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Penderyn Quarry: Abstraction Licence Applications

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1 Introduction

1.1 Background

Hanson Quarry Products Europe Ltd (Hanson) has operated a limestone quarry at Penderyn in the Brecon Beacons National Park for over a hundred years. Penderyn Quarry ("the Site") consists of a main quarry void in the east and a processing plant and office area in the west. Figure 1.1 shows a location plan for the Site showing these areas.

Surface water and groundwater drain to a sump in the quarry void which has been dewatered below the groundwater table under the pre-existing dewatering exemptions since 1998 to facilitate extraction of Limestone. The majority of water pumped from the quarry sump is transferred to the Nant Cadlan that flows to the west of the Site, with the remainder used for dust suppression and wheel washing purposes. These activities were, until January 2018, exempt from abstraction licencing.

Hanson is applying, under the transitional arrangements, for one full abstraction licence and one transfer abstraction licence. The proposed licences will cover the current dewatering at the Site with rates applied for being based on the pumping rates recorded during the seven year qualification period. The transfer licence covers the transfer of water from the quarry sump to the Nant Cadlan. The full licence covers the use of water at the Site for dust suppression and wheel washing purposes.

This document has been written in support of the applications and should be read in conjunction with the application forms.

1.2 Land Ownership

As required by Section 4.2 of the application form, Figure 1.1 shows the Hanson freehold land ownership boundary at the Site. This is also shown in Appendix B, and Appendix A shows the land ownership boundary together with the site water management plan.

1.3 Report Structure

This technical note covers many of the detailed requirements of the New Authorisations applications and includes the following:

- Existing water movements and water management at the Site including abstraction arrangements, consumptive use details and discharge locations (Section 2);
- A summary conceptual model for the Site (Section 3);
- A water balance for the quarry sump estimating the surface water and groundwater inflow components to the sump (Section 4); and
- Summary of the Environmental Impact Assessment (EIA) for dewatering from the Site (Section 5).

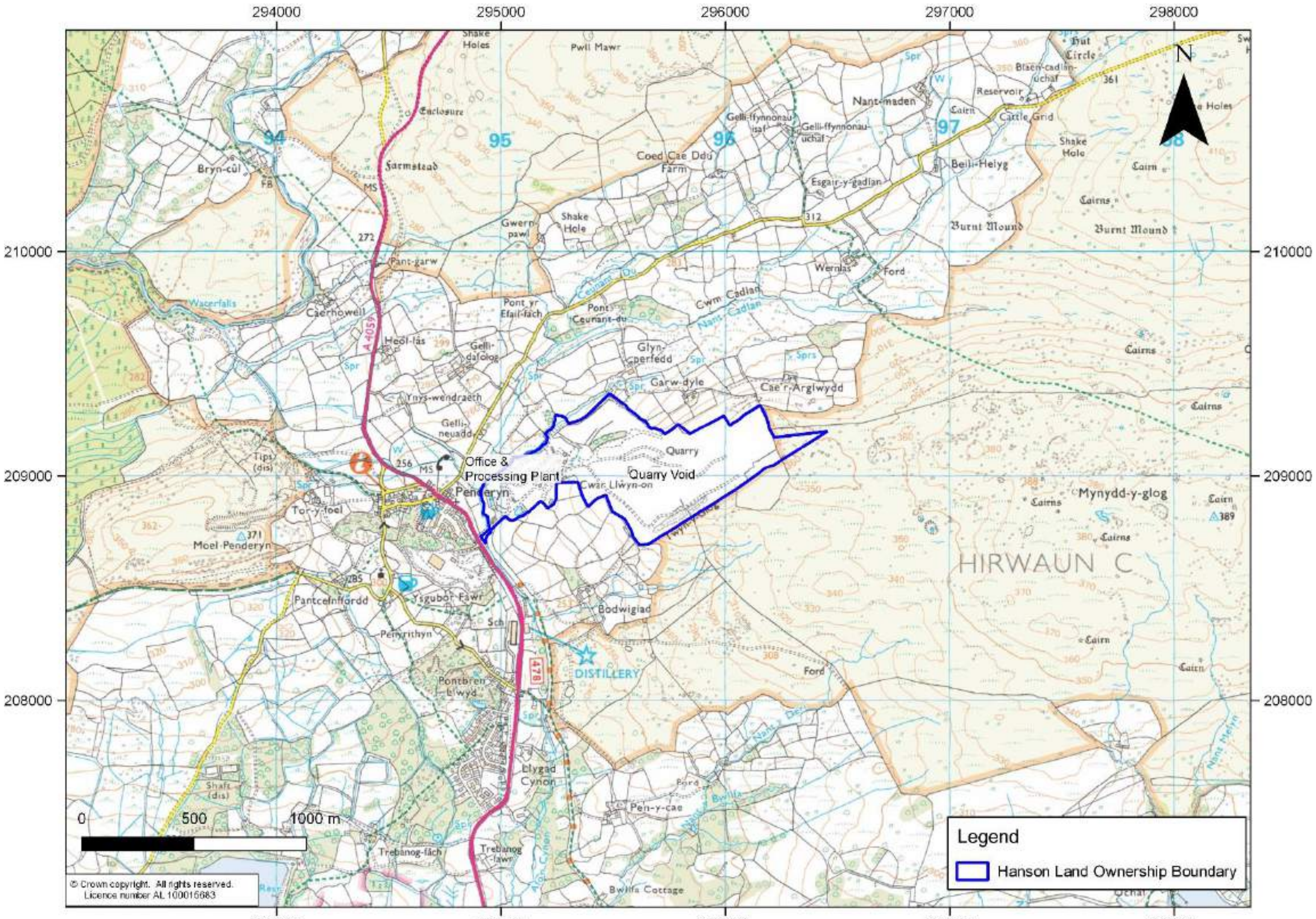


Figure 1.1 Penderyn Quarry location and land ownership boundary

2 Water Management

2.1 Site Water Management Plan

The existing water management plan is described in this section and is shown schematically in Figure 2.1 with a real world image provided in Appendix A (ref. P7m/110).

The quarry sump collects surface water runoff and direct rainfall from the quarry void surface water catchment together with some groundwater ingress. The relative proportion of flows from surface water and groundwater to the sump is considered further in Section 4.2. Water abstracted from the quarry sump is pumped along a pipeline which discharges to the Nant Cadlan. The pump takes water to the top of the void and gravity drainage conveys water to the discharge location at Nant Cadlan (see Appendix A).

When water is required for dust suppression or wheel washing purposes, a stop-cock located at the wheel wash facility (see Appendix A), is manually closed to prevent pumped water from flowing to the Nant Cadlan. Figure 2.2 shows a photograph of the stopcock. When closed, water is diverted to three storage tanks. Two storage tanks are located at the main drystone plant and one at the wheel wash facility. These are filled via gravity drainage as required when the stop-cock is manually closed. From these tanks, water is abstracted for dust suppression purposes at the main drystone plant and coating plant and for wheel washing at the Site entrance. Further details on these consumptive uses are provided below. After water from the main pipeline is diverted to the wheel wash storage tank, this water is pumped to another storage tank at the coating plant as is required.

Excess unused water from the main drystone plant is collected in a pipe and conveyed to a drain in the coating plant, where excess unused water from the coating plant joins this. This drain is joined by another drain collecting excess unused from the wheel wash facility and these discharge to the settlement lagoon adjacent to the quarry office. Water from this settlement lagoon drains to two settlement lagoons (lagoons 1 and 2) in the west of the Site. At lagoons 1 and 2 the inflowing pipe (from the lagoon adjacent to the quarry office) splits flows, approximately equally between lagoons 1 and 2. These lagoons each discharge to Nant Cadlan at two locations separated by approximately 200 m, both of these are upstream of the main discharge location which comes directly from the quarry sump.

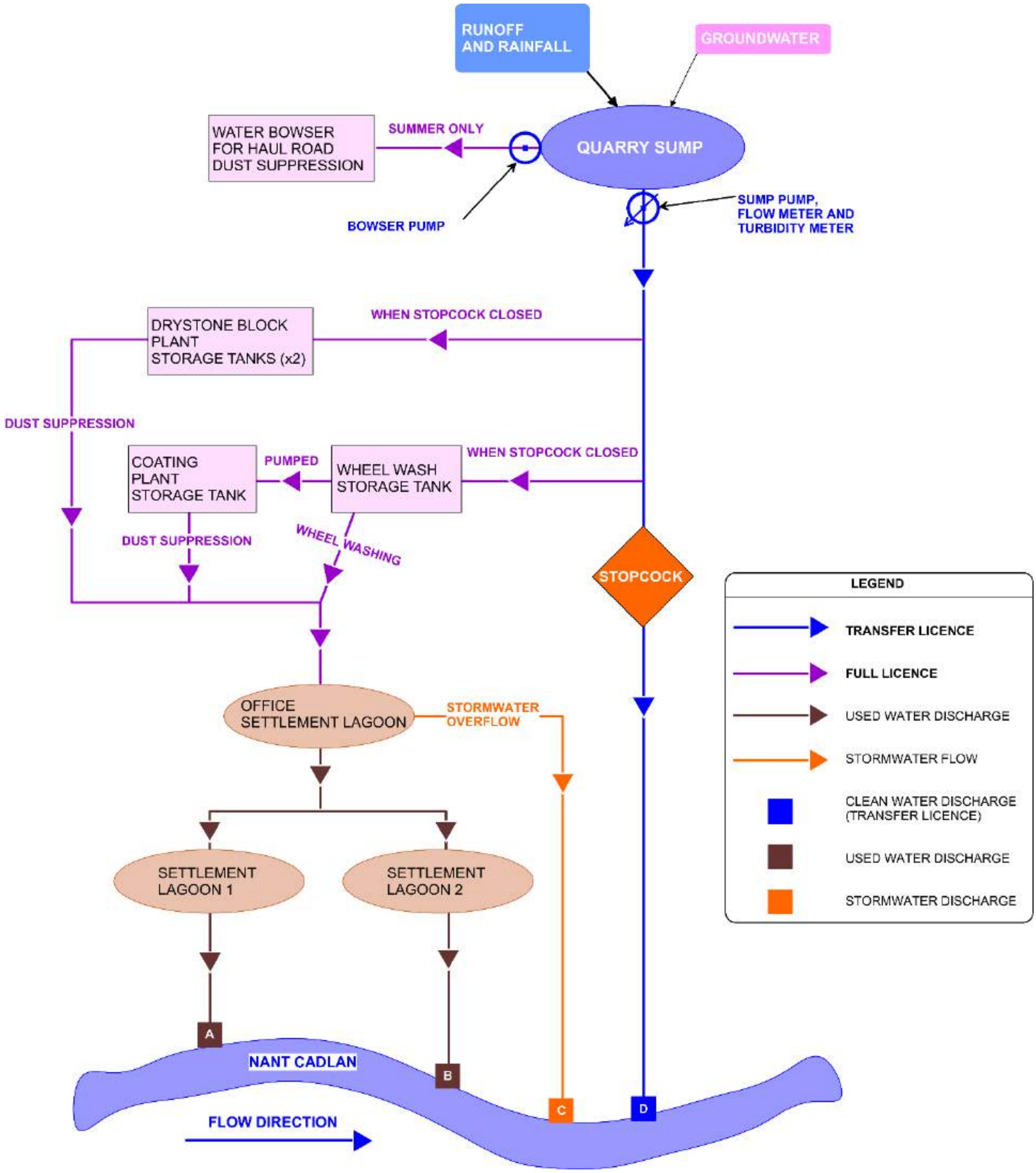


Figure 2.1 Schematic water management plan

Figure 2.2 Photograph of stopcock used to manually divert water for use in dust suppression and wheel washing

2.2 Abstraction Arrangement

The vast majority of abstraction is undertaken from the quarry sump using the sump pump. During dry periods, typically only over the summer months, water is also pumped directly from the sump to a bowser and this water is then used for dust suppression on the quarry haul roads. This procedure is due to change in summer 2019 (as discussed below).

The sump and sump pump, from which abstraction is currently taking place, are shown in Appendix A. Figure 2.3 shows an image of the quarry sump taken from the south looking north taken in October 2018.

The sump pump operates under two modes as follows:

- Automatic: pumping rate controlled by a float switch which activates when water depth in the sump reaches 4.2 m. The sump pump deactivates automatically when water depth in the sump reaches 3.7 m.
- Manual: pumping activated manually within the pump housing at the Site whenever water is required for wheel washing or dust suppression purposes.

The automatic pumping mode setting prevents the quarry from flooding, while the manual override is only used when water is required in the processing plant or wheel wash facility. Manually operated pumping is mostly used in summer when there is increased demand for water for dust suppression purposes and levels in the sump are naturally lower (due to lower summer rainfall).

Figure 2.4 shows a photograph of the quarry sump pump flow meter. This gives real time readings of pumping rate and pumping level which are recorded at 10 second intervals when the pump is active.

As quarrying progresses, the pumping location and area could change and Table 2.1 shows the four points that delineate the pumping area which corresponds to the excavation area that is being dewatered (i.e. the quarry void).

Based on hydrographs of water levels in the quarry sump, the float switch on level is thought to be set at around 250 m AOD. The sump pump is serviced on a quarterly basis by Pump Supplies Limited.

The sump has a maximum depth of around 8 m (i.e. to 242 m AOD) and is approximately 2,000 m^2 in area. The pumping level would therefore drop no lower than 242 m AOD under manually operated pumping conditions. During the qualification period (1 January 2011 – 31 December 2017), sump water level varied from 246.42 – 254.00 m AOD with a mean level of 249.97 m AOD. The highest level of 254 m AOD, was recorded when the pump failed and the quarry floor flooded in December 2015 (ESI, 2016). Over the qualification period, sump levels were typically between 249 and 251 m AOD.

Table 2.1 Quarry abstraction location details

Location	Easting	Northing
North east corner	296150	209310
South east corner	296225	209085
South west corner	295660	208750
North west corner	295410	209200

Figure 2.3 Quarry sump photograph from the south looking north

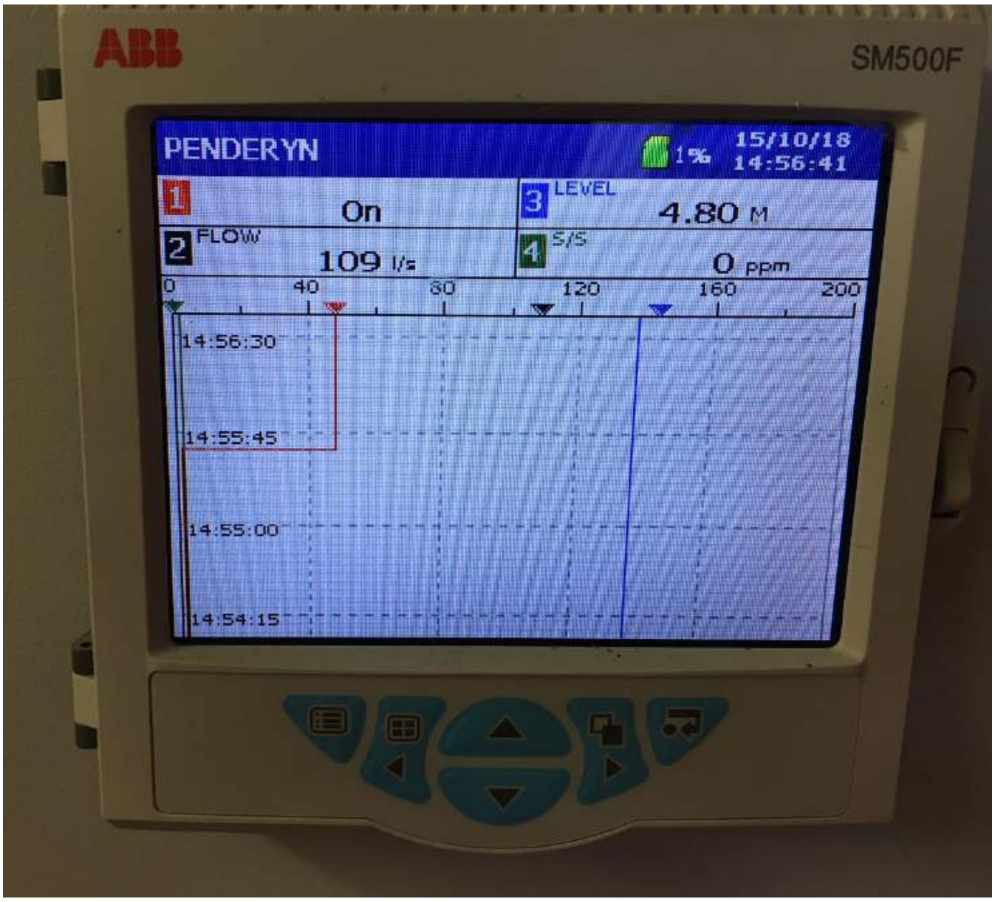


Figure 2.4 Quarry sump flow meter

Pumping to the bowser for haul road dust suppression is only used during dry periods over summer. This abstraction is not metered. Anecdotal evidence (records are not kept) indicates that this additional abstraction is typically used for up to three months per year (over summer) with the bowser being typically filled twice per day. However, this frequency is weather-dependent. Section 4.3 provides an estimate of the abstraction rate.

In 2019, Hanson is proposing to install an additional tank which will take water directly from the sump pipeline. This will be used to supply fixed rain guns for dust suppression purposes which will have an increased coverage across the Site. Therefore, in future the bowser will be used less frequently. Any water used in the bowser will be taken from a storage tank and, as this is after the flow meter, all abstraction at the Site will be metered.

2.3 Site Water Use

Water is used for dust suppression, wheel washing and conditioning at the Site. Table 2.2 summarises these uses and their respective sources. Water used for wheel washing and dust suppression is taken from the quarry sump and is the subject of this application. Water used for conditioning at the pug plant is sourced from mains water and is not considered further.

Water used to fill the storage tanks at the wheel wash and main drystone processing plant is taken directly from the quarry sump water transfer pipeline. Water is pumped from the storage tank at the wheel wash facility to a storage tank at the Coating Plant where it is utilised for dust suppression purposes. Over the qualification period, water was also taken directly from the sump to fill a bowser for dust suppression purposes over the summer period or in dry weather, but this practice will shortly cease as described above.

Photographs of the storage tanks are shown in figures 2.4 to 2.6.

Table 2.2 Details of water use

Use Location	Source of used water	Abstraction method	Storage tank size (m^3)	Water usage
Main drystone processing plant adjacent to primary crusher	Quarry sump	Sump pump	2 x 51.5	Dust suppression
Wheel wash facility	Quarry sump	Sump pump	30	Wheel wash
Coating Plant	Quarry sump	Sump pump	15	Dust suppression
Quarry haul roads	Quarry sump	Pump to bowser (over qualification period) Sump pump (from 2019 onwards)	2.5 (bowser size)	Dust suppression
Pug Plant	Mains water	From mains	n/a	Conditioning

Figure 2.5 Drystone processing plant storage tanks

Figure 2.6 Wheel wash facility storage tank

Figure 2.7 Coating plant storage tank

2.4 Discharge Details

There are four discharge locations at the Site, two convey used water and surface runoff from the plant site area to the Nant Cadlan (A and B), one is a stormwater overflow (C) and the final location is a transfer of unused water from the quarry sump (D). The discharge locations are shown in Appendix A and schematically on Figure 2.1. Table 2.3 summarises details of the discharges and discharge locations together with the permits authorising these. All discharge permits are appended in Appendix C.

Locations C and D are immediately adjacent to each other and south of the site access road. Figure 2.8 shows a photograph of discharge locations C and D. Both of these discharge through plastic pipes. Used water discharges from settlement lagoons 1 and 2 through woodland to the Nant Cadlan. None of these discharges are metered.

Table 2.3 Details of discharge of abstracted water

Discharge location	National Grid Reference	Discharge Limit	Effluent	Type	Permit ID
A	SN 94912 08906	n/a	Trade effluent consisting of site drainage	Used water discharge	AN0238501
B	SN 94923 08858	n/a	Trade effluent consisting of site drainage	Used water discharge	AN0238501
C	SN 94953 08758	368 l/s	Trade effluent consisting of storm site drainage	Stormwater overflow	AN0238501
D	SN 9494 0871	Rainfall dependent not exceeding 50 l/s	Trade effluent comprising pumped groundwater and site drainage from the quarry sump	Transfer of clean water	AN0272901

Figure 2.8 Photograph of discharge locations C and D, C is on the left

2.5 Other Abstractions

The Site holds one abstraction licence (ID 21/57/23/51). This licence allows for up to 45.46 m^3/day of surface water to be abstracted at a rate not exceeding 1.27 l/s from an unnamed tributary of the Nant Cadlan that flows through the northern part of the Site. The licence allows water to be used for the manufacture of ready mixed concrete (termed 'Premix' on the licence).

3 Conceptual Model

3.1 Background

The conceptual hydrogeology at the Site is well understood and is based on site investigations, a comprehensive ongoing monitoring regime, and various analytical and desktop assessments. The latest hydrogeological conceptualisation is provided in Appendix D and a summary of the key aspects of the conceptual model is outlined in Section 3.2.

3.2 Summary

3.2.1 General

Figure 3.1 shows a conceptual hydrogeological cross section through the Site.

Superficial deposits are absent at the Site, but outside the Site boundary they are mostly comprised of glacial till with some peat and alluvium. At depth, glaciofluvial and glaciolacustrine deposits are present. The bedrock geological sequence around the Site features the Twrch Sandstone Formation, which is comprised of cemented sandstone and conglomerate, overlying a sequence of Carboniferous Limestone of the Pembroke Limestone Group. The Dowlais Limestone Formation forms part of this group and comprises the economic mineral at the Site. The Carboniferous strata are offset by the normal northerly dipping Dinas Fault.

The Bodwigiad Stream and Nant Cadlan are the closest watercourses to the Site, being located 200 m south and immediately west of the Site respectively. A tributary of the Nant Cadlan flows through the northern part of the Site. The Bodwigiad Stream joins the Nant Cadlan 400 m south of the Site.

Owing to the cemented nature of the constituent sandstone and conglomerate units, the Twrch Sandstone is less permeable than the limestone and the degree of hydraulic connectivity between the two is thought to be limited. Due to its lower permeability, surface watercourses tend to be mostly sited over areas of Twrch Sandstone rather than the limestone, or where the limestone is overlain by superficial deposits such as glacial till.

The limestone aquifer has a negligible primary porosity and groundwater flow within this unit is largely dependent upon secondary features such as joints, faults and karstic fissures and conduits. Bedding planes may act as inception horizons for development of karst features and where lower permeability mudstone units are present, perched groundwater layers may form. Groundwater flow in these perched layers is likely southwards, in line with the stratigraphic dip.

The bedrock groundwater level surface shown on Figure 3.1 is a simplification and, in reality, the situation is thought to be much more complex with a series of perched water tables and a downwards vertical gradient. Analysis of the summer 2018 dry period by Stantec (2019) suggests that groundwater levels could naturally be below the quarry floor level of 250 m AOD during dry summers. Historical groundwater elevation data presented by Steffen, Robertson and Kirsten (UK) (1998), shows that the water table at the Site prior to quarrying was at around 265 m AOD over winter. This large range in levels is expected in limestone aquifers with low storage where groundwater flow is dominated by flow through fracture systems.

There could be some discharge from the limestone aquifer to surface water features, including the, Bodwigiad Stream and Nant Cadlan, where the watercourses directly overlie the limestone aquifer. Such connectivity will be reduced and may even be absent where the limestone is overlain by Twrch Sandstone or glacial till. Dependent on location, the watercourses could be gaining or losing to groundwater. Epikarst features may locally enhance connectivity with the underlying aquifer.

Groundwater flow within the limestone aquifer appears to be south and westwards. However, flow varies spatially dependent on the density of fractures and karst formation. There is some drawdown due to quarry dewatering evident in monitoring boreholes within the Site boundary, but this has largely stabilised since 2014 and groundwater is thought to comprise only a minor component of quarry dewatering (see Section 4.2).

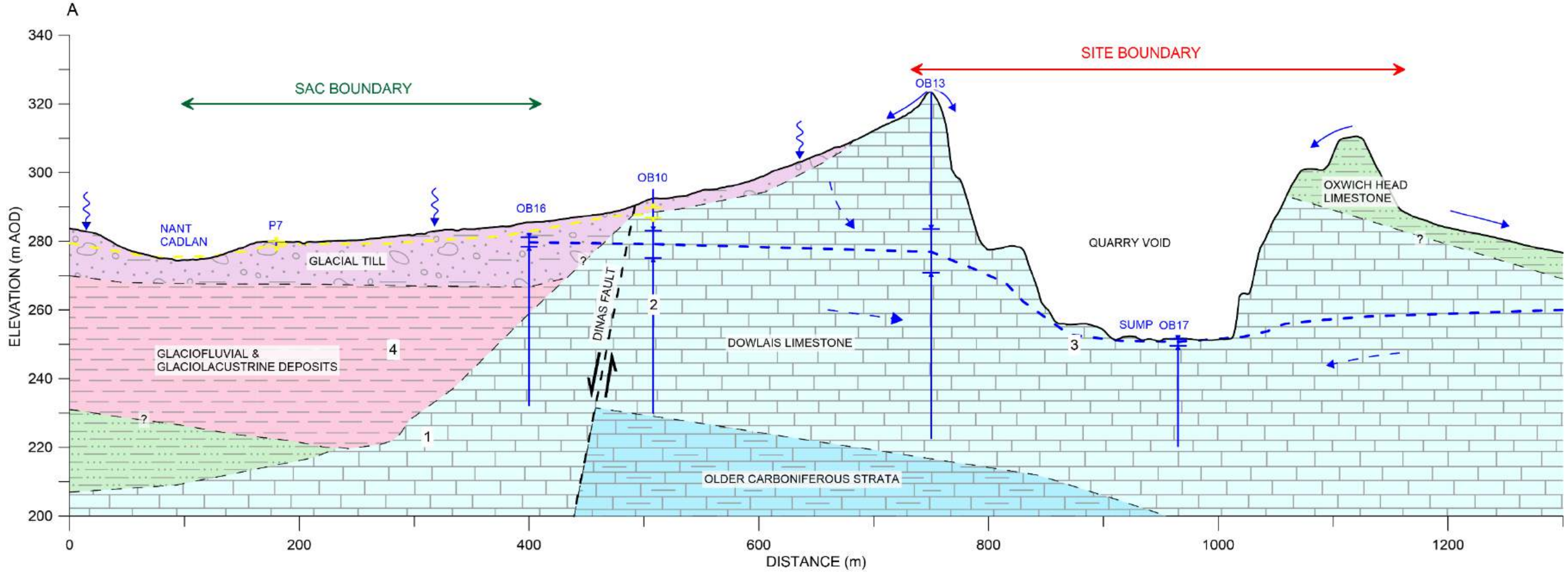
Recharge to the limestone is from direct rainfall and runoff through solutional features (and potentially from loss of flow in surrounding watercourses). Particularly on the southern face of the Penderyn Quarry void, karst has developed though limestone dissolution by acidic runoff from areas of Twrch Sandstone outcrop. Solution features are most prominent at the contact between the Twrch Sandstone and the limestone and represent preferential recharge pathways to the limestone. A series of sinkholes are present on the limestone outcrop around the Site and dolines have formed on the Twrch Sandstone to the south and east of the Site. These also represent preferential recharge pathways to the limestone aquifer and act to limit surface water runoff.

Cwm Cadlan Special Area of Conservation (SAC) (also designated as a Natural Nature Reserve (NNR) and Site of Special Scientific Interest (SSSI)) is the closest designated site to the Site. This SAC is designated for its grassland habitats and is thought to be primarily dependent on surface water. Further detail on the conceptualisation of the SAC is outlined in Section 3.2.2.

3.2.2 Cwm Cadlan SAC

The Cwm Cadlan SAC is located north of the Site and north of Dinas Fault (as is shown in Figure 3.1). North of the Dinas Fault, groundwater flow in the limestone is thought to be limited due to attenuation of recharge to the limestone through the overlying glacial till. Additionally, geological mapping shows that the eastern part of the SAC is underlain by Twrch Sandstone Formation which has a low permeability (BGS, 1979). Boreholes drilled within the SAC, show that the underlying glacial till, glaciofluvial and glaciolacustrine deposits can have a combined thickness of greater than 70 m thick in this area. Surficial glacial till diverts rainfall to springs that are present to the north and north-west of the Site and appear on the northern flanks of the ridge into which the quarry void is excavated. These perched springs also feed the Cwm Cadlan SAC.

Discharge of groundwater to the drift deposits within the SAC from the limestone bedrock is also limited by the low permeability drift material. Given the thickness of the drift material, and that much of the area is inferred to be underlain by Twrch Sandstone Formation, these flushes are not particularly vulnerable to changes in groundwater levels in the limestone. Boreholes installed into the drift indicate that there are significant thicknesses of granular material (sands, gravels) within the sequence. Although these would allow horizontal movement of water, vertical movement would be much lower due to intervening low hydraulic conductivity layers within the drift. Given the above, it is therefore concluded that limestone and drift deposits at the SAC are hydraulically isolated from one another.



Glacial Till	Fault	Drift Maximum*
Glaciolacustrine/fluvial Sediments	Piezometer	Drift Minimum*
Oxwich Head Formation	Bedrock GWL	Bedrock Maximum*
Dowlais Limestone Formation	Superficials GWL	Bedrock Minimum*
Older Carboniferous Strata		

Vertical Exagerration = 3:1

Explanatory Notes

1. Bedrock groundwater levels north of Dinas Fault uncertain - could be confined by overlying low k sediments.
2. Possible Oxwich Head Limestone identified in OB10 which may lie north of the fault. Location of Dinas Fault is from geological mapping. Geology shown is simplest interpretation.
3. Groundwater flow locally towards sump in plane of cross section.
4. Low vertically hydraulic conductivity and thickness of drift deposits hydraulically isolates limestone from overlying drift.

*Typical max and min groundwater levels defined as being with two standard deviations of mean

- Groundwater flow direction
- Surface water flow direction
- Recharge/percolation
- ? Uncertainty in geological contact

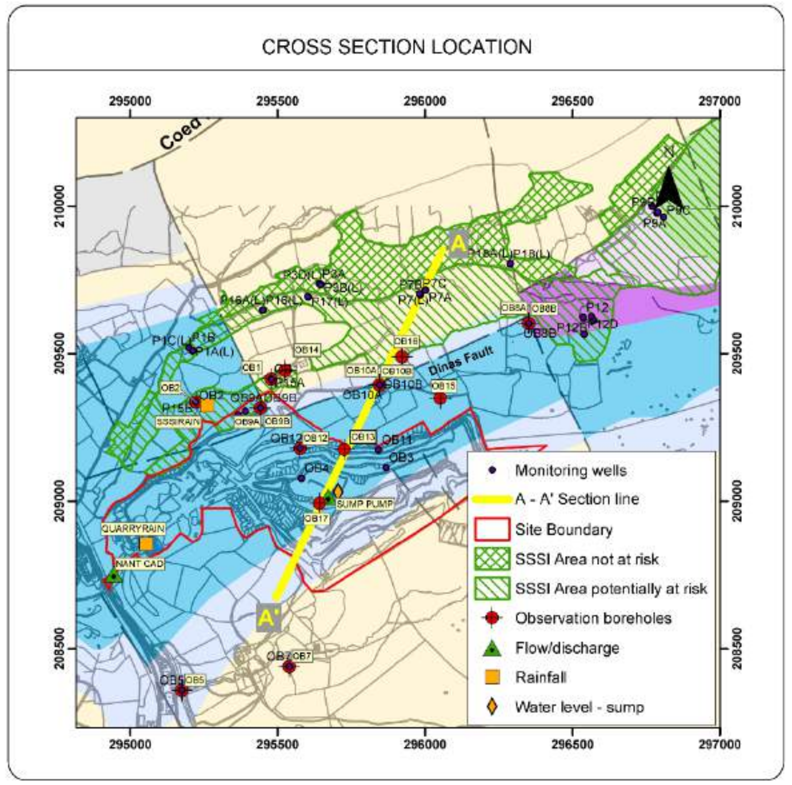


Figure 3.1 Conceptual hydrogeology cross section

4 Quarry Water Balance

4.1 Sump Pumping Records

One flow meter was present at the Site during the qualification period (1 January 2011 – 31 December 2017), and this recorded pumping rate from the quarry sump. The sump pump flow meter records pumping rate at intervals which are dependent on the pumping rate but typically every 10 seconds.

Table 4.1 summarises the maximum recorded quantities that were pumped during the qualification period and Figure 4.1 shows a plot of recorded pumping rate over the qualification period compared to rainfall. The maximum hourly and instantaneous pumping rates are given as the maximum pumping capacity.

During the qualification period, the maximum recorded daily pumping volume was 9,676 m^3/day. This high pumping rate was recorded on 24 December 2013 and is related to a high rainfall event with over 89 mm falling on 23 and 24 December 2013. Mean pumping rates vary from 684 – 979 m^3/day typically being greatest over the winter period and lowest over summer in line with seasonal variations in rainfall.

The maximum recorded annual volume was in 2014 (328,895 m^3) despite the record only being 93% complete. Had the data record been complete for this year, assuming a that the pumping rate operated at the daily average for the remaining 7%, the estimated annual pumping volume is 353,078 m^3.

Table 4.1 Quarry sump: Maximum metered quantities abstracted during the qualification period

Year	Period of Abstraction	Purpose	Record Complete (%)	No. Recorded Abstraction Days	Actual Maximum (m^3/year)	Actual Daily Maximum (m^3/day)	Actual Daily Mean (m^3/day)	Max (m^3/hour)	Max instantaneous flow (l/s)
2011	All year	Dewatering and use (See Section 4.3)	100%	257	249,478	4,582	684	504	140
2012	All year		100%	283	315,869	5,591	863	504	140
2013	All year		100%	295	298,855	9,676	819	504	140
2014	All year		93%	294	328,895	7,538	979	504	140
2015	All year		98%	298	271,897	9,329	832	504	140
2016	All year		30%	94	72,625	5,944	n/a[1]	504	140
2017	All year		99%	305	283,112	7,499	782	504	140

[1]A mean pumping rate has not been calculated due to the record being mostly incomplete

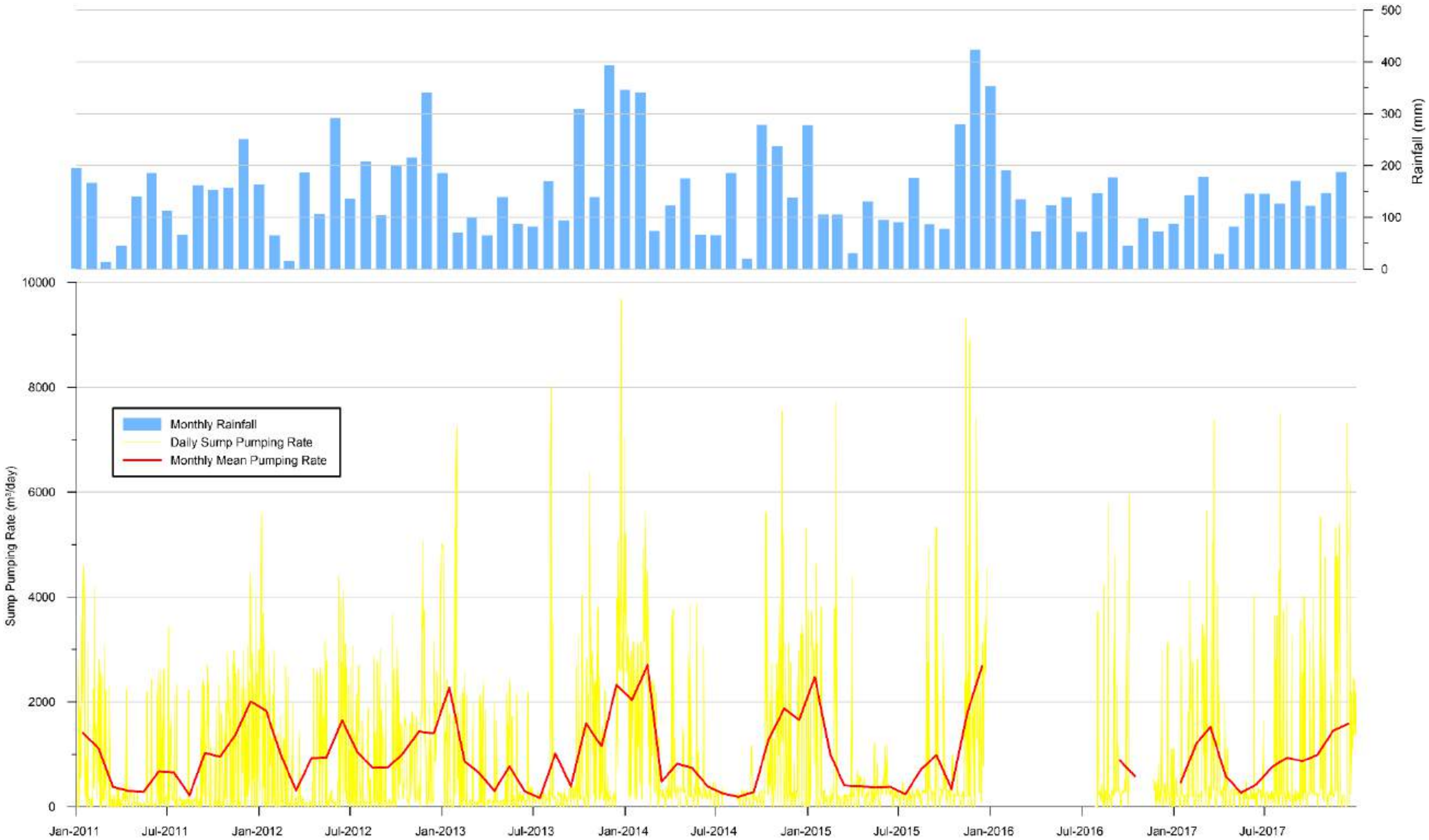


Figure 4.1 Plot of sump pumping rate and rainfall over the qualification period

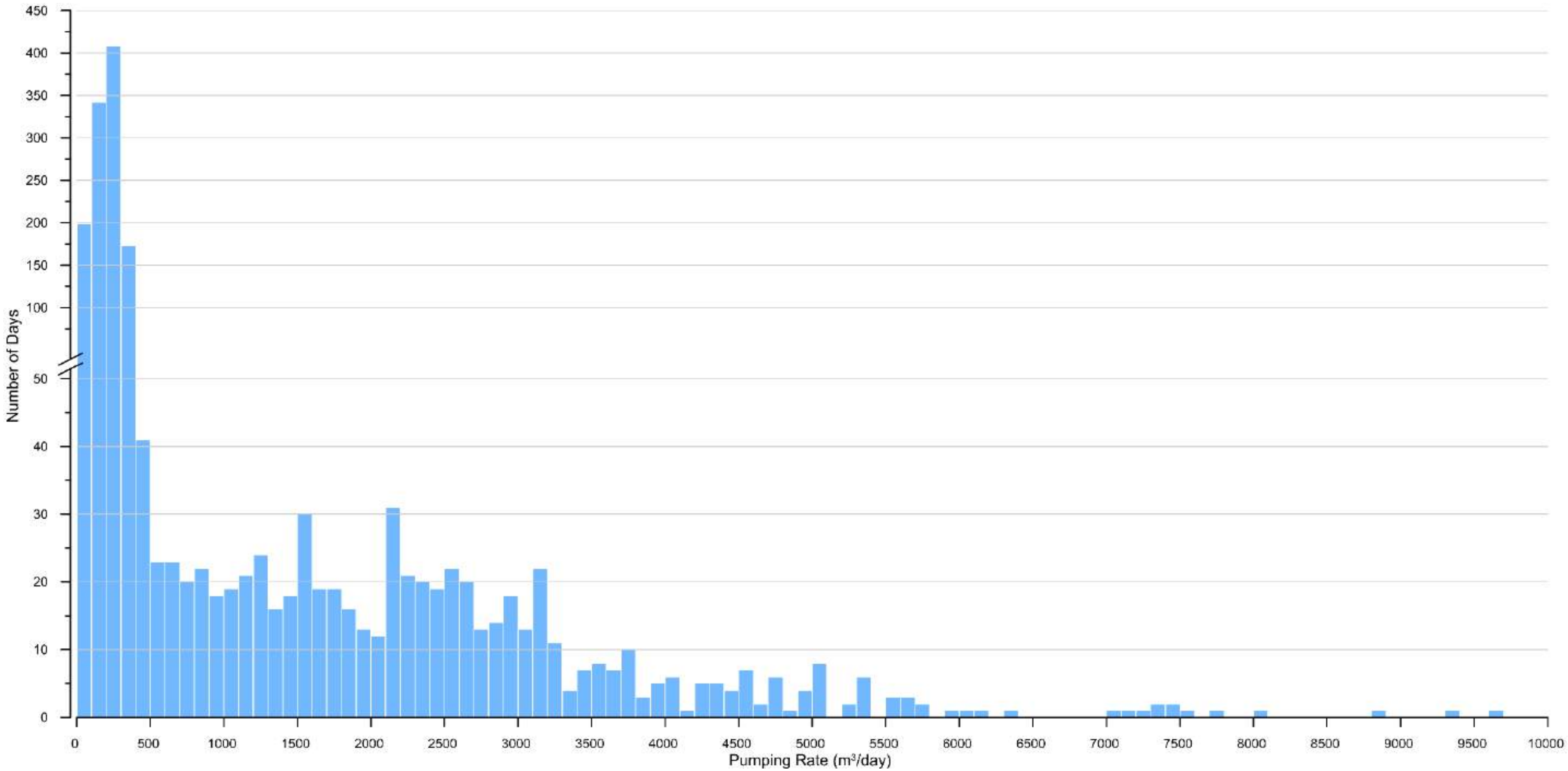


Figure 4.2 Sump pumping rate histogram over the qualification period

4.2 Surface Water and Groundwater Inflows to Sump

Figure 4.1 demonstrates that pumping rate from sump shows a strong correlation with rainfall. Dry weather flow analyses for dry periods in winter and summer 2013 have been undertaken by ESI (2017) to estimate inflows to the sump from groundwater. Accounting for change in sump storage volume using the sump level and recorded pumping rates from the sump, groundwater inflows were estimated to be:

- Approximately 75 m^3/day (0.87 l/s) over summer; and
- Approximately 113 m^3/day (1.31 l/s) over winter.

Groundwater inflows are greater over the winter period when groundwater levels are higher and there is a steeper hydraulic gradient towards the sump. However, flows remain small and the difference is not significant. Further detail on the dry weather flow analyses is provided in ESI (2017) which is appended in Appendix D.

Stantec (2019) undertook an analysis of the exceptionally dry summer of 2018 where between 21 June and 26 July 2018 only 6.8 mm of rain fell. This assessment concluded that groundwater ingress is relatively low and not inconsistent with the value of 75 m^3/day which has been reported previously. Indeed, groundwater inflows were so low that water in the sump was insufficient to meet the water use requirements of the Site and water was imported using tankers.

These estimated groundwater inflows represent up to 16.5% of the mean daily recorded pumping rate during the qualifying period (as shown in Table 4.1. Even allowing for variations in groundwater inflow rate due to changes in pumping level and rainfall, most of the water abstracted, and to be abstracted from the sump, is surface water (comprised of runoff and direct rainfall) and not groundwater. This proportion is clearly lower than what would be classified as “wholly or mainly groundwater” and therefore a licence may not be required.

4.3 Water Usage (Full Licence)

Other than the flow meter fitted to the sump pump, there are no other working meters at the Site. Therefore, an estimate of water use at the Site has been made based on anecdotal evidence supplied by Hanson. Hanson staff indicate that:

- Both storage tanks (each holding 51.5 m^3) at the main drystone processing plant are filled at least once per day and both are filled up to twice a day in summer;
- the storage tank at the wheel wash facility (holding 30 m^3) is filled at least once per day but can be up to twice per day dependent on traffic; and
- the water bowser (holding 2.5 m^3) is filled up to twice per day during summer.

The storage tank at the Coating Plant supply tank is filled on an auto timer from the tank at the wheel wash facility and does not take any additional water from the sump.

Based on the tank storage volumes given in Table 2.2 and the above information, daily usage is assumed to range from 133 – 271 m^3. Water is only used when the quarry is operational and the manual stopcock is closed. Planning permission allows the Site to be operational on Saturdays and the Ready Mixed Concrete Plant can work 24 hours per day, 7 days a week. Assuming that the maximum volume could be used up to 312 days per year (i.e. six days per week over a year). Based on this, the Site is expected to use an annual volume of approximately 84,552 m^3 has been requested. This is equivalent to 312 days multiplied by the maximum expected rate (271 m^3/day). These rates are summarised in Table 6.1.

Hanson will fit a flow meter at discharge location D in 2019. This meter will be west of the stopcock and therefore the difference between the total pumped and total discharged volumes will equal the total volume of water used for wheel washing and dust suppression purposes.

4.4 Water Transfer (Transfer Licence)

Surface water and groundwater ingress to the Penderyn Quarry void are dewatered to facilitate dry working of the limestone mineral. Based on the volumes presented in Table 4.1, the maximum pumping rates are estimated to be:

- Annual (based on 2014): 328,895 m^3 based on 93% of the record, estimated actual use is 353,078 m^3; and
- Daily: (based on 2013): 9,676 m^3.

For simplicity and to account for variations in rainfall, these values have been rounded to 10,000 m^3/day and 360,000 m^3/year.

5 Environmental Impact Assessment

5.1 Planning Permission

Appendix F contains the extant planning permissions for the Site that are associated with this abstraction. Hanson will be submitting a planning application to allow working of mineral in the area denoted "Application Site" on TYG 1b in Appendix G. As part of this application, Hanson proposes to give up the rights to work the "Area to be Preserved" as is shown on TYG 1b (see Appendix G). It is not proposed to work below 265 m AOD in the Application Site and therefore the groundwater table will not be intercepted in this area.

5.2 Environmental Impact Assessment

Various hydrogeological and hydrogeological impact assessments have been undertaken for the Site and these indicate that the principle receptors from the abstraction at the Site are:

- Cwm Cadlan SAC; and
- Penderyn DCWW licenced groundwater abstraction.

Potential impacts from the abstraction on these receptors have been assessed using the most recent conceptualisation (ESI, 2017) (see Appendix D). The latest full Environmental Impact Assessment (EIA) was undertaken as part of the Review of Old Mineral Permissions (ROMP) application (SRK, 2011) and this is appended in Appendix H.

These reports conclude that impacts on the SAC and DCWW abstraction due to abstraction activities at the Site are expected to be negligible when quarrying down to a level of 250 m AOD. Stantec (formerly ESI Ltd) undertakes 6 and 12 monthly monitoring reports on behalf of Hanson. The latest annual report concludes that to date, there have been no impacts on either receptor due to quarry dewatering (Stantec, 2019). SRK (2011) notes that the risks to the SAC and DCWW abstraction are expected to remain low even as quarrying advances to a level of 165 m AOD.

6 Summary of Licencing Requirements

6.1 Summary of Quantities Requiring a Licence

Table 6.1 summarises the quantities that are being applied for as part of the full and transfer licence applications. The maximum annual and daily volumes for the full licence have been estimated based on the discussion in Section 4.3. The maximum annual and daily volumes for the transfer licence have been arrived at using the actual volumes in Table 4.1. The maximum and daily annual transfer volumes are based on the maximum recorded mean daily pumping rate of 9,676 m^3/day from 2015. This has been rounded up to 10,000 m^3/day to allow for variations in rainfall.

Maximum hourly and instantaneous pumping rates are based on the pump capacity.

Although the required volumes for the transfer licence have been estimated, we do not expect the transfer licence to be rate limited.

Table 6.1 Summary of quantities requiring a licence

Type	Maximum (m^3/year)	Maximum (m^3/day)	Maximum (m^3/hour)	Maximum instantaneous (l/s)
Full	84,552	271	504	140
Transfer	360,000	10,000	504	140

The licence is required for the maximum ten year period that is allowed for the Swansea Bay Rivers catchment where the Site is located.

References

BGS. (1979). Geological Survey of England and Wales 1:50,000 geological map series, Merthyr Tydfil Sheet 231.

ESI. (2016). Penderyn Quarry: Interim data summary report for the period 1 Oct 2015 to 31 Mar 2016.

ESI. (2017). Penderyn Quarry Geological/Hydrogeological Reconceptualisation. 61190TN2Rev1.3.

SRK. (2011). Penderyn Quarry ROMP Hydrological Impact Assessment.

