Lafarge Tarmac Trading Limited

MANCETTER QUARRY
Atherstone, Warwickshire

Proposal to Extend Existing Quarry Workings

Hydrogeological and Hydrological Assessment

June 2014

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BCL CONSULTANT HYDROGEOLOGISTS LIMITED

EXPERIENCE & QUALIFICATIONS

BCL is an independent consultancy specialising in all aspects of hydrology and hydrogeology as they relate to minerals extraction, water supply and environmental issues.

Henry Lister (the author of this report) holds a Batchelor of Science (Honours) degree [Applied Geology] conferred by Plymouth University, 1992 and a Master of Science Degree [Groundwater Engineering], Newcastle University, 1994.

BCL has provided specialist services and advice to the extractive industry since 2000. During this time, experience has been gained from involvement in the study of hydrogeological and hydrological systems in connection with planning matters at over 100 quarries throughout the United Kingdom and Ireland.

This report has been prepared by BCL Consultant Hydrogeologists Limited with all reasonable skill, care and diligence, within the terms of the Contract made with the Client. The report is confidential to the Client and BCL Consultant Hydrogeologists Limited accepts no responsibility to third parties to whom this report may be made known. No part of this report may be reproduced without prior written approval of BCL Consultant Hydrogeologists Limited. Where data supplied by third parties has been reproduced herein, the originator’s conditions regarding further reproduction or distribution of that data should be sought and observed.

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NON-TECHNICAL SUMMARY:

HYDROLOGICAL & HYDROGEOLOGICAL RISK ASSESSMENT (HRA)

Mineral extraction at Mancetter Quarry has historically been concentrated in three separate void spaces: the (currently active) Oldbury workings to the south, the (fully restored) Jubilee workings at the centre of the landholding and the (largely restored) Purley workings to the north. The Plant Site lies within a narrow valley to the east of the Jubilee workings.

The screening and processing of Recycled Asphalt Product (RAP) is conducted under an exemption from Environmental Permitting, ref: EPR/XE5902LW/A001. Protocols have been advanced to protect water quality from risks posed by the RAP process, with particular emphasis on measures for dealing with road planings that may contain coal tar. Likewise, there is a Preferred Fluids Handing Protocol to minimise the risk of hydrocarbon spillages (applicable across the entire Site).

The quarry excavations extend along the outcrop of a series of diorite sills. These igneous intrusions occur within the Outwoods Shale Formation. These strata are mapped as impermeable, generally without significant groundwater except at shallow depth within weathered zones and joint systems.

The proposed development involves a Western Extension to the Oldbury void, enlarging the quarry by 29.9 hectares (Ha) and deepening by 20 m below the current level of 70 metres above Ordnance Datum (maOD). It should be noted that not all of the area covered by the proposed extension would be subject to mineral extraction operations, instead a significant area (17 Ha) will be utilised to create a permanent screening landform (Western Landform). This Western Landform will accommodate in the region of 1.5 million m$^3$ of overburden and shale.

The quarry is located upon the Nuneaton Ridge, with ground levels around the perimeter of the workings generally ranging from 130-180 maOD. Aside from the self-contained quarry sump, the lowest point is the Site entrance at the eastern end of the Plant Site (105 maOD).

The Site falls within the catchment area of the River Anker; the valley floor is at 70-75 maOD. It passes circa 1.5 km to the northeast of the Site entrance (2 km northeast of the Oldbury workings), flowing from southeast to northwest. There is no risk of fluvial flooding at the quarry, which is over 30 m above the floodplain.

The Coventry Canal runs roughly parallel to the River Anker, following the foot of the Nuneaton Ridge. At its closest approach, the canal passes 0.5 km to the northeast of the Site entrance.

Tributaries to the River Anker (including Oldbury Stream and Rawn Hill Brook) drain the northeast-facing slopes of the Nuneaton Ridge.

Oldbury Stream receives all ingress waters pumped (via treatment lagoons) from the Purley and Oldbury workings and discharged under Consent T/19/35436/T. It also takes rainfall runoff from the Plant Site, which is passed through a series of weir tanks prior to discharge (Consent T/19/35437/T).

Rawn Hill Brook (flowing northeast) crosses the northern end of Purley Quarry: it is passed under the restored workings via buried pipes. It does not receive any groundwater ingress or rainfall runoff from the Purley workings, because these drainage waters are pumped over to Oldbury. The estimated rate of pumping will remain at current levels: 300 m$^3$/day. This process has been ongoing for many years; therefore it is already factored into the ingress data for the Oldbury void.

Rainfall runoff and seepage from the Western Landform will be intercepted by a perimeter ditch with capacity for the 100-year storm, which will be detailed to discharge into the Oldbury void.

Pre-development groundwater level at Oldbury is likely to have equated to 135 maOD. Some 65 m depth of dewatering drawdown is currently required to maintain dry workings in the Oldbury void; this will be increased by a further 20 m in the final development, with an associated radius of influence of circa 165 m. This will not impinge upon local water supplies.

Currently, the average daily rate of pumping is 950-1,000 m$^3$/day (including input from Purley); this is predicted to increase to 1,670 m$^3$/day in the deepened and extended void. This can be expected to increase to 2,600 m$^3$/day during winter months, which complies with the volumetric constraint in the existing Discharge Consent.

The volume of runoff requiring storage in the Oldbury sump equates to circa 20,750 m$^3$ in the 100-year storm. This will be derived from the active workings and the Western Landform. Spread across the final sinking, this would result in circa 1.75 m rise in the water level in the vicinity of the sump during the design storm. The development is classed as “less vulnerable” in terms of flood risk; thus, any backing up of water around the sump during storm conditions is deemed acceptable.
Following abatement of the storm, water will be pumped from the quarry at the designated rate (up to 2,600 m³/day), based upon the requirement to maintain dry workings under average conditions. The water from the sump will continue to be directed into the existing 2-stage treatment lagoons situated upon higher ground (130 maOD) at the northern end of the Oldbury void. These lagoons have a combined surface area of circa 4,000 m². Calculations have been completed to confirm that these lagoons will provide effective silt settlement.

Site experience shows that there will continue to be significant acidification of ingress water within the quarry workings, particularly where such water infiltrates overburden tips, erodes exposed sections of bedrock and accumulates within exhausted sections of the quarry. The acidification process is due to natural chemical decomposition of sulphide minerals being weathered and flushed out of the diorite sills and country rock.

In order to ensure that the pumped water achieves the limits specified in the Discharge Consent, the pH must be raised to between 6 and 9; Aluminium must be restricted to less than 1 mg/l and Iron should be less than 5 mg/l.

The existing lime-dosing facility will be used (when necessary) to ensure that the pumped water achieves these limits.

More recent work regarding the discharge process (the Biotic Ligand Modelling [BLM] report, appended to the HRA) has focussed upon dissolved heavy metals such as Cadmium, Nickel and Zinc, none of which are covered by the Consent but are highlighted by the EA as an issue for further investigation.

The BLM report concluded that the issue with regard to heavy metals (Cadmium, Nickel and Zinc) in Oldbury Stream is considerably diminished when viewed in the context of the following key factors: the natural background metal loading that would have been apparent in the pre-quarry setting; the long history of quarrying (in excess of 100 years) such that the ecosystem of the stream will have adjusted to the heavy metal content; the difference between total metal content and bioavailable fraction; and the dilution capacity afforded by the River Anker.

Waste Acceptance Criteria (WAC) testing suggests that the concentration of dissolved heavy metals in the drainage waters seeping from the Western Landform will be of lesser magnitude than the current situation.

The water level in the restored landform at Purley will need to be fixed at circa 115 maOD, which is some 5 m below the (extrapolated) pre-development groundwater level i.e. 5 m drawdown will be required in perpetuity.

Currently, this is achieved by pumping the water from the Purley sump over to the Oldbury drainage system. The preferred long-term option is to collect the water in a detention basin or flow-balancing pond (with capacity 5,000 m³), which will be situated upon the floor of the Purley void. Dependent upon water quality, the basin will drain under gravity to the northern end of the void, thus allowing controlled overflow to the Rawn Hill Brook. This will necessitate an application to vary the existing (but disused) Discharge Consent T/19/07655/T.

In the event of “teething” issues / until water quality is proven acceptable, the fallback option (pumping over to Oldbury) will need to be retained.
1 INTRODUCTION

1.1 Background

1.1.1 Lafarge Tarmac Trading Limited (the Applicant) has commissioned the preparation of a Planning Application (the Application) seeking consent to extend the existing workings at Mancetter Quarry, Atherstone, Warwickshire (the Site).

1.1.2 Assuming that output activity levels would remain within currently consented limits, this would have the effect of extending the life of the quarry for a further 6 to 7 years.

1.1.3 Lafarge Tarmac has instructed BCL Consultant Hydrogeologists Limited (BCL) to assess the potential hydrological and hydrogeological impacts associated with the Proposed Development.

1.2 Aim, Scope and Methodology of Assessment

1.2.1 This report presents the findings of the hydrological and hydrogeological Baseline Study and Impact Assessment and constitutes part of the Environmental Statement (ES) accompanying the planning application.

1.2.2 The collection and interpretation of baseline data has facilitated a detailed understanding of the nature of, and interactions between, the groundwater and surface water systems operating at and around the Site.

1.2.3 The understanding of hydrological and hydrogeological conditions has been applied to assess the likely primary impacts of the Proposed Development upon the water environment.

1.2.4 Significant potential impacts identified during the course of investigations have been addressed by the incorporation, at the planning stage, of mitigation measures into the design of the Proposed Development.

1.2.5 Where appropriate, outline monitoring protocols have been advanced to facilitate validation / modification of the effectiveness of mitigation measures.
1.2.6 The scope of investigations has been informed by both mineral and local planning policies, which reinforce the need to pay due regard to the likely effect of development upon various aspects of the water environment.

1.3 Data Sources

1.3.1 Site specific data include the following:

i. Topographic surveying commissioned by Lafarge Tarmac.

ii. Walk over surveys of the Site (made by BCL on 10th November 2011 and 20th March 2014).

iii. Groundwater level and slug test data from piezometers installed at the Site.

iv. Water quality data from piezometers, quarry workings, discharge infrastructure and local water features.

1.3.2 Both published and unpublished documents and other sources of information that have been examined include:

i. Ordnance Survey: Topographic maps at scales of 1:25,000 and 1:10,000.


iii. Environment Agency:
   b. Spatial mapping data: river water quality, landfill sites, flooding, and Source Protection Zone (SPZ) maps.
   c. Radial search of licensed abstraction register.
   d. Groundwater level/quality data.
   e. Catchment Abstraction Management Strategy (CAMS): Tame, Anker and Mease abstraction licensing strategy (February 2013).

iv. Council register of private water supplies.

v. Rainfall data: Meteorological Office and Flood Estimation Handbook (FEH), with accompanying CD-ROM.
vi. Natural England (NE): Spatial mapping & citation information for Designated Sites of ecological interest.

vii. Datasets maintained by the National River Flow Archive (NRFA), giving stage and flow rate information for the local rivers.

viii. Geological information and quarry development plans provided by the Applicant.


x. “National Planning Policy Framework” (NPPF: Department for Communities and Local Government [DCLG], March 2012).


xv. “Improving the FEH Statistical Method”, published in July 2008 by the Centre for Ecology and Hydrology (CEH) at the Natural Environment Research Council (NERC).

xvi. Previous hydrological/hydrogeological work completed by Scott Doherty Associates (SDA) and contained within a report prepared by Wardell Armstrong in October 1999: “Mancetter Quarry, Environmental Statement”.

1.3.3 At the time of report preparation, in addition to topographic site survey data, information relating to the design of the Proposed Development, as supplied by the Applicant, or their agents, comprises:


1.4 Report Structure

1.4.1 Baseline data concerning the topography, geology, hydrology and hydrogeology of the study area are presented at section 2.

1.4.2 An account of the Proposed Development, including description of intended working methods and water management measures, is given in section 3.

1.4.3 Assessment of the potential impacts of the Proposed Development and description of mitigation measures proposed to ameliorate significant such impacts are made in section 4.

1.4.4 A summary of the findings of hydrogeological and hydrological assessment together with report conclusions and recommendations are given in section 5.

1.4.5 All diagrams referred to by this report are included as appendix 1.
2 BASELINE STUDY

2.1 Site Location & Boundaries

2.1.1 The quarry is located approximately 1.5 km southwest of the village of Mancetter in Warwickshire. The landholding is centred upon National Grid Reference (NGR) 430800(E) 295600(N) (figure 1, appendix 1).

2.1.2 Mineral extraction at Mancetter Quarry has historically been concentrated in three separate void spaces: the (currently active) Oldbury workings to the south, the (fully restored) Jubilee workings at the centre of the landholding and the (largely restored) Purley workings to the north.

2.1.3 The Plant Site lies within a narrow valley to the east of the Jubilee workings. The stockpiles occupy the steepest ground at the head of the valley (i.e. the southwest side of the Plant Site); the processing (crushing and screening) plant, two asphalt plants, offices and weighbridge are situated lower in the valley, where it narrows and drops away towards the northeast.

2.1.4 The screening and processing of Recycled Asphalt Product (RAP) is conducted under an exemption from the Environmental Permitting (England & Wales) Regulations 2010, exemption ref: EPR/XE5902LW/A001. The screening area is located to the west of the Plant Site stockpiles; the processing area is situated close to the southwest corner of the Purley workings.

2.1.5 A public highway (Purley Chase Lane), which runs from northeast to southwest, separates the Purley workings from the rest of the landholding.

2.1.6 The proposed development, which involves deepening and extending the Oldbury workings in a westerly direction, is hereafter referred to as the Western Extension.

2.1.7 Current land use within the proposed extension area includes: farmland, scrub and a small part of the Purley Chase Golf Course.
2.1.8 The final development will occupy an area of approximately 106.4 hectares (Ha), with 76.5 Ha constituting the existing development (Oldbury, Purley, Jubilee and Plant Site) and approximately 29.9 Ha constituting the proposed Western Extension. It should be noted that not all of the area covered by the proposed extension would be subject to mineral extraction operations, instead a significant area (17 Ha) will be utilised to create a permanent screening/mounded landform (“the Western Landform”). This Western Landform will accommodate in the region of 1.5 million m$^3$ of overburden and shale.

2.1.9 The full extent of the Application Area is illustrated upon drawing M095_00050.

2.2 Outline of Proposed Development

2.2.1 In outline, the Proposed Development involves the continued extraction of the economic mineral (Diorite) in 4 phases. The relevant development plans, which are contained elsewhere in the Application Documents, are numbered M095_00046 through to M095_00049. Extraction operations start at the southern tip of the extension area and progress northwards. The final floor will be at 50 metres above Ordnance Datum (maOD), some 20 m below current workings.

2.2.2 The final restoration objective involves allowing the Oldbury void to fill with groundwater up to a level of 122 maOD, which will be controlled by gravity discharge (via treatment lagoons) to the existing consented discharge point and onwards into the watercourse adjacent to the Plant Site. The concept restoration proposal, including the Western Landform, is illustrated in drawing M095_00050 (contained elsewhere in the Application Documents).

2.3 Designated Sites

2.3.1 Natural England’s database has been consulted to check for Sites of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC), Special Protection Areas (SPA), Biodiversity Action Plan Priority Habitats (BAPPH), Nature Reserves, Country Parks and Ramsar Sites.
2.3.2 In addition to the above data, the relevant officers at Warwickshire County Council have supplied information regarding locally important geological sites and areas of significant archaeological potential.

2.3.3 Sections of the existing workings at Mancetter Quarry have been judged to qualify as Local Geological Sites (LGS).

2.3.4 The western face in Purley (LGS 41) affords strike sections through the middle part of the Outwoods Shale Formation, dominated by laminated mudstones. Fossils occur at several horizons and include a number of significant trilobites.

2.3.5 Within the Oldbury void, LGS 09 includes exposures of the Oldbury Sill (diorite), which has been intruded into the fossiliferous Outwoods Shale Formation.

2.3.6 In terms of archaeological interest, the southern end of Oldbury void is bordered by a Scheduled Monument (English Heritage Record Number 21586 / Warwickshire Historic Environment Record MWA255). The monument is centred upon NGR SP 3143 9469. It covers an area of some 2.8 Ha and includes the earthworks and buried remains of part of Oldbury Camp, a univallate hillfort. An underground reservoir, which was operational by 1954, occupies the central part of the hillfort’s interior.

2.3.7 Merevale Hall (Grade II* Registered Park and Garden, covering some 195 Ha) is at 280 m standoff to the northwest of Purley, at closest approach. Within the Park, a ridge of high ground extends from the south-west towards the centre of the park, where the Hall stands above steep slopes which fall to the north and west opening up into a shallow valley that holds two monastic fishponds (part of a Scheduled Monument: Merevale Abbey, a Cistercian monastery, English Heritage Record Number 21571 / Warwickshire Record 135).

2.3.8 The ground falls more gently to the east and south of the Merevale Hall, descending into a valley that contains the mid-19th Century Merevale Lake (section 2.9.11.3). At its closest approach, the lake is some 450 m to the north of the restored Purley workings.
2.3.9 Hartshill Hayes Country Park abuts the northeast margin of the Oldbury Camp Scheduled Monument and extends close to the southeast corner of the Oldbury workings. The park (covering some 55 Ha) includes species-rich woodland and open hilltop. There are a number of important geological exposures and abandoned quarry workings upon/close to the eastern fringe of the park, the closest being Woodlands Quarry SSSI (1.05 km east of the Site), which is of international significance because of the early Cambrian fossils found at this locality.

