Suttles Stone Quarries

Swanworth Quarry
Worth Matravers, Dorset

Consultation on the Bournmouth, Dorset & Poole Minerals Site Allocation Plan Swanworth Quarry Extension (PK16)

Preliminary Hydrological & Hydrogeological Risk Assessment

16th December 2016

Report Prepared For:

Suttles Stone Quarries
Swanworth Quarry
Worth Matravers, Swanage
Dorset
BH19 3LE

Tel: 01929 439444
Fax: 01929 439446
Email: info@suttles.co.uk

Consultant Hydrogeologists Limited

Technology Centre
Wolverhampton Science Park, Wolverhampton, WV10 9RU
Tel: 01902 824111, Fax: 01902 824112
email: info@bclhydro.co.uk
web: http://www.bclhydro.co.uk

Company Registration Number: 4043373
Registered in England & Wales. Registered Office: 33, Wolverhampton Road, Cannock

Suttles Stone Quarries

Swanworth Quarry
Worth Matravers, Dorset

Consultation on the Bournmouth, Dorset & Poole Minerals Site Allocation Plan Swanworth Quarry Extension (PK16)

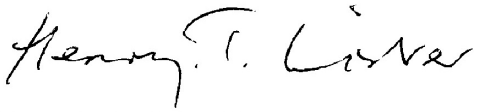
Preliminary Hydrological & Hydrogeological Risk Assessment

16th December 2016

Report Prepared By:

Gavin Chaplin B.Sc. M.Sc.
Senior Hydrogeologist

Report Checked By:



Henry Lister B.Sc. M.Sc.
Senior Hydrogeologist

Consultant Hydrogeologists Limited

Technology Centre
Wolverhampton Science Park, Wolverhampton, WV10 9RU
Tel: 01902 824111, Fax: 01902 824112
email: info@bclhydro.co.uk
web: http://www.bclhydro.co.uk

Company Registration Number: 4043373
Registered in England & Wales. Registered Office: 33, Wolverhampton Road, Cannock

DOCUMENT HISTORY				
Date	Version No.	BCL Ref.	Comments / Principal Amendments and / or Expansion	Issued to:
05/12/16	01	QPL.SSQ.Swth .MPS16.01	Initial Draft for Client & Agent review.	Quarryplan Limited
16/12/16	F1	QPL.SSQ.Swth .MPS16.01	Final Draft following Client & Agent review.	Quarryplan Limited

Contents Page Number

FIGURES

TABLES

APPENDICES

BCL CONSULTANT HYDROGEOLOGISTS LIMITED EXPERIENCE & QUALIFICATIONS

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

Gavin Chaplin (the author of this report) holds a first degree [Geology] conferred by Keele University, 1990 and a Master of Science Degree [Groundwater Engineering], Newcastle University, 1993.

BCL has provided specialist services and advice to the extractive industry since 1990.

BCL's work has included:

(i) Installation and management of information collection systems;
(ii) Data interpretation;
(iii) Conceptualisation of hydrogeological systems;
(iv) Identification of potential impacts;
(v) Formulation of mitigation measures;
(vi) Management and undertaking of operational impact monitoring and impact assessment;
(vii) Review and auditing of contingency mitigation schemes; and
(viii) Reporting in connection with proposed developments within varying hydrogeological terrains at over 225-no. quarries throughout the British Isles.

1 INTRODUCTION

1.1 Planning Background

1.1.1 Swanworth Quarry (the Site) is operated by Suttles Stone Quarries (SSQ) for the extraction and processing of Portland Limestone to produce aggregates for supply to the highways and general civil engineering markets. Quarrying operations are authorised by several permissions, the most recent being dated 24 June 2013 (ref. PL\1487\12 [6/2013/0187]).

1.1.2 Constraints directly relating to the protection or enhancement of the water environment conditioned by the permissions are limited to fluids handling and storage and a restoration commitment concerning provision of a compensation pond.

1.1.3 The Site receives inert wastes which are processed to produce re-cycled aggregates for re-sale and screened clay-based materials that are used in conjunction with indigenous waste stone for site restoration. This operation is authorised by Environment Agency (EA) Permit No. EPR/CB3030RQ, dated 20/02/2012.

1.1.4 The Permit specifies waste types and volumes that may be used in restoration and mandates a Waste Recovery Plan. The Plan provides specifications for materials screening and testing and includes enumerated Waste Acceptance Criteria to ensure only inert materials are used in Site restoration for the protection of the water environment.

1.2 Proposed Extension

1.2.1 SQQ have formally proposed a north-western satellite extension (the Proposed Extension) to the existing Site to the emerging local Minerals Plan. The plans for the Proposed Extension have been subject to various revisions during the design process, the revisions being made chiefly in the interests of minimising impact upon the local landscape.

1.2.2 The current proposals involve the engineering of a tunnel to link the existing quarry with the extension. It is also proposed to continue the importation and recycling of inert wastes, a proportion of which, together with indigenous waste stone, will be used to restore the quarry void of the Proposed Extension back to currently prevailing ground levels.

1.3 Minerals Plan Status & Proposed Planning Application

1.3.1 The Proposed Extension has been included as a "Consultation Site" (PK16) within the Bournemouth, Dorset and Poole Draft Minerals Sites Plan Update, May 2016. Subject to the outcome of further consultation, the Proposed Extension may be identified as an "Allocated Site" within the forthcoming Pre-Submission Draft Minerals Sites Plan, which is anticipated to be published during February 2017.

1.3.2 Assuming confirmation as an Allocated Site, it is understood that SQQ anticipated the preparation and submission of an Application seeking planning permission for the Proposed Extension during 2017.

1.4 Consultancy Commission

1.4.1 BCL Consultant Hydrogeologists Limited (BCL) has been commissioned by SQQ to undertake a preliminary Hydrological and Hydrogeological Risk Assessment (pH&HRA) of the Proposed Extension, the findings of which are reported herein.

1.5 Purpose, Methodology & Outcomes of pH&HRA

1.5.1 This report is intended to inform consultations towards finalisation of the emerging Pre-Submission Draft Minerals Sites Plan and presents preliminary findings regarding:

i. Baseline characterisation of the local water environment;
ii. Evaluation of effects to date;
iii. Impact screening of the Proposed Extension upon that environment, and;
iv. Requirements for further information and assessment.

1.5.2 Collection and interpretation of published data, in conjunction with site specific information provided by SQQ, has facilitated the development of a preliminary conceptual model describing the nature of, and interactions between, the groundwater and surface water systems operating within the area of the Site.

1.5.3 The conceptual model has been employed to assist a screening exercise designed to identify the likely impacts of the Proposed Extension upon the water environment and determine requirements for further information. The assessment reported herein should therefore be viewed as an initial stage of the conventional Environmental Impact Assessment (EIA) process.

1.6 Scope of pH&HRA

1.6.1 The scope of assessment has been informed by national and local planning policies and associated guidance which reinforce the need to pay due regard to the likely effect of the Proposed Extension upon the water environment.

1.6.1 National Planning Policy & Guidance

1.6.1.1 Where appropriate, the methodology and scope of site-specific data-collection and approach to impact assessment and mitigation have been informed by prevailing national guidance, including:

i. "National Planning Policy Framework" (NPPF), Department for Communities and Local Government (DCLG), March 2012;

ii. "Technical Guidance to the National Planning Policy Framework" (tgNPPF), DCLG, March 2012;

iii. "Flood Risk and Coastal Change, Planning Practice Guidance" (NPPG), DCLG / Department for the Environment Food and Rural Affairs (DEFRA), 6th March 2014;

iv. "Development and Flood Risk: A Practice Guide Companion to PPS25" (PPS25pg), DCLG, February 2009;

v. "Rainfall Runoff Management for Developments", joint DEFRA / Environment Agency (EA) Flood and Coastal Erosion Risk Management R&D Programme, Report SC030219, R Kellagher, October 2013;

vi. "Hydrogeological Impact Appraisal for Dewatering Abstractions", EA Science Report SC040020/SR1, April 2007, and;

vii. "Groundwater Protection: Principles and Practice" (GP3) Version 1.1, EA, August 2013.

1.6.2 Local Planning Policy

1.6.2.1 Local policy documents consulted as part of the assessment have included:

i. "Bournemouth, Dorset and Poole Draft Mineral Sites Plan, July 2015;

ii. "Bournemouth, Dorset and Poole Draft Mineral Sites Plan Update, May 2016;

iii. "Bournemouth, Dorset and Poole Draft Mineral Sites Plan, Sustainability Appraisal", 23-05-2016.

iv. "South West River Basin District River Basin Management Plan", EA, February 2016.

v. "Dorset County Council, Strategic Flood Risk Assessment, Bournemouth, Dorset & Poole, Level 1 SFRA for Minerals & Waste", Volume 1, Halcrow Group Limited, 2010;

vi. "Purbeck Local Plan Partial Review, Strategic Flood Risk Assessment", Purbeck District Council, January 2015.

vii. "Dorset Water Framework Directive (WFD) Management Area, Abstraction Licensing Strategy: Dorset Stour and Frome, Piddle and West Dorset catchment Abstraction Management Strategy (CAMS)", EA, December 2012, and;

viii. Water Resource Availability On-Line Digital Mapping, EA, September 2015.

1.6.3 Project Specific Guidance

1.6.3.1 Assessment has also been informed by a formal EA consultation upon the Draft Minerals Sites Plan1, which advised as follows:

" *We understand some additional information has become available regarding private water supplies in the vicinity of the proposed minerals allocation at Swanworth Quarry. Given the proximity to private supplies down gradient of the site we believe the required Hydrogeological Risk Assessment should be carried out prior to allocation. It may be that that the Hydrogeological Risk Assessment guides the processes for ascertaining the extent (and depth) of land that would be suitable for extraction. Without that, there would be a risk that unsuitable land would be formally 'allocated'* ".

1.6.3.2 Many, if not the majority of quarry developments may be said to pose a ***prima facie*** risk to abstractions in their vicinity. However, the matter is not one which would ordinarily require examination at the site allocation stage of Minerals Plan development.

[1] Letter to Trevor Badley, Principal Planning officer, DCC, from Matherine Burt, Sustainable Places – Planning Specialist, EA, 11/08/16, EA reference WX/2006/000372/SL-06/IS2-L01.

1.6.3.3 Instead, it is generally assessed as part of EIA at the planning application stage. Indeed, the EA's request for pre-allocation assessment of the Proposed Extension in the context of potential impact upon existing abstractions is unique in BCL's experience.

1.7 Data Sources

1.7.1 Published and site specific data sources, together with assessment guidance and calculation methodologies referenced during assessment and / or appropriate to further future assessment are listed at *appendix 1*.

1.8 Report Structure

1.8.1 Baseline characterisation of the topography, geology, hydrology and hydrogeology of the study area, concluding with a conceptual model of the extant water environment, is presented at *section 2*.

1.8.2 An account of the Proposed Extension, including description of intended working methods, depths, elevations and water management measures, both during operations and for the support of the proposed restoration, is given at *section 3*.

1.8.3 Impact screening of the Proposed Extension, together with identification of further data requirements and risk assessment, is made at section 4. Report summary, recommendations and conclusions are given at *sections 5*, *6* and *7* respectively.

