASING DIAMETER (mm)	TO (m)
150	11.4	150	11.4

DATE & DRILLING DEPTH (m)	WATER LEVEL & SEEPAGE (m)	Date & CASING DEPTH (m)	DETAIL OF PIEZO./ INCLO. INST.	SAMPLE DEPTH (m)	SOIL SAMPLE No. / ROCK CORE TCR (SCR) [RQD]	SOIL SAMPLE TYPE / ROCK CORE Fracture Index	CHANGE OF STRATA DEPTH (m)	LEGEND	O.D. LEVEL (m)	DESCRIPTION OF STRATA
28/08		28/08	Plain pipe + Concrete	0.5-0.6		D				MADE GROUND - Stiff red brown grey gravelly very silty Clay.
				1.3-1.4		D	1.30		6.985	MADE GROUND - Firm grey mottled brown very silty CLAY with some gravel of brick, sandstone and occasional rootlets.
							1.70		6.585	Firm light grey mottled brown very silty CLAY.
			Slotted pipe and gravel 10.7 to 0.7m	3.1-3.2		D	3.10		5.185	Soft to very soft blue grey silty CLAY.
	1 ▽									

CHISELLING FROM	TO	HOURS	WATER ADDED FROM	TO	REMARKS:

Gwent consultancy

SITE: Docksway Landfill Site		LOGGED BY: I.C.L.	BOREHOLE No. 6
LOCATION: E, N.	REFERENCE No.: 1		SHEET No. 2 of 2
BORING METHOD: Light Cable Percussion Boring			
BORING EQUIPMENT: Dando 150			GROUND LEVEL mAOD
			COMMENCED 20/08/1999

BORING DIAMETER (mm)	TO (m)	CASING DIAMETER (mm)	TO (m)
150	11.4	150	11.4

DATE & DRILLING DEPTH (m)	WATER LEVEL & SEEPAGE (m)	Date & CASING DEPTH (m)	DETAIL OF PIEZO./ INCLO. INST.	SAMPLE DEPTH (m)	SOIL SAMPLE No.	TYPE	CHANGE OF STRATA DEPTH (m)	LEGEND	O.D. LEVEL (m)	DESCRIPTION OF STRATA
										Soft to very soft blue grey very silty CLAY.
	1 ▼		Bentonite 11.4 - 10.7m				11.2		-2.915	
				11.40			11.4		-3.115	Grey medium to coarse SAND and medium to coarse angular to sub-angular GRAVEL (Driller's description).
										END OF BOREHOLE

CHISELLING FROM	TO	HOURS	WATER ADDED FROM	TO

REMARKS:

Gwent consultancy

APPENDIX 4

APPENDIX 4
PERMEABILITY OF COHESIVE ALLUVIUM

1.1 General

The permeability of the Cohesive Alluvium at Docksway for design and modelling purposes has been assessed from the results of the field and laboratory testing carried out during ground investigations at the site. The results are listed in Table A4-1 and summarised on Table A4-2.

1.2 In-situ Testing

Eight falling head tests were carried out by Structural Soils (1994), although those at the top and base of the stratum appear to give uncharacteristically high results and are considered to be spurious probably due to poor casing seals at the top, and heave at the base of the borehole. The remaining tests all gave a very slow response with assessed permeability of less than 1 x 10^{-10} m/sec. These tests were carried out with the base of the casing flush with the soil at the base of the borehole and assess the vertical permeability of the soil.

Six falling head tests were conducted by Exploration Associates (1996) over open lengths of borehole between 0.5 and 1.5m long. These will tend the measure the horizontal permeability of the ground. The results fall in the range from 3.2 x 10^{-7} to 6.4 x 10^{-9} m/sec with an average of 7.8 x 10^{-8} m/sec. Some of the boreholes were dry prior to testing and tests may have been carried out above the water table, thus invalidating the theoretical basis behind the calculation, however the tests serve to give an indication of the horizontal permeability.

1.3 Laboratory Testing

Laboratory falling head tests and triaxial permeability tests have been carried out, and in addition permeability can be inferred from other tests such as the oedometer consolidation test and the consolidation stage of the triaxial test. The majority of the tests carried out will measure the vertical permeability in the sample, although drainage arrangements for some test specimens will give a result representing a combination of vertical and horizontal components of permeability. Where specimens are remoulded, and the structure/microfabric of the soil has been destroyed, the permeability determined is that of the homogenised mass and is not representative of that of the in-situ soil. It does give an indication of the likely permeability of any soil excavated and reused as engineering fill, however.

(a) Laboratory Falling Head Tests

30

The results of 13 tests on undisturbed samples gave a permeability range from 3 x 10^{-11} m/sec to 1.1 x 10^{-8} m/sec with an average value of 1.8 x 10^{-9} m/sec.

Four tests on remoulded samples were carried out with results in the range 8.7 x 10^{-10} to 2.9 x 10^{-11} m/sec, with an average value of 5.3 x 10^{-10} m/sec.

(b) Laboratory Triaxial Permeability Tests

Three tests were carried out on intact samples giving values of 1.9, 2.0, and 2.8 x 10^{-10} m/sec, average 2.2 x 10^{-10} m/sec.

Eight tests were carried out on remoulded specimens giving results in the range from 1.6×10^{-8} m/sec to 3.8×10^{-11} m/sec. Ignoring the high result from a sample of the weathered alluvial crust which may potentially have contained preferential pathways in the form of fissures, the average permeability is 3.7×10^{-10} m/sec.

(c) Triaxial Consolidation Tests

The permeability of intact specimens of soil was assessed from the data obtained during the consolidation stages of five effective stress triaxial strength tests. Drainage was such that an estimate of combined horizontal and vertical permeability was obtained in the range 4×10^{-10} to 7×10^{-12} m/sec, average 1.1×10^{-10} m/sec.

Similar tests on two remoulded specimens gave an average result of 2.4×10^{-10} m/sec.

(d) Oedometer Consolidation Tests

Consolidation properties are related to permeability (k) by the relationship:

$$k = c_v . m_v . \gamma_w$$

where c_v is the coefficient of consolidation
m_v is the coefficient of compressibility and
γ_w is the density of water.

Using this relationship an estimate of the vertical permeability of each specimen tested was made for the first consolidation stage, i.e. when there has been least alteration of the sample fabric by compression. Subsequent test stages usually give lower permeability values as the sample compresses so the value for the first stage is considered the most representative of the in-situ condition.

Twenty one tests gave permeability values in the range 4×10^{-12} to 2.7×10^{-9} m/sec with an average of 4×10^{-10} m/sec.

1.4 Variation in Vertical Permeability with Elevation

Alluvial soil sequences may exhibit vertical permeability changes with depth of burial, degree of consolidation, depositional/sedimentary controls etc through the sequence, and in order to determine if there is any variation in permeability with depth at this site, the relevant vertical permeability test results in Table A4-1 have been plotted against elevation (to Ordnance Datum), and stratigraphic position in the sequence above the base of the unit (top of the Gravel Deposits). Results from remoulded tests have been included because if the sediment gets coarse or finer down the sequence this would be reflected also in any homogeneous remoulded specimen.

The results show that there is no pattern or trend of vertical permeability coefficient increasing or decreasing throughout the sequence.

1.5 Permeability Values Selected for Design

30,49c The average vertical permeability of "intact" Cohesive Alluvium derived from a number of test methods falls in the range from about $<1 \times 10^{-10}$ to 2×10^{-9} m/sec. The average of the average values for vertical permeability presented in Table A4-2 is $< 8.8 \times 10^{-10}$ m/sec. Accordingly it is considered appropriate to use the conservative value of 1×10^{-9} m/sec for design purposes. For the LandSim modelling work, 1.0×10^{-9} m/sec has been used as a single conservative value for the vertical permeability of the Alluvial Clay.

30,49c It is recognised by the EA that an over-reliance on laboratory permeability data can lead to an underestimation of the permeability of the geological barrier (see for example EA, 2004b). If the reliable, available field data alone were to be used as the model input for the alluvium vertical permeability then a value of less than 1×10^{-10} m/sec would be appropriate (see Section 1.2 of this Appendix). Importantly, field data available for this site demonstrates that the vertical permeability value chosen for the input to the model (1×10^{-9} m/sec) is not inappropriately low.

Evidence from a small number of in-situ tests suggests that the horizontal permeability is at least two orders of magnitude higher, say in the order of 1×10^{-7} m/sec. This would not be unusual in a layered alluvial sequence where thin partings of silt or fine sand (often only a grain or two in thickness) are present giving a higher permeability horizontally. However it is the vertical permeability that is of the greater significance in respect of prevention of potential downward contaminant migration, and in forming a geological barrier.

Where remoulded samples were tested permeability values in the order of 2.4 to 5.3 $\times 10^{-10}$ m/sec were recorded. As might be expected, this shows that once the structure of the soil is destroyed the clay fraction present will predominate and the measured permeability is likely to be similar to that measured in the vertical direction.

TABLE A4-1

PERMEABILITY TEST RESULTS IN COHESIVE ALLUVIUM

GI/Date	Hole Ref.	Depth (m)	Permeability m/sec		Remarks
			In-Situ	Laboratory	
Structural Soils 1994	1A	6.0	7.7×10^{-5}		} Top of stratum, probably
	2A	6.8	2.9×10^{-5}		} spurious due to poor casing seal
	3B	8.95	$<1 \times 10^{-10}$		
	4	4.8	$<1 \times 10^{-10}$		
	5	5.5	$<1 \times 10^{-10}$		All Falling Head Tests giving k_v
	6	2.9	$<1 \times 10^{-10}$		
	7	2.9	$<1 \times 10^{-10}$		
	10	9.0	6.8×10^{-6}		Close to base of stratum. Base of borehole may have failed due to water pressures in gravel.
	1A	7.4		6.6×10^{-10}	k_v Falling Head Tests giving k_v
	1A	11.3		6.1×10^{-10}	k_v
	2A	5.6		3.1×10^{-10}	k_v
	2A	8.6		6.5×10^{-10}	k_v
	2A	8.61		5.7×10^{-10}	Remoulded k
	03	7.05		7.5×10^{-9}	k_v
	04	5.4		3.1×10^{-10}	k_v
	04	7.8		2.8×10^{-10}	k_v
	05	2.50		2.8×10^{-10}	k_v
	05	2.51		3.7×10^{-10}	Remoulded k
	05	4.60		6.1×10^{-10}	k_v
	05	4.61		8.7×10^{-10}	Remoulded k
	06	4.10		1.1×10^{-8}	k_v
	07	3.0		1.4×10^{-9}	k_v
	10	1.60		3×10^{-11}	k_v
	10	1.61		2.9×10^{-11}	Remoulded k
	10	7.55		5.0×10^{-10}	k_v
	2A	5.6		$<5 \times 10^{-10}$	k_v Oedometer – Maximum Value
	3B	7.05		$<2 \times 10^{-10}$	k_v Oedometer – Maximum Value
	6	4.10		$<1 \times 10^{-9}$	k_v Oedometer – Maximum Value
EA 1996	1	4.0 – 5.0	5.8×10^{-8}		Falling Head Tests giving k_h
	2	7.0 – 7.5	1.3×10^{-8}		k_h
	4	5.5 – 6.3	6.4×10^{-9}		k_h
	5	6.0 – 7.0	4.8×10^{-8}		k_h
	6	4.5 – 5.0	3.2×10^{-7}		k_h Borehole dry
	7	4.5 – 6.0	2.0×10^{-8}		k_h
	1	3.5		1.9×10^{-10}	k_v Triaxial Permeability
	2	3.0		3.8×10^{-11}	Remoulded Triaxial Permeability
	3	1.0		2.9×10^{-10}	Remoulded
	3	4.0		3.7×10^{-10}	Remoulded
	4	3.0		1.7×10^{-10}	Remoulded
	4	8.0		2.0×10^{-10}	k_v
	7	4.1		2.8×10^{-10}	k_v
	TP1	0.25		1.6×10^{-8}	Remoulded crust - ignored
	TP5	0.7		2.4×10^{-10}	Remoulded
	TP5	1.64		4.1×10^{-10}	Remoulded
	TP6	1.44		1.1×10^{-9}	Remoulded

TABLE A4-1 (Continued)

PERMEABILITY TEST RESULTS IN COHESIVE ALLUVIUM

GI/Date	Hole Ref.	Depth (m)	Permeability m/sec		Remarks
			In-Situ	Laboratory	
EA 1996 (Con'd)	1	3.5		1 to 2 x 10^{-11}	Triaxial Consol Stage k_h/k_v 38mm
	3	1.0		1 x 10^{-11} to 4 x 10^{-10}	Remoulded
	3	4.0		1 to 7 x 10^{-11}	Remoulded
	4	8.0		4 to 7 x 10^{-12}	k_h/k_v
	5	6.0		5 x 10^{-12} to 2 x 10^{-11}	k_h/k_v
	6	5.0		2 to 9 x 10^{-11}	k_h/k_v
	7	4.1		1 to 4 x 10^{-10}	k_h/k_v
GWENT 1998	1A	5.0		<4 x 10^{-11}	k_v oedometer – maximum value
	1A	9.5		<4 x 10^{-11}	k_v oedometer – maximum value
	2	5.05		<4 x 10^{-11}	k_v oedometer – maximum value
	3	6.5		<9 x 10^{-10}	k_v oedometer – maximum value
	3	8.0		<6 x 10^{-11}	k_v oedometer – maximum value
	3	9.0		<5 x 10^{-10}	k_v oedometer – maximum value
	4	8.05		<5 x 10^{-11}	k_v oedometer – maximum value
	4	9.55		<2.5 x 10^{-11}	k_v oedometer – maximum value
	5	5.0		<2.8 x 10^{-10}	k_v oedometer – maximum value
CJ Assoc 2003/1	GW03/06	5.00		<4 x 10^{-12}	k_v oedometer – maximum value
	GW03/06	7.50		<4.5 x 10^{-10}	k_v oedometer – maximum value
	GW03/06	10.50		<4 x 10^{-10}	k_v oedometer – maximum value
	GW03/10A	3.0		<1 x 10^{-10}	k_v oedometer – maximum value
	GW03/10A	6.0		<4 x 10^{-10}	k_v oedometer – maximum value
	GW03/10A	9.0		<2.7 x 10^{-9}	k_v oedometer – maximum value
	GW03/15	6.50		<1 x 10^{-10}	k_v oedometer – maximum value
	GW03/15	9.00		<5 x 10^{-10}	k_v oedometer – maximum value
	GW03/15	10.50		<1.8 x 10^{-10}	k_v oedometer – maximum value

TABLE A4-2

SUMMARY OF PERMEABILITY TEST RESULTS IN COHESIVE ALLUVIUM

Type of Test	No of Tests	Permeability (k) Measured	Average Result m/sec	Remarks
In-situ Falling Head Test	5	Vertical	<1 x 10^{-10}	No response zone in borehole $\therefore k_v$ measured.
In-situ Falling Head Test	6	Horizontal	7.8 x 10^{-8}	Long response zones in boreholes $\therefore k_h$ measured.
Laboratory Falling Head Test	13 11	Vertical Vertical	1.9 x 10^{-9} 1.8 x 10^{-9}	Includes two high values. Including 2 possibly spurious high values at about 1 x 10^{-8} m/sec.
Laboratory Falling Head Test	4	Remoulded	5.3 x 10^{-10}	Homogenised soil.
Laboratory Triaxial	3	Vertical	2.2 x 10^{-10}	
Laboratory Triaxial	7	Remoulded	3.7 x 10^{-10}	1 test on stiff weathered crust excluded in average.
Laboratory Triaxial Consol	5	All Directions Combined	1.1 x 10^{-10}	38mm specimens.
Laboratory Triaxial Consol	2	Remoulded	2.4 x 10^{-10}	38mm specimens.
Oedometer Consolidation	21	Vertical	4.0 x 10^{-10}	Highest value from each test selected, usually 1st stage.

Notes:

k_v = vertical permeability

k_h = horizontal permeability

APPENDIX 5

Appendix 5 - Pre Restoration Water Balance - Infiltration Calculation

PERC = Water percolation through daily cover to TOP of WASTE

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
Temperature (°C)	4.80	4.71	7.14	8.96	12.29	14.94	17.21	16.70	14.24	11.05	7.78	6.01	
It	0.94	0.91	1.72	2.42	3.90	5.25	6.50	6.21	4.88	3.32	1.95	1.32	39.32
TE	39.32	39.32	39.32	39.32	39.32	39.32	39.32	39.32	39.32	39.32	39.32	39.32	
a	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	
PET	20.00	19.56	31.20	40.19	57.26	71.26	83.48	80.70	67.55	50.86	34.32	25.74	582.11
Adj Factor	0.74	0.78	1.02	1.15	1.33	1.36	1.37	1.25	1.06	0.92	0.76	0.70	
Adj PET	14.80	15.26	31.82	46.22	76.15	96.91	114.37	100.87	71.60	46.79	26.09	18.02	658.90
P (mm)	129.91	86.36	102.07	59.36	61.27	62.57	67.97	77.27	96.46	115.52	117.10	136.78	1112.639
C (r/o)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Ro (mm)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
SR (mm)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
IR (mm)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
I	129.91	86.36	102.07	59.36	61.27	62.57	67.97	77.27	96.46	115.52	117.10	136.78	1112.64
I-Adj PET	115.11	71.10	70.25	13.14	-14.88	-34.34	-46.41	-23.61	24.86	68.74	91.01	118.76	453.74
NEG (I-Adj PET)	0.00	0.00	0.00	0.00	-14.88	-34.34	-46.41	-23.61	0.00	0.00	0.00	0.00	
Sum NEG (I-Adj PET)	0.00	0.00	0.00	0.00	-14.88	-49.22	-95.63	-119.24	0.00	0.00	0.00	0.00	
St	20	20	20	20	10	3	1	1	20	20	20	20	
dSt	0	0	0	0	-10	-7	-2	0	19	0	0	0	0
AET (mm)	11.10	11.44	23.87	34.66	35.64	34.78	34.98	38.63	35.80	35.09	19.56	13.51	329.08
PERC (mm)	118.81	74.92	78.21	24.69	0.00	0.00	0.00	38.63	41.66	80.43	97.54	123.27	678.16

It = $(T/5)^{1.514}$
PET = $16(10t/TE)^{a}$
a = $0.000000675\,(TE)^3 - 0.0000771\,(TE)^2 + 0.01792TE + 0.492\,39$
TE = Annual Sum It
Adj Factor = Values adjusted for Latitude 51 degress see table below
P = Average Rainfall
C = Runoff coefficient see table below
Ro = P x C
I = P + SR + IR - Ro
SR = Surface runoff input to landfill
IR = Irrigation input water
NEG (I-Adj PET) = Lack of infiltration water needed for vegetation see table
St = Soil Moisture storage at Field Capacity see table
AET = Actual Evapotranspiration For dry months x 0.5 for wet months x 0.75 as no vegetation
If NEG (I-Adj PET) = negative AET = I+|dSt|
If NEG (I-Adj PET) = positive AET = Adj PET
PERC = Percolation to TOP of capping layer
If dSt = negative PERC = Zero
If dSt = positive PERC = I - AET - dSt

Adjustment Factors for Potential Evapotranspiration computed by Thornwaite Equation

Lattitude	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
0	1.04	0.94	1.04	1.01	1.04	1.01	1.04	1.04	1.01	1.04	1.01	1.04
10	1.00	0.91	1.03	1.03	1.08	1.06	1.08	1.07	1.02	1.02	0.98	0.99
20	0.95	0.90	1.03	1.05	1.13	1.11	1.14	1.11	1.02	1.00	0.93	0.94
30	0.90	0.87	1.03	1.08	1.18	1.17	1.20	1.14	1.03	0.98	0.89	0.88
35	0.87	0.85	1.03	1.09	1.21	1.21	1.23	1.16	1.03	0.97	0.86	0.85
40	0.84	0.83	1.03	1.11	1.24	1.25	1.27	1.18	1.04	0.96	0.83	0.81
45	0.80	0.81	1.02	1.13	1.28	1.29	1.31	1.21	1.04	0.94	0.79	0.75
50	0.74	0.78	1.02	1.15	1.33	1.36	1.37	1.25	1.06	0.92	0.76	0.70

Runoff Coefficient after Salvato for leachate estimation (Lu et al 1985)