2.3.10 The closest SSSI is Bentley Park Wood (105 Ha), which is some 570 m to the west of the Purley workings, at closest approach. The standoff from the proposed mineral extraction area in the Western Extension is *circa* 1.15 km.

2.3.11 Bentley Park Wood SSSI is “dominated by sessile oak high forest”. Alder occurs along the streams and on flushed sites together with tufted hair-grass, sedge and bitter-cress, also patches of lime, wych elm and ash. Noteworthy species include lily-of-the-valley, wood horsetail and wood fescue. Small base-rich flushes are marked by additional species such as ramsons, hard shield-fern and dog’s mercury.

2.3.12 The eastern and western margins of the Purley void are, for the most part, bordered by deciduous woodland, which has BAPPH status; as does the less extensive woodland adjacent to the Oldbury void. These parcels of woodland have not been assigned any Unique Parcel Identifier.

2.3.13 There is an area of (undetermined) grassland abutting the Purley workings, extending north-eastwards towards the village of Mancetter. The site’s Unique Parcel Identifier is 0081:0004215; no decision has been taken by Natural England with regard to the habitat type.

2.3.14 Aside from deciduous woodland, the closest BAPPH to the Oldbury workings is the parcel (0.9 ha) of Purple Moor Grass and Rush Pasture at 420 m standoff to the east of the quarry. The Unique Parcel Identifier is 0081:0004216. The Western Extension will not encroach upon the buffer zone between the BAPPH and the quarry.
The floodplain grazing marsh and lowland meadows lying alongside the River Anker both have BAPPH status. The Unique Parcel Identifiers are 0391:0000325 and 0081:0004212 respectively. At closest approach, the BAPPH marsh and meadows are at 1 km standoff to the ENE of the entrance to the quarry. The existing Oldbury workings are in excess of 1.5 km standoff; this will not be reduced as a result of the development proposal.

The aforementioned designated sites are highlighted on figure 2.

### Landfills

2.4.1 The EA have been consulted in order to identify landfill sites in the vicinity of the proposed extension area (figure 3).

2.4.2 The closest active site is Judkins Landfill Site (Tuttle Hill, Nuneaton, Warwickshire, CV10 0HR), which is some 3.1 km to the southeast of the existing Oldbury workings. Operated by the Waste Recycling Group Limited, this is a co-disposal landfill accepting hazardous waste.

2.4.3 There is a “chain” of historic landfill sites extending round the Oldbury workings.

2.4.4 With respect to the Western Extension, the closest site is referred to as the “Railway Cutting”; it is situated some 570 m to the south of the proposed workings. This landfill was operational from 1969-1980 and is reported to have received inert, industrial, commercial, liquids/sludge and household waste.

2.4.5 There are no published details for the historic landfill at “Ridge Lane” (725 m southwest of the extension area) or “Purley Chase Golf Club” (1.05 km southwest).
2.4.6 On the opposite/northeast side of the Oldbury workings, the closest historic landfill is at 775 m standoff, centred upon Stoneleigh Farm and Worthington Farm, adjacent to the Coventry Canal. The mapped landfill includes a now-flooded void space on the southwest side of the canal, where water level is roughly coincident with that in the canal. These landfill sites are listed as having received inert and commercial waste between 1972 and 1991. The Western Extension will not encroach upon the buffer zone between landfill and quarry.

2.4.7 There is a cluster of small historic landfill sites located due east of (and within the same catchment area as) the southern end of the Oldbury workings. Treated as a group, these received inert, industrial, commercial and household waste up until 1980. The closest is situated within Woodlands Quarry SSSI (1.05 km east of the Site). The others (“Clockhill, Grange Road and Castle Road Landfill Sites”) are all within 1.5 km radius of the quarry. This standoff will not be reduced as a result of the development proposal.

2.5 **Industrial Pollution & Industrial Operator Scores**

2.5.1 The Hartshill Sewage Treatment Works (STW), operated by Severn Trent Water Limited, is located some 2.25 km to the east of the quarry. During 2010, there were no “notifiable releases” to the water environment. Likewise, the Atherstone STW (2.15 km northeast of Purley) reported no “notifiable releases” to the water environment during 2010.

2.5.2 The most recent operator performance (OPRA 2011) score at Hartshill Rendering Plant (Demulder and Son Ltd) was good (Band B), with no “notifiable releases” (2012); the compliance rating score for the first quarter of 2014 was “very good”. This plant is situated some 1.8 km east of the quarry.

2.5.3 Shellingford Quarry (Multi-Agg Ltd) lies some 1.85 km to the southeast of the Application Area. The OPRA score for the year 2008 was “average”. There were no “notifiable releases” to the water environment.
2.5.4 Atherstone Transfer Station (1.8 km northeast of Purley) has a mid-range OPRA 2011 score (Band D); the compliance rating score for the first quarter of 2014 was “poor”.

2.6 Topography

2.6.1 The Site is located on the upper northeast-facing slopes of the Anker Valley.

2.6.2 Going 375-500 m to the southwest of the Oldbury workings, the hillside attains its highest elevation (*circa* 171-172 maOD), beyond which lies a widespread plateau dividing the Anker Valley from the Tame valley, some 9 km to the west.

2.6.3 The town of Atherstone and nearby village of Mancetter are located to the north of the Site, occupying the low ground of the Anker Valley, with the floor of the valley having a basal elevation of approximately 70-75 maOD.

2.6.4 The lower ground of the Anker valley is aligned in a southeast to northwest direction and is approximately 7 km in width.

2.6.5 The Site itself is divided into two halves, Oldbury to the south, and Purley to the north. These two workings form a north-south oriented depression and are separated by higher ground occupied by Purley Chase Lane and the fully restored Jubilee Workings.

2.6.6 The northern (Purley) quarry is largely restored, forming a long narrow depression, the floor of which gently declines from south (115 maOD) to north (110 maOD). The surrounding ground generally ranges from 130 to 145 maOD but is bisected by a natural valley feature (occupied by the Rawn Hill Brook), which descends from southwest to northeast. Ground elevation at the head of the valley (1 km to the southwest of Purley) equates to 155-160 maOD. As it crosses the Site, the valley floor drops from 115 maOD (western boundary) to 110 maOD (eastern boundary), coinciding with the lowest point at the northern end of the restored quarry. From here, the valley drops away to join the main Anker Valley (70-75 maOD), the confluence being some 2 km to the northeast.
2.6.7 The Plant Site occupies a narrow (un-named) valley feature lying to the east of the fully restored Jubilee Workings. The stockpiles occupy the steepest ground at the head of the valley (i.e. the southwest side of the Plant Site); the processing (crushing and screening) plant, two asphalt plants, offices and weighbridge are situated lower in the valley, where it narrows and drops away towards the northeast.

2.6.8 The RAP screening area is located to the west of the Plant Site stockpiles; the RAP processing area is situated close to the southwest corner of the Purley workings.

2.6.9 Extraction operations are now focused upon the southern (Oldbury) quarry, which comprises a deep cutting, aligned north-south. With a floor elevation of circa 70 maOD, these workings are lower than the surrounding ground in all directions: the screening bund upon the northeast boundary of the void space is at 155-165 maOD; the southwest boundary is at 145-150 maOD (beyond which the hillside continues to rise as indicated in section 2.6.2); and the hillfort (Oldbury Camp) adjacent the southernmost tip attains 178 maOD.

2.6.10 The proposed extension area (Western Extension) lies on the southwest side of the Oldbury void. It comprises a steep hillside with ground elevation rising from northeast to southwest. At 375-500 m standoff from the existing void, the slope reaches its maximum elevation of around 171-172 maOD and flattens out on to Purley Chase Golf Club and adjacent farmland.

2.7 Geology

2.7.1 Regional Geology

2.7.1.1 The geology within and surrounding the Site has been characterised by reference to the mapping and literature cited in section 1.3.2. An extract from the relevant BGS Map is presented in figure 4.
2.7.1.2 The Site is situated upon the Nuneaton Ridge, which is associated with the Polesgate Fault (i.e. the ridge lies on the southwest/upthrow side of the fault). This ridge comprises the Stockingford Shale Group (Cambrian to Lower Ordovician), outcropping with a northwest-southeast strike. This sequence dips steeply to the southwest at up to 40°.

2.7.1.3 To the northeast of the Site (but remaining on the upthrow side of the Polesgate Fault), the Hartshill Sandstone Formation (Lower Cambrian) and Caldecote Volcanic Formation (Precambrian) underlie the Stockingford Shale Group. These older formations do not outcrop due to a thin cover of Triassic rocks (namely the Mercia Mudstone Group and Sherwood Sandstone Group).

2.7.1.4 On the northeast/downthrow side of the Polesgate Fault, the Triassic strata are of increased thickness. They directly overlie the Caldecote Volcanic Formation.

2.7.1.5 The Triassic sequence is largely obscured at surface by the presence of post-glacial drift deposits in the Anker Valley.

2.7.1.6 To the southwest of the Site, the Stockingford Shale Group is over-stepped by the Oldbury Farm Sandstone Formation (Upper Devonian), an unconformity bounded sequence with beds dipping to the southwest at 20°.

2.7.1.7 The sandstone is, in turn, overlain by Carboniferous strata (again dipping to the southwest at 20°). These strata include the Millstone Grit Group, the Coal Measures and the Barren Measures. The latter comprises sandstones and mudstones with subordinate limestones and thin coal seams.

2.7.1.8 In places, Glacial Till masks the solid geology of the Nuneaton Ridge.

2.7.2 Site Geology

2.7.2.1 The quarry excavations extend along the outcrop of a series of diorite (lamprophyre) sills of Ordovician age. These igneous intrusions occur within the Outwoods Shale Formation, part of the Stockingford Shale Group.
2.7.2.2 Two sill structures have been exploited, although the smaller/minor sill was only encountered in the Purley workings. They are steeply dipping intrusions, which follow the north-south strike of the Nuneaton Ridge.

2.7.2.3 The Outwoods Shale Formation is also classed as economic mineral. It comprises grey and green-grey bioturbated and pyritic mudstone. The strata dip to the southwest at between 20° to 85° (commonly 35°). The total thickness of the formation equates to 300 m, of which some 50 m can be attributed to the diorite sills. Sandstone beds (micaceous, up to 0.6 m thick) are encountered towards the top of the formation.

2.7.2.4 The proposed extension area is located close to the southwest limit of the Stockingford Shale Group outcrop. The Outwoods Shale Formation is overlain by younger formations of the same Group, namely the Moor Wood Sandstone and the Monks Park Shale.

2.7.2.5 The Moor Wood Sandstone (up to 15m thick) consists of sandstone and siltstone with intervals of shaly micaceous mudstone; the Monks Park Shale is a sequence of black mudstones (pyritic, up to 80 m thick).

2.7.2.6 Beyond the southwest boundary of the Oldbury workings and proposed extension, the Stockingford Shale Group ceases to outcrop and is overlain by the Oldbury Farm Sandstone. Although the occurrence of this unit is not continuous along the Nuneaton Ridge, it is present along the full length of the Site. This unit is partially covered by Glacial till.

2.7.2.7 To the immediate west of the northern end of the Purley workings, there is an area of Sherwood Sandstone. This appears to be a remnant of eroded Triassic cover and is likely to be of limited thickness and extent.

2.8 Meteorology

2.8.1 The relevant data for this catchment area has been obtained from the Meteorological Office and from the Flood Estimation Handbook (FEH).
2.8.2 The FEH data indicates that the long-term annual average rainfall total for the Site and its environs equates to 692 millimetres per year (mm/yr). The FEH modelling process gives a catchment design rainfall of 43.3 mm (100-year return period, 60 minutes duration).

2.8.3 The Met Office reports an annual average rainfall total of 719 mm/yr for MORECS Square 125 for the period 1971-2000. Correcting for potential and actual evaporation, the total effective rainfall (calculated by the Met Office) equates to 185 mm/yr. The most significant rainfall event recorded in this area was the storm occurring on 14\textsuperscript{th} to 15\textsuperscript{th} June 2007, when an estimated 84.3 mm fell during the storm (the return period for this event being 49 years, 28 hours duration).

2.9 Hydrology

2.9.1 Overview

2.9.1.1 The surface water features of the area are illustrated at figure 5. They were inspected during the water features survey conducted by BCL on 10\textsuperscript{th} November 2011 and reviewed on 20\textsuperscript{th} March 2014.

2.9.1.2 The Site falls within the catchment area of the River Anker. It passes \textit{circa} 1.5 km to the northeast of the Site entrance (2 km northeast of the Oldbury workings). The river drains from southeast to northwest, coming through Nuneaton and flowing to its confluence with the River Sence at NGR 431600 299200, some 1.5 km north northeast of Atherstone town centre.

2.9.1.3 The Coventry Canal, which connects Tamworth and Coventry, runs roughly parallel to the River Anker, following the foot of the Nuneaton Ridge (upon which the quarry is located). At its closest approach, the canal passes approximately 0.5 km to the northeast of the Site entrance. It is noteworthy that British Waterways has previously written to the Council with regard to the proposed quarry development. Their letter dated 31\textsuperscript{st} October 2011 (ref: BWYS-PLAN-2011-09467-1) says: “we do not consider that there will be any impact upon British Waterways”.
2.9.1.4 Several small watercourses drain the northeast-facing slopes of the Nuneaton Ridge (upon which the quarry is located). Flowing from southwest to northeast, they are directed via culvert under the Coventry Canal and continue onwards to join the River Anker. The quarry overlaps the catchment area of three such watercourses: the Rawn Hill Brook and two un-named streams, hereafter referred to as the Oldbury Stream and the Hartshill Hayes Stream.

2.9.1.5 The southern end of the Nuneaton Ridge (i.e. the ground to the south of Oldbury Camp) drains to a tributary of the Barpool Brook, which flows to the southeast into Nuneaton, then veers due east towards the River Anker.

2.9.1.6 The flatter ground (Purley Chase Golf Club) to the southwest of the Nuneaton Ridge falls outside the catchment area of the River Anker. This land lies at the head of the Bourne Brook, which drains away to the southwest then west to the River Tame.

2.9.2 The River Anker

2.9.2.1 Water quality data for the River Anker for the monitoring period 1990-2009 are published on the EA’s website.

2.9.2.2 The database includes results for the 2 km stretch of river between Nuneaton Sewage Treatment Works (NGR 433450 295800) and Mancetter Bridge (NGR 432500 297100). This covers the stretch of river receiving input from the Oldbury Stream and Hartshill Hayes Stream.

2.9.2.3 Based upon the most recent data, the EA indicates that the water chemistry in this stretch of the River is at Grade B (Good: suitable for all abstractions and for salmonid/cyprinid fisheries; supporting natural or close to natural ecosystems).

2.9.2.4 The biological classification is Grade C (Fairly Good): “Biology worse than expected for unpolluted river”.

2.9.2.5 In terms of nutrients, the concentration of nitrates is “very high” (Grade 6); the phosphate concentration is “very high” (Grade 5).
2.9.2.6  Further downstream, similar results are posted for the 2 km stretch of river between Mancetter Bridge (NGR 432500 297100) and the confluence with the River Sence (NGR 431600 299200): There is no change in chemistry, nitrates or phosphates; no biological class is given. This Rawn Hill Brook is a tributary to this stretch of river.

2.9.2.7  In the River Basin Management Plan, the current ecological quality of the river is listed as having “moderate potential” and is predicted to remain this way through to 2015. The chemical quality is expected to remain “good” through to 2015.

2.9.2.8  The EA’s Catchment Abstraction Management Strategy (CAMS) examines the “resource availability status” of the River Anker and its tributaries. The Strategy document (“Tame, Anker and Mease abstraction licensing strategy”, February 2013) describes the current status as being in the category: “water available”.

2.9.2.9  Licensed surface water abstractions must have regard to the ‘hands-off flow’ (HoF) condition. This specifies that if the flow in the river drops below 92.3 Ml/d at Polesworth, the abstraction must stop.

2.9.2.10  This does not apply to quarry dewatering, which in this instance would augment flow rate in the River Anker.

2.9.3   The Coventry Canal

2.9.3.1  Water quality data has been obtained for the 8 km stretch of canal between Barpool Brook (NGR 434800 292250) and Atherstone Top Lock (NGR 430500 297500) i.e. the stretch adjacent to the Site.

2.9.3.2  Based upon the most recent data, the EA indicates that the water chemistry in this stretch of the canal is at Grade C (Fairly Good: potable after advanced treatment and good for cyprinid fisheries/ecosystems).

2.9.3.3  The biological classification is Grade B (Good): “Biology is a little short of an unpolluted river”.
2.9.3.4 In terms of nutrients, the concentration of nitrates is “moderately low” (Grade 3); the phosphate concentration is “low” (Grade 2).

2.9.3.5 In the River Basin Management Plan, the current ecological quality of the canal is listed as having “good potential” and is predicted to remain this way through to 2015. The chemical quality “does not require assessment”.

2.9.4 **Oldbury Stream**

2.9.4.1 The upper catchment was formerly occupied by Oldbury Reservoir, which was intended to supply water to the canal but was never operational. Although still shown on OS mapping, the reservoir has been emptied and its footprint has been incorporated into the Oldbury workings.

2.9.4.2 Further west up the hillside, the upper catchment supports some isolated ponds in the vicinity of Oldbury Farm.

2.9.4.3 The two staggered ponds at NGR 430534 295238 (previously overlooking the western edge of the reservoir) were inspected during the water features survey: there was no inflow or egress from the ponds, the overflow pipe and associated ditches were dry.