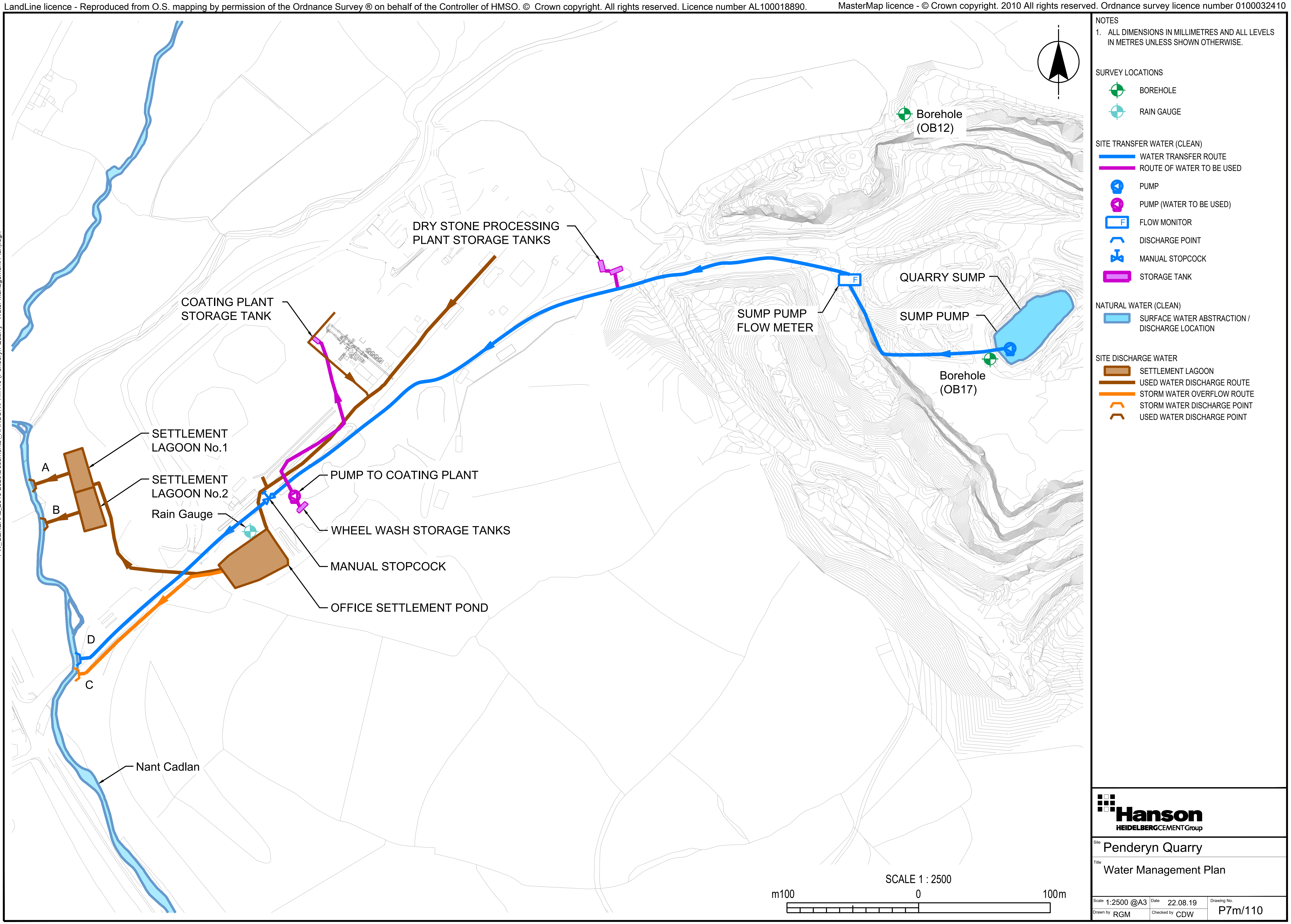
Stantec. (2019). Penderyn Quarry Annual Monitoring Report - October 2017 to September 2018.

Steffen, Robertson and Kirsten (UK). (1998). Penderyn Quarry Hydrogeological Monitoring Annual Review .

Appendices

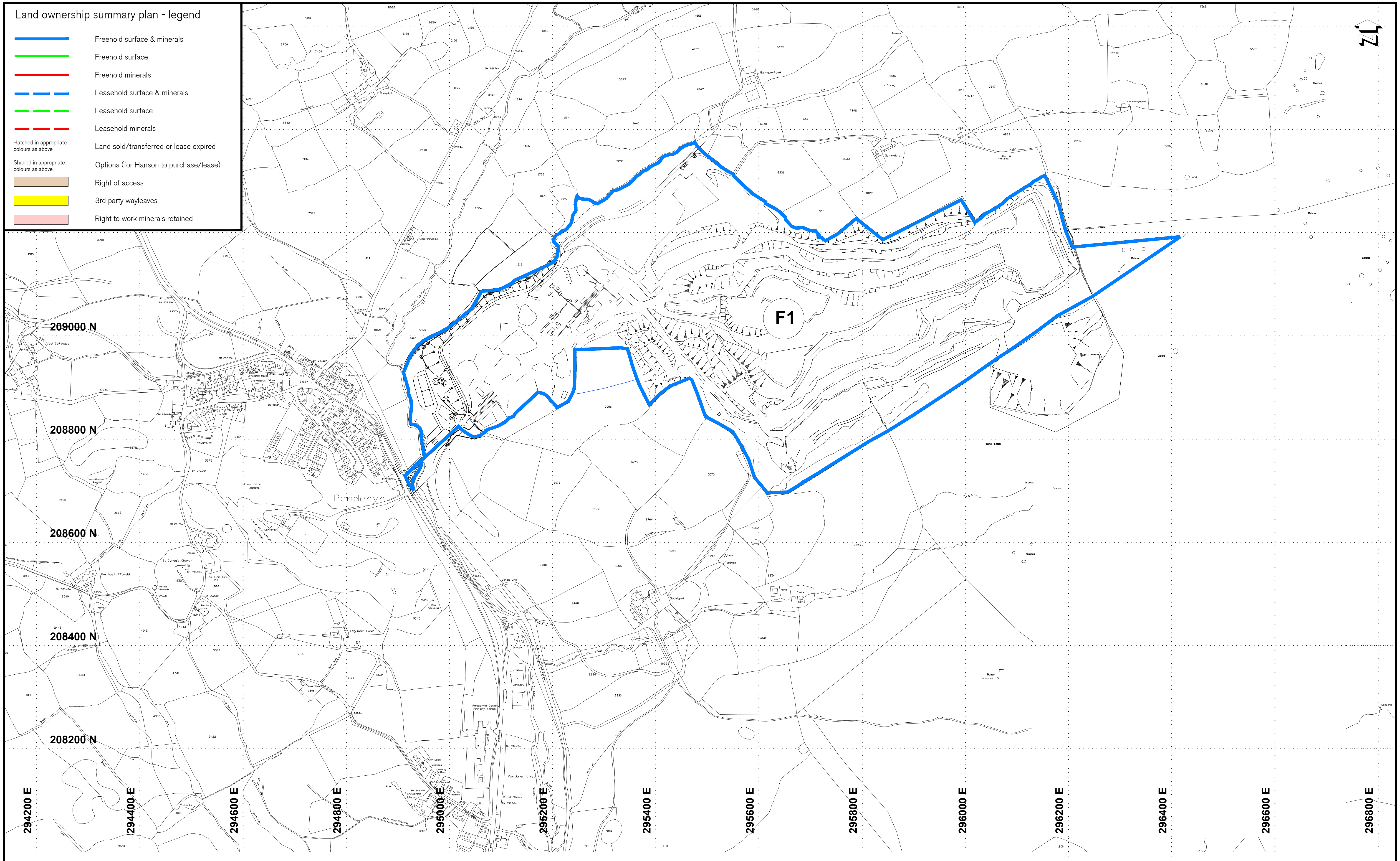
Appendix A

Site Water Management Plan


NOTES
1. ALL DIMENSIONS IN MILLIMETRES AND ALL LEVELS IN METRES UNLESS SHOWN OTHERWISE.
SURVEY LOCATIONS
BOREHOLE
RAIN GAUGE
SITE TRANSFER WATER (CLEAN)
WATER TRANSFER ROUTE
ROUTE OF WATER TO BE USED
PUMP
PUMP (WATER TO BE USED)
FLOW MONITOR
DISCHARGE POINT
MANUAL STOPCOCK
STORAGE TANK
NATURAL WATER (CLEAN)
SURFACE WATER ABSTRACTION / DISCHARGE LOCATION
SITE DISCHARGE WATER
SETTLEMENT LAGOON
USED WATER DISCHARGE ROUTE
STORM WATER OVERFLOW ROUTE
STORM WATER DISCHARGE POINT
USED WATER DISCHARGE POINT
Borehole (OB12)
DRY STONE PROCESSING PLANT STORAGE TANKS
QUARRY SUMP
SUMP PUMP FLOW METER
SUMP PUMP
F
Borehole (OB17)
COATING PLANT STORAGE TANK
SETTLEMENT LAGOON No.1
SETTLEMENT LAGOON No.2
A
B
Rain Gauge
PUMP TO COATING PLANT
WHEEL WASH STORAGE TANKS
MANUAL STOPCOCK
OFFICE SETTLEMENT POND
D
C
Nant Cadlan
SCALE 1 : 2500
m100
0
100m
Hanson
HEIDELBERGCEMENT Group
Site Penderyn Quarry
Title Water Management Plan
Scale 1:2500 @A3
Date 22.08.19
Drawing No. P7m/110
Drawn by RGM
Checked by CDW

Appendix B

Landholding Summary Plan



Hanson
HEIDELBERGCEMENTGroup

P7
PENDERYN - Current Landholding Summary Plan
Do Not Scale

Site	PENDERYN		
Title	Current Landholding Summary Plan		
Scale NTS	Paper Size A3	Drawn by LW	Drawing No. P7/CLSP
Date Oct 2012		Check by KJB	Revision

Appendix C

Discharge Permits

creating a better place

Environment Agency

Mr R Griffiths
Principal Geologist South
The Ridge
Chipping Sodbury
Bristol
BS37 6AY

Our ref: AN0238501
Your ref:

Date: 13 June 2011

Dear Mr Griffiths

Copy of information sent to your client about an application received under the Environmental Permitting (England and Wales) Regulations 2010

Permit reference: AN0238501
Applicant: Hanson Quarry Products
Facility: Penderyn Quarry

I enclose for your information, copies of a letter and permits sent to your client about their application for an environmental permit. The information is important and should be kept safe.

Please quote our reference if you contact us. If you have any questions please phone me on 03708 506 506 or email psc-waterquality@environment-agency.gov.uk.

Yours sincerely

Kathy Nowell
Permitting Support Advisor

Permitting Support Centre WQ Team, Quadrant 2, 99 Parkway Avenue, Parkway Business Park, Sheffield, S9 4WF
Customer services line: 08708 506 506
Email: enquiries@environment-agency.gov.uk
www.environment-agency.gov.uk

M Crow

creating a better place

Environment Agency

15 JUN 2011

Mr R Tyson
Hanson House
14 Castle Hill
Maidenhead
Berkshire
SL6 4JJ

Our ref: AN0238501
Your ref:

Date: 13 June 2011

Julie Phillips
Stapled

Dear Mr Tyson

Issue of variation notice

Permit reference: AN0238501
Applicant: Hanson Quarry Products
Facility: Penderyn Quarry

I enclose a variation notice that gives legal information about the variation and shows the changes to your permit.

If you are not already familiar with our document 'How to comply with your environmental permit' please look at it, as this will help you understand how to meet the conditions of the permit. You can find this on our website at http://www.environment-agency.gov.uk/business/topics/permitting/32320.aspx
If you do not have internet access please telephone our Customer Contact Centre.

Please look at the table below and note any of the information or actions that apply to your permit.

If...	then..
the variation means you now need to submit quarterly waste returns on waste movements	you can get the forms you need from our website http://www.environment-agency.gov.uk/business/topics/waste/32176.aspx If you do not have web access phone our Customer Contact Centre
you need to submit other returns	send these to your area office. Speak to your area officer to check local arrangements.
your variation has added an installation to your permit for the first time	we've enclosed the pollution inventory letter, notice and fact sheet

Permitting Support Centre, Quadrant 2, 99 Parkway Avenue,
Parkway Business Park, Sheffield, S9 4WF
Customer services line: 08708 506 506
Email: enquiries@environment-agency.gov.uk
www.environment-agency.gov.uk

Rights of appeal

If you are not happy with any permit condition that has been imposed by the variation you may appeal to the Secretary of State for permits in England or Welsh Ministers for permits in Wales. You must make your appeal by 9 December 2011. If you are appealing against conditions imposed as a result of your application you must make your appeal by 9 December 2011. If you are appealing against any other conditions we have added at the same time as an Environment Agency initiated variation you must make your appeal by 9December 2011.

Further information about making an appeal and the forms you will need are available from the Planning Inspectorate website or from the contact details below.

For England:

The Planning Inspectorate, Room 4/04 Kite Wing, Temple Quay House,

2 The Square, Temple Quay, Bristol, BS1 6PN. Phone: 0117 3728726

Email: environment.appeals@pins.gsi.gov.uk

For Wales:

The Planning Inspectorate, Crown Buildings, Cathays Park, Cardiff, CF10 3NQ.

Phone: 029 2082 3866 / 389, Fax: 029 2082 5150, Email: wales@pins.gsi.gov.uk

You must send written notice of the appeal and the documents listed below to the Secretary of State or Welsh Ministers to the respective Planning Inspectorate address above. At the same time you must send us a copy of the notice and documents.

The documents are:

- a statement of the grounds of appeal;
- a copy of any relevant application;
- a copy of any relevant environmental permit;
- a copy of any relevant correspondence between the appellant and the regulator;
- a copy of any decision or notice which is the subject matter of the appeal; and
- a statement indicating whether you wish the appeal to be in the form of a hearing or dealt with by way of written representations.

You may withdraw an appeal by notifying the Secretary of State or Welsh Ministers in writing and sending a copy of that notification to us.

If you have any questions about this permit please phone our Customer Contact Centre on 08708 506 506. They will put you in touch with a local area officer.

Yours sincerely

Kathy Nowell
Permitting Support Advisor

Notice of variation and consolidation with introductory note

Environmental Permitting (England & Wales) Regulations 2010

Hanson Quarry Products Europe Limited

Penderyn Quarry site drainage
Penderyn
Near Aberdare
Mid Glamorgan
CF44 0TX

Variation application number

AN0238501/V001

Permit number

AN0238501

Penderyn Quarry site drainage
Permit number AN0238501

Introductory note

This introductory note does not form a part of the notice.

The following notice gives notice of the variation and consolidation of an environmental permit.

This variation is to add a storm overflow on to the attenuation lagoon.

The schedules specify the changes made to the permit.

The status log of a permit sets out the permitting history, including any changes to the permit reference number.

Status log of the permit		
Description	**Date**	**Comments**
Permit determined AN0238501	02/11/92	
Application AN0238501/V001 (variation and consolidation)	Duly made 13/01/11	Application to add a storm discharge
Variation determined AN0238501	09/06/11	Varied and consolidated permit issued in modern condition format and to include storm overflow.

End of introductory note

Notice of variation and consolidation

Environmental Permitting (England and Wales) Regulations 2010

The Environment Agency in exercise of its powers under regulation 20 of the Environmental Permitting (England and Wales) Regulations 2010 varies and consolidates

Permit number
AN0238501

Issued to:
Hanson Quarry Products Europe Limited ("the operator")

whose registered office is

Hanson House
14 Castle Hill
Maidenhead
Berkshire
SL6 4JJ

company registration number **00300002**

to operate a regulated facility at

Penderyn Quarry
Penderyn
Near Aberdare
Mid Glamorgan
CF44 0TX

to the extent set out in the schedules.

The notice shall take effect from 9th June 2011

Name	Date
Christopher Hall	**9th June 2011**

Authorised on behalf of the Environment Agency

Schedule 1

All conditions have been varied by the consolidated permit as a result of the application made by the operator.

Schedule 2 – consolidated permit

Consolidated permit issued as a separate document.

Permit

The Environmental Permitting (England and Wales) Regulations 2010

Permit number
AN0238501

This is the consolidated permit referred to in the variation and consolidation notice for application AN0238501 authorising,

Hanson Quarry Products Europe Limited ("the operator"),

whose registered office is

Hanson House
14 Castle Hill
Maidenhead
Berkshire
SL6 4JJ

company registration number **00300002**

to operate a regulated facility at

Penderyn Quarry
Penderyn
Near Aberdare
Mid Glamorgan
CF44 0TX

to the extent authorised by and subject to the conditions of this permit.

Name	Date
Christopher Hall	**9th June 2011**

Authorised on behalf of the Environment Agency

Conditions

1 Management

1.1 General management

1.1.1 The operator shall manage and operate the activities:

(a) in accordance with a written management system that identifies and minimises risks of pollution, including those arising from operations, maintenance, accidents, incidents, non-conformances and those drawn to the attention of the operator as a result of complaints; and

(b) using sufficient competent persons and resources.

1.1.2 Records demonstrating compliance with condition 1.1.1 shall be maintained.

1.1.3 Any person having duties that are or may be affected by the matters set out in this permit shall have convenient access to a copy of it kept at or near the place where those duties are carried out.

2 Operations

2.1 Permitted activities

2.1.1 The operator is only authorised to carry out the activities specified in schedule 1 table S1.1 (the "activities").

2.2 The site

2.2.1 The activities shall not extend beyond the site, being the land shown edged in green and the discharge shall be made at the point marked on the site plan at schedule 7 to this permit and as listed in table S3.2 (discharge points).

3 Emissions and monitoring

3.1 Emissions to water

3.1.1 There shall be no point source emissions to water except from the sources and emission points listed in schedule 3.

3.1.2 The limits given in schedule 3 shall not be exceeded.

3.2 Emissions of substances not controlled by emission limits

3.2.1 Emissions of substances not controlled by emission limits (excluding odour) shall not cause pollution. The operator shall not be taken to have breached this condition if appropriate measures, including, but not limited to, those specified in any approved emissions management plan, have been taken to prevent or where that is not practicable, to minimise, those emissions.

3.2.2 The operator shall:

(a) if notified by the Environment Agency that the activities are giving rise to pollution, submit to the Environment Agency for approval within the period specified, an emissions management plan;

(b) implement the approved emissions management plan, from the date of approval, unless otherwise agreed in writing by the Environment Agency.

3.3 Monitoring

3.3.1 Permanent means of access shall be provided to enable sampling/monitoring to be carried out in relation to the emission points specified in schedule 3 tables S3.1, S3.2 and S3.3 unless otherwise agreed in writing by the Environment Agency.

4 Information

4.1 Records

4.1.1 All records required to be made by this permit shall:

(a) be legible;

(b) be made as soon as reasonably practicable;

(c) if amended, be amended in such a way that the original and any subsequent amendments remain legible, or are capable of retrieval; and

(d) be retained, unless otherwise agreed in writing by the Environment Agency, for at least 6 years from the date when the records were made.

4.1.2 The operator shall keep on site all records, plans and the management system required to be maintained by this permit, unless otherwise agreed in writing by the Environment Agency.

4.2 Reporting

4.2.1 The operator shall send all reports and notifications required by the permit to the Environment Agency using the contact details supplied in writing by the Environment Agency.

4.3 Notifications

4.3.1 The Environment Agency shall be notified without delay following the detection of:

(a) any malfunction, breakdown or failure of equipment or techniques, accident, or emission of a substance not controlled by an emission limit which has caused, is causing or may cause significant pollution;

(b) the breach of a limit specified in the permit; or

(c) any significant adverse environmental effects.

4.3.2 Any information provided under condition 4.3.1 shall be confirmed by sending the information listed in schedule 5 to this permit within the time period specified in that schedule.

4.3.3 Where the Environment Agency has requested in writing that it shall be notified when the operator is to undertake monitoring and/or spot sampling, the operator shall inform the Environment Agency when the relevant monitoring and/or spot sampling is to take place. The operator shall provide this information to the Environment Agency at least 14 days before the date the monitoring is to be undertaken.

4.3.4 The Environment Agency shall be notified within 14 days of the occurrence of the following matters, except where such disclosure is prohibited by Stock Exchange rules:

Where the operator is a registered company:

(a) any change in the operator's trading name, registered name or registered office address; and

(b) any steps taken with a view to the operator going into administration, entering into a company voluntary arrangement or being wound up.

Where the operator is a corporate body other than a registered company:

(a) any change in the operator's name or address; and

(b) any steps taken with a view to the dissolution of the operator.

4.3.5 Where the operator proposes to make a change in the nature or functioning, or an extension of the activities, which may have consequences for the environment and the change is not otherwise the subject of an application for approval under the Regulations or this permit:

(a) the Environment Agency shall be notified at least 14 days before making the change; and

(b) the notification shall contain a description of the proposed change in operation.

4.4 Interpretation

4.4.1 In this permit the expressions listed in schedule 6 shall have the meaning given in that schedule.

4.4.2 In this permit references to reports and notifications mean written reports and notifications, except where reference is made to notification being made "without delay", in which case it may be provided by telephone.

Schedule 1 - Operations

Table S1.1 Activities		
Activity reference	**Description of activity**	**Limits of specified activity**
A1	Discharge of trade effluent consisting of site drainage via outlet A or A1	
A2	Discharge of trade effluent consisting of storm site drainage via outlet 1	The discharge shall only occur when all the attenuation volume is utilised and only for as long as the flow passed forward as part of Activity reference A1is equal to or greater than the overflow setting indicated in table S3.1.

Schedule 2 - Waste types, raw materials and fuels

Wastes are not accepted as part of the permitted activities and there are no restrictions on raw materials or fuels under this schedule.

Schedule 3 – Emissions and monitoring

Table S3.1 Point Source emissions to water (other than sewer) – emission limits and monitoring requirements						
Discharge source and discharge point ref. & location	**Parameter**	**Limit (Including unit)**	**Reference Period**	**Limit of effective range**	**Monitoring frequency**	**Compliance Statistic**
A1:Discharge of trade effluent consisting of site drainage via outlets A and A1	Suspended solids (measured after drying at 105° C)	100 mg/l	Instantaneous (spot sample)	N/A		Maximum
A1:Discharge of trade effluent consisting of site drainage via outlets A and A1	pH	5 to 9	Instantaneous (spot sample)	N/A		Minimum and maximum
A1:Discharge of trade effluent consisting of site drainage via outlets A and A1	Visible oil or grease	No significant trace present	Instantaneous (spot sample)	N/A	N/A	No significant trace
A2:Discharge of trade effluent consisting of storm site drainage via outlet 1	Attenuation lagoon volume	550 m^3	Instantaneous (spot sample)	N/A	N/A	Minimum
A2:Discharge of trade effluent consisting of storm site drainage via outlet 1	Overflow setting	368 l/s	Instantaneous (spot sample)	N/A	N/A	Minimum
A2:Discharge of trade effluent consisting of storm site drainage via outlet 1	Visible oil or grease	No significant trace present	Instantaneous (spot sample)	N/A	N/A	No significant trace

Table S3.2 Discharge points			
Effluent Name	**Discharge Point**	**Discharge point NGR**	**Receiving water/Environment**
Discharge of trade effluent consisting of site drainage	Outlet A	SN 94912 08906	Nant Cadlan
Discharge of trade effluent consisting of site drainage	Outlet A1	SN 94923 08858	Nant Cadlan
Discharge of trade effluent consisting of storm site drainage	Outlet 1	SN 94953 08758	Nant Cadlan

Table S3.3 Monitoring points		
Effluent(s) and discharge point(s)	**Monitoring type**	**Monitoring point NGR**
Discharge of trade effluent consisting of site drainage via outlet A	Effluent sample point	SN 94912 08906
Discharge of trade effluent consisting of site drainage via outlet A1	Effluent sample point	SN 94923 08858
Discharge of trade effluent consisting of storm site drainage via outlet 1	Storm effluent sample point	SN 94953 08758

Schedule 4 – Reporting

There is no reporting under this schedule.

Schedule 5 - Notification

These pages outline the information that the operator must provide.

Units of measurement used in information supplied under Part A and B requirements shall be appropriate to the circumstances of the emission. Where appropriate, a comparison should be made of actual emissions and authorised emission limits.

If any information is considered commercially confidential, it should be separated from non-confidential information, supplied on a separate sheet and accompanied by an application for commercial confidentiality under the provisions of the EP Regulations.

Part A

Permit Number	
Name of operator	
Location of Facility	
Time and date of the detection	

(a) Notification requirements for any malfunction, breakdown or failure of equipment or techniques, accident, or emission of a substance not controlled by an emission limit which has caused, is causing or may cause significant pollution	
To be notified within 24 hours of detection	
Date and time of the event	
Reference or description of the location of the event	
Description of where any release into the environment took place	
Substances(s) potentially released	
Best estimate of the quantity or rate of release of substances	
Measures taken, or intended to be taken, to stop any emission	
Description of the failure or accident.	

(b) Notification requirements for the breach of a limit	
To be notified within 24 hours of detection unless otherwise specified below	
Emission point reference/ source	
Parameter(s)	
Limit	
Measured value and uncertainty	
Date and time of monitoring	
Measures taken, or intended to be taken, to stop the emission	

Time periods for notification following detection of a breach of a limit	
Parameter	**Notification period**

(c) Notification requirements for the detection of any significant adverse environmental effect	
To be notified within 24 hours of detection	
Description of where the effect on the environment was detected	
Substances(s) detected	
Concentrations of substances detected	
Date of monitoring/sampling	

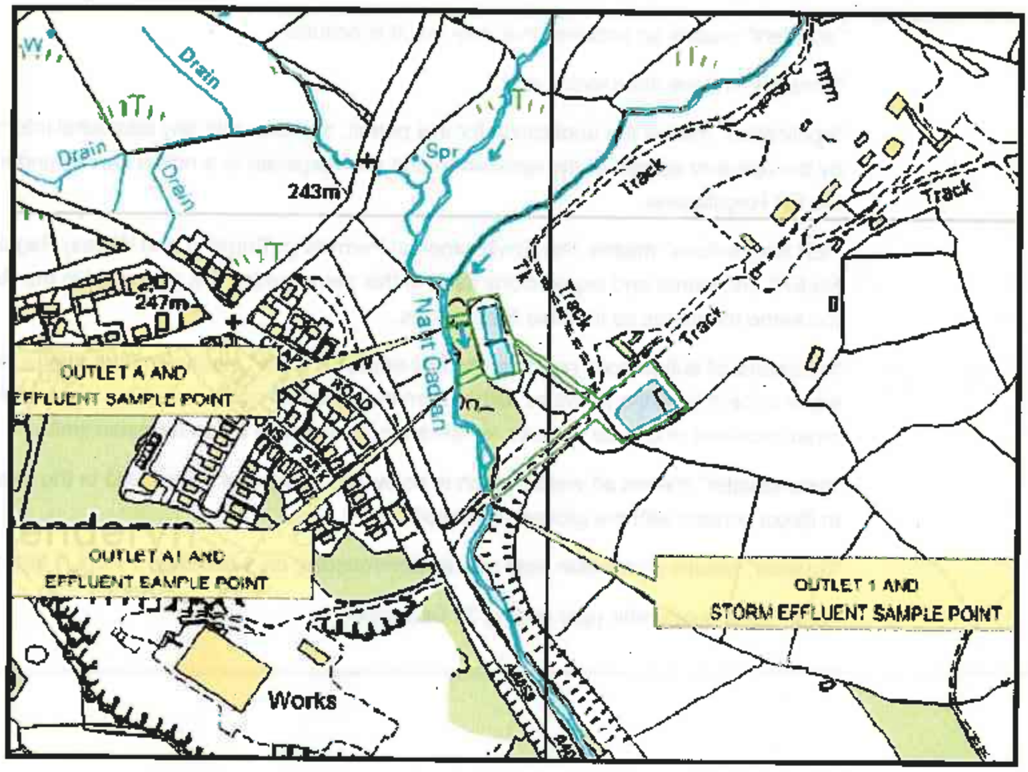
Part B - to be submitted as soon as practicable

Any more accurate information on the matters for notification under Part A.	
Measures taken, or intended to be taken, to prevent a recurrence of the incident	
Measures taken, or intended to be taken, to rectify, limit or prevent any pollution of the environment which has been or may be caused by the emission	
The dates of any unauthorised emissions from the facility in the preceding 24 months.	

Name*	
Post	
Signature	
Date	

* authorised to sign on behalf of the operator

Schedule 7 - Site plan



END OF PERMIT

Schedule 6 - Interpretation

"accident" means an accident that may result in pollution.

"annually" means once every year.

"application" means the application for this permit, together with any additional information supplied by the operator as part of the application and any response to a notice served under Schedule 5 to the EP Regulations.

"EP Regulations" means The Environmental Permitting (England and Wales) Regulations SI 2010 No.675 and words and expressions used in this permit which are also used in the Regulations have the same meanings as in those Regulations.

"emissions of substances not controlled by emission limits" means emissions of substances to air, water or land from the activities, either from the emission points specified in schedule 3 or from other localised or diffuse sources, which are not controlled by an emission limit..

"groundwater" means all water, which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil.

"quarter" means a calendar year quarter commencing on 1 January, 1 April, 1 July or 1 October.

"year" means calendar year ending 31 December.

Water Resources Act 1991
as amended by the Environment Act 1995
Consent to Discharge
Certificate of Holder

ENVIRONMENT AGENCY

Part A

To: HANSON QUARRY PRODUCTS EUROPE LTD
THE COMPANY SECRETARY
THE RIDGE CHIPPING SODBURY
BRISTOL
BS37 6AY

NB: For a body corporate the job title is a point of contact.
Holder Start Date: 26/08/00

The **Environment Agency** ("the Agency") hereby confirm that the above named person is a/the registered holder of consent AN0272901 Consent Issued: 06/06/97

Nature of Discharge(s); TMWC Trade - Minewater - Continuous
at SN9494008710 PENDERYN QUARRY PENDERYN ABERDARE

Note: This certificate should be kept with the consent document for future reference. If you transfer responsibility for the discharge to somebody else you must pass the consent to them and tell the Agency within 21 days. **Responsibility for the consent cannot be disclaimed by the holder but the registration of holder may be transferred to a successor.** To do this please complete the form below, then tear it off and return it to the address shown. If you fail to transfer the consent, even though you are no longer on the site, you may still be liable for prosecution for pollution. If you transfer the consent but do not tell us, you will be committing an offence. In case of any queries please contact your local Environment Agency office.

Part B **Please complete in block capitals or type.**

To:

Water Resources Act 1991: Notice of transfer of consent to discharge

Consent: AN0272901
Consent Issued: 06/06/97

Name: HANSON QUARRY PRODUCTS EUROPE LTD
Address: THE COMPANY SECRETARY
THE RIDGE CHIPPING SODBURY
BRISTOL
BS37 6AY

I/We* hereby serve notice on the Agency that I/we* am/are* no longer a/the* Holder of the above consent which will be/was* transferred to:

* delete as appropriate

Name(s) of new holder(s):

Address:

Post Code:

Date of Transfer to new Holder(s); ....

Signed:.. **Dated:**..

Name (block capitals): .... **Position:** ....

(to be completed when signing on behalf of corporate bodies)

JWE/5/96

Deddf Adnoddau Dwr 1991
fel y'i diwygiwyd gan Ddeddf yr Amgylchedd 1995
Caniatâd Gollwng
Tystysgrif Daliwr

ASIANTAETH YR AMGYLCHEDD

Rhan A

At: HANSON QUARRY PRODUCTS EUROPE LTD
THE COMPANY SECRETARY
THE RIDGE CHIPPING SODBURY
BRISTOL
BS37 6AY

DS: I gorff corfforedig mae teitl y swydd yn bwynt cysylltu.
Dyddiad Cychwyn Daliwr: 26/08/00

Mae **Asiantaeth yr Amgylchedd** ("yr Asiantaeth") yn cadarnhau drwy hyn mai/bod y sawl a enwyd uchod yw/yn ddaliwr cofrestredig uy caniatâd AN0272901 Cyhoeddwyd Caniatâd: 06/06/97

Natur y gollwng: TMWC Trade - Minewater - Continuous
yn SN9494008710 PENDERYN QUARRY PENDERYN ABERDARE

Nodyn: Dylid cadw'r dystysgrif hon gyda'r ddogfen ganiatâd i gyfeirio ati yn y dyfodol. Os byddwch yn trosglwyddo cyfrifoldeb y gollwng i rywun arall, rhaid i chi gyflwyno'r caniatâd iddo ef neu hi a dweud wrth yr Asiantaeth cyn pen 21 diwrnod. **Ni all y daliwr wadu cyfrifoldeb y gollwng, ond gall cofrestriad y daliwr gael ei drosglwyddo i olynydd.** I wneud hynny, byddwch cystal â llenwi'r ffurflen isod, ei datgysylltu a'i dychwelyd i'r cyfeiriad a nodir. Os methwch drosglwyddo'r caniatâd, hyd yn oed os nad ydych ar y safle mwyach, gallwch fod yn agored yr un fath i gael eich erlyn am lygru. Os trosglwyddwch y caniatâd ond heb ddweud wrthom, byddwch yn cyflawni trosedd. Os bydd gennych ymholiadau, byddwch cystal â chysylltu â swyddfa Asiantaeth yr Amgylchedd yn lleol.

Rhan B **Llenwch mewn priflythrennau bras neu deipio.**

At:

Deddf Adnoddau Dwr 1991: Hysbysiad am drosglwyddo caniatâd gollwng

Caniatâd: AN0272901

Cyhoeddwyd Caniatâd: 06/06/97

Enw:
Cyfeiriad: HANSON QUARRY PRODUCTS EUROPE LTD
THE COMPANY SECRETARY
THE RIDGE CHIPPING SODBURY
BRISTOL
BS37 6AY

Yr wyf fi/Yr ydym ni* drwy hyn yn hysbysu'r Asiantaeth nad fi/ni/nad wyf/ydym mwyach yw/yn* Ddeiliad y caniatâd uchod. Caiff/Cafodd hwnnw ei drosglwyddo i:

*dilewch yn ôl yr angen

Enw(au) y Daliwr/Dalwyr newydd:

Cyfeiriad:

Cod Post:

Dyddiad Trosglwyddo i'r Daliwr/Dalwyr newydd: ....

Llofnodwyd:.. **Dyddiedig:** ....

Enw Enw (priflythrennau bras):.. **Safle:** ....

(i'w lenwi wrth lofnodi ar ran cyrff corfforaethol)

JWE/5/96

CONSENT NO.	AN0272901

ASIANTAETH YR AMGYLCHEDD
ENVIRONMENT AGENCY

WATER RESOURCES ACT 1991

SECTION 88 - SCHEDULE 10

(AS AMENDED BY THE ENVIRONMENT ACT 1995)

CONSENT TO DISCHARGE

TO: THE COMPANY SECRETARY
ARC SOUTH WALES LTD
CANAL ROAD
CWMBACH
ABERDARE
CF44 0AG

The **ENVIRONMENT AGENCY** ("The Agency") in pursuance of its powers under the Water Resources Act 1991 **HEREBY CONSENTS** to the making of a discharge **OF TRADE EFFLUENT**, as follows:

PUMPED GROUNDWATER /SITE DRAINAGE

FROM: **EFFLUENT TREATMENT PLANT**

AT: PENDERYN QUARRY, PENDERYN ABERDARE

TO: THE RIVER CYNON

SUBJECT TO the conditions set out in the following schedule:

PUMPED GROUNDWATER/SITE DRAINAGE SCHEDULE NO. AN027290101

Subject to the provisions of Paragraphs 7 and 8 of Schedule 10 of the Water Resources Act 1991, no notice shall be served by the Agency, altering this consent, without the agreement in writing of the consent holder, during a period of 4 years from the date this consent takes effect.

This consent is issued and takes effect on the 6th day of June 1997

Signed ....
Area Water Quality Manager

Asiantaeth yr Amgylchedd
Plas yr Afon, Parc Busnes Llaneirwg, Llaneirwg, Caerdydd CF3 0LT. Ffon 01222 770088, Ffacs 01222 798555

Environment Agency
Rivers House, St. Mellons Business Park, St. Mellons, Cardiff CF3 0LT. Tel 01222 770088, Fax 01222 798555

CONSENT NO.	AN0272901
SCHEDULE NO.	AN027290101
DATE ISSUED	6/6/97

ASIANTAETH YR AMGYLCHEDD
ENVIRONMENT AGENCY

CONDITIONS OF CONSENT TO DISCHARGE

PUMPED GROUNDWATER /SITE DRAINAGE ("the Discharge")

FROM: EFFLUENT TREATMENT PLANT, PENDERYN QUARRY

1. (a) The Discharge shall not contain any poisonous, noxious or polluting matter or solid waste matter.

   (b) Provided that the Discharge hereby consented is made in accordance with the following conditions of this consent, such discharge shall not be taken to be in breach of condition (a) above by reason of containing substances or having properties identified in and controlled by those conditions.

NATURE

2. The Discharge shall consist solely of trade effluent comprising of pumped groundwater and site drainage from a total drainage area of 202300 square metres for the prevention of interference with quarrying.

LOCATION

3. The Discharge shall be made in the manner and at the place specified as:

   (a) discharging via a 300mm dia pipe set in concrete headwall.

   (b) discharging to the River Cynon

   (c) at National Grid Reference SN 9494 0871

   (d) shown marked "Consent Point" on Drawing No P7d/2 attached as Annex 1

SAMPLE POINT

4. The outlet to the watercourse shall be constructed and maintained so that a representative sample of the Discharge may be obtained at National Grid Reference SN 9494 0871 as shown marked 'Consent Point' on Drawing No P7d/2

CONSENT NO	AN0272901
SCHEDULE NO	AN027290101
DATE ISSUED	6/6/97

ASIANTAETH YR AMGYLCHEDD
ENVIRONMENT AGENCY

VOLUME

5. The volume of the Discharge shall be dependant on rainfall.

6. The rate of discharge shall not exceed 50 litres per second.

COMPOSITION

7. The discharge shall not contain more than:

(a) 25 milligrammes per litre of suspended solids (measured after drying at 105°C.);

(b) 10 milligrammes per litre of mineral oil.

(c) a pH value of 9.0pH units or less than a pH value of 6.0 pH units.

(d) 2 milligrammes per litre of total iron (as Fe)

8. The effluent treatment facility shall be maintained in an efficient operational manner at all times.

9. As far as is reasonably practicable, the effluent treatment area shall be operated to prevent:

(i) any matter being present in the Discharge to such an extent as to cause the receiving waters, or any waters of which the receiving waters are a tributary, to be poisonous or injurious to fish in those waters, or to the spawning grounds, spawn or food of fish in those waters, or otherwise cause damage to the ecology of those waters; and

(ii) the Discharge from having any other adverse environmental impact.

Appendix D

61190TN2Rev1.3 Penderyn Reconceptualisation Report

Penderyn Quarry Geological/Hydrogeological Reconceptualisation

Prepared for

Hanson UK
Hanson House
14 Castle Hill
Maidenhead
SL6 4JJ

Report reference: 61190TN2Rev1.3, July 2017

This report has been prepared by ESI Ltd. (ESI) in its professional capacity as soil and groundwater specialists, with reasonable skill, care and diligence within the agreed scope and terms of contract and taking account of the manpower and resources devoted to it by agreement with its client, and is provided by ESI solely for the internal use of its client.

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Author	Barnaby Harding/Henry Kelly/Caroline Chestnutt	
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Confidential
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1 INTRODUCTION

1.1 Background

In 2011, Hanson Quarry Products Europe Limited submitted an Environmental Statement in support of an application for revised planning conditions for Penderyn Quarry as part of the Review of Old Mineral Permissions (ROMP) process (White Young Green, 2011). This included a conceptual model of the local groundwater system. A key element of the ES was to assess the risk posed by the development to the nearby Cwm Cadlan Special Area of Conservation (SAC).

In its response to the application, the Countryside Council for Wales (CCW now Natural Resources Wales (NRW)), whilst disagreeing with some aspects of the conceptual model, accepted that the risk posed by quarrying would remain low whilst working was restricted above the 250 mAOD bench and the rate of pumping from the quarry sump did not indicate that the effective catchment area of the sump was increasing.

At a meeting held on 28 February 2013 between Hanson, Brecon Beacons National Park Authority (BBNPA) and NRW, ESI Ltd (on behalf of Hanson) presented the results of a method for calculating transient water balances at Penderyn Quarry using an approach advocated by CCW in its response to the ROMP. This was written up in a technical note which was reviewed in detail by NRW and is now being applied in the regular hydrometric reporting for the site (ESI, 2014).

At that meeting ESI also presented an outline conceptual model that aimed to bring together some of the points that CCW had made in its response to the ROMP application with other lines of evidence, in order to support the view that further working above 250 mAOD did not pose a significant risk to the SAC.

Since that meeting Hanson, BBNPA and NRW have agreed to take the planning permission forward in two stages for working above and below 250 mAOD. All parties agree that a more comprehensive assessment of risk would be needed to support working below 250 mAOD (albeit that this may be further informed by ongoing monitoring). For working above 250 mAOD, the parties are seeking to converge on a monitoring and management scheme that is proportionate to the level of risk represented by the quarry at its current depth.

1.2 Objectives and Scope

The aim of this report is to review some recently collected data to assess whether this adds further strength to the view that that further working above 250 mAOD does not pose a significant risk to the SAC.

One of the key aims of the conceptual model is to provide an understanding of the degree of hydraulic connection, if any, between the quarry and the SAC. The focus of the reconceptualisation has therefore been on the implications that the new data have on this hydraulic connection and therefore the risk to the SAC.

The new data comprise five new monitoring boreholes, OB13 to OB17, which were drilled around the site in 2015. Details of the new boreholes are provided in ESI, 2015 and their location is shown on Figure 1.1. Two of these (OB13 and OB17) are located within the quarry boundary. These two, along with a third (OB15) are all located to the south of the Dinas Fault, in areas which were expected to be limestone outcrop according to BGS data. The remaining two (OB14 and OB16) are located to the north of the Dinas Fault next to the SSSI/SAC boundary in areas indicated to be drift covered by BGS data. These boreholes have now been equipped with data loggers and data are available from May 2015.

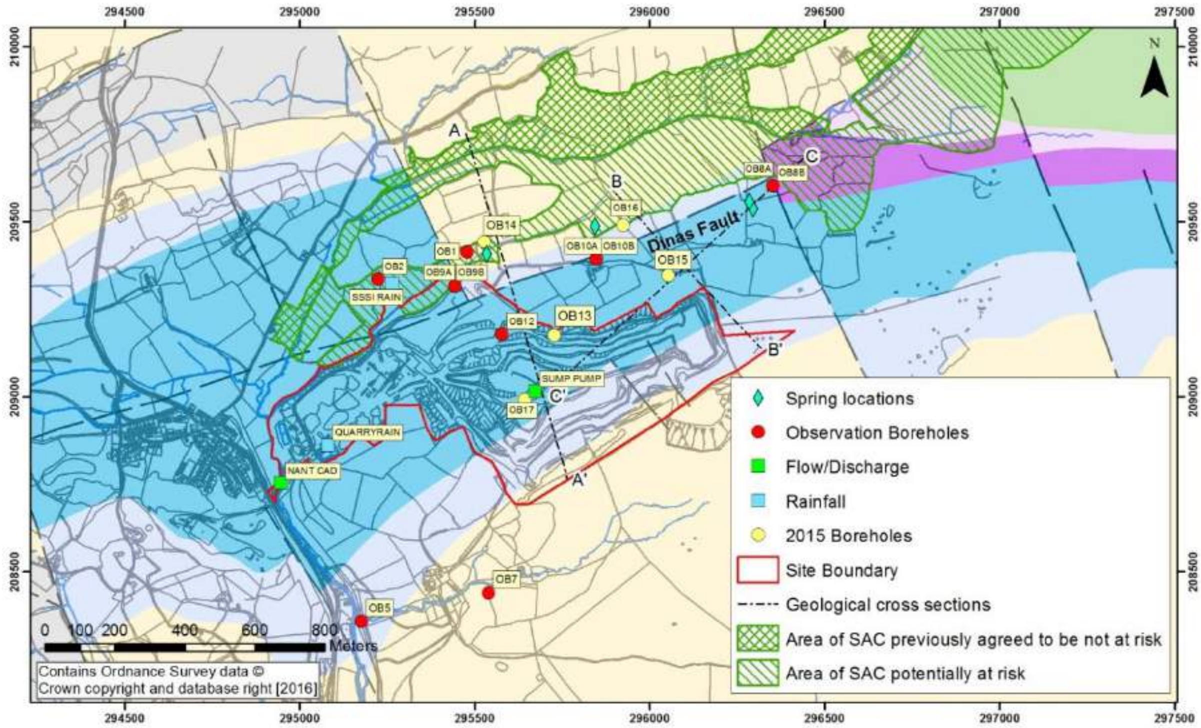


Figure 1.1 Locations of new boreholes

These borehole data have also been supplemented with additional information obtained from a Cardiff University MSc thesis which looked at the hydrology and hydrogeology around Penderyn Distillery (located approximately 1 km south west of the centre of the main quarry).

This revised report (Rev1.3) includes additional data collected from the new boreholes since that considered in the original reconceptualisation report (ESI, 2017) and discusses the implications of the findings for the assessed level of risk that ongoing dewatering of the quarry at 250 mAOD poses to the integrity of the SAC.

2 REASSESSMENT OF CONCEPTUAL MODEL IN LIGHT OF NEW DATA

2.1 ESI, 2013 Conceptual Model

Figure 2.1 below presents a schematic illustration of ESI's 2013 conceptual model which has been developed upon in this report with the recently obtained information.

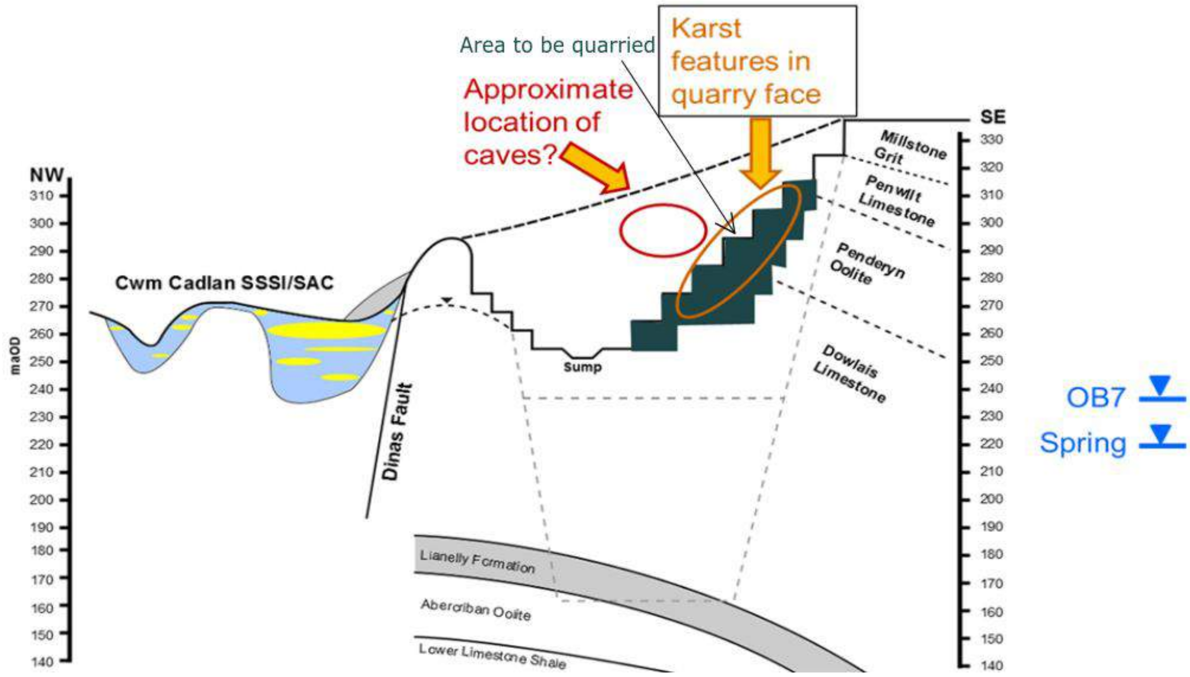


Figure 2.1 Original ESI conceptual model (2013)

The key elements of ESI's 2013 conceptual model are summarised below:

- The sump at Penderyn Quarry appears to be below the water table for much of the time, although there is some historical information to suggest that during very dry years the water table may be below 250 mAOD.
- The ease with which water flows through the limestone worked at Penderyn Quarry varies significantly in 3D: in some places the rock is effectively 'impermeable', whereas in other places large voids have been encountered. Understanding the likely distribution of these more permeable features is key to understanding the risk posed by dewatering to the SAC.

  ESI's 2013 conceptual model proposed that the large voids encountered above the water table and on the south face of Penderyn Quarry were created by aggressive runoff generated from the overlying Millstone Grit which enters the limestone and flows down the dip of the strata towards discharge points to the south west (as proven by tracer tests), much of this flow occurring above the water table.

  In contrast, there was little evidence of major karstic features in the north face of the quarry, although some seepage horizons were apparent in the lower quarry faces. This suggests that layering and flow along bedding horizons may be important within the limestone.
- The above evidence suggests that there are a variety of routes by which rainfall is transmitted to the quarry sump as illustrated in the following schematic. This means that rainfall in the quarry catchment is attenuated by varying degrees as it flows towards the quarry sump. Some of these pathways are clearly 'runoff' and some can be considered

to be ‘groundwater’. However, there appears to be a continuum between the two processes such that it is hard to make a specific distinction between them.