1.9 Key Facets of the Proposed Extension Pertinent to pH&HRA

1.9.1 The key elements of the design of the Proposed Extension and its hydrogeological setting considered central to risk assessment are:

i. Extraction of mineral within the Proposed Extension will be undertaken in a manner that is equivalent to historical workings undertaken at the Site;

ii. On the basis of the available information, the limestones to be worked as part of the Proposed extension are free of groundwater, the underlying Portland Sands holding a piezometric surface c.10m below the base of the limestone units;

iii. There will be no workings beneath the level of groundwater; mineral extraction will be made dry using conventional drilling and blasting techniques without recourse to dewatering;

iv. Recovery of pre-existing ground levels within the proposed Extension will be achieved by deposition of processed inert waste materials which will be undertaken progressively and concurrent with mineral extraction to minimise the duration of visual impact upon the local landscape;

v. The deposit of inert waste materials for restoration will be subject to appropriate formal risk assessment as part of the EA's permitting process; the risk assessment will assess the need for and specifications of any engineered containment and associated monitoring judged to be necessary;

vi. Upon cessation of quarrying activities within the Proposed Extension, all plant and machinery will be removed and the restoration finalised to create a combination of agriculture and wildlife habitats, and;

vii. No part of the existing quarry or Proposed Extension lies within lands designated by the EA to be at risk of tidal, fluvial or surface water flooding.

2 THE SITE

2.1 Site Location

2.1.1 The Site is located upon the southern margin the Isle of Purbeck peninsula, immediately adjacent to the Purbek Way, c.630 metres (m) northwest of Worth Matravers, 1.67 kilometres (km) southwest of Kingston and c.3.3km south of Corfe Castle, Dorset.

2.1.2 The National Grid Reference (NGR) for the approximate centre of the Site is ^{3}9698, ^{0}7824; the Site location is illustrated at *figure 1*.

2.2 Topography

2.2.1 Regional

2.2.1.1 The landscape of the area is dominated by distinct west to east oriented topographic trends that reflect the underlying geology.

2.2.1.2 The Purbeck Hills, situated c.3.8km north of the Site at their closest approach, form a narrow ridge attaining almost 200 metres above Ordnance Datum (maOD) that spans the peninsula from Worbarrow Bay in the west to Ballard Point in the east.

2.2.1.3 Paralleling the Purbeck Hills to their south runs a broader but shallower west to east oriented coastal plateau-ridge upon which the Site is situated.

2.2.1.4 The local plateau attains c.120maOD and spanning the coastline from Brandy Bay in the west to Durlston Head in the East.

2.2.1.5 The two west areas of elevated ground are separated by lower lying ground of the Wealden Valley, the floor of which resides at between 40maOD and 50maOD.

2.2.1.6 The Purbeck Hills are underlain by Chalk whilst the coastal ridge to its south is underlain by limestones; both more resistant to erosive weathering than the sandstones and mudstones underlying the intervening Wealden Valley.

2.2.2 Local

2.2.2.1 The Site is situated at the head of a steeply incised northeast to southwest oriented valley which broadens southwards to open to the coast at Chapmans Pool.

2.2.2.2 Ordnance Survey (OS) mapping refers to the northern Y-shaped reach of the valley, where it abuts the north-western Site boundary, as Combe Bottom and names the lower reaches, to the southwest of the Site, as Hill Bottom; these sections collectively referred to here as the Quarry Combe.

2.2.2.3 The two upper limbs of Quarry Combe slope from c.120maOD to c.90maOD where they converge to abut the north-western Site boundary, from where the combe falls at an average gradient of 1:20 (0.05) towards the coast.

2.2.2.4 Quarry Combe is joined midway along its traverse towards the coast by two minor parasitic valleys that open into the main valley upon western and eastern flanks.

2.2.2.5 Quarry Combe is joined at its coastal mouth by the north to south oriented Westhill Combe.

2.2.2.6 Westhill Combe originates c.1.1km west of the Site at c.127maOD, falling and broadening southwards towards the coast at an average gradient of 1:11.5 (0.086).

2.2.2.7 Two further steeply incised valley's, Winspit Bottom and Seacombe Bottom, open to the coast beyond higher ground to the south and southeast of the Site

2.2.2.8 The topography of the area surrounding the Site is illustrated at *figure 2*.

2.3 Local Land Use & Site Composition

2.3.1 The Site is an active consented limestone quarry with a boundary area of c. 32.9 hectares (ha) situated amongst rural agricultural lands that are predominantly under pasture and arable use.

2.3.2 The lands surrounding the quarry void generally rise southwards such that peripheral elevations range from c.100maOD in the north to 110maOD in the south.

2.3.3 The currently active area of mineral extraction is located within the north-eastern section of the Site, where workings have progressed over a number of benches to an elevation of c.78maOD.

2.3.4 The upper benches along the quarry's eastern boundary have been restored to regular slopes using quarry waste stone.

2.3.5 Site offices, weighbridge and car parking facilities are situated to the north of the active area of mineral extraction, adjacent the quarry entrance road which parallels the northern Site boundary.

2.3.6 The south-eastern section of the Site is undergoing restoration, processed imported inert waste and quarry waste stone being used to create regular slopes against the exhausted quarry faces in this area.

2.3.7 The south-western section of the Site contains areas given over to mineral processing plant, mineral stocking, quarry offices, maintenance workshops, welfare facilities and vehicle parking, this area residing within a relatively level area at c.80maOD.

2.4 Quarry Operations

2.4.1 Mineral Extraction

2.4.1.1 Mineral extraction is undertaken using conventional drilling and blasting techniques, workings having progressed to a basal elevation of some 78maOD within the current extraction area.

2.4.1.2 Extraction has taken place over four principal benches with a maximum face height between individual benches of c.10m.

2.4.1.3 From review of historical surveys produced from 1987 onwards, the lowest section of mineral extraction over the last 30-years appears to be situated against the central eastern Site boundary.

2.4.1.4 Now over-tipped and restored, historical survey indicates workings in this area to have progressed downwards to c.71maOD.

2.4.2 Mineral Processing

2.4.2.1 As blasted limestone is loaded by hydraulic excavator to wheeled dump trucks for transportation to a fixed primary crusher, located in the plant area within the south-eastern section of the Site.

2.4.2.2 The resultant primary aggregate is fed through a series of vibrating screens and a secondary crusher, also located within the plant area, to produce a range of product sizes.

2.4.2.3 In recent years the Site has typically produced some 100,000 tonnes per annum (tpa) of aggregate; future production is anticipated to be maintained at, or around, this level.

2.4.3 Recycling & Deposit for Recovery

2.4.3.1 Imported inert wastes are stored, screened and crushed at the Site to produce recycled aggregate for re-sale into the local construction and civil engineering markets and recovered materials for use in restoration of the Site.

2.4.3.2 The operation is authorised by EA Permit No. EPR/CB3030RQ, which allows recycling for re-sale of 30,000tpa and the deposit of 75,000tpa of recovered materials for restoration.

2.4.3.3 The Permit specifies a schedule of permissible materials (using European Waste Codes [EWC's]) that may be recycled with a more restrictive schedule applying to recovered materials deposited for restoration.

2.4.3.4 Processed recovered wastes permitted to be used in Site restoration are listed below at *table 1*.

Table 1: Permitted Recovered Waste Types for use in Quarry Restoration

EWC	Description	EWC	Description
01 04 08	Waste gravel and crushed rocks other than those mentioned in 01 04 07*	17 01 03	Tiles and ceramics
01 04 09	Waste sands and clays	17 01 07	Mixtures of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06***
01 04 13	Wastes from stone cutting and sawing, other than those mentioned in 01 04 12**	19 01 19	Sands from fluidised beds.
10 12 08	Waste ceramics, bricks,, tiles and construction products (after thermal processing)	19 08 02	Waste from desanding – washed sewage grit only.
17 01 01	Concrete	19 08 99	Wastes not otherwise specified – stone filter media free from sewage contamination
17 01 02	Bricks	19 12 09	Minerals (for example, sand, stones)

*01 04 07: wastes containing dangerous substances from physical and chemical processing on non-metalliferous minerals.
**01 04 12: tailings and other wastes from washing and cleaning of minerals.
***17 01 06: mixtures of, or separate fractions of concrete, bricks, tiles and ceramics containing dangerous substances.

2.4.3.5 The Permit requires adherence to a Waste Recovery Plan[2] which specifies Waste Acceptance Criteria (WAC) for the protection of groundwater quality by ensuring that only inert materials are used in the restoration of the Site.

[2] "Waste Recovery Plan for Swanworth Quarry", Mott McDonald for SQQ, September 2011, Document Ref. EES/286952/B4/01C.

2.4.3.6 The WAC values specified by the Permit represent maximum permissible eluate concentrations (which accord with those required by the relevant regulations[3]) for several determinands that are applied in evaluation of the results of leaching test carried out upon waste materials prior to and / or after importation to the Site.

2.4.4 Historic & Current Water Management

2.4.4.1 Excepting isolated and periodic shallow ponding of incident rainfall, the quarry is free draining.

2.4.4.2 Internal pumped transfers or off-site pumped discharge of water has not historically been required and neither of these operations is currently undertaken or anticipated.

2.4.4.3 The wash-down area serving the maintenance workshop drains, via hydrocarbon interceptor, to a soak-away located adjacent to a relict quarry face at the south-western boundary of the Site.

2.4.5 Water Supply & Foul Water Disposal

2.4.5.1 All Site water requirements are met by piped mains supply, consumption reportedly averaging c.270m3 per month.

2.4.5.2 The principal uses of mains water at the Site are mineral processing (c.63%) and dust suppression (c.7%); the remainder used for potable, sanitary and wash-down applications.

2.4.5.3 Foul water is collected in a Klargester-type system, the tank being emptied as required; typically every 3 to 4-years.

2.4.5.4 The tank contents are classed as hazardous waste and removed from site by licensed carrier, regulated by the waste transfer note system.

2.5 Statutorily Protected Sites

2.5.1 There are no Special Protection Areas (SPA's), Ramsar Sites, National nature Reserves (NNR), Nature Reserves (NR), within a 2.5km radius of the combined boundaries of the currently permitted or Proposed Extension areas.

[3] Council Decision of 19 December 2002 establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC – "The Landfill Directive" (2003/33/EC).

2.5.2 Summary details for Sites of Special Scientific Interest (SSSI's) & Special Areas of Conservation (SAC's) within 2.5km of the Site boundaries are given below at table 2, their locations and boundaries mapped at *figure 3* and citations included at *appendix 2*.

Table 2: Statutorily Protected Sites		
Site Identification	Distance and Direction from Site	Type
South Dorset Coast SSSI	0m SE	B & G
Isle of Portland to Studland Cliffs SAC	0m SE	B & G
Corfe Common SSSI	1.87km NW	B
Blashenwell Farm SSSI	2.5km NW	G
*-at shortest distance between currently consented site and designated site, B – Biological, G – Geological		

2.5.3 The lands comprising the coastal fringe to the south of the Site form part of the South Dorset Coast Site of Special Scientific Interest (SSSI).

2.5.4 The local section of this SSSI, the boundary of which extends locally up Quarry Combe to directly abut the south-eastern margin of the Site, is also designated as Special Area of Conservation (part of the Isle of Portland to Studland Cliffs SAC).

2.5.5 Both the SSSI and SAC citations have been conferred due to abundant nationally and internationally important geological, physiographic and ecological interest.

2.6 Landfill Sites

2.6.1 Data supplied by the EA confirms that there are no operational or historic landfills within either the existing permission or planned extension boundaries of the Site.

2.6.2 Summary details of known operational and historic landfill in the area of the Site are given below at *table 3*; the locations of which, as taken from the EA's Public Register, are illustrated at *figure 4*.