2.9.4.4 These ponds fall immediately to the north of the footprint of the proposed overburden storage area for the Western Extension. They will be retained throughout the life of the development.

2.9.4.5 There are two ponds and a drainage ditch alongside the footpath running southeast from Oldbury Farm. At the time of the survey, there was no visible flow into or out of these ponds and the ditch was dry. These ponds will be adjacent to the northwest margin of the proposed overburden storage area.

2.9.4.6 Given that Oldbury Reservoir has been emptied and incorporated into the quarry, Oldbury Stream now arises within the Plant Site.

2.9.4.7 It receives all ingress waters pumped (via treatment lagoons) from the Purley and Oldbury workings.
2.9.4.8 It also takes rainfall runoff from the Plant Site, which is passed through a series of weir tanks prior to discharge.

2.9.4.9 At the time of the water features survey, the flow rate of the stream (as it exited the Site) was estimated to be *circa* 0.5 litres/second (l/s). Where the stream passes under the canal, the flow rate was seen to increase to 2-3 l/s (due to controlled overflow from the canal).

2.9.4.10 From here, the stream drains east northeast to its confluence with the River Anker.

2.9.4.11 The EA holds no water quality data for this stream and it is not included in the River Basin Management Plan.

2.9.5 **Rawn Hill Brook**

2.9.5.1 The Rawn Hill Brook rises approximately 1 km to the southwest of Purley Quarry.

2.9.5.2 Flowing northeast, its course is intercepted by the Purley workings. The brook is received by a pond as it enters the Site and is then passed under the restored workings via buried pipes.

2.9.5.3 At the eastern margin of the quarry, the pipes discharge into a weir box, with rectangular weir to allow flow gauging (the flow rate on 10th November 2011 being 3 l/s).

2.9.5.4 Downstream from here, the brook regains its natural course and flows northeast across the Outwoods/Atherstone Golf Course.

2.9.5.5 At its junction with the Coventry Canal, British Waterways has installed a sluice structure, which gives the option of diverting the stream into the canal or allowing it to continue onwards to the River Anker.
2.9.5.6  A small tributary of the Rawn Hill Brook arises in a narrow valley feature upon the northwest margin of Purley Park. The source (NGR 430759 296269) is some 90 m east of the Purley workings. The ground level at this location equates to 115 maOD. The stream flows northeast and passes under the canal before joining the Rawn Hill Brook.

2.9.5.7  The EA holds no water quality data for this stream and it is not included in the River Basin Management Plan.

2.9.6  Hartshill Hayes Brook

2.9.6.1  This brook drains the farmland to the north of Hartshill Hayes Country Park. The stream arises upon the northeast-facing hillside below the eastern margin of the Oldbury workings. The source is defined by a catchment pit (NGR 431466 295021), which is at some 215 m northeast of the quarry.

2.9.6.2  The slope above the catchment pit is characterised by areas of seepage and spring flow, which emerge between the 130-140 maOD contour lines. The closest of these features lies within 90 m standoff from the existing quarry.

2.9.6.3  Lower down the valley (some 300 m to the east of the quarry), there is a cluster of small ponds centred upon NGR 431708 294858, where ground elevation equates to 115 maOD.

2.9.6.4  At the time of the water features survey, the stream gained 1-2 l/s between the source and the outfall of these ponds.

2.9.6.5  The uppermost 0.75 km stretch of watercourse flows from west to east. Thereafter, the stream flows in a northerly direction, passing under the canal and ultimately joining the River Anker.

2.9.6.6  There is much evidence of iron staining in the watercourse.

2.9.6.7  The EA holds no water quality data for this stream and it is not included in the River Basin Management Plan.
2.9.7 **Barpool Brook**

2.9.7.1 The southern end of the Nuneaton Ridge (*i.e.* the ground to the south of Oldbury Camp) drains to a tributary of the Barpool Brook, which flows to the southeast into Nuneaton, then veers due east towards the River Anker.

2.9.7.2 The source of the brook is located at NGR 431316 294297, immediately to the south of Oldbury Grange (some 460 m standoff to the south of the existing quarry).

2.9.7.3 Approximately 100 m south of the source, there are two staggered ponds lying on the course of the stream. At the time of the water features survey, there was minimal flow between the ponds and no onward flow into the receiving (dry) ditch.

2.9.7.4 The EA holds no water quality data for this stream and it is not included in the River Basin Management Plan.

2.9.8 **Bourne Brook**

2.9.8.1 The flatter ground (Purley Chase Golf Club) to the southwest of the Nuneaton Ridge falls outside the catchment area of the River Anker. This land lies at the head of the Bourne Brook, which drains away to the southwest then west to the River Tame.

2.9.8.2 The upper catchment of the Bourne Brook includes the drainage system on the golf course and the ponds alongside the southern section of Purley Chase Lane (the closest being 150 m standoff from the proposed overburden storage area).

2.9.8.3 At the time of the survey, there was no visible ingress or outflow from these ponds. The most southerly pond has a piped connection with the nearest drainage ditch but this was dry when inspected.
2.9.8.4 The main stream arises on the southwest side of Ridge Lane – Pipers Lane. The closest section (NGR 430314 293999) is some 675 m standoff from the proposed overburden storage area in the Western Extension. At the time of the survey, this stretch was dry. It receives runoff from the road and drainage from a culvert serving the works (self-storage units) on the opposite side of the road.

2.9.8.5 In the River Basin Management Plan, the current ecological quality of the brook is listed as having “bad status” and is predicted to remain this way through to 2015. The chemical quality “does not require assessment”.

2.9.9 Flooding

2.9.9.1 EA flood mapping has been consulted to check for the risk of fluvial flooding at the quarry.

2.9.9.2 The Site does not overlap any floodplain. The risk of fluvial flooding is confined to (i) the narrow strip of land immediately adjacent the River Anker and (ii) the confluence of the Rawn Hill Brook with the main river. There is some 30 m height difference between the closest stretch of floodplain (75 maOD) and the settlement facilities at the Site entrance (105 maOD).

2.9.9.3 Based upon flood risk guidance published by the EA, it is evident that any site-specific flood risk assessment should check that downstream flooding problems are not exacerbated by run-off from the Application Area.

2.9.9.4 Section 4.4 outlines the various measures that should be implemented to ensure that the proposed development does not exacerbate the risk of flooding downstream.

2.9.10 Pollution Incidents

2.9.10.1 Local pollution incidents are posted on the EA website.
2.9.10.2 Incident Number 422137 (16th May 2006) involved a “significant release of contaminated water” at NGR 430776 296578. This location is some 215 m northeast of the Purley workings and falls within the catchment of the Rawn Hill Brook.

2.9.11 Local Surface Water Abstractions

2.9.11.1 Details were obtained from the EA of licensed surface water abstractions within 3 km radius of the Oldbury workings, centred on NGR 430745 294858 (appendix 2). The locations of these abstractions are illustrated in figure 6.

2.9.11.2 Dobbies Garden Centres plc hold two licences (03/28/19/0066 and 0067) for abstracting surface water from the River Anker (NGR 4330 2961) and an adjacent lagoon (NGR 4329 2959), the latter being sited upon sand and gravel drift deposits atop the Mercia Mudstone Group. The water is used for spray irrigation. The closest of these abstraction points is some 1.85 km to the northeast of the Oldbury void.

2.9.11.3 W S Dugdale Farm Partnership abstract surface water from the Merevale Lake (NGR 4300 2970) and one of its feeder streams, the Innage Brook (NGR 42986 29660). This activity is covered by two licences (03/28/21/0020 and 0033). The water is used for spray irrigation and throughflow in the lake. At its closest approach, the lake is some 450 m to the north of the restored Purley workings.

2.9.11.4 There are no other licensed surface water abstractions in the radius of search.

2.9.11.5 The private water supplies register held by North Warwickshire Borough Council has been consulted (appendix 3).

2.9.11.6 All private water supplies are listed as being taken from wells (section 2.10.4.5).
2.10 Hydrogeology

2.10.1 Regional Hydrogeology

2.10.1.1 The quarry excavations extend along the outcrop of a series of diorite (lamprophyre) sills of Ordovician age. These igneous intrusions occur within the Outwoods Shale Formation, part of the Stockingford Shale Group. Coupled with the Hartshill Sandstone Formation (Lower Cambrian) and Caldecote Volcanic Formation (Precambrian), these solid strata comprise a Secondary B Aquifer with low groundwater vulnerability.

2.10.1.2 On a regional scale, the volcanic rocks and shales are mapped as impermeable, generally without significant groundwater except at shallow depth. The rocks have been deformed tectonically and are highly indurated. Groundwater is confined to sub-surface weathered zones and joint systems.

2.10.1.3 The EA do not hold any groundwater level or quality data for this Secondary B Aquifer.

2.10.1.4 To the southwest of the Site, the Stockingford Shale Group is over-stepped by the Oldbury Farm Sandstone Formation (Upper Devonian). This, in turn, is overlain by Carboniferous strata (the Millstone Grit Group and the Coal Measures). These strata are classed as a Secondary A Aquifer (i.e. an aquifer with limited or local potential).

2.10.1.5 The above strata comprise a rhythmic sequence of shales, seatearths, coals, sandstones and limestones. The latter two display some minor fissure flow. Minewaters from the Coal Measures tend to be ferruginous and acid.

2.10.1.6 The EA has supplied groundwater level data for Robinson’s End Cottage (NGR 43175 29106), which is some 3.7 km south of the Site. The complete record extends from 29.11.1972 to 27.02.2014. Since the mid-1980s, the groundwater level in the Carboniferous strata at this location has remained relatively stable, equating to 118-120 maOD.
2.10.1.7 The EA do not hold any groundwater quality data for the aquifer local to the quarry.

2.10.1.8 The drift deposits in the Anker Valley (and the narrow ribbons of alluvium alongside the Rawn Hill Brook and Hartshill Hayes Brook) are classed as Secondary A Superficial Aquifers.

2.10.1.9 In the River Basin Management Plan, the above aquifers are treated as a “Secondary Combined” unit. The current quantitative quality of the groundwater is listed as being “good” and is predicted to remain this way through to 2015. The chemical quality is expected to remain “poor” through to 2015.

2.10.1.10 The EA’s Catchment Abstraction Management Strategy (CAMS) examines the “resource availability status” in local groundwater bodies.

2.10.1.11 The Strategy Document (“Tame, Anker and Mease abstraction licensing strategy”, February 2013) does not cover the groundwater system encountered on Site, because the volcanic rocks and shales are generally without significant groundwater except at shallow depth.

2.10.2 Groundwater Levels and Flow Direction on Site

2.10.2.1 Monitoring Network

2.10.2.2 In preparation for the hydrogeological report completed in 1999 (section 1.3.2.xvi), seven monitoring stations were installed at the quarry in 1996 in order to give a record of groundwater level in the economic mineral (i.e. the shales and diorite sills). The locations of the monitoring stations (PZ 1/96 through to 7/96) are illustrated at figure 7.

2.10.2.3 Three of the above stations are classed as “standpipes” because they extend through a number of shale and igneous strata with a continuous gravel filter from top to base. The other four stations are true piezometer installations: they sample from one specific horizon and the gravel filter is sealed above and below the sample horizon.
2.10.2.4 A summary of the information collected from the monitoring stations is presented at table 1 below, which includes all known installation details (no borehole logs are available). The data used in the 1999 report is presented as a series of hydrographs in appendix 4.

2.10.2.5 A further three standpipes (PZ 1/01, 2/01 and 3/01) were installed in 2001. Again, summary details are presented at table 1 (no borehole logs are available). The locations of these standpipes are included upon figure 7.

2.10.2.6 For an improved understanding of current groundwater conditions, Piezometers M95-11-001 (deep) and M95-11-001 (shallow) were installed as a Twin Installation at the northern end of the proposed Western Extension Area; and Piezometers M95-10-003 and M95-10-003b were sited towards the southern end of the proposed development. These were completed in late 2010 / early 2011 under the supervision of the Applicant. Their locations are illustrated at figure 7. Borehole logs are reproduced in appendix 5.

2.10.2.7 In table 1, the 1st column of water level data is the average value taken from date of drilling up to October 2011, including initial readings in the M95 piezometers. The final column shows the average water levels recorded over the last 4 years.

2.10.2.8 Table 1: Summary details of the information gleaned from Site piezometers

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</table>
2.10.2.9 All groundwater level data collected from the monitoring network for the period 2005 onwards is presented in appendix 6.

2.10.2.10 Groundwater level data has also been obtained from a monitoring location referred to as “Holgate Hole” (table 1 and figure 7). This is a deep manhole chamber designed to receive drainage from the tip at the northern end of the Purley workings. Drainage pipes lead into the chamber and an overflow conveys water to the sump upon the floor of the Purley void, from where the water is pumped over to the treatment lagoons in Oldbury (as detailed in section 3.2.2).

2.10.2.11 As such, Holgate Hole does not give a true representation of groundwater level and is therefore excluded from the assessment of the piezometer data.

2.10.2.12 Interpretation of piezometer data in Purley workings

2.10.2.13 Since submission of the 1999 report, only one piezometer (PZ 5/96) has remained active in the Purley workings.

2.10.2.14 Therefore, the assessment of groundwater levels in the Purley void (which is close to being fully restored) relies to a large degree upon information taken from that report i.e. data collected between 1996 and 1998.
2.10.2.15 The data collected from the main sill (PZ 6/96 and 7/96) was considered to be indicative of a relatively gentle hydraulic gradient to the north. Groundwater levels in the sill declined from 116.5 to 113 maOD across the northern half of the void.

2.10.2.16 The groundwater levels observed in the shales (PZ 4/96 and 5/96) did not appear to be affected by quarry dewatering. At the centre of the workings, the water level in the shales equated to 120 maOD, some 3.5 m higher than that observed in the main sill. The conclusion was that the hydraulic interconnection between the various strata was incomplete.

2.10.2.17 Restoration water level in the Purley workings

2.10.2.18 Prior to the 1999 investigation, dewatering had ceased in the main excavations at Purley and the void space filled to 118.2 maOD. It was considered that this was representative of long-term equilibrium.

2.10.2.19 However, it is noteworthy that the abstraction activities in the Oldbury workings may have had some bearing on the lake level in the Purley void in 1999.

2.10.2.20 Subsequent to this, the dewatering operation at Oldbury was scaled down and the water level in the Oldbury sump rose from 100.6 maOD (June 1999) up to 122.8 maOD (May 2001). During the same time period, the groundwater level in PZ 5/96 (the only surviving piezometer in Purley) rose by 1.5 m and a response of similar magnitude would be expected in the Purley sump, such that water level would rise to circa 120 maOD.

2.10.2.21 Upon completing the Western Extension, the proposed restoration landform (drawing M095_00050) will involve allowing the Oldbury void space to fill with water to a controlled level of 122 maOD i.e. roughly the same as what was established in May 2001.

2.10.2.22 Thus, taking a conservative approach, it is anticipated that the long-term water level at Purley would equate to some 120 maOD unless control measures (pumping/overflow) are put in place.
2.10.2.23 In the final restoration at Purley, the intention is to continue pumping water over
to Oldbury or (depending upon water quality) allow controlled overflow to the
Rawn Hill Brook. This will involve suppressing the water level at 115 maOD i.e.
5 m drawdown will be required throughout the life of the proposed development
and in perpetuity.

2.10.2.24 **Face inspection in the Oldbury workings**

2.10.2.25 At the time of the 1999 report, groundwater seepage was principally occurring
along the lowermost contact of the main sill in the eastern excavation slope. Other
seepages were present at the interface of minor sills/shales in the western
excavation slope and from the toe of the tip at the southern end of the quarry
floor.

2.10.2.26 A similar assessment of ingress/seepage processes was undertaken on the 15th
February 2011, concentrating upon the section of quarry face that will be
advanced into the Western Extension Area.

2.10.2.27 A number of significant seepages were observed to occur from the southwest
quarry face at an elevation of approximately 115 maOD (some 15 m above the
upper surface of the diorite outcrop).

2.10.2.28 These seepage areas contributed to ingress to the quarry sump of approximately 2
l/s. Additional areas of ingress were also observed from the south-eastern (5 l/s)
and southern sections (3 l/s) of the inspected face, as illustrated upon figure 8.

2.10.2.29 The above seepage is sourced from the shales overlying the main sill. As the
quarry face progresses into the extension area, the movement of groundwater
within these shales will depend upon the degree and interconnectivity of
fracturing within the strata.

2.10.2.30 By contrast, the diorite appears much less fractured and no significant
groundwater ingress was seen to be coming from the main sill.

2.10.2.31 The above observation of seepage processes suggests that the groundwater within
the shale is perched on top of the lower permeability diorite.
2.10.2.32 Interpretation of piezometer data in Oldbury workings

2.10.2.33 Evidence/data obtained from the M95 piezometers (i.e. those sited within the extension area) lends support to the conclusion that the hydraulic interconnection between the shales and igneous strata is incomplete.

2.10.2.34 At M95-11-001s (northern end of the extension area), the average groundwater level in the shales (139 maOD) is some 2 m above that in the main diorite sill (M95-11-001d).

2.10.2.35 At M95-10-003b, which is close to the southern end of the proposed development, the average groundwater level in the minor diorite sill has declined by 10 m since the date of installation, dropping from 147.41 maOD to 137.46 maOD in response to quarry dewatering. In contrast, the average water level in the underlying shales (M95-10-003) has remained relatively steady at 148.0-148.5 maOD.