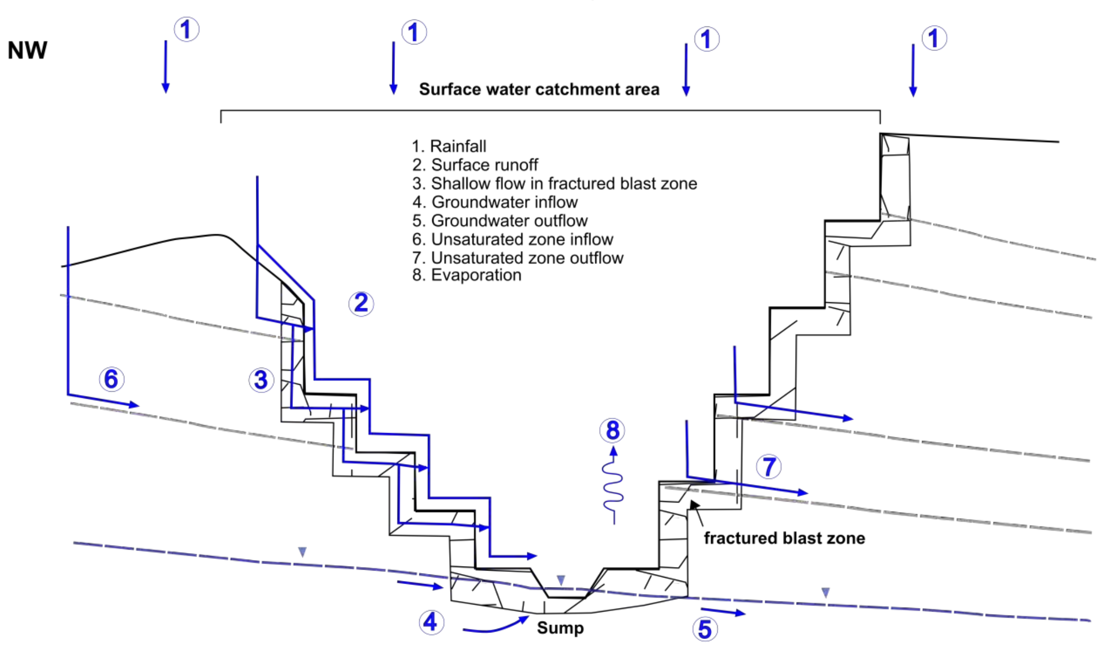


Figure 2.2 Conceptual model of flow routes to the quarry sump

The 2013 conceptual model was mainly focussed on understanding flows into the quarry sump in support of the transient water balance calculations. These showed that the area required to generate the flows observed in the quarry was very similar to the surface water catchment of the quarry[1]. This suggests that the quarry is not drawing in water from a significant distance away and supports the view that the current quarry operations (i.e. above 250 mAOD) do not pose a significant risk to the SAC.

Having shown that the quarry is not drawing in water from a significant distance, the 2013 conceptual model did not focus in detail on the potential pathway between the quarry and the SAC. The following aspects of the conceptual model are relevant to that area:

- There is a potential pathway through the limestone north of the quarry along which drawdown effects could propagate towards the SAC.
- Groundwater levels collected in the area appear to indicate the presence of a groundwater divide between the quarry and the SAC.
- The Dinas Fault, a sub vertical fault, lies between the SAC and the quarry and may act as a barrier to flow. However, its proximity to the groundwater divide makes this difficult to confirm.
- The Cwm Cadlan SSSI/SAC is entirely underlain by drift deposits. These are vertically and horizontally heterogeneous (including both low and high hydraulic conductivity deposits) and provide a degree of hydraulic separation from the underlying limestone.
- The drift deposits are of variable thickness which may impact on the degree of hydraulic separation from the underlying limestone.

[1] Note that, due to the dipping strata and the groundwater gradients from north east to south west, it is likely that the catchment of the quarry sump is not exactly the same as the surface water catchment: some areas to the north and east outside of the current quarry surface water catchment may be part of the sump catchment, whilst some parts of the quarry itself, e.g. benches on the southern faces, may not have been in the sump catchment, particularly prior to recent development.

- Most of the eastern parts of SAC may also be underlain by Millstone Grit which overlies the Carboniferous Limestone (See Figure 1.1). If present, this formation would provide additional attenuation of any drawdown signal from dewatering within the limestone.
- The Nant Cadlan provides a hydraulic barrier across which effects are not likely to propagate. This means that the areas of SSSI/SAC to the north of the river are not expected to be at risk from dewatering from the quarry. The areas that have been agreed by NRW and Hanson not to be at risk through this protective mechanism are shown on Figure 1.1.

2.2 2015 Geology Data

Information from the new boreholes and the MSc thesis (Hull, 2013) is consistent with the presence of a deep, drift-filled channel underlying the SSSI/SAC as previously discussed. However, this new information has provided significant additional detail and refinement to the previous understanding of the drift lithology and extent/depth/morphology. This is summarised in Figure 2.3 and Figure 2.4 and is discussed in more detail below.

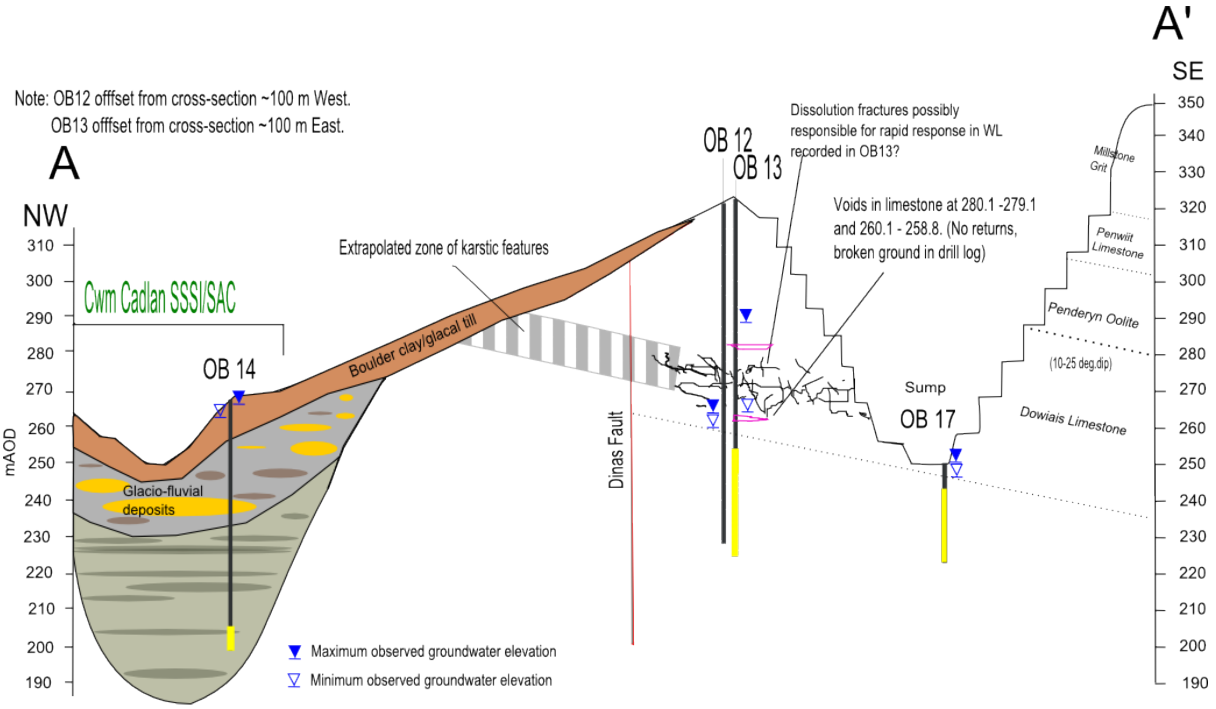


Figure 2.3 Revised schematic geological section north west – south east (GW level data reviewed covers 01/01/2015 to 31/03/2017)

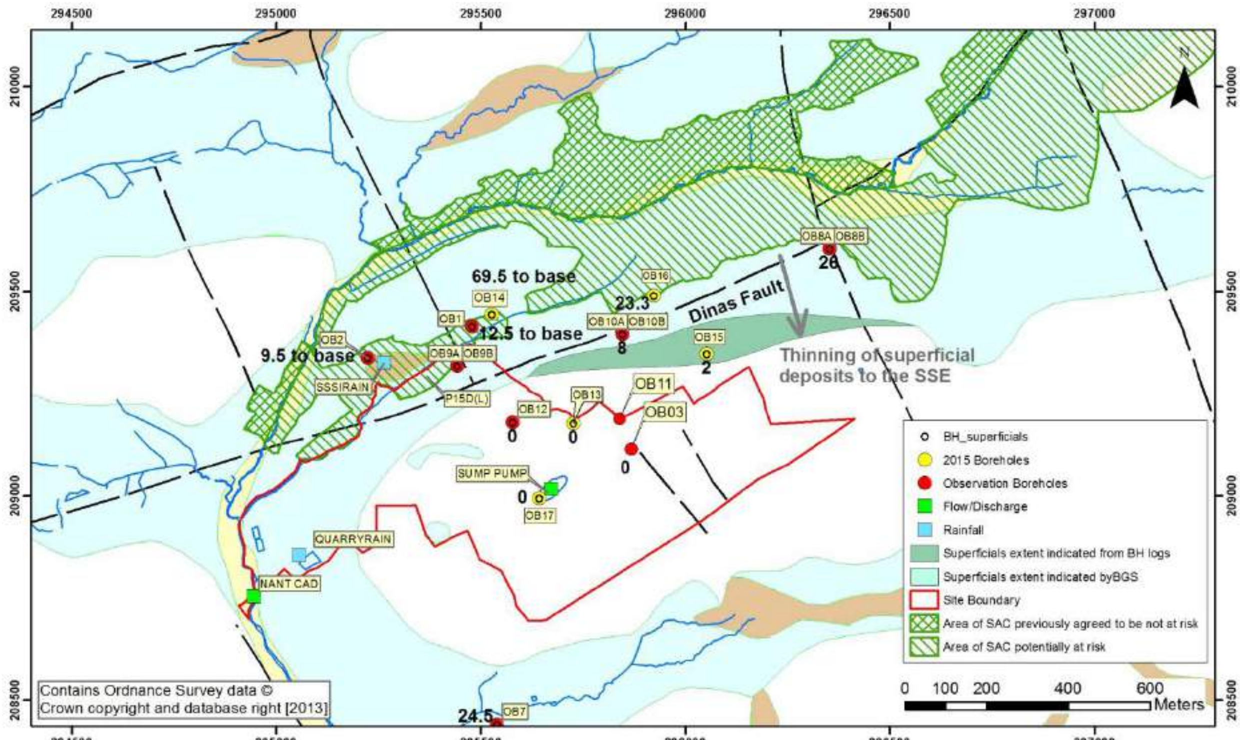


Figure 2.4 Revised extent of drift

2.2.1 Extent and nature of the drift

The extent of the drift is recorded on the published BGS 1:50,000 drift map and has so far been encountered in all boreholes outside the site boundary. The presence of two metres of Glacial Till in newly-drilled OB15 (immediately north of the quarry) indicates that this unit extends further south (closer to the quarry) in the vicinity of OB15 than mapped by the BGS (Figure 2.4). The additional drift cover means that recharge to the limestone aquifer to the north of the site is probably lower than previously implied and this would mean that there is less groundwater flowing to the SAC and to the quarry from this area. However, runoff and interflow generated from this relatively impermeable material will flow northwards to the SAC above the water table in the and may support the springs in this area. Any such flows would therefore be perched and thus not vulnerable to dewatering at the quarry.

Newly-drilled OB14 encountered a much greater thickness of drift than had previously been found in any of the boreholes in the area (the borehole was completed at 70 m without encountering limestone). This is potentially significant in that the greater the thickness of drift, the greater the potential for hydraulic separation between the shallow drift water table (that in part supports the SAC vegetation) and the underlying limestone water level. Whilst thicker than previously encountered, this finding is consistent with the conceptual understanding of drift-filled palaeochannels, where thicker drift deposits would occur over the palaeovalley thalweg (a thalweg being the line formed down the valley by joining the lowest points in a section across the valley).

Examination of the thickness of the drift deposits in the boreholes drilled to date shows that drift thickness within the outcrop increases consistently with distance from the outcrop boundary. The borehole data and drift deposits outcrop pattern suggests that OB14 lies fairly close to the thalweg and the thickest part of the drift sequence. Although other boreholes (e.g. OB 2) have been drilled close to the thalweg, these did not prove the full drift thickness and were drilled to shallower depth than OB14. The hypothesised channel thalweg is shown in Figure 2.5.

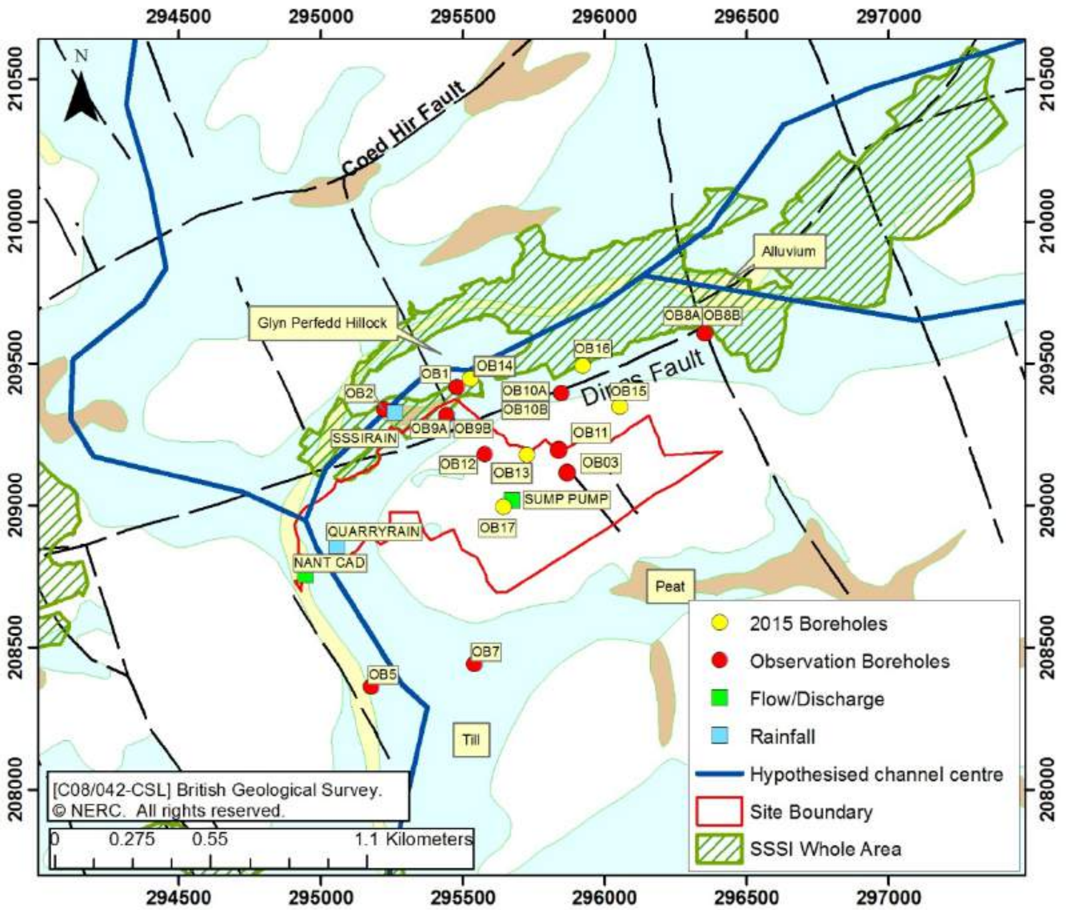


Figure 2.5 Inferred palaeo-channel route

It had been previously suggested by CCW that the Glyn Perfedd hillock feature (Figure 2.5) that separates the SAC into two arms might be bedrock-cored. This would have brought limestone close to surface which could then have provided the flow to the base-rich flushes on the feature's northern flank. However, the thickness of drift seen in OB14 suggests that the feature is actually drift-cored. The new borehole evidence therefore supports the view in SRK, 2011 that these flushes do not originate directly from limestone bedrock, but from the drift which is now shown to be >70 m thick in this area; the basic nature of their chemistry is therefore probably the result of the limestone being one of the sources for the material making up the drift. This therefore means that these flushes are significantly less vulnerable to any changes in the water level in the underlying limestone than CCW had previously suggested.

The presence of a thicker drift sequence is suggestive of a greater potential for hydraulic separation between the limestone and the SAC. However, this depends on both the thickness of the drift and its nature. Both the borehole log for OB14 and the conceptual model presented in the MSc thesis (Hull, 2013) indicate that there are significant thicknesses of granular material (sands, gravels) within the sequence. Although these would allow horizontal movement of water, vertical movement would be much lower due to intervening layers of low hydraulic conductivity within the drift. A summary of the lithology encountered in OB14 is provided below:

- The top 7.3 m of OB 14 is Glacial Till. This Glacial Till deposit is found widely across most boreholes in the area varying in thickness from c. 1 -15.4 m.
- The dominant unit below this is a thick, sandy gravel unit which is interpreted as fluvio-glacial deposits. This unit is thickest in OB14 at 27.2 m but is also encountered in

OB8a, OB9a and OB16 as a mixture of clays and gravel with a thickness of c. 13 m, c. 10 m and 7.9 m respectively.

- Laminated red and green clays were encountered below the fluvio-glacial deposits in OB14. These glacio-lacustrine deposits have not been found in any other boreholes drilled to date in the area.
- Fine green gravel with red clay with sands and gravel occur below the laminated clays. These have also been interpreted as glacio-lacustrine deposits. These account for the lowermost 23.5 m of the superficial deposits in OB14. The limestone bedrock was not encountered.

The typical sequence of Devensian drift in the Brecon Beacons area includes a further sequence of glacial till beneath the glacio-lacustrine deposits, suggesting that the base of the drift in the vicinity of Glyn Perfedd could be at significantly greater depth than the 70 m drilled within OB14 without encountering limestone bedrock.

The lithological data obtained to date therefore indicate that the drift sequence can be subdivided into three main lithological units: Glacial Till, glacio-fluvial deposits and glacio-lacustrine deposits.

The thickness of drift beneath the SAC will vary at any particular point based on its location relative to the centreline of the buried valley and the outcrop boundary. This, along with the variable lithology means that it is difficult to determine the precise level of hydraulic separation afforded by the drift. Multiple pathways could exist through the drift material depending on the relative elevation of the limestone water level and the lithology of the drift material contacting the palaeo-channel sides. For example where limestone abuts sands and gravels relatively high up the drift sequence, then this would bypass the potentially isolating effects of low hydraulic conductivity deposits lower down the drift sequence. Conversely, where there was no direct hydraulic connection between the limestone groundwater and granular drift deposits, the multiple clay and silt layers which are always present would afford a high degree of hydraulic separation to vertical flow even where significant thicknesses of granular deposits were also present.

Irrespective of the drift variability, the ubiquitous presence of Glacial Till over the drift outcrop will offer a high degree of hydraulic separation between the ground surface and groundwater at deeper levels.

2.2.2 Solid geology

The information collected from the new boreholes was generally consistent with previous borehole information. Evidence of voids and/or fractures in the limestone encountered was only noted in OBH13 at elevations above the current sump elevation. This is consistent with the 2013 conceptual model.

Figure 1.1 shows that large parts of the SAC are mapped as being underlain by Millstone Grit. This formation overlies the Carboniferous Limestone and could potentially attenuate the effects of dewatering in the limestone. However, the nature of the Millstone Grit and its presence locally has not been proved in any boreholes in the area: in fact the deep drift filled channel may have cut through the Millstone Grit to the underlying strata in places. The current assumption is therefore that the Millstone Grit does not act to limit dewatering effects being transmitted to the SAC along the line of the drift filled channel (Figure 2.5). However, to the north of this, the areas of the SAC mapped as being underlain by Millstone Grit are more likely to be shielded from dewatering by the Millstone Grit.

2.3 Groundwater Level Data

2.3.1 Amplitude of seasonal fluctuations

The hydrographs of groundwater levels in the boreholes monitoring the limestone around the quarry (Figure 2.6 shows recent data) fall into two groups: those with larger amplitude seasonal variations (particularly OB13 (annual range c. 20 m) and OB15) and those with smaller amplitude variations. Larger amplitude variations are seen in areas of limestone outcrop/thin drift whilst smaller amplitude variations are seen in areas of drift cover. This supports the view that the extensive areas of Glacial Till to the north and east of the quarry reduce/attenuate recharge to the limestone in these areas.

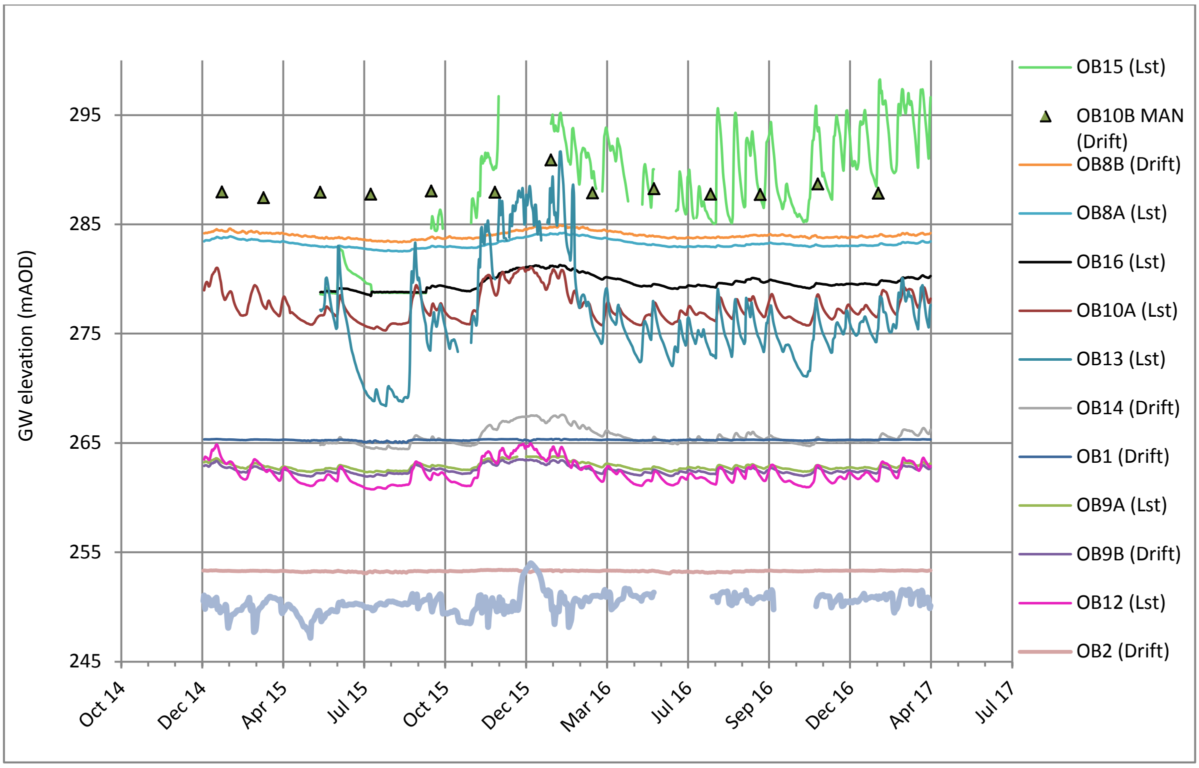


Figure 2.6 Recent groundwater levels

The large amplitude at OBH13 in particular (e.g. compared to OB12 which is nearby) suggests a greater connection with the surface and shallower flow pathways and it may, in part, represent an ephemeral perched or semi-perched horizon within the limestone sequence (See Figure 2.2). This may be linked to the presence of voids encountered during the drilling of this borehole at 260-280 mAOD (i.e. around the current position of the water levels recorded in the borehole and above the current base of the quarry at 250 mAOD).

The 2013 conceptual model suggests that karstification will tend to be focussed along stratigraphic horizons. The location of the voids in OBH13 and the general dip of the strata in the area suggests that these horizons have been intercepted by the quarry and this may be linked to the location of seepage faces in the lower benches of the quarry. By extrapolating the elevation of the void-containing horizon up-dip, away from the quarry and toward the SAC (as shown on Figure 2.3), it can be seen that it would crop out above the level of the water table to the north and therefore would not represent a direct pathway to the SAC.

Seasonal fluctuations in water levels in boreholes monitoring the superficial deposits are generally small and this may reflect relatively good connection with surface (levels are generally at or above ground level).

However, a recharge signal is evident in the deep drift at OB14 data which is similar in nature to the signal seen in the limestone at OB16 to the east. The recharge signal at OB14 is also similar to the signal in the limestone at OB12 (to the south) but the water levels are higher at OB14 than at OB12 and so the recharge signal at OB14 must be driven from further to the north east rather than from OB12. The monitoring zone at OB14 is completed in the superficial deposits at depth (from 64 to 70 mbgl); this suggests that a recharge signal is being transmitted into the deep drift in this area from the limestone to the east, but that it is buffered from the shallower depths near the surface by overlying lower permeability material.

2.3.2 Direction of groundwater flow

Groundwater level data collected from the newly-drilled boreholes have provided additional information on the pattern of groundwater levels around the quarry. These confirm hydraulic gradients in the limestone from the north and east towards the quarry and, whilst these are consistent with the previously postulated groundwater divide along the location of the Dinas Fault, they do not categorically confirm it.

The steep, north-south, hydraulic gradient in the limestone between OB15 and OB16 observed throughout the majority of the period for which data are available suggests that the pathway between these monitoring locations is of low transmissivity; this may be in part due to the presence of low permeability superficial material and/or the Dinas Fault.

In contrast, some of the groundwater hydraulic gradients to the north east of the quarry are very shallow (between OB15 and OB8A for example) which, combined with the evidence of reduced recharge through the Glacial Till in this area (discussed above), suggests that there is little active groundwater flow in this area.

2.3.3 Vertical hydraulic gradients between limestone and drift

Comparison of water levels in the previously-drilled dual installations at OB8, OB9, and OB10 (Figure 2.7) provides an indication of the degree of connectedness between the drift and the limestone, although care needs to be exercised in interpretation due to the combination of the extent of the piezometer response zone and the variable drift lithology. In general, these show a similarity in the amplitude of variation in the drift and the limestone. Amplitude of variation in both drift and limestone is of the order of 1 to 2 m at OB8 and OB9, but is significantly higher, just under 10 m, at OB10 (closer to the edge of the mapped superficial deposits).

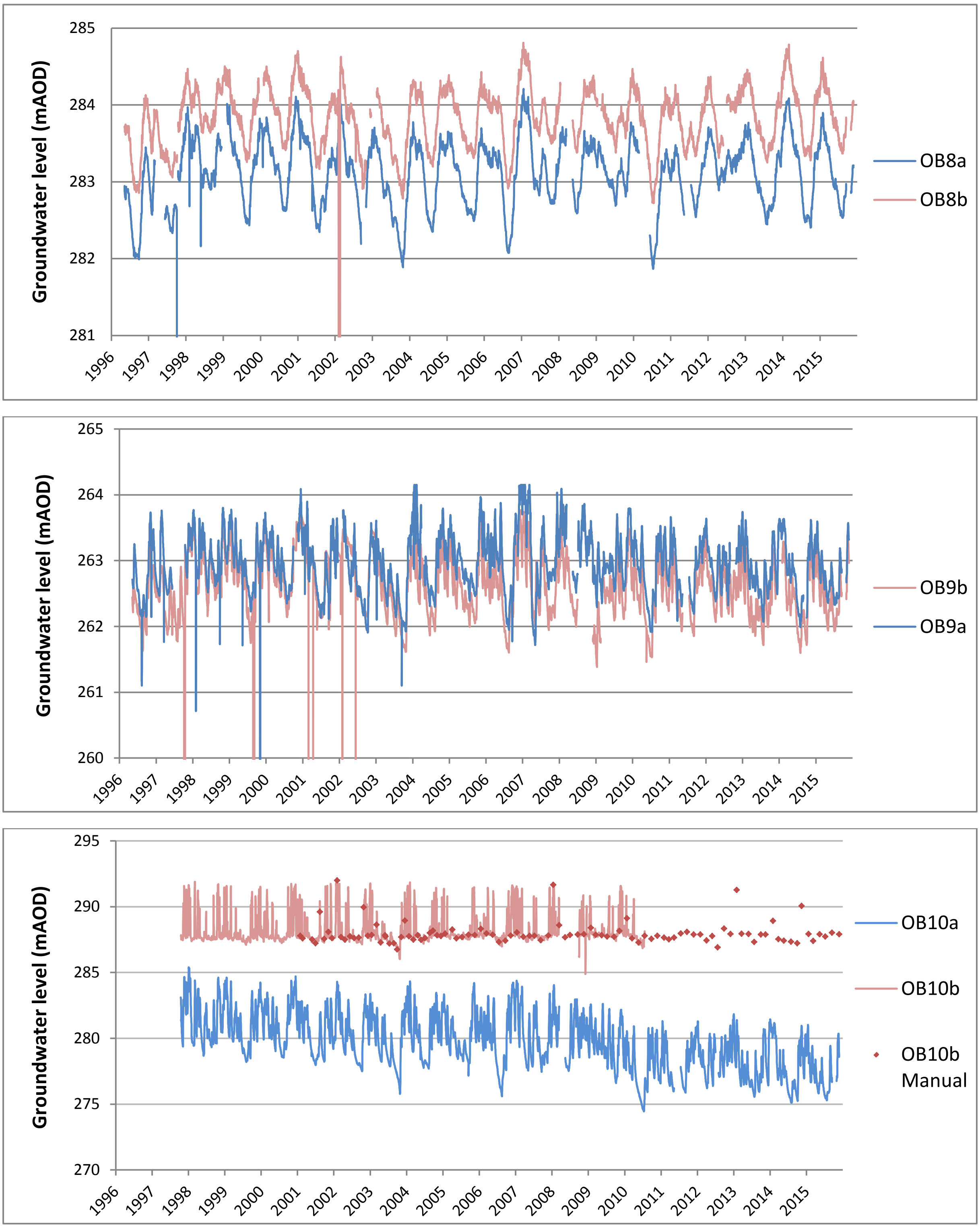


Figure 2.7 Groundwater levels in dual installations

The dual piezometers also suggest that hydraulic gradients between the drift and limestone may be variable in direction – they are upward at OB9 (near the discharge zone associated with the Nant Cadlan) and downward at OB8 and OB10 (i.e. this area is a recharge zone to the limestone, albeit the rates of recharge are attenuated by the overlying drift).

At OB10 (to the south of the Dinas Fault), the difference between the limestone and drift is around 8 m (downward gradient). Whilst this is suggestive of greater separation between the drift and the limestone, the piezometer installation at this location is such that this may, in part, represent the hydraulic gradient within the limestone rather than the hydraulic gradient between the top of the limestone and the water table in the drift. There is a difference in the amplitudes of variation at this location (around 4 m for the upper zone and up to 8 m for the lower zone) which also supports a hydraulic separation between the two units or within the limestone (i.e. suggests that the variations in water level in the limestone are being transmitted laterally from a recharge area rather than downwards through the drift in this area as it is hard to conceptualise how the range of amplitude of seasonal fluctuation can increase along a flow path).

The hydrographs in OB10 suggest that there may be some degree of perching within the limestone units, possibly as a result of intervening lower hydraulic conductivity horizons. This was also observed in OB13, where seepage was noted well above the base of the immediately adjacent quarry. It was roughly coincident with the elevation at which seepages can be seen in the quarry face, above a thin mudstone band, and hence may indicate an element of perched water within the limestone mass. This suggests that there may be a significant degree of hydraulic separation perpendicular to the limestone bedding planes. The implication of this is that dewatering effects from the quarry would be largely limited to the horizons intercepted by the quarry; whilst they could propagate along the bedding plane, the ability to propagate across it would be more limited.

At OBH10a, the limestone hydrograph shows some effect of the quarry dewatering with a small drawdown occurring from around 2009 onwards but stabilising since 2014[2]. This is not reflected in the upper horizon (OBH10b): this also supports the idea that there is a weak connection between the shallow and deep limestone groundwater at this location. This small drawdown is not seen in other limestone locations that are close to OB10 but on the other side of the Dinas Fault (e.g. OB09A/B) supporting the possibility that the fault is acting as some form of barrier.

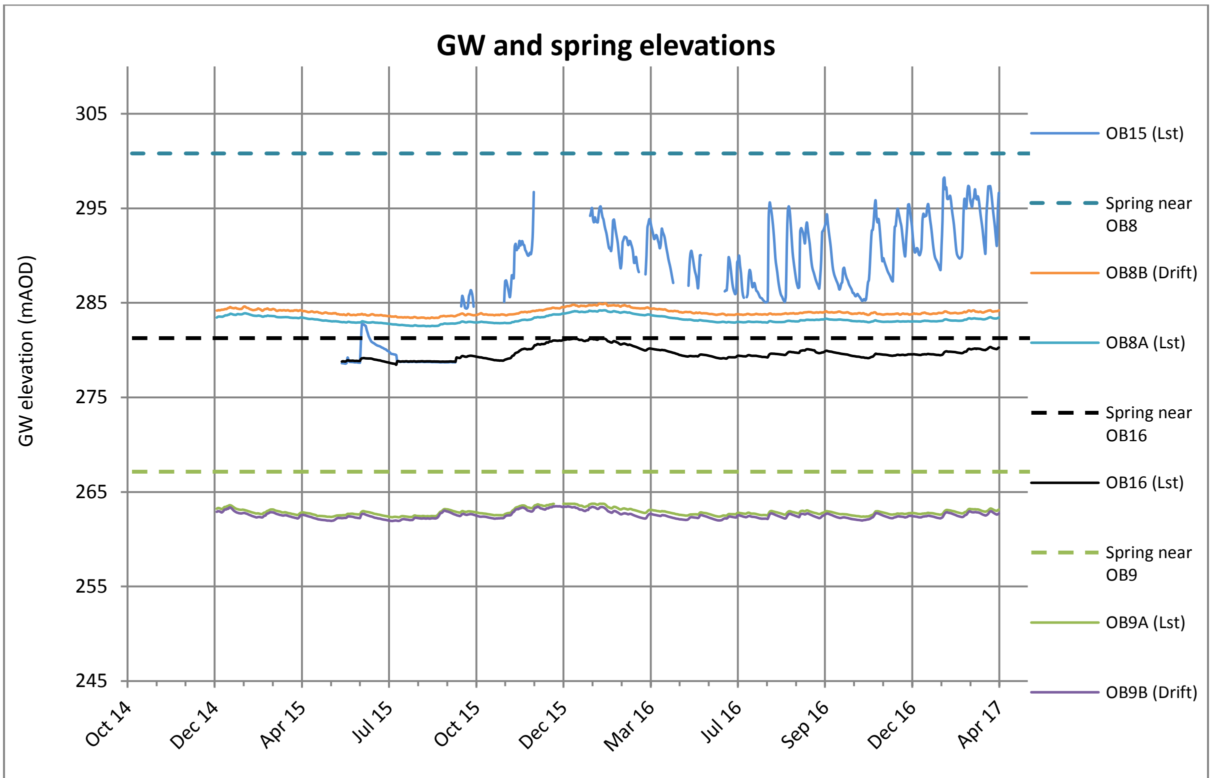


Figure 2.8 Groundwater and spring elevations north of Penderyn quarry

2 Similar drawdown is also observed at OBH12

Aside from OB10, there is other evidence for perched water within the drift at the site. To the north east of the site, springs issue from Glacial Till at locations shown in Figure 1.1. The elevation of these springs is above the groundwater levels in the adjacent limestone OB locations – as shown in Figure 2.8 - and must therefore represent perched groundwater within the drift. A conceptual cross section between OB8 and OB15 is shown on Figure 2.9.

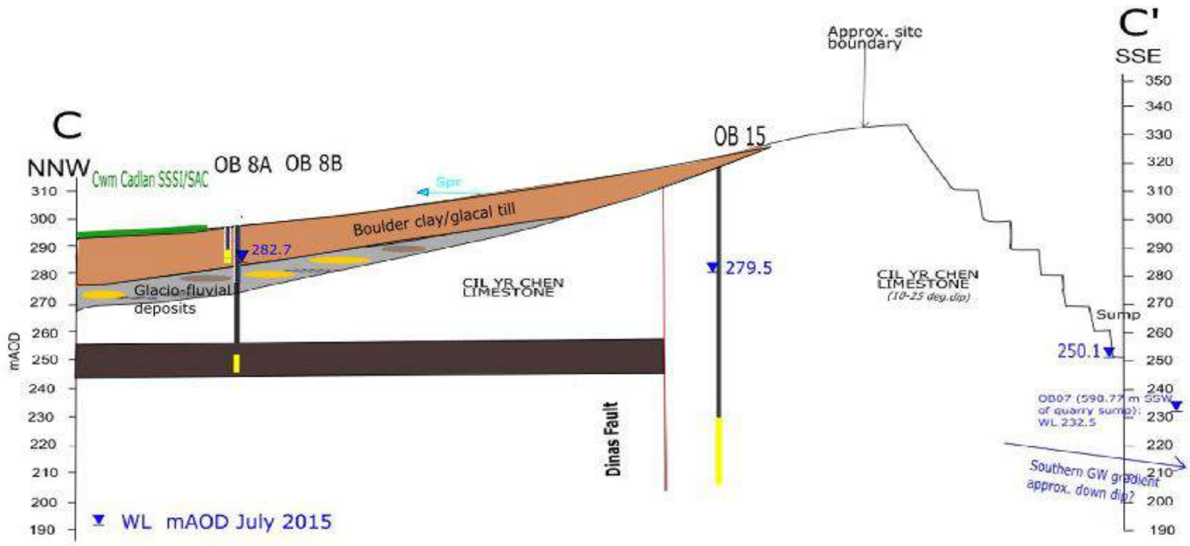


Figure 2.9 Perched springs to north east of quarry (water levels recorded July 2015)

2.3.4 Groundwater levels near the quarry sump and groundwater inflows to the quarry

Groundwater levels at OB17 have been compared with the nearby quarry sump water levels (Figure 2.11 – note period of high sump levels during pump failure over Christmas 2015). In the period of record, there is an almost continuously present upward hydraulic gradient between the borehole and the sump which suggests that groundwater flow into the sump is occurring throughout most of this period. Occurrences of sump levels exceeding water levels observed at OB17 are rare and short lived within the observed data; (see April 2016 in Figure 2.10 below).

During the pump failure and flooding event over Christmas 2015, water levels in the quarry rose to c. 254 mAOD before the pumps were reengaged. Although some of this rise is likely to have resulted from collection of runoff water, it suggests that the winter groundwater levels at this location are several metres above 250 mAOD.

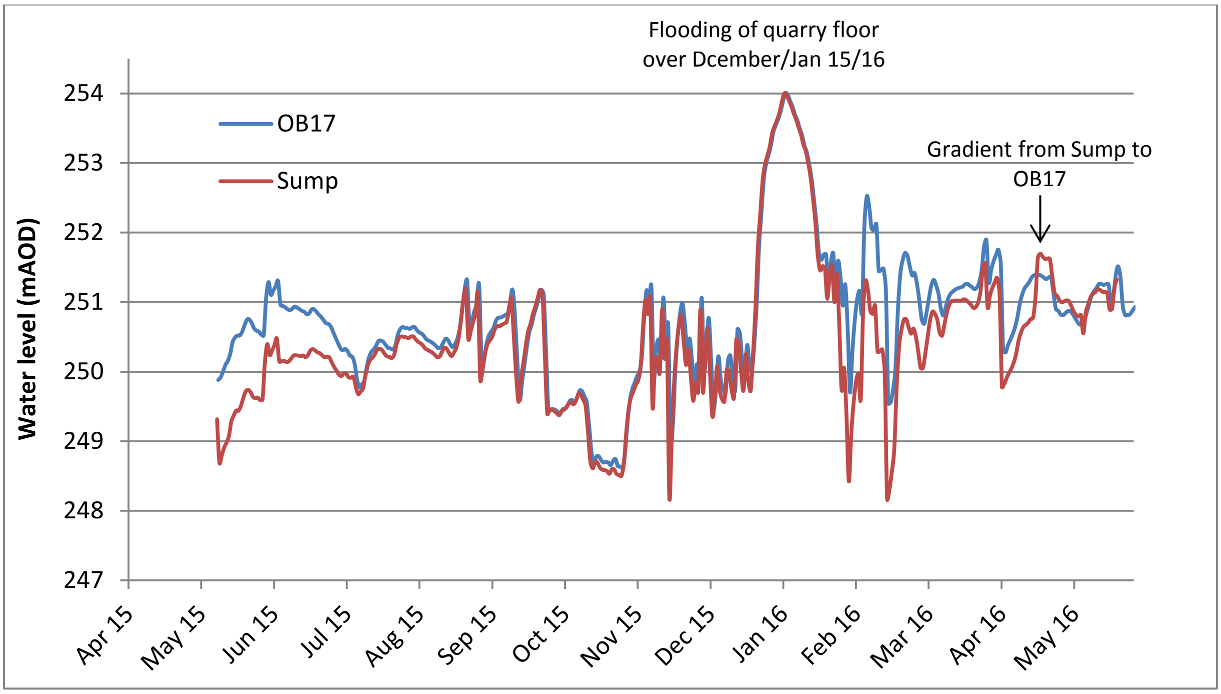


Figure 2.10 Water levels around Penderyn sump

It is currently much harder to say anything definitive about the position of summer groundwater levels. There is a one-off record during drilling at the site in the 1990s that suggests that, during very dry periods, the groundwater level may be below 250 mAOD, but this has not yet been substantiated due to the lack of a very dry period since OB17 was drilled. The current summer period has been quite dry and it will be useful to review the latest site data when it becomes available.

SRK, 2000 reports that '*The base of the new development is currently at about 258 mAOD, which is just below the summer groundwater table, with about 0.5 m water collecting in the deepest part of the sump during dry spells during the summer. Pumping was intermittent during the period June to September*.' Note that groundwater levels in summer 2000 were higher than in many other summers and so the 'normal' summer groundwater level is likely to be lower than this.

A short period of reversal in the hydraulic gradient between the sump and OB17 can be observed in April/May 2016 in Figure 2.10. This is a period of 19 days during which time the maximum difference in water levels was 0.32 m. It is expected that there was minimal pumping required over this period as rainfall was low and seepage to ground was likely to be occurring[3]. This would tend to suggest that the groundwater level was close to the sump level at this time.

2.4 Groundwater Inflow During Dry Weather.

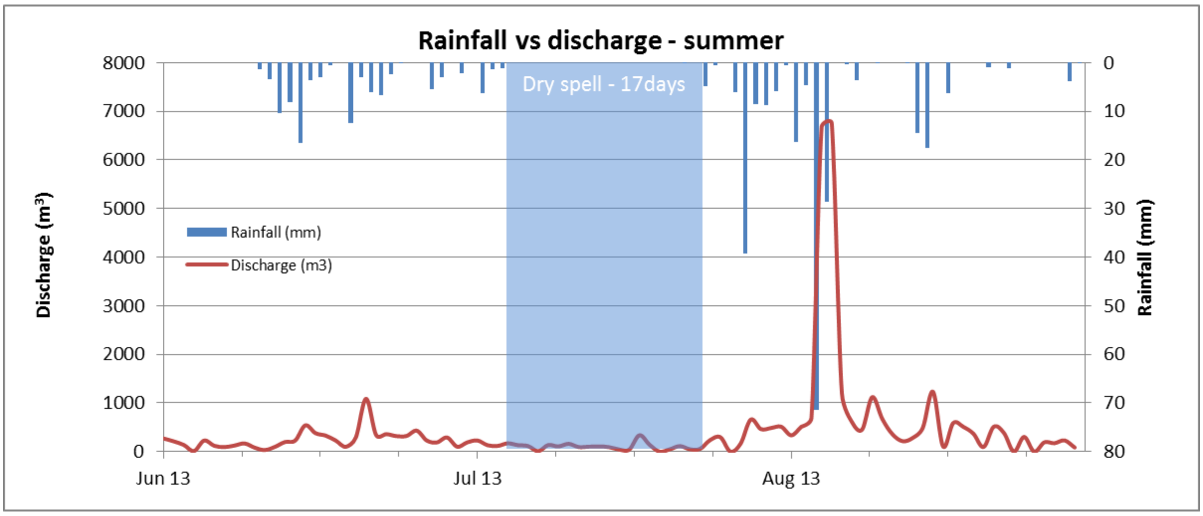
Figure 2.2 shows that water may reach the sump from a variety of sources some of which may be interflow, some of which is perched groundwater leakage and some of which is deeper groundwater inflow. These results from OB17 would suggest that there is a small but fairly continuous deeper groundwater flow component for much of the time. Water taken from the sump during dry periods is therefore expected to be entirely derived from groundwater.

In order to ascertain what proportion of the water pumped from the quarry is derived from a deep groundwater pathway, pumping rates were reviewed over periods of no rainfall. It is

[3] Unfortunately, metered flow data are not available for this period, but low pump run hours suggest that pumping was minimal over this time.

considered that, towards the end of a period of dry weather (i.e. with zero rainfall), any water entering the quarry will be derived from groundwater. Dry periods were identified in both summer and winter when the ambient groundwater levels would be lower and higher respectively. The purpose of this is to see how the magnitude of such groundwater inflows changes across the year.

Pumping rates (including allowance for change in storage volume) were assessed over dry periods in the summer (June to August) of 2013 and winter (Jan to March) of 2013 as shown in Figure 2.11.



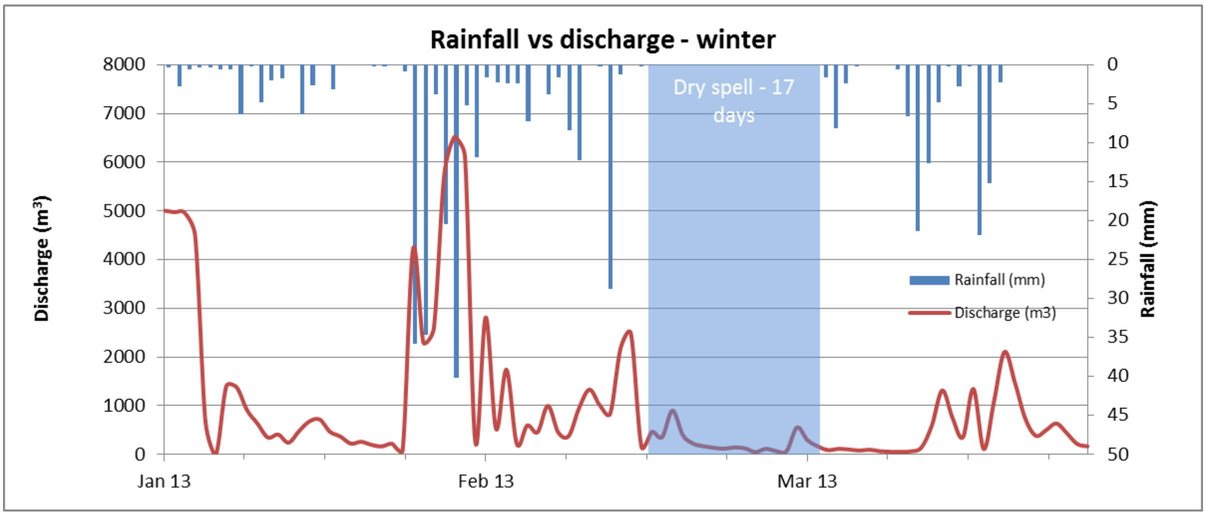


Figure 2.11 Rainfall and discharge data in dry conditions

The average dry weather discharge in summer was 75 m^3/d (over 12th – 21st July 2013, discounting the small peak visible towards the end of the period which is considered to be a rainfall event, albeit not captured by the rain gauge) compared with an average discharge of 416 m^3/d over the whole three month period observed (i.e. dry weather flow (groundwater) constituted 18 % of mean flow for the three month period observed).

Average dry weather discharge in winter was calculated as 113 m^3/d (over 23rd Feb 2013 to 5th March 2013 discounting the small peak in flow towards the end of the period which is considered to be a rainfall event not captured by the rain gauge) compared with an overall average discharge of 1020 m^3/d over the whole three month period observed, which includes the period of dry weather noted above (dry weather flow (groundwater) constituted 11 % of mean flow for the three month period observed).

The long term mean daily discharge rate from Penderyn between 1999 and 2017 is 721 m^3/d. Assuming that, say, 15% of this flow was groundwater (using the indicative percentages above), this would suggest that the long term rate of groundwater abstraction at the quarry is around 110 m^3/d. This is considered to be a small flow compared to, for instance, an average flow of c. 24,500 m^3/d [4] in the Nant Cadlan; when scaled to the area of the Cwm Cadlan SAC this gives an estimate of effective precipitation of 1,629 m^3/d for the SAC (i.e. long term average ‘groundwater’ abstraction from the quarry is about 7% of the effective precipitation over the SAC).

2.5 Catchment Area to the Quarry

The surface water catchment of the quarry has been estimated by applying an automatic algorithm to the latest survey data. There has been a small increase (+2%) in area compared with the previous catchment area calculated due to continued development of the southern face of the quarry in this period. Note that the current development of the southern benches may also intercept larger proportions of rainfall where this previously flowed down dip (Flowpath 7 on Figure 2.2).

It is recommended that an increase in catchment area is factored into the transient water balance in future hydrometric reports for the site. The increase applied should be at least 2% depending on the consensus about the amount of capture of what was previously Flowpath 7 water.