Surface condtion	Slope (%)		Runoff Coefficient		
			Sandy Loam	Clay or Silt Loam	Clay
Pasture or meadow (surface with cover crop)	0-2	flat	0.10	0.30	0.40
	5-10	rolling	0.16	0.36	0.55
	10-30	hilly	0.22	0.42	0.60
No vegetation (raw soil surface)	0-2	flat	0.30	0.50	0.60
	5-10	rolling	0.40	0.60	0.70
	10-30	hilly	0.52	0.72	0.82

Soil Moisture retention after Potential Evapotranspiration has occurred

	St								
Sum NEG (I-Adj PET)	25	50	75	100	125	150	200	250	300
0	25	50	75	100	125	150	200	250	300
10	16	41	65	90	115	140	190	240	290
20	10	33	57	81	106	131	181	231	280
30	7	27	50	74	98	122	172	222	271
40	4	21	43	66	90	114	163	213	262
50	3	17	38	60	83	107	155	204	254
60	2	14	33	54	76	100	148	196	245
70	1	11	28	49	70	93	140	188	237
80	1	9	25	44	65	87	133	181	229
90	1	7	22	40	60	82	127	174	222
100		6	19	36	55	76	120	167	214
150		2	10	22	37	54	94	136	181
200		1	5	13	24	39	73	111	153
250			2	8	16	28	56	91	130
300			1	5	11	20	44	74	109
350			1	3	7	14	34	61	92
400				2	5	10	26	50	78
450				1	3	7	20	41	66
500				1	2	5	16	33	56
600					1	3	10	22	40
700						1	6	15	28
800						1	4	10	20
1000							1	4	10

Mean average daily temperatures 1978 -1995

Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
1978	4.75	3.55	7.25	7.30	12.40	14.00	15.25	15.50	14.30	12.80	9.10	5.80
1979	0.85	2.00	5.50	8.50	9.90	14.00	16.75	15.05	13.35	12.10	7.35	7.05
1980	2.60	7.15	5.80	9.45	12.55	14.30	15.10	16.30	15.15	9.55	7.45	6.40
1981	5.70	3.75	9.15	9.25	11.65	14.20	16.35	17.10	15.10	9.05	8.30	2.70
1982	3.70	6.05	6.85	9.45	12.05	16.55	17.40	16.25	15.05	10.90	8.75	5.35
1983	7.30	2.90	7.20	7.65	11.00	15.20	20.50	18.35	14.05	11.15	8.40	6.70
1984	4.95	4.85	5.90	9.25	11.45	15.75	17.80	18.55	14.65	12.10	8.70	6.10
1985	1.95	3.40	5.75	9.45	12.05	13.55	16.85	15.35	14.95	11.40	4.85	7.55
1986	4.85	-0.10	6.10	6.65	11.30	15.65	16.30	14.25	12.05	10.75	8.20	6.75
1987	1.80	4.65	5.45	11.10	11.45	13.95	16.85	16.95	14.55	10.45	7.55	6.45
1988	6.45	5.65	7.65	9.25	12.70	15.50	15.30	15.60	13.95	11.40	6.05	8.30
1989	6.80	6.65	8.20	7.25	14.85	15.70	19.40	17.20	15.20	12.10	7.50	6.05
1990	7.15	8.30	8.90	8.95	14.50	14.40	18.25	18.45	13.75	12.85	7.35	5.20
1991	4.35	2.60	8.75	8.95	12.45	12.90	17.45	17.75	15.45	10.40	7.20	5.55
1992	4.25	5.90	8.10	9.35	14.40	16.70	17.15	15.90	13.95	8.30	7.85	4.70
1993	6.85	5.60	7.25	10.20	12.25	16.05	15.95	15.30	13.25	9.15	5.95	6.60
1994	6.20	4.30	8.35	9.05	11.95	15.00	18.35	16.50	13.45	10.75	10.95	7.60
1995	5.90	7.50	6.40	10.15	12.30	15.55	18.85	20.25	14.20	13.75	8.50	3.40
Average	**4.80**	**4.71**	**7.14**	**8.96**	**12.29**	**14.94**	**17.21**	**16.70**	**14.24**	**11.05**	**7.78**	**6.01**

Monthly Rainfall Figures 1978 - 1995

Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
1978	134.10	134.10	121.30	63.60	30.60	29.60	110.10	40.50	34.10	12.00	82.80	219.50	1012.30
1979	117.80	81.90	112.90	60.20	109.80	25.90	37.30	135.40	59.10	88.80	90.90	180.90	1100.90
1980	96.60	122.40	152.60	15.00	43.60	125.80	67.20	85.80	99.20	147.50	131.80	108.20	1195.70
1981	58.20	62.90	204.10	37.10	125.00	49.50	30.10	27.80	218.80	148.40	72.50	118.70	1153.10
1982	85.30	69.50	152.40	31.50	34.30	77.70	29.70	95.40	101.10	128.90	193.90	166.90	1166.60
1983	190.30	30.40	57.20	97.70	137.90	32.20	18.00	34.20	185.70	93.20	64.30	122.30	1063.40
1984	205.70	67.30	31.10	9.50	60.00	35.90	14.70	47.50	149.10	147.70	218.20	115.00	1101.70
1985	88.00	69.40	79.20	71.60	44.20	157.40	95.90	186.60	64.00	69.70	59.50	175.50	1161.00
1986	153.80	6.40	108.20	78.40	89.10	60.20	69.70	118.10	20.60	137.40	177.60	179.50	1199.00
1987	17.00	111.20	105.30	74.70	36.00	97.90	71.00	36.10	79.60	190.90	109.40	91.40	1020.50
1988	222.00	74.40	112.30	46.60	79.90	31.80	154.40	140.30	103.20	126.40	39.40	35.60	1166.30
1989	69.60	127.80	157.50	76.90	10.10	41.40	68.90	56.80	68.60	144.40	81.90	155.20	1059.10
1990	162.20	180.60	23.90	25.10	13.80	94.60	58.40	53.90	71.00	129.40	89.20	98.30	1000.40
1991	128.50	75.50	100.70	95.70	3.50	126.00	83.30	30.40	66.80	121.20	118.20	49.00	998.80
1992	41.00	46.40	76.50	83.20	49.00	20.70	90.30	184.80	109.90	63.20	220.00	71.60	1056.60
1993	181.80	15.30	26.40	89.70	62.70	64.90	135.70	40.00	95.30	84.40	95.10	249.50	1140.80
1994	175.20	140.30	148.30	84.00	87.20	45.80	44.50	68.00	87.80	139.70	146.00	199.70	1366.50
1995	211.30	138.70	67.40	27.90	86.20	8.90	44.20	9.20	122.40	106.20	117.10	125.30	1064.80
Average	**129.91**	**86.36**	**102.07**	**59.36**	**61.27**	**62.57**	**67.97**	**77.27**	**96.46**	**115.52**	**117.10**	**136.78**	**1112.64**

APPENDIX 6

APPENDIX 6
CALCULATION OF CAP DESIGN INFILTRATION

Docksway Landfill Site.
Area 2 Cap Design Infiltration

Assume 1.0m thickness Clay capping at $k = 5 \times 10^{-10}$ m/s

Calculate Hydraulic Gradient

i = Hydraulic gradient $= \dfrac{h + Hs}{Hs}$

h = Head of precipitation on cap
Hs = Thickness of cap

Assuming maximum head of precipitation on cap = mean infiltration (see Table 9.1)	h =	0.451	m
Assuming thickness of cap as Drawing D.41 (NCC, 2003) of	Hs =	1.00	m

$$i = \frac{0.45 + 1}{1} = 1.45 \text{ m/m}$$

Calculate Seepage Velocity, V $= \dfrac{k \times i}{n}$

n =	porosity of the clay = e /(1 + e)		
e =	void ratio = wG (fully saturated)		
w =	placement moisture content, assumed at	26	%
G =	specific gravity, assumed at	2.7	
hence e =		0.702	
and n =		0.412456	
k =	Permeability of cap	5.0E-10	m/s
V =	Seepage velocity	2.29E-09	m/s

Calculate Seepage Rate, Q

Where Q = k (h + Hs)/Hs

Q =	Seepage Rate	9.43E-10	m3/s/m2
Q =	Seepage Rate	297	m3/hectare/year
	Total Unit Seepage Rate =	**23**	**mm/year**

If a permeability of 1×10^{-9} is used, a value of 46 mm/yr is arrived at for the unit seepage rate. For the LandSim modelling the cap design infiltration has been set as a uniform distribution between 23 mm/yr and 46 mm/yr.

41 If a permeability of 1×10^{-4} is used (to simulate a catastrophic failure of the cap), a value of 4575874 mm/yr is arrived at for the unit seepage rate. This exceeds the pre-restoration infiltration rate of 678mm which has been used as cdi for cap failure (see Section 14 and Appendix 10).

APPENDIX 7

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9th January 2004

TEST REPORT

Our Report No: B03024474 **Re Issue No. 1 (dated 26.01.04)**

Your Order No: Instns. of 18.12.2004

3 no. soil samples submitted for analysis on 19.12.2004

Project Name: Docksway Samples

Project Code: P0866

Results enclosed: Page 2

Peter Brett Associates
Project No: DW
Partner: Darren Wilcox
29 JAN 2004
Distribution

Laboratory analysis started on 19.12.2004
All laboratory analysis completed by 9th January 2004

Tracy Pia
Quality Manager
ALCONTROL TECHNICHEM

Leigh Burton
Project Co-ordinator
ALCONTROL TECHNICHEM

Test Methods are Documented In House Procedures or where appropriate Standard Methods.
Non accredited tests *(if applicable)* are identified on each page. Procedures for sampling are outside the scope of the laboratory UKAS accreditation. Opinions and interpretations expressed herein are outside the scope of our UKAS accreditation.
All samples connected with this report, including any 'on hold', will be stored and disposed of according to Company policy. A copy of this policy is available on request.

Re-Issue Details Sheet

Our Report No:	B03024474
Re-Issue No:	1
Re-Issue Date:	26.01.04
Project Name:	Docksway Samples
Project Code:	P0866

Amendment No.	Page No.	*Details*
1	2	*CEC results amended as results were incorrectly moisture corrected.*

Please destroy the original report which this replaces.
Sincere apologies for any inconvenience caused.

TAPia
Tracy Pia
Quality Manager
ALCONTROL TECHNICHEM

APPENDIX 8

Moisture contents and initial void ratios for samples of Alluvium

CJA Aug 03 Report

BH	MC	Initial Void Ratio
GW03/01	33	
	46	
	59	
GW03/02	35	
	41	
GW03/03	58	
	34	
GW03/04	35	
	56	
	37	
GW03/05	58	
	50	
	50	
	52	
	15	
	30	
	29	
	13	
	23	
GW03/06A	38	0.698
	14	0.95
	33	0.937
	17	
	29	
	43	
	28	
	25	
	34	
	16	
	28	
	35	
GW03/10A	14	1.026
	16	1.443
	16	1.175
	55	
	53	
GW03/13	47	
	59	
	66	
	70	
	61	
	58	
	61	
	56	
GW03/15	38	0.848
	52	1.069
	52	1.142

CJA Jan 04 Report

BH	MC
LL03/01	30
	46
	43
	48
	47
GP03/06	55
	52
	65
	66
	66
	67
GP03/08	54
	55
	71
	66
	59
	64
GP03/09	33
	43
	58
	50
	52
	46
	40
GP03/13	38
	40
	48
	49

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BH	MC
GW03/11b	28
	31
	31
GW03/17	65
	65
	14
GW03/18	37
GW03/19	49
GW03/20	71
GW03/21	43
GW03/22	60
	46
	47

SS DATA

TP/BH	MC	Initial Void Ratio
TP1	52	
	68	
TP2	40	
TP5	41	
TP6	42	
BH01A	41	
	63	
BH02A	68	1.064
BH03B	65	1.911
BH04	51	
	54	
BH05	62	
	63	
BH06	73	2.014
	72	
BH07	64	
	57	
	57	
BH08	39	
BH09	30	
	62	
BH10	31	
	60	

GC Oct 99 Report a

BH	MC	Initial Void Ratio
1A	48	1.185
	63	1.641
2	58	1.399
3	40	0.999
	50	1.3
	43	1.007
4	74	1.802
	85	2.246
5	51	1.242

Average MC for all results		Av. Initial Void Ratio		Av. Porosity	
42.02222 15.76666 STDev		1.290380952		0.563391	
MC Range		IVR Range		Porosity Range	
13	85	0.698	2.246	0.411072	0.692

APPENDIX 9

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ALcontrol Geochem Analytical Services
Table Of Results

\# ISO 17025 accredited
M MCERTS accredited
* Subcontracted test
» Shown on prev. report

Job Number: 04/08570/02/01
Client: Peter Brett Associates
Client Ref. No.:

Matrix: LIQUID
Location: DOCKSWAY
Client Contact: James Amos

Sample Identity	GP03/04A	GP03/09	GP03/12A	GW03/07	GW03/14	GW03/16	GW03/02	GW03/03	LF03/03	Method Code	LoD/Units
Depth (m)											
Sample Type	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER		
Sampled Date									23.06.04		
Sample Received Date	07.06.04	07.06.04	07.06.04	07.06.04	07.06.04	07.06.04	09.06.04	09.06.04	24.06.04		
Batch	1	1	1	1	1	1	2	2	4		
Sample Number(s)	31-32	33-34	35-36	1-10	11-20	21-30	38-39	37,40	47-56		
Arsenic Dissolved (ICP-MS)	-	-	-	11	3	3	-	-	-	TM152#	<1 ug/l
Boron Dissolved (ICP-MS)	-	-	-	2297	2838	2277	-	-	-	TM152#	<10 ug/l
Cadmium Dissolved (ICP-MS)	-	-	-	<0.4	<0.4	<0.4	-	-	0.7	TM152#	<0.4 ug/l
Calcium Dissolved (ICP-MS)	-	-	-	126800	344600	176600	-	-	-	TM152#	<5 ug/l
Chromium Dissolved (ICP-MS)	-	-	-	7	10	6	-	-	-	TM152#	<1 ug/l
Copper Dissolved (ICP-MS)	-	-	-	<1	<1	<1	-	-	-	TM152#	<1 ug/l
Lead Dissolved (ICP-MS)	-	-	-	<1	<1	<1	-	-	-	TM152#	<1 ug/l
Magnesium Dissolved (ICP-MS)	-	-	-	207100	108600	180400	-	-	-	TM152#	<5 ug/l
Manganese Dissolved (ICP-MS)	-	-	-	953	1454	652	-	-	-	TM152#	<1 ug/l
Nickel Dissolved (ICP-MS)	-	-	-	19	20	5	-	-	-	TM152#	<1 ug/l
Selenium Dissolved (ICP-MS)	-	-	-	12	4	9	-	-	-	TM152#	<1 ug/l
Zinc Dissolved (ICP-MS)	-	-	-	7	8	3	-	-	-	TM152#	<3 ug/l
Mercury Dissolved (CVAAS)	-	-	-	<0.05	<0.05	<0.05	-	-	<0.05	TM127#	<0.05 ug/l
Alkalinity Total as CaCO3	-	-	-	1545	1775	1580	-	-	10350	TM043#	<2 mg/l
Electrical Conductivity (at 25 deg. C)	13.670	7.010	5.070	7.860	5.840	7.470	2.670	3.860	24.300	TM120#	<0.025 mS/cm
Potassium	-	-	-	10.5	13.2	13.1	-	-	-	TM083#	<0.2 mg/l
Sodium	-	-	-	1095.0	645.0	960.0	-	-	-	TM083#	<0.2 mg/l
Nitrate as NO3	-	-	-	0.3	0.3	<0.3	-	-	0.8	TM102#	<0.3 mg/l
Nitrite as NO2	-	-	-	0.37	<0.05	<0.05	-	-	<0.05	TM103#	<0.05 mg/l
Sulphate (soluble)	-	-	-	40	15	<3	-	-	29	TM098#	<3 mg/l
Chloride	2114	900	538	1853	959	1565	229	435	2221	TM097#	<1 mg/l
Phosphate (Ortho as PO4)	-	-	-	0.53	<0.08	0.21	-	-	311.66	TM100#	<0.08 mg/l
Sulphide	-	-	-	<0.05	<0.05	<0.05	-	-	NDP	TM101#	<0.05 mg/l
Ammoniacal Nitrogen as NH4-N	780.5	320.8	127.8	463.8	140.8	98.7	61.8	131.8	2396.6	TM099#	<0.2 mg/l
Total Organic Carbon	-	-	-	56	78	53	-	-	-	TM090#	<1 mg/l
Total Phenols HPLC	-	-	-	<0.01	<0.01	<0.01	-	-	0.55	TM062#	<0.01 mg/l
Total Cyanide	-	-	-	<0.05	<0.05	<0.05	-	-	<0.05	TM153#M	<0.05 mg/l
Free Cyanide Water Low	-	-	-	<0.01	<0.01	<0.01	-	-	<0.01	TM153#	<0.01 mg/l
BOD (Unfiltered Sample)	-	-	-	16	28	24	-	-	-	TM045#	<1 mg/l
COD (Unfiltered Sample)	1272	501	220	233	278	248	38	87	4810	TM107#	<10 mg/l
Hardness Total	-	-	-	1170	1309	1185	-	-	-	TM152#	<1 mg/l

Date 03.08.2004

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ALcontrol Geochem Analytical Services
Table Of Results

ISO 17025 accredited
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Job Number: 04/08570/02/01
Client: Peter Brett Associates
Client Ref. No.:
Matrix: LIQUID
Location: DOCKSWAY
Client Contact: James Amos

Sample Identity	GP03/04A	GP03/09	GP03/12A	GW03/07	GW03/14	GW03/16	GW03/02	GW03/03	LF03/03	Method Code	LoD/Units
Depth (m)											
Sample Type	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER		
Sampled Date									23.06.04		
Sample Received Date	07.06.04	07.06.04	07.06.04	07.06.04	07.06.04	07.06.04	09.06.04	09.06.04	24.06.04		
Batch	1	1	1	1	1	1	2	2	4		
Sample Number(s)	31-32	33-34	35-36	1-10	11-20	21-30	38-39	37,40	47-56		
pH Value In Water	7.13	6.99	6.89	7.55	7.04	7.40	7.25	7.30	8.40	TM133#	<1.00 pH Units
EPH (DRO) (C10-C40)	-	-	-	<10	1720	<10	-	-	172598	$TM061^{\#}_{M}$	<10 ug/l
EPH (Mineral Oil)	-	-	-	<10	1435	<10	-	-	82544	$TM061^{\#}_{M}$	<10 ug/l
Tributyl Tin	-	-	-	<50	<50	<50	-	-	<10		<50 ng/l
Triphenyl Tin	-	-	-	<50	<50	<50	-	-	<10		<50 ng/l
Dibutyl Tin	-	-	-	<50	<50	<50	-	-	<10		<50 ng/l

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Validated	✓
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ALcontrol Geochem Analytical Services
Table Of Results

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Job Number: 04/08570/02/01
Client: Peter Brett Associates
Client Ref. No.:

Matrix: LIQUID
Location: DOCKSWAY
Client Contact: James Amos

Sample Identity	GP03/04A	GP03/09	GP03/12A	GW03/07	GW03/14	GW03/16	GW03/02	GW03/03	LF03/03	Method Code	LoD/Units
Depth (m)											
Sample Type	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER		
Sampled Date									23.06.04		
Sample Received Date	07.06.04	07.06.04	07.06.04	07.06.04	07.06.04	07.06.04	09.06.04	09.06.04	24.06.04		
Batch	1	1	1	1	1	1	2	2	4		
Sample Number(s)	31-32	33-34	35-36	1-10	11-20	21-30	38-39	37,40	47-56		
OCP											
Tecnazene	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
Trifluralin	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
Alpha-BHC (Lindane)	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
Hexachlorobenzene	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
Beta-BHC (Lindane)	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
Gamma-BHC (Lindane)	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
Quintozene (PCNB)	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
Triallate	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
Chlorothalonil	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
Heptachlor	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
Aldrin	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
Triadimefon	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
Pendimethalin	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
Heptachlor Epoxide	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
o,p'-DDE	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
Endosulfan I	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
p,p'-DDE	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
Dieldrin	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
o,p'-TDE (DDD)	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
Endrin	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
Endosulfan II	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
o,p'-TDE (DDD)	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
o,p'-DDT	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
p,p'-DDT	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
Endosulfan Sulphate	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
o,p'-Methoxychlor	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
p,p'-Methoxychlor	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
Permethrin	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l
Organochlorine Pesticides Total of 28	-	-	-	<10	<10	<10	-	-	<10	TM144	<10 ng/l