Table 3: Summary Details for Landfill in the Vicinity of the Site					
Site Name	EP Ref.	Address	Status	Class	Operator
Gallows Gore Landers Quarry		Langton Matravers, Swanage, Dorset	Historic	Largely non Biodegradable / putrescible	NI
D & P Lovell Quarries	EAEPR\EA/ EPR/QP35 97HZ/A001	Downs Quarry, Kingston Road, Langton Matravers, Swanage, Dorset, BH19 3JP	Active	Largely non Biodegradable / putrescible	D & P Lovell Quarries
Downs Quarry			Historic	Inert & Industrial	NI
Gallows Gore Quarry		Langton Matravers, Swanage, Dorset	Historic	Inert & Industrial	NI
Acton Quarries No.1		Langton Matravers, Swanage, Dorset	Historic	Largely non Biodegradable / putrescible	NI
Acton Quarries No.2			Historic	Inert	NI
Acton Quarries No.3			Historic	Inert	NI
NI = No Information					

2.7 Regional Geology

2.7.1 Background

2.7.1.1 The geology within and surrounding the Site has been characterised by reference to:

i. GSNI & GSI maps and publications;

ii. Geological logs of mineral evaluation boreholes drilled at the Site;

iii. Geological & Hydrogeological reports made in respect of historical planning matters at the Site;

iv. Experience of similar quarry operations within the region, and;

v. The results of historical mineral evaluation drilling undertaken within and immediately surrounding the Site.

2.7.2 Solid Geology

Overview

2.7.2.1 The distribution of the solid strata within the southern part of the Isle of Purbeck is illustrated at *figure 5* which shows the bedrock geology to be dominated by Jurassic and Cretaceous sediments and carbonates.

Regional Structure

2.7.2.2 The strata reside within an anticline, the axis of which is oriented from west to east and passes close to the north of the Site.

2.7.2.3 Whilst situated close to its core, the Site is located on the southern limb of the anticline, the strata here strata dipping sub-horizontally southwards towards the coast.

2.7.2.4 The very shallow dip of the anticline's southern limb gives rise to little stratagraphic variation at subcrop upon the Purbeck Plateau with distance south from its core.

2.7.2.5 The exceptions to this are the steeply incised combes that open to the coast; the erosional effects that have created the combes revealing progressively older strata down the valley flanks.

2.7.2.6 The northern limb of the anticline is considerably steeper at c.25˚, resulting in progressively younger strata at immediate sub-crop with increasing distance northwards away from its core.

Stratigraphy

2.7.2.7 The published stratigraphy of the Site area is summarised below at table 4.

Table 4: Summary Published Local Stratigraphy

Period	Subgroup	Formation	Member	Lithology	Thickness
Cretaceous	White Chalk	Portsdown Chalk		Chalk	
		Seaford Chalk			
		Lewes Chalk			
		Holywell Nodular Chalk			
	Grey Chalk	Zig Zag Chalk			
	Greensand	Upper Greensand		Sands, Sandstones and Mudstones	
		Gault Formation		Sandy Mudstones	
		Lower Greensand		Sands, Sandstones and Mudstones	
		The Wealden		Extensive units of Sandstone and Mudstone with laterally discontinuous coarse-grained Sandstones.	
	Purbeck Group	Durlston	Peveril Point	Multiple Limestones, Micritic Mudstones and Mudstone units with varying calcitic content	
			Stair Hole		
		Lulworth	Worbarrow Tout		
			Mupe		14m to 18m
Jurassic	Portland Group	Portland Stone	Portland Freestone	Limestones	10m to 15m
			Portland Chert		10m to 15m
		Portland Sand		Sandstones	20m to 50m
		Kimmeridge Clay		Mudstones (calcareous or kerogen-rich or silty or sandy); thin siltstone and cementstone beds; locally sands and silts	Up to 465m

Succession & Lithology

2.7.2.8 The strata of the area form an almost continuous unbroken sequence with the only hiatus being between the Green Sand Formation which lies unconformably on top of the Wealden Formation.

Kimmeridge Clay Formation

2.7.2.9 The oldest strata of the area are Jurassic Kimmeridge Clays, which constitute solid sub-crop across the lower sections of Quarry Combe and Westhill Combe to the south-west of the Site

2.7.2.10 BGS mapping shows the upper boundary of the Kimmeridge Clay within the two Combes to reside between c.82maOD and c.57maOD, suggesting an eastward downward dip component superimposed upon the more general southwards dipping regional structure.

2.7.2.11 The Kimmeridge Clay is described by the BGS as a sequence of up to 465m of mudstones (calcareous or kerogen-rich or silty or sandy); thin siltstone and cementstone beds and which can locally contain sands and silts.

2.7.2.12 A cored borehole drilled by Tarmac in 1989 ("BH10"; *figure 6*), c.100m west of the Proposed Extension (NGR: 396300, 078700 at a collar elevation of 139.9maOD), determined the upper surface of the clay to reside at 48.8 metres below ground level (mbGL) at an elevation of 91.1maOD.

2.7.2.13 The geological log for the borehole (included here at *appendix 3*), which penetrated the upper 31.7m of the clay, describes the upper 10.9m of the strata as dark grey, thinly laminated mudstone with occasional sandstone and siltstone bands, underlain by 20.8m of dark grey slightly clayey siltstone.

Portland Sand Formation

2.7.2.14 The Kimmeridge Clay is conformably overlain by the Jurassic Portland Sand Formation, the lower part of the Portland Group, which has a locally apparent thickness of c.35m exposed within the combes to the south of the Site.

2.7.2.15 The Portland Sand is described by the BGS as a sequence of between 20m and 50m thickness, the lower part comprising mixed siliciclastic and carbonate sediments, including bioturbated clay-rich siltstones, fine-grained sandstones and silty mudstones with variable amounts of calcite and dolomite, some beds being shell-rich, especially with oysters.

2.7.2.16 The upper part of the formation is described to comprise purer carbonate lithologies, including finely crystalline, bioturbated dolomite (usually described as sandstone in lithological accounts).

2.7.2.17 Tarmac's 1989 cored borehole BH10 determined the sand to be c.14.1m thick, with its upper surface residing at 34.7mbGL; an elevation of 105.2maOD.

2.7.2.18 The geological log for the borehole describes the strata as a grey thinly laminated fine to medium grained sandstone with occasional siltstone bands.

2.7.2.19 The argillaceous sections of the formation are described as very clayey with closely spaced narrow joints, some being filled with calcite.

Portland Stone Formation

2.7.2.20 The Portland Sand is conformably overlain by the Portland Stone Formation, the upper part of the Portland Group, and the economic mineral of the Site operations.

2.7.2.21 The Portland Stone locally comprises a lower Portland Chert Member (BGS: 15m to 22m thick) and an upper Portland Freestone Member (BGS: 10m to 15m thick).

2.7.2.22 The Portland Chert is described by the BGS to comprise buff-coloured lime-packstones and lime-wackestones with conspicuous black nodular chert and horizons of tabular chert.

2.7.2.23 The lower boundary of the Portland Chert is transitional, and is recognised as a conformable upward facies change from the fine-grained dolomitic limestone of the underlying Portland Sand.

2.7.2.24 The upper boundary of the Portland Chert also occurs over a facies change; the BGS recording the transition from its chert-bearing lime-packstones and wackestones to massive ooidal grainstones of the overlying Portland Freestone.

2.7.2.25 On the Isle of Purbeck, where the full sequence of the Portland Freestone is present, its uppermost bed comprises a massive calcilutite known as the Shrimp Bed, yielding remains of Callianassa; however, this upper bed was not encountered within Tarmac's BH10.

2.7.2.26 Tarmac's BH10 determined the Portland Stone Formation present at the Site to be c.33.6m thick, with its upper surface residing at 1.1mbGL below shallow soils; at an elevation of 138.8maOD.

2.7.2.27 The geological log for the borehole describes the strata as a light brown, thinly laminated, sandy limestone with abundant chert nodules.

Purbeck Group

2.7.2.28 The Portland Stone Formation quarried at the Site is conformably overlain by the Purbeck Group, the lowest (and hence oldest) strata of which belong to the Mupe Member.

2.7.2.29 The Mupe is mapped by the BGS to constitute subcrop beneath soils over the extreme eastern (now restored) boundary of the existing quarry and similarly across c.4% of the north-easternmost part of the Proposed Extension.

2.7.2.30 The Mupe is described by the BGS as a sequence of between 14m and 18m, the lower part of which comprises white-weathering marls and micrites containing algal laminations and some evaporitic material with interbedded carbonaceous mudstones (caps, dirt beds) and localised brecciated limestone pockets (broken beds).

2.7.2.31 Limestones, particularly in the upper part of the Mupe (lower part of Cypris Freestones), are commonly Ostracod-rich micrites and sparites; detrital quartz is rare.

2.7.2.32 The succeeding (progressively younger) members of the Purbeck Group present locally above the Mupe are the Worbarrow Tout Member (BGS: 21m to 38m thick) and the Stair Hole Member (BGS: 8m to 40m thick).

2.7.2.33 These units outcrop at distance to the north and east of the Site; and, due to their distance and structural separation, are not considered in any further detail here.

Wealden Formation

2.7.2.34 The Purbeck Group is overlain by the Wealden Formation, which is present at immediate subcrop c.1.2km north of the Site.

2.7.2.35 The BGS describe the Wealden Formation to comprise interbedded thick sandstones, siltstones, mudstones ("shales"), limestones and clay ironstones of predominantly non-marine facies.

2.7.2.36 Again, due to due to the great distance from the Site and the structural separation afforded by the anticlinal structure of the Isle of Purbeck peninsula, are not considered in any further detail here.

Local Structure

2.7.2.37 The Site is located on a north to south oriented normal fault which downthrows to the east bringing older strata to its west into lateral juxtaposition with younger units to its east.

2.7.2.38 The orientation and nature of the fault corresponds with numerous north to south trending faults present along the coastline, suggesting that it is part of a wider stress regime.

2.7.2.39 Although the fault strongly influences local outcrop patterns at the Site, it is not laterally continuous and has no significant importance to the wider distribution of strata.

2.7.3 Mine Workings

2.7.3.1 Several disused stone mine workings are located upon the Purbeck Group to the east of the Site between Worth Matravers and Swanage.

2.7.3.2 The general method of mining involved sinking of a steeply inclined shaft of 30m depth or more, from which sub-horizontal galleries were driven along bedding planes parallel to the strike of the strata.

2.7.4 Superficial Deposits

2.7.4.1 Superficial deposits are almost entirely absent from the Site area, the only drift mapped by the BGS consisting of an extremely limited area of plateau gravels located c.2.7km west of the quarry.

2.8 Rainfall, Evaporation & Runoff

2.8.1 Area Statistics

2.8.1.1 The Standard Average Annual Rainfall for the Site area in the period 1961 to 1990 (SAAR6190) as reported by the FEH CD-ROM database No.3[4] is 859 millimetres (mm, SAAR4170: 889mm).

2.8.1.2 These values accord well with the annual average for the period 1981 to 2010 of 829.4mm recorded by the Meteorological Office (MO) Swanage rain-gauge.

2.8.1.3 Monthly average rainfall totals measured at the MO Swanage gauge, together with potential evaporation statistics taken from MAFF Technical Bulletin 34[5] (Area 46) are given at *table 5* below.

Table 5: Area Long Term Average Monthly Rainfall and Potential Transpiration

mm	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Total*
Area Average Rainfall (MO, Swanage)	87.2	64.6	65.2	51.9	48.2	45.9	46.5	46.2	63.9	105.8	104.7	99.4	829.5
Potential Evaporation (MAFF)	4	11	32	57	82	98	97	79	47	24	9	3	

2.8.2 Derived Values

2.8.2.1 The above data have been utilised to derive estimates of monthly average effective rainfall for both vegetated and wooded surfaces and also for open water, using the methods of Grindley[6] and EA R&D Handbook W6-043/HB[7]. These estimates are presented below at *table 6*.