Figure 2.12 Surface water catchment of Penderyn Quarry 2017

[4] Mean daily flow between January 2000 and May 2016

3 SUMMARY AND CONCLUSIONS

3.1 Revised Conceptual Model

The revised conceptual model is shown in Figure 3.1 and Figure 3.2 and discussed in the following text

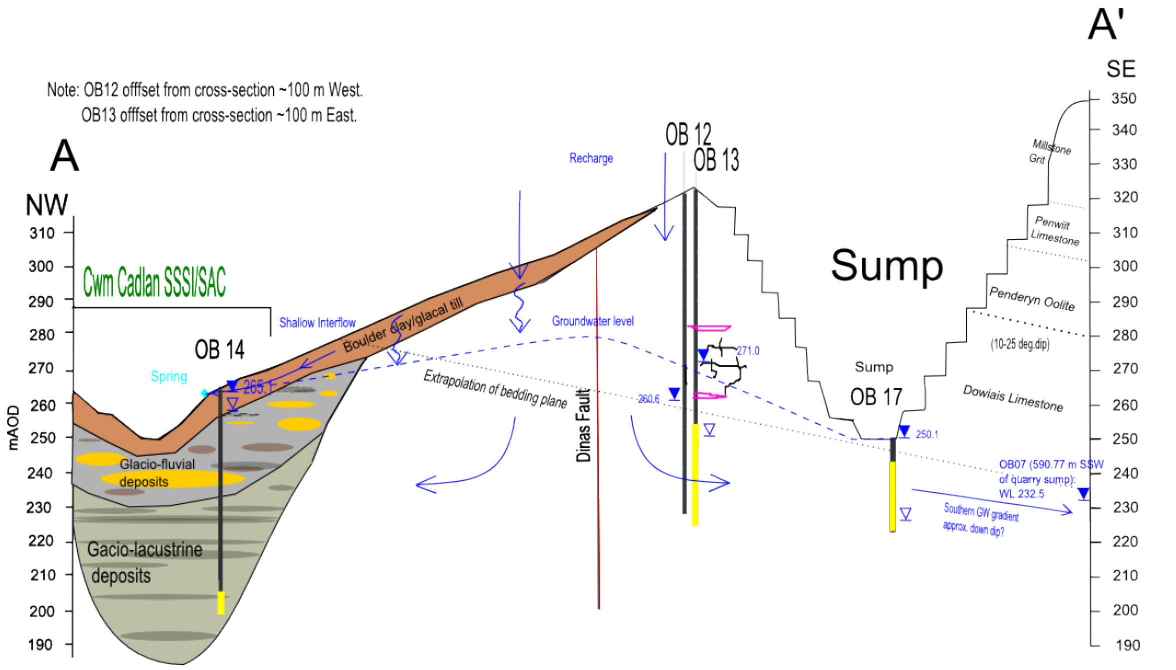


Figure 3.1 Revised conceptual model

NB (low (hollow) and high (filled) water levels recorded on 01/01/2015 – 31/03/2017 respectively)

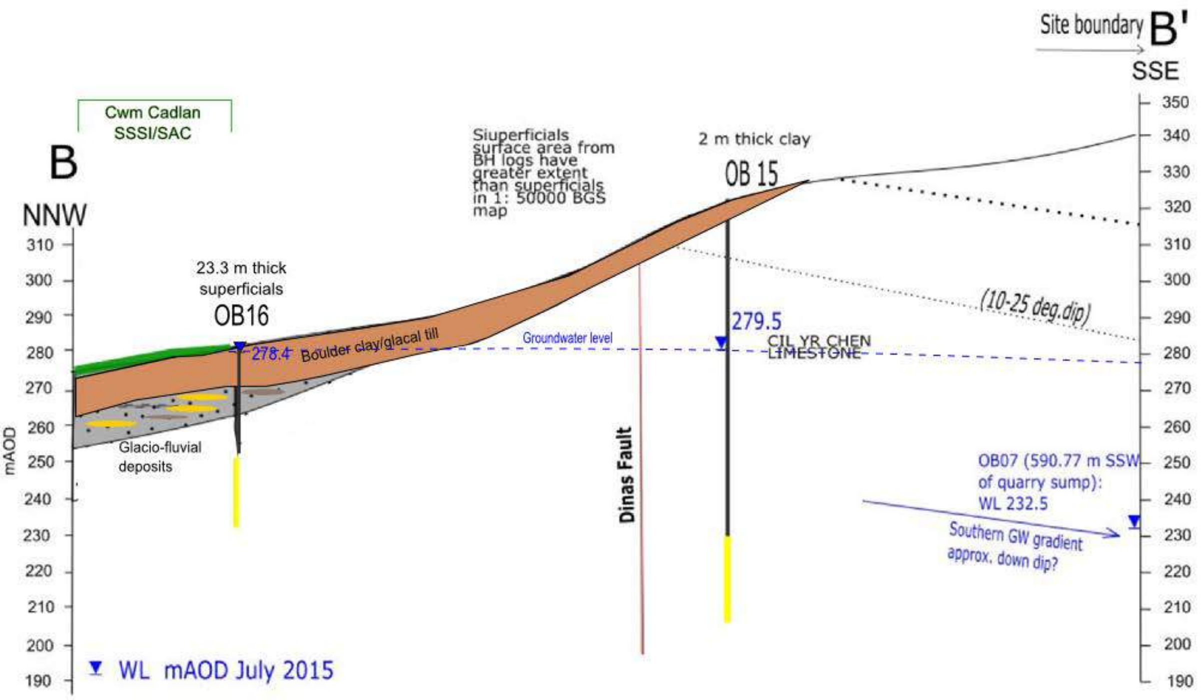


Figure 3.2 Revised conceptual model (north-east of quarry)

The groundwater system in the limestone to the north of the Dinas Fault is not very active due to attenuation of recharge to the limestone through the overlying Glacial Till which diverts rainfall to the springs that occur to the north and north west of the quarry. The diverted recharge flows to perched springs which appear on the northern flanks of the ridge into which the quarry is excavated and which feed into the SAC (see Figure 2.9, Figure 3.1 and Figure 3.2). Recharge of the drift within the SAC from the bedrock is also limited by the low permeability material.

There is some evidence for recharge signals from the limestone to the north of the Dinas fault affecting water levels in the deepest horizons within the drift (e.g. OB14 which is constructed in the deep drift below the SAC) – being transmitted there from the east rather than the south. However, this deep signal in the drift below the SAC is significantly attenuated as it passes upwards through the drift and is not at all pronounced in the shallow water levels in the SAC. This suggests that OB14 is an important pathway monitoring site.

Recharge to the limestone in the groundwater system to the south of the Dinas fault occurs through the drift close to the fault and directly through the limestone nearer to the quarry. The upper horizons of the limestone here are often more directly connected with the surface, possibly by karstified horizons close to the water table, as indicated by the greater amplitude of groundwater variations and flashy responses.

There is evidence that the limestone is acting as a multi-layer aquifer system and therefore the pathway for effects of the quarry dewatering may be largely confined to the horizons intercepted by the quarry. The dip of the beds means that, to the north, this 'pathway' would rise, extending to surface before it reached the SAC.

A significant part of the SAC to the north and east is mapped as being underlain by the Millstone Grit and this is likely to shield the SAC from any dewatering effects in the limestone, particularly in conjunction with the intervening deep, drift filled channel.

3.2 Resultant Pathways between Quarry and SAC

There are therefore two potential pathways for dewatering effects to extend from the quarry to the SAC as shown in the conceptual model figures above.

1. Via the overlying Glacial Till in the few places where the underlying limestone is fully saturated (i.e. where water levels in the till are not perched). In these locations, a reduction in limestone water levels would potentially result in a reduction in Glacial Till water levels and this then could reduce interflow and spring flow.
2. Via the main body of the deep, drift filled channel underlying the SAC. In this case, reduction in groundwater levels in the limestone would be transmitted laterally across the Dinas Fault, into the deep drift and then upwards through the drift to the surface hydrological system on which the SAC depends.

In both cases there is evidence that the risk of effects occurring over these pathways is low.

- In the case of the pathway through the Glacial Till, the new evidence of perching presented in this note suggests that much of the shallow hydrological system arising from the Glacial Till between the quarry and the SAC is perched and hydraulically isolated from the underlying limestone (and thus at no risk from quarry dewatering). The degree of separation increases to the north east of the quarry due to thickening of the till.
- In the second case, the presence of a very deep sequence of layered, low hydraulic conductivity deposits (including widespread Glacial Till at surface) under the SAC provides a high degree of hydraulic separation between the limestone and shallow water system on which the integrity of the SAC depends. The groundwater level data presented in this note shows clear evidence of significant attenuation of the recharge signal through this layered system. This again implies a very low risk to the SAC from continued quarry operation at 250 mAOD.

There is some suggestion in the evidence reviewed above that the Dinas Fault is acting as a hydraulic barrier (and is possibly the reason for the groundwater divide), but this is not conclusive. If this were the case, it would mean that the risk posed by quarrying dewatering is lower than would otherwise be the case.

In summary, the new boreholes and water level data have provided useful new information about the conceptual model of the local hydrogeology. This new information is generally consistent with the ESI 2013 conceptual model and in each case indicates that the risks to the SAC posed by the quarry dewatering at 250 mAOD are even lower than previous evidence could demonstrate.

3.3 Implications for Degree of Risk to Cwm Cadlan SAC

Hanson and NRW had previously agreed that some parts of the Cwm Cadlan SAC north of the Nant Cadlan were not susceptible to impacts from quarry dewatering. The above lines of evidence regarding geology, groundwater levels and pumping rates have been used to review the levels of risk in different parts of the SAC from continued working of the quarry at 250 mAOD as follows:

- The evidence presented above suggests that, to the north of the quarry, groundwater within the Glacial Till - which provides a source for a few small springs between the SAC and the quarry – is perched and not in hydraulic continuity with the deeper groundwater. This would mean that there is no risk that dewatering at Penderyn Quarry could derogate stream flows that feed water into the southern side of the SAC. Any surface water issuing from this source will be intercepted by the Nant Cadlan tributary which runs parallel to the main stream along the southern edge of the SAC. This suggests that the degree of risk of dewatering to these springs and the southernmost part of the SAC near the quarry is lower than the ‘low risk’ was previously assessed by NRW/CCW.
- Areas of the SAC between the quarry and the Nant Cadlan to the north east of the quarry are now considered to be at negligible risk from quarry dewatering given the significant thickness of heterogeneous – but generally low permeability – drift deposits present in this area and evidence of perching above the piezometric surface in the limestone.
- The new boreholes have now shown that the Glyn Perfedd hillock is underlain by significant thickness of heterogeneous drift rather than limestone. It is considered that this implies that there is no risk to the SAC from dewatering to the north of the hillock nor to any seeps on its southern side.

As a result of this re-evaluation, the area of SAC that is considered to be at no risk from dewatering Penderyn Quarry at 250 mAOD has been considerably expanded (Figure 3.3). The small, residual area in which the risk is considered to be very low but which cannot be completely excluded is restricted largely to the southernmost part of the original SSSI nearest to the quarry. The relevant areas are as follows:

SAC whole area	85.6	Ha
Area of SAC previously agreed to be not at risk	25.1	Ha
Area of SAC no longer considered to be at risk from dewatering at 250 mAOD	59.1	Ha
Residual area of SAC at which risk from dewatering at 250 mAOD cannot be completely precluded	1.3	Ha
% area of SAC at which risk cannot be completely precluded	1.5%	

The following combination of (improbable) events would all need to occur for such a risk to materialise:

- A substantial fissure in the limestone between the quarry and the SAC that is not currently active would need to become active (note that no further working will take place on the northern side of the quarry whilst the quarry is restricted to working above the 250 mAOD level);
- This fissure would need to intercept large amounts of water (which would be detected using the transient water balance) which would significantly change the amount of groundwater flowing towards the SAC. This is considered to be unlikely given the low recharge and inactive groundwater flow to the north of the quarry;
- The fissure would then need to be closely connected to a permeable horizon within the drift sequence under the SAC. There is some evidence that there is some connection between the limestone and the deep drift (i.e. recharge signal in OB14) but this appears to be driven from the east not the south;
- Any deep permeable drift horizons would in turn need to be well connected to the surface: the available logs suggest that the drift sequence under the SAC is very layered and so any transmission of a signal through these strata is likely to result in significant attenuation (as evidenced by the difference in the OB14 and OB9 recharge signals);
- The overall hydraulic resistance through the whole of the above sequence would need to be very low to cause any significant change in groundwater fluxes to a point that could cause a perceptible change in moisture content of the shallow horizons such that would cause an impact on the local flora (note that there is virtually no head difference between the current quarry floor and the SAC at this location);

In our opinion the probability of such a sequence of occurrences is very low. This, together with the small residual area of the SAC which cannot be precluded from risk, as well as the maintenance of the early warning monitoring arrangements at the site in the form of a Scheme of Working[5] is more than satisfactory to be able to conclude that continuing to work Penderyn Quarry at the 250m AOD level will not adversely affect the integrity of the SAC.

[5] The Scheme of Working originally approved in February 1998 is to be updated to record various amendments to the scheme that have taken place over time and will be submitted to the BBNPA for formal approval prior to the determination of the ROMP application.

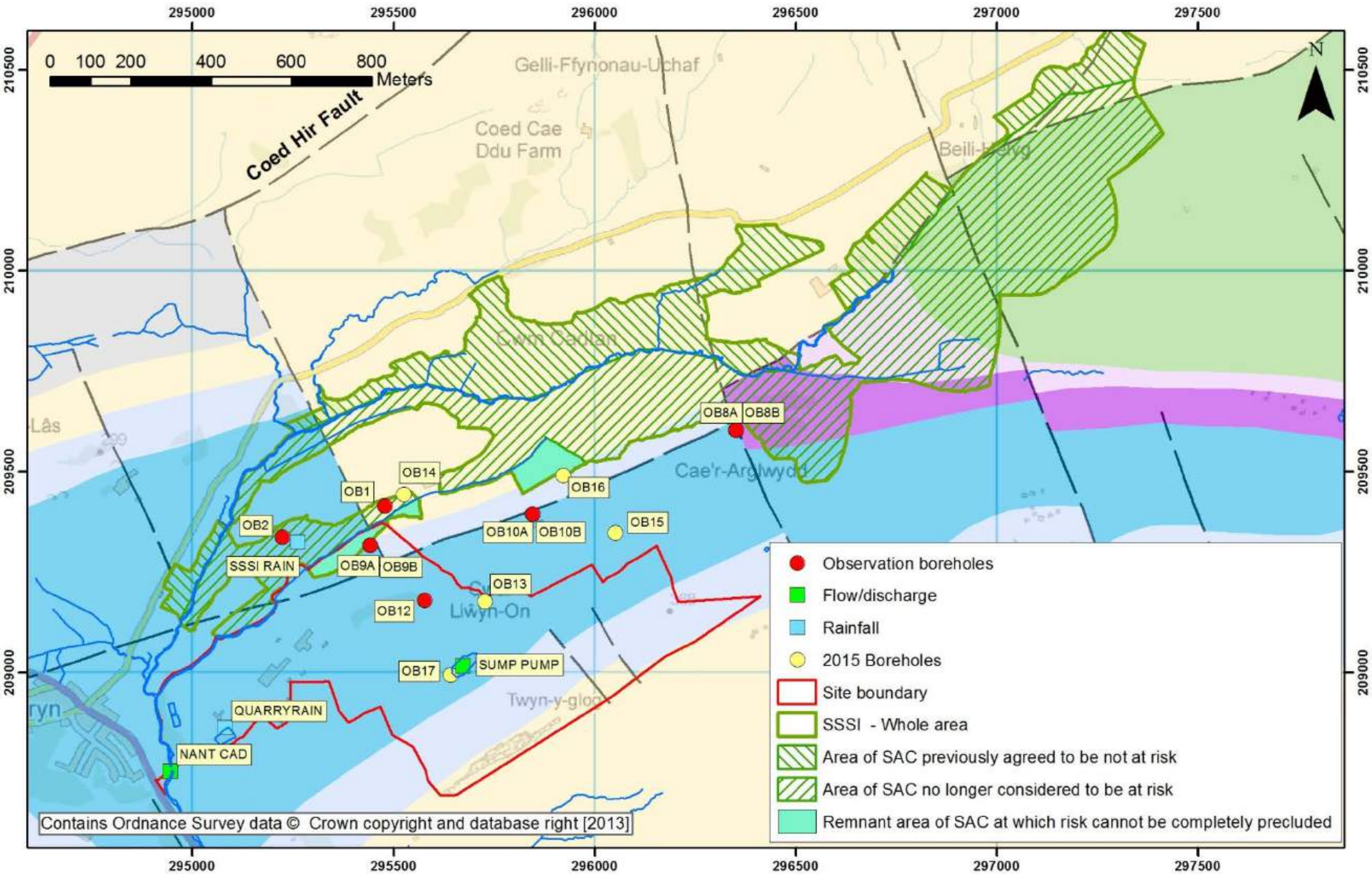


Figure 3.3 Revised assessment of areas of Cwm Cadlan SAC considered not to be at risk from further working of Penderyn Quarry at 250 mAOD

4 REFERENCES

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Caves of South Wales (2), 2016. Online reference (18/01/2016)**:** http://www.ogof.org.uk/ogof-fechan.html

ESI, 2014. Penderyn Quarry: Technical Note on Transient Water Balances. December 2014. Report reference 61190R1 2014 Update D6.

ESI, 2015. 61190TNRev1 Penderyn Quarry: Borehole Installation 2015.

ESI, Feb 2017 61190TN2 Penderyn Quarry Geological/Hydrogeological Reconceptualisation

Hull, 2013. A geoenvironmental assessment of the Penderyn Distillery site. Cardiff University, Wales.

SRK, 2011, Penderyn quarry ROMP hydrological impact assessment

Appendix E

Quarry Sump Pumping Records (Electronic appendix)

Appendix F

Penderyn Quarry Planning Permission

Brecon Beacons National Park Committee

PERMISSION FOR DEVELOPMENT

Under: Town and Country Planning Act, 1990; Town and Country Planning General Development Order 1988

BRECON BEACONS NATIONAL PARK

To: ARC South Wales Ltd
Canal Road
Cwmbach
Aberdare
Mid Glamorgan
CF44 0AG

BRECON BEACONS NATIONAL PARK

This permission does NOT include approval under Building Regulations

CV14033

SN956089

In pursuance of its powers under the above mentioned Act and Regulations, the BRECON BEACONS NATIONAL PARK COMMITTEE (hereinafter called "the Committee") as Local Planning Authority hereby grants:

Continuation of quarrying operations (Full)
Penderyn Quarry, Penderyn

PERMIT in accordance with the application form and plans received on 5th December 1994 subject to the following conditions :

(subject to the conditions specified hereunder):-

CONDITIONS

1. Unless stated otherwise below, the duration of this permission is as specified overleaf.

2. The proposed development shall be carried out in accordance with the submitted plans (Ref. Nos. P7/P/4 and P7/P/5) together with the accompanying written statement all stamped as approved by the National Park Committee, except as modified by the following conditions :

3. With the exception of works necessary for the restoration and aftercare of the site, the planning permission hereby granted shall expire on 21st February 2042.

4. Following expiry of the planning permission, all extraction, treatment, consumption, utilisation and stockpiling of minerals shall cease.

5. Except in the case of emergency(*) the sole means of access for the site shall be from the main quarry entrance on Chapel Road (A4059).

Signed [signature] for Secretary to the National Park Committee

Date 14 September 1995

It is important that you should read the notes on the reverse side of this form

6. Unless otherwise approved in writing by the National Park Committee, except in the case of emergency (*), quarrying operations shall take place only between the hours of 6.00am and 8.00pm Monday to Friday and 6.00am to 6.00pm on Saturdays and Sundays. No quarry operations shall take place on statutory Public/Bank Holidays, with the exception of Good Friday when quarrying operations will be permitted.

N.B. For the purposes of this condition, quarrying operations shall be defined as the winning and working of stone from the quarry face, the haulage of stone from the face and the operation of the primary crusher or any replacement thereof.

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7. Within twelve months of the date of this permission, or such other period as may be agreed with the National Park Committee, the applicant will carry out a hydrogeological survey of Penderyn Quarry and the surrounding area, the specification for the survey to be agreed with the National Park Committee in consultation with the NRA and CCW. The aim of the survey shall be to gather and evaluate background information in order to facilitate the preparation of the scheme of working required by Condition No. 8 below and provide a baseline for future monitoring. In particular, an assessment will be made of the effects, if any, that dewatering operations within the quarry may have on the seasonal water levels, soil moisture and soil chemical variables of relevance to the special interests within the Cwm Cadlan Grasslands SSSI and on water levels and water quality in the Penderyn borehole.

8. Within twelve months of the date of this permission, or such other period as may be agreed, the applicant shall, submit a scheme of working for the quarry for the approval of the National Park Committee. The Committee may require amendments to the scheme or impose conditions or limitions thereon as part of the approval process. The scheme of working will not be approved unless it clearly demonstrates that dewatering of the quarry in accordance with the scheme will not have adverse implications for the special interest of Cwm Cadlan SSSI or the Penderyn borehole. After the date of its approval, all operations shall be carried out strictly in accordance with the scheme of working or such variation or revision thereof as may be approved in writing by the National Park Committee, (including any conditions or limitations imposed in connection therewith). At intervals to be agreed by the National Park Committee, the scheme of working shall be reviewed.

9. The scheme of working referred to in Condition No. 8 above shall include inter alia details of :

a) development (e.g. phasing, areas to be worked, depth of working etc.)
b) method of dewatering the quarry workings
c) predicted impacts on the local groundwater and surface water regime as a consequence of dewatering the quarry
d) ground and surface water monitoring arrangements in the form of a monitoring

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Signed [signature] for Secretary to the National Park Committee

Date 14 September 1995

It is important that you should read the notes on the reverse side of this form

network, which shall include the monitoring of soil chemistry and plant communities within the Cwm Cadlan SSSI, the details of which are to be agreed with the National Park Committee in consultation with the NRA and CCW

e) a mechanism for sharing and evaluating the data gathered from the monitoring network with the NRA and CCW
f) a subordinate scheme identifying the arrangements for remedial action to be taken in the event that the data collected from the monitoring network referred to above establishes to the satisfaction of the National Park Committee, that dewatering operations within the quarry are having or are liable to have an adverse effect on the special interest of the Cwm Cadlan Grasslands SSSI, the water levels in the Penderyn borehole or any other receptor at risk identified in Condition No.9c above. Remedial action will involve either the cessation of dewatering operations or the implementation of an adequate scheme of mitigating measures with details of the scheme to be submitted for the prior approval of the National Park Committee.

10. The monitoring network referred to in Condition No. 9d above shall be maintained throughout the life of the quarry.

11. No dewatering operations shall be carried out below the level of the existing quarry floor, i.e. 265 metres AOD, apart from that required for the mobile spraying unit referred to in Condition No.15 below, until such time as the scheme of working referred to in Condition No. 8 above is approved in writing by the National Park Committee.

12. Within six months of the date of this permission, details of measures to be taken to ensure that pollution of water courses is prevented shall be submitted for the approval of the National Park Committee. These measures shall include details of settling ponds, tanks etc as appropriate, and once approved shall be implemented within a period to be agreed by the National Park Committee.

13. Until such time as the measures for the prevention of pollution referred to in Condition No.12 above are approved, all site operations shall take place using the best practicable means in accordance with NRA standards.

14. Any oil, fuel, lubricant., paint, solvent or other potential contaminate within the site shall be stored in a suitable impermeable enclosure to prevent such material contaminating any soil forming material or entering a watercourse or groundwater.

15. The emission and propagation of dust shall be minimised by the use of effective dust control measures. Such measures shall include :

a) The provision of a mobile spraying unit to be maintained in efficient working order and used so as to ensure that haulage roads and other areas subject to vehicular traffic are kept adequately damped down during periods of dry weather.

Signed [signature] for Secretary to the National Park Committee
Date 14 September 1998

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The mobile spraying unit shall have an adequate supply of water available at all times.

b). The installation and maintenance of suitable dust suppression systems on all drilling rigs.

16. Best practicable measures shall be taken to minimise noise levels generated by the site operations. Inter alia, such measures shall ensure that all vehicles are fitted with effective silencers which shall be maintained in good and efficient working order and that all machinery in intermittent use shall be shut down in the intervening periods between use or throttled down to a minimum.

17. Blasting operations shall be controlled to ensure that :

a) Except in the case of emergency (*), no blasting shall be carried out on site except between 10.00am and 6.00pm Monday to Friday and 10.00am to 12.00 noon on Saturday. There shall be no blasting on Sundays or statutory Public/Bank Holidays.

b) A warning siren shall be sounded prior to the commencement of blasting operations.

c) At all times, blasting shall be designed so that the peak particle velocity as measured in any one of three mutually perpendicular planes at the nearest residential property (existing at the date of this permission) shall not exceed 10mm per second for 95% of all blasts as measured over a period of six months and no individual blast shall ever exceed a peak particle velocity of 12mm per second.

18. The operator shall make every practicable effort to reduce the effects of air overpressure arising from blasting, having regard to the blast design, methods of initiation and also to weather conditions prevailing at the time of blasting.

19. Within five years of the date of this permission, a detailed scheme for the phased restoration, after-use and five year aftercare of the site shall be submitted for approval by the National Park Committee.

(*) For the purpose of Conditions 5, 6 and 17 above, "emergency" means any circumstances in which the operator has a reasonable cause for apprehending injury to persons or serious damage to property.

REASONS

1. Conditions imposed by the above-mentioned Act.

Signed [signature] for Secretary to the National Park Committee

Date 14 September 1995

It is important that you should read the notes on the reverse side of this form

2. To define the permission.

3. To satisfy the requirements of paragraph 1 of Schedule 5 of the Town and Country Planning Act 1990.

4. To define the permission and qualify condition No. 2 of this consent.

5. In the interests of highway safety.

~~6. In the interests of the amenities of local residents.~~

7.-11. In the interests of ensuring the quarry is worked and operated in a manner that will not damage or interfere with matters of national or local interest.

12.-14. In the interests of ensuring no pollution occurs to local ground water or water courses.

15.-18. In the interests of the amenities of the area and local residents.

19. In the interests of the landscape of this part of the National Park.

Signed [signature] for Secretary to the National Park Committee

Date 14 September 1995

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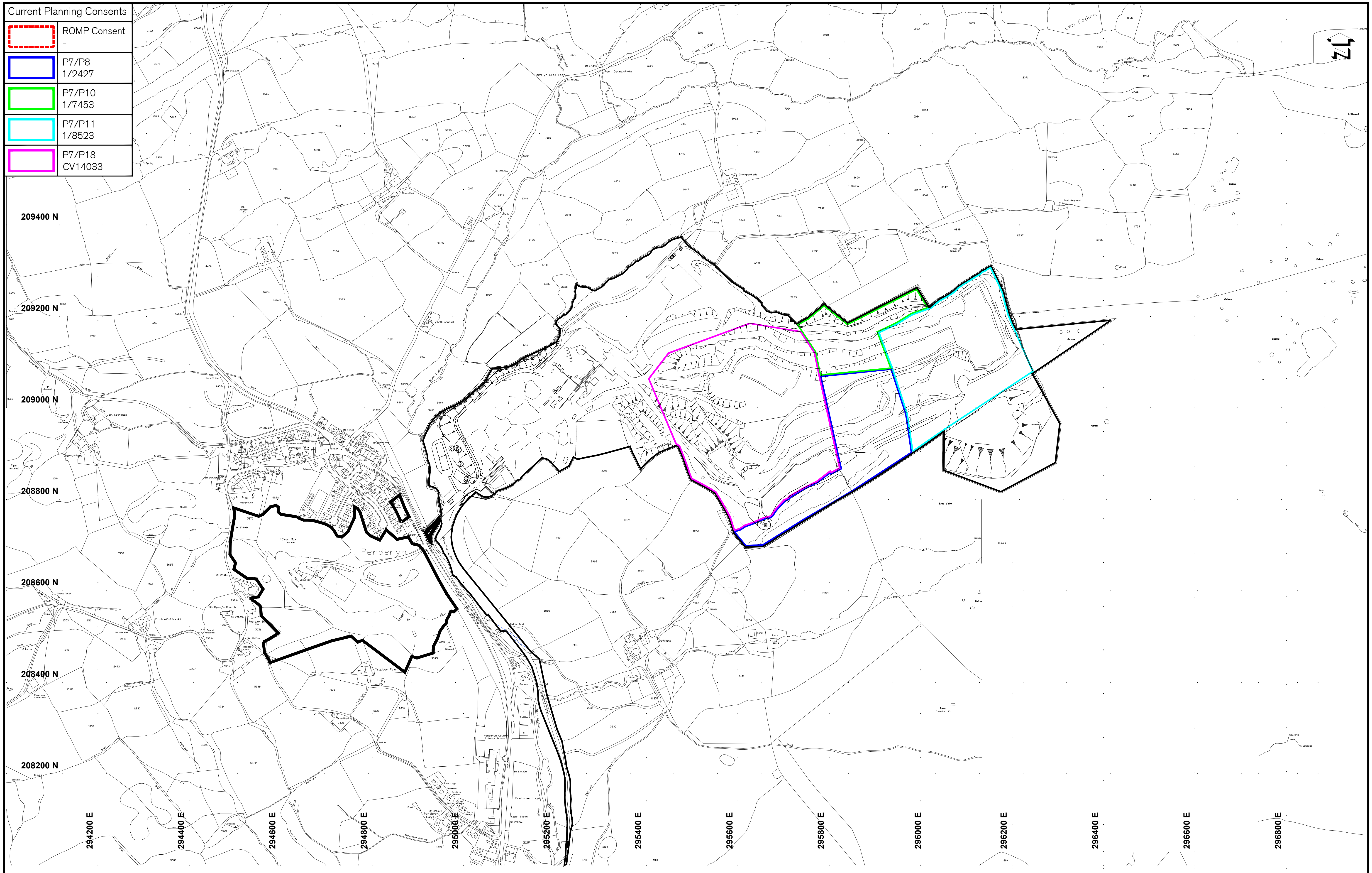

Legend

Company Landholding
(Relevant surface and minerals interests only)

Note: To view historic planning permissions (expired, revoked/surrendered, superseded) the relevant layers need to be switched on in the PDF.

Hanson
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Site	PENDERYN □□ARRY		
Title	Planning Permission Summary Plan □ssued on Date□17/10/2012		
Scale 1:7□00	Paper Size A3	Drawn by LW	Drawing No. P7/PPSP
Date Oct 2012		Check by KJB	Revision

C.P.2

6

District Council's Ref.................. Planning Authority's Ref. 1/2427

TOWN AND COUNTRY PLANNING ACT, 1947.

To: Roads Reconstruction (1934) Ltd.,
Stoneleigh House,
Frome, Somerset.

In pursuance of its powers under the above-mentioned Act and all Orders and Regulations made thereunder, the Breconshire County Council * (xxxxxxxxxxxxxxxx) * (as) the Local Planning Authority hereby permit: The extension of Quarry at Llwyn-on, Penderyn

In accordance with the plan and application received by the Council on 22nd August, 1957 * (subject to the conditions specified hereunder):—

(1) No material shall be tipped on the area coloured green on the plan; without prejudice to the applicant's right to make further application for permission to tip, no tipping shall be carried out anywhere within the areas edged pink or coloured blue on the plan other than between the yellow line on the plan and the lines A.B.C.D. as specified in the permission granted for the working of the quarry by the Vaynor & Penderyn Rural District Council dated 4th March, 1948, reference number P. 51. No tip shall exceed in height the natural level of the ground before excavation.

(2) The permission of the Local Planning Authority shall be obtained for the erection of any plant, machinery, structures or erections other than moveable plant or machinery.

(3) The site shall be maintained in a tidy condition to the reasonable satisfaction of the Local Planning Authority, and on the cessation of operations all plant, machinery, structures, erections and materials shall be removed from the site.

*(The reasons for the Council's decision to grant permission for the development subject to compliance with the conditions hereinbefore specified XXXXXXXXXXX : –) is:-

To preserve the amenities of the district, and of the National Park.

DATED this **thirteenth** day of **August,** 19**58.**

Signed C. W. S. Wells.

Capacity **Clerk of the County Council.**

(ADDRESS OF COUNCIL)

County Hall,
Brecon.
S. Wales.

IT IS IMPORTANT THAT YOU SHOULD READ THE FOLLOWING NOTES.

1. This is a planning consent only, and permission must be obtained under the local building bye-laws before the development can be carried out.

2. If the Applicant is agrieved by the decision of the local planning authority to grant permission subject to conditions, he may by notice served within one month of receipt of this notice, appeal to the Minister of Housing and Local Government in accordance with Section 16 of the Town and Country Planning Act, 1947. The Minister has power to allow a longer period for the giving of a notice of appeal and he will exercise his power in cases where he is satisfied that the applicant has deferred the giving of notice because negotiations with the local planning authority in regard to the proposed development are in progress. The Minister is not, however, required to entertain such an appeal if it appears to him that permission for the proposed development could not have been granted by the local planning authority otherwise than subject to the conditions imposed by them, having regard to the provisions of the Act. Appeals should be lodged with the Under Secretary, Ministry of Housing and Local Government, Cathays Park, Cardiff.

3. If permission to develop land is granted subject to conditions, whether by the local planning authority or by the Minister of Housing and Local Government, and the owner of the land claims that the land has become incapable of reasonably beneficial use in its existing state and cannot be rendered capable of reasonably beneficial use by the carrying out of any development which has been or would be permitted, he may serve (on the Council of the county borough or county district in which the land is situate) a purchase notice requiring that Council to purchase his interest in the land in accordance with Section 19 of the Town and Country Planning Act, 1947.

4. In certain circumstances a claim may be made against the local planning authority for compensation, where permission is granted subject to conditions by the Minister on appeal or on a reference of the application to him. The circumstances in which such compensation is payable are set out in Section 20 of the Town and Country Planning Act, 1947.

5. In the case of permission being granted for a limited period only, if at a later date an extension of the period of this permission is desired, an application for the purpose should be made to the Council before the expiration of the period.

6. Any departure from the plans submitted or from the particulars stated on the application form other than

(7)

C.P.2

District Council's Ref. .... Planning Authority's Ref. 1/7453

TOWN & COUNTRY PLANNING ACT, 1962

To A.R.C. (Western) Limited,

Shrewsbury.

In pursuance of its powers under the above-mentioned Act and all Orders and Regulations made thereunder the Breconshire County Council ~~*(acting as agent for)~~

*(as) the Local Planning Authority hereby permit; ~~approve the details of~~

the extension of quarry workings on and adjacent Garw-Dwle Farm, Penderyn,

In accordance with the plan and application received by the Council on 17th November, 1969 *(subject to the conditions specified hereunder):

1. The filling of the area proposed for tipping, which will be topsoil from the adjoining working, shall be graded in to the general contour of the surrounding hillside so as to form a flattish convex slope feathering out to zero at the edges, and as work proceeds (and on completion) shall be grassed down to agriculture.

2. Insofar as may be reasonable with this kind of operation, the site and its surroundings shall at all times be maintained in a tidy condition to the satisfaction of the Local Planning Authority.

*(The reasons for Council's decision to permit ~~approve~~ the details of the development subject to compliance with the conditions hereinbefore specifed are respectively:)

1. & 2. In the interests of local amenity and general landscape of the Brecon Beacons National Park.

DATED this 19th day of March, 1970

Signed ....

(ADDRESS OF COUNCIL) Capacity Clerk of the County Council

County Hall, BRECON.

IT IS IMPORTANT THAT YOU SHOULD READ THE FOLLOWING NOTES

1. This is a planning permission only, and permission must be obtained under the Building Regulations before the development can be carried out.

2. If the applicant is aggrieved by the decision of the local planning authority to permit or approve the details of the development subject to conditions, he may by notice served within one month of receipt of this notice, appeal to the Secretary of State, Welsh Office in accordance with Section 23 of the Town and Country Planning Act, 1962. The Secretary of State, Welsh Office has the power to allow a longer period for the giving of a notice of appeal and he will exercise his power in cases where he is satisfied that the applicant has deferred the giving of notice because negotiations with the local planning authority in regard to the proposed development are in progress. The Secretary of State, Welsh Office is, not, however, required to entertain such an appeal if it appears to him that permission for the proposed development could not have been granted by the local planning authority otherwise than subject to the conditions imposed by them, having regard to the provisions of the development order, and to any directions given under the order.

If the applicant wishes to exercise his right of appeal as mentioned in para. (2) above, he should do so on the appropriate form obtainable from the Secretary of State, Welsh Office, Cathays Park, Cardiff.

3. If permission to develop land is granted subject to conditions, whether by the local planning authority or by the Secretary of State, Welsh Office and the owner of the land claims that the land has become incapable of reasonably beneficial use in its existing state and cannot be rendered capable of reasonably beneficial use by the carrying out of any development which has been or would be permitted, he may serve (on the Council of the county borough or county district on which the land is situate) a purchase notice requiring that Council to purchase his interest in the land in accordance with the provisions of Part VIII of the Town and Country Planning Act, 1962.

4. In certain circumstances a claim may be made against the local planning authority for compensation where permission is granted subject to conditions by the Secretary of State, Welsh Office on appeal or on a reference of the application to him. The circumstances in which such compensation is payable are set out in Section 123 of the Town and Country Planning Act, 1962.

5. In the case of permission being granted for a limited period only, if at a later date an extension of the period of this permission is desired, an application for the purpose should be made to the Council before the

C.182

B.R.E.—15788

District Council's Ref. .... Planning Authority's Ref. 1/8523........

TOWN & COUNTRY PLANNING ACT, 1971

To ....Amalgamated Roadstone Corporation Ltd.,........................

......................15 Stanhope Gate,..

......................London,...

In pursuance of its powers under the above-mentioned Act and all Orders and Regulations made thereunder the Council ~~*(acting as agent for)~~ *(as) the Local Planning Authority hereby } permit; ~~approve the details of;~~

Extension to Quarry Workings and Tipping Area on land adjoining Penderyn Quarry
In accordance with the plan and application received by the Council on 23rd February, 19 72 *(subject to the conditions specified hereunder):

1 Any soil making material removed in the course of quarrying shall be stripped and stored separately in accordance with conditions 3 and 5.

2 Apart from the soil-making material reffered to in condition 1, all waste material removed in the course of quarrying shall be tipped within the area edged by a broken green line on the submitted plans, or in the existing tipping area or within the excavated area.

3 As soon as it is practicable and as the tipping proceeds, the waste materials tipped in accordance with condition 2 shall be graded to a slope not steeper than one vertical in two horizontal; any edges and angles shall be rounded to the reasonable requirements of the Local Planning Authority; all stones shall be removed from the surface, the soil-making material referred to in condition 1 shall be spread evenly over the tip to suitable depth and the area shall be grassed and trees planted in accordance with a scheme to be approved by the Local Planning Authority before tipping operations are commenced in the area covered by this permission.

4 The quarry shall be worked in such a manner that when quarrying is complet in the area covered by this permission, a series of benches and faces is formed, no bench being less than 50 ft, in depth horizontally, at any point and no face being more than 50 ft. in height at any point; the angle of any face shall nowhere be less than 40° from the vertical.

5 Any excess soil-making material or other waste material shall be disposed of in accordance with a scheme to be approved by the Local Planning Authority before quarrying in the area covered by this permission is completed; and no waste material of any kind shall be disposed of other than in accordance with this scheme or conditions 1, 2, and 3.

*Cross out words inapplicable.

/Continued on attached sheet...
(Continued overleaf)

6 Steps shall be taken whenever conditions make it necessary to ensure that no nuisance, including visual nuisance, is caused by dust generated by the quarrying in the area covered by this permission.

7 The whole of the area covered by this permission shall be enclosed with a stock proof fence at all times.

81 No quarrying operations of any kind shall be carried out by virtue of this permission in the area hatched red on the attached plan.

*(The reasons for Council's decision to { permit / ~~approve~~ } the details of the development subject to compliance with the conditions hereinbefore specified are respectively:)

1, 2, 3, 4, 5, 6, 8 — To preserve the amenities of this part of the National Park both during and after quarrying operations and to minimise the eventual loss of pasture.

4, 7 — To minimise the danger to the public and to farm stock both during and after quarrying operations.

N.B. The Clerk of the Glamorgan River Authority states:-

"My Authority's consent will be required in respect of the construction of any new outlet to, the commencement of any new discharge to the diversion of, or any other interference with the water course".

DATED this 29th day of June, 1972

Signed ....

(ADDRESS OF COUNCIL) Capacity ~~Clerk of the County Council.~~

New County Hall,

Brec[illegible]

IT IS IMPORTANT THAT YOU SHOULD READ THE FOLLOWING NOTES

1. This is a planning permission only, and permission must be obtained under the Buildings Regulations before the development can be carried out.

2. If the applicant is aggrieved by the decision of the local planning authority to permit or approve the details of the development subject to conditions, he may by notice served within six months of receipt of this notice, appeal to the Secretary of State, Welsh Office in accordance with Section 36 of the Town and Country Planning Act, 1971. The Secretary of State, Welsh Office has the power to allow a longer period for the giving of a notice of appeal and he will exercise his power in cases where he is satisfied that the applicant has deferred the giving of notice because negotiations with the local planning authority in regard to the proposed development are in progress. The Secretary of State, Welsh Office is, not, however, required to entertain such an appeal if it appears to him that permission for the proposed development could not have been granted by the local planning authority otherwise than subject to the conditions imposed by them, having regard to the provisions of the development order, and to any directions given under the order.

If the applicant wishes to exercise his right of appeal as mentioned in para. (2) he should do so on the appropriate form obtainable from the Secretary of State, Welsh Office, Cathays Park, Cardiff.

3. If permission to develop land is granted subject to conditions, whether by the local planning authority or by the Secretary of State, Welsh Office, and the owner of the land claims that the land has become incapable of reasonably beneficial use in its existing state and cannot be rendered capable of reasonably beneficial use by the carrying out of any development which has been or would be permitted, he may serve (on the Council of the county borough or county district on which the land is situate) a purchase notice requiring that Council to purchase his interest in the land in accordance with the provisions of Part IX of the Town and Country Planning Act, 1971.

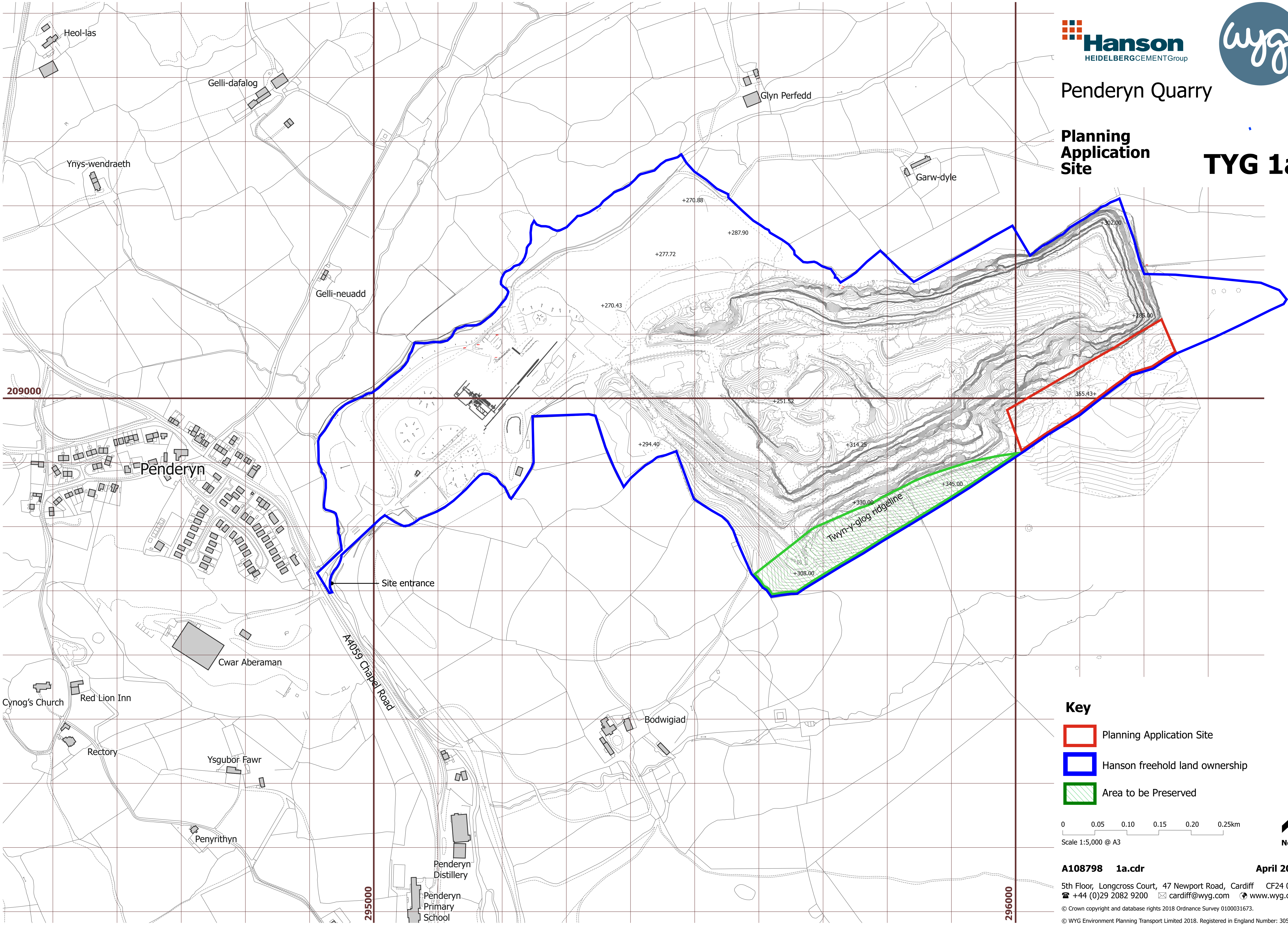
4. In certain circumstances a claim may be made against the local planning authority for compensation where permission is granted subject to conditions by the Secretary of State, Welsh Office on appeal or on a reference of the application to him. The circumstances in which such compensation is payable are set out in Section 169 of the Town and Country Planning Act, 1971.

5. In the case of permission being granted for a limited period only, if at a later date an extension of the period of this permission is desired, an application for the purpose should be made to the Council before the expiration of the period.