Date 03.08.2004

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ALcontrol Geochem Analytical Services
Table Of Results

ISO 17025 accredited
M MCERTS accredited
* Subcontracted test
» Shown on prev. report

Job Number: 04/08570/02/01
Client: Peter Brett Associates
Client Ref. No.:

Matrix: LIQUID
Location: DOCKSWAY
Client Contact: James Amos

Sample Identity	GP03/04A	GP03/09	GP03/12A	GW03/07	GW03/14	GW03/16	GW03/02	GW03/03	LF03/03	Method Code	LoD/Units
Depth (m)											
Sample Type	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER		
Sampled Date									23.06.04		
Sample Received Date	07.06.04	07.06.04	07.06.04	07.06.04	07.06.04	07.06.04	09.06.04	09.06.04	24.06.04		
Batch	1	1	1	1	1	1	2	2	4		
Sample Number(s)	31-32	33-34	35-36	1-10	11-20	21-30	38-39	37,40	47-56		
OPP											
Dichlorvos	-	-	-	<10	<10	<10	-	-	<10	TM145	<10 ng/l
Mevinphos	-	-	-	<10	<10	<10	-	-	<10	TM145	<10 ng/l
Dimethoate	-	-	-	<10	<10	<10	-	-	<10	TM145	<10 ng/l
Propetamphos	-	-	-	<10	<10	<10	-	-	<10	TM145	<10 ng/l
Diazinon (Dimpylate)	-	-	-	<10	<10	<10	-	-	<10	TM145	<10 ng/l
Etrimphos	-	-	-	<10	<10	<10	-	-	<10	TM145	<10 ng/l
Chlorpyrifos-methyl	-	-	-	<10	<10	<10	-	-	<10	TM145	<10 ng/l
Methyl Parathion	-	-	-	<10	<10	<10	-	-	<10	TM145	<10 ng/l
Pirimiphos Methyl	-	-	-	<10	<10	<10	-	-	<10	TM145	<10 ng/l
Fenitrothion	-	-	-	<10	<10	<10	-	-	<10	TM145	<10 ng/l
Malathion	-	-	-	<10	<10	<10	-	-	<10	TM145	<10 ng/l
Fenthion	-	-	-	<10	<10	<10	-	-	<10	TM145	<10 ng/l
Chlorpyrifos	-	-	-	<10	<10	<10	-	-	<10	TM145	<10 ng/l
Parathion	-	-	-	<10	<10	<10	-	-	<10	TM145	<10 ng/l
Chlorfenvinphos	-	-	-	<10	<10	<10	-	-	<10	TM145	<10 ng/l
Ethion	-	-	-	<10	<10	<10	-	-	<10	TM145	<10 ng/l
Triazophos	-	-	-	<10	<10	<10	-	-	<10	TM145	<10 ng/l
Carbophenothion	-	-	-	<10	<10	<10	-	-	<10	TM145	<10 ng/l
Phosalone	-	-	-	<10	<10	<10	-	-	<10	TM145	<10 ng/l
Azinphos methyl	-	-	-	<10	<10	<10	-	-	<10	TM145	<10 ng/l
Azinphos ethyl	-	-	-	<10	<10	<10	-	-	<10	TM145	<10 ng/l
Organophosphorus Pesticides Total of 21	-	-	-	<10	<10	<10	-	-	<10	TM145	<10 ng/l

Date 03.08.2004

Validated	✓
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ALcontrol Geochem Analytical Services
Table Of Results

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* Subcontracted test
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Job Number: 04/08570/02/01 **Matrix:** LIQUID
Client: Peter Brett Associates **Location:** DOCKSWAY
Client Ref. No.: **Client Contact:** James Amos

Sample Identity	GP03/04A	GP03/09	GP03/12A	GW03/07	GW03/14	GW03/16	GW03/02	GW03/03	LF03/03	Method Code	LoD/Units
Depth (m)											
Sample Type	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER		
Sampled Date									23.06.04		
Sample Received Date	07.06.04	07.06.04	07.06.04	07.06.04	07.06.04	07.06.04	09.06.04	09.06.04	24.06.04		
Batch	1	1	1	1	1	1	2	2	4		
Sample Number(s)	31-32	33-34	35-36	1-10	11-20	21-30	38-39	37,40	47-56		
SVOC											
Phenol	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
2-Chlorophenol	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
-Methylphenol	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
4-Methylphenol	-	-	-	<1	<1	<1	-	-	7	TM143	<1 µg/l
2-Nitrophenol	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
4-Nitrophenol	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
2,4-Dichlorophenol	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
2,4-Dimethylphenol	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
4-Chloro-3-methylphenol	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
2,4,6-Trichlorophenol	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
2,4,5-Trichlorophenol	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Pentachlorophenol	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
1,3-Dichlorobenzene	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
1,4-Dichlorobenzene	-	-	-	<1	<1	<1	-	-	21	TM143	<1 µg/l
1,2-Dichlorobenzene	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
1,2,4-Trichlorobenzene	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Nitrobenzene	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Azobenzene	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
lexachlorobenzene	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Naphthalene	-	-	-	2	6	3	-	-	14	TM143	<1 µg/l
Acenaphthylene	-	-	-	<1	<1	<1	-	-	1	TM143	<1 µg/l
Acenaphthene	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Fluorene	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Phenanthrene	-	-	-	<1	<1	<1	-	-	9	TM143	<1 µg/l
Anthracene	-	-	-	<1	<1	<1	-	-	2	TM143	<1 µg/l
Fluoranthene	-	-	-	<1	<1	<1	-	-	7	TM143	<1 µg/l
Pyrene	-	-	-	<1	<1	<1	-	-	5	TM143	<1 µg/l
Benzo(a)anthracene	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Chrysene	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Benzo(b)fluoranthene	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l

Date 03.08.2004

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Preliminary

ALcontrol Geochem Analytical Services
Table Of Results

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Job Number: 04/08570/02/01
Client: Peter Brett Associates
Client Ref. No.:
Matrix: LIQUID
Location: DOCKSWAY
Client Contact: James Amos

Sample Identity	GP03/04A	GP03/09	GP03/12A	GW03/07	GW03/14	GW03/16	GW03/02	GW03/03	LF03/03	Method Code	LoD/Units
Depth (m)											
Sample Type	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER		
Sampled Date									23.06.04		
Sample Received Date	07.06.04	07.06.04	07.06.04	07.06.04	07.06.04	07.06.04	09.06.04	09.06.04	24.06.04		
Batch	1	1	1	1	1	1	2	2	4		
Sample Number(s)	31-32	33-34	35-36	1-10	11-20	21-30	38-39	37,40	47-56		
SVOC (cont)											
Benzo(k)fluoranthene	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Benzo(a)pyrene	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
'ndeno(1,2,3-cd)pyrene	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Dibenzo(a,h)anthracene	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Benzo(ghi)perylene	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
2-Chloronaphthalene	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
2-Methylnaphthalene	-	-	-	1	2	1	-	-	<1	TM143	<1 µg/l
Carbazole	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Isophorone	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Dibenzofuran	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Dimethyl phthalate	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Diethyl phthalate	-	-	-	<1	5	<1	-	-	<1	TM143	<1 µg/l
Di-n-butyl phthalate	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Di-n-Octyl phthalate	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Bis(2-ethylhexyl) phthalate	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Butylbenzyl phthalate	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
4-Chloroaniline	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
2-Nitroaniline	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
›-Nitroaniline	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
4-Nitroaniline	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
2,4-Dinitrotoluene	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
2,6-Dinitrotoluene	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Bis(2-chloroethyl)ether	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
4-Bromophenylphenylether	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
4-Chlorophenylphenylether	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Hexachloroethane	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Hexachlorobutadiene	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Hexachlorocyclopentadiene	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
Bis(2-chloroethoxy)methane	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l
N-nitrosodi-n-propylamine	-	-	-	<1	<1	<1	-	-	<1	TM143	<1 µg/l

Date 03.08.2004

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Preliminary ☐

ALcontrol Geochem Analytical Services
Table Of Results

ISO 17025 accredited
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* Subcontracted test
» Shown on prev. report

Job Number: 04/08570/02/01
Client: Peter Brett Associates
Client Ref. No.:

Matrix: LIQUID
Location: DOCKSWAY
Client Contact: James Amos

Sample Identity	GP03/04A	GP03/09	GP03/12A	GW03/07	GW03/14	GW03/16	GW03/02	GW03/03	LF03/03	Method Code	LoD/Units
Depth (m)											
Sample Type	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER		
Sampled Date									23.06.04		
Sample Received Date	07.06.04	07.06.04	07.06.04	07.06.04	07.06.04	07.06.04	09.06.04	09.06.04	24.06.04		
Batch	1	1	1	1	1	1	2	2	4		
Sample Number(s)	31-32	33-34	35-36	1-10	11-20	21-30	38-39	37,40	47-56		
TRIAZINE HERBICIDES											
Atrazine	-	-	-	-	-	-	-	-	<1	PENDING	<1 ug/l
Simazine	-	-	-	-	-	-	-	-	<1	PENDING	<1 ug/l

Date 03.08.2004

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ALcontrol Geochem Analytical Services
Table Of Results

ISO 17025 accredited
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* Subcontracted test
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Job Number: 04/08570/02/01 **Matrix:** LIQUID
Client: Peter Brett Associates **Location:** DOCKSWAY
Client Ref. No.: **Client Contact:** James Amos

Sample Identity	GP03/04A	GP03/09	GP03/12A	GW03/07	GW03/14	GW03/16	GW03/02	GW03/03	LF03/03	Method Code	LoD/Units
Depth (m)											
Sample Type	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER		
Sampled Date									23.06.04		
Sample Received Date	07.06.04	07.06.04	07.06.04	07.06.04	07.06.04	07.06.04	09.06.04	09.06.04	24.06.04		
Batch	1	1	1	1	1	1	2	2	4		
Sample Number(s)	31-32	33-34	35-36	1-10	11-20	21-30	38-39	37,40	47-56		
VOC											
Dichlorodifluoromethane	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
Chloromethane	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
Vinyl Chloride	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
Bromomethane	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
Chloroethane	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
Trichlorofluoromethane	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
trans-1-2-Dichloroethene	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
Dichloromethane	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
Carbon Disulphide	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
1.1-Dichloroethene	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
1.1-Dichloroethane	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
Methyl Tertiary Butyl Ether	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
cis-1-2-Dichloroethene	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
Bromochloromethane	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
Chloroform	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
2.2-Dichloropropane	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
1.2-Dichloroethane	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
1.1.1-Trichloroethane	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
..1-Dichloropropene	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
Benzene	-	-	-	<1	<1	<1	-	-	5	TM116#	<1 ug/l
Carbontetrachloride	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
Dibromomethane	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
1.2-Dichloropropane	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
Bromodichloromethane	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
Trichloroethene	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
cis-1-3-Dichloropropene	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
trans-1-3-Dichloropropene	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
1.1.2-Trichloroethane	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
Toluene	-	-	-	<1	<1	<1	-	-	83	TM116#	<1 ug/l
1.3-Dichloropropane	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l

Date 03.08.2004

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ALcontrol Geochem Analytical Services
Table Of Results

ISO 17025 accredited
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* Subcontracted test
» Shown on prev. report

Job Number: 04/08570/02/01
Client: Peter Brett Associates
Client Ref. No.:
Matrix: LIQUID
Location: DOCKSWAY
Client Contact: James Amos

Sample Identity	GP03/04A	GP03/09	GP03/12A	GW03/07	GW03/14	GW03/16	GW03/02	GW03/03	LF03/03	Method Code	LoD/Units
Depth (m)											
Sample Type	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER		
Sampled Date									23.06.04		
Sample Received Date	07.06.04	07.06.04	07.06.04	07.06.04	07.06.04	07.06.04	09.06.04	09.06.04	24.06.04		
Batch	1	1	1	1	1	1	2	2	4		
Sample Number(s)	31-32	33-34	35-36	1-10	11-20	21-30	38-39	37,40	47-56		
VOC (cont)											
Dibromochloromethane	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
1.2-Dibromoethane	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
Tetrachloroethene	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
1.1.1.2-Tetrachloroethane	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
Chlorobenzene	-	-	-	<1	1	<1	-	-	<1	TM116#	<1 ug/l
Ethylbenzene	-	-	-	<1	<1	<1	-	-	58	TM116#	<1 ug/l
p/m-Xylene	-	-	-	<1	<1	<1	-	-	143	TM116#	<1 ug/l
Bromoform	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
Styrene	-	-	-	<1	<1	<1	-	-	4	TM116#	<1 ug/l
1.1.2.2-Tetrachloroethane	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
o-Xylene	-	-	-	<1	1	<1	-	-	45	TM116#	<1 ug/l
1.2.3-Trichloropropane	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
Isopropylbenzene	-	-	-	<1	<1	<1	-	-	10	TM116#	<1 ug/l
Bromobenzene	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
2-Chlorotoluene	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
Propylbenzene	-	-	-	<1	<1	<1	-	-	37	TM116#	<1 ug/l
4-Chlorotoluene	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
1.2.4-Trimethylbenzene	-	-	-	<1	3	<1	-	-	100	TM116#	<1 ug/l
p-Isopropyltoluene	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
1.3.5-Trimethylbenzene	-	-	-	<1	<1	<1	-	-	29	TM116#	<1 ug/l
1.2-Dichlorobenzene	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
1.4-Dichlorobenzene	-	-	-	<1	<1	<1	-	-	52	TM116#	<1 ug/l
sec-Butylbenzene	-	-	-	<1	<1	<1	-	-	9	TM116#	<1 ug/l
tert-Butylbenzene	-	-	-	<1	<1	<1	-	-	896	TM116#	<1 ug/l
1.3-Dichlorobenzene	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
n-Butylbenzene	-	-	-	<1	<1	<1	-	-	13	TM116#	<1 ug/l
1.2-Dibromo-3-chloropropane	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
1.2.4-Trichlorobenzene	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l
Naphthalene	-	-	-	<1	<1	<1	-	-	14	TM116#	<1 ug/l
1.2.3-Trichlorobenzene	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l

Date 03.08.2004

Validated	✓
Preliminary	

ALcontrol Geochem Analytical Services
Table Of Results

ISO 17025 accredited
M MCERTS accredited
* Subcontracted test
» Shown on prev. report

Job Number: 04/08570/02/01
Client: Peter Brett Associates
Client Ref. No.:

Matrix: LIQUID
Location: DOCKSWAY
Client Contact: James Amos

Sample Identity	GP03/04A	GP03/09	GP03/12A	GW03/07	GW03/14	GW03/16	GW03/02	GW03/03	LF03/03	Method Code	LoD/Units
Depth (m)											
Sample Type	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER		
Sampled Date									23.06.04		
Sample Received Date	07.06.04	07.06.04	07.06.04	07.06.04	07.06.04	07.06.04	09.06.04	09.06.04	24.06.04		
Batch	1	1	1	1	1	1	2	2	4		
Sample Number(s)	31-32	33-34	35-36	1-10	11-20	21-30	38-39	37,40	47-56		
VOC (cont)											
Hexachlorobutadiene	-	-	-	<1	<1	<1	-	-	<1	TM116#	<1 ug/l

Date 03.08.2004

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Preliminary ☐

ALcontrol Geochem Analytical Services
Table Of Results

ISO 17025 accredited
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Job Number: 04/12507/02/01

Client: Peter Brett Associates

Client Ref. No.:

Matrix: LIQUID

Location: DOCKSWAY DISPOSAL SITE

Client Contact: James Amos

Sample Identity	LF03/04									Method Code	LoD/Units
Depth (m)											
Sample Type	WATER										
Sampled Date	12.08.04										
Sample Received Date	14.08.04										
Batch	1										
Sample Number(s)	4-11										
Arsenic Dissolved (ICP-MS)	88									TM152#	<1 ug/l
Beryllium Dissolved (ICP-MS)	<1									TM152#	<1 ug/l
Boron Dissolved (ICP-MS)	5392									TM152#	<10 ug/l
Cadmium Dissolved (ICP-MS)	<0.4									TM152#	<0.4 ug/l
Calcium Dissolved (ICP-MS)	47050									TM152#	<5 ug/l
Chromium Dissolved (ICP-MS)	427									TM152#	<1 ug/l
Cobalt Dissolved (ICP-MS)	79									TM152#	<1 ug/l
Copper Dissolved (ICP-MS)	11									TM152#	<1 ug/l
Lead Dissolved (ICP-MS)	28									TM152#	<1 ug/l
Magnesium Dissolved (ICP-MS)	91310									TM152#	<5 ug/l
Manganese Dissolved (ICP-MS)	202									TM152#	<1 ug/l
Nickel Dissolved (ICP-MS)	274									TM152#	<1 ug/l
Selenium Dissolved (ICP-MS)	7									TM152#	<1 ug/l
Vanadium Dissolved (ICP-MS)	47									TM152#	<1 ug/l
Zinc Dissolved (ICP-MS)	220									TM152#	<3 ug/l
Alkalinity Total as CaCO3	9150									TM043#	<2 mg/l
Electrical Conductivity (at 25 deg. C)	22.100									TM120#	<0.025 mS/cm
Potassium	935.5									TM083#	<0.2 mg/l
Sodium	1312.5									TM083#	<0.2 mg/l
Nitrate as NO3	1.3									TM102#	<0.3 mg/l
Nitrite as NO2	<0.05									TM103#	<0.05 mg/l
Sulphate (soluble)	12									TM098#	<3 mg/l
Chloride	2119									TM097#	<1 mg/l
Phosphate (Ortho as PO4)	57.27									TM100#	<0.08 mg/l
Sulphide	<0.05									TM101#	<0.05 mg/l
Ammoniacal Nitrogen as NH4-N	2053.0									TM099#	<0.2 mg/l
Total Organic Carbon	1225									TM090#	<1 mg/l
Phenols Total Monohydric	0.06									TM062#	<0.01 mg/l
Total Cyanide	<0.05									TM153#M	<0.05 mg/l
Free Cyanide Water Low	<0.01									TM153#	<0.01 mg/l
BOD (Unfiltered Sample)	636									TM045#	<1 mg/l

Date 06.09.2004

ALcontrol Geochem

Extractable Petroleum Hydrocarbons (EPH) By GC-FID

Mineral Oil - Carbon Range C10-C40

Job Number : 04/12507/02/01
Client : Peter Brett Associates
Client Ref :
Matrix [Units] : LIQUID [ug/l]

Sample No	Sample Identity	Depth	Mineral Oil	Interpretation
4	LF03/04		1418	

Mineral Oil :- Aliphatic compounds in the range C10-C40 which are not retained on Silica.