[4] "Flood Estimation Handbook CD-ROM, Version 3.0", Centre for Ecology and Hydrology (CEH; formerly the Institute of Hydrology [IoH]), 2009.

[5] "Climate & Drainage", Technical Bulletin No. 34, Ministry of Agriculture Fisheries & Food (MAFF), September 1976.

[6] The Calculation of Actual Evaporation and Soil Moisture Deficit over Specified Catchment Areas", Grindley J, November 1969, Hydrological Memorandum 38, Meteorological Office (MO), Bracknell, UK.

[7] "Estimation of Open Water Evaporation, Guidance for Environment Agency Practitioners", R&D Handbook W6-043/HB, Finch JW and Hall RL, October 2001

Table 6: Derivation of Effective Rainfall for Various Surfaces using the Grindley Water Budget Method (MAFF Rainfall Data)

rc = 75 (permanent grassland); PE – Well Watered Short Grass

	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Total*
Rainfall	87	65	65	52	48	46	47	46	64	106	105	99	830
Pe	4	11	32	57	82	98	97	79	47	24	9	3	543
rf-Pe	83	54	33	-5	-34	-52	-51	-33	17	82	96	96	287
dPsmd	0	0	0	5	34	52	51	33	-17	-82	-76	0	
dAsmd	0	0	0	5	34	41	31	6	-17	-82	-18	0	
Psmd	0	0	0	5	39	91	142	174	157	76	0	0	684
Asmd	0	0	0	5	39	80	111	117	100	18	0	0	470
Ae	4	11	32	57	82	87	78	52	47	24	9	3	485
ERF	83	54	33	0	0	0	0	0	0	0	78	96	344

rc = 200mm (woodland); PE – Woodland

	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Total*
Rainfall	87	65	65	52	48	46	47	46	64	106	105	99	830
Pe	4	11	32	57	82	98	97	79	47	24	9	3	543
rf-Pe	83	54	33	-5	-34	-52	-51	-33	17	82	96	96	287
dPsmd	0	0	0	5	34	52	51	33	-17	-82	-76	0	
dAsmd	0	0	0	5	34	52	51	32	-17	-81	-76	0	
Psmd	0	0	0	5	39	91	142	174	157	76	0	0	684
Asmd	0	0	0	5	39	91	142	174	157	76	0	0	684
Ae	4	11	32	57	82	98	98	78	47	25	9	3	543
ERF	83	54	33	0	0	0	0	0	0	0	20	96	286

Open Water

	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Total*
Correction Constants	1.4	1.1	0.9	1.0	0.9	1.0	1.2	1.4	1.5	2.0	2.3	2.0	
Ae	5.7	12.5	29.4	54.2	74.6	100.0	120.3	108.2	69.1	47.8	20.6	5.9	648.3
ERF	81.5	52.1	35.8	-2.3	-26.4	-54.1	-73.8	-62.0	-5.2	58.0	84.1	93.6	181.3

rc: Root Constant
rf: Rainfall
dAsmd: Change in Actual Soil Moisture Deficit
Asmd: Actual Soil Moisture Deficit
ERF: Effective Rainfall
Pe: Potential Evaporation
Psmd: Change in Potential Soil Moisture Deficit
Psmd: Potential Soil Moisture Deficit
Ae: Actual Evaporation
All units are millimetres

2.8.3 Greenfield Runoff Rate

2.8.3.1 Computing site-specific parameters[8] with the methodology described in current lead technical guidance[9] indicate 1:1-year, 1:30-year and 1:100-year undeveloped Greenfield Runoff Rates (GRR's) applicable to the 12.97ha Proposed Extension of 2.3 litres per second (l/s), 6.2/s and 8.6l/s respectively (appendix 4).

2.8.3.2 The calculated GRR values are remarkably low, reflecting the permeable nature of soils and substrata, and subdued relief of the lands comprising the Proposed Extension.

[8] Taken from Centre for Ecology and Hydrology (CEH; formerly the Institute of Hydrology [IoH]): "Flood Estimation Handbook CD-ROM, Version 3.0", 2009 (FeH CD-ROM3).

[9] "Rainfall Runoff Management for Developments", R Kellagher, October 2013, joint DEFRA / EA Flood and Coastal Erosion Risk Management R&D Programme, Report SC030219.

2.9 Hydrology

2.9.1 Information concerning the surface water catchments, water-courses and water-bodies of the area has been obtained from:

i. Published OS mapping, published EA LIDAR height data and topographic surveying undertaken by QDL on behalf of SSQ;

ii. FEH CDRom No.3, recently superseded by the CEH's FeH Web-Service;

iii. EA digital data-sets;

iv. Report upon the private water supply network operated by the adjoining Encombe Estate[10], and;

v. Preliminary walk-over reconnaissance survey, BCL, October 2016.

2.9.1 Catchments

EA WFD River Basin District

2.9.1.1 The Site is located towards the very southern margin of the EA defined South West River Basin District.

EA WFD Operational Catchment

2.9.1.2 The Site is located within the EA's West Dorset Rivers Operational Catchment area; all 11-no. water-bodies draining which were judged during the EA's 2015 review-cycle period to be of "good" chemical status; 3-no. of "good" ecological status, 4-no. of "moderate" ecological status and 4-no. of "poor" ecological status.

2.9.1.3 Where water-bodies have not achieved objective status, none of the 27-no. identified reasons included mining or quarrying activities.

EA WFD Functional Catchment

2.9.1.4 The Site is located within an area undefined by EA functional catchment mapping, but immediately to the south of the southern extent of the Corfe River (Dorset) catchment and southeast of the Swan River (Dorset) catchment.

[10] "Encombe Estate, Report on Survey of Water Supply", Martin & Boyland (1980) Limited, Agricultural & Domestic Water Engineers, August 1986.

2.9.1.5 It is presumed that the Site lies beyond any mapped EA functional catchment due to the permeable nature of the strata and resultant paucity of surface water-courses along the coastal fringe within which it is located.

FEH Catchment

2.9.1.6 Similarly, the local mapped FEH catchment boundary, whilst encompassing the entirety of the existing quarry and majority of Proposed Extension area, leave a belt of land stretching from the northern section of the extension to Greystone Court undefined.

2.9.1.7 Again, the area of undefined surface catchment shown by FEH mapping is considered likely to be a function of the efficient percolation of the strata in this area.

2.9.1.8 The surface water catchments of the Site area, taken from EA WFD Cycle2 and FEH mapping data, are illustrated at *figure 7*.

2.9.2 Surface Water-courses

Overview

2.9.2.1 There are no surface water-courses within the boundaries of either the existing consented quarry or Proposed Extension.

2.9.2.2 The surface water-courses of the area are illustrated at *figure 7* which shows that developed perennial water-courses are rare in the vicinity of the Site.

2.9.2.3 Again, this seemingly reflects the efficient percolation drainage of incident rainfall facilitated by the absence of low permeability superficial cover and free-draining solid strata.

2.9.2.4 Drainage along the coastal fringe of the Isle of Purbeck peninsula occurs within a series of independent, short and steeply incised valleys.

2.9.2.5 Of these valleys, Quarry Combe and Westhill Combe are located to the southwest of the Site, whilst Winspit Bottom and Seacombe Bottom are located to the south and southeast respectively.

Quarry Combe Stream

2.9.2.6 The upper reaches of Quarry Combe within its course against the northwest, west and southwest boundaries of the existing consented area are dry.

2.9.2.7 OS mapping and BCL survey indicate that perennial spring-fed flow conditions within the combe initiate around NGR. ^{3}9636, ^{0}7786, c.390m south of the Site boundary at an elevation of c. 64maOD.

2.9.2.8 BGS mapping indicates that the area of perennial stream-flow coalesces mid-way up the section of the Portland Sands outcropping and forming the local flanks of the combe.

2.9.2.9 The nature of the dry-bed of the watercourse within the upper reaches of Quarry Combe suggests that flows above c.64maOD are sporadic and linked to extreme rainfall events.

2.9.2.10 Quarry Combe Stream flows south-westwards over a course of c.1.2km, from c. NGR ^{3}9636, ^{0}7786, to meet the coast at Chapmans Pool (NGR: ^{3}95613, ^{0}7706).

Westhill Combe Stream

2.9.2.11 Westhill Combe contains a spring-fed stream which coalesces around NGR: ^{3}9538, ^{0}7762, at an elevation of c.60.9maOD, to flow south-eastwards for c. 570m before converging with Quarry Combe Stream c.120m before out-falling to the sea.

Winspit Bottom

2.9.2.12 Winspit Bottom holds a stream that originates from a spring located within Worth Matravers (NGR: ^{3}9735, ^{0}7736) which is augmented by flow from a smaller spring, rising at NGR: ^{3}9757, ^{0}7661,

2.9.2.13 Winspit Bottom Stream flows over the majority of the length of the valley but is reported[11] to sink, near Winspit Cottage at NGR: ^{3}9757, ^{0}7618, where BGS mapping shows the area to be underlain by limestone of the Portland Stone Formation.

[11] "An Assessment of the Impact of the Proposed Additional Extraction and restoration on the Existing Hydrology and Hydrogeology in the vicinity of Swanworth Quarry, Dorset", Leake CC, Principal Hydrogeologist, Tarmac Quarry Products Limited, for Tarmac Roadstone (Southern) Limited, August 1993.

2.9.2.14 From here, the onward channel becomes less well defined suggesting only ephemeral flow occurs within the streams lower reaches, probably prevailing during or immediately following periods of extreme rainfall.

Seacombe Bottom

2.9.2.15 The head of Seacombe Bottom is highly dendritic, with 5 or 6-no. springs draining from a number of minor valleys reportedly[11] contributing to aggregate flow within the stream draining the combe.

2.9.2.16 As with Winspit Bottom Stream, Seacombe Bottom Stream sinks towards the mouth of the valley at NGR: ^{3}9722, ^{0}7689 where BGS mapping shows the area to be underlain by limestone of the Portland Stone Formation.

2.9.3 Surface Water-bodies

2.9.3.1 There are no surface water-bodies within the boundaries of either the existing consented quarry or Proposed Extension, the closest being situated in the grounds of Encombe House at respective distances of c.2.1km and c.1.95m.

2.9.4 Flooding

2.9.4.1 Data provided by the EA shows that no part of the existing quarry or Proposed Extension lies within lands designated by the EA to be at risk of tidal, fluvial or surface water flooding.

2.9.4.2 The position of the Site within Flood Risk Zone 1 (i.e. the lowest risk zonation, beyond the modelled limit of a 1:1,000-year return period flood event) is maintained when incorporating the anticipated effects of climate change.

2.10 Preliminary Water Features Survey

2.10.1 A preliminary water features survey was undertaken by BCL during October 2016, the results of which are summarised at *figure 8*.

2.11 Aquifer Classifications

2.11.1 The Portland Freestone and Portland Chert comprising the economic mineral of the Site are designated by the EA as a "*Principal Bedrock Aquifer*".

2.11.2 The designation is both economic and environmental, encompassing strata that have *"…high intergranular and / or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer."*

2.11.3 The Portland Sandstone and Purbeck Group which underlie and overlie the economic deposit respectively, are designated by the EA as a "Secondary A" bedrock aquifer.

2.11.4 This designation includes strata that have "*…permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.*"

2.11.5 The Kimmeridge Clay which forms the base of the local geological sequence has no formal EA aquifer designation.

2.12 Groundwater Vulnerability

2.12.1 EA mapping shows the entirety of the Site to be located within an area designated to be of "High Vulnerability" to percolation of contaminants from the surface to groundwater.