2.10.2.36 This difference in reaction to quarry dewatering illustrates the poor hydraulic interconnection between the shales and igneous strata at this location. Further evidence is provided by comparing the seasonal behaviour of the two piezometers, with the diorite showing a more marked response to rainfall.

2.10.2.37 The other monitoring stations in the Oldbury workings are classed as “standpipes” because they extend through a number of shale and igneous strata with a continuous gravel filter from top to base. These stations include PZ 1/96 (southeast of existing void space; average groundwater level at 129.55 maOD), PZ 2/96 (northeast of void with water level at 129.5 maOD) and PZ 3/01 (north of void with water level at 124.05 maOD).

2.10.2.38 The quarry face will extend through various igneous and shale horizons in the Western Extension. Therefore, it is not unreasonable to make an estimate of groundwater level using the standpipe approach.

2.10.2.39 If standpipes had been installed at M95-11-001 and M95-10-003, it is estimated that average groundwater level (pre-quarrying) would equate to 137.7 maOD and 147.7 maOD respectively.
2.10.2.40 The above information is shown on a groundwater level contour plan in figure 9.

2.10.2.41 Triangulating between the Oldbury standpipes, it is inferred that the pre-development groundwater flow direction is from southwest to northeast i.e. towards the Anker valley. This ignores the pumped water level in the Oldbury sump, where a localised cone of depression would be superimposed upon the above pattern.

2.10.2.42 Within Oldbury Quarry, the only piezometer spanning the entire monitoring period (1996 to date) is Piezometer PZ 2/96. Correcting for the effects of dewatering, seasonal variations of some 5-7 m are typically encountered at this location.

2.10.2.43 The other hydrographs are incomplete (appendix 4) but there is sufficient overlap to conclude that the other Oldbury monitoring points would show a similar seasonal response.

2.10.2.44 **Restoration water level in the Oldbury workings**

2.10.2.45 The levels recorded within the Site piezometers suggest groundwater to reside at around 150 maOD in the area to the southwest of the Oldbury void and 130 maOD in the area to the northeast (figure 9).

2.10.2.46 Historic sump water levels recorded since 2000 show levels to have varied between 122.8 maOD (May 2001) and the current minimum of 82 maOD. Site management advises that the maximum water elevation coincided with a period when pumping from the sump was reduced, although some abstraction was periodically made.

2.10.2.47 Extrapolation of the groundwater levels recorded within the Site piezometers suggests the natural restoration water level would occur at around 130-135maOD within the Oldbury void. However, the proposed restoration landform will create a low point of 122 maOD at the northern lip of the quarry void; hence under the proposed configuration this would be expected to act as the upper limit on surface water levels in the flooded void.
2.10.3 Hydraulic Conductivity

2.10.3.1 The 1999 report looked at summer pumping rates from Oldbury Quarry and assumed no input from rainfall. This mass balance approach produced an estimated hydraulic conductivity value of some 0.02 metres/day (m/d), treating the shales and diorite sills as a single aquifer unit.

2.10.3.2 As part of the current investigation, a series of falling head tests have been undertaken upon selected piezometers at the Site, which allow for quantitative analysis of the hydraulic parameters of the economic mineral.

2.10.3.3 The falling head test comprises the introduction of a slug of water to the piezometer and the measurement of the ensuing change in groundwater level. The rate of change in water level is used to determine the hydraulic conductivity of the \textit{in situ} rock strata.

2.10.3.4 The data was analysed using the Bouwer & Rice method, which is detailed in “Analysis and evaluation of pumping test data”, Kruseman and de Ridder, 1990. This method is utilised where the change in groundwater level occurs above the screened section of piezometer.

2.10.3.5 The results of the tests are summarised in \textit{table 2}.

\begin{table}
\centering
\begin{tabular}{|c|c|c|c|}
\hline
Piezometer & \textbf{Hydraulic conductivity (m/d)} & & \\
\hline & Maximum & Minimum & \\
\hline M95-10-003 & 1.000 & 0.200 & Shale above main sill \\
M95-10-003b & 0.700 & 0.100 & Minor (upper) sill \\
PZ 2/36 (Test 1) & 0.016 & 0.011 & Shale below main sill \\
PZ 2/36 (Test 2) & 0.018 & 0.011 & Shale below main sill \\
\hline
\end{tabular}
\end{table}

2.10.3.6 The raw data and calculations are presented in \textit{appendix 7}.

2.10.3.7 The hydraulic conductivity data presented above is consistent with published data (Domenico and Schwartz, 1990, “Physical and Chemical Hydrogeology”, p65).
2.10.4 Local Groundwater Abstractions

2.10.4.1 There are no licensed groundwater abstractions or Groundwater Source Protection Zones within the search area (i.e. within 3 km radius of the Oldbury workings, centred upon NGR 430745 294858).

2.10.4.2 The private water supplies register held by North Warwickshire Borough Council has been consulted (appendix 3). Again, the search area covered 3 km radius of the Oldbury workings.

2.10.4.3 There are 4 private water supplies listed as being taken from wells/boreholes. Their locations are highlighted upon figure 6.

2.10.4.4 As part of the water features survey, these properties were visited to check the status of their water supplies.

2.10.4.5 The findings are summarised in table 3.

<table>
<thead>
<tr>
<th>Location</th>
<th>Easting</th>
<th>Northing</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lady Wood Farm</td>
<td>429820</td>
<td>294350</td>
<td>6-inch borehole feeds 25 mm pipe, drilled 2008 through clay and into sandstone, not used for house, only for agricultural uses. Dip at 14.4 m below datum (~14.2 m below ground level), plumbed at ~30.45 m below datum. Water is discoloured (reddish), having silt troubles. Land originally belonged to the Coal Board</td>
</tr>
<tr>
<td>Canal Cottage</td>
<td>431480</td>
<td>296290</td>
<td>Hand-dug well, approx 3 ft wide, sole water source for cottage. Dip at 1.7 m below ground level, plumbed at ~4.5 m below ground level. Suction pump installed at surface with non return valve, regularly fails as a water supply possibly due to pump installation being unsuitable or due to being installed in shales (according to BGS map). Resident is Mr Lewis, wants mains connection.</td>
</tr>
<tr>
<td>Railway Cottage</td>
<td>431806</td>
<td>296409</td>
<td>Hand-dug well with submersible pump, approx 2 ft wide. Dip at 5.19 m below datum (~4.7 m below ground level), plumbed at ~9 m below datum. Sole water supply for cottage, reliable and consistent supply (probably installed in Triassic sandstones).</td>
</tr>
<tr>
<td>Spring Farm</td>
<td>432197</td>
<td>296009</td>
<td>Well, used for domestic supply, no mains water, old well, likely hand-dug, no access as farmer not available.</td>
</tr>
</tbody>
</table>

2.10.4.6 The supply at Lady Wood Farm lies in closest proximity to the extension area, being circa 1 km standoff to the southwest of the proposed limit of extraction. The water supply is sourced from a sandstone formation, which is separated from the economic mineral by the Oldbury Farm Sandstone Formation, the Millstone Grit and the Coal Measures.
2.10.4.7 The other private supplies are located 1.0-1.5 km to the northeast of the existing Oldbury void (i.e. the opposite side from the proposed extension area). There will be no reduction in standoff.

2.10.4.8 Dependent upon agreeing access rights, it is recommended that the monitoring programme be expanded to include checking groundwater level in the closest wells (together with the Site piezometers).

2.10.5 Water Quality

2.10.5.1 Overview

2.10.5.2 Site experience shows that there will continue to be significant acidification of ingress water within the quarry workings, particularly where such water infiltrates overburden tips, erodes exposed sections of bedrock and accumulates within exhausted sections of the quarry.

2.10.5.3 The acidification process is due to natural chemical decomposition of sulphide minerals being weathered and flushed out of the diorite sills and country rock.

2.10.5.4 The water collecting in the base of the workings has a low pH (down to 4), high sulphate content and significant concentration of metals (iron, aluminium, zinc, manganese, nickel, cadmium and, to a lesser extent, copper).

2.10.5.5 As a consequence of the above issue, the ingress water is directed through a treatment system (section 3.2.3) prior to being discharged off Site. This includes the option for lime dosing, when required. The system, which deals with the combined input from Purley and Oldbury, is located upon high ground (130 maOD) at the northern end of the Oldbury void.

2.10.5.6 An assessment of water quality being discharged off Site (and the attendant risk of impact upon the receiving waters) is the subject of a separate report: “Biotic Ligand Modelling of Heavy Metals (Cadmium, Nickel & Zinc) in the Discharge Waters at Mancetter Quarry”, BCL, May 2014 (hereafter: the BLM report).

2.10.5.7 A copy of the BLM report is included in appendix 8.
2.10.5.8 Water quality data for the Oldbury workings

2.10.5.9 The 1999 report includes various data (“typical water analysis results”) for the Oldbury discharge point (but no data for the Oldbury sump).

2.10.5.10 According to the above report, the pH of the water at the discharge point equated to 7.7 after treatment, while the concentration of aluminium was given as 0.16 mg/l. Other “typical results” include iron (0.28 mg/l), copper (0.01 mg/l), zinc (0.04 mg/l) and nickel (0.11 mg/l).

2.10.5.11 Historic data retrieved from the Applicant’s archives (1999-2001) gives a preliminary indication of extant water quality within the Oldbury workings.

2.10.5.12 The pH of the water in the sump ranged from 4.1 to 7.4 during the above monitoring period; the concentration of aluminium was generally less than 1.5 mg/l (with a single outlier at 7.4 mg/l).

2.10.5.13 Summary information regarding current requirements for treating the water arising in the Oldbury void is given in section 3.2.3. For full details, please refer to the BLM report contained in appendix 8: “Biotic Ligand Modelling of Heavy Metals (Cadmium, Nickel & Zinc) in the Discharge Waters at Mancetter Quarry”.

2.10.5.14 Water quality data for the Purley workings

2.10.5.15 The 1999 report includes “typical water analysis results” for the Purley sump.

2.10.5.16 More recently, the Applicant has collected 7 sets of water quality data from the Purley sump with a view to assessing options for treating the acidic water being generated in the restored void.

2.10.5.17 The initial round of monitoring was undertaken in October 2009. Further sampling was completed on a monthly basis between December 2010 and May 2011.

2.10.5.18 In terms of problem species, the water quality data for the Purley sump is presented in table 4.
2.10.5.19 For comparison, samples have also been collected from the Rawn Hill Brook, the sample point (NGR 430595 296457) being the outfall from the buried pipes that convey the stream across the Site.

2.10.5.20 It is noteworthy that these pipes may be at risk of corrosion because they are buried in spoil, which is prone to generating acidic waters. In the long term, consideration should be given to engineering the pipes to be above ground (or constructing a lined channel) to avoid any possibility of leachate ingress.

2.10.5.21 The relevant data for Rawn Hill Brook are tabulated below (table 5).

<table>
<thead>
<tr>
<th>Date</th>
<th>SO₄ (mg/l)</th>
<th>Fe (mg/l)</th>
<th>Al (mg/l)</th>
<th>Cu (mg/l)</th>
<th>Zn (mg/l)</th>
<th>Mn (mg/l)</th>
<th>Ni (mg/l)</th>
<th>Cd (mg/l)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999 report</td>
<td>1.11</td>
<td>0.16</td>
<td>0.010</td>
<td>0.02</td>
<td>1.57</td>
<td>0.02</td>
<td>7.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21-Oct-09</td>
<td>1260</td>
<td>0.09</td>
<td>0.1</td>
<td>0.001</td>
<td>1.05</td>
<td>0.065</td>
<td>6.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21-Dec-10</td>
<td>213</td>
<td>0.01</td>
<td>0.75</td>
<td>0.002</td>
<td>0.82</td>
<td>4.26</td>
<td>7.6</td>
<td>0.655</td>
<td>0.00009</td>
</tr>
<tr>
<td>29-Jan-11</td>
<td>145</td>
<td>2.17</td>
<td>1.66</td>
<td>0.003</td>
<td>0.095</td>
<td>2.25</td>
<td>7.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23-Feb-11</td>
<td>96</td>
<td>0.79</td>
<td>1.005</td>
<td>0.044</td>
<td>1.65</td>
<td>0.617</td>
<td>7.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23-Mar-11</td>
<td>124</td>
<td>0.01</td>
<td>0.15</td>
<td>0.001</td>
<td>0.020</td>
<td>1.41</td>
<td>7.6</td>
<td>0.622</td>
<td>0.00009</td>
</tr>
<tr>
<td>28-Apr-11</td>
<td>109</td>
<td>0.23</td>
<td>0.001</td>
<td>0.041</td>
<td>1.11</td>
<td>0.615</td>
<td>7.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31-May-11</td>
<td>74</td>
<td>0.33</td>
<td>0.42</td>
<td>0.001</td>
<td>0.020</td>
<td>0.62</td>
<td>7.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>289</td>
<td>0.5</td>
<td>0.57</td>
<td>0.003</td>
<td>0.045</td>
<td>1.71</td>
<td>0.030</td>
<td>0.00011</td>
<td>7.4</td>
</tr>
</tbody>
</table>

The data have been compared with the relevant Environmental Quality Standards (EQS), where available. The Non-Statutory Freshwater EQS for manganese is 0.03 mg/l (annual average) up to 0.3 mg/l (maximum acceptable concentration).

2.10.5.23 From the available data, it is evident that water quality in the Rawn Hill Brook generally complies with the EQS, with the exception of nickel (marginal non-compliance) and manganese (exceeding the maximum acceptable concentration by up to a factor of 13).
2.10.5.24 In contrast, the results for Purley Sump (sulphate, iron, aluminium, zinc, manganese, nickel, cadmium and pH) are consistently in excess of the EQS, while the copper data is marginal.

2.10.5.25 The most visible source of the problem is the ochreous water seeping from the tip at the northern end of the Purley workings. A deep manhole chamber (Holegate Hole) has been installed to receive these waters. This chamber discharges to the sump upon the floor of the Purley void. The sump is also likely to receive sub-surface flow and contaminant loading from the backfill material at the southern end of the Purley workings.

2.10.5.26 From here, the water is pumped over to the treatment lagoons in Oldbury (as detailed in section 3.2.3). The associated impact upon the quality of the water discharged off site is examined in the BLM report (appendix 8).
3 SITE ACTIVITIES

3.1 Mineral Extraction

3.1.1 The four working phases and final restoration of the quarry are detailed upon the following development plans:


3.1.2 Extraction operations will start at the southern tip of the extension area and progress northwards. The final floor will be at 50 maOD, some 20 m below current workings.

3.1.3 A significant proportion of the extension area (17 Ha) will be utilised to create a permanent screening/mounded landform (as illustrated upon Drawing No. M095_00050). This Western Landform will accommodate in the region of 1.5 million m$^3$ of overburden and shale.

3.1.4 The final restoration objective involves allowing the Oldbury void to fill with groundwater up to a level of 122 maOD, which will be controlled by gravity discharge (via treatment lagoons) to the existing consented discharge point and onwards into the watercourse adjacent to the Plant Site.
3.2 Water Management

3.2.1 Current Dewatering Requirement in the Oldbury Workings

3.2.1.1 All ingress waters (*i.e.* rainfall runoff as well as groundwater input) drain under gravity into the quarry sump (70 maOD). This allows for preliminary settlement of any suspended solids entrained in the rainfall runoff from the incoming stretch of haul road as well as from the benches and overburden tips.

3.2.1.2 The water is removed from the quarry void using a 6-inch pump.

3.2.1.3 Site management advise that the pump is only operated for 6 hours per day during the summer months. In contrast, following a period of inactivity (*e.g.* a Bank Holiday), the pump will be run for up to 24 hours per day, particularly in the wetter months (or following storm events).

3.2.1.4 On this basis, it is estimated that water is abstracted at a rate of between 650 m$^3$/d and 2,600 m$^3$/d, depending upon the operating schedule and rainfall conditions. The water level in the sump is maintained at a fixed depth (+/- 1 m).

3.2.1.5 A flow meter has been fitted on the discharge from the quarry sump to provide a more reliable measure of current abstraction levels. The meter was installed on 17th April 2011, set at zero. Readings are taken on a monthly basis.

3.2.1.6 The readings that have been collected since installation are consistent with the estimated data given in section 3.2.1.4.

3.2.1.7 Averaged over the entire period (17th April 2011 to present), the daily rate of pumping (as derived from the flow meter readings) equates to 950-1,000 m$^3$/d.

3.2.1.8 The maximum pumping rate (1,960 m$^3$/d) occurred during the winter period 20th December 2013 to 31st March 2014, when there was a prolonged spell of unusually heavy rainfall.

3.2.1.9 The water from the quarry void is pumped to 2-stage treatment lagoons situated upon higher ground (130 maOD) at the northern end of the Oldbury void. These lagoons have a combined surface area of *circa* 4,000 m².
3.2.1.10 The current treatment process is detailed in section 3.2.3.

3.2.1.11 Having passed through the lagoons, the water is piped to the consented discharge point (section 3.2.1.13) and released into the receiving watercourse, the Oldbury Stream.

3.2.1.12 These dewatering operations are undertaken in accordance with Discharge Consent T/19/35436/T.

3.2.1.13 Under this consent, water is discharged to Oldbury Stream (“a tributary of the River Anker”) via an outlet and sampling point (“Outlet B”) at NGR 431230 295950.