Validated ✓

Preliminary

ALcontrol Geochem Analytical Services
Table Of Results

ISO 17025 accredited
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* Subcontracted test
» Shown on prev. report

Job Number: 04/12507/02/01 **Matrix:** LIQUID

Client: Peter Brett Associates **Location:** DOCKSWAY DISPOSAL SITE

Client Ref. No.: **Client Contact:** James Amos

Sample Identity	LF03/04									Method Code	LoD/Units
Depth (m)											
Sample Type	WATER										
Sampled Date	12.08.04										
Sample Received Date	14.08.04										
Batch	1										
Sample Number(s)	4-11										
COD (Unfiltered Sample)	421									TM107#	<10 mg/l
Hardness Total	494									TM152#	<1 mg/l
pH Value In Water	8.19									TM133#	<1.00 pH Units
EPH (DRO) (C10-C40)	10092									TM061#M	<10 ug/l
EPH (Mineral Oil)	1418									TM061#M	<10 ug/l
PRO (C4-C10)	<10									TM089#	<10 ug/l
Benzene	<10									TM089#	<10 ug/l
Toluene	<10									TM089#	<10 ug/l
Ethyl benzene	<10									TM089#	<10 ug/l
m & p Xylene	<10									TM089#	<10 ug/l
o Xylene	<10									TM089#	<10 ug/l
Tributyl Tin	79										<50 ng/l
Triphenyl Tin	<50										<50 ng/l
Dibutyl Tin	<50										<50 ng/l

Date 06.09.2004

Validated ✓

Preliminary ☐

ALcontrol Geochem Analytical Services
Table Of Results

ISO 17025 accredited
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* Subcontracted test
» Shown on prev. report

Job Number: 04/12507/02/01
Matrix: LIQUID
Client: Peter Brett Associates
Location: DOCKSWAY DISPOSAL SITE
Client Ref. No.:
Client Contact: James Amos

Sample Identity	LF03/04									Method Code	LoD/Units
Depth (m)											
Sample Type	WATER										
Sampled Date	12.08.04										
Sample Received Date	14.08.04										
Batch	1										
Sample Number(s)	4-11										
OCP											
Tecnazene	<100									TM144	<10 ng/l
Trifluralin	<100									TM144	<10 ng/l
Alpha-BHC (Lindane)	<100									TM144	<10 ng/l
Hexachlorobenzene	<100									TM144	<10 ng/l
Beta-BHC (Lindane)	<100									TM144	<10 ng/l
Gamma-BHC (Lindane)	<100									TM144	<10 ng/l
Quintozene (PCNB)	<100									TM144	<10 ng/l
Triallate	<100									TM144	<10 ng/l
Chlorothalonil	<100									TM144	<10 ng/l
Heptachlor	<100									TM144	<10 ng/l
Aldrin	<100									TM144	<10 ng/l
Triadimefon	<100									TM144	<10 ng/l
Pendimethalin	<100									TM144	<10 ng/l
Heptachlor Epoxide	<100									TM144	<10 ng/l
o,p'-DDE	<100									TM144	<10 ng/l
Endosulfan I	<100									TM144	<10 ng/l
p,p'-DDE	<100									TM144	<10 ng/l
Dieldrin	<100									TM144	<10 ng/l
p,p'-TDE (DDD)	<100									TM144	<10 ng/l
Endrin	<100									TM144	<10 ng/l
Endosulfan II	<100									TM144	<10 ng/l
o,p'-TDE (DDD)	<100									TM144	<10 ng/l
o,p'-DDT	<100									TM144	<10 ng/l
p,p'-DDT	<100									TM144	<10 ng/l
Endosulfan Sulphate	<100									TM144	<10 ng/l
o,p'-Methoxychlor	<100									TM144	<10 ng/l
p,p'-Methoxychlor	<100									TM144	<10 ng/l
Permethrin	<100									TM144	<10 ng/l
Organochlorine Pesticides Total of 28	<100									TM144	<10 ng/l

Date 06.09.2004

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ALcontrol Geochem Analytical Services
Table Of Results

ISO 17025 accredited
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* Subcontracted test
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Job Number: 04/12507/02/01
Client: Peter Brett Associates
Client Ref. No.:
Matrix: LIQUID
Location: DOCKSWAY DISPOSAL SITE
Client Contact: James Amos

Sample Identity	LF03/04									Method Code	LoD/Units
Depth (m)											
Sample Type	WATER										
Sampled Date	12.08.04										
Sample Received Date	14.08.04										
Batch	1										
Sample Number(s)	4-11										
OPP											
Dichlorvos	<100									TM145	<10 ng/l
Mevinphos	<100									TM145	<10 ng/l
Dimethoate	<100									TM145	<10 ng/l
Propetamphos	<100									TM145	<10 ng/l
Diazinon (Dimpylate)	<100									TM145	<10 ng/l
Etrimphos	<100									TM145	<10 ng/l
Chlorpyrifos-methyl	<100									TM145	<10 ng/l
Methyl Parathion	<100									TM145	<10 ng/l
Pirimiphos Methyl	<100									TM145	<10 ng/l
Fenitrothion	<100									TM145	<10 ng/l
Malathion	<100									TM145	<10 ng/l
Fenthion	<100									TM145	<10 ng/l
Chlorpyrifos	<100									TM145	<10 ng/l
Parathion	<100									TM145	<10 ng/l
Chlorfenvinphos	<100									TM145	<10 ng/l
Ethion	<100									TM145	<10 ng/l
Triazophos	<100									TM145	<10 ng/l
Carbophenothion	<100									TM145	<10 ng/l
Phosalone	<100									TM145	<10 ng/l
Azinphos methyl	<100									TM145	<10 ng/l
Azinphos ethyl	<100									TM145	<10 ng/l
Organophosphorus Pesticides Total of 21	<100									TM145	<10 ng/l

Date 06.09.2004

Validated	✓
Preliminary	

ALcontrol Geochem Analytical Services
Table Of Results

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* Subcontracted test
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Job Number: 04/12507/02/01 **Matrix:** LIQUID
Client: Peter Brett Associates **Location:** DOCKSWAY DISPOSAL SITE
Client Ref. No.: **Client Contact:** James Amos

Sample Identity	LF03/04									Method Code	LoD/Units
Depth (m)											
Sample Type	WATER										
Sampled Date	12.08.04										
Sample Received Date	14.08.04										
Batch	1										
Sample Number(s)	4-11										
SVOC											
Phenol	<1									TM143	<1 µg/l
2-Chlorophenol	<1									TM143	<1 µg/l
2-Methylphenol	<1									TM143	<1 µg/l
4-Methylphenol	<1									TM143	<1 µg/l
2-Nitrophenol	<1									TM143	<1 µg/l
4-Nitrophenol	<1									TM143	<1 µg/l
2,4-Dichlorophenol	<1									TM143	<1 µg/l
2,4-Dimethylphenol	<1									TM143	<1 µg/l
4-Chloro-3-methylphenol	<1									TM143	<1 µg/l
2,4,6-Trichlorophenol	<1									TM143	<1 µg/l
2,4,5-Trichlorophenol	<1									TM143	<1 µg/l
Pentachlorophenol	<1									TM143	<1 µg/l
1,3-Dichlorobenzene	<1									TM143	<1 µg/l
1,4-Dichlorobenzene	<1									TM143	<1 µg/l
1,2-Dichlorobenzene	<1									TM143	<1 µg/l
1,2,4-Trichlorobenzene	<1									TM143	<1 µg/l
Nitrobenzene	<1									TM143	<1 µg/l
Azobenzene	<1									TM143	<1 µg/l
Hexachlorobenzene	<1									TM143	<1 µg/l
Naphthalene	3									TM143	<1 µg/l
Acenaphthylene	<1									TM143	<1 µg/l
Acenaphthene	<1									TM143	<1 µg/l
Fluorene	<1									TM143	<1 µg/l
Phenanthrene	<1									TM143	<1 µg/l
Anthracene	<1									TM143	<1 µg/l
Fluoranthene	<1									TM143	<1 µg/l
Pyrene	<1									TM143	<1 µg/l
Benzo(a)anthracene	<1									TM143	<1 µg/l
Chrysene	<1									TM143	<1 µg/l
Benzo(b)fluoranthene	<1									TM143	<1 µg/l

Date 06.09.2004

Validated	✓
Preliminary	

ALcontrol Geochem Analytical Services
Table Of Results

\# ISO 17025 accredited
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* Subcontracted test
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Job Number: 04/12507/02/01
Client: Peter Brett Associates
Client Ref. No.:
Matrix: LIQUID
Location: DOCKSWAY DISPOSAL SITE
Client Contact: James Amos

Sample Identity	LF03/04									Method Code	LoD/Units
Depth (m)											
Sample Type	WATER										
Sampled Date	12.08.04										
Sample Received Date	14.08.04										
Batch	1										
Sample Number(s)	4-11										
SVOC (cont)											
Benzo(k)fluoranthene	<1									TM143	<1 µg/l
Benzo(a)pyrene	<1									TM143	<1 µg/l
Indeno(1,2,3-cd)pyrene	<1									TM143	<1 µg/l
Dibenzo(a,h)anthracene	<1									TM143	<1 µg/l
Benzo(ghi)perylene	<1									TM143	<1 µg/l
2-Chloronaphthalene	<1									TM143	<1 µg/l
2-Methylnaphthalene	<1									TM143	<1 µg/l
Carbazole	<1									TM143	<1 µg/l
Isophorone	<1									TM143	<1 µg/l
Dibenzofuran	<1									TM143	<1 µg/l
Dimethyl phthalate	<1									TM143	<1 µg/l
Diethyl phthalate	<1									TM143	<1 µg/l
Di-n-butyl phthalate	<1									TM143	<1 µg/l
Di-n-Octyl phthalate	<1									TM143	<1 µg/l
Bis(2-ethylhexyl) phthalate	<1									TM143	<1 µg/l
Butylbenzyl phthalate	<1									TM143	<1 µg/l
4-Chloroaniline	<1									TM143	<1 µg/l
2-Nitroaniline	<1									TM143	<1 µg/l
3-Nitroaniline	<1									TM143	<1 µg/l
4-Nitroaniline	<1									TM143	<1 µg/l
2,4-Dinitrotoluene	<1									TM143	<1 µg/l
2,6-Dinitrotoluene	<1									TM143	<1 µg/l
Bis(2-chloroethyl)ether	<1									TM143	<1 µg/l
4-Bromophenylphenylether	<1									TM143	<1 µg/l
4-Chlorophenylphenylether	<1									TM143	<1 µg/l
Hexachloroethane	<1									TM143	<1 µg/l
Hexachlorobutadiene	<1									TM143	<1 µg/l
Hexachlorocyclopentadiene	<1									TM143	<1 µg/l
Bis(2-chloroethoxy)methane	<1									TM143	<1 µg/l
N-nitrosodi-n-propylamine	<1									TM143	<1 µg/l

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ALcontrol Geochem Analytical Services
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Job Number: 04/12507/02/01 **Matrix:** LIQUID
Client: Peter Brett Associates **Location:** DOCKSWAY DISPOSAL SITE
Client Ref. No.: **Client Contact:** James Amos

Sample Identity	LF03/04									Method Code	LoD/Units
Depth (m)											
Sample Type	WATER										
Sampled Date	12.08.04										
Sample Received Date	14.08.04										
Batch	1										
Sample Number(s)	4-11										
TRIAZINE HERBICIDES											
Atrazine	<1									PENDING	<1 ug/l
Simazine	<1									PENDING	<1 ug/l

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Validated	✓
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ALcontrol Geochem Analytical Services
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Job Number: 04/12507/02/01
Client: Peter Brett Associates
Client Ref. No.:
Matrix: LIQUID
Location: DOCKSWAY DISPOSAL SITE
Client Contact: James Amos

Sample Identity	LF03/04									Method Code	LoD/Units
Depth (m)											
Sample Type	WATER										
Sampled Date	12.08.04										
Sample Received Date	14.08.04										
Batch	1										
Sample Number(s)	4-11										
VOC											
Dichlorodifluoromethane	<1									TM116#	<1 ug/l
Chloromethane	<1									TM116#	<1 ug/l
Vinyl Chloride	<1									TM116#	<1 ug/l
Bromomethane	<1									TM116#	<1 ug/l
Chloroethane	<1									TM116#	<1 ug/l
Trichlorofluoromethane	<1									TM116#	<1 ug/l
trans-1-2-Dichloroethene	<1									TM116#	<1 ug/l
Dichloromethane	<1									TM116#	<1 ug/l
Carbon Disulphide	2									TM116#	<1 ug/l
1.1-Dichloroethene	<1									TM116#	<1 ug/l
1.1-Dichloroethane	<1									TM116#	<1 ug/l
Methyl Tertiary Butyl Ether	<1									TM116#	<1 ug/l
cis-1-2-Dichloroethene	<1									TM116#	<1 ug/l
Bromochloromethane	<1									TM116#	<1 ug/l
Chloroform	<1									TM116#	<1 ug/l
2.2-Dichloropropane	<1									TM116#	<1 ug/l
1.2-Dichloroethane	13									TM116#	<1 ug/l
1.1.1-Trichloroethane	<1									TM116#	<1 ug/l
1.1-Dichloropropene	<1									TM116#	<1 ug/l
Benzene	2									TM116#	<1 ug/l
Carbontetrachloride	<1									TM116#	<1 ug/l
Dibromomethane	<1									TM116#	<1 ug/l
1.2-Dichloropropane	<1									TM116#	<1 ug/l
Bromodichloromethane	31									TM116#	<1 ug/l
Trichloroethene	<1									TM116#	<1 ug/l
cis-1-3-Dichloropropene	<1									TM116#	<1 ug/l
trans-1-3-Dichloropropene	<1									TM116#	<1 ug/l
1.1.2-Trichloroethane	<1									TM116#	<1 ug/l
Toluene	50									TM116#	<1 ug/l
1.3-Dichloropropane	<1									TM116#	<1 ug/l

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Job Number: 04/12507/02/01
Matrix: LIQUID
Client: Peter Brett Associates
Location: DOCKSWAY DISPOSAL SITE
Client Ref. No.:
Client Contact: James Amos

Sample Identity	LF03/04									Method Code	LoD/Units
Depth (m)											
Sample Type	WATER										
Sampled Date	12.08.04										
Sample Received Date	14.08.04										
Batch	1										
Sample Number(s)	4-11										
VOC (cont)											
Dibromochloromethane	<1									TM116#	<1 ug/l
1.2-Dibromoethane	<1									TM116#	<1 ug/l
Tetrachloroethene	<1									TM116#	<1 ug/l
1.1.1.2-Tetrachloroethane	<1									TM116#	<1 ug/l
Chlorobenzene	<1									TM116#	<1 ug/l
Ethylbenzene	18									TM116#	<1 ug/l
p/m-Xylene	83									TM116#	<1 ug/l
Bromoform	<1									TM116#	<1 ug/l
Styrene	<1									TM116#	<1 ug/l
1.1.2.2-Tetrachloroethane	<1									TM116#	<1 ug/l
o-Xylene	35									TM116#	<1 ug/l
1.2.3-Trichloropropane	<1									TM116#	<1 ug/l
Isopropylbenzene	3									TM116#	<1 ug/l
Bromobenzene	<1									TM116#	<1 ug/l
2-Chlorotoluene	7									TM116#	<1 ug/l
Propylbenzene	2									TM116#	<1 ug/l
4-Chlorotoluene	2									TM116#	<1 ug/l
1.2.4-Trimethylbenzene	28									TM116#	<1 ug/l
4-Isopropyltoluene	4									TM116#	<1 ug/l
1.3.5-Trimethylbenzene	7									TM116#	<1 ug/l
1.2-Dichlorobenzene	<1									TM116#	<1 ug/l
1.4-Dichlorobenzene	18									TM116#	<1 ug/l
sec-Butylbenzene	9									TM116#	<1 ug/l
tert-Butylbenzene	85									TM116#	<1 ug/l
1.3-Dichlorobenzene	<1									TM116#	<1 ug/l
n-Butylbenzene	<1									TM116#	<1 ug/l
1.2-Dibromo-3-chloropropane	<1									TM116#	<1 ug/l
1.2.4-Trichlorobenzene	<1									TM116#	<1 ug/l
Naphthalene	<1									TM116#	<1 ug/l
1.2.3-Trichlorobenzene	<1									TM116#	<1 ug/l

Date 06.09.2004

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Job Number: 04/12507/02/01
Client: Peter Brett Associates
Client Ref. No.:
Matrix: LIQUID
Location: DOCKSWAY DISPOSAL SITE
Client Contact: James Amos

Sample Identity	LF03/04									Method Code	LoD/Units
Depth (m)											
Sample Type	WATER										
Sampled Date	12.08.04										
Sample Received Date	14.08.04										
Batch	1										
Sample Number(s)	4-11										
VOC (cont)											
Hexachlorobutadiene	<1									TM116#	<1 ug/l

Date 06.09.2004

Anion - Cation Balance

Job No 04/12507	Sample 1		
Client Reference	LF03/04		
Ion	**Conc mg/l**	**Factor**	**Conc meq/l**
Calcium	47.05	0.04990	2.347795
Magnesium	91.31	0.08229	7.5138999
Sodium	1312.5	0.04350	57.09375
Potassium	935.5	0.02558	23.93009
Total Cations			**90.8855349**
Alkalinity as $CaCO_3$	9150		
Bicarbonate as HCO_3	11163	0.01639	182.96157
Nitrate	1.3	0.01613	0.020969
Chloride	2119	0.02821	59.77699
Sulphate	12	0.02082	0.24984
Total Anions			**243.009369**

% Difference = **-45.5603941**

% Difference = **Sum meq/l cations - Sum meq/l anions / Sum meq/l cations + Sum meq/l anions**

Alcontrol Geochem

VOC Tentatively Identified Compounds

Job Number	-	200412507
Client	-	Peter Brett Associates
Sample Identity	-	010 - LF03/04
Sample Type [Units]	-	Water - µg/l
Date Acquired	-	19/08/2004
Date Reported	-	20/08/2004

Tentative Compound Identification	RetentionTime min	Concentration Water - µg/l
4-Heptanone	9.27	15
Alpha-pinene	13.48	25
Limonene	15.88	40
Camphor	18.54	25
C9-C13 Hydrocarbon fraction*	13.82 - 22.47	665

* includes all identified peaks.

please note: the identification and semi-quantification of these tentatively identified compounds is outside the scope of the UKAS accreditation for this method

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ALcontrol Geochem Analytical Services
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ISO 17025 accredited
* Subcontracted test

Job Number: 03/15489/02
Client: Peter Brett Associates
Client Ref. No.:
Matrix: LIQUID
Location: Docksway Disposal Site
Client Contact: Darren Wilcox

Sample Identity	LF03/01	LF03/06	NorthLeak	SouthLeak	SurfaceTrench					Method Code	LoD/Units
Depth (m)											
Sample Type	WATER	WATER	WATER	WATER	WATER						
Sampled Date											
Sample Received Date	28.11.03	28.11.03	28.11.03	28.11.03	28.11.03						
Batch	1	1	1	1	1						
Sample Number(s)	1-7	8-14	15-17	18-20	21						
Arsenic by ICP-MS	111	75	4	3	3					TM152#	<1 ug/l
Boron by ICP-MS	7184	14760	1044	1049	1045					TM152#	<10 ug/l
Cadmium by ICP-MS	1.5	2.2	0.9	1.0	0.9					TM152#	<0.4 ug/l
Calcium by ICP-MS	91480	45150	154300	189600	187800					TM152#	<5 ug/l
Chromium by ICP-MS	268	346	15	9	18					TM152#	<1 ug/l
Copper by ICP-MS	9	37	8	7	119					TM152#	<1 ug/l
Lead by ICP-MS	40	111	<1	<1	9					TM152#	<1 ug/l
Magnesium by ICP-MS	112700	71010	251200	237500	59820					TM152#	<5 ug/l
Nickel by ICP-MS	271	389	4	4	42					TM152#	<1 ug/l
Zinc by ICP-MS	192	294	50	49	101					TM152#	<3 ug/l
Mercury Low Dutch Target AA	<0.05	<0.05	<0.05	<0.05	<0.05					TM127#	<0.05 ug/l
Alkalinity Total as CaCO3	8575	10550	230	420	650					TM043#	<2 mg/l
Electrical Conductivity	ndp	ndp	12.790	12.810	3.310					TM120#	<0.025 mS/cm
Potassium	1215.0	915.0	112.5	101.3	153.8					TM083#	<0.2 mg/l
Sodium	2040.0	2010.0	2220.0	2190.0	322.5					TM083#	<0.2 mg/l
Nitrate	9.5	8.5	<0.3	<0.3	27.7					TM102#	<0.3 mg/l
Sulphate (soluble)	17	<3	694	682	383					TM098#	<3 mg/l
Chloride	2688	2553	4059	4243	387					TM097#	<1 mg/l
Ammoniacal Nitrogen as NH4-N	1763.3	2438.7	3.1	2.3	64.0					TM099#	<0.2 mg/l
Total Cyanide on Water	<0.05	<0.05	<0.05	<0.05	<0.05					TM153#	<0.05 mg/l
Free Cyanide Water Low	<0.01	<0.01	<0.01	<0.01	<0.01					TM153#	<0.01 mg/l
BOD in unfiltered water	120	804	<1	<1	2					TM045#	<1 mg/l
pH Value In Water	7.86	8.11	7.98	7.73	7.80					TM133#	<1.00 pH Units
Tributyl Tin	<50	<50	<50	<50	<50						<50 ng/l
Triphenyl Tin	<50	<50	<50	<50	<50						<50 ng/l
Dibutyl Tin	<50	<50	<50	<50	<50						<50 ng/l

Date 12.12.2003

Validated	✓
Preliminary	

ALcontrol Geochem Analytical Services
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[#] ISO 17025 accredited
[*] Subcontracted test

Job Number: 03/15489/02
Client: Peter Brett Associates
Client Ref. No.:
Matrix: LIQUID
Location: Docksway Disposal Site
Client Contact: Darren Wilcox