2.13 Source Protection Zones

2.13.1 Data on the locations and forms of groundwater Source Protection Zones (SPZs) in the region have been obtained from the EA which confirms that the entirety of the Site lies outwith any SPZ.

2.14 Catchment Abstraction Management Strategy (CAMS) Status

2.14.1 The Site is located within the Dorset Stour and Frome, Piddle and West Dorset catchment Abstraction Management Strategy (CAMS) area[12].

[12] "Dorset Water Framework Directive (WFD) Management Area, Abstraction Licensing Strategy: Dorset Stour and Frome, Piddle and West Dorset catchment Abstraction Management Strategy (CAMS)", EA, December 2012.

2.14.2 CAMS areas are generally divided into surface water Assessment Points (AP's) and Groundwater Management Units (GWMU's).

2.14.3 However, owing to the lack of areally extensive Principal Aquifers in the Isle of Purbeck area, there are no local Groundwater Management Units (GWMU) defined within the CAMS.

2.14.4 In such cases, the EA generally apply the policy restrictions developed for surface water resources to any applications for abstraction from groundwater.

2.14.5 CAMS generally define surface water resource availability under four differing flow conditions relating to the relevant AP, namely: Q30 (the flow rate that is exceeded for 30% of the time, i.e. a measure of high flow), intermediary Q50, Q70 flow rates and Q95 (the flow rate that is exceeded for 95% of the time, i.e. a measure of low-flow).

2.14.6 In catchments where the EA have assessed water resources to be under pressure, restrictions upon proposed or existing licensed abstractions may be imposed when flows at the AP fall below identified levels.

2.14.7 For example; within a catchment under moderate water resources pressure, the abstraction rates permitted to licence holders may be reduced when flows at the AP fall below the Q95 threshold, whilst for catchments under extreme stress, restrictions may apply from Q95 right through to Q30 AP flows.

2.14.8 Review of the local CAMS documentation indicates that for the sub-catchment within which the Site is situated; “Water is available for licensing" at all 4-no. AP flow condition , implying that:

i. There is more water than required to meet the needs of the environment, and;

ii. New licences can be considered depending on local and downstream impacts.

2.15 Existing Abstractions

2.15.1 EA & PDC Data

2.15.1.1 Data has been obtained from the EA and Purbeck District Council (PDC) regarding licensed and deregulated abstractions in the vicinity of the Site.

2.15.1.2 The supplied data indicates that all but one of existing local abstractions are made from groundwater, generally from a spring source.

2.15.1.3 The collated information is summarised below at table 7.

Table 7: Licensed and Deregulated Abstractions within the Vicinity of the Site

I.D. (*fig. 6*)	NGR		Lic. No.	Address	Source Name	Licensed Volume*	Distance from Site**
L1-a	395620	077740	13/44/00 3/S/012	Encombe Limited, Encombe House, Corfe Castle, Wareham, Dorset BH20 5LW	Spring #7	68,191.1 / 272.76	1,065m
L1-b	396340	077840			Spring #3		380m
L1-c	395600	077910			Spring #6		1,050m
L1-d	396470	077980			Spring #2		210m
L1-e	395320	077980			Spring #4		1,310m
L1-f	396580	078060			Spring #1		95m
L1-g	395460	078280			Spring #5		1,180m
L2	401200	080100	13/44/00 3/S/006	I B Bowerman, t/a JC & JM Bowerman, Godlingston Manor, Swanage, DORSET BH19 3DJ	Godlingston Manor Stream Point #4	22,730 / 981.85	4,150m
L3-a	392600	079100	13/44/00 3/G/010	Smedmore Estate, c/o Chichesters Land Agents, The Reading Room, Blandford, Dorset DT11 0AE	Well #3 Springs At Kimmeridge	934 / 2.56	3,800m
L3-b	392600	079100	13/44/00 3/G/010			19.066 / 52.23	
L4	393100	081900	13/44/09 0/S/043	Trustees of D E Scott, C/o Savills (L & P) Ltd, Rolfes House, Salisbury, WILTSHIRE SP1 2BP	Spring & Catchpit At Cocknolwle, Point #1	19,912 / 54.6	4,300m
D1-a	394461	078563	N/A-DR	Encombe House	Encombe Estate – Spring	NA-DR	95m***
D1-b	395166	080287		Blashenwell Farm, Corfe Castle			
D1-c	395451	080106		West Lynch Cottage, Kingston			
D1-d	395605	079668		5 The Lane, Kingston			
D1-e	395350	077942		West Hill Cottage, Kingston			
D1-f	395747	079634		2 West Street Kingston			
D1-g	395690	079614		3 West Street Kingston			
D1-h	395630	079615		14 West Street Kingston			
D1-i	395613	079612		18 West Street Kingston			
D1-j	395586	079608		20 West Street Kingston			
D1-k	395796	079634		Woodside, West Street Kingston			
D1-l	394329	078503		The Stable House, Kingston			
D1-m	394352	078575		The Garden House, Kingston			
D1-n	395625	079581		2 South Street, Kingston			
D1-o	395621	079532		5 South Street, Kingston			
D1-p	395591	079422		13 South Street, Kingston			
D1-q	396430	079963		2 Hoots, Lower Scoles Farm			
D2-a	392393	081266		Old Farmhouse, Whiteway Farm, Church Knowle	Whiteway Farm – Spring		4,430m
D2-b	392414	081219		Valley View, Whiteway Farm, Church Knowle			4,390m
D3-a	396149	077768		Primrose Cottage	Hill Bottom – Spring		95m
D3-b	396167	077845		Bake House Cottage			
D3-c	396155	077848		Mermaid Cottage			
D3-d	396135	077862		Bramble Cottage			
D3-e	396135	077822		Honeysuckle Cottage			
D3-f	396142	077812		Rose Cottage			

* - cubic metres per Annum / Day.
*- at shortest distance between the the existing consented quarry / Proposed Extension boundaries and the abstraction.
*** - PDC information upon deregulated supplies is assumed to identify point of use rather than source location. Thus distances quoted are to nearest assumed supplying spring source (*i.e.* spring sources within Quarry Combe).
NR-DR – Not applicable, dereugulated.

The locations of these abstractions[13] are illustrated at *figure 9*.

2.15.2 Encombe Estate Private Water Supply & Distribution Network

2.15.2.1 The Encombe Estate operates a private water supply and distribution system, information regarding which has been sourced from:

i. Report upon the private water supply network operated by the adjoining Encombe Estate[10];

ii. A report upon earlier hydrogeological investigations undertaken in respect of Planning matters at the Site[11], and;

iii. Discussions held with staff of the Encombe Estate, BCL, Water Features Survey, October 2016.

2.15.2.2 The system is understood to supply c.70-no. dwellings and numerous live-stock watering troughs over an area of c.6.5km^2 centering upon Kingston Village to the north, northwest and west of the Site.

2.15.2.3 The majority of the system was installed during the 19th century, with improvements and additions having been added since that time.

2.15.2.4 A preliminary schematic diagram illustrating the sources, storage facilities and distribution points of the Estate's water supply network is given at *figure 10*.

Sources

2.15.2.5 Water supply for the system is taken under gravity, using a series of collector chambers and pipes, from several spring sources within Quarry Combe and Westhill Combe.

2.15.2.6 The combes are understood to hold numerous individual springs, not all which are mapped, or, due to the steeply sided and heavily wooded nature of parts of the combes, practicably individually identifiable.

2.15.2.7 However, it is understood that the locations of the largest springs are known and it is to these that abstraction licence no. 13/44/003/S/012 relates (*table 6*).

[13] The PDC information upon deregulated supplies is assumed to identify point of use rather than source location.

Collection

2.15.2.8 The various spring collectors in Quarry Combe feed a 0.23m diameter pipe-line, the intake of which is located upon the valley bottom, from where water is piped westward, across the floor of Westhill Combe to discharge to a tunnel.

2.15.2.9 Flow is augmented at the tunnel entrance by discharge from a 75mm diameter gravity- fed collector pipe supplied by springs further up Westhill Combe.

2.15.2.10 The c.820m long tunnel caries water west-northwest, day-lighting close to Encombe Dairy, from where the majority of the collected water is piped under gravity to an apparently man-made pond of c.1ha situated to the south of Encombe House.

Distribution

2.15.2.11 Pumping is made from the pipe-line feeding the pond to provide supply into the onward distribution system to the west, north and west.

2.15.2.12 The onward distribution system comprises numerous pipe-lines, booster pumps, storage reservoirs and tanks and ultimately, feeder-troughs and end-user supplies to properties.

2.15.2.13 A take-off from the tunnel entrance at Encombe Dairy is also used to feed a sunken fire reservoir to the west of Encombe House which is understood to provide a gravity supply for the fire-sprinkler system of the central estate buildings.

Volumes

2.15.2.14 A preliminary understanding of the water volumes supplying and fed by the Encombe Estate distribution network have been taken from an earlier system maintenance report[10].

2.15.2.15 The flow below the now defunct hydraulic-ram at NGR $^{3}962$, $^{0}777$ within Quarry Combe was measured at 99.88m^3/day (c.1.15l/s); this is considered to represent the total volume of flow from the combe.

2.15.2.16 The combined flows from the two sources within Westhill Combe were measured at 311m^3/day (c.3.6l/s) which thus, together with the Quarry Combe supply, gives a total measured flow supplying the system at the time of reporting of 410m^3/d (4.75l/s).

2.15.2.17 Pumping from pipe-line feeding Encombe House pond is understood to me made at a rate of c.5.8l/s for 5-hours per day.

2.15.2.18 On the basis of the collected information, it would appear that the distribution network exploits c.20% (c.104m3/d) of the available volumes supplied by the combined spring sources within Quarry Combe and Westhill Combe (510m^3/d).

2.15.2.19 Applying the estimated combined spring flow for Quarry Combe and Westhill Combe of c.410m^3/d and adopting the annual average value of 0.344m for effective rainfall estimated by previous calculation (table 5), suggests a tentative recharge area for the springs of c.43ha.

2.16 Hydrogeology

2.16.1 The hydrogeological regime of the area has been elucidated on the basis of:

i. Review of published geological and hydrogeological data;

ii. Review of a previous hydrogeological report prepared in support of historical planning matters at the Site;

iii. Groundwater level measurements made historical Site piezometers by previous operators of the quarry;

iv. Geological logs of historical Site piezometers and mineral evaluation drilling boreholes;

v. The occurrence and elevation of local groundwater dependent features such as springs and streams;

vi. Field measured water quality sampling undertaken by BCL during October 2016, and;

vii. Experience of similar hydrogeological terrains within the British Isles.

2.16.2 The individual components of the local hydrogeological regime are discussed below. Discussion concludes with description of the prevailing conceptual hydrogeological model for the Site and surrounding area.

2.16.1 Hydrostratigraphic Groupings

2.16.1.1 The hydrostratigraphic grouping of the area is influenced principally by the lithological nature of the strata with an important but secondary influence from the geological structure.

2.16.1.2 The main hydrostratigraphic groups therefore align with the lithostratigraphy, which is well understood, and are considered to be as follows:

2.16.2 Lower Purbeck Group (Mupe Member)

Background

2.16.2.1 The local expression of the Lower Purbeck Group, represented by the Mupe Member which is present at immediate subcrop to the north and west of the Site, is made up of multiple limestones and mudstone units.

2.16.2.2 Despite the EA classification of "Secondary A" aquifer (formerly termed "non-aquifer") to these beds, the diverse and relatively thinly bedded nature of the group make useful generalisation regarding their hydraulic properties problematic.

2.16.2.3 The mudstones can reasonably be assumed to possess low primary porosity and permeability and are thus likely to act as aquicludes or perching layers.