3.2.1.14 The maximum permitted rate of discharge is 5,237 m$^3$/day. The limit for suspended solids equates to 50 milligrammes per litre (mg/l) and pH should be between 6-9. Aluminium must be restricted to less than 1 mg/l and iron should be less than 5 mg/l. The discharge must be non-injurious to fish and must contain no visible signs of oil or grease.

3.2.2 Ingress Waters within the Restoration Landform at Purley

3.2.2.1 As detailed in appendix 9, the Purley landform is dewatered by means of two electro-pumps (on floats, operated automatically). There is a diesel pump on standby, activated automatically if the other pumps fail. In such event, a telemetry system will alert Site management.

3.2.2.2 Site management has been monitoring the rate of pumping from Purley to Oldbury. The programme as described in 2012 (appendix 9) continues to be operated on the same basis i.e. the average rate of abstraction equates to 300 m$^3$/d.

3.2.2.3 Previously this water would have been pumped direct to the Oldbury sump. Now, pumped discharge from Purley is piped into a stone-filled hollow adjacent to the Oldbury haul road, some 50 m to the east of the Oldbury treatment lagoons (section 3.2.1.9), to be channelled alongside the haul road and down into the Oldbury sump.
3.2.2.4 The Applicant holds a consent allowing direct discharge of water from the Purley void to the Rawn Hill Brook. This consent has not been used for discharging “pumped quarry water” during current ownership of the Site.

3.2.2.5 Under this consent (T/19/07655/T), the Applicant has the option to discharge to Rawn Hill Brook (“a tributary of the River Anker”) via an outlet located within “grid square” 43 0400 29 6200.

3.2.2.6 The maximum permitted rate of discharge is 455 m³/day. The limit for suspended solids equates to 50 mg/l and pH should be between 5-9. Non-volatile matter extractable by light petroleum must be restricted to less than 5 mg/l.

3.2.3 Treatment Process: Combined Input from Oldbury and Purley

3.2.3.1 In order to ensure that the pumped water achieves acceptable discharge standards, the pH must be raised to between 6-9 and the concentration of dissolved metals (aluminium and iron) must be reduced to the limits specified in the Discharge Consent.

3.2.3.2 When “lime” (calcium hydroxide) is added to the water in the Oldbury sump, it neutralises the acidity and raises the pH, such that the dissolved metal ions precipitate out as metal hydroxides.

3.2.3.3 Historically (pre-2001), if 50% of the pumped water was sent via the lime dosing plant and the remainder was left untreated, then the combined water being discharged off Site was found to comply with the Consent.

3.2.3.4 The process was found to be most efficient if the lime-dosed water was returned to the lower depths of the water-filled sump. Any discharge would be taken from near the surface and away from the tips/shale slopes. This minimised the risk of re-acidification.

3.2.3.5 Laboratory analysis showed that 150 g/m³ of calcium hydroxide were needed to raise the pH of the incoming Purley water to comply with the pH range in the Discharge Consent (pH 6-9). In practice, the dosage was increased to 200 g/m³ in order to combat the risk of re-acidification.
3.2.3.6 The supplier of the dosing plant warned that the over-application of calcium hydroxide could cause the pH to rise above 9.5, risking re-mobilisation of the aluminium hydroxide.

3.2.3.7 The lime dosing facility has rarely been required since the change in discharge arrangements at Purley, whereby water is now pumped into a stone-filled hollow adjacent to the Oldbury haul road (rather than direct discharge to the Oldbury sump).

3.2.3.8 It is considered that the poorest quality water is being diluted/attenuated in its sub-surface passage through the stone-filled hollow, channelling onwards to the Oldbury sump.

3.2.3.9 The discharge infrastructure includes an automated device for monitoring pH levels. If the pH fails to comply with the standards specified in the Consent, the discharge is automatically shutdown until the problem is rectified.

3.2.4 Drainage in the Plant Site

3.2.4.1 Runoff from the Plant Site is collected in a number of catchment pits for use in process, with any excess waters being directed to the lagoon system below the quarry office.

3.2.4.2 There will be no change in the Plant Site catchment area i.e. surface materials and gradients will stay the same. The drainage process is already authorised by Discharge Consent T/19/35437/T.

3.2.4.3 Under this consent, “Site Drainage” is discharged to Oldbury Stream (“a tributary of the River Anker”) via “Outlet A” at NGR 431220 295920.

3.2.4.4 The limit for suspended solids equates to 50 mg/l and pH should be between 6-9. The discharge must be non-injurious to fish and must contain no visible signs of oil or grease.

3.2.4.5 The impact of the “Outlet A” discharge process upon the quality of the receiving waters is examined in the BLM report (appendix 8).
4 IMPACT ASSESSMENT & RECOMMENDATIONS FOR MITIGATION

4.1 Background

4.1.1 Baseline assessment has facilitated a conceptual understanding of the extant groundwater and surface water regimes operating within and around the Site. This understanding has been applied to assess the potential impacts posed by the Proposed Development upon the water environment.

4.1.2 In common with other quarrying operations of this type and scale, it is considered that the Proposed Extraction Areas and Restoration Landform have the potential to impact upon the water environment in the following primary ways:

- Interception of groundwater causing a modification of groundwater levels and flow rates within and surrounding the area from which mineral is to be extracted, both during and following workings.
- Derogation of existing groundwater quality.
- Derogation of surface water quantity and quality.
- Modification of existing flooding characteristics.

4.2 Potential Modification of Groundwater Regime

4.2.1 As outlined in section 2.10, the quarry strata (volcanic rocks and shales) are mapped as impermeable, generally without significant groundwater except at shallow depth (where it is confined to sub-surface weathered zones and joint systems).

4.2.2 The groundwater levels recorded within the Site piezometers suggest groundwater to reside at around 150 maOD in the area to the southwest of the Oldbury void and 130 maOD in the area to the northeast (figure 9).

4.2.3 It is inferred that the pre-development groundwater flow direction was from southwest to northeast i.e. towards the Anker valley.
4.2.4 The contours shown on figure 9 should not necessarily be viewed as representing a conformable watertable within the economic mineral; instead (as stated above) they are considered to be representative of groundwater moving through a diffuse network of small joints and fissures.

4.2.5 The results derived from falling head tests indicate that the hydraulic conductivity of the economic mineral is likely to average 0.015 m/d. This data was obtained from PZ 2/96, a standpipe piezometer extending from the main sill into the underlying shales, which is analogous with the mixed rock types exposed in the quarry void.

4.2.6 Site experience (i.e. the current pumping requirement in Oldbury) suggests that a more representative value for the hydraulic conductivity of the economic mineral would be 0.035 m/d.

4.2.7 The final floor level in the proposed development will extend down to 50 maOD (i.e. 20 m below current floor level).

4.2.8 Averaged across the Oldbury void, a pre-development groundwater level of 135 maOD has been adopted for the purpose of this assessment. This is an interpolated level, based upon the groundwater level contour plan presented upon figure 9.

4.2.9 Comparing groundwater level (135 maOD) with floor level in the deepest part of the workings (50 maOD), it is evident that there will be a requirement for 85 m depth of dewatering drawdown to maintain dry workings in the final development. It is noteworthy that the bulk of this drawdown (65 m) has already been established as a result of the current development.

4.2.10 The water from the quarry sump will be pumped to the 2-stage settlement lagoons described in sections 3.2.1 and 3.2.3.

4.2.11 To aid quantification of the degree of risk posed to potential receptors as a result of the predicted lowering of groundwater levels, calculations have been undertaken to establish the radius of influence of dewatering drawdown. These calculations are presented in appendix 10.
4.2.12 Utilising the most representative value for hydraulic conductivity gained from Site experience (0.035 m/day), it is estimated that a radius of influence of *circa* 165 m will be associated with dewatering drawdown in the final development. This means that quarry-related lowering of groundwater levels is unlikely to extend greater than 165 m from the toe of the quarry face in the deepest sinking.

4.2.13 *Appendix 10* includes calculation of the potential groundwater ingress rate associated with the final development (where floor level extends to 50 maOD). The estimated rate is in the region of 900 m$^3$/day.

4.2.14 To check the accuracy of the calculations, they were repeated for the current floor level (70 maOD), keeping all other input parameters unchanged. In this example, the groundwater ingress rate is calculated to be in the region of 630 m$^3$/day.

4.2.15 This is backed up by current experience within the Oldbury void. Site management advise that, during dry days in the summer period, the 6-inch pump is generally operated for 6 hours per day and the estimated throughput equates to 650 m$^3$/day.

4.2.16 Furthermore, the calculations are consistent with the flow meter readings presented in *sections 4.2.23 to 4.2.24*, where the average daily rate is 950-1,000 m$^3$/day. Of this total, some 300 m$^3$/day would be derived from incident rainfall; thus, the remainder (650-700 m$^3$/day) is attributed to groundwater ingress.

4.2.17 Within the extended quarry void, the average rainfall run-off rate will increase to approximately 770 m$^3$/day, 490 m$^3$/day of which will come from the Western Extension. This is based upon a catchment area of 47.9 hectares and effective rainfall rate of 49.6 mm/month (using MORECS data for January, the wettest month of the MORECS year).

4.2.18 Adding together the groundwater input of 900 m$^3$/day (*section 4.2.13*) and rainfall input of 770 m$^3$/day (*section 4.2.17*), this indicates that an average ingress rate of some 1,670 m$^3$/day (19.5 l/s) will be draining into the void in the final development and will need to be accommodated in the water management system (*section 4.3.1*).
4.2.19 In line with current practice, following a period of inactivity (e.g. a Bank Holiday), the quarry operator will continue to have the option of running the pump for up to 24 hours per day (equivalent to 2,600 m$^3$/d), which is sufficient to accommodate the anticipated ingress rate in the enlarged quarry.

4.2.20 **Hydrometric monitoring**

4.2.21 A flow meter has been fitted on the discharge from the quarry sump to provide a reliable measure of current abstraction levels.

4.2.22 The meter was installed on 17th April 2011, set at zero.

4.2.23 Averaged over the entire period (17th April 2011 to present), the daily rate of pumping (as derived from the flow meter readings) equates to 950-1,000 m$^3$/d.

4.2.24 The maximum pumping rate (1,960 m$^3$/d) occurred during the winter period 20th December 2013 to 31st March 2014, when there was a prolonged spell of unusually heavy rainfall.

4.2.25 Going forward, it is recommended that flow meter readings continue to be collected on a monthly basis.

4.2.26 The quarry operator (or appointed contractor) should also check groundwater level in the Site piezometers on a monthly basis.

4.3 **Review of Water Management Practices**

4.3.1 **Dewatering Process in the Oldbury Void (including the Western Extension)**

4.3.1.1 The dewatering process in the Oldbury void will be conducted as follows:

- Groundwater ingress and rainfall run-off from the active quarry workings will drain under gravity to a sump upon the quarry floor. The sump will also receive runoff from the solid tips at the southern end of the landholding and the overburden storage area in the Western Extension.
• The sump will accommodate rainfall run-of occurring during a design storm event (section 4.4.1) and allow for preliminary settlement of any suspended solids entrained in the runoff from the incoming stretch of haul road and from the benches.

• Storm event run-off will be retained within the sump upon the quarry floor until cessation of storm conditions.

• Following abatement of the storm, water will be pumped from the quarry at the designated rate (up to 2,600 m$^3$/day), based upon the requirement to maintain dry workings under average conditions. The water level in the sump will generally be maintained at a fixed depth (+/- 1 m).

• The water from the quarry void will be pumped to the 2-stage treatment lagoons situated upon higher ground (130 maOD) at the northern end of the Oldbury void. These lagoons have a combined surface area of circa 4,000 m$^2$.

• These facilities are reviewed in section 4.5 to ensure that they are sufficient to cater with the specified rate of dewatering (up to 2,600 m$^3$/day).

• The proposed increase in the rate of dewatering can be undertaken without compromising the volumetric constraints of the existing Discharge Consent T/19/35436/T (the maximum permitted rate of discharge being 5,237 m$^3$/day).

4.3.2 Detail of the Drainage Infrastructure serving the Western Landform

4.3.2.1 A significant proportion of the extension area (17 Ha) will be utilised to create a permanent screening/mounded landform (as illustrated upon Drawing No. M095_00050). This Western Landform will utilise in the region of 1.5 million m$^3$ of overburden and shale.

4.3.2.2 The Western Landform will be served by a perimeter ditch, which should be detailed to discharge into the active quarry workings.

4.3.2.3 The highest point (172 maOD) upon the perimeter of the landform is roughly midway along the southwest edge, abutting the golf course. This high point is the “watershed” for the perimeter ditch system.
4.3.2.4 To the north of the watershed, the ditch will have a gradient that allows the water to flow northwards around the northern end of the landform and then eastwards into the Oldbury void.

4.3.2.5 To the south of the watershed, the ditch will descend around the southern end of the landform and continue downhill eastwards into the closest section of the Oldbury void.

4.3.2.6 The dimensions of the ditch are described in section 4.4.1.

4.3.3 Drainage Process in the Restored Purley Void

4.3.3.1 Purley void will be drained as follows:

- The water level in the restored landform at Purley will need to be fixed at circa 115 m aOD, which is some 5 m below the (extrapolated) pre-development groundwater level i.e. 5 m drawdown will be required in perpetuity.

- Currently, this is achieved by pumping the water from the Purley sump over to the Oldbury drainage system, the estimated rate of pumping being 300 m$^3$/day (section 3.2.2). This process has been ongoing for many years; therefore it is already factored into the ingress data presented in section 4.2.

- The preferred long-term option (depending upon water quality) is to direct the water under gravity to the (currently disused) discharge point at the northern end of the Purley void and allow controlled overflow to the Rawn Hill Brook.

- The proposed discharge rate of 300 m$^3$/day complies with the volumetric constraints of the existing Discharge Consent (T/19/07655/T), which permits the Applicant to discharge 455 m$^3$/day to Rawn Hill Brook.

- Until water quality is proven acceptable, the quarry operator will retain the existing infrastructure for pumping over to Oldbury. This will serve as a fallback option in the event of “teething” problems e.g. compliance with water quality targets.

- The projected average discharge requirement (300 m$^3$/day) is based upon estimated figures derived from current experience (section 3.2.2).
• Section 4.4.2 includes details of calculations completed to inform how storm runoff will be managed in the restored Purley void.

4.3.4 Drainage in the Plant Site

4.3.4.1 Runoff from the Plant Site is collected in a number of catchment pits for use in process, with any excess waters being directed to the lagoon system below the quarry office and onwards to Discharge Outlet A.

4.3.4.2 There will be no change in the Plant Site catchment area i.e. surface materials and gradients will stay the same. The drainage process is already authorised by Discharge Consent T/19/35437/T.

4.3.4.3 The impact of the “Outlet A” discharge process upon the quality of the receiving waters is examined in the BLM report (appendix 8).

4.4 Rainfall Ingress during the Design Storm

4.4.1 Oldbury Void and Western Extension (47.9 Ha)

4.4.1.1 The volumes of rainfall-derived water generated during storm events will be considerably greater than the average conditions described in section 4.2.

4.4.1.2 Assessment of the implications of storm events has been undertaken in respect of the catchment area presented by the extended Oldbury workings (47.9 Ha), assuming a 1 in 100-year storm event, 60 minutes duration. This catchment includes the solid tips at the southern end of the Site and the Western Landform (i.e. the new overburden storage area occupying 17 Ha in the Western Extension), as illustrated upon Drawing No. M095_00050. This Western Landform will accommodate in the region of 1.5 million m$^3$ of overburden and shale.

4.4.1.3 Depth Duration Frequency (DDF) data for the Site have been taken from the Flood Estimation Handbook CD Rom (FEHcd).
4.4.1.4 The FEH DDF rainfall for the design storm event is 43.3 mm. For the 47.9 Ha catchment area, the volume of stormwater requiring storage in the quarry sump equates to *circa* 20,750 m$^3$. Spread across the final sinking at the base of the quarry, this would result in *circa* 1.75 m rise in the water level in the vicinity of the sump during the design storm.

4.4.1.5 Following abatement of the storm, water will be pumped from the quarry at the designated rate (up to 2,600 m$^3$/day), based upon the requirement to maintain dry workings under average conditions. The water will be directed into the lagoons situated upon higher ground (130 maOD) at the northern end of the Oldbury void.

4.4.1.6 For full details of the runoff calculations, please refer to the Flood Risk Assessment presented in *appendix 11*. However, it is important to highlight specific information relating to the proposed drainage infrastructure in the extension area:

4.4.1.7 As outlined previously, the Western Landform must incorporate a perimeter ditch, which should be detailed to discharge into the active quarry workings.

4.4.1.8 At this location, the 100-yr peak rate of runoff per unit area equates to 14 l/s/ha (*item 10.3 within appendix 12*).

4.4.1.9 Given that the surface area of the new overburden storage mound will equate to 17 hectares, the perimeter ditch should be designed to accommodate a flow rate of 238 l/s.

4.4.1.10 Applying the Manning equation (using a coefficient of 0.05) and assuming a gradient of 1 in 100, a ditch/swale with dimensions 1.5 m width by 0.3 m depth would provide sufficient capacity for the above flow rate, safely conveying the runoff from the overburden storage area into the sump at the base of the quarry workings.
4.4.2 Restored Purley Landform (17 Ha)

4.4.2.1 Assessment of the implications of the 100-year storm event has been undertaken in respect of the catchment area (17 Ha) presented by the restored Purley landform.