Sample Identity	LF03/01	LF03/06	NorthLeak	SouthLeak	SurfaceTrench					Method Code	LoD/Units
Depth (m)											
Sample Type	WATER	WATER	WATER	WATER	WATER						
Sampled Date											
Sample Received Date	28.11.03	28.11.03	28.11.03	28.11.03	28.11.03						
Batch	1	1	1	1	1						
Sample Number(s)	1-7	8-14	15-17	18-20	21						
SVOC											
Phenol (Water)	90	112	<1	<1	<1					TM143	<1 µg/l
2-Chlorophenol (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
2-Methylphenol (Water)	36	24	<1	<1	<1					TM143	<1 µg/l
4-Methylphenol (Water)	268	80	<1	<1	<1					TM143	<1 µg/l
2-Nitrophenol (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
4-Nitrophenol (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
2,4-Dichlorophenol (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
2,4-Dimethylphenol (Water)	78	22	<1	<1	<1					TM143	<1 µg/l
4-Chloro-3-methylphenol (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
2,4,6-Trichlorophenol (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
2,4,5-Trichlorophenol (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Pentachlorophenol (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
1,3-Dichlorobenzene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
1,4-Dichlorobenzene (Water)	1	<1	<1	<1	<1					TM143	<1 µg/l
1,2-Dichlorobenzene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
1,2,4-Trichlorobenzene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Nitrobenzene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Azobenzene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Hexachlorobenzene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Naphthalene (Water)	10	3	<1	<1	<1					TM143	<1 µg/l
Acenaphthylene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Acenaphthene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Fluorene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Phenanthrene (Water)	2	<1	<1	<1	<1					TM143	<1 µg/l
Anthracene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Fluoranthene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Pyrene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Benzo(a)anthracene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Chrysene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Benzo(b)fluoranthene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l

Date 12.12.2003

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ALcontrol Geochem Analytical Services
Table Of Results

ISO 17025 accredited
* Subcontracted test

Job Number: 03/15489/02
Client: Peter Brett Associates
Client Ref. No.:

Matrix: LIQUID
Location: Docksway Disposal Site
Client Contact: Darren Wilcox

Sample Identity	LF03/01	LF03/06	NorthLeak	SouthLeak	SurfaceTrench					Method Code	LoD/Units
Depth (m)											
Sample Type	WATER	WATER	WATER	WATER	WATER						
Sampled Date											
Sample Received Date	28.11.03	28.11.03	28.11.03	28.11.03	28.11.03						
Batch	1	1	1	1	1						
Sample Number(s)	**1-7**	**8-14**	**15-17**	**18-20**	**21**						
SVOC (cont)											
Benzo(k)fluoranthene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Benzo(a)pyrene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Indeno(1,2,3-cd)pyrene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Dibenzo(a,h)anthracene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Benzo(ghi)perylene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
2-Chloronaphthalene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
2-Methylnaphthalene (Water)	2	<1	<1	<1	<1					TM143	<1 µg/l
Carbazole (Water)	2	<1	<1	<1	<1					TM143	<1 µg/l
Isophorone (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Dibenzofuran (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Dimethyl phthalate (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Diethyl phthalate (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Di-n-butyl phthalate (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Di-n-Octyl phthalate (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Bis(2-ethylhexyl) phthalate (Water)	<1	177	<1	<1	<1					TM143	<1 µg/l
Butylbenzyl phthalate (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
4-Chloroaniline (Water)	<1	<1	<1	<1	<1		DETECTED		IN	TM143	<1 µg/l
2-Nitroaniline (Water)	<1	<1	<1	<1	<1		GW03/14			TM143	<1 µg/l
3-Nitroaniline (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
4-Nitroaniline (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
2,4-Dinitrotoluene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
2,6-Dinitrotoluene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Bis(2-chloroethyl)ether (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
4-Bromophenylphenylether (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
4-Chlorophenylphenylether (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Hexachloroethane (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Hexachlorobutadiene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Hexachlorocyclopentadiene (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
Bis(2-chloroethoxy)methane (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l
N-nitrosodi-n-propylamine (Water)	<1	<1	<1	<1	<1					TM143	<1 µg/l

Date 12.12.2003

Validated ✓

Preliminary ☐

ALcontrol Geochem Analytical Services
Table Of Results

ISO 17025 accredited

* Subcontracted test

Job Number: 03/15489/02

Client: Peter Brett Associates

Client Ref. No.:

Matrix: LIQUID

Location: Docksway Disposal Site

Client Contact: Darren Wilcox

Sample Identity	LF03/01	LF03/06	NorthLeak	SouthLeak	SurfaceTrench					**Method Code**	**LoD/Units**
Depth (m)											
Sample Type	WATER	WATER	WATER	WATER	WATER						
Sampled Date											
Sample Received Date	28.11.03	28.11.03	28.11.03	28.11.03	28.11.03						
Batch	1	1	1	1	1						
Sample Number(s)	**1-7**	**8-14**	**15-17**	**18-20**	**21**						
VOC											
Dichlorodifluoromethane	<1	<100	<1	<1	<1					TM116#	<1 ug/l
Chloromethane	<1	<100	<1	<1	<1					TM116#	<1 ug/l
Vinyl Chloride	<1	<100	<1	<1	<1					TM116#	<1 ug/l
Bromomethane	<1	<100	<1	<1	<1					TM116#	<1 ug/l
Chloroethane	<1	<100	<1	<1	<1					TM116#	<1 ug/l
Trichlorofluoromethane	<1	<100	<1	<1	<1					TM116#	<1 ug/l
trans-1-2-Dichloroethene	<1	<100	<1	<1	<1					TM116#	<1 ug/l
Dichloromethane	<1	<100	<1	<1	<1					TM116#	<1 ug/l
Carbon Disulphide	<1	<100	<1	<1	<1					TM116#	<1 ug/l
1.1-Dichloroethene	<1	<100	<1	<1	<1					TM116#	<1 ug/l
1.1-Dichloroethane	<1	<100	<1	<1	<1					TM116#	<1 ug/l
MTBE GCMS	<1	<100	<1	<1	<1					TM116#	<1 ug/l
cis-1-2-Dichloroethene	<1	<100	<1	<1	<1					TM116#	<1 ug/l
Bromochloromethane	<1	<100	<1	<1	<1					TM116#	<1 ug/l
Chloroform	<1	<100	<1	<1	<1					TM116#	<1 ug/l
2.2-Dichloropropane	<1	<100	<1	<1	<1					TM116#	<1 ug/l
1.2-Dichloroethane	<1	<100	<1	<1	<1					TM116#	<1 ug/l
1.1.1-Trichloroethane	<1	<100	<1	<1	<1					TM116#	<1 ug/l
1.1-Dichloropropene	<1	<100	<1	<1	<1					TM116#	<1 ug/l
Benzene	4	<100	<1	<1	<1					TM116#	<1 ug/l
Carbontetrachloride	<1	<100	<1	<1	<1					TM116#	<1 ug/l
Dibromomethane	<1	<100	<1	<1	<1					TM116#	<1 ug/l
1.2-Dichloropropane	<1	<100	<1	<1	<1					TM116#	<1 ug/l
Bromodichloromethane	<1	<100	<1	<1	<1					TM116#	<1 ug/l
Trichloroethene	<1	<100	<1	<1	<1					TM116#	<1 ug/l
cis-1-3-Dichloropropene	<1	<100	<1	<1	<1					TM116#	<1 ug/l
trans-1-3-Dichloropropene	<1	<100	<1	<1	<1					TM116#	<1 ug/l
1.1.2-Trichloroethane	<1	<100	<1	<1	<1					TM116#	<1 ug/l
Toluene	16	<100	<1	<1	<1					TM116#	<1 ug/l
1.3-Dichloropropane	<1	<100	<1	<1	<1					TM116#	<1 ug/l

Date 12.12.2003

Validated	✓
Preliminary	

ALcontrol Geochem Analytical Services
Table Of Results

ISO 17025 accredited
* Subcontracted test

Job Number: 03/15489/02
Client: Peter Brett Associates
Client Ref. No.:

Matrix: LIQUID
Location: Docksway Disposal Site
Client Contact: Darren Wilcox

Sample Identity	LF03/01	LF03/06	NorthLeak	SouthLeak	SurfaceTrench	Method Code	LoD/Units
Depth (m)							
Sample Type	WATER	WATER	WATER	WATER	WATER		
Sampled Date							
Sample Received Date	28.11.03	28.11.03	28.11.03	28.11.03	28.11.03		
Batch	1	1	1	1	1		
Sample Number(s)	1-7	8-14	15-17	18-20	21		
VOC (cont)							
Dibromochloromethane	<1	<100	<1	<1	<1	TM116#	<1 ug/l
1.2-Dibromoethane	<1	<100	<1	<1	<1	TM116#	<1 ug/l
Tetrachloroethene	<1	<100	<1	<1	<1	TM116#	<1 ug/l
1.1.1.2-Tetrachloroethane	<1	<100	<1	<1	<1	TM116#	<1 ug/l
Chlorobenzene	5	<100	<1	<1	<1	TM116#	<1 ug/l
Ethylbenzene	57	<100 77	<1	<1	<1	TM116#	<1 ug/l
p/m-Xylene	148	128	<1	<1	<1	TM116#	<1 ug/l
Bromoform	<1	<100	<1	<1	<1	TM116#	<1 ug/l
Styrene	1	<100	<1	<1	<1	TM116#	<1 ug/l
1.1.2.2-Tetrachloroethane	<1	<100	<1	<1	<1	TM116#	<1 ug/l
o-Xylene	39	<100 53	<1	<1	<1	TM116#	<1 ug/l
1.2.3-Trichloropropane	<1	<100	<1	<1	<1	TM116#	<1 ug/l
Isopropylbenzene	6	<100	<1	<1	<1	TM116#	<1 ug/l
Bromobenzene	<1	<100	<1	<1	<1	TM116#	<1 ug/l
2-Chlorotoluene	<1	<100	<1	<1	<1	TM116#	<1 ug/l
Propylbenzene	3	<100	<1	<1	<1	TM116#	<1 ug/l
4-Chlorotoluene	<1	<100	<1	<1	<1	TM116#	<1 ug/l
1.2.4-Trimethylbenzene	11	<100	<1	<1	<1	TM116#	<1 ug/l
4-Isopropyltoluene	<1	<100	<1	<1	<1	TM116#	<1 ug/l
1.3.5-Trimethylbenzene	55	<100 81	<1	<1	<1	TM116#	<1 ug/l
1.2-Dichlorobenzene	<1	<100	<1	<1	<1	TM116#	<1 ug/l
1.4-Dichlorobenzene	<1	<100	<1	<1	<1	TM116#	<1 ug/l
sec-Butylbenzene	1	<100	<1	<1	<1	TM116#	<1 ug/l
tert-Butylbenzene	16	455	<1	<1	<1	TM116#	<1 ug/l
1.3-Dichlorobenzene	<1	<100	<1	<1	<1	TM116#	<1 ug/l
n-Butylbenzene	2	<100	<1	<1	<1	TM116#	<1 ug/l
1.2-Dibromo-3-chloropropane	<1	<100	<1	<1	<1	TM116#	<1 ug/l
1.2.4-Trichlorobenzene	<1	<100	<1	<1	<1	TM116#	<1 ug/l
Naphthalene	18	<100 99	<1	<1	<1	TM116#	<1 ug/l
1.2.3-Trichlorobenzene	<1	<100	<1	<1	<1	TM116#	<1 ug/l

Date 12.12.2003

File : H:\120903\VOC016.D
On : 10 Dec 2003 1:20
mple : 200315489-014 LF03/06
isc : /Water

Vial: 16
Operator:
Inst : GC/MS Ins
Multiplr: 100.00
Sample Amount: 0.00

MS Integration Params: EVENTS.E
Quant Time: Dec 10 10:47 2003

Quant Results File: HS_VOC1!.RES

Quant Method : C:\HPCHEM\1\METHODS\HS_VOC1!.M (Chemstation Integrator)
Title : Volatile Organic Compounds (EPA 624/8260)
Last Update : Wed Dec 10 09:01:53 2003
Response via : Initial Calibration
DataAcq Meth : HS_VOC1!

	Compound	R.T.	QIon	Response	Conc Unit	Qvalue
36)	1,2-Dibromoethane	0.00	107	0	N.D.	
37)	Tetrachloroethene	0.00	166	0	N.D.	
39)	1,1,1,2-Tetrachloroethane	0.00	131	0	N.D.	
40)	Chlorobenzene	0.00	112	0	N.D.	
41)	Ethylbenzene	11.32	91	5965m	76.637 ppb	
42)	p/m-Xylene	11.55	106	3859m	127.775 ppb	
43)	Bromoform	0.00	173	0	N.D.	
44)	Styrene	0.00	104	0	N.D.	
45)	1,1,2,2-Tetrachloroethane	0.00	83	0	N.D.	
46)	o-Xylene	12.20	106	1495m	53.199 ppb	
47)	1,2,3-Trichloropropane	0.00	75	0	N.D.	
49)	Isopropylbenzene	0.00	105	0	N.D.	
50)	Bromobenzene	0.00	156	0	N.D.	
51)	2-Chlorotoluene	0.00	91	0	N.D.	
52)	Propylbenzene	0.00	91	0	N.D.	
53)	4-Chlorotoluene	0.00	91	0	N.D.	
54)	1,2,4-Trimethylbenzene	0.00	105	0	N.D.	
55)	4-Isopropyltoluene	0.00	119	0	N.D.	
56)	1,3,5-Trimethylbenzene	15.09	105	5239m	80.871 ppb	
57)	1,3-Dichlorobenzene	0.00	146	0	N.D.	
59)	1,4-Dichlorobenzene	0.00	146	0	N.D.	
60)	sec-Butylbenzene	0.00	105	0	N.D.	
61)	tert-Butylbenzene	15.96	119	38564m	455.451 ppb	
62)	1,2-Dichlorobenzene	0.00	146	0	N.D.	
63)	n-Butylbenzene	0.00	91	0	N.D.	
64)	1,2-Dibromo-3-chloropropan	0.00	157	0	N.D.	
65)	1,2,4-Trichlorobenzene	0.00	180	0	N.D.	
66)	Naphthalene	20.03	128	6490m	98.912 ppb	
67)	1,2,3-Trichlorobenzene	0.00	180	0	N.D.	
68)	Hexachlorobutadiene	0.00	225	0	N.D.	

(#) = qualifier out of range (m) = manual integration

Validated ✓
Preliminary ☐

ALcontrol Geochem Analytical Services
Table Of Results

ISO 17025 accredited
* Subcontracted test

Job Number: 03/15489/02
Client: Peter Brett Associates
Client Ref. No.:
Matrix: LIQUID
Location: Docksway Disposal Site
Client Contact: Darren Wilcox

Sample Identity	LF03/01	LF03/06	NorthLeak	SouthLeak	SurfaceTrench					Method Code	LoD/Units
Depth (m)											
Sample Type	WATER	WATER	WATER	WATER	WATER						
Sampled Date											
Sample Received Date	28.11.03	28.11.03	28.11.03	28.11.03	28.11.03						
Batch	1	1	1	1	1						
Sample Number(s)	**1-7**	**8-14**	**15-17**	**18-20**	**21**						
VOC (cont)											
Hexachlorobutadiene	<1	<100	<1	<1	<1					TM116#	<1 ug/l

Date 12.12.2003

Alcontrol Geochem

Herbicides by GC-MS

Job Number - 03/15489
Client - Peter Brett Assoc.
Sample Type [Units] - μg/l
Date Acquired - 12/08/2003
Date Reported - 12/10/2003

	Sample No.	001	008	015	018	021
	Client Ref.	LF03/01	LF03/06	North Leak	South Leak	Surface Trench
CAS Number						
122-34-9	Simazine	<1	<1	<1	<1	<1
1912-24-9	Atrazine	<1	<1	<1	<1	<1

Alcontrol Geochem

Mineral Oil

Job Number	-	03/15489/1-X
Client	-	Peter Brett Associates
Sample Type [Units]	-	water [ug/l]
Date Acquired	-	06/12/2003
Date Reported	-	10/12/2003

Sample No	Sample Ref	Depth m/ft	Mineral Oil µg/l
001	LF03/01		28
008	LF03/06		1067
015	North Leak		<10
018	South Leak		<10
021	Surface Trench		<10

Organochlorine Pesticides

Sample Identity - 200315489-1-lf03-01
Client - Sample matrix - -water
Units - ng-l

CAS Number	Compound	Concentration
117-18-0	Tecnazene	<10
1582-09-8	Trifluralin	<10
319-84-6	alpha-HCH(Lindane)	<10
118-74-1	Hexachlorobenzene	<10
319-85-7	beta-HCH (Lindane)	<10
58-89-9	gamma-HCH(Lindane)	<10
82-68-8	Quintozene (PCNB)	<10
2303-17-5	Triallate	<10
1897-45-6	Chlorothalonil	<10
76-44-8	Heptachlor	<10
309-00-2	Aldrin	<10
43121-43-3	Triadimefon	<10
40487-42-1	Pendimethalin	<10
1024-57-3	Heptachlor Epoxide	<10
3424-82-6	o,p'-DDE	<10
959-98-8	Endosulfan I	<10
72-55-9	p,p'-DDE	<10
60-57-1	Dieldrin	<10
72-54-8	p,p'-TDE(DDD)	<10
72-20-8	Endrin	<10
33213-65-9	Endosulfan II	<10
53-19-0	o,p'-TDE	<10
789-02-6	o,p'-DDT	<10
50-29-3	p,p'-DDT	<10
1031-07-8	Endosulfan Sulphate	<10
	o,p'-Methoxychlor	<10
72-43-5	p,p'-Methoxychlor	<10
52645-53-1	Permethrin	<10
Total		<10

Organochlorine Pesticides

Sample Identity - 200315489-8-lf03-06
Client - Sample matrix - -water
Units - ng-l

CAS Number	Compound	Concentration
117-18-0	Tecnazene	<10
1582-09-8	Trifluralin	<10
319-84-6	alpha-HCH(Lindane)	<10
118-74-1	Hexachlorobenzene	<10
319-85-7	beta-HCH (Lindane)	<10
58-89-9	gamma-HCH(Lindane)	<10
82-68-8	Quintozene (PCNB)	<10
2303-17-5	Triallate	<10
1897-45-6	Chlorothalonil	<10
76-44-8	Heptachlor	<10
309-00-2	Aldrin	<10
43121-43-3	Triadimefon	<10
40487-42-1	Pendimethalin	<10
1024-57-3	Heptachlor Epoxide	<10
3424-82-6	o,p'-DDE	<10
959-98-8	Endosulfan I	<10
72-55-9	p,p'-DDE	<10
60-57-1	Dieldrin	<10
72-54-8	p,p'-TDE(DDD)	<10
72-20-8	Endrin	<10
33213-65-9	Endosulfan II	<10
53-19-0	o,p'-TDE	<10
789-02-6	o,p'-DDT	<10
50-29-3	p,p'-DDT	<10
1031-07-8	Endosulfan Sulphate	<10
	o,p'-Methoxychlor	<10
72-43-5	p,p'-Methoxychlor	<10
52645-53-1	Permethrin	<10
Total		<10

Organochlorine Pesticides

Sample Identity - 200315489-15-northleak
Client - Sample matrix - -water
Units - ng-l

CAS Number	Compound	Concentration
117-18-0	Tecnazene	<10
1582-09-8	Trifluralin	<10
319-84-6	alpha-HCH(Lindane)	<10
118-74-1	Hexachlorobenzene	<10
319-85-7	beta-HCH (Lindane)	<10
58-89-9	gamma-HCH(Lindane)	<10
82-68-8	Quintozene (PCNB)	<10
2303-17-5	Triallate	<10
1897-45-6	Chlorothalonil	<10
76-44-8	Heptachlor	<10
309-00-2	Aldrin	<10
43121-43-3	Triadimefon	<10
40487-42-1	Pendimethalin	<10
1024-57-3	Heptachlor Epoxide	<10
3424-82-6	o,p'-DDE	<10
959-98-8	Endosulfan I	<10
72-55-9	p,p'-DDE	<10
60-57-1	Dieldrin	<10
72-54-8	p,p'-TDE(DDD)	<10
72-20-8	Endrin	<10
33213-65-9	Endosulfan II	<10
53-19-0	o,p'-TDE	<10
789-02-6	o,p'-DDT	<10
50-29-3	p,p'-DDT	<10
1031-07-8	Endosulfan Sulphate	<10
	o,p'-Methoxychlor	<10
72-43-5	p,p'-Methoxychlor	<10
52645-53-1	Permethrin	<10
Total		<10

Organochlorine Pesticides

Sample Identity - 200315489-18-southleak
Client - Sample matrix - -water
Units - ng-l