6. Any departure from the plans submitted or from the particulars stated on the application form other than in accordance with conditions imposed, is a contravention of this permission and renders the developer liable

Appendix G

Future Planning Application



Hanson
HEIDELBERGCEMENTGroup

wyg

Penderyn Quarry

Planning Application Site

TYG 1a

Key

- Planning Application Site
- Hanson freehold land ownership
- Area to be Preserved

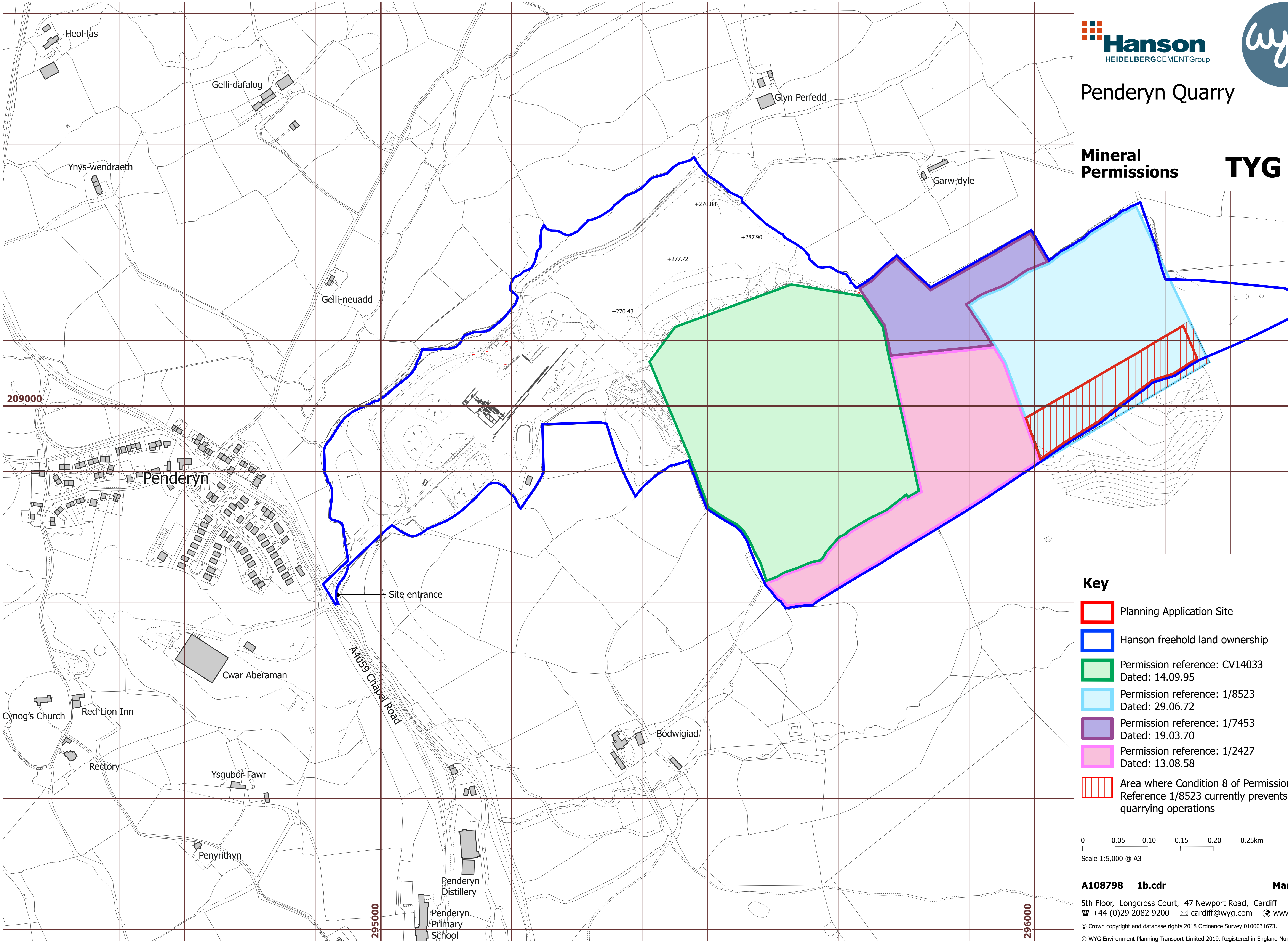
0 0.05 0.10 0.15 0.20 0.25km

Scale 1:5,000 @ A3

North

A108798 1a.cdr **April 2019**

5th Floor, Longcross Court, 47 Newport Road, Cardiff CF24 0AD
☎ +44 (0)29 2082 9200 ✉ cardiff@wyg.com www.wyg.com



Hanson
HEIDELBERGCEMENTGroup

wyg

Penderyn Quarry

Mineral Permissions

TYG 1b

Key

- Planning Application Site
- Hanson freehold land ownership
- Permission reference: CV14033 Dated: 14.09.95
- Permission reference: 1/8523 Dated: 29.06.72
- Permission reference: 1/7453 Dated: 19.03.70
- Permission reference: 1/2427 Dated: 13.08.58
- Area where Condition 8 of Permission Reference 1/8523 currently prevents quarrying operations

0 0.05 0.10 0.15 0.20 0.25km

Scale 1:5,000 @ A3

North

A108798 1b.cdr **March 2019**

5th Floor, Longcross Court, 47 Newport Road, Cardiff CF24 0AD
☎ +44 (0)29 2082 9200 ✉ cardiff@wyg.com www.wyg.com

Appendix H

Penderyn Quarry ROMP Hydrological Impact Assessment

PENDERYN QUARRY ROMP HYDROLOGICAL IMPACT ASSESSMENT

Report Prepared for:

HANSON AGGREGATES

Hanson House
14, Castle Hill
Maidenhead
SL6 4JJ

Report Prepared by

SRK Consulting
Engineers and Scientists

FILE REF: **Penderyn_2010_ROMP_HIA_Final.docx** **JANUARY 2011**

SRK Version 09/03

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PENDERYN QUARRY ROMP HYDROLOGICAL IMPACT ASSESSMENT

Report Prepared for

HANSON AGGREGATES

U4138

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FILE REF: **P:\U4138 Penderyn ROMP EIA\Project\Reps\Penderyn_2010_ROMP_HIA_Final.docx**

JANUARY 2011

Report Authors
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Reviewed by:
William Harding

SRK DISTRIBUTION RECORD

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CF10 2HH
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Our ref: *P:\U4138 Penderyn ROMP EIA\Project\Reps\Penderyn_2010_ROMP_HIA_Final.docx* *January 2011*

PENDERYN QUARRY ROMP - HYDROLOGICAL IMPACT ASSESSMENT

1 INTRODUCTIONBACKGROUND

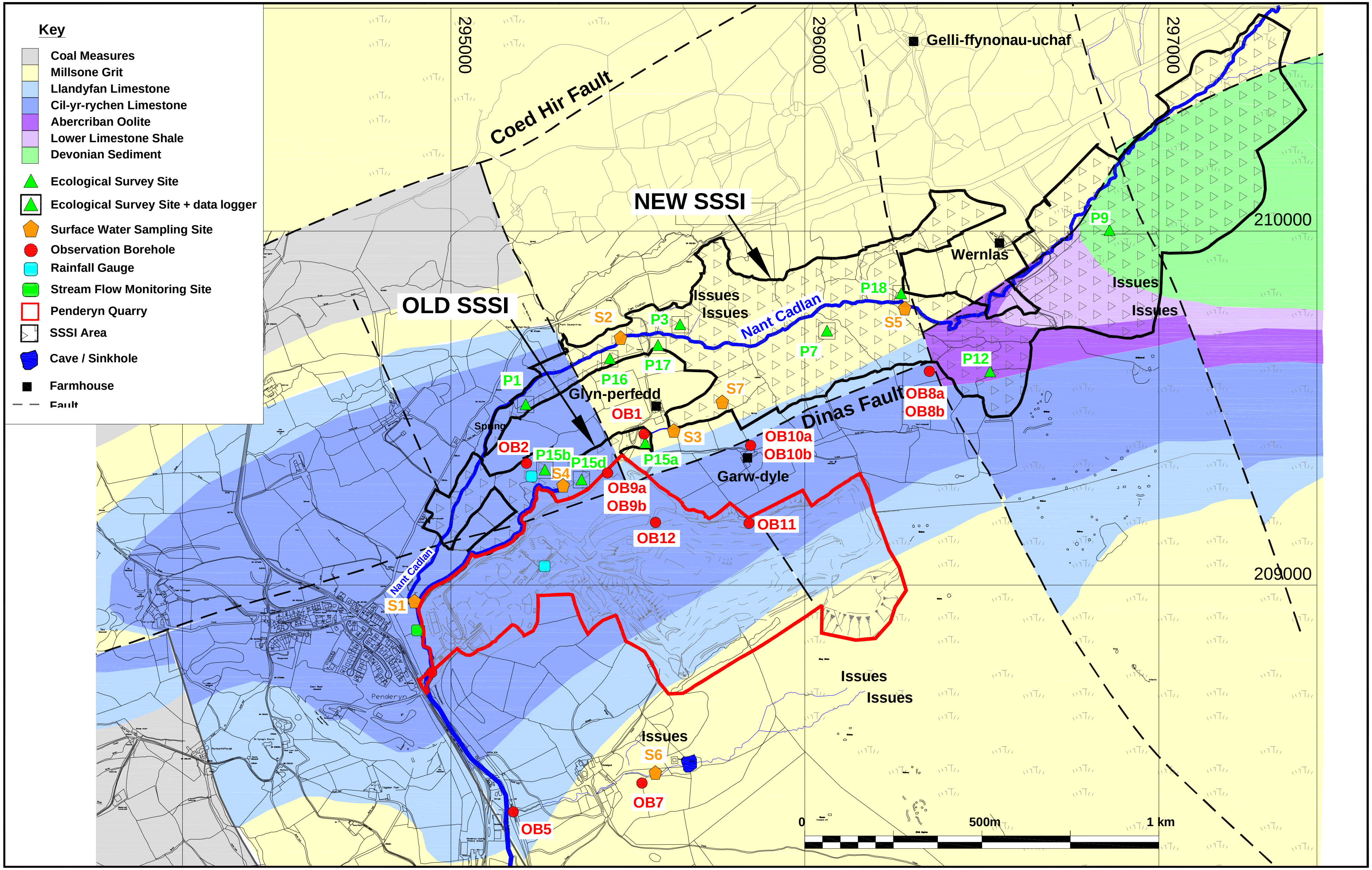
Hanson UK (Hanson, formerly ARC) are currently undertaking a review of old minerals permissions (ROMP) for Penderyn Quarry. The ROMP requires an environmental impact assessment (EIA) to support the approval of planning conditions controlling proposed future quarrying activities. SRK Consulting (UK) Ltd. (SRK) were commissioned by Hanson to produce a hydrological impact assessment (HIA) which will feed into the main EIA and ROMP that WYG Environment Planning Transport Ltd. (WYG) are compiling. The EIA will include impact assessments for various environmental aspects including water, noise, aesthetics and ecology. The HIA will look specifically at potential impacts to surface water and groundwater receptors.

SRK was originally engaged by Hanson in April 1995 to assist with the design and installation of a monitoring network around Penderyn Quarry, in order to comply with Conditions No 7, 8 and 9 of the planning consent Ref No CV 14033 to deepen and extend the quarry. A requirement for dewatering in the quarry and the associated potential reduction in local groundwater levels was identified as a potential pathway for impact on two main potential receptors - the Cwm Cadlan Grasslands Site of Special Scientific Interest (SSSI), immediately to the north of the quarry and the Penderyn water supply borehole about 1 km to the south (Figure 1-1). The key stakeholders, being the Brecon Beacons National Park Authority (the BBNPA) who administer planning control within the national park, the Countryside Council for Wales (CCW) who now manage the SSSI and the Environment Agency (EA) who are responsible for protection of the Penderyn borehole and water resources as a whole in the area of the national park, were engaged at this point. The three key stakeholders together with Hanson Aggregates are referred to collectively as "the Relevant Parties" in the Scheme of Working (SoW) referred to below.

In accordance with the planning consent, a SoW was agreed by the Relevant Parties and approved specifically by the BBNPA which sets out the requirements for groundwater monitoring, survey of vegetation in the Cwm Cadlan SSSI, exchange of data and remedial action if required. Monitoring results have been presented to the aforementioned stakeholders on an annual basis since 1996 in the form of an annual monitoring report which summarises the results of hydrological monitoring over the previous year (and ecological monitoring on a bi-annual basis). Where any significant changes from the baseline are recorded, the implications of these changes on the site conceptual model and potential for resulting negative environmental impacts are discussed. A liaison meeting is held annually between Hanson, CCW, the EA, BBNPA and SRK to discuss the findings of the previous year's monitoring and any changes to quarrying arrangements or monitoring required going forward.

Hydrological monitoring has been ongoing since 1996 and a comprehensive three and a half year baseline hydrological data set had already been acquired by the time the quarry floor went sub-water table in 2000. No adverse effects of dewatering on either the SSSI or the Penderyn borehole have been detected since monitoring began.

H:\Penderyn\010_Reports\2010\Figures\Fig1.1GT.dwg



January 2011	PROJ. No: U4138	PENDERYN QUARRY	
SRK Consulting Engineers and Scientists		Monitoring Locations Around Penderyn Quarry	Figure 1.1

This report summarises the hydrological conditions at Penderyn using hydrological monitoring results collected on a continuous basis since 1996. The long record of hydrological monitoring data acquired for the site has enabled a robust conceptual hydrological model to be developed for the site in which Hanson and SRK have a high degree of confidence. Following a review of sensitive sites in the area, the conceptual model has been used to derive an assessment of potential risk to each of these sites. Mitigation measures for any potential impacts identified are discussed.

A list of previous reports and relevant texts is presented at the end of this report. The reader is referred to these for background information.

1.1 Scope

The scope of this HIA is to:

- Summarise proposed operations in the context of potential hydrological impacts;
- Discuss the conceptual site model;
- Review sensitive sites;
- Summarise hydrological monitoring results to date; and
- Review the risk of hydrological impacts to sensitive sites and their mitigation, should it be necessary.

2 APPROACH

EA (2007) [Ref 8] presents various methodologies for hydrological impact assessment of quarries. Because of the difficulties in characterising and predicting flow in fractured aquifers, such as the limestone which may exhibit conduit flow, it may not be possible to use a methodology which involves quantitative estimation of potential impacts. In this situation, a 'monitor and mitigate' approach offers a favourable alternative. This approach is summarised in Box 2-1.

Box 2-1: Monitor and mitigate approach to HIA (after EA, 2007 [Ref 8])

Step 1: Establish the regional water resource status.

Step 2: Develop a conceptual model for the abstraction and the surrounding area.

Step 3: Identify sensitive sites.

Step 4: Commence preliminary monitoring at those sites.

Step 5: Design and demonstrate effective mitigation measures for the sensitive sites.

Step 6: Specify trigger levels for the mitigation measures.

Step 7: Continue surveillance monitoring at the sensitive sites.

Step 8: If necessary, implement mitigation measures when trigger levels have been passed.

The monitor and mitigate approach is employed at Penderyn quarry because of the dominance of conduit flow in the underlying bedrock, which has been observed in some areas of the site (see Section 4). Hydrological monitoring has been in place at Penderyn quarry since 1996 and a mitigation procedure in case of risk of impacts to sensitive sites is outlined in the original SoW (Appendix A). This report will provide a review and update of the HIA at Penderyn approximately following the procedure outlined in Box 2-1 and based on monitoring results to date.

No specific trigger levels for mitigation measures (step 6 in Box 2-1) have been set for Penderyn Quarry, nor is it the intention to do so as part of this HIA or otherwise, as it was decided between SRK, Hanson and the other Relevant Parties that the hydrological system at Penderyn is complex and as such any significant changes from the baseline conditions (acquired prior to quarry deepening below the regional groundwater level) should be considered on an individual basis should the need arise.

3 SITE SETTING AND PROPOSED DEVELOPMENT

3.1 Location

Penderyn quarry is situated to the east- northeast of Penderyn Village, some 8 km north of Aberdare, and is served by a direct access off the A4059 Hirwaun to Brecon Road. It is located within the southern central portion of the Brecon Beacons National Park.

3.2 Topography

The land surrounding Penderyn quarry can be mainly described as moderately undulating upland. Elevation of the surrounding land varies between around 240mAD in the Nant Cadlan valley bottom and 460mAD on the surrounding hilltops.

3.3 Geology

Figure 1-1 shows the lithology and major structures identified in the general vicinity of Penderyn quarry.

Penderyn quarry is working Carboniferous Limestone at the northern edge of the south Wales coal fields. Aggregate quality limestone is extracted from upper light grey beds, the Llandyfan Limestone and lower dark grey beds, the Cil Yr Ychen Limestone. The limestone dips gently (10-25 degrees) to the southeast and forms part of the southern limb of a regional east west trending anticline.

The bedrock in the area around Penderyn is heterogeneous and block faulted. The eastern end of the quarry is reasonably proximate to a significant fault which strikes northwest-southeast and downthrows the productive measures to the east. This is around 250m beyond the property curtilage. A regionally significant structure – the Dinas Fault, runs northeast-southwest across the north-western boundary of the quarry footprint.

There is a regionally consistent structural pattern across the limestone and Millstone Grit and major joints are believed to cross the junction between the two lithologies (SRK, 2003[Refs 16, 17, 18]).

3.4 Groundwater

There are two aquifers present in the general vicinity of Penderyn quarry:

- Millstone Grit – minor aquifer producing small, but useful, local supplies; and
- Llandyfan and Cil-yr-Ychen Carboniferous Limestones – a major aquifer of local importance and often proving public supplies.

Results from monitoring to date have suggested the importance of faults and unconformities in influencing the hydrogeological regime at Penderyn (Section 6.3). The limestone and Millstone Grit demonstrate heterogeneous hydraulic characteristics typical of a system dominated by conduit groundwater flow. Block faulting is likely to be the dominant control on groundwater flow in the region. Faults, by their very nature, tend to obstruct groundwater flow perpendicular to strike by positioning permeable strata against less permeable strata, by causing compaction of sediment and through the development of impermeable clay gouge. Contrastingly, they can promote flow parallel to strike and, in limestone terrains, these pathways frequently develop solution features which, in time, become karstified.

The limestone at Penderyn shows evidence of karstic features. Two cave systems have been identified just to the east of the quarry site, Ogof Fawr (Grid Ref. SN 984 097) and Ogof Fach (Grid Ref. SN 975 097). There is strong evidence of intrastratal karstification and collapse structures ("cave zones") at the juncture between the limestone and the Millstone Grit formations and at the contact between the Llandyfan and Cil Yr Ychen Limestones. This phenomenon can be observed on the southern fringes of the Penderyn Quarry. Both Ogof Fawr and Ogof Fach are located in the Oolite Group, an observation that has led researchers to suggest that significant cave systems in the Penderyn area are largely confined to this group and that the mechanism for such localised channelling of flow has been the presence of impermeable shale bands above and below (Humphreys,1980 [Ref 6]). It is worth noting in this context that the Oolite Group resides some depth below the planned limit of the Penderyn Quarry. The cave system at Ogof Fawr provides evidence of having evolved in the vadose zone with flow occurring down the slope of the bedding plane. Humphreys thus conjectured that in the Penderyn area flow tends to occur in a down dip direction in the unsaturated zone, but then flows along strike once beneath the water table. He therefore concluded that water entering the Ogof Fawr passes well south of the Penderyn Quarry. Furthermore, a more recent tracer experiment performed by Bristol University during 2000 (Maurice, 2003 [Ref 3]) picked up little or no tracer in the quarry.

The limestone and Millstone Grit show a clear and direct hydraulic connection, demonstrated in monitoring results to date (Section 6.3).

The drift deposits that overly the limestone and Millstone Grit are generally thin (5-15m) and of significantly lower permeability than the underlying bedrock so as to be of little regional significance in terms of groundwater flow. The drift, however, plays a role in local-scale hydrogeology at the SSSI (Sections 4 and 1.1).

The regional status of groundwater in the area is discussed in Section 3.7.

3.5 Surface Water

The Nant Cadlan stream is the most significant surface water body in the vicinity of Penderyn quarry and all surface water from the quarry and adjacent wetland (Cwm Cadlan SSSI) drains to this watercourse.

The Nant Cadlan shows strong evidence of a major and direct link between surface water and groundwater, as discussed in Section 1.1. Conversely, surface waters in the Cwm Cadlan SSSI receive little or no direct recharge from the underlying limestone or Millstone Grit (Sections 4 and 1.1). There are two springs that rise, respectively, just to the south and east of Glyn Perfedd farm and pass into a stream that flows through the old SSSI immediately adjacent to the quarry. Their proximity to, and alignment with, the Dinas Fault suggests a close association with the fault. Flow in both springs is perennial and largely confined to well-defined channels that provide little opportunity for water to disperse over adjoining pastures.

3.6 Proposed Development

Hanson is currently working below the water table at the 250 m AOD (above ordnance datum) level. Quarrying operations are now focussing on the southern quarry faces. To deal with water flowing into the quarry, Hanson periodically pumps a combination of ground and surface water from a sump in the base of the quarry (Figure 1-1). The base of the sump is at approximately 242 m AOD i.e. 8m below the quarry floor. It is expected that quarrying will continue on the southern quarry faces for another five years, with no deepening of the quarry floor. The next quarry deepening is anticipated to take place in 2015, when another bench level will be excavated to 235m AOD. The final development will see the quarry floor at 165m AOD.

The planned method of dewatering throughout the quarry life is sump pumping.

3.7 Regional Water Resource Status

Groundwater and surface water in the area is located within the Taff and Ely catchment and is managed by the EA as part of a Catchment Abstraction Management Strategy (CAMS) of the same name (EA, 2006). More specifically, the Penderyn area is located within Water Resource Management Unit (WRMU) 6 and Groundwater Management Unit (GWMU) 12. The current status of WRMU6 is “over-licensed” with a target status for 2016 of “no water available”.

According to the EA CAMS document (EA, 2006), the status of water resource in the Penderyn area can be summarised as follows:

“Current actual abstraction is such that no water is available at low flows. If existing licences were used to their full allocation they could cause unacceptable environmental damage at low flows. Water may be available at high flows, with appropriate restrictions.”

4 CONCEPTUAL HYDROLOGICAL MODEL

This step is equivalent to Step 2 in Box 2-1 and discusses the conceptual model derived for Penderyn. This conceptual model has been developed over the previous 14 years using monitoring data discussed in Section 6. It concentrates on the two main receptor sites identified in previous studies (SRK, 1997 [Ref 19]), but is equally applicable to receptors located more distant from the quarry.

A conceptual model of the site was first described in August 1997 (SRK, 1997 [Ref 19]), but this original model has been reviewed and, where applicable revised and updated every year since 1997, based on the results of annual monitoring. The result is a conceptual model that has been tested and adapted to a wide range of hydrological conditions ranging from very dry periods, such as October 1996 to September 1997 (1076mm) and very wet periods, such as October 2006 to September 2007 (2287mm). A discussion of previous and current monitoring and results is included in Section 6.

The model, shown in Figure 4-1, simplifies the hydrogeological regime at the SSSI into three layers:

- **The Surface Layer,** which consists of the rooting zone of the SSSI along with the drift immediately below this zone and which is in hydraulic continuity with the surface.
- **The Drift Layer**, comprising an intermediate layer between the surface layer and the underlying limestone; and
- **The Bedrock Layer,** which consists of a) the Cil-yr-Ychen Limestone under the western part of the SSSI which is a fault bounded and locally karstified formation, with moderate to high permeability along major discontinuities and correspondingly low permeability and storage within the intervening blocks, and b) the Millstone Grit under the eastern part of the SSSI which has indicated good hydraulic continuity with the limestone (SRK, 2003 [Refs 16. 17, 18]).

The limestone and Milltstone Grit aquifers respond rapidly to rainfall, with the hydrograph showing peaks corresponding to antecedent rainfall. The response is typical of a well-connected fracture-dominated aquifer. This notion is reinforced by the similarity in behaviour between hydrographs of the borehole and nearby River Cynon. The bedrock aquifer appears to be in direct hydraulic connection with the Nant Cadlan in the area to the west of the quarry, and this connection must have a high transmissivity.

The model assumes that lateral groundwater flow in the Bedrock Layer is controlled by the presence and distribution of faults and fractures in the bedrock. The potential exists for considerable volumes of groundwater to flow along such discontinuities, but equally for the same features to act as barriers to flow perpendicular to strike, especially where such features have been filled with clay gouge. The limestone in the area around Penderyn is heterogeneous and block faulted causing the groundwater regime to be compartmentalised. The Penderyn borehole is located in a different block to the quarry and buffered from the immediate effects of dewatering by proximity and connection to the River Cynon (see also Section 3.4).

Compartmentalisation of groundwater is demonstrated when comparing the falling groundwater levels observed at OB7 since 2000, with the unaffected water levels at OB5, just 300m to the west-southwest.

It has previously been postulated that the Dinas Fault, a major strike-slip fault forming part of the regionally important Neath disturbance (Figure 1-1), helps to buffer the bedrock and overlying SSSI to the north from the effects of dewatering in the Penderyn Quarry (SRK, 2003 [Refs 16, 17, 18]). To this end it is pertinent to note that during working of the southern quarry faces in the past few years many gouge-filled structures, approximately parallel to the Dinas fault, have been intersected and have caused operational difficulties due to their unstable nature. The crosscutting NNW-SSE joint sets that intersect the quarry appear to be fairly tight so far, although this condition has the potential to change if solution cavities are intersected during further quarry deepening.

The source of water supplying the Surface Layer and therefore supporting the SSSI vegetation is an important element to the model and the assessment of potential impact to the Cwm Cadlan SSSI.

Monitoring to date indicates that the SSSI is a surface water controlled regime strongly influenced by antecedent rainfall and soil moisture conditions. SRK therefore consider that the Cwm Cadlan SSSI is principally a surface water fed system with little or no direct recharge from the underlying limestone or Millstone Grit.

This assertion is supported by several lines of evidence, these are summarised as follows:

- Presence of thin locally continuous layers of impermeable clay just beneath the soil horizon. This clay layer means that the Surface Layer hydrology supporting the SSSI vegetation is likely to be perched above the drift, and largely confined to peaty surface soils except when the drift is penetrated by more coarse gravely material. In this regard, the extent of the surface catchment supplying the flushed areas, together with the lateral permeability of the surface soils, is instrumental in prolonging the supply of surface water draining to the flush, especially during periods of low rainfall. As the main vegetation communities are coincident with these lateral flushes, the loss of water through vertical drainage is not considered significant.
- Differences in the relative elevations of the water table in boreholes across the site tend to reinforce the notion that the near surface and deep groundwater regimes operate independently. At the eastern end of the site, limestone water levels are lower than those in the nearby surface sediments; this is clearly seen in OB8. Further west around OB9 and OB12, the limestone water level is above the water level in the overlying drift and surface sediments.

- There is a strong correlation between the water chemistry in the Surface Layer piezometers and the soils (collected within 0.15m of ground surface). The hydrochemical lines of evidence suggest that the water chemistry observed in the Surface Layer, particularly at the New SSSI ecological sites, is dominated by processes occurring within the shallow drift and surface soil system, coupled to the influence of antecedent rainfall as recorded by the hydrographs. SRK recognises that the drift will be heterogeneous, but the similarity of the Mg/Ca ratio at all ecological sites, regardless of underlying geology, and the presence of alkalinity sources in the soil suggest that similar processes are controlling water chemistry at each ecological site. One of the common features between the ecological sites is the blanket coverage of the underlying bedrock by drift deposits. Therefore, the source of the chemical signature observed in the Surface Layer water (indicating a limestone source) appears to be dissolution of limestone fragments hosted within the drift deposits, combined with the effects of mixing with rainfall, as suggested by the hydrographs and field observations. To support this conclusion, SRK has previously reported observing limestone clasts and boulders in parts of the drift during the installation of OB1, OB9, OB10 and P7. Additional evidence for limestone in the drift was obtained during the installation of replacement piezometer P15d through visual observation of limestone clasts, positive fizz tests with dilute (10%) hydrochloric acid, and analysis of sediment from three depths for pH, Ca, Mg, SO4 and alkalinity.
- January to July 2010 was very dry with only relatively small and short-lived rainfall events occurring. These events were ineffective at recharging the Drift and Limestone Layers and consequently the recession of water levels over the spring months was long and uninterrupted. The water levels in the Shallow Layer, however, remained above ground level and similar to winter levels for the most part of the spring, despite falling water levels in the underlying drift and limestone. From mid May, the typical “summer low” occurred where water levels in the Surface Layer fall consistently below ground level and become far more sensitive to individual rainfall events. This “summer low” for the most part continues even after the onset of unseasonably high rainfall from July to the end of September, despite the gradual but consistent recovery of water levels in the limestone and drift during this period. This would suggest that:

  a) the Shallow Layer is hydrologically quite independent from the underlying drift and limestone; and
  b) the water levels in the SSSI can be maintained with small rainfall events (which are not sufficient to maintain the water levels in the drift or limestone) and the “summer low” is most likely to be the result of soil drying due to both higher summer temperatures as well as reduced rainfall.

There are, however, two potential areas of the SSSI where limestone sourced groundwater may contribute to moisture in the Surface Layer. These are located:

- To the south of the Nant Cadlan in the Old SSSI (around OB1 and OB2) where there is underlying limestone bedrock and where there may be upward / lateral flow of limestone-sourced groundwater through the shallow drift and emergence as surface issues.
- Just north of the north-eastern quarry boundary around OB8 and OB10, where the Surface Layer could receive contributions from the adjacent weathered limestone outcrops to the south / southeast; these are topographically higher than the ecological sites. There are two springs that rise in this area along the approximate break of slope most likely associated with the Dinas fault and that emerge through the drift; these are respectively, just to the north (distance: approximately 90m) and west (distance: approximately 300m) of OB10 and pass into a stream that flows through the old SSSI immediately adjacent to the quarry (Figure 1-1).

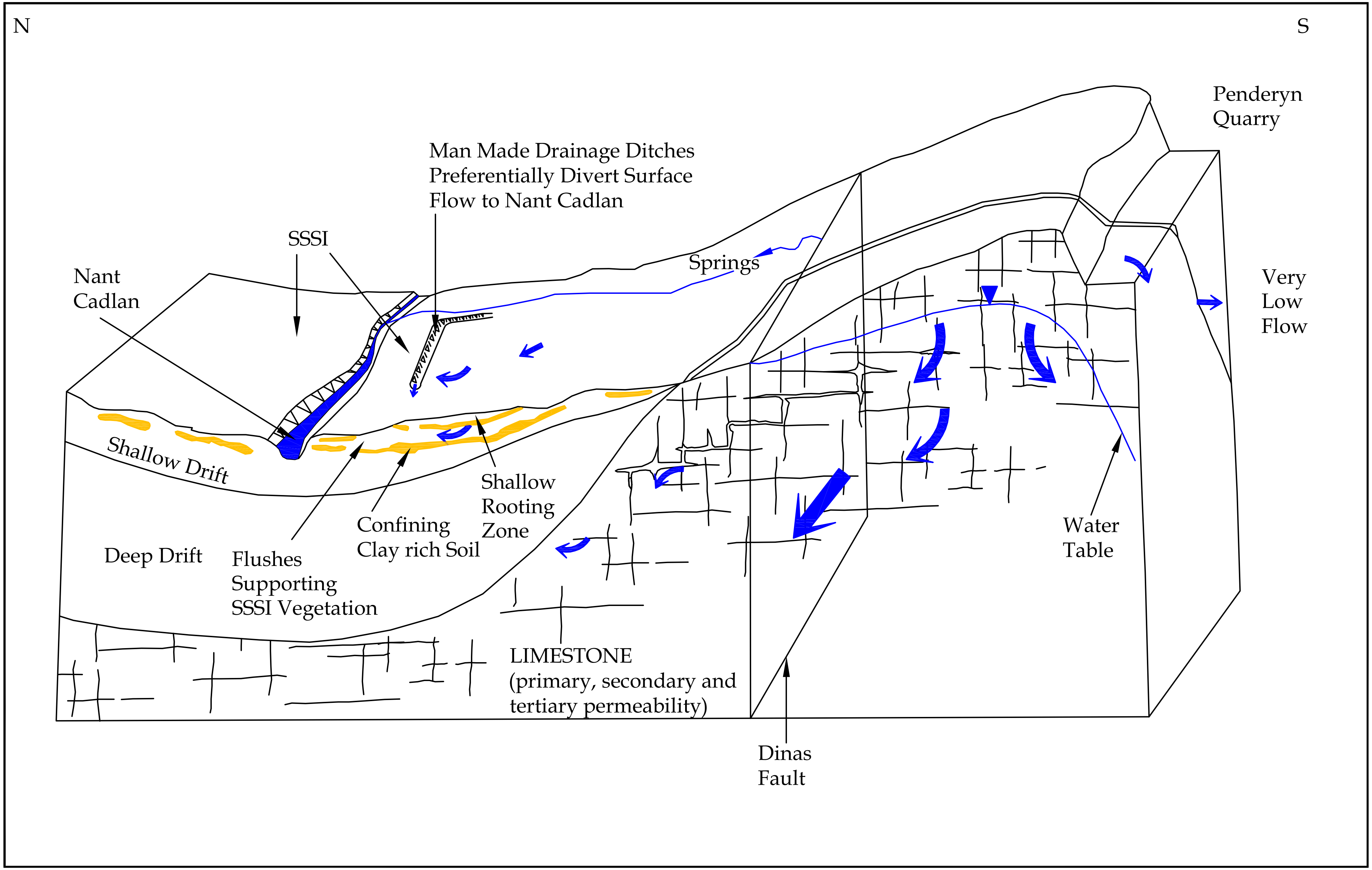
However, in respect of the second point above, flow in both springs is perennial and largely confined to well-defined channels that provide little opportunity for water to disperse over adjoining pastures. Although there is a possibility that declining water levels in the limestone brought on by drier summers may impact on flows in these springs, the springs themselves are not thought to sustain the SSSI floral communities. Most of the boggy ground and ponding (flushes) is upslope of the springs and the majority of the plant communities are located some distance away from these sources. Furthermore, a sampling exercise undertaken by SRK in 1998-1999 at Ecological Survey Site 12, to the south of the property known as Wernlas, was able to establish that the chemistry of the spring was very different in character to the water collected at the vegetation survey site. There have also been numerous field drains installed over the years that also serve to direct portions of surface flow away from the ecological sites, though some of these drains are now being filled in by CCW as part of their management plans for the SSSI. The main features of the conceptual model for areas in the SSSI that could potentially be influenced by limestone sourced groundwater are illustrated in Figure 4-1.

The quarry sump is currently about 20m below the surrounding groundwater table; therefore some pumping must be expected. As part of a water balance undertaken by SRK for the Nant Cadlan Catchment (see SRK, August 1997), SRK concluded that a likely maximum groundwater discharge from the quarry of 4.5 Ml/day would constitute about 14% of the total catchment output of 32 Ml/day (long-term average value), but that this loss would be partly mitigated by the return of pumped water back in to the Nant Cadlan, which is known to recharge the underlying aquifer. However, actual pumping from the quarry sump pump i.e. the amount of both surface run-off and groundwater inflow is consistently well below 4.5 Ml/day and generally around 2% of catchment output.

SRK consider that surface processes, rather than lateral limestone groundwater recharge processes are the predominant mechanism for sustaining the SSSI. This observation is reinforced by water level monitoring in the SSSI Surface Layer and underlying drift and limestone over the most recent annual monitoring period (October 2009 to September 2010).

Therefore we conclude that, based on the conceptual understanding of the hydrological system at the SSSI, as well as flow data from the quarry that demonstrates that only a very small amount of dewatering is occurring from the limestone, the risk of any impacts from quarry dewatering is currently low.

As the quarry continues to deepen it is inevitable that more groundwater will flow to the sump and that pumping as a proportion of the total catchment budget will increase. SRK advocate, however, that the risks to the SSSI will remain low even as quarrying progresses due the buffering influence of the Dinas fault and due to the minimal hydrological connection between the SSSI Surface Layer and the Limestone Layer.



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SRK Consulting Engineers and Scientists		Simplified Conceptual Cross-section of SSSI Underlain by Limestone	Fig 4.1

5 SENSITIVE SITES

This step is equivalent to Step 3 of the HIA methodology outlined in Box 2-1, where water dependant features susceptible to flow and drawdown impacts are identified. Defining the search area for such features in a fractured aquifer, especially karst, is very difficult due to the unpredictable nature of groundwater in such an environment (EA, 2007 [Ref 8]). Therefore, the search area has been guided by the conceptual model and knowledge gained over 14 years of site monitoring.

Potentially sensitive sites in the vicinity of Penderyn quarry are shown on Figure 5-1 along with a nominal radius of 2.5km from the quarry sump.

- Cwm Cadlan SSSI (which is also a Special Area of Conservation under EC Directive 92/443/EEC) and other SSSI sites also managed by CCW (Dyffrynoedd Nedd A Mellte A Moel Penderyn, Cors Bryn-Y-Gaer and Woodland Park and Pontpren);
- Public Water Supply (PWS) abstraction borehole belonging to Dwr Cymru Cyfyngedig (Welsh Water) – Licence No. 21/57/23/60; and
- An unlicensed private abstraction borehole belonging to The Welsh Whisky Co Ltd.

The SSSI and the Public Water supply are considered by the Relevant Parties to be the most sensitive sites to potential impact and by focussing the SoW on the protection of these two sites it is considered that the other more distant sites will be adequately protected by default – see 7.2.3 below.

The unlicensed abstraction borehole belonging to The Welsh Whisky Co Ltd. was drilled in 2000 into the Carboniferous Limestone aquifer and is limited to a relatively minor 20m3/day (the current limit for unlicensed abstractions). The Welsh Water PWS borehole is located approximately 560m to the south and also abstracts from the limestone. This borehole is licensed to abstract up to 1,136,500m3/year or 4,046m3/day. Although the Welsh Water PWS borehole has not been used since early 1997, it remains a potential water source.

A monitor and mitigate approach has been adopted for protection of sensitive sites from potential impacts from dewatering at Penderyn quarry. This approach has been accepted by the Relevant Parties. Although monitoring to date has focussed on protection of the Cwm Cadlan SSSI and the Welsh Water borehole as the most sensitive sites to potential impact, monitoring at Penderyn is also designed to detect any changes to the hydrological regime that might have the potential to impact some of the less sensitive sites.

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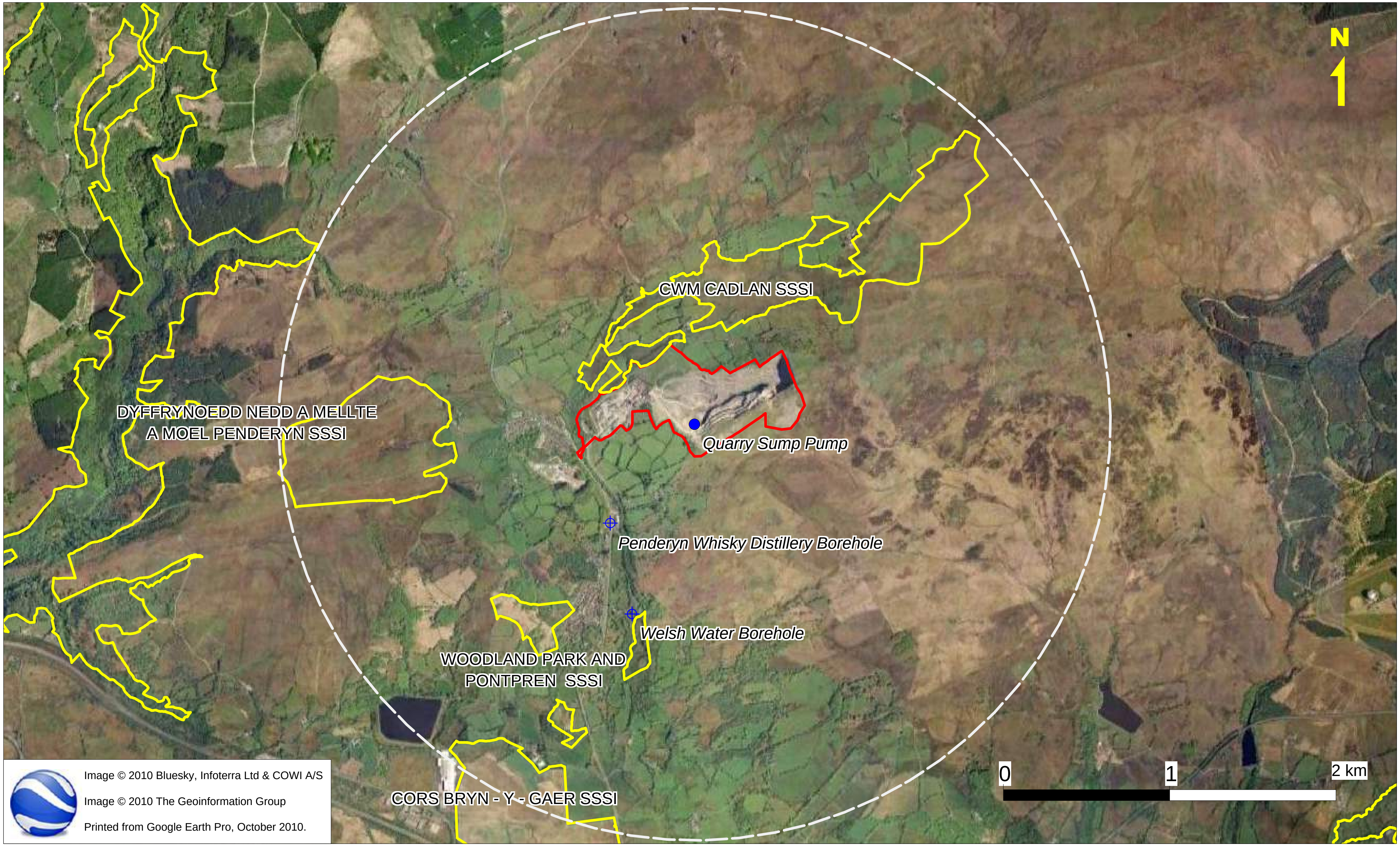

January 2011	PROJ. No: U4138	PENDERYN ROMP HIA	
SRK Consulting Engineers and Scientists		Potentially Sensitive Sites in the Vicinity of Penderyn Quarry	Figure 5-1

6 GROUNDWATER AND SURFACE WATER MONITORING AND ANALYSIS

6.1 Introduction

Preliminary monitoring (step 4, Box 2-1) was instigated at Penderyn quarry in 1996 as part of a background survey required as a pre-requisite to the approval of the SoW. The system comprises a combination of automated water level logging and manual water level measurements in boreholes and piezometers screened[1] in each of the layers discussed in the conceptual hydrological model (Section 4). Details of the monitoring system specified in the SoW as approved in 1998 are included in Appendix A.

At various points in the past 14 years the scope of monitoring outlined in the original SoW has been altered, either with an increase in monitoring in some critical areas (such as the installation of OB11 and OB12 in 2003/2004) or a decrease in monitoring (such as in July 2010 where monitoring was suspended in areas which are unlikely to be affected by dewatering prior to the next quarry deepening). Where any changes to the monitoring system specified in the SoW have occurred, it has taken place with the full agreement of the Relevant Parties.

It is not within the scope of this report to outline the exact details of the monitoring system and how it has changed over time, nor is it the purpose to provide a detailed description of all results since 1996. Instead, the following section provides an overview of the past and current monitoring system and the key responses and trends observed at pertinent locations since 1996.

[1] *The screened interval of a borehole or piezometer is the interval over which the hole is open to groundwater ingress from the surrounding geological formation(s). All of the installations at Penderyn are sealed with a bentonite seal above the screened interval, which means that groundwater flowing into the hole and/or water levels measured in the hole reflect only the hydrogeological conditions in the geology over which the hole is screened and are not influenced by the conditions in the overlying geology.*

6.2 Monitoring Details

Figure 1-1 shows the location of all monitoring locations used since monitoring began in 1996. Figure 6-1 shows only the hydrological monitoring locations that are currently being used, following the recent revisions to the monitoring system. Monitoring boreholes and piezometers have been attributed various letters to help differentiate between their depth and position.

- Observation boreholes in the drift and limestone are prefixed by the letters ‘OB’.
- Where an observation borehole (OB) name is followed by the letter ‘a’, the borehole monitors water levels in the Bedrock Layer, while a letter ‘b’ indicates monitoring of water levels in the overlying Drift Layer.
- Piezometers in the Surface Layer of the SSSI sites are prefixed by the letter ‘P’.
- The use of letters to denote different piezometers does not indicate the same lithology, but instead reflects different piezometers at a single SSSI monitoring location such as P3a, P3b, P3c at ecological site 3; and the letter ‘L’ following a sample site name indicates the site contains a data logger, such as P3d (L) and this position is not sampled for water chemistry.

Detailed lithological logs were taken during the drilling of the monitoring system in order to better interpret the monitoring results and to define the conceptual model. These are included in Appendix B.

Rainfall is continuously monitored using automated gauges positioned in the old SSSI near OB2, and at the quarry near the site office. Both locations are shown on Figure 6-1.

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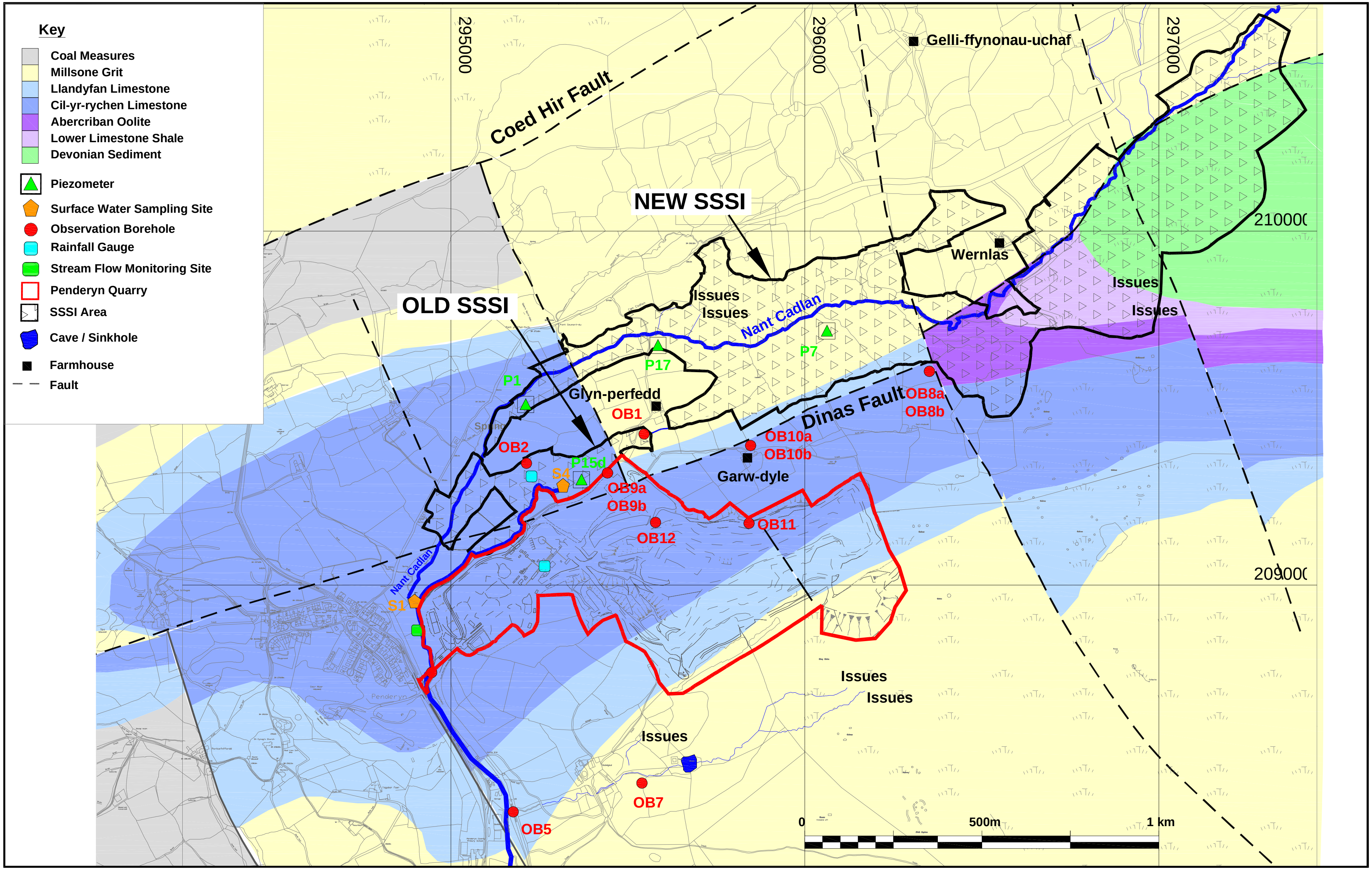

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Site Plan Showing Ongoing Hydrological Monitoring Locations

Figure 6.1

6.3 Water Level Monitoring in the Bedrock Layer

6.3.1 Equipment Summary

Up to July 2010, groundwater levels were monitored in the limestone bedrock ('Bedrock Layer') in seven boreholes (OB5, OB7, OB8a, OB9a, OB10a, OB11 and OB12). OB7 is in fact screened both in limestone and Millstone Grit. In July 2010, automated water level monitoring at OB5 and OB12 was suspended until at least the next quarry deepening and replaced with manual measurements.

6.3.2 Results and Analysis

Table 6-1 outlines the typical responses observed in each of the monitoring location screened in the limestone or limestone and Millstone Grit. Hydrographs for these boreholes from the start of monitoring until present are included in Appendix C.

Table 6-1: Summary of hydrograph behaviour in the Bedrock Layer

Borehole	Typical Historical Behaviour
OB5	• Hydrograph shows rapid response to rainfall (<1 day) with sharp peaks and steep recession curves, characteristics that suggest high hydraulic conductivity (K) at this locality. • Base level of hydrograph (~215mAOD) supports notion of at least one major feature associated with this borehole at this level. • Strong correlation with nearby River Cynon hydrograph.
OB7	• OB7 is screened in both limestone and Millstone Grit. • WL has declined in OB7 since significant sump pumping began in second half of 1999. • WL has two distinct and contrasting episodes of behaviour. Before 22/09/99, WL variation due to rainfall was negligible (0.08 m); after this date, it began to fluctuate significantly (3.18 m) and became very sensitive to rainfall. • Onset of water level (WL) fluctuations at precisely the time significant sump pumping began proves good connection with the quarry some 700 m away. • Emergence of erratic WL fluctuations may indicate change in the Storage properties of the limestone aquifer near OB7. Limited variation in WL before pumping was probably due to the dampening effect of a cavity intersected below the water table (WT) when drilling OB7. • WL decline has levelled off since 2007. The quarry has not been deepened since this date and so it would seem that a further reduction in water levels will not occur until at least the next quarry deepening.
OB8a	• Time between rainfall and peaks on hydrograph is usually <2 days. • Response to recharge events is similar to OB8b in the deep drift, which suggests the two lithologies are fairly well connected at this location. • Limestone piezometric surface has been consistently ~0.5 m below that of the overlying drift, indicating a potential for downward flow from the drift to the limestone.

Borehole	Typical Historical Behaviour
OB9a	• Response to recharge is very similar, although not identical, to OB9b in the deep drift, which suggests the two lithologies are fairly well connected at this location • Lag time between a rainfall event and the peak in the limestone hydrograph is usually less than a day • Response to rainfall in the limestone usually precedes that of the deep drift (OB9b) by a day. • The limestone piezometric surface was consistently above that of the drift prior to Sept. 2000 (by up to 0.1 m), but was then periodically exceeded by the head in the drift until mid-2003. However, since 2003 water levels have reverted to the old pattern of behaviour. It is assumed from these observations that the screened interval was blocked for a time.
OB10a	• Piezometric surface in the limestone generally reacts more slowly to rainfall events (3-5 days) than WL in the shallow drift (1-3 days; see OB10b). • Piezometric surface in the limestone has been consistently below (by 8 – 10 m) that of the shallow drift since installation in 1997, so that potential exists for recharge waters to migrate down to the limestone from the drift. • Hydrograph of OB10a shows greater fluctuation in WL than OB10b.
OB11	• WL monitoring commenced on 20/06/03. • Hydrograph behaviour is very different to its predecessor (OB3) but similar to OB5 with rapid response to rainfall. • WL has fluctuated by up to 18 m since monitoring began. However, this volatility and range in WL variation has become more attenuated since the start of 2005. • Hydrogeological characteristics suggest the borehole has intersected a conduit-like feature with high conductivity and low storage characteristics.
OB12	• WL monitoring commenced on 01/11/04. • Response is very similar to OB11, with a very rapid response to rainfall. • WL has fluctuated up to 6 m since monitoring began. • Hydrogeological characteristics suggest the borehole has intersected a conduit like feature as at OB11.

Based on the information obtained from the hydrographs of the boreholes in Table 6-1, several key conclusions can be drawn:

- A marked "summer low" was evident in 2010 due to a dry first 6 months of the year. As a result the water level in the Limestone Layer was significantly reduced during the first half of the summer and water levels at many locations were at their lowest since monitoring began.
- With the exception of borehole OB7 none of the monitoring locations in the Bedrock Layer have shown a discernable change in water level or response type from the baseline conditions prior to 2000 and therefore no discernable response to the long-term effects of dewatering of groundwater. The water levels in OB7 seem to have stabilised and even recovered slightly since 2007. Although, in the 2006/2007 annual report (SRK, 2007 [Ref 19]) it was suggested that borehole OB10a might have begun to show some evidence of a limited decline, this seems to have been chiefly due to a very dry summer and no sustained decline has been observed since.

- Water levels in all limestone observation boreholes respond positively to rainfall with variable lag times, typical of a system exhibiting conduit flow.
- The head of water in the limestone at Borehole OB10 is typically some 4 - 10m below that of the drift. Historically, it has remained at least 1m below the drift/limestone contact. By contrast, the head of water in the overlying drift has always been 2m or more above this contact. The difference in water level elevation between these two formations serves to show that the groundwater regime in the overlying drift is perched and quite separate from the one that resides in the underlying limestone. The overlying drift continues to show no effects due to dewatering.
- The head of water in the limestone at Borehole OB9 is generally at or above that of the drift indicating little opportunity for vertical drainage of groundwater from the drift to the limestone, but with the possibility of recharge from the limestone to the drift.