4.4.2.2 Depth Duration Frequency (DDF) data for the catchment area have been taken from the Flood Estimation Handbook CD Rom (FEHcd).

4.4.2.3 The employed assessment procedure is based upon calculations and procedures described in a document entitled: “Preliminary rainfall runoff management for developments” (Technical Report W5-074A/TR/1, Revision E), prepared as part of the Flood and Coastal Defence R&D Programme undertaken by Defra and the Environment Agency.

4.4.2.4 To reflect climate change, a 10% increase in rainfall depth has been factored into the calculations (equivalent to 20% increase in rainfall run-off for larger events).

4.4.2.5 The aim of the procedure is to ensure that the requisite “Attenuation Storage Volume” (ASV) be incorporated into the development i.e. to store a proportion of rainfall run-off on Site till after the storm has abated.

4.4.2.6 The water management scheme should also cater for Long Term Storage Volume (LTV): to specifically address the additional volume of runoff caused by the development under average rainfall conditions. This is either infiltrated into the ground or, if this is not possible due to ground conditions, attenuated and discharged at very low rates of flow to the receiving watercourse so as to minimise the risk of exacerbating river flooding.

4.4.2.7 In terms of attenuation requirements, the findings of the assessment can be summarised as follows:

- Maximum off-site discharge rate: 5 l/s/ha.
- Required attenuation storage volume (ASV): 3,312 m³.
- Required long term storage volume (LTV): 1,607 m³.
4.4.2.8 Full details of the calculations are presented in appendix 12.

4.4.2.9 On the basis of the above calculations, it is proposed that the drainage infrastructure in Purley void (when restored) should include the following key elements:

4.4.2.10 The first stage of the system should comprise a flow-balancing pond (detention basin). The key is to ensure that there is sufficient capacity to accommodate the total stormwater volume (4,919 m³) e.g. a pond measuring 125 m by 40 m, with a storage depth of 1 m in readiness for the 100-year storm event.

4.4.2.11 Given the configuration of the quarry floor and subject to advice from the Quarry Manager (e.g. regarding safe depth), alternative dimensions would be acceptable as long as the overall volume (4,919 m³) is safeguarded e.g. the surface area may be increased and the freeboard depth reduced.

4.4.2.12 The outlet from the flow-balancing pond should be restricted to a flow rate of 5 l/s using orifice plates. Even allowing for a margin of error of up to 1.5 l/s, this flow rate will satisfy the projected average discharge requirement (300 m³/day), which is based upon estimated figures derived from current experience (section 3.2.2). The rate will be subject to review once further monitoring data has been collected.

4.4.2.13 The aforementioned outlet (i.e. the pipe restricted to 5 l/s) should be installed at least 1 m below the brim of the flow-balancing pond (assuming the pond adheres to the dimensions given in section 4.4.2.10). In this way, 1 m freeboard will be maintained during dry periods, in readiness for the onset of the design storm.

4.4.2.14 In the event that the design storm is exceeded and the flow-balancing pond reaches full capacity, an overflow facility will be provided to connect directly into the ditch leading to the Rawn Hill Brook.

4.4.2.15 Key considerations for the design, construction, operation, performance and maintenance of a detention basin (flow balancing pond) are detailed within Section 9.11 of the SUDS Manual (“Sustainable Drainage Systems: Hydraulic, Structural and Water Quality Advice”, CIRIA Report C609, published 2004).
4.4.2.16 Depending upon water quality, the detention basin will drain under gravity to the (currently disused) discharge point at the northern end of the Purley void, thus allowing controlled overflow to the Rawn Hill Brook.

4.4.2.17 Given current experience in the catchment area, it is evident that there will continue to be risk of acidification of ingress water within the restored void at Purley (due to natural chemical decomposition of sulphide minerals in the diorite sills and country rock).

4.4.2.18 Until water quality is proven acceptable, the quarry operator will retain the existing infrastructure for pumping over to Oldbury. This will serve as a fallback option in the event of “teething” problems e.g. compliance with water quality targets.

4.5 Silt Settlement within the Drainage Infrastructure

4.5.1 Oldbury Void and Western Extension

4.5.1.1 The following calculations are based upon design procedures described in a document entitled “Technical Management of Water in the Coal Mining Industry”, National Coal Board (NCB), 1982, Chapters 6, 11 and 14.

4.5.1.2 The water from the quarry void will be pumped to the 2-stage treatment lagoons situated upon higher ground (130 maOD) at the northern end of the Oldbury void. These lagoons have a combined surface area of circa 4,000 m².

4.5.1.3 The NCB document refers to Stokes’ Law for free settling in quiescent conditions and states that a flow velocity through the lagoons of 1x10⁻⁵ m/s should ensure effective settlement (subject to particle size analysis of the fines material, to confirm compliance with Stokes’ Law).

4.5.1.4 Multiplying the area of the lagoons (4,000 m²) by the above velocity (1x10⁻⁵ m/s), it is calculated that a flow rate of 0.04 m³/s (40 l/s) would be acceptable.

4.5.1.5 This is sufficient to cope with the anticipated dewatering process, where a flow rate of up to 2,600 m³/day (30 l/s) will be passing through the lagoons.
4.5.1.6 Therefore, assuming it is designed in accordance with the NCB guidance, the lagoon system should therefore provide sufficient silt settlement capacity.

4.5.1.7 However, the NCB document highlights several factors that may diminish the efficiency of the lagoons in terms of settlement performance (e.g. flow arrangements, particle size and shape). In the event that such a problem is detected when monitoring the suspended solids content of the discharge water, the same guidance document recommends various measures to tackle the problem.

4.5.1.8 Initially, it is important to ensure that the flow of water through the lagoon is spread over the whole surface area. This can be achieved by installing multiple inlets or castellated weirs. Energy can be dissipated by use of check barriers, under which the incoming water is forced to flow, although this may necessitate more regular localised de-sludging.

4.5.1.9 At the exit from the lagoons, the construction of an outlet weir (or installation of multiple pipe outlets) will reduce the risk of short-circuiting and re-suspension of settled solids.

4.5.1.10 Should the problem persist, other methodologies should be considered, such as flocculants/coagulants dosing or mechanical filtration.

4.5.1.11 The efficacy of the silt settlement system should be verified on a daily basis using a turbidity meter. In addition, water samples should be collected from the discharge point on a weekly basis, to be sent for laboratory analysis to check the suspended solids content.

4.5.2 Restored Purley Landform

4.5.2.1 Within the restored Purley void, all ingress water (i.e. rainfall runoff as well as groundwater input) will drain under gravity into the proposed detention basin, which should be designed with a storage capacity of 4,919 m$^3$ (section 4.4.2.10).

4.5.2.2 Given that the void is already largely restored, the silt content of any runoff water will be minimal compared to that encountered in the active Oldbury workings.
4.5.2.3 Nonetheless, the method outlined in section 4.5.1 has been repeated to assess the silt settlement capacity of the detention basin.

4.5.2.4 It is calculated that the average throughflow rate will equate to 300 m$^3$/day (less than 3.5 l/s).

4.5.2.5 The detention basin will have a surface area of circa 5,000 m$^2$ (assuming the pond adheres to the dimensions given in section 4.4.2.10). As such, it will provide sufficient silt settlement capacity as long as the flow rate is restricted to 5 l/s, which is more than the anticipated requirement given above (3.5 l/s).

4.6 Treatment Process to tackle Acidification Issue

4.6.1 Active Workings: Oldbury Void and Western Extension

4.6.1.1 In order to ensure that the pumped water achieves the limits specified in the Discharge Consent, the pH must be raised to between 6 and 9; Aluminium must be restricted to less than 1 mg/l and Iron should be less than 5 mg/l.

4.6.1.2 When “lime” (calcium hydroxide) is added to the water in the Oldbury sump, it neutralises the acidity and raises the pH, such that the dissolved aluminium and iron precipitate out as metal hydroxides.

4.6.1.3 Historically (pre-2001), if 50% of the pumped water was sent via the lime dosing plant and the remainder was left untreated, then the combined water being discharged off Site was found to be of satisfactory quality.

4.6.1.4 The process was found to be most efficient if the lime-dosed water was returned to the lower depths of the water-filled sump. Any discharge would be taken from near the surface and away from the tips/shale slopes. This minimised the risk of re-acidification.

4.6.1.5 Laboratory analysis showed that 150 g/m$^3$ of calcium hydroxide were needed to raise the pH of the incoming Purley water to comply with the pH range in the Discharge Consent (pH 6-9). In practice, the dosage was increased to 200 g/m$^3$ in order to combat the risk of re-acidification.
4.6.1.6 The supplier of the dosing plant warned that the over-application of calcium hydroxide could cause the pH to rise above 9.5, risking re-mobilisation of the aluminium hydroxide.

4.6.1.7 The lime dosing facility has rarely been required since the change in discharge arrangements at Purley, whereby water is now pumped into a stone-filled hollow adjacent to the Oldbury haul road (rather than direct discharge to the Oldbury sump).

4.6.1.8 It is considered that the poorest quality water is being diluted/attenuated in its subsurface passage through the stone-filled hollow, channelling onwards to the Oldbury sump.

4.6.1.9 Thus, the above treatment process has been developed and progressively adapted in response to the demands of the existing Discharge Consent T/19/35436/T.

4.6.1.10 More recent work regarding the discharge process has focussed upon dissolved heavy metals such as Cadmium, Nickel and Zinc, none of which are covered by the Consent but are highlighted by the EA as an issue for further investigation.

4.6.1.11 This triggered an assessment of water quality being discharged off Site (and the attendant risk of impact upon the receiving waters); full findings are presented in the BLM report (appendix 8).

4.6.1.12 The BLM report concluded that the issue with regard to heavy metals (Cadmium, Nickel and Zinc) in Oldbury Stream is considerably diminished when viewed in the context of the following key factors: the natural background metal loading that would have been apparent in the pre-quarry setting; the long history of quarrying (in excess of 100 years) such that the ecosystem of the stream will have adjusted to the heavy metal content; the difference between total metal content and bioavailable fraction; and the dilution capacity afforded by the River Anker.
4.6.2 Minimising Acidification in Seepage Waters from the Western Landform

4.6.2.1 A significant proportion of the extension area (17 Ha) will be utilised to create a permanent screening/mounded landform (as illustrated upon Drawing No. M095_00050). This Western Landform will accommodate in the region of 1.5 million m³ of overburden and shale.

4.6.2.2 Given Site experience with respect to acidified drainage waters coming from the overburden tips, core samples have been retrieved from the shale horizons and subjected to Waste Acceptance Criteria (WAC) testing.

4.6.2.3 The results of the WAC Testing are summarised in appendix 13.

4.6.2.4 The amount leached (mg/kg) during each WAC test has been compared with the published Limit Value for Inert Waste for each individual parameter.

4.6.2.5 The vast majority of the data comply with the Inert Limit Values.

4.6.2.6 Some of the Sulphate and Total Dissolved Solids (TDS) data marginally exceeds the standards for Inert Waste but the average value is in compliance.

4.6.2.7 The average nickel data is above the Limit Value for Inert Waste but remains closer to the inert tier rather than approaching the next level (Stable Non-Reactive Hazardous Waste).

4.6.2.8 The average WAC eluate (ug/l) data is generally in compliance with EQS, with the exception of cadmium, nickel and zinc. No EQS is given for barium but the average data is marginally above Drinking Water Standards (DWS), likewise pH is outside the guideline range.

4.6.2.9 Where direct comparison can be made, the average WAC eluate data (appendix 13) is of better quality than that the composition of the Quarry Discharge Waters on 20th March 2014 (BLM report, appendix 8).
4.6.2.10 Most importantly, the WAC eluate data suggests that the concentration of dissolved heavy metals (cadmium, nickel and zinc) in the drainage waters seeping from the proposed landform will be of lesser magnitude than the current situation, as described in the BLM report.

4.6.2.11 For example:

- **Cadmium**: Average WAC eluate result was 3.17 ug/l; compared with Quarry Discharge Waters on 20\textsuperscript{th} March 2014 (BLM report), which ranged from 17.7 to 21.5 ug/l.

- **Nickel**: Average WAC eluate result was 218 ug/l; compared with Quarry Discharge Waters on 20\textsuperscript{th} March 2014 (BLM report), which ranged from 1275 to 1466 ug/l.

- **Zinc**: Average WAC eluate result was 229 ug/l; compared with Quarry Discharge Waters on 20\textsuperscript{th} March 2014 (BLM report), which ranged from 1837 to 2197 ug/l.

4.6.2.12 Despite these results, the limitations of the shale sampling programme (\textit{e.g.} WAC testing was restricted to key horizons) mean that the overall composition of the drainage waters (contaminant loading) cannot be calculated with complete confidence.

4.6.2.13 Therefore, a precautionary approach is adopted, whereby it is assumed that water quality arising from the Western Landform will be consistent with the more difficult data given in the BLM report \textit{i.e.} a continuation of the current situation.

4.6.2.14 Thus, the conclusions given in section 4.6.1.12 are equally important in this context.

### 4.6.3 Restored Purley Landform

4.6.3.1 Depending upon water quality, the detention basin (as detailed in section 4.4.2) will drain under gravity to the (currently disused) discharge point at the northern end of the Purley void, thus allowing controlled overflow to the Rawn Hill Brook.
4.6.3.2 Given current experience in the catchment area, it is evident that there will continue to be risk of acidification of ingress water within the restored void at Purley (due to natural chemical decomposition of sulphide minerals in the diorite sills and country rock).

4.6.3.3 Until water quality is proven acceptable, the quarry operator will retain the existing infrastructure for pumping over to Oldbury. This will serve as a fallback option in the event of “teething” problems e.g. compliance with water quality targets.

4.6.3.4 The quarry operator will need to vary the existing Discharge Consent (T/19/07655/T).

4.6.3.5 Currently, the only water quality constraints in the above Consent are as follows: The limit for suspended solids equates to 50 mg/l and pH should be between 5-9. Non-volatile matter extractable by light petroleum must be restricted to less than 5 mg/l.

4.7 Potential for Impact upon Groundwater Quality

4.7.1 Operation of Mobile and Fixed Plant

4.7.1.1 The operation of mobile and fixed plant presents a risk that pollutants may enter groundwater as a result of hydrocarbon spillage or leakage on Site. Such sources are identified as fuel, lubricating and hydraulic oils. Experience has demonstrated that the risk of such a pollution incident may be minimised by adoption of the following measures.

- The operator will adhere to a code of practice for the refuelling of machinery. Such work shall be carried out only by trained personnel and take place within a surfaced area equipped with surface water interceptors and bunded tanks. No refuelling or maintenance should be carried out in areas of mineral working.

- Operators shall check their vehicles on a daily basis before starting work to confirm that leakages are not present. Operators will report any defect to ensure that repairs are undertaken to that vehicle before it enters the working area.
• Sufficient oil sorbant material (3M Oil-Sorb or similar) shall be available on Site to cope with a loss equal to the total fluid content of the largest item of plant.

• Following the use of such oil sorbant material, any contaminated materials shall be disposed from Site in accordance with current tipping legislation.

• Adequate containment should be provided for all oils stored on the Site, to be equipped with bunds complying with the relevant British Standard.

4.7.1.2 The foregoing measures have been incorporated within a fluids handling protocol that is included here at appendix 14. It is considered that the correct adoption of these measures will provide appropriate mitigation against the potential for derogation of groundwater quality as a result of plant operations.

4.7.1 Screening and Processing of Recycled Asphalt Product (RAP)

Sourcing the Raw Material

4.7.1.1 The following information is intended as a summary of the Applicant’s nationwide protocol for Handling, Screening and Processing of RAP. The aim is to ensure that recycled and recovered aggregates are manufactured in a controlled manner in order to meet national / proprietary specifications and customer requirements in accordance with the quality protocol for the production of aggregates from waste asphalt.

4.7.1.2 Raw materials will normally be obtained from waste holders of known capability for supplying acceptable material. Waste holders must hold a current Waste Carrier Licence issued by the EA, unless exempt.

4.7.1.3 Copies of Waste Carrier Licences should be obtained and held at the weighbridge for all suppliers of raw materials.

4.7.1.4 Where a waste holder has renewed their Waste Carrier Licence, the Licence details available from the EA website may be used in lieu of a copy of the current Waste Carrier Licence.
4.7.1.5 Where a single source is expected to supply large quantities of materials, or for potential new suppliers with no history of previous satisfactory performance, it will be necessary to assess the new source and agree levels of quality.

4.7.1.6 Approved suppliers of raw materials must be issued with a quotation that includes all types of waste that they are intending to deposit.

4.7.1.7 Basic characterisation information supplied by the waste producer shall be reviewed by the technical manager or other suitably qualified person to determine if the waste is suitable to be accepted at this site.

4.7.1.8 When a waste stream is deemed acceptable for receipt on the site, it will be subject to Compliance testing.

4.7.1.9 The EA has expressed specific concern regarding the potential for impact upon groundwater resources as a result of drainage from road planings. It is noteworthy that such material is typically sourced from the Highways Agency / Local Authority, who have a Duty of Care for the road planings.

4.7.1.10 The supplier must make sure that any coal tar-based planings get sent to a hazardous waste facility. Failing this, if Lafarge Tarmac takes receipt of such material, then this material must be collected and the cost of its disposal should be borne by the supplier (in accordance with the Duty of Care).