CAS Number	Compound	Concentration
117-18-0	Tecnazene	<10
1582-09-8	Trifluralin	<10
319-84-6	alpha-HCH(Lindane)	<10
118-74-1	Hexachlorobenzene	<10
319-85-7	beta-HCH (Lindane)	<10
58-89-9	gamma-HCH(Lindane)	<10
82-68-8	Quintozene (PCNB)	<10
2303-17-5	Triallate	<10
1897-45-6	Chlorothalonil	<10
76-44-8	Heptachlor	<10
309-00-2	Aldrin	<10
43121-43-3	Triadimefon	<10
40487-42-1	Pendimethalin	<10
1024-57-3	Heptachlor Epoxide	<10
3424-82-6	o,p'-DDE	<10
959-98-8	Endosulfan I	<10
72-55-9	p,p'-DDE	<10
60-57-1	Dieldrin	<10
72-54-8	p,p'-TDE(DDD)	<10
72-20-8	Endrin	<10
33213-65-9	Endosulfan II	<10
53-19-0	o,p'-TDE	<10
789-02-6	o,p'-DDT	<10
50-29-3	p,p'-DDT	<10
1031-07-8	Endosulfan Sulphate	<10
	o,p'-Methoxychlor	<10
72-43-5	p,p'-Methoxychlor	<10
52645-53-1	Permethrin	<10
Total		<10

Organochlorine Pesticides

Sample Identity - 200315489-21-surfacetrench
Client - Sample matrix - -water
Units - ng-l

CAS Number	Compound	Concentration
117-18-0	Tecnazene	<10
1582-09-8	Trifluralin	<10
319-84-6	alpha-HCH(Lindane)	<10
118-74-1	Hexachlorobenzene	<10
319-85-7	beta-HCH (Lindane)	<10
58-89-9	gamma-HCH(Lindane)	<10
82-68-8	Quintozene (PCNB)	<10
2303-17-5	Triallate	<10
1897-45-6	Chlorothalonil	<10
76-44-8	Heptachlor	<10
309-00-2	Aldrin	<10
43121-43-3	Triadimefon	<10
40487-42-1	Pendimethalin	<10
1024-57-3	Heptachlor Epoxide	<10
3424-82-6	o,p'-DDE	<10
959-98-8	Endosulfan I	<10
72-55-9	p,p'-DDE	<10
60-57-1	Dieldrin	<10
72-54-8	p,p'-TDE(DDD)	<10
72-20-8	Endrin	<10
33213-65-9	Endosulfan II	<10
53-19-0	o,p'-TDE	<10
789-02-6	o,p'-DDT	<10
50-29-3	p,p'-DDT	<10
1031-07-8	Endosulfan Sulphate	<10
	o,p'-Methoxychlor	<10
72-43-5	p,p'-Methoxychlor	<10
52645-53-1	Permethrin	<10
Total		<10

Organophosphorous Pesticides

Sample Identity - 200315489-1-lf03-01
Client - Sample matrix - -water
Units - ng-l

CAS Number	Compound	Concentration
62-73-7	Dichlorvos	<10
26718-65-0	Mevinphos	<10
60-51-5	Dimethoate	<10
31218-83-4	Propetamphos	<10
331-41-5	Diazinon (Dimpylate)	<10
38260-54-7	Etrimphos	<10
5598-13-0	Chlorpyrifos-methyl	<10
298-00-0	Methyl Parathion	<10
29232-93-7	Pirimiphos methyl	<10
122-14-5	Fenitrothion	<10
121-75-5	Malathion	<10
55-38-9	Fenthion	<10
2921-88-2	Chlorpyrifos	<10
56-38-2	Parathion	<10
470-90-6	Chlorfenvinphos	<10
563-12-2	Ethion	<10
24017-47-8	Triazophos	<10
786-19-6	Carbophenothion	<10
2310-17-0	Phosalone	<10
86-50-0	Azinphos methyl	<10
2642-71-9	Azinphos ethyl	<10
Total		<10

Organophosphorous Pesticides

Sample Identity - 200315489-8-lf03-06
Client - Sample matrix - -water
Units - ng-l

CAS Number	Compound	Concentration
62-73-7	Dichlorvos	<10
26718-65-0	Mevinphos	<10
60-51-5	Dimethoate	<10
31218-83-4	Propetamphos	<10
331-41-5	Diazinon (Dimpylate)	<10
38260-54-7	Etrimphos	<10
5598-13-0	Chlorpyrifos-methyl	<10
298-00-0	Methyl Parathion	<10
29232-93-7	Pirimiphos methyl	<10
122-14-5	Fenitrothion	<10
121-75-5	Malathion	<10
55-38-9	Fenthion	<10
2921-88-2	Chlorpyrifos	<10
56-38-2	Parathion	<10
470-90-6	Chlorfenvinphos	<10
563-12-2	Ethion	<10
24017-47-8	Triazophos	<10
786-19-6	Carbophenothion	<10
2310-17-0	Phosalone	<10
86-50-0	Azinphos methyl	<10
2642-71-9	Azinphos ethyl	<10
Total		<10

APPENDIX 11

13 January 2004 - Low Spring Tidal Cycle

Sample time	OD GW03/04	Sample ti	OD GW03/05	Sampl	Maesglas	Sampl	OD GW03/06		GW03/09		GW03/10A		GW03/13
10:45:00	3.25	10:48:00	2.907	10:54	1.65	11:03	3.278	11:40	3.208	11:50	2.304	11:55	3.554
11:15:00	3.25	11:18:00	2.907	11:24	1.93	11:33	3.278	12:25:00	3.208	12:28	2.254	12:30	3.134
11:45:00	3.25	11:48:00	2.907	11:54	2.15	12:03	3.268	13:05:00	3.208	13:07	2.204	13:10	2.584
12:15:00	3.25	12:18:00	2.907	12:24	2.3	12:33	3.268	13:50:00	3.208	13:54	2.104	13:57	2.004
12:45:00	3.25	12:48:00	2.907	12:54	2.32	13:03	3.268	14:41:00	3.208	14:43	1.974	14:47	1.864
13:15:00	3.25	13:18:00	2.907	13:24	2.33	13:33	3.268	15:23:00	3.208	15:25	1.824	15:30	1.784
13:45:00	3.25	13:48:00	2.907	13:54	2.33	14:03	3.258	16:04:00	3.208	16:07	1.714	16:09	1.684
14:15:00	3.25	14:18:00	2.907	14:24	2.33	14:33	3.258	16:34:00	3.208	16:37	1.714	16:39	1.624
14:45:00	3.25	14:48:00	2.907	14:54	2.33	15:03	3.258	17:39:00	3.208	17:41	1.654	17:45	1.594
15:15:00	3.25	15:18:00	2.907	15:24	2.34	15:33	3.258	18:09:00	3.208	18:14	1.634	18:16	1.534
15:45:00	3.25	15:48:00	2.907	15:54	2.34	16:03	3.258	18:42:00	3.208	18:45	1.624	18:50	1.514
16:15:00	3.25	16:18:00	2.907	16:24	2.34	16:33	3.258	19:14:00	3.208	19:17	1.614	19:20	1.514
16:45:00	3.25	16:48:00	2.897	16:54	2.35	17:03	3.258	19:41:00	3.208	19:45	1.634	19:48	1.514
17:15:00	3.25	17:18:00	2.897	17:24	2.35	17:33	3.248	20:34:00	3.208	20:37	1.684	20:41	1.834
17:45:00	3.25	17:48:00	2.897	17:54	2.35	18:03	3.248	21:08:00	3.208	21:12	1.804	21:15	2.284
18:15:00	3.25	18:18:00	2.897	18:24	2.36	18:33	3.248	21:38:00	3.208	21:44	1.934	21:47	2.834
18:45:00	3.25	18:48:00	2.897	18:54	2.36	19:03	3.238	22:14:00	3.208	22:19	2.004	22:23	3.244
19:15:00	3.25	19:18:00	2.897	19:24	2.37	19:33	3.238						
19:45:00	3.25	19:48:00	2.897	19:54	2.37	20:03	3.228						
20:15:00	3.25	20:18:00	2.897	20:24	2.37	20:33	3.228						
20:45:00	3.25	20:48:00	2.897	20:54	2.38	21:03	3.228						
21:15:00	3.25	21:18:00	2.887	21:24	2.38	21:33	3.228						
21:45:00	3.25	21:48:00	2.887	21:54	2.38	22:03	3.228						
22:15:00	3.25	22:18:00	2.887	22:24	1.93	22:33	3.218						
22:45:00	3.25	22:48:00	2.887	22:54	1.74	23:03	3.218						

Lowest Va

13 January 2004 - Low Spring Tidal Cycle

Sampl	OD GP03/04A	Sample time	OD GP03/011	Sampl	OD GP03/03A	Sampl	GP03/06	Sampl	GP03/08	Sampl	LL03/01	Sample tim	GP03/09
11:06	5.51	10:56	8.24	10:50	7.51	11:30	6.86	12:00	7.25	12:03	8.36	12:05:00	8.11
11:36	5.5	11:26	8.24	11:20	7.51	12:20	6.86	12:35	7.25	12:37	8.33	12:40:00	8.11
12:06	5.49	11:56	8.24	11:50	7.51	13:00	6.86	13:13	7.25	13:15	8.36	13:20:00	8.11
12:36	5.47	12:26	8.24	12:20	7.51	13:45	6.86	14:04	7.25	14:07	8.36	14:09:00	8.12
13:06	5.46	12:56	8.24	12:50	7.51	14:37	6.86	14:51	7.25	14:53	8.36	14:58:00	8.11
13:36	5.46	13:26	8.24	13:20	7.51	15:20	6.86	15:37	7.25	15:39	8.36	15:45:00	8.11
14:06	5.45	13:56	8.24	13:50	7.51	16:00	6.86	16:13	7.25	16:15	8.36	16:20:00	8.11
14:36	5.44	14:26	8.24	14:20	7.51	16:30	6.86	16:45	7.25	16:47	8.36	16:50:00	8.11
15:06	5.43	14:56	8.23	14:50	7.51	17:30	6.86	17:52	7.25	17:56	8.36	17:59:00	8.11
15:36	5.42	15:26	8.23	15:20	7.51	18:05	6.86	18:21	7.25	18:24	8.36	18:27:00	8.11
16:06	5.42	15:56	8.23	15:50	7.51	18:37	6.86	18:53	7.25	18:55	8.36	18:58:00	8.11
16:36	5.41	16:26	8.23	16:20	7.51	19:11	6.86	19:23	7.25	19:25	8.36	19:27:00	8.11
17:06	5.41	16:56	8.23	16:50	7.51	19:37	6.86	19:52	7.25	19:55	8.36	19:58:00	8.11
17:36	5.4	17:26	8.23	17:20	7.51	20:30	6.86	20:48	7.25	20:51	8.36	20:55:00	8.11
18:06	5.39	17:56	8.24	17:50	7.5	21:05	6.86	21:20	7.25	21:22	8.36	21:24:00	8.11
18:36	5.39	18:26	8.24	18:20	7.5	21:35	6.86	21:52	7.24	21:55	8.36	21:58:00	8.11
19:06	5.38	18:56	8.24	18:50	7.5	22:10	6.86	22:28	7.25	22:31	8.36	22:34:00	8.11
19:36	5.37	19:26	8.24	19:20	7.5								
20:06	5.37	19:56	8.24	19:50	7.5								
20:36	5.36	20:26	8.24	20:20	7.5								
21:06	5.36	20:56	8.24	20:50	7.5								
21:36	5.36	21:26	8.24	21:20	7.49								
22:06	5.36	21:56	8.24	21:50	7.49								
22:36	5.35	22:26	8.24	22:20	7.49								
23:06	5.35	22:56	8.24	22:50	7.49								

	Mean High Water Spring Tide	Highest Astronomical Tide	1 in 200 Still Water Level
09:00	6.29	7.69	8.5
09:30	6.29	7.69	8.5

	GW03/14	Sample tim	GW03/15	Sample Tin	Dip	GW03/16
11:58	3.55	12:07	3.51	11:48:00	10.20	4.221
12:32	3.15	12:43	3.41	12:22:00	10.32	4.101
13:12	2.78	13:22	3.26	12:45:00	10.39	4.031
14:00	2.64	14:14	3.21	13:23:00	10.46	3.961
14:49	2.57	15:00	3.11	13:52:00	10.50	3.921
15:34	2.52	15:48	3.11	14:21:00	10.52	3.901
16:11	2.5	16:22	3.01	14:58:00	10.56	3.861
16:44	2.45	16:53	3.01	15:29:00	10.56	3.861
17:50	2.44	18:01	3.01	15:59:00	10.59	3.831
18:19	2.4	18:30	2.99	16:26:00	10.62	3.801
18:52	2.41	19:03	2.97			
19:22	2.38	19:30	2.97			
19:51	2.48	20:00	2.97			
20:45	2.55	21:00	2.99			
21:18	2.85	21:27	3.11			
21:51	3.27	22:02	3.36			
22:26	3.52	22:39	3.51			

alue

Newport docks data from ABP

Time	corrected to OD
00:00:00	3.534
00:05:00	3.401
00:10:00	3.258
00:15:00	3.1
00:20:00	2.955
00:25:00	2.789
00:30:00	2.604
00:35:00	2.417
00:40:00	2.25
00:45:00	2.104
00:50:00	1.934
00:55:00	1.776
01:00:00	1.615
01:05:00	1.431
01:10:00	1.234
01:15:00	1.06
01:20:00	0.879
01:25:00	0.706
01:30:00	0.543
01:35:00	0.386
01:40:00	0.244
01:45:00	0.109
01:50:00	-0.023
01:55:00	-0.158
02:00:00	-0.299
02:05:00	-0.428
02:10:00	-0.554
02:15:00	-0.71
02:20:00	-0.875
02:25:00	-1.029
02:30:00	-1.169
02:35:00	-1.299
02:40:00	-1.418

26 January 2004 - High Spring Tidal Cycle

Sample Time	Dip	OD GW03/02	SampleTime	Dip	OD GW03/03	Sample Time	Dip	OD GW03/05	Sample Time	Dip	OD GW03/06	Sample Time	Dip	OD GW03/07	Sample Time	Dip	OD GW03/09
07:30:00	9.47	5.344	07:35:00	11.02	4.362	07:32:00	9.92	2.817	07:36:00	6.67	3.248	07:40:00	7.04	3.188	07:45:00	7.36	3.148
08:00:00	9.47	5.344	08:13:00	11.02	4.362	08:01:00	9.92	2.817	08:05:00	6.68	3.238	08:08:00	7.04	3.188	08:13:00	7.36	3.148
08:39:00	9.47	5.344	08:42:00	11.02	4.362	08:30:00	9.93	2.807	08:42:00	6.70	3.218	08:45:00	7.04	3.188	08:48:00	7.36	3.148
09:10:00	9.47	5.344	09:15:00	10.97	4.412	09:10:00	9.90	2.837	09:12:00	6.73	3.188	09:15:00	7.03	3.198	09:19:00	7.35	3.158
10:03:00	9.37	5.444	10:06:00	10.90	4.482	10:00:00	9.92	2.817	10:03:00	6.74	3.178	10:04:00	7.02	3.208	10:08:00	7.37	3.138
10:35:00	9.33	5.484	10:38:00	10.86	4.522	10:30:00	9.91	2.827	10:34:00	6.71	3.208	10:37:00	7.02	3.208	10:40:00	7.38	3.128
11:16:00	9.33	5.484	11:20:00	10.81	4.572	11:27:00	9.92	2.817	11:30:00	6.70	3.218	11:32:00	7.01	3.218	11:35:00	7.34	3.168
11:49:00	9.37	5.444	11:53:00	10.82	4.562	12:15:00	9.92	2.817	12:18:00	6.70	3.218	12:22:00	7.02	3.208	12:25:00	7.35	3.158
12:26:00	9.40	5.414	12:29:00	10.87	4.512	12:43:00	9.92	2.817	12:45:00	6.70	3.218	12:47:00	7.02	3.208	12:49:00	7.33	3.178
12:57:00	9.42	5.394	13:00:00	10.90	4.482	13:15:00	9.92	2.817	13:18:00	6.70	3.218	13:20:00	7.03	3.198	13:22:00	7.34	3.168
13:33:00	9.43	5.384	13:37:00	10.93	4.452	13:36:00	9.92	2.817	13:42:00	6.71	3.208	13:43:00	7.02	3.208	13:45:00	7.33	3.178
14:06:00	9.44	5.374	14:09:00	10.94	4.442	14:15:00	9.92	2.817	14:18:00	6.71	3.208	14:20:00	7.03	3.198	14:23:00	7.33	3.178
14:32:00	9.44	5.374	14:37:00	10.95	4.432	15:38:00	9.92	2.817	15:42:00	6.72	3.198	15:44:00	7.02	3.208	15:46:00	7.36	3.148
15:33:00	9.46	5.354	15:37:00	10.98	4.402	16:15:00	9.92	2.817	16:17:00	6.72	3.198	16:20:00	7.02	3.208	16:25:00	7.34	3.168
16:02:00	9.47	5.344	16:07:00	10.98	4.402	17:00:00	9.92	2.817	17:05:00	6.74	3.178	17:07:00	7.06	3.168	17:09:00	7.38	3.128
16:32:00	9.47	5.344	16:36:00	10.99	4.392	17:40:00	9.92	2.817	17:46:00	6.74	3.178	17:52:00	7.03	3.198	17:55:00	7.40	3.108
17:15:00	9.48	5.334	17:19:00	11.00	4.382	18:15:00	9.92	2.817	18:19:00	6.74	3.178	18:23:00	7.03	3.198	18:25:00	7.38	3.128
17:46:00	9.49	5.324	17:52:00	11.00	4.382												
18:15:00	9.47	5.344	18:19:00	11.01	4.372												

Lowest
Highest

Sample Time	Dip	OD GW03/10A	Sample Time	Dip	OD GW03/13	Sample Time	Dip	OD GW03/14	Sample Time	Dip	OD GW03/15	Sample Time	Dip	OD GW03/16	REBBW	
07:49:00	8.15	1.554	07:52:00	6.00	1.984	07:54:00	7.25	2.70	07:45:00	8.7	3.01	07:41:00	10.73	3.691	08:58:00	5.78
08:18:00	8.13	1.574	08:21:00	5.98	2.004	08:24:00	7.25	2.70	08:23:00	8.66	3.05	08:18:00	10.70	3.721	09:33:00	6.60
08:50:00	8.00	1.704	08:55:00	5.16	2.824	08:57:00	6.58	3.37	08:51:00	8.37	3.34	08:46:00	10.56	3.861	10:24:00	6.96
09:22:00	7.90	1.804	09:24:00	4.70	3.284	09:29:00	6.16	3.79	09:28:00	8	3.71	09:19:00	10.33	4.091	10:54:00	6.44
10:10:00	7.80	1.904	10:13:00	4.25	3.734	10:16:00	5.80	4.15	10:20:00	7.7	4.01	10:12:00	10.04	4.381	11:36:00	5.24
10:43:00	7.93	1.774	10:46:00	4.21	3.774	10:49:00	5.80	4.15	10:51:00	7.7	4.01	10:44:00	9.97	4.451	12:17:00	4.09
11:37:00	7.72	1.984	11:39:00	4.58	3.404	11:42:00	6.30	3.65	11:31:00	7.91	3.8	11:24:00	10.03	4.391		
12:27:00	7.78	1.924	12:29:00	5.20	2.784	12:31:00	6.80	3.15	12:14:00	8.19	3.52	11:57:00	10.18	4.241		
12:50:00	7.82	1.884	12:54:00	5.58	2.404	12:56:00	7.36	2.59	12:40:00	8.4	3.31	12:33:00	10.39	4.031		
13:24:00	7.88	1.824	13:26:00	6.14	1.844	13:29:00	7.55	2.40	13:16:00	8.56	3.15	13:06:00	10.49	3.931		
13:47:00	7.94	1.764	13:50:00	6.32	1.664	13:53:00	7.62	2.33	13:55:00	8.66	3.05	13:43:00	10.57	3.851		
14:24:00	8.04	1.664	14:27:00	6.50	1.484	14:29:00	7.70	2.25	14:21:00	8.68	3.03	14:14:00	10.60	3.821		
15:48:00	8.23	1.474	15:51:00	6.68	1.304	15:53:00	7.78	2.17	14:49:00	8.72	2.99	14:42:00	10.63	3.791		
16:26:00	8.30	1.404	16:28:00	6.75	1.234	16:30:00	7.80	2.15	15:52:00	8.78	2.93	15:41:00	10.68	3.741		
17:12:00	8.34	1.364	17:15:00	6.84	1.144	17:18:00	7.86	2.09	16:22:00	8.8	2.91	16:13:00	10.71	3.711		
18:00:00	8.34	1.364	18:02:00	6.86	1.124	18:05:00	7.87	2.08	17:01:00	8.84	2.87	16:43:00	10.72	3.701		
18:27:00	8.34	1.364	18:28:00	6.88	1.104	18:30:00	7.88	2.07	17:37:00	8.87	2.84	17:23:00	10.74	3.681		
									18:05:00	8.88	2.83	17:58:00	10.75	3.671		
									18:33:00	8.9	2.81	18:25:00	10.77	3.651		