6.4 Water Level Monitoring in the Drift Layer

6.4.1 Equipment Summary

Up to July 2010, groundwater levels were monitored in:

- two boreholes located in the 'Old SSSI' (OB1, OB2) which record water levels in the shallow superficial glacial deposits ('Shallow Drift');
- three boreholes located in the 'Old SSSI' (OB8b, OB9b and OB10b) which record water levels in the deep superficial glacial deposits ('Deep Drift'); and

In July 2010, automated water level monitoring at OB10b was suspended until at least the next quarry deepening and replaced with manual measurements.

6.4.2 Results and Analysis

Table 6-2 outlines the typical responses observed in each of the monitoring points located in the Drift Layer. Hydrographs for these boreholes from the start of monitoring to present are included in Appendix C.

Table 6-2: Summary of hydrograph behaviour in the Drift Layer

Borehole	Typical Historical Behaviour
	Shallow Drift
OB1	• WL is within 0.15 m of ground surface for most of the year and only falls significantly below after prolonged dry spells. • WL rarely rises above ground surface, even after periods of heavy rain, which implies surface control and unconfined conditions. • Hydrograph response time to rainfall events is <1 day.
OB2	• Behaviour in OB2 is very similar to OB1 with a WL that fluctuates within 0.2 m of ground surface for most of the year. Rapid response times to rainfall and evidence of periodic control by a discharge point near the borehole also indicate a close link with the surface water system. • However, the tendency for WL to occasionally break from the influence of this discharge feature suggests that it is not persistent and possibly bedded between less conductive soils. This reinforces the notion of a drift with highly variable physical properties.
	Deep Drift
OB8b	• See Table 6-1.
OB9b	• See Table 6-1.
OB10b	• See Table 6-1. • WL is strongly influenced by surface recharge and appears to be controlled by a discharge point at 287m AOD. The latter suggests some independence from the underlying limestone. Certainly, the connection is likely to be weak because the constant pressure signature does not appear to be translated to the limestone.

Based on these responses, four key observations can be made:

- Water levels in all drift observation boreholes respond positively to rainfall with variable lag times;
- Low rainfall in the first 6 months of 2010 has resulted in lower than average water levels in the Drift Layer, as has been observed in the limestone;
- Water levels and responses in the Drift monitoring boreholes have not discernibly changed from the baseline conditions and there is therefore no evidence of quarry sump pumping having impacted on water levels in the drift;
- There is no indication of significant change in the potential for drainage from the drift to the underlying limestone.

6.5 Water Level Monitoring in the Surface Layer

6.5.1 Equipment Summary

Water levels in the Surface Layer of the SSSI are automatically recorded and manually checked at ecological sites 1, 3, 7, 15, 16, 17, and 18 using loggers located approximately 1.5 metres below ground level (mbgl).

In July 2010, water level monitoring at P3 and P18 was stopped permanently and suspended at P16.

6.5.2 *Results and Analysis*

Table 6-3 outlines the typical responses observed at each of the monitoring location screened in the Surface Layer. Hydrographs for these boreholes from the start of monitoring to present are included in Appendix C.

Table 6-3: Summary of typical hydrograph behaviour for the Surface Layer

Site	Typical Historical Behaviour
P1	• WL remains above ground surface (258.46m AOD) for most of the year except for during the summer months, indicating connection to a nearby constant pressure source and probable temporary confining conditions. • When WL is above ground, it has generally been near constant and insensitive to rainfall events. • When WL drops below ground surface it becomes more sensitive to rainfall events, with sharp peaky responses. • P1a was replaced by P1c in April 2003.
P3	• Responses are similar to P1a, and have remained above ground for the majority of the time indicating probable temporary confining conditions. • P3b was replaced by P3d during June 2002.
P7	• WL has regularly fluctuated between confined and unconfined conditions and is very sensitive to rainfall. • P7 was replaced by P7a in April 2003.
P15	• WL coincides with and is controlled by the elevation of the ground surface. When WL drops below ground surface, fluctuations in the hydrograph become more pronounced, as the water available from storage in the soil is much reduced. • P15c(L) was replaced by P15d(L) in June 2004.
P16	• WL at P16 and P17 behave in a similar way to P7. • P16 was replaced by P16a in April 2003. The water level at this locality is now rarely above ground level.
P17	• P17 was replaced by P17a in April 2003. Again, the character of the local groundwater regime at this locality is noticeably different since it's replacement in 2003, with Wl now generally below ground level.
P18	• P18 was replaced by P18a in April 2003. • WL has been predominantly below ground surface for both P18 and P18a, since installation in 1998. Only rarely has the piezometric level risen above ground surface. During these times, the volatile nature of the hydrograph in response to rainfall events indicates that the shallow water system is periodically confined and controlled by a constant pressure feature a short distance from the hole.

Based on this assessment, the following conclusions can be drawn:

- Water levels in all areas of the SSSI show no affects that are considered to be related to dewatering at the quarry sump;
- Water levels in the surface layer are strongly influenced by antecedent rainfall (especially dry periods) and indicate that the surface layer is governed by direct recharge to, and drainage and evapotranspiration from a shallow soil system;
- The impact of low rainfall on water levels in the surface layer in the winter/spring of 2010 appears to be significantly less accentuated than in the underlying limestone and water levels in the surface layer during this period remained akin to previous years. This significant difference in long-term response to long-term rainfall is an important point which further suggests that water levels in the shallow soils in the SSSI are not controlled by recharge from the underlying limestone.
- Hydrographs since 2003 show that water levels have tended to fall below ground level more frequently than in earlier years. Heavy rainfall separated by abrupt dry periods is a phenomenon that appears to be much more common than pre-2007, particularly in summer, and therefore this observation is considered to be attributable to a change in rainfall patterns.

6.6 Nant Cadlan Flow Monitoring

6.6.1 Equipment Summary

River stage at the Nant Cadlan (River Cynon) is automatically logged at a culvert (Figure 1-1) where it passes the quarry entrance. A stage-volume relationship has been developed for the cross-sectional area at this location in order that river flow can be calculated from the stage measurements. Manual checks are also made at a staff gauge in the same location on a bi-monthly basis.

6.6.2 Results and Analysis

Flow records for the Nant Cadlan are presented in Appendix E. The stream shows a flashy response to rainfall events, as would be expected in such a catchment. No discernible changes in the hydrograph have been detected since monitoring began in 1997.

6.7 Penderyn Borehole

6.7.1 Equipment Summary

Water levels are downloaded at the Penderyn borehole on a monthly basis by Hydrologic, who manage the data on behalf of Welsh Water.

6.7.2 Results and Analysis

The Penderyn Borehole is dependent on the groundwater in the limestone aquifer for its supply. Although this borehole has not been used since early 1997, it remains a potential water source and, as such, could be at risk from quarry dewatering.

Hydrographs showing the Nant Cadlan at the culvert and Penderyn Borehole are presented in Appendix E.

The Penderyn borehole water level responds rapidly to rainfall, with the hydrograph showing peaks corresponding to antecedent rainfall. During the current monitoring period, the base water level during the winter months remained between 215.5 and 216m AOD.

The borehole continues to show that it is highly responsive to rainfall events and that it exhibits traits that are typical of a well-connected fracture-dominated limestone. This notion is reinforced by the similarity in behaviour between hydrographs of the borehole and nearby River Cynon.

6.8 Hydrochemistry

6.8.1 Sampling Undertaken

Water samples are taken from a selection of boreholes and piezometers bi-annually – in May and September. All samples are tested in the field for a range of physio-chemical parameters. The samples taken in May are analysed in the laboratory for Ca and Mg and the samples taken in September are analysed for a comprehensive suite of inorganic determinants. Full details of sampling protocol, locations and determinants as well as results for all samples since monitoring began are included in (SRK, 2010 [Ref 21]). Sampling was undertaken from 1997 in order to build a baseline data set against which samples taken after 2000 could be compared.

Mg-Ca ratios are calculated for both May and September analyses as a primary indicator of water source, especially where groundwater originating from limestone sources is concerned. A change in Mg/Ca may indicate a change is the source of groundwater to a particular sampling point.

6.8.2 Results and Analysis

Although hydrochemistry has varied outside of the baseline values since 2000 for many of the determinants, including Mg-Ca ratio, no consistent trends have been observed that indicate a change in groundwater or surface water flow regimes.

7 RISK OF HYDROLOGICAL IMPACTS

7.1 Introduction

Steps 5 to 8 in Box 2-1 require the assessment of trigger levels and development of mitigation measures should ongoing surveillance deem such measures necessary. As already discussed in Section 2, no specific trigger levels for mitigation measures have been or will be set for Penderyn Quarry, as it has been decided between the Relevant Parties that any significant trend in change from the baseline conditions (acquired prior to quarry deepening below the regional groundwater level) should be considered on an individual basis should the need arise.

The following section, therefore, reviews the sites identified in Section 5 and provides a qualitative assessment of risk from hydrological impacts.

As discussed in Section 2, a ‘monitor and mitigate’ approach has been taken towards hydrological impact assessment at Penderyn quarry and as such no quantative predictions of impact, either physical or chemical, have been made. The approach relies instead on a robust conceptual model based on long-term monitoring results and ongoing indicator monitoring in order to detect any impacts early that would allow the instigation of appropriate mitigation measures before significant negative impacts could occur.

7.2 Risk Assessment

7.2.1 Cwm Cadlan SSSI

Risk:

Impact on hydrological input to the SSSI, resulting in unfavourable conditions specifically for two plant communities, the M10 carex dioica – Pinguicula vulgaris mire and the M24 Molinia caerulea – Cirsium dissectum fen.

Key Stakeholders:

CCW

Assessment:

Based on the current conceptual model, it can be concluded that the vegetation communities in the SSSI area to the north of the Nant Cadlan are not at risk from quarry dewatering, as there is no possibility of recharge of limestone groundwater to the surface layer. This has been agreed by CCW (CCW, 2009).

Although the possibility exists that limestone groundwater could be recharging the SSSI to the south of the Nant Cadlan, the lines of evidence outlined in Section 4 suggest that surface water processes, rather than lateral limestone groundwater recharge processes are the predominant mechanism for sustaining the SSSI. Furthermore, the Dinas fault appears to provide a hydraulic barrier between groundwater abstraction at the quarry sump and groundwater under the SSSI. Therefore, SRK would conclude that the risk to the SSSI from dewatering is low, and will remain so even as the quarry continues to deepen and flow to the sump as a proportion of total catchment output increases. Moreover, any risk will be further reduced by the presence of ongoing hydrological monitoring as an early warning for any potential hydrological changes in the Surface Layer at the SSSI. Thus, the present approach to monitoring at the site coupled with the procedures for resolving change as defined in the SoW (Section 7.2.4) are considered entirely adequate for limiting the risk of impact on the Cwm Cadlan SSSI.

7.2.2 Welsh Water Borehole

Risk:

Derogation of water levels at the Welsh Water PWS abstraction borehole leading to increased pumping costs.

Key Stakeholders:

Welsh Water, the interests of whom are represented by the EA.

Assessment:

The quarry sump is currently about 20m below the surrounding groundwater table. As part of a water balance undertaken by SRK for the Nant Cadlan Catchment (SRK, 1997), SRK concluded that the total catchment output is around 32 Ml/day (long-term average value) and that abstraction from the sump would be partly mitigated by the return of pumped water back in to the Nant Cadlan, which is known to recharge the underlying aquifer. Actual pumping from the quarry sump pump since 1996 (which includes both surface run-off and groundwater components) has never exceeded 0.9 ML/day averaged over the year (highest to date recorded in 2006/2007 monitoring period) which represents less than 3% of the catchment water budget. The present rate of pumping is not therefore impacting the groundwater resource on which the unused Penderyn Borehole is dependent. This is demonstrated by an absence of decreasing water levels at OB5.

Unless the rate of sump pumping increases radically, the risk of quarry dewatering impacting the regional groundwater resource is low. It is not known how the quarry dewatering volumes will increase with quarry deepening although it is inevitable that more groundwater will flow to the sump and that pumping as a proportion of the total catchment budget will increase. However, dewatering volumes are unlikely to represent a significant portion of the catchment budget unless several significant groundwater flow features are intersected. Moreover, monitoring at the site coupled with the procedures for resolving change as defined in the SoW (Section 7.2.4) are again considered to be entirely adequate for limiting the risk of impact on the Welsh Water PWS borehole.

7.2.3 Other Sites

SRK consider the Cwm Cadlan SSSI and the Welsh Water borehole as the most sensitive sites to potential impact. This assertion has been accepted by the EA, CCW and BBNP since liaison regarding dewatering operations began. However, monitoring at Penderyn is also considered appropriate for the early detection of any changes to the hydrological regime surrounding Penderyn quarry before they have the potential to impact any of the less sensitive sites mentioned in Section 5.

7.2.4 Monitoring and Mitigation

The existing monitoring network summarised in Table 7-1 below (locations shown on Figure 6-1), coupled with the procedures for interpreting change as defined in the SoW (Section 7.2.4) is deemed adequate for protection of sensitive sites until the next quarry deepening scheduled for 2015.

Table 7-1: Summary of existing monitoring network at Penderyn quarry

Conceptual Model Layer	Monitoring Location Ids
Shallow Layer	Automated 3-hourly WL monitoring: P1, P7, P15 and P17 Bi-monthly manual dips: None Bi-annual chemistry: P1, P7 and P15
Drift Layer	Automated 3-hourly WL monitoring: OB1, OB2, OB8b and OB9b Bi-monthly manual dips: None Bi-annual chemistry: OB2, OB9b and OB10b
Bedrock Layer	Automated 3-hourly WL monitoring: OB7, OB8a, OB9a, OB10a, OB11 Bi-monthly manual dips: OB5, OB10a and OB12 Bi-annual chemistry: OB7, OB9a, OB10a and OB11
Surface Waters	Bi-annual chemistry: S2 and S4

At the next quarry deepening phase, locations at which monitoring was temporarily suspended in July 2010 (OB5, OB10b, OB12, P12, P16, and S6) will need to be re-assessed and re-commissioned where required. However, no change to the established approach of monitoring and mitigation will be necessary. This process will take place in liaison with all key stakeholders. SRK suggests that only the re-commissioning of OB5 would be required to produce a monitoring system that could adequate detect changes from the next quarry deepening to the final quarry design.

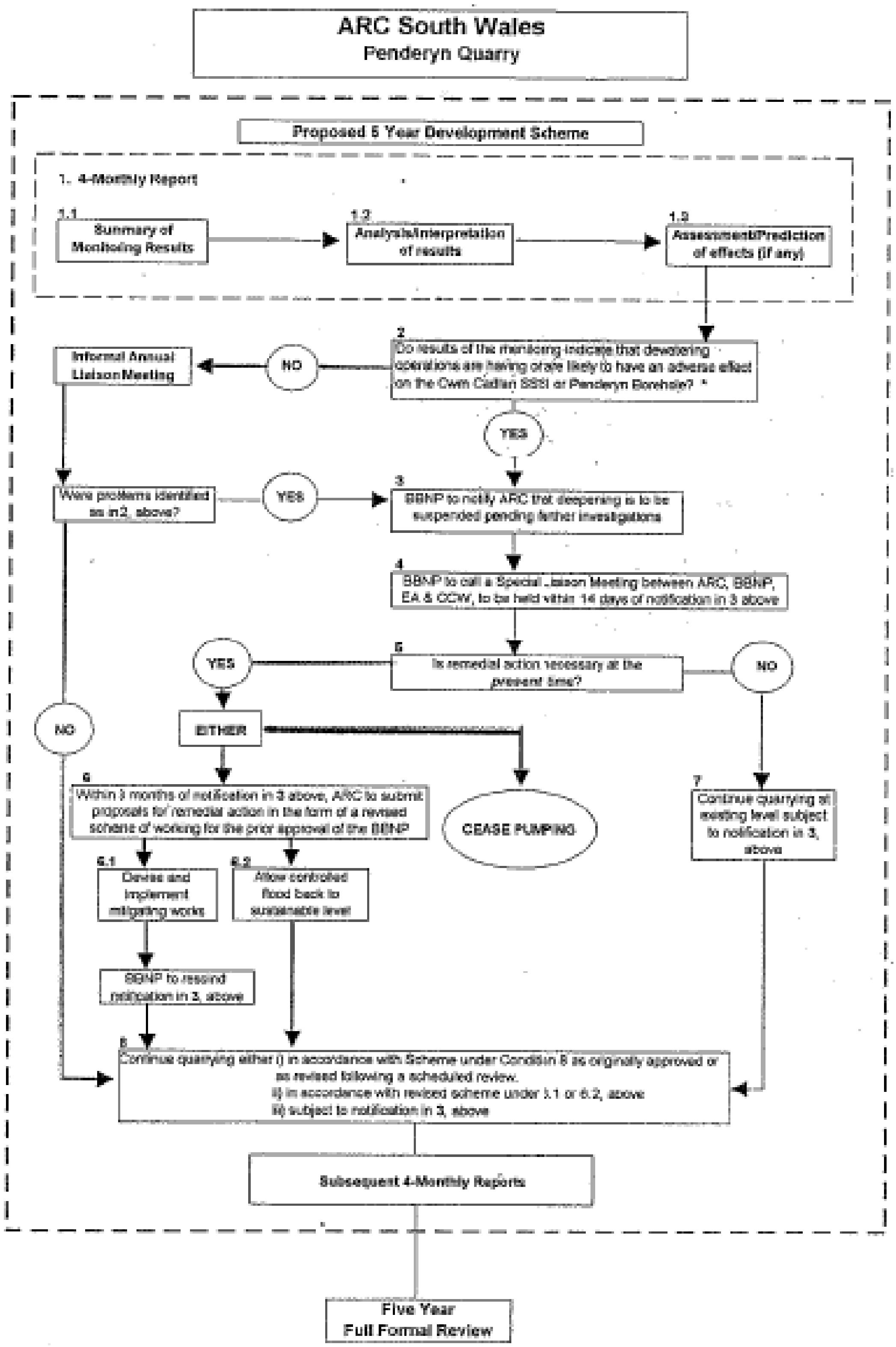
Data from the monitoring system are reviewed by the Relevant Parties on an annual basis to check for trends or changes that might represent a pre-cursor to negative hydrological impacts on the surrounding sensitive sites. In the event that significant changes in the hydrological regime are detected, the mitigation implementation procedure is outlined in Figure 7-1. It should be noted that any requirement for the implementation of mitigating action as a result of hydrological changes in the SSSI which result from quarry dewatering should be accompanied by clear evidence for a risk of an accompanying adverse change in the vegetation communities, as revealed by the two yearly ecological surveys.

The SoW states that deepening of the quarry must be suspended if the results of the monitoring indicate that dewatering operations at the quarry are having or are likely to have an adverse impact on either the Cwm Cadlan SSSI or the Penderyn Borehole. There is then provision for a "Special Liaison Meeting" to be called between the Relevant Parties to decide whether remedial action is required. If action is required then Hanson should provide proposals for a remedial solution within 3 months of notification to cease deepening. The SoW provides 3 likely alternatives for remedial action:

- Continuation of quarrying with appropriate mitigating measures e.g. augment supply to plant communities or recharge aquifer;
- Controlled floodback of the quarry; or
- Cessation of dewatering operations allowing aquifer levels to return to normal.

In relation to Box 1 of Figure 7-1 it should be noted that this indicates the arrangements within the SoW, as originally approved, for interpretive reports to be prepared and circulated to the relevant parties at four monthly intervals, with ecological survey reports in the SSSI to be prepared annually. Owing to the current perception of low risk, at least until the next phase of quarry deepening, hydrological reports are supplied at six monthly intervals, comprising an interim report supplied in May and a full annual report in December, with ecological survey reports prepared every other year. This change in the scope of reporting has been agreed by the Relevant Parties in stages at various previous ALMs.

Figure 7-1: Mitigation procedure in the event of detection of significant hydrological changes at the Cwm Cadland SSSI



*** NB**

(a) A YES answer will result from the question posed in Box 2 above in the event of the Ecological Trigger Level described in sub-section 7.3.6 being exceeded
(b) A YES answer to Box 2 as a result of the Ecological Trigger Level being exceeded shall not prejudice the answer to the question posed in Box 5

8 CONCLUSIONS

A Hydrological Impact Assessment (HIA) has been undertaken as part of a Review of Old Minerals Permissions (ROMP) for Penderyn quarry. The site conceptual model has been reviewed and updated based on monitoring results from 1996 to date.

Due to the presence of conduit flow in the bedrock aquifer underlying the site (including some solution enhanced/karst features), a monitor and mitigate approach has been adopted.

Sensitive sites that might potentially be affected by detwatering operations in the quarry have been identified. Out of these sites, the Cwm Cadlan SSSI and Welsh Water PWS are considered the most sensitive to potential hydrological change at the quarry. Based on the monitoring results since 1996 and updated conceptual site model, **the current risk to identified sensitive sites is low as**:

- The Cwm Cadlan SSSI has been shown to be a mainly surface water dependent system which is for the most part hydrologically independent to the underlying bedrock. The hydrological separation of the SSSI and underlying drift and limestone has been particularly demonstrated in monitoring results from 2010.
- The limestone underlying the SSSI appears to be hydraulically buffered from quarry dewatering operations by the gouge filled Dinas fault.
- The current rate of sump dewatering represents a very small percentage of the overall budget for the Nant Cadlan catchment which suggests that the present rate of pumping is not impacting the groundwater resource available to the Penderyn Borehole.
- Based on the above observations, the current risk to the SSSI and groundwater resources at Penderyn is low.

As the quarry continues to deepen, it is inevitable that more groundwater will flow to the sump and that pumping as a proportion of the total catchment budget will increase. SRK advocate that **the risks to the sensitive sites will remain low even as quarrying advances due to**:

- The buffering influence of the Dinas fault.
- The minimal hydrological connection between the SSSI Surface Layer and the Limestone Layer, demonstrated particularly in this year’s hydrological monitoring results.
- The fact that future sump dewatering volumes are unlikely to represent a significant portion of the catchment budget, unless several significant groundwater flow features are intersected by the quarry.

Moreover, ongoing monitoring will provide an early warning system against potential hydrological impacts which could be a pre-cursor to ecological impacts at the SSSI or potential derogative impacts to groundwater resources on which the Welsh Water PWS borehole relies.

In both cases a mitigation implementation procedure is in place in the case of any potentially significant hydrological impacts being detected in the monitoring data, as defined by the quarry Scheme of Working, which has been agreed by the EA, CCW and BBNP. Mitigation measures might include re-distribution of dewatering water or partial/total cessation of dewatering, depending on the circumstances of the potential impacts. Selection of a suitable mitigation measure would be undertaken if and when required, which would be undertaken through close liaison between the Relevant Parties.

9 RECOMMENDATIONS

- Continue with hydrological monitoring at the current locations until the next planned quarry deepening in 2015;
- Continue with annual reporting and meetings with key stakeholders; and
- Review the requirement to re-instate monitoring at OB5, OB10b, OB12, P12, P16, and S6 in 2015, in liaison with all key stakeholders.
- Details of the monitoring arrangements within the SoW should be updated to take account of the various changes that have taken place since the scheme was first approved in February 1998. A revised document should be submitted along with the ROMP application for approval by the BBNPA. All of the changes that have taken place have been recorded in sequential Annual Reports, so the revision of the SoW will in essence be an administrative exercise to summarise all of the changes into a single document. The principles of the monitor and mitigate methodology will remain unchanged.

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Appendix A

Scheme of Working for Penderyn Quarry

ARC South Wales

SCHEME OF WORKING
FOR
PENDERYN QUARRY

Scheme approved by BBNP Planning Committee on 3RD Feb. 1998, confirmed in letter from G. C. John, Area Planning Advisor (West) dated 17.03.98

OCTOBER 1997

ARC SOUTH WALES LIMITED

SCHEME OF WORKING FOR PENDERYN QUARRY

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PLANS

Plan No	Description
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2	Plan showing quarry location in relation to the Cwm Cadlan SSSI and the Penderyn Borehole
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SCHEME OF WORKING FOR PENDERYN QUARRY

1. INTRODUCTION

1.1 Penderyn Quarry is located due east of Penderyn Village adjacent to the A4059 Hirwaun to Brecon Road, about 8km north west of Aberdare.

On 14th September 1995, the Brecon Beacons National Park Committee granted planning permission Ref No CV 14033 (the 1995 Permission) for the continuation of quarrying operations at Penderyn Quarry within the area shown edged and hatched red on Plan 1. Earlier planning permissions granted in 1958, 1970 and 1972 allow quarrying within the remainder of the area shown edged red.

1.2 It is recognised that deepening of the quarry will require pumping to dewater the workings and consequently the 1995 Permission is subject to conditions to protect features of acknowledged importance, namely the Cwm Cadlan Grasslands Site of Special Scientific Interest just north of the quarry and the public water supply from the Penderyn Borehole, some 1000 metres to the south (see Plan 2). The relevant planning conditions 7, 8 and 9 are reproduced at Annex 1 to this scheme.

Condition 7 requires the applicant to carry out a hydrogeological survey of Penderyn Quarry and the surrounding area in accordance with a specification to be agreed with the National Park Committee (NPC). ARC South Wales Limited (ARC) have engaged consulting engineers and scientists Steffen Robertson and Kirsten (UK) Limited (SRK) to carry out the survey and act as technical consultants in dealing with all hydrological and hydrogeological matters connected with the development of Penderyn Quarry. The specification for the survey was agreed by the NPC in June 1996 and a final report of survey was completed this September. The results of the survey will provide a baseline for future ground and surface water monitoring at the quarry.

Condition 8 requires the applicant to submit a scheme of working for the quarry (the Scheme) for the approval of the NPC. After its approval, all operations at the quarry are to be carried out strictly in accordance with the Scheme or such variation or revision thereof as may be approved in writing by the NPC. Condition 9 sets out the main details which are to be included in the Scheme.

1.4 The details set out below represent the Scheme as proposed by ARC and are submitted for the approval of the NPC in order to discharge Condition 8 of the 1995 Permission.

2 FIVE YEAR WORKING PROGRAMME

2.1 Condition 8 requires that at intervals to be agreed by the NPC the Scheme shall be reviewed.

It is proposed that progress with the quarry development shall be formally reviewed with the NPC once every five years from the date of approval of the Scheme. In intervening years, a liaison meeting shall be convened between the applicant (ARC), the Brecon Beacons National Park Authority (BBNP), the Environment Agency (EA) and the Countryside Council for Wales (CCW) to review progress on an informal basis.

Within 3 months of the formal reviews a revised five year programme shall be submitted for the written approval of the NPC, and until such time as any revised scheme is approved quarrying will be carried out in accordance with the details of the Scheme as previously in force.

2.2 Any formal review or liaison meeting to consider the Scheme and/or progress with the quarry development programme shall involve an assessment of the results from the ongoing ground and surface monitoring arrangements, together with consideration of the need to agree any further action necessary to protect the special interests of the Cwm Cadlan SSSI or the Penderyn Borehole.

The proposed arrangements for the exchange of information between ARC, the BBNP, EA and CCW, together with the arrangements for reviewing the Scheme are described in greater detail in sections 8 and 9 below.

3 QUARRY DEVELOPMENT

3.1 *Phased Deepening*

The workings at Penderyn Quarry form a rectangular configuration with its long axis in an approximately north east-south west direction (see plan 3.0). The existing faces on the southern side of the quarry comprise stone of a poorer quality with high silica content, often contaminated with muck pockets. The hitherto selective extraction of clean stone has meant that the working in the eastern part of the quarry have become restricted and there is now urgent need to increase the width of the workings by pushing back the southern faces, which will in turn require the poor stone to be supplemented with clean stone from greater depth. The quarry floor is at 265m A.O.D and quarrying beneath this level will require pumping to dewater the workings (see Section 4 below).

The quarry will be deepened by developing a series of successively lower benches, each with a face height of approximately 15 metres, down to the anticipated base of the economically workable limestone at 165m A.O.D. this would yield reserves of approximately 20 million tonnes which at an average annual production of 500,000 tonnes represents a working life of about 40 years.

Modern quarrying practice results in the formation of distinct physical horizons (or benches) which will greatly assist in the monitoring and assessment of any impacts on the groundwater regime (see sections 5 and 6 below)

3.2 *Phase 1*

A decline will be excavated from the current quarry floor to provide initial access to the 250m level (see plan 3.1). The decline will be quarried at a gradient of 1:10 with the dimensions of the excavation being dictated by the requirements for safe working practice in the operation of the excavator and dumper vehicles.

In order to maximise the area available for quarrying at each bench level, deepening will take place simultaneously with development to push back the existing southern faces. Waste generated from the poorer quality southern faces will be disposed of initially on the Sinkhole Tip and thereafter on Tip 4 and/or Tip 5 in accordance with existing planning permissions for tipping.

Limestone production will thus be split between the decline and the southern flank of the quarry.

3.3 *Phase 2*

Conventional development will be undertaken on the 250m level once proper access has been established (see plan 3.2). A shallow sump will be formed to collect surface run off and groundwater inflow with the workings being kept dry by continuous pumping.

Production will also continue from the southern flanks of the quarry involving the extraction of poorer quality stone and muck pocket contamination. An existing tip located within the south western corner of the quarry will need to be removed by relocating the material to the adjacent Tip 4. This will enable the main haul road to be realigned further west to its final design position and also allow access to further reserves both on the upper benches and at depth. In addition, a small settlement lagoon located in the western neck of the quarry will be removed.

This development will enable the 250m level to be quarried progressively towards its final design position and for the permanent access ramp to this level to be established.

3.4 *Phase 3*

The third phase of development (plan 3.3) will involve access to the 235m level by quarrying a decline in a similar manner to that described in Phase 1 above. The timing of this development will obviously depend upon the completion of Phases 1 and 2, which in turn will be dependent on the overall level of production from the quarry (dictated by sales) and the tonnage ratio between the working of clean stone and poor stone from the lower and upper benches respectively. As the likely incidence of muck pocket contamination on the southern flanks is unknown this ratio is difficult to predict, but based on current best estimates it is anticipated that it will not be necessary to quarry below the 250m level within the first 10 years of the Scheme. Therefore, it is likely that the details of the Scheme will have been formally reviewed with the BBNP on two occasions, before Phase 3 is commenced.

3.5 *Phase 4*

Production from the 235 level will again take place simultaneously with development on the southern flanks of the quarry which will gradually progress eastward, thus facilitating the lateral extension of the 250m level and the levels above (plan 3.4)

3.6 Phases 3 and 4 above have been included to demonstrate the cyclic nature of the quarrying process which will be repeated so as to exploit the full potential of the reserve, subject of course to the provisions for safeguarding the special interests of the Cwm Cadlan SSSI and the Penderyn Borehole, as described in Section 9 below. As stated, the first two formal review periods, i.e. 10 years of development, are likely to be taken up by Phases 1 and 2 which will involve deepening the quarry by only one bench level.

4 METHOD OF DEWATERING

4.1 The existing settlement lagoons at the quarry have a limited ability to handle any additional capacity, therefore, the water from the dewatering operations will be handled/processed as a separate entity with the discharge from the new facilities, described below, being made to the Cynon River in accordance with the conditions of a discharge consent granted by the EA in June 1997. Surface run-off water from the processing plant and stockyard areas will continue to be managed via the existing arrangements as described in the details submitted under Condition 12 of the 1995 Permission which were approved by the NPC as confirmed in a letter dated 5th September 1996 (Ref.CV14033/gigj 151.let).

It will not be possible to produce precise details of the final dewatering arrangements until the quantity and quality of the water to be handled becomes more accurately known. An initial estimate is that the quantity is likely to be in the region of 0.5 - 4.5 million litres per day, with pumping taking place on a 24 hour basis throughout the year. The quality of water to be pumped is an unknown factor, but for practical purposes the assumption is being made that it will contain suspended solids in excess of 0.1mm diam particle size.

4.2 The principal method of detwatering will be by pumping from a sump within the lower workings. If suitable geological conditions are encountered then consideration will be given to the use of a combination of dewatering techniques involving conventional pumping from a sump and an arrangement consisting of a series of air lift pumps positioned in advance of the lower quarry faces. The latter arrangement produces clean water which could be pumped direct to the discharge point subject to its quality being continually monitored.

The water arising from the main sump will be of variable quality and this will be automatically monitored via a turbidity meter arrangement so as to permit a direct discharge to the Cynon River if it is within the limits set by the discharge consent. If the water exceeds these limits then the turbidity monitor will direct the flow to new water treatment lagoons.

Preliminary calculations have shown that the magnitude of flow (assuming the estimated maximum quantity of 4.5 million litres per day will need to be handled) will require two continuous flow type settlement lagoons of circa 20m x 10m arranged in parallel. In the earlier stages of the development it is anticipated that the flows will be much lower than this ultimate requirement and therefore the construction of the settlement facility can take place in a phased manner. This approach is the preferred option as it will allow flexibility to modify the design if necessary to enhance the efficiency of the facility.

4.3 It is intended to construct an attenuation pond prior to the settlement lagoons, the holding capacity of which will be maximised to suit the available floor space (see schematic diagram - fig 1). The attenuation pond will serve two main purposes:

a. To accommodate fluctuating deliveries from the dewatering pumps

b. To act as a crash box to absorb the momentum of the water before it enters the settlement facility

The attenuation pond will be provided with several outlets to direct the water to the settlement lagoons which in turn will pass the cleaned water to the discharge point.

The likelihood is that there will ultimately be four settlement lagoons allowing each lagoon to be selectively taken out of circuit for de-silting purposes whilst retaining the required functional settlement area for normal use in settling out suspended solids.

4.4 As regards monitoring the quality of the discharges it is proposed that a system incorporating several turbidity meters will be arranged to monitor the discharge from the pumps and also the final discharge to the consented point. As previously mentioned the turbidity meter monitoring the discharge from the pumping column will be used to automatically direct the discharge to the attenuation pond and thereafter the lagoons in the event of the level of suspended solids exceeding a predetermined level. Other turbidity meters will be provided to aid the daily management of the settlement facility.

Records of the quantity of water pumped will be kept and incorporated with the data from the ground and surface water monitoring arrangements described in Section 6 below.

The use of flocculants has not been considered as the particle size distribution of the suspended solids is not known at this stage, however, should their use become necessary then a dosing station will be incorporated into the final design of the settlement facilities.

4.5 No discharge to any surface watercourse will be made other than in accordance with the appropriate discharge consent issued by the EA and for the time being in force. Full consultation will be carried out with the EA in relation to the above details prior to the implementation of dewatering works.

5 PREDICTED IMPACTS ON THE LOCAL WATER REGIME

5.1 *Potential Impacts*

Dewatering Penderyn Quarry will result in a localised lowering of the water table in the limestone aquifer. The minimum elevation to which lowering will take place will be the base of the quarry at any particular time. As the quarry is deepened, then the area of impact due to dewatering will expand thus increasing the risk of an effect being experienced at any particular location.

The lowering of the water table will extend away from the quarry until either a geological barrier is reached or until flow towards the quarry is balanced with the water pumped out. Changes in groundwater levels will be monitored in the boreholes installed around the quarry (see 6.1.1 below) but at present any quantification of the likely extent of groundwater lowering in the areas surrounding the quarry will have a low resolution due to the complex hydrogeology at the site.

The extent of the impact at any given point is likely to increase as the quarry is deepened , as is the risk of any adverse effect being experienced by water dependent features. However, as explained in section 3 above, the nature of the quarrying process dictates that development is both phased and gradual, with the rate of deepening measured by intervals of several years between progress to successively lower benches. As development progresses at this low rate, information relating to the behaviour of the aquifer system will grow, allowing the prediction of future impacts to be made with an ever increasing level of confidence. Thus, the confidence in predictions and the level of risk increase together.

5.2 *Possible Adverse Effects*

The impact on the local water regime as a result of dewatering the quarry may in turn result in adverse effects being experienced by sensitive water dependent features. It is recognised that the potentially sensitive features around Penderyn Quarry are:

* the surface water regime, i.e. rivers and streams
* the Cwn Cadlan SSSI
* the Penderyn Borehole

The implications of dewatering for each of these features is summarised as follows:-

5.2.1 *Surface Water Regime*

The surface water regime (see Plan 4) comprises two types of stream; those such as the Cynon River which flow over limestone outcrop and those such as the Bodwigiad Stream which flow over gritstone outcrop. The Nant Cadlan flows principally over gritstone outcrop and drift and therefore generally falls into the latter group. Where surface streams are not in direct contact with the limestone, then they will not be affected by a drop in the limestone water table. Furthermore, water chemistry studies carried out as part of the investigations at the quarry to date show that the water in the Bodwigiad and Cadlan streams is principally rainwater fed. Flows in these streams are therefore unlikely to be affected.

In the case of the Cynon River, it is known that there is a direct relationship between the limestone water table and river water levels, and lowering the water table could reduce flows in the river. However, the water pumped from the quarry will be discharged to the river via an existing consented discharge point, thus replacing any lost groundwater contribution to flows. The Cynon River is the point to which the local groundwater flows naturally, and as the water pumped from the quarry will be discharged to this river there will be no change in the overall catchment water balance. The overall impact on the Cynon River will, therefore, be minimal.

5.2.2 *Cwm Cadlan SSSI*

It has been agreed with the CCW that in respect of dewatering it is the hydrological regime that is the most important factor in determining the success of the M10 and to a lesser extent the M24 plant communities at Cwm Cadlan. Water levels are therefore a key monitoring parameter, since dewatering of the quarry will lower regional ground water levels and this has the potential to lower water levels within the SSSI. A range of investigations has been carried out at Cwm Cadlan to assess the likelihood of dewatering having an adverse effect on the SSSI. These investigations have included drilling boreholes, carrying out geophysical surveys, soil auguring, water level and rainfall measurements, water sampling and chemical analysis.

The geology beneath the SSSI comprises a number of different layers. These layers can be divided into three main groups; the bed rock limestone at the bottom; the drift in the middle, which is made up from a mixture of clay, silt, sand and possibly gravel; and the surface peaty soil in which the plants of the SSSI grow. In order for an impact on the SSSI to be experienced as a result of dewatering the quarry, the moisture in the top layer must be reduced as a result of enhanced drainage into the lower layers.

The test work and monitoring carried out to date indicates that there are 3 possible scenarios relating to drainage:

(i) *Scenario 1* is that there is full hydraulic connection between the three layers and drainage from the bottom (limestone) layer would result in drainage from the top layer. Here the deep groundwater could provide a significant input into the system which supports the SSSI and dewatering of the quarry could lead to the lowering of water levels in the drift and the failure or downslope migration of springs/flushes.

(ii) *Scenario 2* is that there are no inputs from deep groundwater into the SSSI, with the clays in the middle layer preventing drainage in some areas but not in others. In this case dewatering could result in slow drainage of the shallow groundwater system.

(iii) *Scenario 3* is that the clay in the middle layer forms a hydraulic barrier which prevents all drainage from the top layer to the bottom layer. Thus the sole input to the SSSI is precipitation which infiltrates into and discharges from the shallow groundwater system. In this case there would be no impact upon the SSSI from the proposed quarry dewatering.

The work carried out at the SSSI to date indicates that the actual situation lies between scenarios two and three. In addition, the results of monitoring water levels in the top layer of the SSSI, together with rainfall, shows that the soil moisture content of the top layer is principally controlled by the balance of evapotranspiration (evaporation plus the water used by the plants) and rainfall. Drainage from the top layer (if it occurs) is likely to be a subsidiary control. Therefore, based on our current understanding of the hydrological regime at the SSSI, it is expected that dewatering at Penderyn Quarry will have little or no effect on the SSSI.

5.2.3 *Penderyn Borehole*

A possible impact of dewatering may be a lowering of the water level at the Penderyn Borehole, the consequence of which would be an increase in the cost of pumping water from the borehole.

In section 5.2.2 the geology was described as forming three layers. Dewatering at the quarry will take place from the bottom layer. The Penderyn Borehole also pumps water from the bottom (limestone) layer. Therefore, there is the potential for a direct impact on the borehole due to dewatering. In order for this impact to be experienced at the borehole, the quarry dewatering must create a 'cone of depression' that extends as far as the borehole. This cone of depression will be limited in extent due to the depth of dewatering at the quarry, the nature of the rock being dewatered and the proportion of the catchment water resources that are being abstracted.

Detailed analysis of rainfall and river flow data from the Nant Cadlan and Cynon rivers has allowed the catchment water balance to be characterised. This characterisation indicates that the amount of water that the quarry is licensed to discharge via pumping accounts for some 14% of total catchment. Mitigating against this is the observation that the Nant Cadlan loses flow between the entrance to the quarry and the Llygad Cynon resurgence. This indicates that the quarry discharge will to some degree replenish the water pumped from the catchment and limit the impact on Penderyn Borehole. The speed at which the 'cone of depression' develops and the nature of the limestone aquifer means that any effects will only occur slowly and will be fully reversible if ground water levels are allowed to recover.

5.3 In the event of adverse effects being experienced at either the SSSI or the Penderyn Borehole, remedial action will be considered via the review process described in section 9 below. Should the cessation of dewatering ultimately prove necessary then the quarry will be flooded back with groundwater being allowed to return to is natural level.

6 GROUND AND SURFACE WATER MONITORING ARRANGEMENTS

6.1 General Arrangements

Ground and surface water monitoring arrangements have been installed in and around the quarry and data has been collected since the inception of works in September 1995. Continuous monitoring from the full array of monitoring points has taken place since May 1996. The foundation for the monitoring network is the specification for the hydrogeological survey (required by Condition 7 of the 1995 Permission), as approved by NPC in June 1996, albeit certain additional arrangements have now been put in place and a full description of the network is given below.

The data gathered from the monitoring network will fall into two categories: firstly that obtained form the hydrogeological survey prior to the commencement of dewatering operations, which will provide baseline information for future monitoring, and secondly data collected once dewatering commences which will allow the impacts of dewatering to be measured and possible adverse effects to be predicted.

The data collected by ARC will be supplemented by data collected by Hyder Consulting (Hyder), on behalf of Dwr Cymru Welsh Water (DCWW), at the Penderyn Borehole, the Cynon River and Penderyn Reservoir. Data from these sources has been supplied by Hyder in a report entitled *'Penderyn Reservoir Inflows and Groundwater Monitoring Data Report'*, (Ref G:AS065/PENREP. doc) dated November 1996. Hyder are co-operating with ARC in the exchange of data which will be particularly pertinent to the Penderyn Borehole.

A summary of the monitoring points comprised in the network is given in Table 1, whilst the locations of the points in relation to the quarry are shown on Plan 4.

6.1.1 *Groundwater Levels*

Groundwater levels are monitored at eleven observation points:

* Two shallow boreholes located in the 'Old SSSI' (PENDOB1 and PENDOB2), record water levels in the superficial glacial deposits.

* Four deeper boreholes record levels in the limestone bedrock (PENDOB3, PENDOB4, PENDOB5, PENDOB7). These holes are situated in the quarry and between the quarry and Penderyn Borehole.

* Three boreholes each containing two stand pipes which enable them to record water levels in both drift deposits (PENDOB8b, PENDOB9b and PENDOB10b) and the underlying limestone (PENDOB8a, PENDOB9a and PENDOB10a). These holes are situated between the quarry and the SSSI.

All the stand pipes are fitted with 'Tuber' data loggers which record water level and water temperature readings at hourly intervals. Manual measurements are taken every 8 - 12 weeks to check that the system is working correctly.

Table 1 **Summary of Scheme of Monitoring at Penderyn Quarry**

Monitoring Point	Location	Easting	Northing	Elevation (mAOD)	Start of monitoring	Frequency	Comment
PENDOB1	Old SSSI East	295478.42	209414.09	266.28	January 1996	Hourly	Shallow
PENDOB2	Old SSSI west	295223.21	209336.43	254.21	January 1996	Hourly	Shallow
PENDOB3	Quarry, east	295867.67	209114.02	280.68	January 1996	Hourly	Deep limestone
PENDOB4	Quarry, west (lowest level)	295581.71	209077.29	266.34	April 1996	Hourly	Deep limestone
PENDOB5	Cynon River	295176.05	208359.46	228.71	January 1996	Hourly	Weathered zone, structure
PENDOB7	Bodwigiad Farm	295539.67	208440.82	259.24	May 1996	Hourly	Deep limestone
PENDOB8	Glyn Perfedd Farm east	296351.81	209603.66	294.16	May 1996	Hourly	Deep limestone & drift
PENDOB9	Glyn Perfedd Farm track	295442.48	209316.60	264.02	May 1996	Hourly	Deep limestone & drift
PENDOB10	Adjacent to Garw Dyle	295850	209390	~ 295	December 1997	Hourly	Deep limestone & drift
Cynon River	Downstream from Penderyn Borehole	295240	207700	~ 217	November 1996	Monthly	Stream flow
Cynon River	Entrance to quarry	294950	208755	~ 235	March 1996	Monthly/ Hourly	Stream flow/ Stage+
Rainfall	Quarry offices	295050	208900	~ 246	May 1996	Daily	Daily totals data logged
Rainfall	Location to be agreed				December 1997	Hourly	
SSSI Site 1, Piezometer 1a	Southern end of SSSI	295211.35	209509.8	258.75	July 1996	Hourly	Annual floristic survey
SSSI Site 1, Piezometer 1b	Southern end of SSSI	295199.46	209520.88	256.19	July 1996	Fortnightly	Annual floristic survey
SSSI Site 3, Piezometer 3a	Central SSSI, south facing	295641.43	209737.88	268.23	July 1996	Fortnightly	Annual floristic survey
SSSI Site 3, Piezometer 3b	Central SSSI, south facing	295647.44	209735.45	267.93	July 1996	Hourly	Annual floristic survey

Monitoring Point	Location	Easting	Northing	Elevation (mAOD)	Start of monitoring	Frequency	Comment
SSSI Site 3, Piezometer 3c	Central SSSI, south facing	295653.32	209735.45	268.02	July 1996	Fortnightly	Annual floristic survey
SSSI Site 7, Piezometer 7a	Central SSSI, north facing	296002.17	209716.20	279.97	July 1996	Fortnightly	Annual floristic survey
SSSI Site 7, Piezometer 7b	Central SSSI, north facing	295981.98	209704.85	279.39	July 1996	Fortnightly	Annual floristic survey
SSSI Site 7, Piezometer 7c	Central SSSI, north facing	295985.09	209699.24	280.21	July 1996	Fortnightly	Annual floristic survey
SSSI Site 7, Piezometer 7d	Central SSSI, north facing	~296002	~209716		December 1997	Hourly	Annual floristic survey
SSSI Site 9, Piezometer 9a	Eastern end of SSSI	296770.54	209991.20	299.43	July 1996	Hourly	Annual floristic survey
SSSI Site 9, Piezometer 9b	Eastern end of SSSI	296785.58	209977.03	301.88	July 1996	Fortnightly	Annual floristic survey
SSSI Site 9 Piezometer 9c	Eastern end of SSSI	296788.40	209979.65	302.12	July 1996	Fortnightly	Annual floristic survey
SSSI Site 9, Piezometer 9d	Eastern end of SSSI	296809.49	209963.11	304.77	July 1996	Fortnightly	Annual floristic survey
SSSI Site 12, Piezometer 12a	Extreme eastern end SSSI	296564.14	209626.42	298.77	July 1996	Fortnightly	Annual floristic survey
SSSI Site 12, Piezometer 12b	Extreme eastern end SSSI	296536.41	209623.06	298.53	July 1996	Fortnightly	Annual floristic survey
SSSI Site 12, Piezometer 12c	Extreme eastern end SSSI	296571.48	209613.31	300.14	July 1996	Fortnightly	Annual floristic survey
SSSI Site 12, Piezometer 12d	Extreme eastern end SSSI	296539.05	209566.40	302.53	July 1996	Fortnightly	Annual floristic survey

Monitoring Point	Location	Easting	Northing	Elevation (mAOD)	Start of monitoring	Frequency	Comment
SSSI Site 12, Piezometer 12e	Extreme eastern end SSSI	~296536	~209623		December 1997	Hourly	Annual floristic survey
SSSI Site 15 Piezometer 15a	Eastern end of 'old SSSI'	~295478	~209414		August 1997	Fortnightly	Annual floristic survey
SSSI Site 15 Piezometer 15b	Western end of 'old SSSI'	~295223	~209336		August 1997	Fortnightly	Annual floristic survey
SSSI Site 16 Piezometer 16a	To be agreed					Hourly	Annual floristic survey
SSSI Site 17 Piezometer 17a	To be agreed					Hourly	Annual floristic survey
SSSI Site 18 Piezometer 18a	To be agreed					Hourly	Annual floristic survey

\+ Stream flow will be monitored by recording stage height every hour using a pressure transducer and data logger. Flow ratings will be taken every month to calibrate stage readings with flow. Ratings will be taken during periods of low flow. A staff gauge will be fitted enabling check stage heights to be taken at any time.

The analysis of water level changes with time allows the development of the area of impact, caused by the lowering of the limestone water table, to be monitored and mapped as the quarry develops.

6.1.2 *Water Chemistry*

Water samples are collected from 18 different sources and submitted to an accredited laboratory for the analysis of a full range of determinands. The sources comprise the 10 groundwater level monitoring points, 3 points on the Nant Cadlan, 3 spring sources, the Bodwigiad stream and the stream running through the area of the 'Old SSSI' (see Plan 4). The sampling points have been selected to be representative of a range of hydrological situations over the full area of interest. The results of the analysis allow the relative proportions of water derived from rainfall and deep limestone groundwater to be evaluated and any changes to be monitored over time.