2.16.2.4 Unlike the mudstones, the limestones of the group may be expected to possess at least the potential for limited groundwater storage and substantial transit, and locally, where perched upon underlying argillaceous units, to be water-bearing.

Groundwater Flow Mechanism

2.16.2.5 Limestones do not operate as conventional granular aquifers; the susceptibility of the strata to chemical dissolution and physical erosion by flowing water can, under certain circumstances, lead to the development of enlarged preferential sub-surface pathways for groundwater transit (karst).

2.16.2.6 However, there is little evidence of well developed karsification in the Site area, and groundwater flow within the limestones of the Purbeck group is therefore considered to occur predominantly within a dual-porosity system (comprising primary and secondary porosity)

2.16.2.7 Primary porosity (a measure of the ability of strata to store water) is conferred by interstitial pore spaces within the rock.

2.16.2.8 Due to the cementitious nature of limestone, the degree of interconnection between interstitial pore spaces is generally negligible and this severely limits the ability for groundwater to transit between any pore spaces that might exist.

2.16.2.9 Thus primary permeability (the ability of strata to convey water at pore-scale) is typically indiscernible and is therefore generally regarded to be largely insignificant in supporting groundwater flow, but may provide limited storage reserves within a karstic groundwater system.

2.16.2.10 Secondary porosity is lent to carbonate rocks by the fracture and joint networks and bedding planes of the strata.

2.16.2.11 Due to the small partings generally associated with such networks, groundwater flow is typically slow.

2.16.2.12 However, due to the typically wide distribution, and often high density of these discontinuities, secondary porosity is generally regarded as the main source of storage for a groundwater body within carbonate rocks.

2.16.2.13 Groundwater flow made via fracture and bedding plane networks is typically diffuse and laminar (*i.e.* non-turbulent).

Groundwater Levels

2.16.2.14 Previous study[11] reported a limited series of groundwater level measurements made within piezometers P-BH1 and P-BH2 during the summer of 1993, recording an average depth to groundwater of 6m and 5.7m respectively.

2.16.2.15 The collar elevations for these piezometers are unknown and the area within which the piezometers were installed has subsequently been subject to quarrying and restoration.

2.16.2.16 However, applying estimated collar elevations of c.100maOD indicates a groundwater level within the Purbeck Group upon the south-eastern margin of the existing quarry of c. 95maOD.

2.16.2.17 This estimated level was elevated well above the next-lowest quarry bench level, which at the time was at c.90maOD and free (as were lower benches) of groundwater ingress.

2.16.2.18 These observations, together with that the fact that the quarry face separating the piezometers from the c.90maOD bench was situated only a few metres away from the piezometers, indicates that the groundwater levels recorded were perched with little interconnectivity with any substantial groundwater body.

Aquifer Characteristics

2.16.2.19 Previous study[11] reported the results of falling-head hydraulic conductivity testing carried out within 2-no. piezometer boreholes installed within the Lower Purbeck Group upon the eastern Margin of the Site (P-BH1 & P-BH2 located c.22m apart; *figure 6*).

2.16.2.20 Although geological logs for these boreholes are unavailable, it is known that they were drilled entirely within the Purbeck Group without penetrating the underlying Portland Limestones which comprise the present-day economic mineral of the Site.

2.16.2.21 Testing revealed markedly differing characteristics between the sections of strata under test; a permeability of 0.005m/d was calculated from test data obtained from P-BH1, whereas the decay of induced head within P-BH2 was too rapid to allow capture of data (thus implying high local permeability).

2.16.2.22 The earlier study concluded that the test value of 0.005m/d obtained from P-BH1 was reflective of the non-fissured matrix permeability of the strata whilst the rapid draining of P-BH2 was the result of fissure interception by the piezometer.

Groundwater Quality

2.16.2.23 No data have been elucidated during study regarding quality of groundwater contained within the local strata of the Lower Purbeck Group.

2.16.3 Upper Portland Group (Portland Freestone & Portland Chert Members) and Lower Portland Group (Portland Sandstone)

Background

2.16.3.1 The Upper Portland Group, locally represented by the Portland Freestone and Portland Chert members (the economic mineral of the Site) is dominated by a series of limestones categorised by the EA as a "Principal Aquifer" (formerly termed "major-aquifer").

2.16.3.2 Again, these strata may be expected to possess at least the potential for limited groundwater storage and substantial transit.

2.16.3.3 The Portland Sand Formation that underlie the limestones of the quarry have a recorded local thickness of between 14m and 35m (apparent thickness).

2.16.3.4 Its argillaceous nature and the local abundance of discrete springs emanating from the strata suggest that the primary porosity is low (for sandstone) and that permeability within the rock is likely to be dominated by fracture flow (i.e. secondary porosity groundwater flow).

Groundwater Flow Mechanism

2.16.3.5 Groundwater flow within the Upper Portland Group limestones is considered to occur predominantly within a dual-porosity system (comprising primary and secondary porosity).

2.16.3.6 Primary porosity related permeability is likely to be much higher within the underlying Portland Sandstones, groundwater flow occurring within the interconnected intersticial spaces existing between the individual sand grains comprising the rock.

2.16.3.7 However, fracturing within the sandstone is also likely to make secondary porosity related permeability an important factor in groundwater flow, as implied by the presence of numerous discrete springs draining from the outcrop.

Groundwater Levels

2.16.3.8 Mineral extraction has been conducted to an elevation of 71maOD within the Upper Portland Group at the Quarry without ingress of groundwater from the strata[14].

2.16.3.9 There are no piezometer data for the Upper Portland limestones within or within the immediate area of the existing quarry.

2.16.3.10 The Portland limestones were observed to be dry, with ingress noted only below their base at the Portland Sandstone / Kimmeridge Clay boundary at c.91.1maOD (49.9mbGL), at the time of drilling of BH10 in January 1989 (*figure 6* & *appendix 3;* located c.100m west of the Proposed Extension).

2.16.3.11 Subsequent groundwater level measurements within a piezometer standpipe installed within BH10 were made by Tarmac between September 1989 and August 1993.

[14] SSQ Operations management, pers. Comm. October 2016.

2.16.3.12 The data, included here at *appendix 5*, indicate a piezometric head below the Upper Portland limestones, mid-way within the underlying sequence of Portland Sandstone, at an average elevation of 94.7maOD.

2.16.3.13 On the basis of the available information, it is tentatively concluded that Upper Portland group limestones extracted at the current quarry and those comprising the Proposed Extension are free of groundwater.

2.16.3.14 Furthermore, an apparent separation of c.10m exists between the base of the limestones and groundwater contained within the underlying Portland Sandstones.

Aquifer Characteristics

2.16.3.15 No data have been elucidated that enumerate the permeability or porosity of the local Upper Portland limestones.

2.16.3.16 Previous study[11] reported the results of falling-head hydraulic conductivity testing carried out within BH10 (*appendix 3* & *figure 6*).

2.16.3.17 Although BH10 passes through the overlying Portland Group limestones, due to the configuration of the piezometer installation, the results of testing have rightly been attributed to the Portland Sands.

2.16.3.18 Analysis of test data revealed a permeability for the Portland Sands of c.0.014m/d, a low value which, given the free-draining nature of the rock observed at outcrop, shows the importance of fissure flow to groundwater movement and, by implication, a relative paucity of fissures intercepted by the borehole.

Groundwater Quality

2.16.3.19 No historical data have been elucidated during study regarding quality of any groundwater that might be contained within the Upper Portland Group limestones.

2.16.3.20 4-no. water samples were taken during water features surveying carried out by BCL during October 2016, from: standing water from the quarry floor and from three locations within the spring-collector system supplying the Encombe Estate distribution system.

2.16.3.21 The results of laboratory water quality analysis are included at *appendix 6*, along with relevant water quality standards.

2.16.3.22 Examination of the data indicates that all determinands under analysis for all 4-no. samples were within drinking water quality standards with no evidence of anthropogenic contamination.

2.16.3.23 A Piper-Plot has been constructed from the data to assist diagnostic interpretation and is included here at *figure 11*.

2.16.3.24 The Piper Plot illustrates measured cations (left ternary plot) against measured anions (right ternary plot) deriving classifying ordinates within the central diamond plot.

2.16.3.25 In the case of the three spring derived samples, the Piper Plot assessment indicates calcium-bicarbonate waters, indicative of recently recharged shallow groundwater.

2.16.3.26 Field and laboratory measurements of electrical conductivity for the spring sources averaged c.690µS/cm, indicating moderate mineralisation during groundwater transit, this being consistent with the Piper Plot classification.

2.16.3.27 The standing water sample taken from the quarry void revealed a markedly lower value of electrical conductivity of 220µS/cm, the low mineralisation implied by this strongly suggesting the source for this water to be recent rainfall with little or no contact with groundwater.

2.16.4 Kimmeridge Clay

2.16.4.1 The Kimmeridge Clay has negligible aquifer characteristics and thus forms the base of the local groundwater system of the Portland Sands.

2.17 Conceptual Hydrogeological Model

2.17.1 Although possessing hydraulic characteristics conducive to the development of aquifer conditions, the Upper Portland Group limestones of the current quarry and Proposed Extension Areas do not appear to contain a watertable.

2.17.2 Ready downward percolation of incident rainfall is made through relatively friable and thin soils to pass rapidly downwards through the fracture system of the limestones to recharge a watertable contained within the underlying Lower Portland Group Sandstones.

2.17.3 Therefore, the floor of the existing quarry and Proposed Extension both reside above the local level of groundwater.

2.17.4 With the exception of shallow seasonal ponding following heavy or prolonged rainfall, continuation of consented operations and working of the proposed extension are therefore anticipated to be undertaken above the watertable and thus free of standing-water.

2.17.5 Groundwater movement within the sandstones underlying the economic mineral of the Site appears to be concordant with the local dip direction, transporting water southwards to discharge at several springs held within the deeply incised valleys that fringe the coastline.

2.17.6 To the north of the Site, beyond the axis of the anticline, the dip of the beds turns through 180˚ to dip northwards.

2.17.7 Given the relatively steep dip of the beds in this area and the shallow saturated thickness of Portland Sandstone aquifer, groundwater flow to the north of the anticline is anticipated to be made northwards away from the Site.

2.17.8 Spring flows within Quarry Combe and Westhill Combe to the south and south-west of the Site respectively constitute the single supply of water for a private distribution system, maintained by the Encombe Estate.

2.17.9 The distribution system is extensive, and is thought to supply in the order of 70-no. properties that do not currently have benefit of a mains water alternative.

2.17.10 The results of a preliminary water sampling exercise, involving sampling of standing water within the site and spring flows feeding the Encombe Estate distribution system do not indicate any evidence of anthropogenic contamination of groundwater.

2.17.11 Further, all tested determinands fell well within maximum permissible limits prescribed by regulation.

2.17.12 The available chemical data indicates successful application of the several measures observed at the Site for the protection of groundwater quality (which include screening and testing of imported materials for deposition in restoration and fluids handling and storage protocols).

2.17.13 The available data upon spring flows from the coastal combes does not account for the total volume of groundwater flow that might be anticipated to discharge from the Portland Sandstones to the sea.

2.17.14 This suggests that further examination is required of the fate of southwards flowing groundwater within the Portland Sandstones, with a requirement for a comprehensive series of spring and stream flow measurements and further field-based chemistry measurements.

3 PROPOSED QUARRY EXTENSION

3.1 Current proposals involve the engineering of a tunnel through bedrock upon the north-western flank of the site which will be driven north-westwards for c.40m beneath the Purbeck Way to link the existing quarry with the south-eastern margin of the Proposed Extension.