26/1/04

Sample Time	Dip	OD GP03/08	SampleTime	Dip	OD GP03/09	REBBW	
07:57:00	3.47	6.51	10:17:00	3.34	8.22	08:58:00	5.78
08:27:00	3.48	6.5	10:48:00	3.34	8.22	09:33:00	6.60
08:58:00	3.48	6.5	11:28:00	3.34	8.22	10:24:00	6.96
09:30:00	3.5	6.48	12:01:00	3.34	8.22	10:54:00	6.44
10:18:00	3.49	6.49	12:37:00	3.34	8.22	11:36:00	5.24
10:52:00	3.48	6.5	13:12:00	3.34	8.22	12:17:00	4.09
11:44:00	3.49	6.49	13:49:00	3.34	8.22		
12:32:00	3.46	6.52	14:18:00	3.34	8.22		
12:57:00	3.48	6.5	14:45:00	3.34	8.22		
13:30:00	3.5	6.48	15:45:00	3.34	8.22		
13:54:00	3.5	6.48	16:17:00	3.34	8.22		
14:31:00	3.5	6.48	16:47:00	3.34	8.22		
15:54:00	3.5	6.48	17:27:00	3.34	8.22		
16:31:00	3.5	6.48	18:01:00	3.34	8.22		
17:19:00	3.52	6.46	18:29:00	3.34	8.22		
18:06:00	3.5	6.48					
18:31:00	3.5	6.48					

14 July 2004, Neap Tide Cycle

Sample time	D.D. GW03/11E	GW03/11B	Sample time	D.D GW03/12I	GW03/12D	Sample time	O.D GW03/19	GW03/19	Sample time	D.D. GW03/2
08:33:00	1.98	7.45	08:25:00	2.16	5.88	8:30	1.16	8.1	8:37	2.12
08:57:00	1.77	7.66	08:50:00	2.13	5.91	8:55	0.85	8.41	9:00	2.11
09:22:00	1.63	7.8	09:17:00	1.99	6.05	9:21	0.83	8.43	9:23	2.12
09:51:00	1.54	7.89	09:47:00	1.86	6.18	9:50	0.85	8.41	9:52	2.12
10:20:00	1.47	7.96	10:14:00	1.77	6.27	10:19	0.83	8.43	10:21	2.12
10:51:00	1.45	7.98	10:46:00	1.69	6.35	10:49	0.85	8.41	10:52	2.12
11:20:00	1.40	8.03	11:15:00	1.60	6.44	11:18	0.87	8.39	11:21	2.12
11:52:00	1.42	8.01	11:47:00	1.55	6.49	11:51	0.83	8.43	11:54	2.12
12:20:00	1.34	8.09	12:15:00	1.51	6.53	12:19	0.84	8.42	12:21	2.12
12:50:00	1.32	8.11	12:46:00	1.45	6.59	12:49	0.84	8.42	12:51	2.12
13:20:00	1.30	8.13	13:17:00	1.41	6.63	13:20	0.84	8.42	13:21	2.12
13:51:00	1.28	8.15	13:46:00	1.38	6.66	13:50	0.84	8.42	13:51	2.12
14:23:00	1.26	8.17	14:16:00	1.36	6.68	14:21	0.84	8.42	14:24	2.12
14:50:00	1.26	8.17	14:45:00	1.35	6.69	14:49	0.83	8.43	14:51	2.12
15:22:00	1.28	8.15	15:16:00	1.49	6.55	15:21	0.93	8.33	15:23	2.12
15:51:00	1.43	8	15:46:00	1.76	6.28	15:50	1.73	7.53	15:53	2.50
16:21:00	1.93	7.5	16:16:00	2.11	5.93	16:20	2.36	6.9	16:22	2.80
16:50:00	2.88	6.55	16:45:00	2.60	5.44	16:49	2.96	6.3	16:51	3.12
17:21:00	3.51	5.92	17:16:00	3.06	4.98	17:20	3.59	5.67	17:21	3.45
17:52:00	3.84	5.59	17:45:00	3.35	4.69	17:51	3.92	5.34	17:53	3.77
18:20:00	3.98	5.45	18:16:00	3.50	4.54	18:20	4.10	5.16	18:21	3.90
18:53:00	3.80	5.63	18:47:00	3.52	4.52	18:52	3.94	5.32	18:54	3.69
19:23:00	3.39	6.04	19:16:00	3.32	4.72	19:22	3.56	5.7	19:24	3.26
19:49:00	2.85	6.58	19:46:00	2.84	5.2	19:48	2.97	6.29	19:50	2.79
20:12:00	2.38	7.05	20:04:00	2.43	5.61	20:08	2.21	7.05	20:12	2.30

Sample time	D.D. GW03/10A	GW03/10A	Sample time	O.D. GW03/25	GW03/25	Sample time	O.D. GW03/08E	GW03/08B	Sample time	D.D. GW03/1
08:40	1.58	8.22	08:27	1.63	6.27	08:22	2.62	5.08	08:27	1.78
09:02	1.54	8.26	08:52	1.43	6.47	09:09	2.61	5.09	09:14	1.38
09:25	1.50	8.3	09:19	1.19	6.71	09:50	2.61	5.09	10:00	1.24
09:53	1.42	8.38	09:48	1.01	6.89	10:44	2.61	5.09	10:49	1.17
10:24	1.34	8.46	10:15	0.79	7.11	11:30	2.61	5.09	11:34	1.11
10:54	1.27	8.53	10:48	0.65	7.25	12:35	2.61	5.09	13:28	1.02
11:23	1.18	8.62	11:17	0.54	7.36	13:16	2.61	5.09	13:59	1.01
11:56	1.14	8.66	11:48	0.46	7.44	13:55	2.61	5.09	14:33	0.99
12:24	1.10	8.7	12:17	0.40	7.5	14:27	2.60	5.1	15:15	1.13
12:53	1.08	8.72	12:48	0.36	7.54	15:10	2.60	5.1	16:09	1.63
13:24	1.07	8.73	13:19	0.32	7.58	16:05	2.60	5.1	16:40	2.00
13:54	1.08	8.72	13:49	0.29	7.61	16:35	2.60	5.1	17:12	2.34
14:25	1.11	8.69	14:18	0.37	7.53	17:08	2.60	5.1	17:46	2.65
14:53	1.13	8.67	14:47	0.49	7.41	17:42	2.60	5.1	18:35	2.88
15:25	1.14	8.66	15:18	0.74	7.16	18:30	2.60	5.1	19:11	2.83
15:56	1.20	8.6	15:48	0.96	6.94	19:08	2.60	5.1		
16:24	1.35	8.45	16:18	1.30	6.6					
16:54	1.42	8.38	16:47	1.53	6.37					
17:23	1.50	8.3	17:18	1.81	6.09					
17:55	1.56	8.24	17:48	2.01	5.89					
18:23	1.61	8.19	18:18	2.16	5.74					
18:56	1.65	8.15	18:49	2.26	5.64					
19:26	1.65	8.15	19:19	2.24	5.66					
19:52	1.66	8.14	19:47	2.16	5.74					
20:14	1.62	8.18	20:06	1.86	6.04					

GW03/21	Sample time	D.D. GW03/23	GW03/23	Sample time	D.D. GW03/2	GW03/24	Docks
7.06	08:15	6.57	1.16	08:17	6.57	1.19	8.13
7.07	08:45	6.57	1.16	08:48	6.57	1.19	8.13
7.06	09:15	6.56	1.17	09:16	6.56	1.2	8.13
7.06	09:45	6.55	1.18	09:45	6.57	1.19	8.13
7.06	10:13	6.56	1.17	10:13	6.56	1.2	8.13
7.06	10:45	6.55	1.18	10:45	6.57	1.19	8.13
7.06	11:15	6.55	1.18	11:15	6.57	1.19	8.13
7.06	11:45	6.56	1.17	11:45	6.56	1.2	8.13
7.06	12:14	6.56	1.17	12:15	6.56	1.2	8.13
7.06	12:45	6.56	1.17	12:45	6.57	1.19	8.23
7.06	13:15	6.56	1.17	13:15	6.57	1.19	8.23
7.06	13:45	6.56	1.17	13:45	6.57	1.19	8.23
7.06	14:15	6.56	1.17	14:15	6.57	1.19	8.23
7.06	14:45	6.56	1.17	14:45	6.57	1.19	8.23
7.06	15:15	6.56	1.17	15:16	6.56	1.2	8.23
6.68	15:45	6.56	1.17	15:45	6.56	1.2	8.23
6.38	16:15	6.56	1.17	16:15	6.56	1.2	8.23
6.06	16:45	6.56	1.17	16:45	6.56	1.2	8.23
5.73	17:15	6.56	1.17	17:15	6.56	1.2	8.23
5.41	17:45	6.56	1.17	17:45	6.56	1.2	8.23
5.28	18:15	6.56	1.17	18:15	6.56	1.2	8.23
5.49	18:45	6.56	1.17	18:46	6.56	1.2	8.23
5.92	19:15	6.56	1.17	19:15	6.56	1.2	8.23
6.39	19:45	6.56	1.17	19:45	6.56	1.2	8.23
6.88	20:03	6.56	1.17	20:04	6.56	1.2	8.23

GW03/13	Sample time	D.D. GW03/14	GW03/14	Sample time	D.D. GW03/1	GW03/16	Sample time	D.D. GW03/2	GW03/26	Sample time	Ebbw Stairs
6.24	08:30	1.97	8.01	08:43	3.37	11.1	08:55	2.26	8.63	08:39	-
6.64	09:15	1.86	8.12	09:26	3.34	11.13	09:41	2.28	8.61	09:19	-
6.78	10:05	1.81	8.17	10:13	3.31	11.16	10:21	2.28	8.61	10:08	-
6.85	10:51	1.77	8.21	10:58	3.31	11.16	11:15	2.28	8.61	10:55	-
6.91	11:37	1.75	8.23	11:45	3.30	11.17	11:54	2.28	8.61	11:40	-
7	12:45	1.73	8.25	12:58	3.29	11.18	13:00	2.28	8.61	12:50	-
7.01	13:30	1.71	8.27	13:37	3.29	11.18	13:45	2.28	8.61	13:33	-
7.03	14:04	1.70	8.28	14:10	3.28	11.19	14:17	2.28	8.61	14:07	-
6.89	14:37	1.68	8.3	14:45	3.28	11.19	14:55	2.27	8.62	14:40	rise
6.39	15:19	1.70	8.28	15:30	3.27	11.2	15:35	2.25	8.64	15:25	-
6.02	16:44	2.36	7.62	16:19	3.29	11.18	16:25	2.25	8.64	16:15	rise
5.68	17:15	2.62	7.36	16:52	3.36	11.11	16:58	2.24	8.65	16:50	rise
5.37	17:50	2.82	7.16	17:25	3.47	11	17:30	2.24	8.65	17:21	rise
5.14	18:38	2.95	7.03	18:02	3.57	10.9	18:15	2.24	8.65	17:58	rise
5.19	19:15	2.84	7.14	18:50	3.64	10.83	19:00	2.24	8.65	18:45	fall
				19:25	3.59	10.88	19:35	2.25	8.64	19:20	fall

	Mean High W	Highest Astr	1 in 200 Still Water Level
09:00	6.29	7.69	8.5
09:30	6.29	7.69	8.5

Date	Time	Borehole	Easting	Northing	Dip from Cover	Cover elevation (mAOD)	Water Level m AOD
01/09/2004	1000hrs	GW03/10	331024.4	184767.8	7.84	9.799	1.959
01/09/2004	1000hrs	GW03/15	330721	185308.9	7.53	11.765	4.235
01/09/2004	1000hrs	GW03/26	331361.6	185547.4	8.31	10.89	2.58
01/09/2004	1000hrs	GW03/27	331184.2	185852.2	8.85	11.01	2.16
01/09/2004	1700hrs	GW03/10	331024.4	184767.8	8.52	9.799	1.279
01/09/2004	1700hrs	GW03/15	330721	185308.9	8.81	11.765	2.955
01/09/2004	1700hrs	GW03/26	331361.6	185547.4	8.25	10.89	2.64
01/09/2004	1700hrs	GW03/27	331184.2	185852.2	8.8	11.01	2.21
09/09/2004	1330hrs	GW03/10	331024.4	184767.8	8.52	9.799	1.279
09/09/2004	1330hrs	GW03/16	330660.1	185475.9	11.28	14.472	3.192
09/09/2004	1330hrs	GW03/26	331361.6	185547.4	8.25	10.89	2.64
09/09/2004	1330hrs	GW03/27	331184.2	185852.2	8.8	11.01	2.21
09/09/2004	1330hrs	GW03/29	330739.3	186156.1	5.05	8.68	3.63

APPENDIX 12

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0	10	30	70	100	300	1000	3046	20000
Area 2								
1589.96	1589.96	1589.96	3776.16	3776.16	3776.16	3776.16	3776.16	3776.16
2169.34	2169.34	2169.34	5152.17	5152.17	5152.17	5152.17	5152.17	5152.17
2707.62	2707.62	2707.62	6430.6	6430.6	6430.6	6430.6	6430.6	6430.6
2851.48	2851.48	2851.48	6772.26	6772.26	6772.26	6772.26	6772.26	6772.26
2990.95	2990.95	2990.95	7103.5	7103.5	7103.5	7103.5	7103.5	7103.5
3150.72	3150.72	3150.72	7482.97	7482.97	7482.97	7482.97	7482.97	7482.97
3690.87	3690.87	3690.87	8765.82	8765.82	8765.82	8765.82	8765.82	8765.82
3876.05	3876.05	3876.05	9205.61	9205.61	9205.61	9205.61	9205.61	9205.61
4033	4033	4033	9578.36	9578.36	9578.36	9578.36	9578.36	9578.36
4240.84	4240.84	4240.84	10072	9795.13	9795.13	9795.13	9795.13	9795.13
4424.59	4424.59	4424.59	10508.4	10050.6	10050.6	10050.6	10050.6	10050.6
4529.39	4529.39	4529.39	10757.3	10148.5	10148.5	10148.5	10148.5	10148.5
4732.59	4732.59	4732.59	11239.9	10202.1	10202.1	10202.1	10202.1	10202.1
4813.56	4813.56	4813.56	11432.2	10387.3	10387.3	10387.3	10387.3	10387.3
4958.08	4958.08	4958.08	11775.4	10511.6	10511.6	10511.6	10511.6	10511.6
5098.26	5098.26	5098.26	12108.4	10609	10609	10609	10609	10609
5342.93	5342.93	5342.93	12689.5	10737.4	10737.4	10737.4	10737.4	10737.4
5392.23	5392.23	5392.23	12806.5	10884.8	10884.8	10884.8	10884.8	10884.8
5602.36	5602.36	5602.36	13305.6	11119.2	11119.2	11119.2	11119.2	11119.2
5685.74	5685.74	5685.74	13503.6	11239.9	11239.9	11239.9	11239.9	11239.9
5827.5	5827.5	5827.5	13752.4	11393.5	11393.5	11393.5	11393.5	11393.5
5918.67	5918.67	5918.67	14034.5	11468.2	11468.2	11468.2	11468.2	11468.2
6055.13	6055.13	6055.13	14324.4	11775.4	11775.4	11775.4	11775.4	11775.4
6222.77	6222.77	6222.77	14752.7	12008.6	12008.6	12008.6	12008.6	12008.6
6488.81	6488.81	6488.81	14917.3	12082.3	12082.3	12082.3	12082.3	12082.3
6603.04	6603.04	6603.04	15410.9	12219.6	12219.6	12219.6	12219.6	12219.6
6733.72	6733.72	6733.72	15682.2	12519.9	12519.9	12519.9	12519.9	12519.9
6814.9	6814.9	6814.9	15962.4	12736.3	12736.3	12736.3	12736.3	12736.3
6922.92	6922.92	6922.92	16058.8	12791	12791	12791	12791	12791
7063.1	7063.1	7063.1	16249.7	12869.2	12869.2	12869.2	12869.2	12869.2
7151.51	7151.51	7151.51	16453	13017.9	13017.9	13017.9	13017.9	13017.9
7260.82	7260.82	7260.82	16737.9	13145.9	13145.9	13145.9	13145.9	13145.9
7372.01	7372.01	7372.01	16981.9	13336.2	13336.2	13336.2	13336.2	13336.2
7400.17	7400.17	7400.17	17244.4	13572.1	13572.1	13572.1	13572.1	13572.1
7635.87	7635.87	7635.87	17555.1	13641.3	13641.3	13641.3	13641.3	13641.3
7937.56	7937.56	7937.56	17876.7	13960.8	13960.8	13960.8	13960.8	13960.8
8004.29	8004.29	8004.29	18135.2	14106.2	14106.2	14106.2	14106.2	14106.2
8141.9	8141.9	8141.9	18631.9	14324.4	14324.4	14324.4	14324.4	14324.4
8394.67	8394.67	8394.67	18859.6	14795.8	14795.8	14795.8	14795.8	14795.8
8594.98	8594.98	8594.98	19266.1	15152.8	15152.8	15152.8	15152.8	15152.8
8654.6	8654.6	8654.6	19838	15410.9	15410.9	15410.9	15410.9	15410.9
8974.55	8974.55	8974.55	19967.1	15641.1	15641.1	15641.1	15641.1	15641.1
9188.53	9188.53	9188.53	20174.6	16000.7	16000.7	16000.7	16000.7	16000.7
9391.17	9391.17	9391.17	20413.1	16233.9	16233.9	16233.9	16233.9	16233.9
9555.91	9555.91	9555.91	21282.5	16689.4	16689.4	16689.4	16689.4	16689.4
9945.75	9945.75	9717.3	21782.5	17122	17122	17122	17122	17122
10170	10170	10170	22021.9	17555.6	17555.6	17555.6	17555.6	17555.6
10444.7	10444.7	10444.7	22695.3	18106.7	18106.7	18106.7	18106.7	18106.7
10564.7	10564.7	10564.7	23715.5	18733.8	18733.8	18733.8	18733.8	18733.8
10930.5	10930.5	10930.5	24370.9	19148.4	19148.4	19148.4	19148.4	19148.4

Model submitted to EA in respnse to Sched 4 notice.
Basal Leakage

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Area 2 Mineral Oil	Area 2 Mineral Oil	Area 2 Mineral Oil	Area 2 Mineral Oil	Area 2 Mineral Oil	Area 2 Mineral Oil	Area 2 Mineral Oil	Area 2 Mineral Oil	Area 2 Mineral Oil
0	10	30	70	100	300	1000	3046	20000
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

As submitted model for Sched 4 notice.
Aliphatic hydrocarbonse at base of vertical pathway