6.1.3 *Surface Water Flows*

Surface water flows are measured at two locations: in the Nant Cadlan at the quarry entrance (by ARC) and in the Cynon River approximately 75m downstream from the Llygad Cynon Resurgence (by DCWW). River stage is monitored at both locations by electronic water level monitoring devices and the measurement is recorded on a data logger. Rating curves have been established for each monitoring point and these are used to convert the continuous stage record to a continuous flow record.

The use of the two flow measuring points allows the surface and groundwater catchments to be quantified in terms of overall water balance. Direct impacts on the water balance will be identified by the regular review of the data.

6.1.4 *Rainfall*

The total daily rainfall is measured and recorded at the quarry offices with the information being supplemented by data collected by DCWW at Penderyn Reservoir If a secure site can be identified, an additional automatic rain gauge will be installed at the western end of the SSSI.

The rainfall data will be used to analyse the response of the shallow and deep water tables to recharge, and to provide input into the regional water balance. STET

6.2 Cwm Cadlan SSSI

It has been agreed with CCW that the hydrological regime rather than nutrient status or agricultural management is the primary controlling factor over plant distribution in the SSSI. The monitoring network has therefore been designed to provide data on the hydrological regime in the SSSI. An annual floristic survey will also be undertaken, the details of which are described in section 6.2.3.

6.2.1 *SSSI Water Levels*

Water levels in standpipes at the monitoring sites within the SSSI are currently measured manually on a fortnightly basis. The monitoring sites are all located in close proximity to M10 type vegetation which has been identified as being most susceptible to changes in the hydrological regime. Between 1 and 4 standpipes are located at each of the monitoring sites from which water levels are obtained. Before the end of 1997, an electronic water level measuring device and data logger will be installed at each of the 5 existing monitoring sites as well as at 3 proposed new monitoring sites in the 'New SSSI' (see Plan 4). This will allow water levels and water temperature readings to be taken on an hourly basis. Manual measurements will be taken at the remaining piezometers when the transducer is downloaded. The electronic measurements will be checked against the manual measurements to ensure that the system is working properly.

This data will be supplemented with data from the 2 piezometers PENDOB1 and PENDOB2 in the Old SSSI.

The data will be compared with the water levels recorded prior to the commencement of dewatering, taking account of variations in rainfall and evapotranspiration, to determine whether water levels have declined due to quarry dewatering.

6.2.2 *Soil Chemistry*

As agreed with CCW, soil chemistry will not be routinely monitored since quarry dewatering will not have any direct effect on soil nutrient status. Changes in nutrient status will only occur as a result of a change in soil moisture content. Any changes in moisture content will be measured by monitoring changed in water levels.

6.2.3 *Floristic Surveys*

The following floristic survey will be carried out annually.

Five 1m by 1m permanent quadrats will be located at each of eight monitoring sites (five existing and three proposed) within the New SSSI. These quadrats will be distributed as follows:

* One in the homogenous centre of the M10 community. This will be a control quadrat

* Three at the margins of the M10 community, at the interface with the M24 community. These quadrats are most likely to detect an early vegetation change. Depending on the extent of the M10 community at each site, it may only be possible to locate one or two quadrats on the M10/M24 interface.

* One in the adjacent M24 community. This will be a control quadrat.

In the Old SSSI ten permanent quadrats will be established, with five at each of the two monitoring sites, adjacent to the existing piezometers. There are no adjacent M24 communities and therefore each quadrat will be located within the M10 community.

Each quadrat will be divided into 16 equal sections with the presence or absence of critical indicator species recorded within each section. The indicator species will include both those species likely to decrease in number and those likely to increase in number should dehydration occur. At least 50% of the quadrats should contain the indicator species.

The following indicator species will be monitored:

Those likely to decrease	*Pinguicula vulgaris* *Triglochin palustris* *Pedicularis palustris* *Anagallis tenalla* *Drepanocladus revolvens (bryophyte)* *Campylium stellatum*
Those likely to increase	*Succisa pratensis* *Potentilla erecta* *Cirsium dissectum* *Serratula tinctoria*

Each quadrat will also be photographically monitored from a fixed point at the time of data collection.

The annual floristic survey will be carried out at the same time each year. However, rather than specifying a calendar date, and in order to account for seasonal fluctuations, the quadrats will be monitored two to three weeks after the onset of Dactylorchid flowering.

The data collected will be statistically analysed using analysis of variance techniques (ANNOVA).

6.3 Penderyn Borehole

A groundwater level monitoring borehole has been installed adjacent to the Penderyn Borehole by Hyder on behalf of DCWW. The monitoring borehole has been designed to allow the measurement of groundwater levels, which are representative of the water level in the production borehole. An electronic water level measuring device and data logger have been installed in the monitoring borehole and the water level is recorded on an hourly basis.

Water level measurement commenced in November 1996 and Hyder will be providing the recorded information to ARC on an ongoing basis for incorporation into the ARC monitoring data base. The water level data will allow any impact on the borehole to be measured and any adverse effect to be assessed.

6.4 Adequacy of Monitoring Arrangements

At the beginning of the quarry development programme, it is recognised that the confidence in prediction of the possible impacts is low. However, the risk to the SSSI and the Penderyn Borehole will be correspondingly low during the early stages, with the level of confidence in prediction increasing with the growth of the hydrogeological data base. A monitoring programme has been designed over the last 18 months, in consultation with the Environment Agency and CCW, to cover the potential area of impact of the proposed development, taking into account the locations of water sensitive features. Data on the key indicator parameters which will identify any impacts will be collected and regularly reviewed (see Sections 8 and 9 below). The review process will also allow the monitoring network to be refined over time if necessary. It is considered that the monitoring network provides an adequate level of data collection, commensurate with the scale of the project and the risks to the water environment

7. EVALUATION AND INTERPRETATION OF MONITORING DATA

7.1 General Methodology

7.1.1 The essence of the methodology to be employed in evaluating and interpreting the collected data is that of risk minimisation through the regular analysis of information at intervals which are sufficiently short to allow for action to be taken before any long term or irreparable impact can occur. KEY STATEMENT

The approach which has been chosen is to carry out long term hydrogeological monitoring, with frequent collation and analysis of data. The aim of the monitoring network will be threefold:

* to identify any impacts on the local groundwater and surface water regime as a result of quarry detwatering.

* to assess and predict any adverse effects on water dependent features of recognised importance.

* to continually contribute to the build-up of a conceptual hydrogeological model for the quarry and the surrounding area, in order to increase the resolution of predictions as to the impact of dewatering.

7.1.2 It is accepted that the ability to predict changes in the water regime will be low during the early stages of dewatering. However, the risk to water dependent features in the early stages will be correspondingly low for three main reasons:

* the depth of the initial deepening is small, i.e. a 15m bench.

* the rate of deepening is extremely slow, with something in excess of 10 years production expected from the first bench.

* the frequent analysis of monitoring results will provide the basis for decision making and remedial action, if necessary.

7.1.3 The analysis of the monitoring results will be aimed at drawing conclusions under the following headings:

* extent of influence of dewatering on the regional water table

* impact (if any) on Penderyn Borehole

* extent (if any) of drainage from the drift deposits within the Cwm Cadlan SSSI

* variations in water chemistry that would indicate changes in the source of water-supporting the plant communities in the SSSI.

* change in status of the M10 and M24 communities of the SSSI

* Adverse effects (if any) on the SSSI

The following sections describe the detailed methodology that will be applied in order to draw conclusions under the headings given above insofar as they relate specifically to either the Penderyn Borhole or the Cwm Cadlan SSSI.

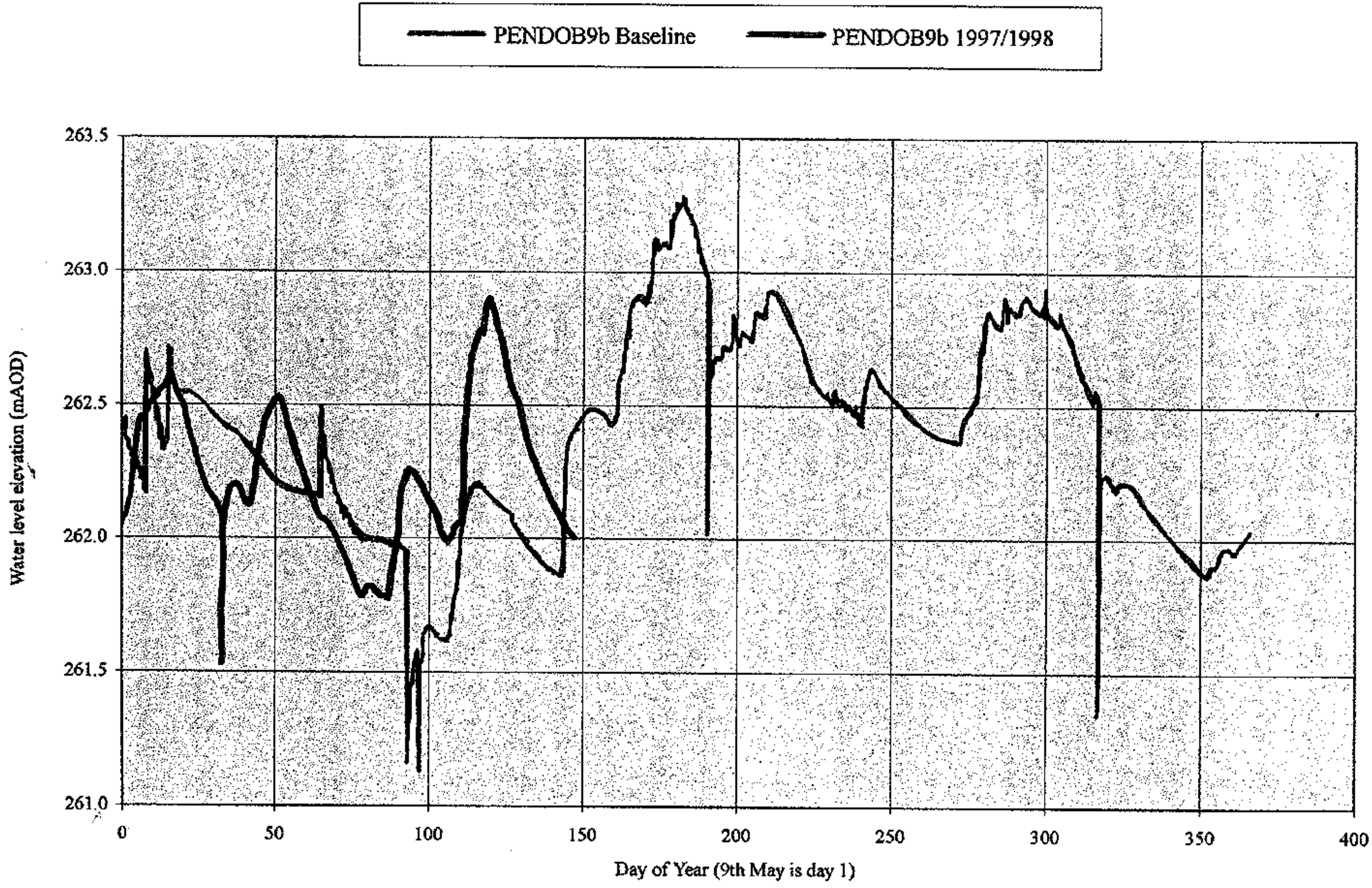
7.2 Penderyn Borehole

The regional hydrogeology is monitored using the deep observation boreholes situated around the quarry as described in 6.1.1. above. Water level data is collected on an hourly basis using pressure transducers and data loggers. More than 12 months data is now available which provides a baseline covering the full seasonal fluctuations. In addition to the ARC monitoring holes, data will be obtained from the Penderyn Borehole, and its associated observation borehole, via DCWW.

All new data will be compared directly to the base data collected during the same period in previous years. Figure 2 shows an example of how the data will be presented. This method of presentation allows direct comparisons to be made. The water level in a borehole will fluctuate for many reasons. For example, Figure 2 shows that even when no dewatering is taking place the water levels in this particular piezometer during May and June 1997, were very different form that recorded in May and June 1996, although the trends are similar. The differences can be explained by taking account of hydrometric data which is also collected. The hydrometric data comprises rainfall records at the quarry and at Penderyn Reservoir (DCWW) and evapotranspiration data for the relevant MORECS Square, obtained from the Met. Office. Using this information the amount of change in groundwater levels resulting from quarry dewatering may be deduced at any of the observation boreholes located around the quarry. The same principles will be applied to the data obtained via DCWW in relation to the Penderyn Borehole itself.

Once dewatering commences it can be assumed that some of the deep limestone water levels which are monitored will be effected. The effect will be made manifest by a steepening of the rate of fall of water levels in the summer and a shallowing of the rate of increase in water levels in the winter, thereby resulting in an overall fall in water level. Once these changes commence two principal plots will be produced to review the spread of the zone of influence around the quarry. The first will be a plot of contours of drawdown around the quarry, with an estimate of the position of the zero drawdown contour made by extrapolation. The second will be a plot of the drawdown measured in each observation piezometer against the distance of the piezometer from the quarry sump. This will, over time, give a representation of the spread of the zone of influence.

Evidence of regional groundwater levels being lowered will therefore be provided by the observation network, which will give an early warning of any impact likely to occur at the Penderyn Borehole. Data from the Penderyn Borehole itself, and the associated observation hole, will measure the degree of any impact.



Draw. Ref P7/P/WS/Fig.2	ARC South Wales - PENDERYN QUARRY	
DATE: October 1997	**Comparison of Water Levels in PENDOB9b Baseline against 1997/98**	**Figure 2**

7.3 **Cwm Cadlan SSSI**

7.3.1 *Background*

The SSSI has been designated because of the 'special interest' provided by two distinct types of plant community. These are the National Vegetation Classification M10 and M24 communities, which are both types of fen. The principal controlling factors in the distribution of these types of plant communities are soil water, soil nutrients and agricultural management practices. Of these, it is the soil water that is the only factor that could be at risk from the quarry dewatering activities. The monitoring programme has therefore concentrated upon measuring changes in water levels in the shallow drift and an annual floristic survey of both types of plant communities. These investigations are undertaken at 2 sites in the Old SSSI and 5 sites in the New SSSI.

The strategy that has been adopted is that the piezometer water level measurements act as an 'early warning' and may indicate the possibility of future changes to the plant communities which would be identified by the annual floristic survey. Current levels of knowledge are such that it is not yet possible to predict the extent of any floristic changes on the basis of observed changes in the piezometer water levels. What is important is that whilst the ability to relate 'cause and effect' will be low during the early stages of dewatering, the risks to the SSSI will be similarly low and ARC believe that careful evaluation of the monitoring data, allied with the arrangements described in Section 9 below will provide adequate protection for the SSSI.

7.3.2 *Variations in Water Chemistry*

Variations in water chemistry may provide evidence of a change in the source of the water at any particular monitoring point. It has been demonstrated that the deep limestone waters are characterised by a Mg/Ca ratio of > 0.14, and a magnesium concentration of >10mg/l. The shallow waters have Mg/Ca ratios of <0.1 and a magnesium concentration of < 4mg/l. The use of these indicators and changes in the characteristics of water chemistry at a particular point can be used as an indicator of change in the source of supply.

Plots of Mg/Ca ratio against TDS will be presented and the relative positions of the data points on the plots, monitored to provide the indication of change.

7.3.3 *Extent of Drainage from the Drift*

The movement of water in the drift is monitored by the deep drift piezometers. The water level in these is recorded every hour and the measurements logged electronically on a data logger. The data will be presented in the same format as that described for the deep limestone piezometers.

The importance of this data is to obtain an early warning if the deep drift is draining into the dewatered limestone below. The rate of drainage will be dependent on the amount of clay in the drift sequence which will to a large degree control the vertical permeability of the drift. For this reason the water level in the limestone and deep drift piezometers will be plotted on the same graph and deviations from the baseline data noted. Drainage of some or all the drift does not necessarily imply that the M10 and/or M24 communities will be affected, however, it would be prudent to review the monitoring intensity if marked drainage of the drift was observed.

7.3.4 *Piezometer Measurements*

At each of the seven monitoring sites within the SSSI water levels will be automatically recorded from one shallow piezometer fitted with a data logger. Water levels in the three or four other piezometers located at each monitoring site are recorded manually at fortnightly intervals. During the baseline investigations water levels were shown to respond closely to a balance between rainfall and evapotranspiration. Drainage acted in a secondary role in terms of the response of the water levels. The basis of the data analysis will therefore be a comparison between observed daily water levels and the daily rainfall and evapotranspiration data for the same period. Comparison with the observations made during the same months in previous years as well as the baseline survey period will show whether there are any trends in relation to longer term climatic patterns If the observed variations in water levels at a piezometer cannot be readily explained by the rainfall and evapotranspiration data, the following will be considered in order to explain the observations:

* magnitude of the fall relative to the range of variations previously recorded,
* variations in water levels in the manually read piezometers at the same site,
* observed change in agricultural practices adjacent to the site,
* variations in water levels at other monitoring sites in the SSSI,
* pumping rates over the period,
* variations in water levels in the deep drift and limestone, and
* predicted area of influence of draw down in the limestone aquifer

If the observed variations recorded during any period of monitoring can reasonably be concluded to be the result of dewatering then this will be clearly stated in the relevant report for the period. The implications of such conclusions would then be examined under the arrangements for the sharing of information and the assessment of need for remedial action described in Sections 8 and 9 below.

Whilst changes in deep and shallow drift water levels may indicate the potential for changes in the M10 and M24 communities of the SSSI, and provide an early warning of a changing environment, floristic analysis will be necessary to provide quantitative data on the extent of any changes.

7.3.5 *Floristic Analysis*

An annual floristic survey will be carried out as described in 6.2.3 above in order to allow statistical comparisons to be made between the results obtained from year to year. These comparisons will be made on the basis of the status of a number of indicator species, both higher plants and mosses, which are considered to be most indicative of changing conditions. In the context of dewatering, any changes would most likely occur as a drying of the M10 community leading to a reduction in the M10 indicator species and an increase in the M24 indicator species. However, because plant associations are essentially dynamic, and respond to a variety of environmental factors, there may well be 'natural' variations in individual species quite unrelated to quarry dewatering activities. In order to overcome this, only changes that involve two indicator species will be critically examined, although all variations from year to year will be reported.

7.3.6 *Ecological Trigger Level*

The statistical analysis of the data from each floristic survey will be aimed at clearly identifying changes in the status of the indicator species in any of the fixed quadrats. In order to safeguard against any risk to the SSSI owing to the inability to accurately predict the consequences of changes in water levels which may occur during the early stages of dewatering, it is proposed to define an 'Ecological Trigger' for further action, based upon the statistical analysis.

In this context it is proposed that a significant change in the status of either the M10 or M24 communities will be deemed to have occurred if a change of more than 20% is recorded for at least 2 indicator species in any of the fixed quadrats. If such a level of change is registered i.e. the 'Ecological Trigger Level' of 20% change is exceeded, then a detailed review of all the relevant monitoring data will be carried out at a meeting between ARC, BBNP, EA and CCW, hereinafter referred to as a Special Liaison Meeting, at which the following will be critically examined:

* floristic records of the other quadrats at the site,
* piezometer and climatic records at the site,
* detailed agricultural management practices in the area adjacent to the site for the previous 2-3 years as well as any major changes in the previous 10 years,

* field evaluation of the status of the communities and individual species at the site,

* accumulated floristic records at the site to identify any longer term trends, and

* floristic, piezometer and climatic records at the other SSSI monitoring sites;

The objectives of the Special Liaison Meeting shall be firstly be to consider to what extent (if any) the changes in the plant communities have been brought about as a result of quarry dewatering, and secondly, whether any remedial action is required under the arrangements described in Section 9 below.

8. EXCHANGE OF MONITORING DATA

8.1 The information gathered from the monitoring network will be collated at four monthly intervals with the results being presented in a series of written reports in February, June and October of each year. Copies of the reports will be provided to the BBNP, EA and CCW for information and/or comment.

Information on water levels at the Penderyn Borehole, the associated observation hole and flows in the River Cynon is obtained from DCWW. This data will be included in the monitoring reports as and when it is received from DCWW.

8.2 The reports will include an analysis and interpretation of the results in terms of any impacts which may occur to the local groundwater or surface water regime as a consequence of dewatering the quarry. An assessment will also be made as to whether the dewatering operations are having or are likely to have an adverse effect on the special interest of the Cwm Cadlan SSSI or the Penderyn Borehole.

8.3 A four monthly reporting cycle is considered valid for the following reasons:-

* reports can be based on data collected at the critical hydrological and ecological times of the year, i.e. the end of the summer hydrological recession and end of the summer growing period (October), the hydrological peak in mid-winter (February) and the late spring-early summer ecological growth period and hydrological mid-cycle (June).

  The informal annual review of the Scheme described in 2.1 above will be timed to take place shortly after receipt of the October report.

* The period between reports allows an appropriate interval for the EA and CCW to consider the findings and make any comment or recommendations they may feel necessary to the BBNP.

* in the context of the quarrying process the interval is extremely short and no irreversible impact on the local water regime could occur during such a brief period of development.

If, however, experience proves that a longer interval between reports would be adequate, e.g. every six months, then the interval shall be capable of review, subject to the agreement of the NPC.

8.4 Reporting at regular intervals will continue throughout the life of the quarry and will form the basis for decision making as to whether any action will be necessary to mitigate the effects of dewatering - (see section 9 below).

9. ARRANGEMENTS FOR REMEDIAL ACTION

9.1 Condition 9 (f) of the 1995 Permission requires the inclusion of a subordinate scheme identifying the arrangements for remedial action to be taken in the event that the data collected from the monitoring network establishes to the satisfaction of the NPC that dewatering operations within the quarry are having or are liable to have an adverse effect on the special interest of the Cwm Cadlan SSSI, the water levels in the Penderyn Borehole or any other receptors identified in Condition 9 (c) (see Annex 1).

It has already been explained in 5.2.1 above that it is unlikely that the flows in surface watercourses in the vicinity of the quarry will be adversely affected and therefore the primary receptors to be considered are the Cwm Cadlan SSSI and the Penderyn Borehole (the Special Interests).

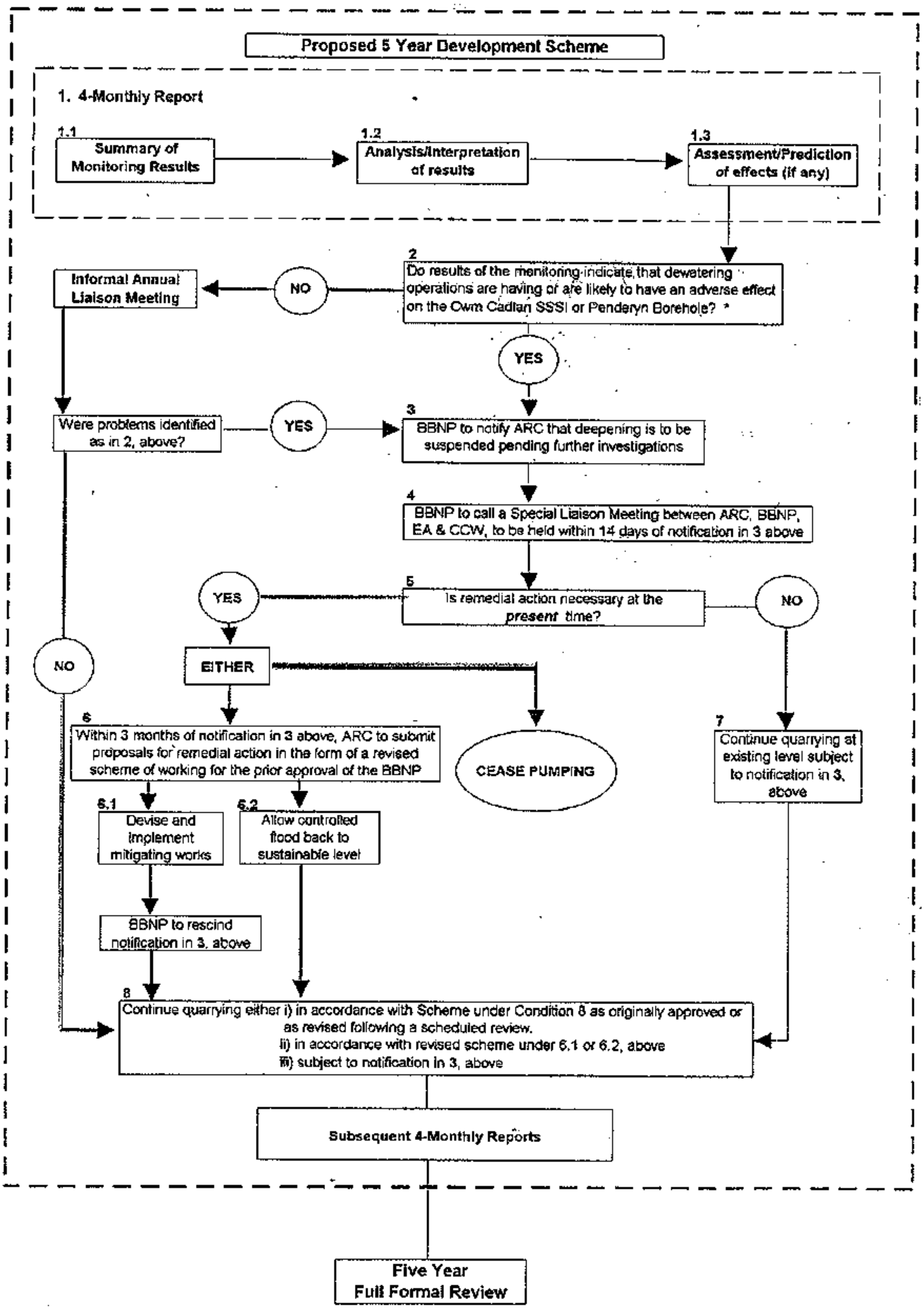
9.2 As mentioned above, the assessment of the need for remedial action will follow from the analysis and interpretation of the monitoring data. A five year development programme with informal annual reviews and the regular exchange of information will provide a framework for decision making and allow the necessary consultation and discussion between ARC, the BBNP, EA and CCW (the Relevant Parties), A flexible and expeditious decision making process will be achieved by also making provision for ad hoc liaison meetings between the Relevant Parties to be called at any time during the annual review cycle should this prove necessary.

The subordinate scheme required by Condition 9 (f) is shown in the form of a flow diagram in Fig.3, with the arrangements being described in greater detail below.

9.3 The conclusions and recommendations of each four monthly report will be considered by each of the parties. If the results of the monitoring do not indicate any adverse implications for the Special Interests then quarrying will progress in accordance with the Scheme through successive report phases and/or annual liaison meetings with progressive long term deepening taking place as described in Section 3 above. If, however, the results of the monitoring indicate to the satisfaction of the NPC (having taken full account of all the facts following consultation between the Relevant Parties) that dewatering operations are having or are likely to have an adverse effect on the Special Interests, or if the Ecological Trigger Level referred to in 7.3.6 above is exceeded, then the BBNP shall give notification in writing to ARC (the Notification) that deepening of the quarry is to be suspended pending further investigations. This shall mean that pending further approval from the NPC (see below) no working shall take place below the level of the lowest point in the quarry as exists at the time of the Notification.

Further deepening to the next bench level will only be permitted if details of mitigating action in the form of a revised Scheme are first submitted to and approved by the BBNP, or if the results of subsequent investigations indicate that mitigating measures will not be necessary. In either case the Notification restricting the depth of working would be rescinded with working allowed to proceed in strict accordance with the Scheme or any revision thereof.

ARC South Wales
Penderyn Quarry



*** NB**

(a) A YES answer will result from the question posed in Box 2 above in the event of the Ecological Trigger Level described in sub-section 7.3.8 being exceeded
(b) A YES answer to Box 2 as a result of the Ecological Trigger Level being exceeded shall not prejudice the answer to the question posed in Box 5

FIGURE 3

9.4 If Notification is given restricting the depth of working, then the BBNP shall, within 14 days of the Notification, call a 'Special Liaison Meeting' between the Relevant Parties to consider whether any mitigating/remedial action is required. Where the reason for Notification is that the Ecological Trigger Level has been exceeded, then it will be necessary to first consider to what extent (if any) the changes in the plant communities have been brought about as a result of quarry dewatering activities. Changes may have occurred due to natural causes, and the fact that the Ecological Trigger Level has been exceeded will not prejudice the key question as to whether remedial action is necessary, which can only be answered following a thorough examination of all the relevant evidence contained within the monitoring data.

If it is agreed at a Special Liaison Meeting that there is imminent need for remedial action then ARC shall, within 3 months of the Notification, submit proposals in the form of a revised Scheme for the prior approval of the NPC.

Remedial action would be likely to involve one of the following options:-

(i) the continuation of quarrying, and subsequent deepening, subject to the implementation and maintenance of appropriate mitigating works. The measures available have not been considered in detail to date but might, for example, involve the use of pumped water to artificially recharge the aquifer or augment the supply of water to either the plant communities of the SSSI or the resource at the Penderyn Borehole. Any such proposals will require the prior approval of the NPC, and once approval is given the Notification restricting the depth of quarrying shall be rescinded.

(ii) the controlled flood-back of the quarry to an agreed level, to be maintained by carefully controlled pumping. The level to which the groundwater in the quarry would be allowed to return would be that which the results of past monitoring indicate would be sustainable without having an adverse effect on the Special Interests.

(iii) the cessation of dewatering operations, whereby the quarry will be allowed to flood back with groundwater in the aquifer returning to its natural levels.

It is possible that a combination of the above options could be used, for example, by dewatering only during the winter months when moisture levels in the SSSI are kept high by rainfall, with the cessation or regulation of pumping during the drier summer months. Alternatively, if the need for remedial action becomes apparent then dewatering could be suspended for a temporary period whilst possible mitigating works are explored.

9.5 The above arrangements for the regular analysis and reporting of the results from the monitoring network will ensure that the efficiency of any mitigating works can be assessed, and allow conclusions to be drawn as to whether any further changes to the Scheme need to be made.

All quarrying operations will be carried out strictly in accordance with the details of the Scheme for the time being in force, as revised or amended following consultation between the Relevant Parties and as approved by the NPC.

PENDERYN QUARRY - Scheme of Working
Planning Conditions 7, 8 and 9 to Consent No. CV14033 Dated 14 09.95

7. Within twelve months of the date of this permission, or such other period as may be agreed with the National Park Committee, the applicant will carry out a hydrogeological survey of Penderyn Quarry and the surrounding area, the specification for the survey to be agreed with the National Park Committee in consultation with the NRA and CCW. The aim of the survey shall be to gather and evaluate background information in order to facilitate the preparation of the scheme of working required by Condition No.8 below and provide a baseline for future monitoring. In particular, an assessment will be made of the effects, if any, that dewatering operations within the quarry may have on the seasonal water levels, soil moisture and soil chemical variables of relevance to the special interests within the Cwm Cadlan Grasslands SSSI and on water levels and water quality in the Penderyn borehole.

8. Within twelve months of the date of this permission, or such other period as may be agreed, the applicant shall, submit a scheme of working for the quarry for the approval of the National Park Committee. The Committee may require amendments to the scheme or impose conditions or limitations thereon as part if the approval process. The scheme of working will not be approved unless it clearly demonstrates that dewatering of the quarry in accordance with the scheme will not have adverse implications for the special interest of Cwm Cadlan SSSI or the Penderyn borehole. After the date of its approval, all operations shall be carried out strictly in accordance with the scheme of working or such variation or revision thereof as may be approved in writing by the National Park Committee, (including any conditions or limitations imposed in connection therewith). At intervals to be agreed by the National Park Committee, the scheme of working shall be reviewed.

9. The scheme of working referred to in Condition No.8 above shall include inter alia details of:

   a development (e.g. phasing, areas to be worked, depth of working etc)

   b method of dewatering the quarry workings

   c predicted impacts on the local groundwater and surface water regime as a consequence of dewatering the quarry

   X d ground and surface water monitoring arrangements in the form of a monitoring network, which shall include the monitoring of soil chemistry and plant communities within the Cwm Cadlan SSSI, the details of which are to be agreed with the National Park Committee in consultation with the NRA and CCW.

✗ e a mechanism for sharing and evaluating the data gathered from the monitoring network with the NRA and CCW

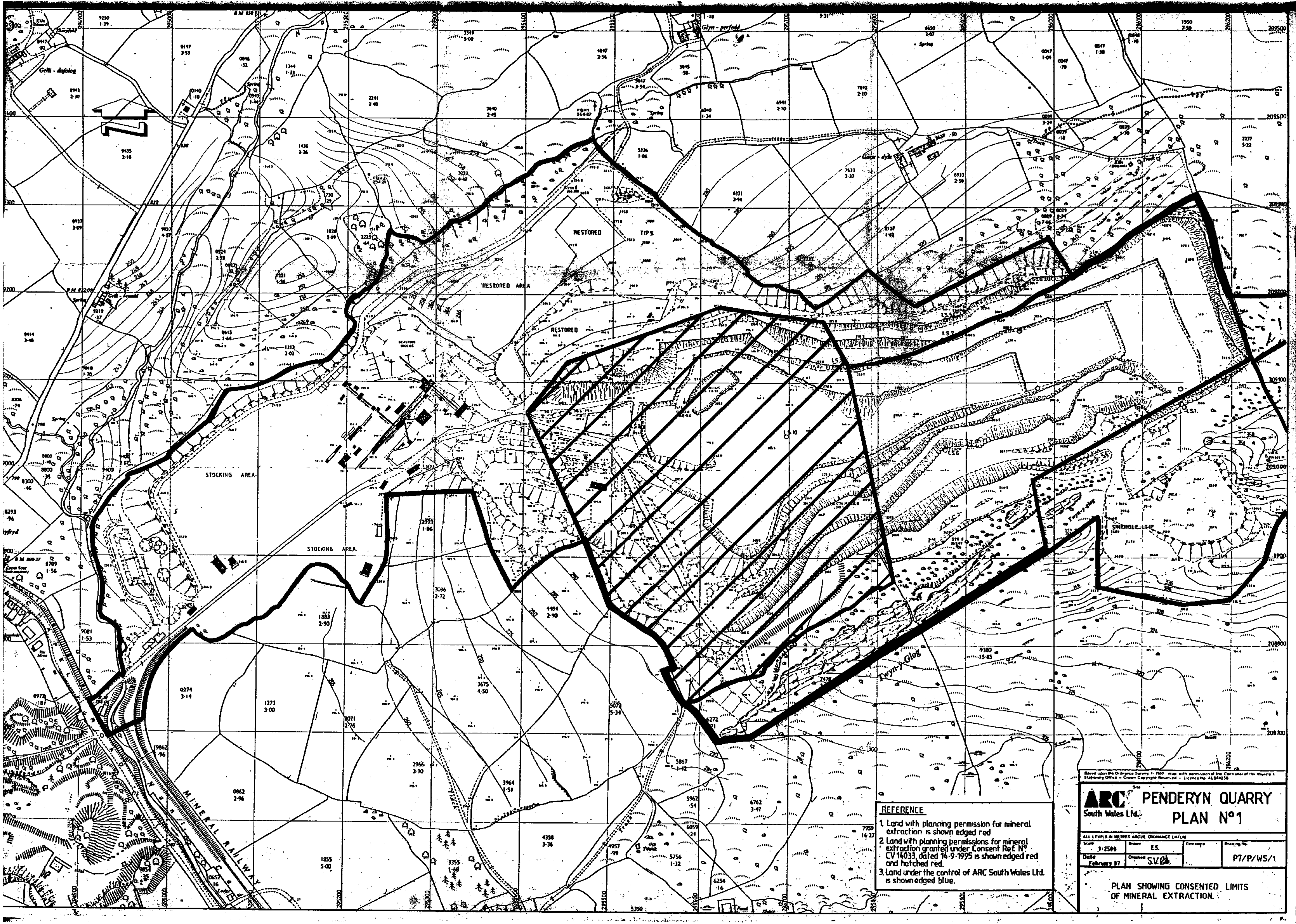
✗ f a subordinate scheme identifying the arrangements for remedial action to be taken in the event that the data collected from the monitoring network referred to above establishes to the satisfaction of the National Park Committee, that dewatering operations within the quarry are having or are liable to have an adverse effect on the special interest of the Cwm Cadlan Grasslands SSSI, the water levels in the Penderyn borehole or any other receptor at risk identified in Condition No.9c above. Remedial action will involve either the cessation of dewatering operations or the implementation of an adequate scheme of mitigating measures with details of the scheme to be submitted for the prior approval of the National Park Committee.

Concise Oxford Dictionary —

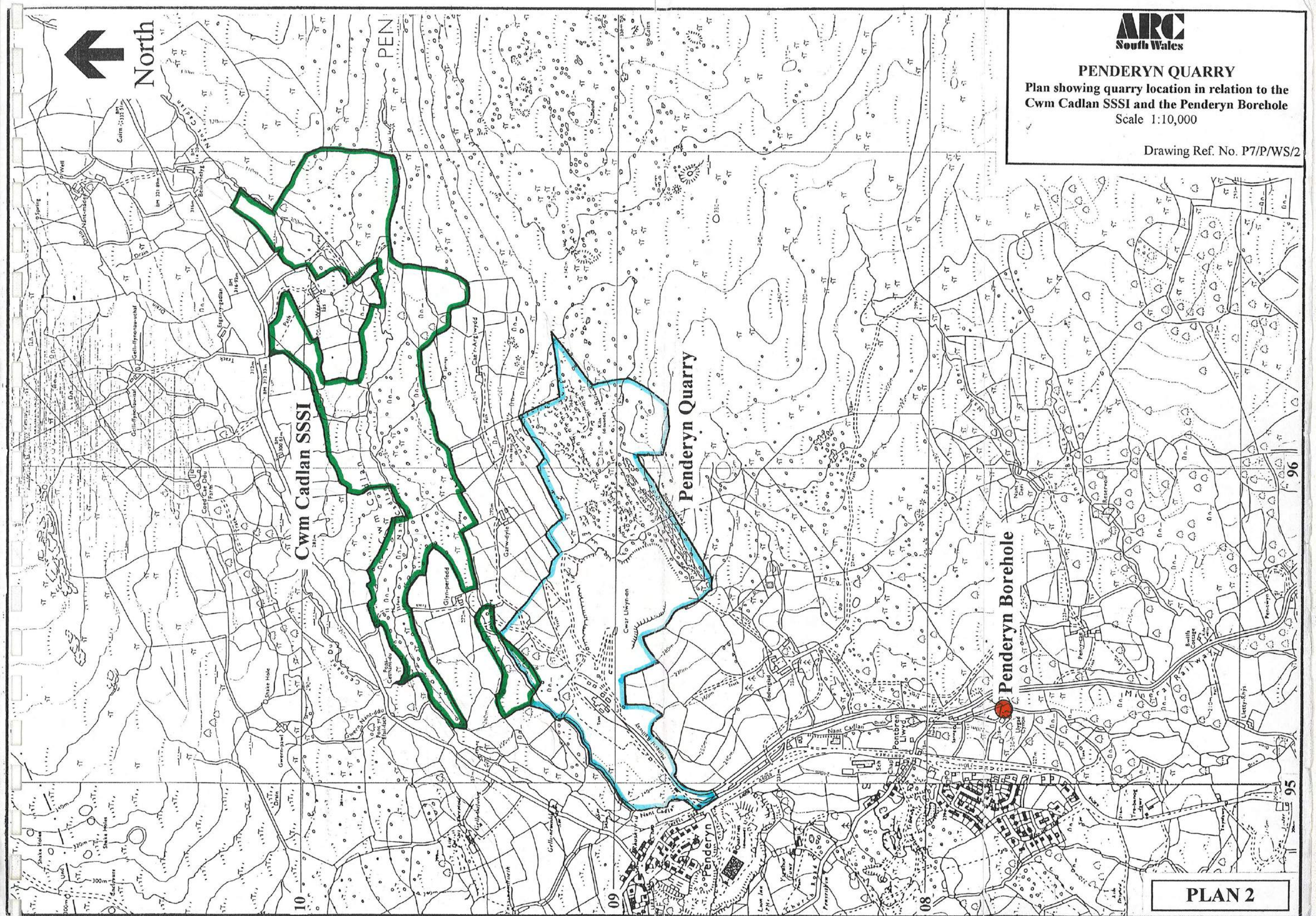
"liable" —subject or amenable to to tax or penalty, exposed or open to, apt to do or suffer, something undesirable (difficulties are liable to occur)--

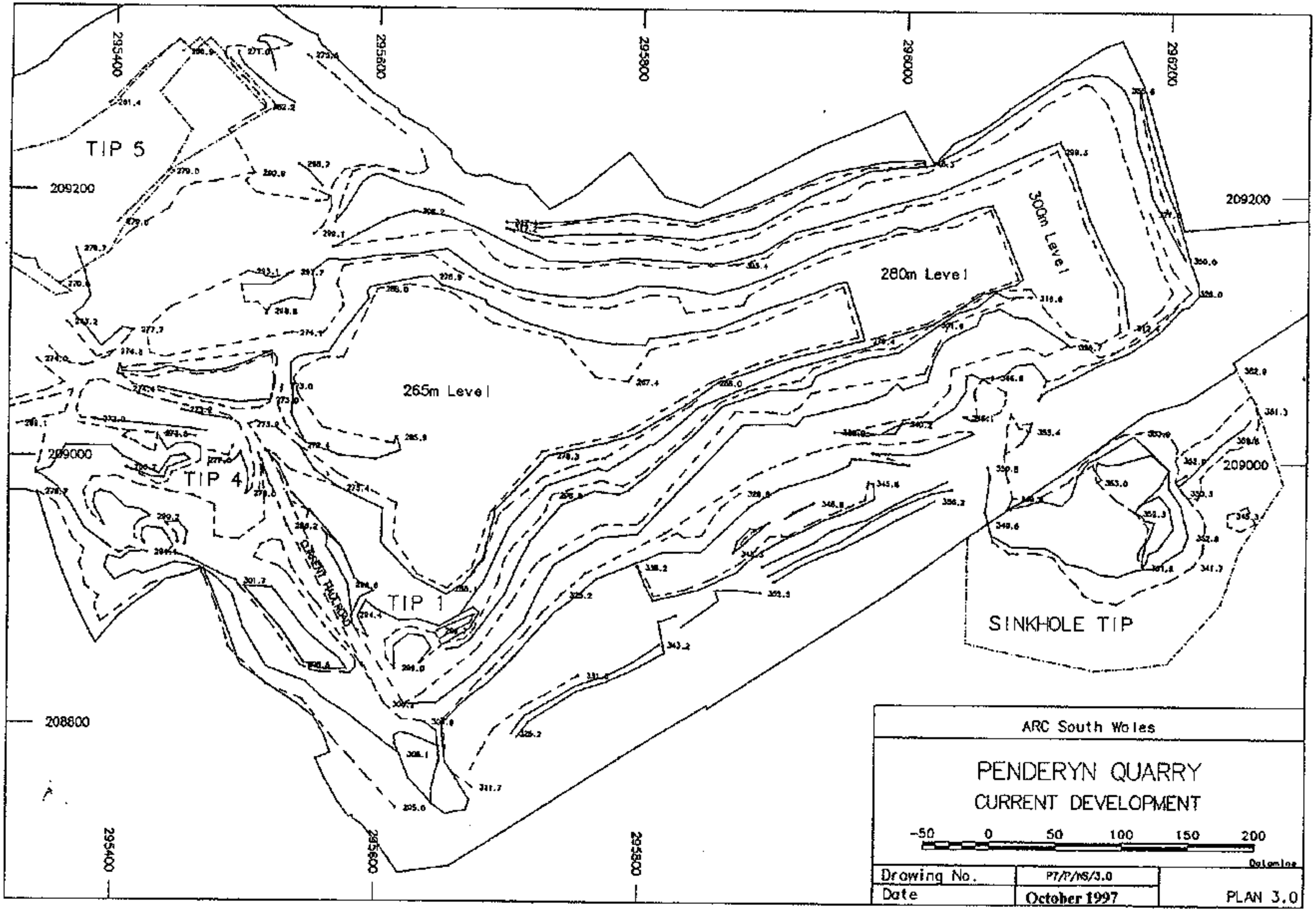
Ref:MMF/ME/g/Lands/Mark/Scheme
September 1997

PLANS

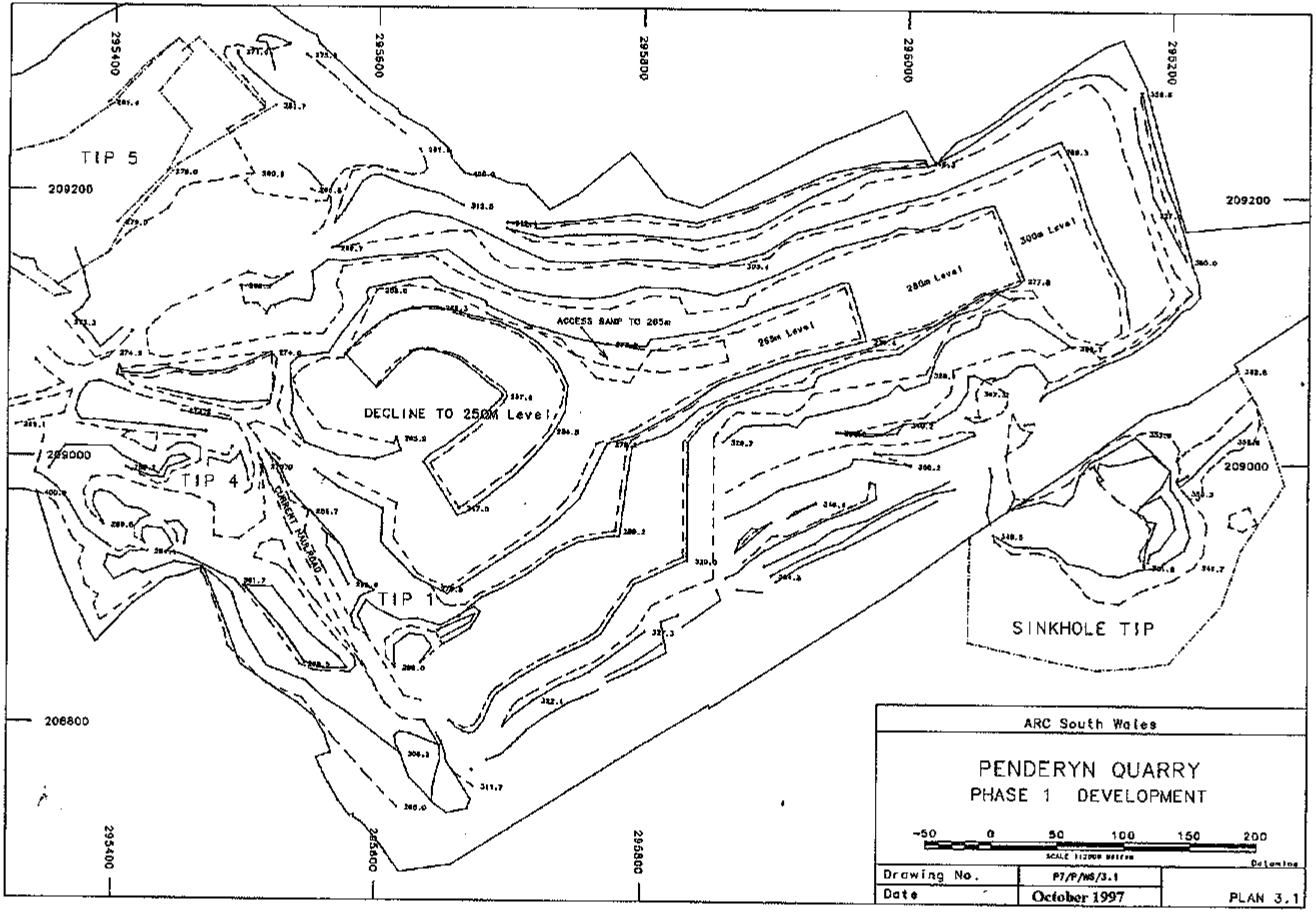


RESTORED
TIPS
RESTORED AREA
RESTORED
STOCKING AREA
STOCKING AREA
SINKHOLE TIP
Twyn-y-Glog
Glyn-perfedd
Gelli-dafolog
MINERAL RAILWAY
REFERENCE
1. Land with planning permission for mineral extraction is shown edged red
2. Land with planning permissions for mineral extraction granted under Consent Ref. N° CV 14033, dated 14-9-1995 is shown edged red and hatched red.
3. Land under the control of ARC South Wales Ltd. is shown edged blue.
ARC South Wales Ltd.
Site
PENDERYN QUARRY
PLAN N°1
ALL LEVELS IN METRES ABOVE ORDNANCE DATUM
Scale 1:2500
Drawn E.S.
Checked S.V.
Date February 97
Drawing No. P7/P/WS/1
PLAN SHOWING CONSENTED LIMITS OF MINERAL EXTRACTION.