3.2 Working of the c.19.97ha Proposed Extension will be progressed in three principal extraction phases as shown at *figures 12*, *13* and *14*. Extraction will proceed to the base of the economically workable Upper Portland Group limestones, with planned general quarry floor level of between 103maOD and 106maOD.

3.3 No permanent fixed plant will be stationed within the Proposed Extension Area. Extraction of mineral will be undertaken in a manner equivalent to historical workings at the Site; using conventional drilling and blasting techniques to win stone for transport by wheeled loader to the processing plant within the existing quarry void.

3.4 The current programme of importation and recycling of inert wastes will be continued during working of the Proposed Extension. A proportion of the recycled wastes, in combination with indigenous waste stone, will be used to restore the workings back to pre-quarrying ground levels (*figure 15*).

3.5 On the basis of the available information and as is the case for the current quarry operations, the Proposed Extension will be worked above the level of groundwater. Therefore, no active water management measures, other than standard protective and reactive contingency measures relating to fluids handling and storage, are envisaged.

This Page Intentionally Left Blank

4 RISK SCREENING

4.1 Overview

4.1.1 Baseline assessment has facilitated understanding and conceptualisation of the extant groundwater and surface water regimes operating within and around the Site. This understanding has been utilised to inform a risk screening assessment of the impacts that may potentially be posed by the Proposed Extension to the water environment. In turn, the results of risk screening have allowed identification of the further data and assessments required to support a robust planning application for the Proposed Extension.

4.2 Generic Potential Impacts

4.2.1 As is typical of the majority of quarrying operations of the type and scale of the Proposed Extension, working and subsequent restoration of the Site in the planned manner has the potential to cause the following effects upon the water environment:

i. Modification of groundwater levels and flow;

ii. Derogation of groundwater quality;

iii. Derogation of flow / levels within surface water-courses & water bodies;

iv. Derogation of surface water quality; and

v. Exacerbation of existing flood risk.

4.2.2 The effects outlined above may, in-turn, lead to *impacts* upon:

i. The volumes and / or quality of groundwater available to existing or potential abstractions;

ii. The volumes and / or quality of surface water available to existing or potential abstractions;

iii. The volumes and / or quality of groundwater available to support of floral and / or faunal communities; and

iv. The volumes and / or quality of surface water available to support of floral and / or faunal communities.

4.3 Approach to Screening

4.3.1 Screening has considered a range of quarry-works related actions and determined the potential for related effects to occur. Where an effect is judged likely to occur, sequential consideration is given to the potential for that effect to cause impacts upon each aspect of the water environment. Individual impacts upon the water environment may have a number of possible causes. Thus, whilst screening may discount the potential for certain effects to cause an impacts, this does not preclude the potential for the same or similar impact to be caused by a differing effect.

4.3.2 Screening categorises all potential impacts within a 4-tier hierarchy, namely:

i. No potential for impact;
ii. Insignificant impact anticipated;
iii. Potential for significant impact, requires further assessment, and;
iv. Potential for significant impact, requires mitigation.

4.3.3 Where screening has identified potential for impact within categories iii) and iv) above, assessment concludes with consideration of the requirements for further assessment and / or mitigation required to ensure an environmentally acceptable and sustainable approach to the working of the Proposed Extension.

4.3.4 It is important to recognise that where screening identifies potential for impact within categories i) and ii), this does not imply further consideration will not be given at EIA stage. Instead, it signifies that both / either the likelihood and / or significance of occurrence are not singular to the Proposed Development or that "mitigation measures", other than those inherent to the every-day operation of a well run quarry are not required, and therefore, in the context of the Mineral Plan Submission for which this assessment has been prepared, further discussion of these matters here is unnecessary.

Table 8: Impact Screening Matrix

- : No Potential for Occurrence.
-*: No Potential for Occurrence based upon current conceptual hydrogeological model, further data collection recommended.
P: Potential for Occurrence.
II: Insignificant Impact Anticipated.
FA: Potential for Significant Impact, Requires Further Assessment.
RM: Potential for Significant Impact, Requires Mitigation.

		Aspect	Action		Effects		IMPACTS					
							Groundwater		Surface Water		Sites of Ecological Interest	
							Abstractions	Resources	Abstractions	Resources	Statutory	Non-Statutory
					Description	Potential	Potential for Impact					
EFFECTS All potentially applying during the working and post-restoration phases of the Proposed Development	Groundwater	Flows & Levels	Earthworks	Unsaturated Zone	Physical removal of abstractions	-	-	-	-	-	-	-
					Modification of recharge	P	II	II	II	II	II	II
					Karstic conduit interception	-	-	-	-	-	-	-
				Saturated zone	Modification of hydraulic gradient	-	-	-	-	-	-	-
					Evaporative loss	P	II	II	II	II	II	II
					Karstic conduit interception	-	-	-	-	-	-	-
			Dewatering		Lowering of groundwater levels	-*	-	-	-	-	-	-
		Quality	Removal of unsaturated zone materials		Mobilisation of pre-existing natural contaminants	-	-	-	-	-	-	-
					Mobilisation of pre-existing anthropogenic contaminants	-	-	-	-	-	-	-
					Reduction of attenuation	P	II	II	II	II	II	II
			Removal of saturated zone materials		Mobilisation of pre-existing natural contaminants	-	-	-	-	-	-	-
					Mobilisation of pre-existing anthropogenic contaminants	-	-	-	-	-	-	-
			Spillages & leakages (fuel & lubricating oils)		Derogation of groundwater quality	P	RM	RM	RM	RM	RM	RM
			Fugitive suspended solids (within karstic conduit systems)			-	-	-	-	-	-	-
			Unanticipated generation and escape of potentially polluting leachate			P	FA,RM	FA,RM	FA,RM	FA,RM	FA,RM	FA,RM
	Surface Water	Flows & Levels	Earthworks		Physical removal of abstractions	-	-	-	-	-	-	-
					Interception / re-alignment of water-courses	-	-	-	-	-	-	-
					Interception / removal of water bodies	-	-	-	-	-	-	-
					Catchment modification	P	II	-	II	II	II	II
			Dewatering discharge		Increased surface water flow	-	-	-	-	-	-	-
		Quality	Spillages & leakages (fuel & lubricating oils)		Derogation of surface water quality	P	RM	RM	RM	RM	RM	RM
			Fugitive suspended solids	Runoff		P	-	-	II	II	II	II
				Dewatering discharge		-	-	-	-	-	-	-
				Other discharges		-	-	-	-	-	-	-
			Unanticipated generation and escape of potentially polluting leachate			P	FA,RM	FA,RM	FA,RM	FA,RM	FA,RM	FA,RM

4.4 Requirements for Mitigation / Further Assessment

4.4.1 Those matters for which screening has indicated further assessment and / or mitigation are required relate to the protection of groundwater and surface water quality.

4.4.2 Screening indicates the potential for significant effects upon groundwater quality stemming from:

i. Accidental spillage or undetected long-term leakage of potential contaminants (judged to require immediate consideration of mitigation measures), and;

ii. Unanticipated generation and escape of potentially polluting leachate (judged to require further assessment and / or mitigation measures).

4.4.1 Accidental Spillages / Long-Term Leakage of Contaminants

Background

4.4.1.1 BGS mapping defines the strata of the Proposed Extension to comprise lands defined as "Highly" vulnerable to groundwater contamination.

4.4.1.2 Regardless of the mapped classification, the removal of overburdens which has already occurred prior to commencement of mineral extraction cedes the extant classification (whatever that classification were) to one of "extreme" or "most extreme" vulnerability.

4.4.1.3 However, this applies to almost all quarry developments, and therefore renders the classification system almost redundant as a differentiating factor for assessing the merits of the Proposed Extension relative to other quarrying proposals in the region.

Assessment of Effects

4.4.1.4 Potential contaminants present within the Proposed Extension will be limited to fuel, lubricating and hydraulic oils serving mobile plant.

Assessment of Impacts

4.4.1.5 Quarrying is a historical and on-going activity at the Site; workings within the Proposed Extension will be carried out in an equivalent manner, and within the same hydrostratigraphic environment, as the current operations.

4.4.1.6 Therefore, the potential scale, likelihood of occurrence, or consequences of groundwater contamination will not materially increase as a result of the Proposed Extension.

4.4.1.7 It should be noted that these factors are effectively identical to those associated with numerous similar operations sited throughout the region.

Requirement for Mitigation Measures

4.4.1.8 Notwithstanding the foregoing, in recognition of the potential for groundwater quality derogation resulting from accidental spillage or undetected long-term leakage of fuel, lubricating or hydraulic oils to occur, measures to minimise these risks have been formulated, as advanced below.

i. Fuel-oil powered mobile plant shall be restricted to that necessary to undertake mineral extraction, remedial measures and subsequent restoration of the Site;

ii. A code of practice should be developed for the refuelling and maintenance of machinery. This code should be incorporated into a formal Environmental Management System (EMS, or similar) that should be incorporated into the overall Site management system. Such work should be carried out only by trained personnel and take place within a surfaced area equipped with fluid interceptors;

iii. Any oil storage tanks to be located within the proposed extension should be sited upon impermeable bases enclosed by oil-tight walls. The enclosure should remain at a volume of at least 110% of the capacity of the oil tank and maintained free of accumulations of rainwater;

iv. All fill and draw pipes emanating from oil storage tanks should be provided with locking mechanisms and be contained within the impermeable enclosure;

v. No maintenance should be carried out in areas of mineral working;

vi. Refuelling within areas of mineral working will be undertaken to a protocol designed to minimise the risk of spillages which shall also specify measures for immediate containment and removel of any significant spillages that do occur.

vii. Operators should check their vehicles on a daily basis before starting work to confirm the absence of leakages. A reporting system should be implemented to ensure that repairs are undertaken to that vehicle before it enters the working area;

viii. Sufficient oil sorbant material (*3M Oil-Sorb* or similar) should 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 should be disposed of from Site in accordance with current waste disposal legislation; and

ix. Hydraulic & fuel oil lines on all plant operated within the extraction areas shall be renewed at the manufacturers recommended service intervals to minimise the potential for contamination following failure of hoses or lines.

4.4.1.9 The foregoing outline measures have been incorporated into a code of practice template which is included here as a fluids handling protocol, as attached at *appendix 7*.

4.4.1.10 In view of the proximity of several down-gradient spring sources that are exploited for domestic and agricultural water supply (the Encombe Estate reticulation system), it is considered prudent to initiate a routine programme of sampling and analysis from the springs.

4.4.1.11 This will provide confirmatory data regarding the effectiveness of the foregoing control measures and data for formal assessment required to any planning application that might be made in respect of the Proposed Extension.

4.4.1.12 The design and requirements of the monitoring programme should have cognisance of similar sampling and analysis that may already be undertaken by the Encombe Estate.

Residual Impacts

4.4.1.13 It is considered that the potential for contamination of groundwater by accidental spillages and / long-term leakage of fuel, hydraulic or lubricating oils may be reasonably and satisfactorily mitigated by adoption of the foregoing measures; residual impacts are therefore not anticipated.

4.4.2 Unanticipated Generation and Escape of Potentially Polluting Leachate

Background

4.4.2.1 The Site already receives imported inert waste materials which are processed to produce recycled aggregate for re-sale and recovery of inert materials suitable for deposit in quarry restoration.

4.4.2.2 It is planned that these activities should continue in order to generate suitable infill materials to create an acceptable restored landform for the Proposed Extension.

Assessment of Effects

4.4.2.3 The limited water quality data-set assembled during this study indicates that historical operations do not appear to have had an adverse effect upon downstream groundwater quality, at least with respect to the currently exploited spring sources within Quarry Combe and Westhill Combe.