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0	10	30	70	100	300	1000	3046	20000
Area 2	Area 2	Area 2	Area 2	Area 2	Area 2	Area 2	Area 2	Area 2
Ammoniaca	Ammoniaca	Ammoniaca	Ammoniaca	Ammoniaca	Ammoniaca	Ammoniaca	Ammoniac	Ammoniac
0	10	30	70	100	300	1000	3046	20000
0	0	0	0	0	0	0.070953	5.50E-09	0
0	0	0	0	0	6.51E-11	35.6535	0.926953	0
0	0	0	0	0	2.38E-09	41.3693	1.79747	0
0	0	0	0	0	5.06E-07	71.9593	2.73939	0
0	0	0	0	0	8.99E-06	98.6015	3.60749	0
0	0	0	0	0	5.12E-05	115.074	5.65488	0
0	0	0	0	0	0.000162	136.772	10.7863	0
0	0	0	0	0	0.000409	146.002	11.8028	1.20E-12
0	0	0	0	0	0.001669	166.53	16.2583	2.54E-12
0	0	0	0	0	0.004167	176.493	18.7262	3.44E-12
0	0	0	0	3.10E-17	0.006789	183.62	21.5014	1.26E-11
0	0	0	0	1.37E-16	0.013691	199.084	24.041	1.54E-10
0	0	0	0	3.82E-16	0.019265	215.445	25.7255	1.48E-09
0	0	0	0	5.77E-16	0.035868	242.851	27.1781	7.63E-09
0	0	0	0	1.91E-15	0.041999	246.965	34.1941	1.60E-08
0	0	0	0	7.41E-15	0.069847	274.955	36.2534	2.90E-08
0	0	0	0	1.56E-14	0.081321	297.688	38.8575	4.38E-08
0	0	0	0	2.79E-14	0.129312	300.511	42.1595	8.92E-08
0	0	0	0	7.33E-14	0.16904	314.913	44.7352	1.20E-07
0	0	0	0	2.18E-13	0.19939	334.382	48.2282	1.73E-07
0	0	0	0	6.11E-13	0.443597	342.226	58.0137	2.12E-07
0	0	0	0	1.72E-12	0.778881	359.797	60.8299	2.55E-07
0	0	0	0	3.76E-12	0.962294	375.106	64.4211	3.66E-07
0	0	0	0	1.11E-11	1.28663	386.335	67.8651	4.73E-07
0	0	0	0	2.73E-11	1.48272	398.218	70.7553	6.07E-07
0	0	0	2.10E-17	8.78E-11	1.84082	414.792	75.6711	8.17E-07
0	0	0	8.94E-17	2.16E-10	2.20363	437.248	79.991	1.16E-06
0	0	0	1.63E-16	4.60E-10	2.42545	449.849	89.3424	1.32E-06
0	0	0	2.33E-16	7.88E-10	3.69042	453.055	90.5517	2.34E-06
0	0	0	3.80E-16	1.41E-09	4.49063	467.654	98.0918	4.23E-06
0	0	0	5.91E-16	2.39E-09	5.75671	477.361	101.956	7.98E-06
0	0	0	1.32E-15	5.12E-09	6.57381	484.561	107.013	1.35E-05
0	0	0	2.24E-15	8.84E-09	9.07051	490.964	114.913	2.25E-05
0	0	0	2.64E-15	2.39E-08	11.8555	497.017	117.202	4.60E-05
0	0	0	4.10E-15	7.13E-08	14.6707	508.857	122.674	5.29E-05
0	0	0	6.67E-15	1.30E-07	15.2067	521.53	127.696	6.07E-05
0	0	0	1.35E-14	4.58E-07	20.3176	528.586	134.03	6.53E-05
0	0	0	1.93E-14	2.01E-06	31.97	548.013	139.238	8.89E-05
0	0	0	4.52E-14	3.48E-06	39.0755	564.765	149.379	0.000107
0	0	0	1.02E-13	1.27E-05	45.6953	588.009	150.463	0.000177
0	0	0	2.33E-13	3.09E-05	55.7414	600.584	160.764	0.000257
0	0	0	4.12E-13	6.49E-05	68.1553	606.024	174.511	0.000459
0	0	0	2.90E-12	0.00015	74.8995	611.426	183.767	0.000537
0	0	0	5.01E-12	0.000197	87.0739	644.466	189.726	0.000752
0	0	0	9.36E-12	0.000287	111.143	665.401	201.808	0.001259
0	0	0	3.05E-11	0.000564	134.647	687.979	226.287	0.001828
0	0	0	5.89E-10	0.001883	201.635	727.099	238.935	0.003265
0	0	0	1.26E-08	0.010492	250.618	748.863	275.058	0.004708
0	0	0	3.62E-07	0.032408	282.599	776.22	285.023	0.010142
0	0	1.82E-17	8.37E-05	0.363605	391.683	894.071	327.675	0.018383

Ammoniacal_N at base of vertical pathway - Master. As model submitted to EA

J:\14000series\14739\038B - HRA\LandSim\Area2-DrftJ-Master.sim

Area 2 Arsenic	Area 2 Arsenic	Area 2 Arsenic	Area 2 Arsenic	Area 2 Arsenic	Area 2 Arsenic	Area 2 Arsenic	Area 2 Arsenic	Area 2 Arsenic
0	10	30	70	100	300	1000	3046	20000
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	1.15E-11
0	0	0	0	0	0	0	0	3.02E-11
0	0	0	0	0	0	0	0	6.43E-09
0	0	0	0	0	0	0	0	5.83E-08
0	0	0	0	0	0	0	0	1.22E-07
0	0	0	0	0	0	0	0	4.45E-07
0	0	0	0	0	0	0	0	1.20E-06
0	0	0	0	0	0	0	0	2.34E-06
0	0	0	0	0	0	0	0	4.93E-06
0	0	0	0	0	0	0	0	8.94E-06
0	0	0	0	0	0	0	0	1.43E-05
0	0	0	0	0	0	0	0	1.76E-05
0	0	0	0	0	0	0	0	3.65E-05
0	0	0	0	0	0	0	0	5.12E-05
0	0	0	0	0	0	0	0	6.55E-05
0	0	0	0	0	0	0	0	9.88E-05
0	0	0	0	0	0	0	0	0.0001112
0	0	0	0	0	0	0	0	0.0001597
0	0	0	0	0	0	0	0	0.0002473
0	0	0	0	0	0	0	0	0.0003227
0	0	0	0	0	0	0	0	0.0003823
0	0	0	0	0	0	0	0	0.0004679
0	0	0	0	0	0	0	0	0.0005979
0	0	0	0	0	0	0	0	0.0007244
0	0	0	0	0	0	0	0	0.0008139
0	0	0	0	0	0	0	0	0.0008817
0	0	0	0	0	0	0	0	0.0010114
0	0	0	0	0	0	0	0	0.0011884
0	0	0	0	0	0	0	0	0.0013712
0	0	0	0	0	0	0	0	0.0015201
0	0	0	0	0	0	0	0	0.0018207
0	0	0	0	0	0	0	0	0.0022032
0	0	0	0	0	0	0	0	0.0023683
0	0	0	0	0	0	0	0	0.0024723
0	0	0	0	0	0	0	0	0.0026112
0	0	0	0	0	0	0	0	0.003272
0	0	0	0	0	0	0	0	0.0036906
0	0	0	0	0	0	0	1.56E-17	0.0045503
0	0	0	0	0	0	0	2.31E-17	0.0055507
0	0	0	0	0	0	0	7.10E-17	0.0067622
0	0	0	0	0	0	0	1.25E-15	0.0086898
0	0	0	0	0	0	0	9.33E-15	0.0101291
0	0	0	0	0	0	0	1.17E-14	0.0138708
0	0	0	0	0	0	0	5.21E-14	0.0156721
0	0	0	0	0	0	0	8.90E-13	0.0182146
0	0	0	0	0	0	0	4.28E-12	0.0260448
0	0	0	0	0	0	0	4.27E-11	0.0362497
0	0	0	0	0	0	0	2.62E-10	0.0459763
0	0	0	0	0	0	0	3.09E-09	0.0604898

As submitted model for Sched 4 notice.
Arsenic at base of vertical pathway

J:\14000series\14739\038B - HRA\LandSim\Area2-DrftJ-Master.sim

0	10	30	70	100	300	1000	3046	20000
Area 2 Benzene	Area 2 Benzene	Area 2 Benzene	Area 2 Benzene	Area 2 Benzene	Area 2 Benzene	Area 2 Benzene	Area 2 Benzene	Area 2 Benzene
0	10	30	70	100	300	1000	3046	20000
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

As submitted model for Sched 4 notice.
Benzene at base of vertical pathway

J:\14000series\14739\038B - HRA\LandSim\Area2-DrftJ-Master.sim

0	10	30	70	100	300	1000	3046	20000
Area 2 Mercury	Area 2 Mercury	Area 2 Mercury	Area 2 Mercury	Area 2 Mercury	Area 2 Mercury	Area 2 Mercury	Area 2 Mercury	Area 2 Mercury
0	10	30	70	100	300	1000	3046	20000
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

As submitted model for Sched 4 notice.
Mercury at base of vertical pathway

J:\14000series\14739\038B - HRA\LandSim\Area2-DrftJ-Master.sim

Area 2	Area 2	Area 2	Area 2	Area 2	Area 2	Area 2	Area 2	Area 2
Naphthaler	Naphthaler	Naphthaler	Naphthaler	Naphthaler	Naphthaler	Naphthaler	Naphthaler	Naphthaler
0	10	30	70	100	300	1000	3046	20000
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

As submitted model for Sched 4 notice.
Naphthalene at base of vertical pathway

Area 2 Potassium	Area 2 Potassium	Area 2 Potassium	Area 2 Potassium	Area 2 Potassium	Area 2 Potassium	Area 2 Potassium
0	30	70	300	1000	3046	20000
0	0	1.44E-13	52.7137	4.96536	0.0064832	0
0	0	3.66E-13	70.9444	7.75275	0.0130862	0
0	0	2.42E-12	71.7459	16.6973	0.0410637	0
0	0	9.30E-12	110.935	21.883	0.0960744	0
0	7.58E-17	1.48E-09	120.152	26.9911	0.230463	0
0	2.70E-16	2.96E-08	129.041	29.2555	0.748424	0
0	2.23E-15	1.19E-07	133.312	43.353	0.912631	0
0	4.26E-15	1.83E-06	137.896	44.8456	1.04656	0
0	1.20E-14	6.38E-06	139.308	46.8073	1.1416	0
0	3.03E-14	5.23E-05	146.129	52.583	1.31949	0
0	3.86E-14	0.000139	150.293	58.1939	1.41279	0
0	4.63E-14	0.0001966	170.613	63.554	1.89231	0
0	9.12E-14	0.0003668	177.81	66.8503	2.55776	0
0	1.14E-13	0.0005062	182.184	70.7814	2.59233	0
0	2.29E-13	0.0013734	183.811	75.4348	3.03301	0
0	4.58E-13	0.0039107	199.019	77.3923	3.12829	0
0	7.97E-13	0.00594	205.593	78.6578	4.29817	0
0	1.03E-12	0.0060032	225.006	92.3323	4.64848	0
0	1.17E-12	0.0165489	231.109	93.3069	6.1409	0
0	1.69E-12	0.0194634	236.658	103.038	6.59905	0
0	2.07E-12	0.0236947	251.391	104.865	6.97015	0
0	2.35E-12	0.0283512	254.188	113.928	8.02133	0
0	2.76E-12	0.0453012	266.214	116.997	8.21148	0
0	3.67E-12	0.0630832	268.132	119.043	8.64503	0
0	2.20E-11	0.220484	280.881	119.996	9.67872	0
0	1.73E-10	0.323485	285.708	123.137	10.0571	0
0	3.79E-10	0.387956	292.985	124.639	10.5318	0
0	2.22E-09	0.697903	295.016	132.978	10.7207	0
0	2.55E-09	1.05138	312.218	133.575	11.8025	0
0	3.78E-09	1.19397	319.169	141.205	12.5643	0
0	6.97E-09	1.52354	330.382	145.407	13.2066	0
0	5.81E-08	2.21494	333.777	157.644	13.6074	0
0	9.82E-08	2.74047	339.794	161.878	15.3691	0
0	1.98E-07	3.08213	344.324	167.717	15.5038	0
0	2.87E-07	3.39545	348.611	178.801	16.388	0
0	1.43E-06	3.67491	354.998	183.04	16.591	0
0	2.48E-06	4.64467	365.659	184.304	17.5257	0
0	4.27E-06	5.84558	372.535	190.03	18.7709	0
0	5.20E-06	6.61897	377.55	196.221	22.0685	0
0	6.26E-06	7.19838	382.6	199.359	22.8219	0
0	5.81E-05	12.1949	407.848	208.829	27.0759	0
0	0.0014003	30.5923	420.408	215.538	28.6934	0
0	0.0058295	34.8495	434.409	224.061	29.6652	1.33E-07
0	0.0080682	55.255	439.65	236.287	30.5114	9.03E-07
0	0.0227548	55.9266	445.542	249.729	41.8129	1.67E-05
0	0.0242719	58.441	458.565	259.366	47.9836	4.83E-05
0	0.0419001	71.8368	469.76	262.113	54.2644	0.0001339
0	0.0624291	95.103	479.187	268.256	56.1342	0.0001723
0	0.23573	126.627	491.133	278.206	61.3805	0.0001914
0	0.348263	137.705	501.123	297.969	68.0486	0.000343

Potassium at base of vertical pathway.
As per submitted model for Sched 4 Notice: sensitivity analysis standard

J:\14000series\14739\038B - HRA\LandSim\Area2-DrftJ-Master.sim

Area 2 Xylene	Area 2 Xylene	Area 2 Xylene	Area 2 Xylene	Area 2 Xylene	Area 2 Xylene	Area 2 Xylene	Area 2 Xylene	Area 2 Xylene
0	10	30	70	100	300	1000	3046	20000
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

As submitted model for Sched 4 notice.
Xylene at base of vertical pathway

Organophosphorous Pesticides

Sample Identity - 200315489-15-northleak
Client - Sample matrix - -water
Units - ng-l

CAS Number	Compound	Concentration
62-73-7	Dichlorvos	<10
26718-65-0	Mevinphos	<10
60-51-5	Dimethoate	<10
31218-83-4	Propetamphos	<10
331-41-5	Diazinon (Dimpylate)	<10
38260-54-7	Etrimphos	<10
5598-13-0	Chlorpyrifos-methyl	<10
298-00-0	Methyl Parathion	<10
29232-93-7	Pirimiphos methyl	<10
122-14-5	Fenitrothion	<10
121-75-5	Malathion	<10
55-38-9	Fenthion	<10
2921-88-2	Chlorpyrifos	<10
56-38-2	Parathion	<10
470-90-6	Chlorfenvinphos	<10
563-12-2	Ethion	<10
24017-47-8	Triazophos	<10
786-19-6	Carbophenothion	<10
2310-17-0	Phosalone	<10
86-50-0	Azinphos methyl	<10
2642-71-9	Azinphos ethyl	<10
Total		<10

Organophosphorous Pesticides

Sample Identity - 200315489-18-southleak
Client - Sample matrix - -water
Units - ng-l

CAS Number	Compound	Concentration
62-73-7	Dichlorvos	<10
26718-65-0	Mevinphos	<10
60-51-5	Dimethoate	<10
31218-83-4	Propetamphos	<10
331-41-5	Diazinon (Dimpylate)	<10
38260-54-7	Etrimphos	<10
5598-13-0	Chlorpyrifos-methyl	<10
298-00-0	Methyl Parathion	<10
29232-93-7	Pirimiphos methyl	<10
122-14-5	Fenitrothion	<10
121-75-5	Malathion	<10
55-38-9	Fenthion	<10
2921-88-2	Chlorpyrifos	<10
56-38-2	Parathion	<10
470-90-6	Chlorfenvinphos	<10
563-12-2	Ethion	<10
24017-47-8	Triazophos	<10
786-19-6	Carbophenothion	<10
2310-17-0	Phosalone	<10
86-50-0	Azinphos methyl	<10
2642-71-9	Azinphos ethyl	<10
Total		<10

Organophosphorous Pesticides

Sample Identity - 200315489-21-surfacetrench
Client - Sample matrix - -water
Units - ng-l

CAS Number	Compound	Concentration
62-73-7	Dichlorvos	<10
26718-65-0	Mevinphos	<10
60-51-5	Dimethoate	<10
31218-83-4	Propetamphos	<10
331-41-5	Diazinon (Dimpylate)	<10
38260-54-7	Etrimphos	<10
5598-13-0	Chlorpyrifos-methyl	<10
298-00-0	Methyl Parathion	<10
29232-93-7	Pirimiphos methyl	<10
122-14-5	Fenitrothion	<10
121-75-5	Malathion	<10
55-38-9	Fenthion	<10
2921-88-2	Chlorpyrifos	<10
56-38-2	Parathion	<10
470-90-6	Chlorfenvinphos	<10
563-12-2	Ethion	<10
24017-47-8	Triazophos	<10
786-19-6	Carbophenothion	<10
2310-17-0	Phosalone	<10
86-50-0	Azinphos methyl	<10
2642-71-9	Azinphos ethyl	<10
Total		<10

Alcontrol Geochem

VOC Tentatively Identified Compounds

Job Number	-	200315489
Client	-	Peter Brett Associates
Sample Identity	-	007 - LF03-01
Sample Type [Units]	-	Water - µg/l
Date Acquired	-	09-Dec
Date Reported	-	10-Dec

Tentative Compound Identification	RetentionTime min	Concentration Water - µg/l
Isopropyl ketone	9.33	15
C9-C13 Aromatic isomers*	13.40-25.00	1345

*Includes identified peaks

please note: the identification and semi-quantification of these tentatively identified compounds is outside the scope of the UKAS accreditation for this method

Alcontrol Geochem

VOC Tentatively Identified Compounds

Job Number	-	200315489
Client	-	Peter Brett Associates
Sample Identity	-	014 - LF03-06
Sample Type [Units]	-	Water - µg/l
Date Acquired	-	09-Dec
Date Reported	-	10-Dec

Tentative Compound Identification	RetentionTime min	Concentration Water - µg/l
C9-C13 Hydrocarbon fraction*	13.40-25.00	887105

*Includes identified peaks

please note: the identification and semi-quantification of these tentatively identified compounds is outside the scope of the UKAS accreditation for this method

Alcontrol Geochem

SVOC Tentatively Identified Compounds

Job Number	-	15489
Client	-	Peter Brett Associates
Sample Identity	-	001-LF03-01
Sample Type [Units]	-	Water - µg/l
Date Acquired	-	09/12/2003
Date Reported	-	09/12/2003

Tentative Compound Identification	Retention Time min	Concentration µg/l
C10 - 26 hydrocarbons: 20% aromatic	-	1640
Terpene type compounds	-	670
C8 - 15 phenols	-	545
Diethyltoluamide	18.94	15
Unknown	19.03	60
Benzothiazolone	20.34	95
Acetyl-hydroxy-methyl-isopropylbicyclononane	20.94	335
Unknown	21.21	290
Fyrol PCF	21.37	80
Unknown	23.31	110
Dehydroabietic acid	27.55	140
Requested compounds not detected	-	<1

Alcontrol Geochem

SVOC Tentatively Identified Compounds

Job Number	-	15489
Client	-	Peter Brett Associates
Sample Identity	-	008-LF03-06
Sample Type [Units]	-	Water - µg/l
Date Acquired	-	09/12/2003
Date Reported	-	09/12/2003

Tentative Compound Identification	Retention Time min	Concentration µg/l
C12 - 28 hydrocarbons	-	3600
Terpene type compounds	-	100
C8 - 15 phenols	-	300
Diethyltoluamide	18.93	20
Benzothiazolone	20.35	55
Acetyl-hydroxy-methyl-isopropylbicyclononane	20.92	75
Fyrol PCF	21.35	30
Unknown	23.29	35
Ethylhexyl diphenyl phosphate	27.19	40
Dehydroabietic acid	27.55	145
Requested compounds not detected	-	<1

None of these or listed List I or List II substances

as identified. Round I!

No tributyl-phosphate in GW03/04 data

Alcontrol Geochem

SVOC Tentatively Identified Compounds

Job Number	-	15489
Client	-	Peter Brett Associates
Sample Identity	-	15-North Leak
Sample Type [Units]	-	Water - µg/l
Date Acquired	-	09/12/2003
Date Reported	-	09/12/2003

Tentative Compound Identification	Retention Time min	Concentration µg/l
Dehydroabietic acid	27.47	10
Requested compounds not detected	-	<1

Alcontrol Geochem

SVOC Tentatively Identified Compounds

Job Number	-	15489
Client	-	Peter Brett Associates
Sample Identity	-	18-South Leak
Sample Type [Units]	-	Water - µg/l
Date Acquired	-	09/12/2003
Date Reported	-	09/12/2003

Tentative Compound Identification	Retention Time min	Concentration µg/l
No compounds detected	-	<1
Requested compounds not detected	-	<1

Alcontrol Geochem

SVOC Tentatively Identified Compounds

Job Number	-	15489
Client	-	Peter Brett Associates
Sample Identity	-	021-Surface Trench
Sample Type [Units]	-	Water - µg/l
Date Acquired	-	09/12/2003
Date Reported	-	09/12/2003

Tentative Compound Identification	Retention Time min	Concentration µg/l
C12 - 26 hydrocarbons	-	270
Trichloroethyl phosphate	20.99	1
Fyrol PCF	21.31	10
Requested compounds not detected	-	<1