**Taking Receipt of Raw Material**

4.7.1.11 The weighbridge operator shall direct delivery vehicles onto the weighbridge for weighing and inspection.

4.7.1.12 If a valid Waste Carrier Licence is not available and the haulier is not exempt, the material will be rejected and the raw material is dispatched from Site without being unloaded.

4.7.1.13 The weighbridge operator must inspect the Waste Transfer Note for material description, site of origin (if appropriate) and customer details, to be compared against the agreed levels of quality (where applicable).
4.7.1.14 If the waste carrier has not completed a Waste Transfer Note, inform them of their legal obligation to do so. If they are unwilling to produce a completed Waste Transfer Note, the material will be rejected and the raw material will be dispatched from Site without being unloaded.

4.7.1.15 The weighbridge operator must ensure that the Waste Transfer Note has been completed correctly.

4.7.1.16 A Waste Transfer Note may cover multiple consignments for a period of up to one year, provided that the waste carrier is the same, the type of waste is the same and the location of the transfer of the waste is the same. An end date must be included on the Note. Without an end date, the Waste Transfer Note is only valid for the first date stated.

**Inspecting/Testing Raw Material**

4.7.1.17 The load must be categorised as one of the following: Road Arisings/Planings and Waste Asphalt arising from Coating Plants (*e.g.* Bituminous Asphalt, Asphalt Filler Dust).

4.7.1.18 The Unit Manager / Supervisor must ensure that all loads are inspected after tipping to ensure deleterious materials are not buried within the load. Where a load is found to be contaminated with unacceptable material so as to prevent recycling, the load must be rejected, reloaded and the vehicle driver and supplier informed. The raw material must be removed from Site.

4.7.1.19 A record must be maintained of all rejected loads / reloaded vehicles. If necessary, the EA Officer must be informed.

4.7.1.20 If the contamination is found to be hazardous, it must be quarantined and the EA Officer must be informed as soon as is practicable. Contaminants will be placed in the appropriately signed skip.

4.7.1.21 Stockpiles will normally be picked over after the vehicle has discharged and prior to the load being pushed up to remove obvious contaminants such as wood, metal waste, hazardous materials *etc.* and any ‘added value’ components.
4.7.1.22 Stockpiles of different raw materials must be kept separate and adequate vehicular access is maintained to minimise contamination by operational traffic.

4.7.1.23 All stockpiles must be checked daily to confirm continued suitability for use. If contamination of a stockpile occurs which threatens product quality, the affected material must be considered as non-conforming.

**Action/Advice relating specifically to Road Planings containing Coal Tar**

4.7.1.24 As explained in section 4.7.1.10, the supplier of any road planings has Duty of Care for the raw material. They must provide the first safety check: namely, testing the material at source and ensuring that any planings containing coal tar get sent to an authorised waste facility.

4.7.1.25 Lafarge Tarmac routinely tests the waste stream by spraying the planings with an approved reactant (similar to white paint). If the “paint” stays white, the planings are free from coal tar. If the “paint” turns yellow, this is indicative of coal tar contamination. In this instance, the supplier has Duty of Care and must pay for the planings to be removed from Site and delivered to a hazardous waste facility.

4.7.1.26 It is noteworthy that road planings containing coal tar have limited leaching potential (assuming that they are not subject to thermal degradation). As such, the EA previously adopted a low risk waste position for the storage of up to 5,000 tonnes of waste road planings containing coal tar (pending recovery to an authorised facility).

4.7.1.27 Following the exemptions review, the S2 Exemption now covers the storage of waste road planings containing coal tar. This allows for the storage of up to 500 tonnes of such waste for 12 months in a secure place.

4.7.1.28 Some of the types of waste covered by the S2 Exemption are subject to additional specific conditions (e.g. the waste should be stored in a container or the storage place should have sealed drainage). No such conditions are applied to the storage of waste road planings containing coal tar.
4.7.1.29 The EA is currently in the early stages of a review process, which involves quantifying the benefits of creating a quality protocol for waste road planings containing coal tar. Subject to developing a treatment process to bind the coal tar to the end product, the Agency aims to encourage its use as recycled aggregate. This could create substantial financial savings for businesses and generate new markets for recycled materials.

**Recycling the Waste**

4.7.1.30 Notwithstanding the above measures, which will have been taken to remove contamination at the earliest practical opportunity, further monitoring is conducted as the material is being brought from storage to the recycling plant.

4.7.1.31 The shovel driver should maintain a steady feed of materials to the plant and should undue levels of contaminants be identified he must avoid these areas of the stockpile and inform the Unit Manager/Supervisor.

4.7.1.32 After processing, the shovel driver must ensure that materials are transferred from the plant surge piles to the appropriate stockpiles as necessary. Should any unacceptable contamination be detected, the Site Supervisor must be informed and appropriate corrective action implemented and recorded.

4.8 **Potential for Impact upon Surface Water Regime**

4.8.1 Comparing groundwater level (135 maOD) with floor level in the deepest part of the workings (50 maOD), it is evident that there will be a requirement for 85 m depth of dewatering drawdown to maintain dry workings in the final development. It is noteworthy that the bulk of this drawdown (65 m) has already been established as a result of the current development.

4.8.2 Based upon the findings presented in section 4.2.12, it is estimated that a radius of influence of 165 m will be associated with dewatering drawdown in the final development. It is important to emphasise that the bulk of any quarry-related lowering of groundwater levels will have already taken place as a result of existing operations.
4.8.3 Looking beyond the boundary of the Western Extension Application Area, two water features lie within the predicted radius of influence.

4.8.4 The closest is an isolated pond (NGR 430991 294670) located upon the northeast-facing slope overlooking the southern end of the existing Oldbury void. This is at 45-50 m standoff from the Western Extension.

4.8.5 The aforementioned pond is considered to be a perched feature, relying upon rainfall runoff (rather than groundwater movement in the underlying shale formation). Given its topographic setting, the catchment area for this pond will be largely unaffected by the development, the majority of any runoff coming from the golf course to the southwest.

4.8.6 There are two ponds alongside the footpath running southeast from Oldbury Farm. These ponds will be adjacent to the northwest margin of the proposed overburden storage area.

4.8.7 The closest of these ponds (NGR 430400 295078) is at 150 m standoff from the extraction area. At the time of the survey, there was no visible flow into or out of these ponds and the associated drainage ditch (parallel to the footpath) was dry.

4.8.8 Again, these ponds are considered to be perched features, not at risk of quarry-related dewatering drawdown. Their topographic setting suggests that any runoff would primarily come from land unaffected by the development.

4.8.9 Upon restoration, the quarry void will fill with groundwater up to a level of 122 maOD (controlled by gravity discharge).

4.8.10 The conceptual model presented in section 2 has been used to check whether the raising of water level in the void space has potential to increase the flow rate in the springs/seepage comprising the upper catchment of the Hartshill Hayes Brook.

4.8.11 The following data are relevant to this assessment:

- Groundwater level averages 130 maOD along the eastern margin of the quarry i.e. the land separating the quarry workings from the Hartshill Hayes Brook.
• The springs/seepage generally emerge between the 130-140 maOD contour lines and there will be no reduction in standoff as the quarry progresses.

4.8.12 On this basis, the current regime is higher than 122 maOD. Therefore, it is concluded that there will be no significant increase in spring flow when the water level in the quarry void rises to 122 maOD.

4.8.13 Surface water quality will be safeguarded against quarry-related impact by the same measures (sections 4.5-4.7) adopted (i) for silt settlement and treatment of acidified waters and (ii) for protecting groundwater quality.

4.8.14 Following settlement of suspended solids and treatment of acidified waters in the water management system, any discharge of trade effluent from the Western Extension Area will be conducted in accordance with the existing Discharge Consent T/19/35436/T.

4.8.15 As highlighted by the EA, the discharge waters contain various dissolved heavy metals (Cadmium, Nickel and Zinc) that are not listed on the Consent.

4.8.16 The BLM report (appendix 8) concluded that the issue with regard to heavy metals (Cadmium, Nickel and Zinc) in Oldbury Stream is considerably diminished when viewed in the context of the following key factors: the natural background metal loading that would have been apparent in the pre-quarry setting; the long history of quarrying (in excess of 100 years) such that the ecosystem of the stream will have adjusted to the heavy metal content; the difference between total metal content and bioavailable fraction; and the dilution capacity afforded by the River Anker.

4.9 Potential for Impact upon Water Supplies

4.9.1 Sections 2.9.11 and 2.10.4 give details of all registered private and licensed abstractions lying within 3 km radius of the Site.
4.9.2 The supply at Lady Wood Farm lies in closest proximity to the Western Extension, being *circa* 1 km standoff to the southwest of the proposed limit of extraction. This is outside the predicted radius of influence of dewatering drawdown. Furthermore, the water supply is sourced from a sandstone formation, which is separated from the economic mineral by the Oldbury Farm Sandstone Formation, the Millstone Grit and the Coal Measures.

4.9.3 It is considered that the proposed development will cause no derogation in the quantity of any of these water supplies. Their water quality will be safeguarded by the same measures specified in *sections 4.5-4.7*.

4.10 **Flood Risk Assessment**

4.10.1 The Flood Risk Assessment is presented in *Appendix 11*. 
5 SUMMARY & CONCLUSIONS

5.1 Baseline Study

5.1.1 BCL has been instructed by Lafarge Tarmac to carry out a Hydrological and Hydrogeological Risk Assessment (HRA) to support a Planning Application for the Western Extension at Mancetter Quarry, Atherstone (the Site). The landholding is centred upon NGR 4 30800(E) 295600(N).

5.1.2 Mineral extraction at Mancetter Quarry has historically been concentrated in three separate void spaces: the (currently active) Oldbury workings to the south, the (fully restored) Jubilee workings at the centre of the landholding and the (largely restored) Purley workings to the north. The Plant Site lies within a narrow valley to the east of the Jubilee workings.

5.1.3 The screening and processing of Recycled Asphalt Product (RAP) is conducted under an exemption from the Environmental Permitting (England & Wales) Regulations 2010, exemption ref: EPR/XE5902LW/A001.

5.1.4 Current land use within the proposed Western Extension includes: farmland, scrub and a small part of the Purley Chase Golf Course.

5.1.5 In terms of archaeological interest, the southern end of Oldbury void is bordered by a Scheduled Monument (Oldbury Camp).

5.1.6 Hartshill Hayes Country Park abuts the northeast margin of the Scheduled Monument and extends close to the southeast corner of the Oldbury workings.

5.1.7 The closest SSSI is Bentley Park Wood (105 Ha), which is some 570 m to the west of the Purley workings, at closest approach. The standoff from the proposed mineral extraction area in the Western Extension is circa 1.15 km.

5.1.8 The eastern and western margins of the Purley void are, for the most part, bordered by deciduous woodland, which has BAPPH status; as does the less extensive woodland adjacent to the Oldbury void.
5.1.9 There is also a BAPPH area of (undetermined) grassland abutting the Purley workings, extending north-eastwards towards the village of Mancetter.

5.1.10 Aside from woodland, the closest BAPPH to the Oldbury workings is the parcel (0.9 ha) of Purple Moor Grass and Rush Pasture at 420 m standoff to the east of the quarry.

5.1.11 The closest active landfill is the Judkins Site (Tuttle Hill, Nuneaton, Warwickshire, CV10 0HR), which is some 3.1 km to the southeast of the existing Oldbury workings. Operated by the Waste Recycling Group Limited, this is a co-disposal landfill accepting hazardous waste.

5.1.12 There is a “chain” of historic landfill sites extending round the Oldbury workings, the closest being the “Railway Cutting”, which is situated some 570 m to the south of the proposed workings. This landfill was operational from 1969-1980 and is reported to have received inert, industrial, commercial, liquids/sludge and household waste.

5.1.13 The Proposed Development (the Western Extension) involves deepening and extending the Oldbury workings in a westerly direction.

5.1.14 The final development will occupy an area of approximately 106.4 hectares (Ha), with 76.5 Ha constituting the existing development (Oldbury, Purley, Jubilee and Plant Site) and approximately 29.9 Ha constituting the proposed Western Extension. It should be noted that not all of the area covered by the proposed extension would be subject to mineral extraction operations, instead a significant area (17 Ha) will be utilised to create a permanent screening landform (Western Landform). This Western Landform will accommodate in the region of 1.5 million m$^3$ of overburden and shale.

5.1.15 The Site is located on the upper northeast-facing slopes of the Anker Valley. The valley is aligned in a southeast to northwest direction and is approximately 7 km in width. Its floor has a basal elevation of approximately 70-75 maOD.
5.1.16 The northern (Purley) quarry is largely restored, forming a long narrow depression, the floor of which gently declines from south (115 maOD) to north (110 maOD). The surrounding ground generally ranges from 130 to 145 maOD but is bisected by a natural valley feature (occupied by the Rawn Hill Brook), which descends from southwest to northeast. As it crosses the Site, the valley floor drops from 115 maOD (western boundary) to 110 maOD (eastern boundary), coinciding with the lowest point at the northern end of the restored quarry. From here, the valley drops away to join the main Anker Valley (70-75 maOD), the confluence being some 2 km to the northeast.

5.1.17 The Plant Site occupies a narrow (un-named) valley feature lying to the east of the fully restored Jubilee Workings. The stockpiles occupy the steepest ground at the head of the valley (i.e. the southwest side of the Plant Site); the processing (crushing and screening) plant, two asphalt plants, offices and weighbridge are situated lower in the valley, where it narrows and drops away towards the northeast.

5.1.18 The RAP screening area is located to the west of the Plant Site stockpiles; the RAP processing area is situated close to the southwest corner of the Purley workings.

5.1.19 Extraction operations are now focused upon the southern (Oldbury) quarry, which comprises a deep cutting, aligned north-south. With a floor elevation of circa 70 maOD, these workings are lower than the surrounding ground in all directions: the screening bund upon the northeast boundary of the void space is at 155-165 maOD; the southwest boundary is at 145-150 maOD (beyond which the hillside continues to rise up to circa 171-172 maOD); and the hillfort (Oldbury Camp) adjacent the southernmost tip attains 178 maOD.

5.1.20 The proposed extension area (Western Extension) lies on the southwest side of the Oldbury void. It comprises a steep hillside with ground elevation rising from northeast to southwest. At 375-500 m standoff from the existing void, the slope reaches its maximum elevation of around 171-172 maOD and flattens out on to Purley Chase Golf Club and adjacent farmland.
5.1.21 As stated above, the Site falls within the catchment area of the River Anker. It passes *circa* 1.5 km to the northeast of the Site entrance (2 km northeast of the Oldbury workings), flowing from southeast to northwest.

5.1.22 The Coventry Canal, which connects Tamworth and Coventry, runs roughly parallel to the River Anker, following the foot of the Nuneaton Ridge (upon which the quarry is located). At its closest approach, the canal passes approximately 0.5 km to the northeast of the Site entrance.

5.1.23 Several small watercourses (including Oldbury Stream, Rawn Hill Brook and Hartshill Hayes Brook) drain the northeast-facing slopes of the Nuneaton Ridge (upon which the quarry is located). Flowing from southwest to northeast, they are directed via culvert under the Coventry Canal and continue onwards to join the River Anker.

5.1.24 Oldbury Stream receives all ingress waters pumped (via treatment lagoons) from the Purley and Oldbury workings. It also takes rainfall runoff from the Plant Site, which is passed through a series of weir tanks prior to discharge. Downstream from here, the stream drains east northeast to its confluence with the River Anker.

5.1.25 Rawn Hill Brook rises approximately 1 km to the southwest of Purley Quarry. Flowing northeast, its course is intercepted by the Purley workings. The brook is received by a pond as it enters the Site and is then passed under the restored workings via buried pipes. At the eastern margin of the quarry, the pipes discharge into a weir box and the brook regains its natural course, flowing northeast towards the River Anker.

5.1.26 Hartshill Hayes Brook arises upon the northeast-facing hillside below the eastern margin of the Oldbury workings. The slope is characterised by areas of seepage and spring flow, which emerge between the 130-140 m aOD contour lines. The closest of these features lies within 90 m standoff from the existing quarry. The uppermost 0.75 km stretch of watercourse flows from west to east. Thereafter, the stream flows in a northerly direction, passing under the canal and ultimately joining the River Anker.
5.1.27 The Application Area lies within Flood Zone 1 i.e. outside the floodplain.

5.1.28 The risk of fluvial flooding is confined to (i) the narrow strip of land immediately adjacent the River Anker and (ii) the confluence of the Rawn Hill Brook with the main river.

5.1.29 There is some 30 m height difference between the closest stretch of floodplain (75 maOD) and the settlement facilities at the Site entrance (105 maOD).

5.1.30 The quarry excavations extend along the outcrop of a series of diorite sills. These igneous intrusions occur within the Outwoods Shale Formation, part of the Stockingford Shale Group. These solid strata comprise a Secondary B Aquifer with low groundwater vulnerability.

5.1.31 On a regional scale, the volcanic rocks and shales are mapped as impermeable, generally without significant groundwater except at shallow depth. The rocks have been deformed tectonically and are highly indurated. Groundwater is confined to sub-surface weathered zones and joint systems.

5.1.32 A network of piezometers installed on Site has informed an assessment of groundwater levels in the Secondary B Aquifer.

5.1.33 The most representative value for hydraulic conductivity gained from Site experience is 0.035 m/day.

5.1.34 The groundwater levels recorded within the Site piezometers suggest groundwater to reside at around 150 maOD in the area to the southwest of the Oldbury void (including the Western Extension) and 130 maOD in the area to the northeast. Correcting for the effects of dewatering, seasonal variations of some 5-7 m are typically encountered at this location.