4.4.2.4 This is good, if numerically sparse, evidence that the controls against groundwater contamination applying to the current operations (preventative procedures to ensure against deposit of potentially contaminating recovered wastes in the first-instance) have been effective.

4.4.2.5 However, as control procedures are innately fallible, adoption of the precautionary approach dictates consideration of the potential impacts of minor but systematic failures in these controls.

4.4.2.6 Given that the possibility exists for minor failure of control procedures to result, for example, in the deposit of individually small, but cumulatively significant "rogue-loads" over many years, it is therefore prudent to consider the imported recovered wastes as a potential source of contaminants.

Assessment of Impacts

4.4.2.7 In addition to the presence of a potential source, a pathway and a receptor are also present, being the Portland Sandstones and the Encombe Estate spring collector system respectively.

4.4.2.8 The identified presence of a potential source, pathway and receptor leads directly to the determination that potential for significant impact exists.

Requirement for Further Assessment / Mitigation Measures

4.4.2.9 The use of recovered wastes in restoration of the Site is currently undertaken under an EA "Recovery Permit".

4.4.2.10 The permit stipulates control procedures, together with WAC testing, to ensure only inert materials may be deposited for restoration.

4.4.2.11 Historically, the EA have not interpreted a regulatory need for containment engineering of such "recovery" operations, indeed, this is the case for existing restoration operation, whereby recovered inert materials are deposited directly upon rock-head / indigenous wastes without an intervening purpose-engineered containment liner.

4.4.2.12 As discussed, there is good, if numerically sparse, evidence that the controls (preventative procedures) against groundwater contamination applied for the current operations have been effective and groundwater contamination has not occurred.

4.4.2.13 Notwithstanding this, given the proximity of the down-gradient spring sources exploited by the Encombe Estate, it is considered prudent that any application to the EA for an Environmental Permit authorising deposit of recovered inert waste within the Proposed Extension should be accompanied by a formal risk assessment undertaken in accordance with LFTGN01[15].

4.4.2.14 This would allow full and systematic examination, using nationally agreed protocols and standards, of the need for further measures to protect groundwater quality in the restoration of the Proposed Extension.

4.4.2.15 In particular, the results of risk assessment would dictate both the need for and specification of engineered containment lining and groundwater quality monitoring together with providing a rationale for the specification of waste types that may be received by the operations and the WAC applied to materials testing.

4.4.2.16 Whilst the recommendation relating to formal risk assessment (with its possible implications for lining requirements and groundwater quality monitoring) is made on the basis of prudence, it is noteworthy that recent EA regulatory interpretation appears designed to remove the disparities regarding engineering and testing requirements that have historically existed between "recovery" and "non-recovery" waste disposal operations.

[15] (LFTGN1) "Hydrogeological Risk Assessments for Landfills and the Derivation of Groundwater Control and Trigger Levels, Environment Agency", March 2003.

4.4.2.17 Formal risk assessment, applying LFTGN01/02 protocols will require the installation of a minimum of 3-no. groundwater observation and quality sampling boreholes arranged to place 1-no. borehole up-gradient (north) and 2-no. boreholes downstream (south) of the Proposed Extension.

4.4.2.18 Quality monitoring from the boreholes will allow derivation of control and trigger levels for water quality, which would act as an adjunct to the current system of WAC testing for the further protection and confirmation of groundwater quality.

4.4.2.19 Groundwater level monitoring data from the boreholes would also add to the currently sparse data-set upon which the present interpretation that the Proposed Extension will remain above the watertable is based.

Residual Impacts

4.4.2.20 It is considered that the potential for contamination of groundwater by unanticipated generation and escape of potentially polluting leachate may be reasonably and satisfactorily mitigated by adoption of the approach to risk assessment and monitoring recommended above.

4.4.2.21 The recommended approach is made in view of the potential for impact upon established water supply spring sources and involves application of the most rigorous nationally accepted protocols and decision making regarding the need for and specification of containment lining and confirmatory groundwater quality monitoring.

4.4.2.22 Therefore, assuming adoption of the recommended approach, residual impacts are not anticipated.

EA Locational Guidance

4.4.2.23 Review has been made of the most recent EA locational guidance[16] relevant to the planned deposition of recovered inert waste materials as part of the restoration of the Proposed Extension and in view of the hydrogeological setting of the Site.

[16] "Groundwater Protection: Principles and Practice" (GP3) Version 1.1, EA, August 2013.

4.4.2.24 When taking into account the hydrological and hydrogeological setting of the Site, EA Position statement E1, which presents a series of considerations relating to the location of prospective waste disposal / deposition operations, does not indicate any reason for presumption against the infilling element of the Proposed Extension.

4.5 Note upon Flood Risk

4.5.1 A brief examination of flood risk has been made as the matter is one mandated by the NPPF[17] for consideration during the development of local Minerals Plans.

4.5.2 Data provided by the EA shows that no part of the existing quarry or Proposed Extension lies within lands designated by the EA to be at risk of tidal, fluvial or surface water flooding.

4.5.3 The position of the Site within Flood Risk Zone 1 (i.e. the lowest risk zonation, beyond the modelled limit of a 1:1,000-year return period flood event) is maintained when incorporating the anticipated effects of climate change.

4.5.4 Following review of key information sources, it is considered that the Proposed Extension accords with the following key tests:

i. That the Proposed Development will not be prone to fluvial flooding;

ii. That the Proposed Development represents appropriate development in the context of prevailing EA flood risk mapping and NPPF acceptability classifications;

iii. That whilst the Proposed Extension has *potential* to suffer flooding from incident rainfall (*i.e.* "surface water flooding"), appropriate and practicable measures are available and will be applied for the complete amelioration of associated risk;

iv. That neither the Operational or post-restoration phases (assuming provision of balancing storage to attenuate drainage from low-permeability infilled areas) of the Proposed Extension will increase flood risk elsewhere; and

v. That the Proposed Extension is safe with respect to prevailing and future flood risk when accounting for the anticipated effects of climate change.

[17] "National Planning Policy Framework" (NPPF), Department for Communities and Local Government (DCLG), March 2012.

5 SUMMARY

5.1 Although possessing hydraulic characteristics conducive to the development of aquifer conditions, the Upper Portland Group limestones of the current quarry and Proposed Extension Areas do not appear to contain a watertable. Downward percolation of incident rainfall is made through thin soils, then passing rapidly downwards through the fracture system of the limestones to recharge a watertable contained within the underlying Lower Portland Group Sandstones. On the basis of the available information, both the floor of the existing quarry and that planned for the Proposed Extension both appear to reside several metres above the local level of groundwater.

5.2 Groundwater movement within the Portland Sandstones appears to be made southwards, a substantial proportion of which discharges at several springs situated within the deeply incised valleys fringing the coastline. Groundwater flow to the north of the Site, beyond the axis of the local anticlinal structure, is anticipated to be made northwards away from the Site.

5.3 Spring flows within Quarry Combe and Westhill Combe to the south and south-west of the Site emanate from the Portland Sandstone and constitute the single supply of water for a private distribution system, maintained by the Encombe Estate. The distribution system is extensive, and is thought to supply in the order of 70-no. properties that do not currently have benefit of a mains water alternative.

5.4 The results of a preliminary water sampling exercise, involving sampling of standing water within the site and spring flows feeding the Encombe Estate distribution system do not indicate any evidence of anthropogenic contamination of groundwater. Further, all tested determinands fell well within maximum permissible limits prescribed by regulation.

5.5 Although not representing an extensive suite of time-series data, the available chemical information indicates the successful application of the several measures observed at the Site for the protection of groundwater quality (which include screening and testing of imported materials for deposition in restoration and fluids handling and storage protocols).

5.6 Mineral Extraction within the Proposed Extension will proceed to the base of the economically workable Upper Portland Group limestones, with planned general quarry floor level of between 103maOD and 106maOD. Extraction of mineral will be undertaken in a manner equivalent to historical workings at the Site; using conventional drilling and blasting techniques to win stone for transport by wheeled loader to the processing plant within the existing quarry void.

5.7 The current programme of importation and processing of inert wastes will be continued during working of the Proposed Extension. A proportion of the processed wastes, in combination with indigenous waste stone, will be deposited within the void created by mineral extraction within the Proposed Extension used to restore the workings back to pre-quarrying ground levels.

5.8 The risks posed to groundwater quality from accidental spillages or long-term undiscovered leakage of fuel, hydraulic or lubricating oils used at the Site may be satisfactorily minimised by the adoption / continuance of fluids handling protocols (*appendix 7*).

5.9 When taking into account the hydrological and hydrogeological setting of the Site, EA Position statement E1[16], which presents considerations relating to the location of prospective waste disposal / deposition operations, does not indicate any reasons for presumption against the infilling element of the Proposed Extension.

5.10 The potential for contamination of groundwater resources and sources, including those utilised by the Encombe Estate, by unanticipated generation and escape of potentially polluting leachate associated with the recycling and deposition of imported inert wastes may be reasonably and satisfactorily mitigated by adoption and enforcement of the findings of formal risk assessment undertaken using nationally recognised protocols. Such risk assessments would ordinarily be anticipated at the planning application / permit application stage.

6 RECOMMENDATIONS

6.1 Data Requirements

6.1.1 The following measures are recommended for immediate implementation to provide the data required for further assessment that will be needed if the proposals are to be progressed through to authorisation.

i. Confirmation of the details, volumes and flow rates associated with the Encombe Estate reticulation system;

ii. Collection of spring data for the springs locates within Westhill Combe, Quarry Combe, Winspit Bottom and Seacpmbe Bottom;

iii. Initiation of a routine programme of sampling and analysis for the spring systems in Quarry Combe and Westhill Combe. the design of which should have regard to any similar sampling and analysis that may already be undertaken by the Encombe Estate;

iv. The installation of at least 3-no. appropriately designed groundwater level monitoring and sampling piezometers; 1-no. to the north of the Proposed Extension and 2-no. to the south, and arranged to facilitate triangulation of the watertable surface, and;

v. Initiation of a programme of routine groundwater level monitoring and sampling for laboratory analysis from the piezometers.

6.2 Requirements for Further Assessment

6.2.1 Should the plans for the Proposed Extension be taken forward to authorisation stage, both Hydrological & Hydrogeological Impact Assessments (planning application) and Hydrogeological Risk Assessment (permit application) will be required.

6.2.2 Notwithstanding any determination of the EA's position regarding the applicability of a "recovery" permit to the restoration element of the Proposed Extension, in view of the proximity of existing abstractions (receptors) and existence for a mechanism for impact (potential contaminant source, and the groundwater pathway), it is recommended that formal risk assessment of the infilling proposals be undertaken using nationally adopted risk assessment protocols (LFTGN01/02).

6.2.3 Further, it is recommended that any engineering requirements for containment that may be identified by this process be integrated into the design of the proposals at an early stage.

This Page Intentionally Left Blank

7 CONCLUSIONS

7.1 In view of the findings of assessment and the specified approach to finalising the design of the Proposed Extension, which includes specific recommendations regarding data collection, nationally adopted risk assessment protocols to inform any future planning and permit applications, and practicable measures for the protection of the water environment; there are considered to be no over-riding hydrogeologically or hydrologically based reasons why the proposal should not receive allocation within the local Minerals Plan.

7.2 This conclusion assumes that any allocation or permission, if granted, should be conditioned by implementation and adherence to any relevant recommendations advanced within this report and other such recommendations or pre-conditions that may be reasonably imposed by the Planning Authority.

Gavin Chaplin B.Sc. M.Sc.
Senior Hydrogeologist
BCL Consultant Hydrogeologists Limited
16th December 2016

This Page Intentionally Left Blank