5.1.35 The natural restoration water level would occur at around 130-135maOD within the Oldbury void. However, the proposed restoration landform will create a low point of 122 maOD at the northern lip of the quarry void; hence, under the proposed configuration, this would be expected to act as the upper limit on surface water levels in the flooded quarry.
5.1.36 Prior to a previous hydrogeological investigation (completed in 1999), dewatering had ceased in the main excavations at Purley and the void space filled to 118.2 maOD. At the time, it was considered that this was representative of long-term equilibrium.

5.1.37 However, when the dewatering operation at Oldbury was scaled down, groundwater levels at Purley rose by a further 1.5 m. Thus, taking a conservative approach, it is anticipated that the long-term water level at Purley would equate to some 120 maOD unless control measures (pumping/overflow) are put in place.

5.1.38 In reality, the intention at Purley (dependent upon water quality) is to allow controlled overflow to the Rawn Hill Brook. This will involve suppressing the water level at 115 maOD i.e. 5 m drawdown will be required throughout the life of the proposed development and in perpetuity.

5.1.39 Given current experience in the catchment area, it is evident that there will continue to be risk of acidification of ingress water within the restored void at Purley (due to natural chemical decomposition of sulphide minerals in the diorite sills and country rock).

5.1.40 Until water quality is proven acceptable, the quarry operator will retain the existing infrastructure for pumping from Purley over to Oldbury, where the water is directed through a treatment system (section 5.3) prior to being discharged off Site. This includes the option for lime dosing, when required. The system, which deals with the combined input from Purley and Oldbury, is located upon high ground (130 maOD) at the northern end of the Oldbury void.

5.1.41 This pumping process will serve as a fallback option in the event of “teething” problems at the Rawn Hill Brook discharge point e.g. compliance with water quality targets.

5.1.42 The impact of the discharge process upon the quality of the receiving waters is examined in the BLM report (appendix 8).

5.1.43 The Site does not overlap any Groundwater Source Protection Zone.
5.14 The water supply at Lady Wood Farm lies in closest proximity to the extension area, being *circa* 1 km standoff to the southwest of the proposed limit of extraction. The water supply is sourced from a sandstone formation, which is separated from the economic mineral by the Oldbury Farm Sandstone Formation, the Millstone Grit and the Coal Measures.

5.2 **Proposed Development**

5.2.1 For planning purposes, the extraction operation has been subdivided into four working phases, as shown in *drawings M095_00046 to M095_00049*.

5.2.2 Work will start at the southern end of the extension area and progress northwards. The final floor will be at 50 m aOD, some 20 m below current workings.

5.2.3 A significant proportion of the extension area (17 Ha) will be utilised to create the Western Landform, which will incorporate in the region of 1.5 million m$^3$ of overburden and shale.

5.2.4 The final restoration objective involves allowing the Oldbury void to fill with groundwater up to a level of 122 m aOD, which will be controlled by gravity discharge (via treatment lagoons) to the existing consented discharge point and onwards into the watercourse (Oldbury Stream) adjacent to the Plant Site.

5.3 **Site Drainage – Oldbury Void**

5.3.1 All ingress waters (*i.e.* rainfall runoff as well as groundwater input) drain under gravity into the quarry sump (70 m aOD). This allows for preliminary settlement of any suspended solids entrained in the rainfall runoff from the incoming stretch of haul road as well as from the benches and overburden tips.

5.3.2 During a storm event, the sump accommodates rainfall run-off from the active quarry workings (as well as runoff from the solid tips at the southern end of the landholding and any future drainage from the overburden storage area in the Western Extension).

5.3.3 The water is removed from the quarry void using a 6-inch pump.
5.3.4 Site management advise that water is abstracted at a rate of between 650 m$^3$/d and 2,600 m$^3$/d, depending upon the operating schedule and rainfall conditions. The water level in the sump is maintained at a fixed depth (+/- 1 m).

5.3.5 This is confirmed by flow meter readings, which show that the average daily rate of pumping is 950-1,000 m$^3$/day. The maximum pumping rate (1,960 m$^3$/d) occurred during the winter period: 2013 to 2014.

5.3.6 The water from the quarry void is pumped to the 2-stage treatment lagoons situated upon higher ground (130 maOD) at the northern end of the Oldbury void. These lagoons have a combined surface area of circa 4,000 m².

5.3.7 Lime-dosing equipment is available to ensure that the pumped water achieves the standards specified in the Discharge Consent.

5.3.8 Having passed through the lagoons, the water is piped to the consented discharge point (“Outlet B”, NGR 431230 295950, as per Consent T/19/35436/T) and released into Oldbury Stream.

5.3.9 The maximum permitted rate of discharge is 5,237 m$^3$/day. The limit for suspended solids equates to 50 mg/l and pH should be between 6-9. Aluminium must be restricted to less than 1 mg/l and iron should be less than 5 mg/l. The discharge must be non-injurious to fish and must contain no visible signs of oil or grease.

5.4 Site Drainage – Purley Void

5.4.1 The water level in the restored landform at Purley will need to be fixed at circa 115 maOD, which is some 5 m below the (extrapolated) pre-development groundwater level i.e. 5 m drawdown will be required in perpetuity.

5.4.2 Currently, this is achieved by pumping the water from the Purley sump over to the Oldbury drainage system, the estimated rate of pumping being 300 m$^3$/day. This process has been ongoing for many years; therefore it is already factored into the ingress data for the Oldbury void.
5.4.3 The preferred long-term option is to collect the water in a detention basin (to be situated upon the floor of the Purley void). Depending upon water quality, the detention basin will drain under gravity to the (currently disused) discharge point at the northern end of the Purley void, thus allowing controlled overflow to the Rawn Hill Brook.

5.4.4 The proposed discharge rate of 300 m$^3$/day complies with the volumetric constraints of the existing (but unused) Discharge Consent T/19/07655/T, which permits the Applicant to discharge 455 m$^3$/day to Rawn Hill Brook. The limit for suspended solids equates to 50 mg/l and pH should be between 5-9. Non-volatile matter extractable by light petroleum must be restricted to less than 5 mg/l.

5.4.5 Until water quality is proven acceptable, the quarry operator will retain the existing infrastructure for pumping over to Oldbury. This will serve as a fallback option in the event of “teething” problems e.g. compliance with water quality targets.

5.5 Drainage from the Plant Site

5.5.1 Runoff from the Plant Site is collected in a number of catchment pits for use in process, with any excess waters being directed to the lagoon system below the quarry office.

5.5.2 The Proposed Development does not involve any change in the Plant Site catchment area i.e. surface materials and gradients will stay the same. The drainage process is already authorised by Discharge Consent T/19/35437/T.

5.5.3 Under this consent, “Site Drainage” is discharged to Oldbury Stream (“a tributary of the River Anker”) via “Outlet A” at NGR 431220 295920.

5.5.4 Maintaining the status quo in this part of the Site and given the existing authorisation, this sub-catchment is not reviewed within the HRA.

5.5.5 However, the impact of the “Outlet A” discharge process upon the quality of the receiving waters is examined in the BLM report (appendix 8).
5.6 Impact Assessment – Oldbury Void and the Western Extension

5.6.1 Comparing groundwater level (135 maOD) with floor level in the deepest part of the workings (50 maOD), it is evident that there will be a requirement for 85 m depth of dewatering drawdown to maintain dry workings in the final development. It is noteworthy that the bulk of this drawdown (65 m) has already been established as a result of the current development.

5.6.2 Utilising the most representative value for hydraulic conductivity gained from Site experience (0.035 m/day), it is estimated that a radius of influence of circa 165 m will be associated with dewatering drawdown in the final development.

5.6.3 Looking beyond the boundary of the Western Extension Application Area, two water features lie within the predicted radius of influence.

5.6.4 These ponds (the closest of which is at 45-50 m standoff) are considered to be perched features, relying upon rainfall runoff (rather than groundwater movement in the underlying shale formation). Given their topographic setting, the catchment area for these ponds will be largely unaffected by the development.

5.6.5 The supply at Lady Wood Farm lies in closest proximity to the Western Extension, being circa 1 km standoff to the southwest of the proposed limit of extraction. This is outside the predicted radius of influence of dewatering drawdown. Furthermore, the water supply is sourced from a sandstone formation, which is separated from the economic mineral by the Oldbury Farm Sandstone Formation, the Millstone Grit and the Coal Measures.

5.6.6 Upon restoration, the quarry void will fill with groundwater up to a level of 122 maOD (controlled by gravity discharge). This is unlikely to impact upon the flow rate in the springs/seepage comprising the upper catchment of the Hartshill Hayes Brook because they are perched well above the restoration water level.
5.6.7 Ingress calculations have been completed for the Final Development: Adding together the estimated groundwater input of 900 m$^3$/day (section 4.2.13) and rainfall input of 770 m$^3$/day (section 4.2.17), this indicates that an average ingress rate of some 1,670 m$^3$/day (19.5 l/s) will be draining into the void and will need to be accommodated in the water management system.

5.6.8 In line with current practice, following a period of inactivity (e.g. a Bank Holiday), the quarry operator will continue to have the option of running the pump for up to 24 hours per day (equivalent to 2,600 m$^3$/d), which is sufficient to accommodate the anticipated groundwater ingress rate in the enlarged quarry.

5.6.9 Assessment of the implications of storm events has been undertaken in respect of the catchment area presented by the extended Oldbury workings (47.9 Ha), given a 1 in 100-year storm event, 60 minutes duration.

5.6.10 The calculations are based upon the assumption that the new overburden storage area in the Western Extension will incorporate a perimeter ditch, which will be detailed to discharge into the active quarry workings.

5.6.11 The volume of stormwater requiring storage in the quarry sump equates to circa 20,750 m$^3$. Spread across the final sinking at the base of the quarry, this would result in circa 1.75 m rise in the water level in the vicinity of the sump during the design storm.

5.6.12 Following abatement of the storm, water will be pumped from the quarry at the designated rate (up to 2,600 m$^3$/day), based upon the requirement to maintain dry workings under average conditions.

5.6.13 The water will be directed into the existing 2-stage treatment lagoons situated upon higher ground (130 maOD) at the northern end of the Oldbury void. These lagoons have a combined surface area of circa 4,000 m$^2$.

5.6.14 Stokes’ Law for free settling in quiescent conditions states that a flow velocity through the lagoons of $1 \times 10^{-5}$ m/s should ensure effective silt settlement.
5.6.15 Multiplying the area of the lagoons (4,000 m²) by the above velocity (1x10⁻⁵ m/s), it is calculated that a flow rate of 0.04 m³/s (40 l/s) would be acceptable.

5.6.16 This is sufficient to cope with the anticipated dewatering process, where a flow rate of up to 2,600 m³/day (30 l/s) will be passing through the lagoons.

5.6.17 The existing lime-dosing facility will be used (when necessary) to ensure that the pumped water achieves limits specified in the Discharge Consent T/19/35436/T.

5.6.18 More recent work regarding the discharge process (the BLM report, *appendix 8*) has focussed upon dissolved heavy metals such as Cadmium, Nickel and Zinc, none of which are covered by the Consent but are highlighted by the EA as an issue for further investigation.

5.6.19 The BLM report concluded that the issue with regard to heavy metals (Cadmium, Nickel and Zinc) in Oldbury Stream is considerably diminished when viewed in the context of the following key factors: the natural background metal loading that would have been apparent in the pre-quarry setting; the long history of quarrying (in excess of 100 years) such that the ecosystem of the stream will have adjusted to the heavy metal content; the difference between total metal content and bioavailable fraction; and the dilution capacity afforded by the River Anker.

5.6.20 The Western Landform will utilise in the region of 1.5 million m³ of overburden and shale. Given Site experience with respect to acidified drainage waters coming from the overburden tips, core samples have been retrieved from the shale horizons and subjected to Waste Acceptance Criteria (WAC) testing.

5.6.21 Most importantly, the WAC eluate data suggests that the concentration of dissolved heavy metals (cadmium, nickel and zinc) in the drainage waters seeping from the shale waste within proposed landform will be of lesser magnitude than the current situation, as described in the BLM report.
5.6.22 Despite these results, the limitations of the shale sampling programme (e.g. WAC testing was restricted to key horizons) mean that a precautionary approach is adopted, whereby it is assumed that water quality arising from the Western Landform will be consistent with the more difficult data given in the BLM report *i.e.* a continuation of the current situation.

5.7 **Impact Assessment – Purley Void**

5.7.1 Assessment of the implications of the 100-year storm event has been undertaken in respect of the catchment area (17 Ha) presented by the restored Purley landform.

5.7.2 The employed assessment procedure ensures that the requisite attenuation storage volume (ASV) and long term storage volume (LTV) be incorporated into the development *i.e.* to store a proportion of rainfall run-off on Site till after the storm has abated.

5.7.3 On the basis of the above procedure, it is proposed that the new drainage infrastructure in the Purley void should include the following key elements:

5.7.4 The first stage of the system should comprise a flow-balancing pond (detention basin). The key is to ensure that there is sufficient capacity to accommodate the total stormwater volume (4,919 m$^3$) *e.g.* a pond measuring 125 m by 40 m, with a storage depth of 1 m in readiness for the 100-year storm event.

5.7.5 The outlet from the flow-balancing pond should be restricted to a flow rate of 5 l/s using orifice plates. Even allowing for a margin of error of up to 1.5 l/s, this flow rate will satisfy the projected average discharge requirement (300 m$^3$/day). The rate will be subject to review once further monitoring data has been collected.

5.7.6 The aforementioned outlet (*i.e.* the pipe restricted to 5 l/s) should be installed at least 1 m below the brim of the flow-balancing pond. In this way, 1 m freeboard will be maintained during dry periods, in readiness for the onset of the design storm. As back-up, the pond should include an overflow channel.
5.7.7 Depending upon water quality, the detention basin will drain under gravity to the (currently disused) discharge point at the northern end of the Purley void, thus allowing controlled overflow to the Rawn Hill Brook.

5.7.8 Given current experience in the catchment area, it is evident that there will continue to be risk of acidification of ingress water within the restored void at Purley (due to natural chemical decomposition of sulphide minerals in the diorite sills and country rock).

5.7.9 Until water quality is proven acceptable, the quarry operator will retain the existing infrastructure for pumping over to Oldbury. This will serve as a fallback option in the event of “teething” problems e.g. compliance with water quality targets.

5.7.10 The proposed discharge rate complies with the volumetric constraints of the existing (but disused) Discharge Consent T/19/07655/T, which permits the Applicant to discharge 455 m³/day to Rawn Hill Brook.

5.7.11 Currently, the only water quality constraints in the above Consent are as follows: The limit for suspended solids equates to 50 mg/l and pH should be between 5-9. Non-volatile matter extractable by light petroleum must be restricted to less than 5 mg/l. New constraints/parameters will need to be added to the Consent in light of the acidification issue.

5.7.12 Across the entire Site, the risk of hydrocarbon spillages will be minimised by enforcing working procedures that conform to the Preferred Fluids HANDLING Protocol as described in this report. Trained personnel will undertake all refuelling and maintenance, following relevant environmental standards.

5.7.13 In the unlikely event of a hydrocarbon spillage, a contingency plan will be followed for containing and safely disposing of any contaminant. It is considered that these measures would prevent groundwater contamination during operation of fixed and mobile plant.
5.7.14 With regard to the Screening and Processing of Recycled Asphalt Product (RAP), the Applicant will adhere to nationwide protocol for Handling, Recycling and Storage of Waste Asphalt. The aim is to ensure that recycled and recovered aggregates are manufactured in a controlled manner in order to meet national / proprietary specifications and customer requirements in accordance with quality protocol for the production of aggregates from waste asphalt.

5.7.15 Focusing upon the risk posed by road planings containing coal tar, the supplier of any road planings has Duty of Care for the raw material. They must provide the first safety check: namely, testing the material at source and ensuring that any planings containing coal tar get sent to an authorised waste facility.

5.7.16 Lafarge Tarmac routinely tests the waste stream by spraying the planings with an approved reactant (similar to white paint). If the “paint” stays white, the planings are free from coal tar. If the “paint” turns yellow, this is indicative of coal tar contamination. In this instance, the supplier has Duty of Care and must pay for the planings to be removed from Site and delivered to a hazardous waste facility.

5.7.17 It is important to note that road planings containing coal tar have limited leaching potential (assuming that they are not subject to thermal degradation). This is reflected by the S2 Exemption, which allows for the storage of up to 500 tonnes of such waste for 12 months in a secure place. It is noteworthy that the waste does not need be stored in a container and the storage place does not require sealed drainage.

5.7.18 The implementation of the treatment systems, engineering measures and fluids handling protocol advanced to protect groundwater quality will, in turn, serve to safeguard the surface water environment and water supplies.
5.7.19 On the basis of baseline study and subsequent impact assessment, there are considered to be no over-riding hydrological or hydrogeological related reasons why the Proposed Development should not proceed in the manner described by the Application. This conclusion assumes that any permission, if granted, should be conditioned by implementation and adherence to any relevant recommendations advanced within this report and other such conditions that may be reasonably imposed by the Planning Authority and subject to the considerations of ecological specialists of the findings presented herein.

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June 2014
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MANCESTER QUARRY
Atherstone, Warwickshire

Proposal to Extend Existing Quarry Workings

Hydrogeological and Hydrological Assessment

June 2014

APPENDIX I
Figures