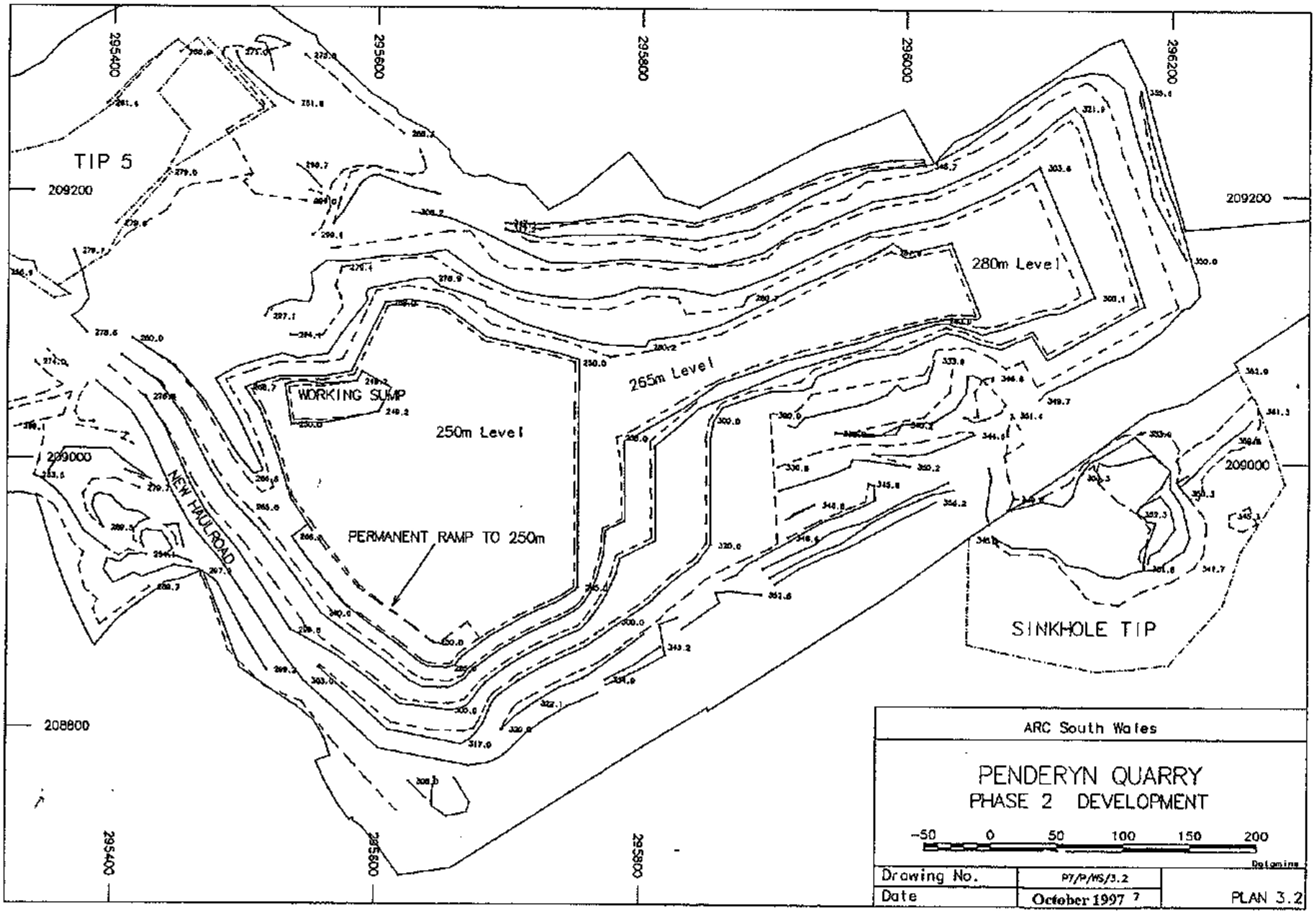

ARC
South Wales
PENDERYN QUARRY
Plan showing quarry location in relation to the Cwm Cadlan SSSI and the Penderyn Borehole
Scale 1:10,000
Drawing Ref. No. P7/P/WS/2
North
Cwm Cadlan SSSI
Penderyn Quarry
Penderyn Borehole
PLAN 2



ARC South Wales		
PENDERYN QUARRY CURRENT DEVELOPMENT		
-50 0 50 100 150 200		Dolomine
Drawing No.	P7/P/NS/3.0	PLAN 3.0
Date	October 1997	



TIP 5
TIP 4
TIP 1
SINKHOLE TIP
DECLINE TO 250M Level
ACCESS RAMP TO 265m
265m Level
280m Level
300m Level
CURRENT HAULROAD
295400
295600
295800
296000
296200
209200
209000
208800
ARC South Wales
PENDERYN QUARRY
PHASE 1 DEVELOPMENT
-50 0 50 100 150 200
Drawing No.
P7/P/WS/3.1
Date
October 1997
PLAN 3.1


TIP 5
280m Level
265m Level
250m Level
WORKING SUMP
PERMANENT RAMP TO 250m
NEW HAULROAD
SINKHOLE TIP
295400
295600
295800
296000
296200
209200
209000
208800
ARC South Wales
PENDERYN QUARRY
PHASE 2 DEVELOPMENT
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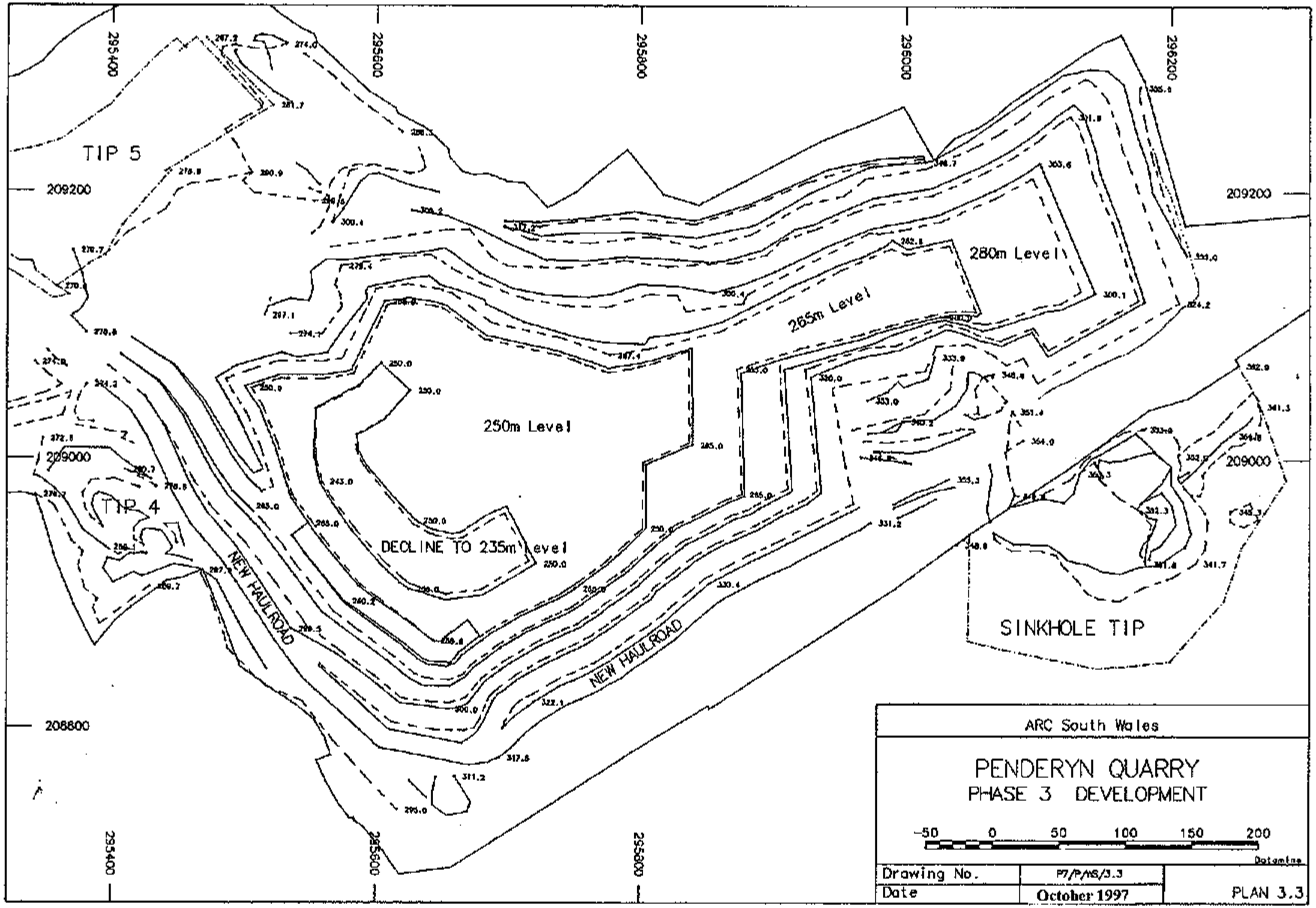
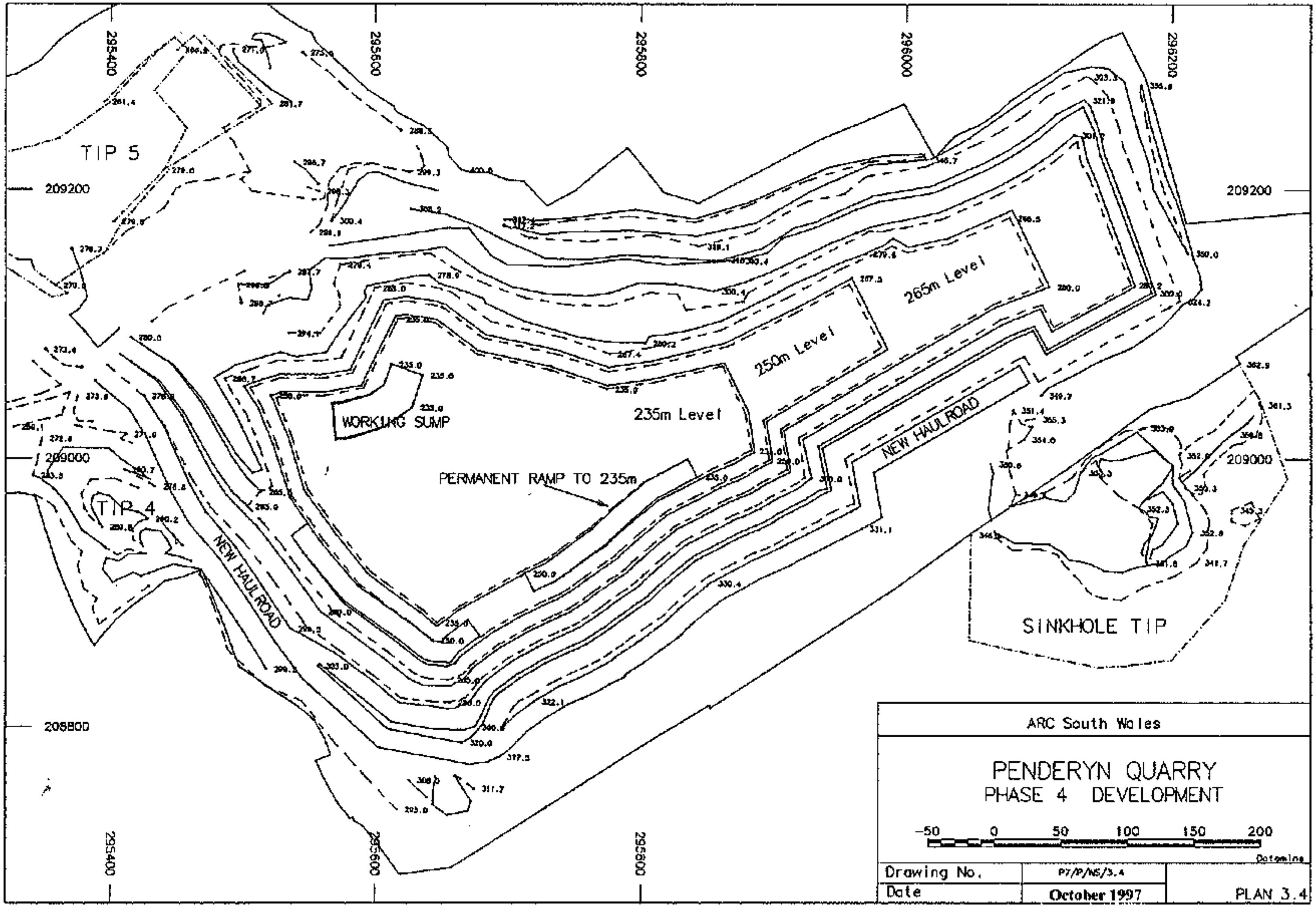
Drawing No.
P7/P/WS/3.2
Date
October 1997
PLAN 3.2


TIP 5
TIP 4
280m Level
265m Level
250m Level
DECLINE TO 235m Level
NEW HAULROAD
NEW HAULROAD
SINKHOLE TIP
295400
295600
295800
296000
296200
209200
209000
208800
ARC South Wales
PENDERYN QUARRY
PHASE 3 DEVELOPMENT
-50 0 50 100 150 200
Datamine
Drawing No. P7/P/MS/3.3
Date October 1997
PLAN 3.3



TIP 5
TIP 4
SINKHOLE TIP
265m Level
250m Level
235m Level
WORKING SUMP
PERMANENT RAMP TO 235m
NEW HAULROAD
NEW HAULROAD
295400
295600
295800
296000
296200
209200
209000
208800
ARC South Wales
PENDERYN QUARRY
PHASE 4 DEVELOPMENT
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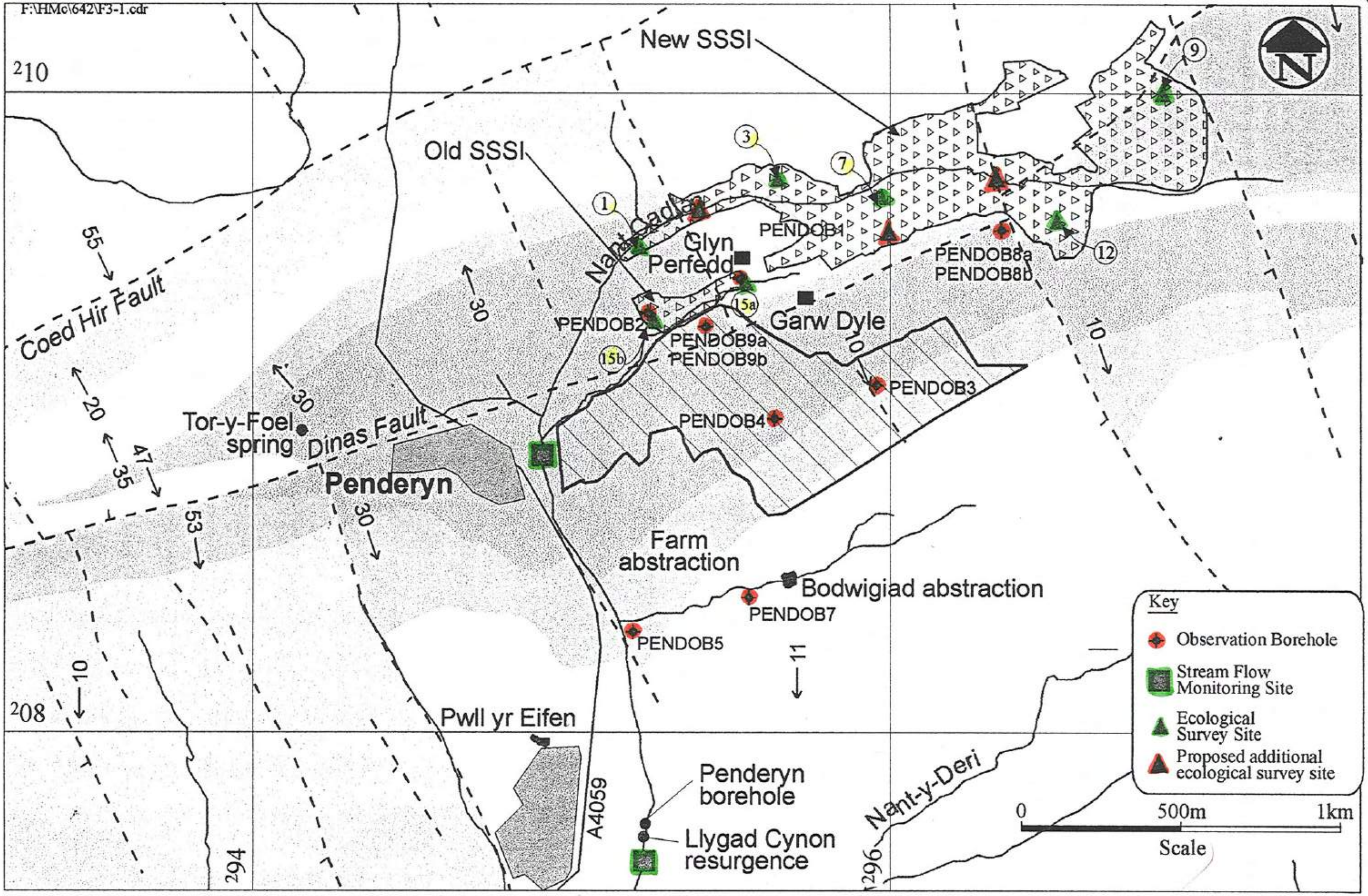
Drawing No.
P7/P/NS/3.4
Date
October 1997
PLAN 3.4



DATE : OCTOBER 1997 | Draw Ref. P7/P/WS/4a | ARC (SOUTH WALES) - PENDERYN QUARRY

LOCATION OF MONITORING POINTS

PLAN 4

Appendix B

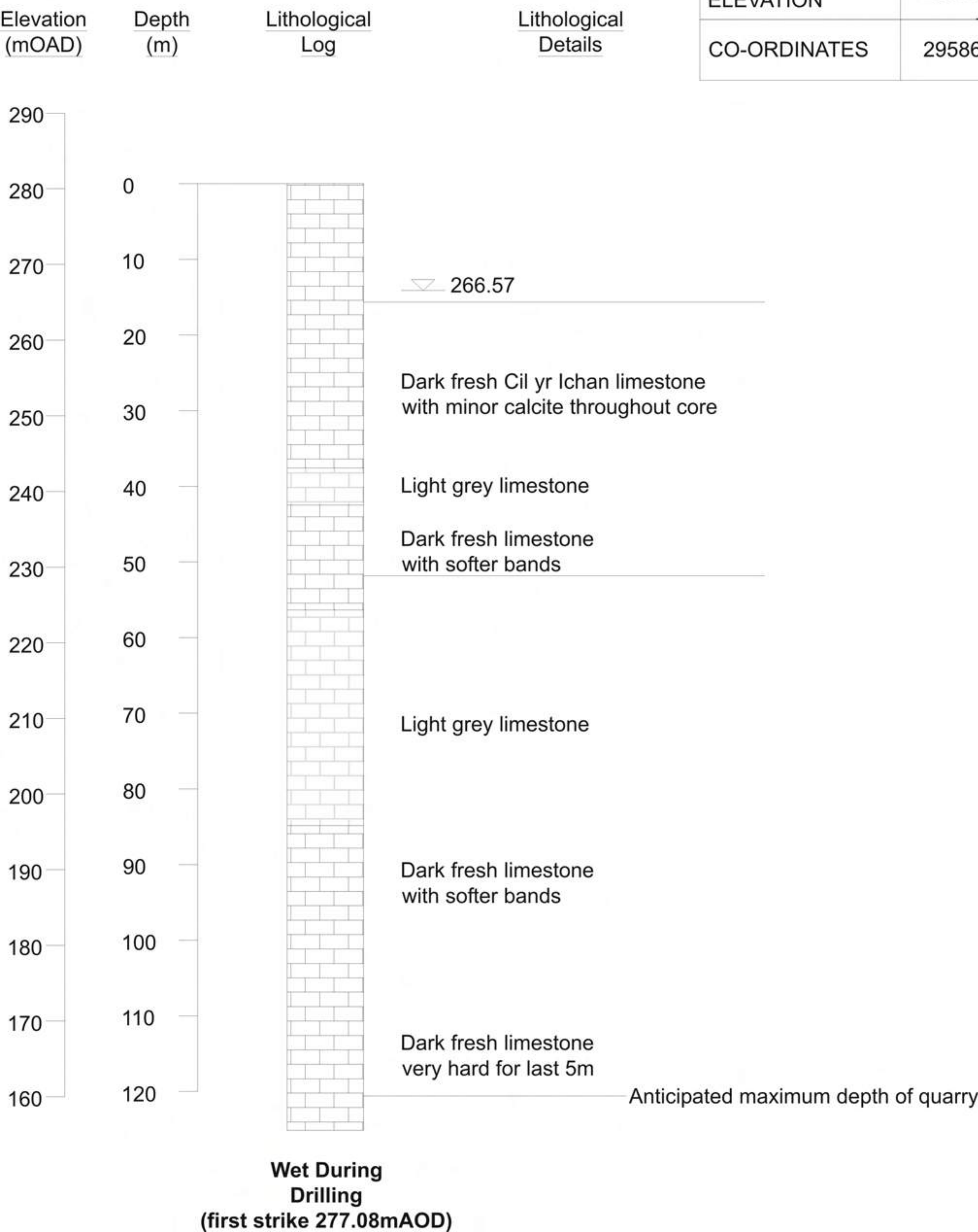
Lithological Borehole Logs

SITE ENGINEER	REES
BOREHOLE I.D.	OB1
GROUND ELEVATION	266.28m AOD
CO-ORDINATES	295478,209414

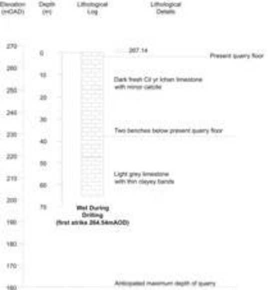
SITE ENGINEER	REES
BOREHOLE I.D.	OB2
GROUND ELEVATION	254.22m AOD
CO-ORDINATES	295223,209336

Depth (m)	Elevation (mOAD)	Lithological Log	Lithological Details
0.0	254.21		Dark brown PEAT with small traces of light brown sand.
			Light brown fine to coarse silty Sand with small to medium rounded to subrounded pebbles and cobbles. Bands of brown very stiff CLAY.
	250.00		Grey very stiff CLAY
5.0			
	245.00		
10.0			

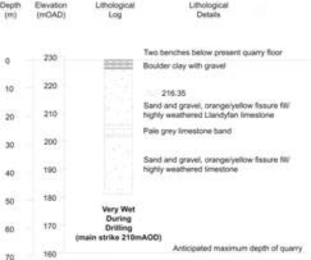
SITE ENGINEER	REES
BOREHOLE I.D.	OB3
GROUND ELEVATION	280.68m AOD
CO-ORDINATES	295868,209114



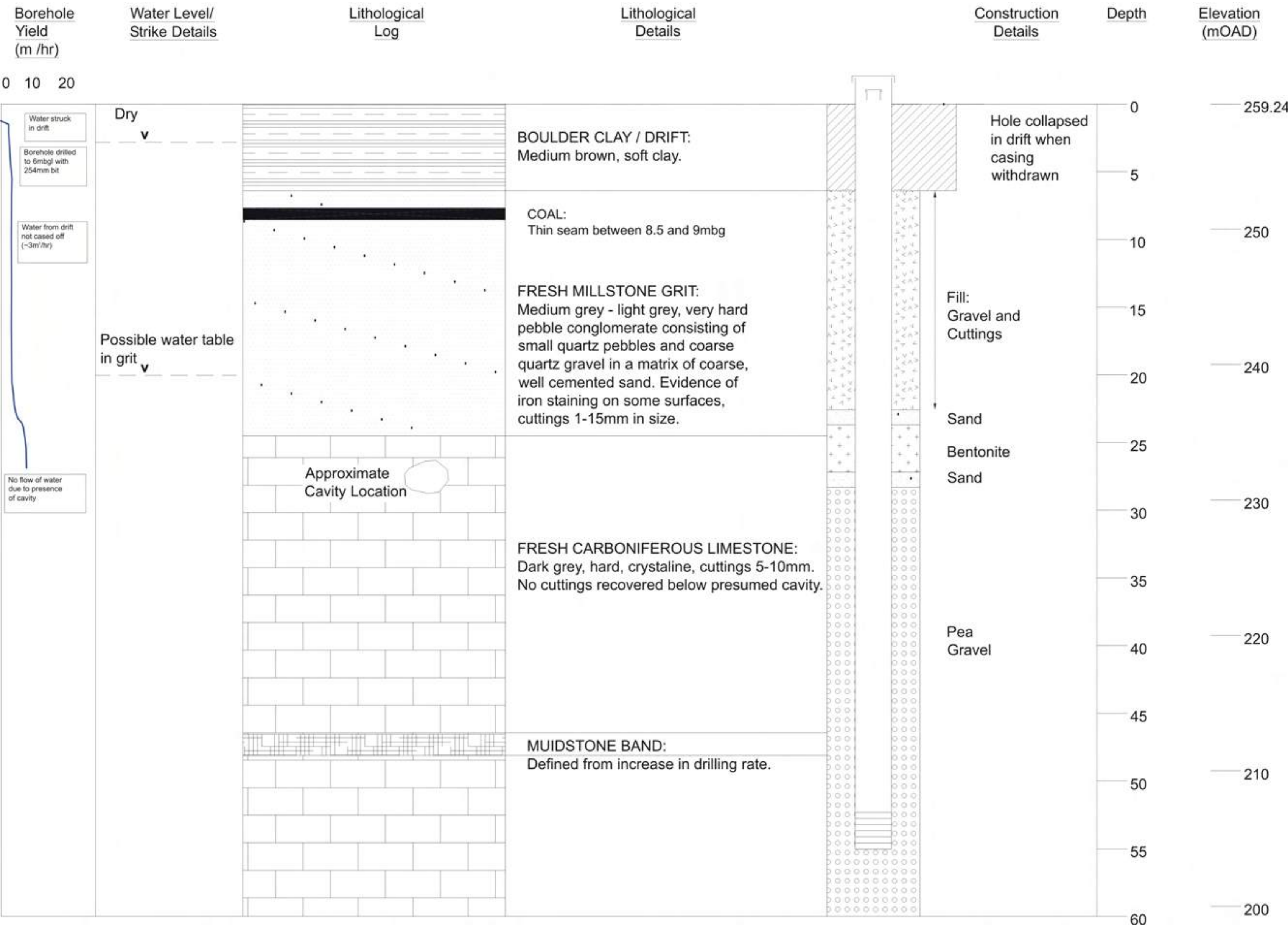
SITE ENGINEER	REES
BOREHOLE I.D.	OB4
DATE OF INSTALLATION	DECEMBER 1996
GROUND ELEVATION	268.34m AOD
MEASURING DATUM (0.6m below top of lower casing plate)	267.51m AOD
CO-ORDINATES	295581,209077



SITE ENGINEER	REES
BOREHOLE I.D.	OB5
GROUND ELEVATION	228.71m AOD
CO-ORDINATES	295176,208359

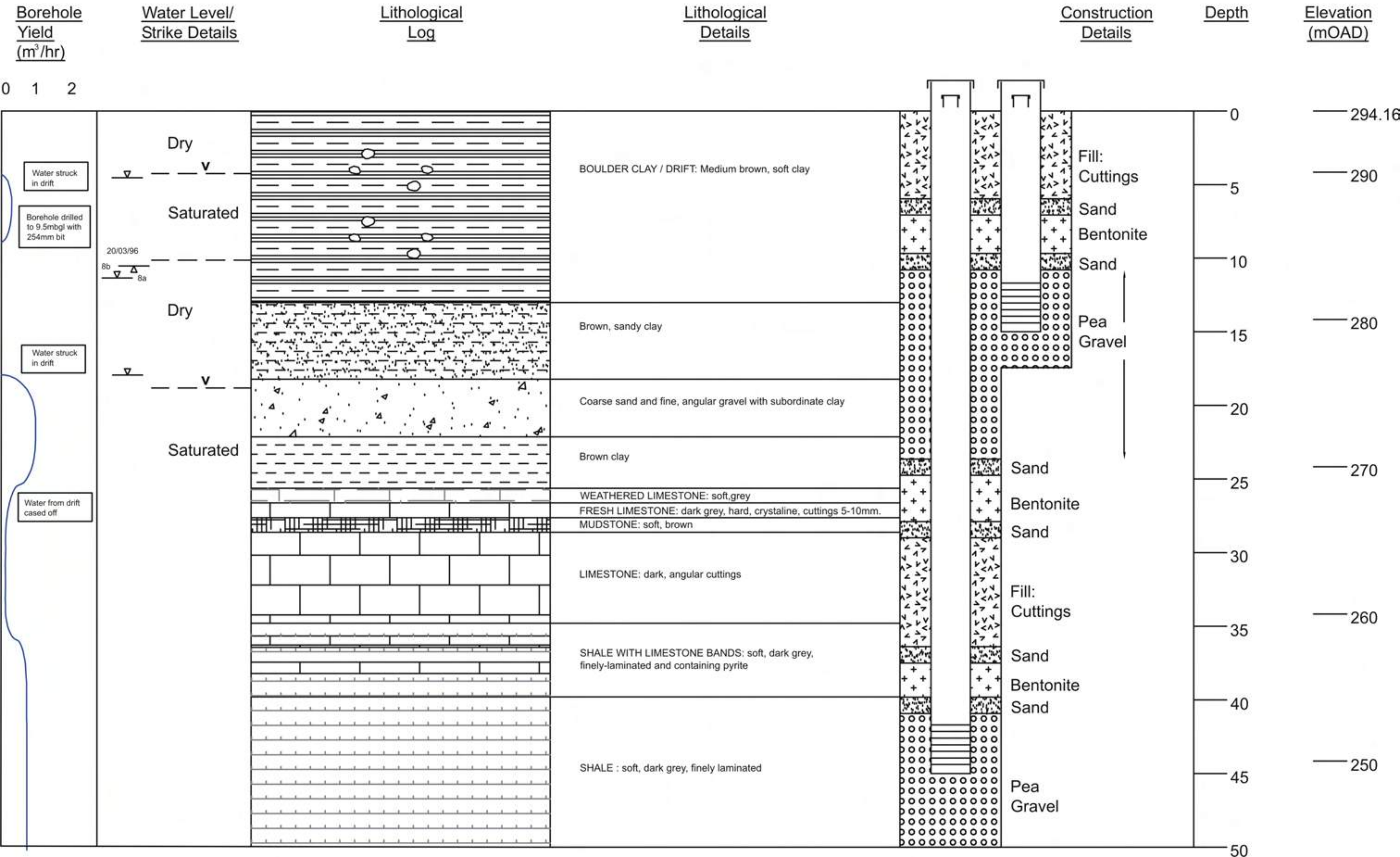


BOREHOLE ID:	**OB07**
CO-ORDINATES:	**295540,208441**
ELEVATION: (mAOD)	**259.24**

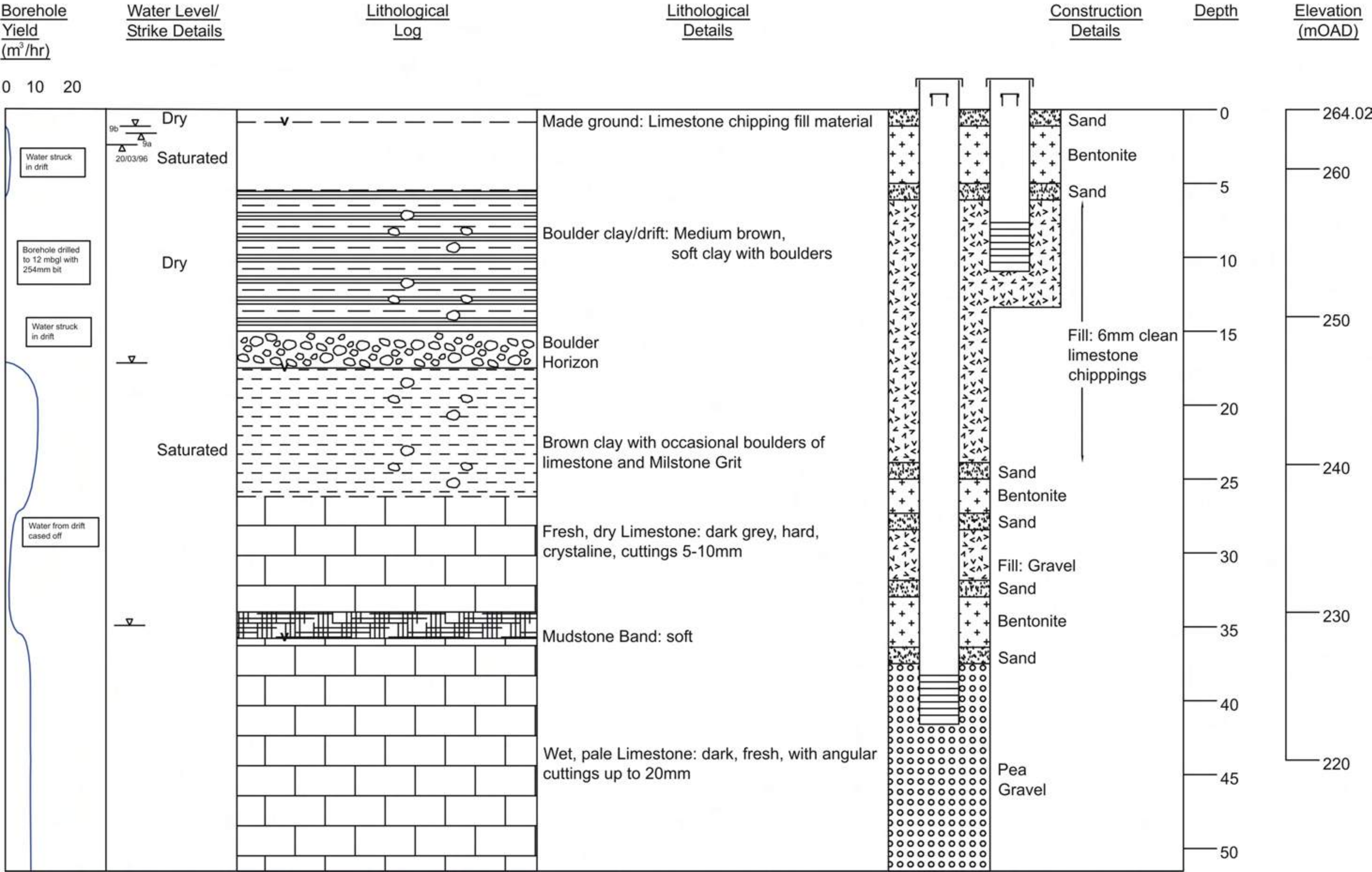


BOREHOLE ID:	OB08
CO-ORDINATES:	296352,209604
ELEVATION: (mAOD)	294.16

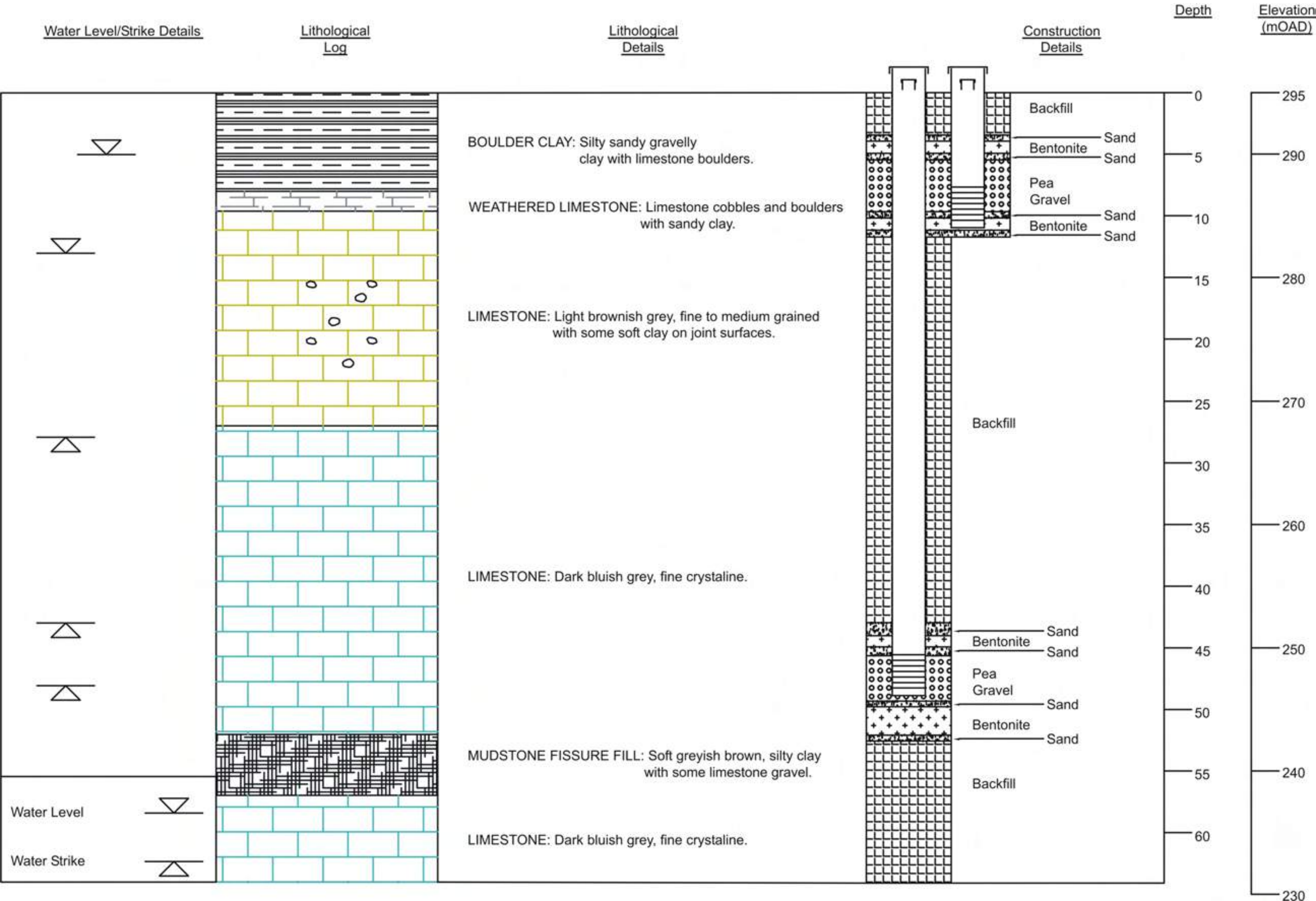
OB8



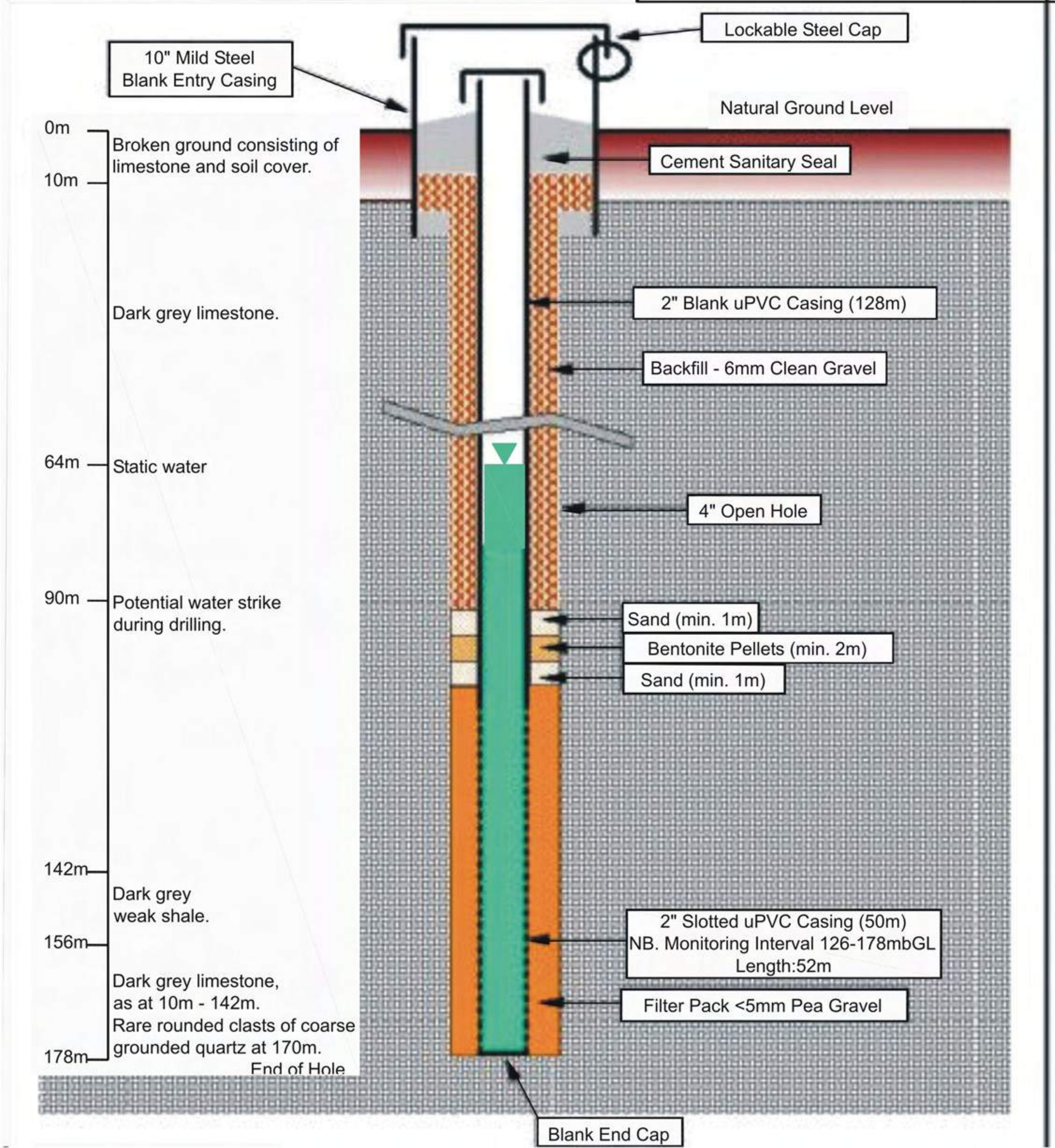
BOREHOLE ID:	**OB09**
CO-ORDINATES:	**295442,209317**
ELEVATION: (mAOD)	**264.02**

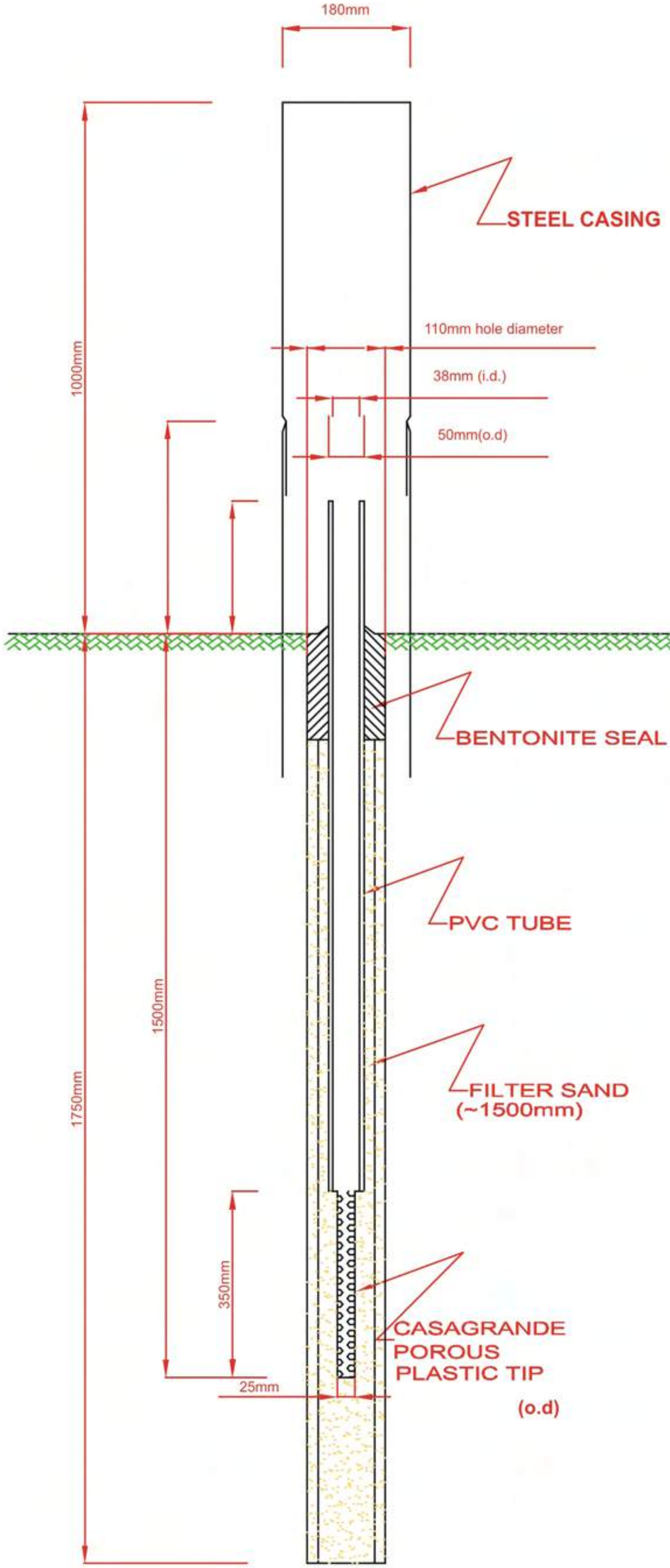


BOREHOLE ID:	OB10
CO-ORDINATES:	295850,209390
ELEVATION: (mAOD)	~295



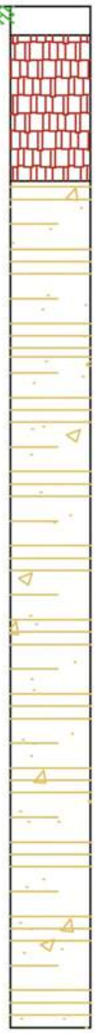
SITE ENGINEER	REES
PIEZOMETER I.D.	OB11
DATE OF INSTALLATION	07/06/03
GROUND ELEVATION	333.18m
DEPTH OF HOLE	178m
DATUM ELEVATION (top of plastic casing)	333.43m AOD
CO-ORDINATES	295842,209174





SITE ENGINEER	REES
PIEZOMETER I.D.	P1c(L)
DATE OF INSTALLATION	15/04/03
GROUND ELEVATION	258.46m AOD
MEASURING DATUM (0.08m below top of lower casing pipe)	259.02m AOD
CO-ORDINATES	295212,209511

GEOLOGICAL LOG



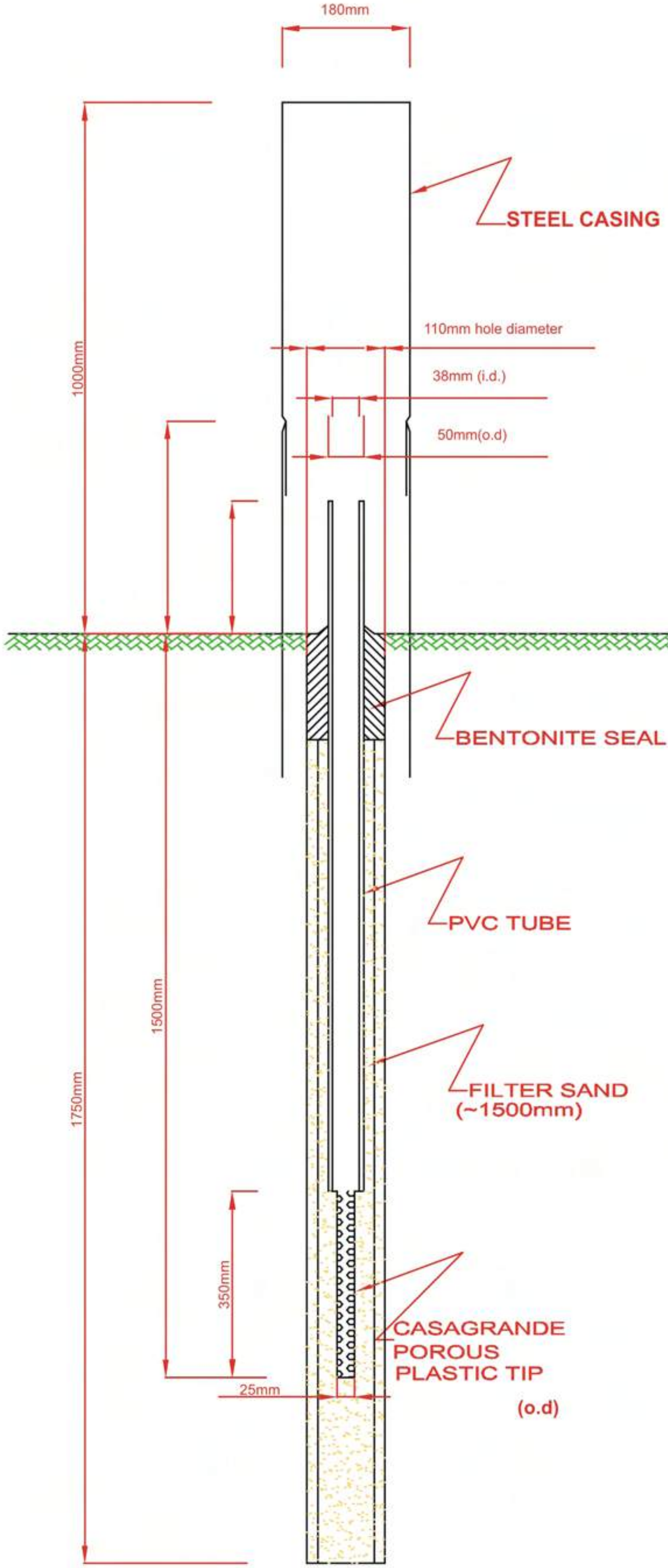
0m - 0.05m Grass cover with roots.

0.05m - 0.3m Dark brown humic (peaty) material with roots. Slightly sandy clayey soil

0.3m - 0.6m Light grey/brown with patches of red/yellow/green due to iron redox chemistry. Moist slightly clayey silty sand. Rock flour at base with angular quartz clasts up to 25mm.

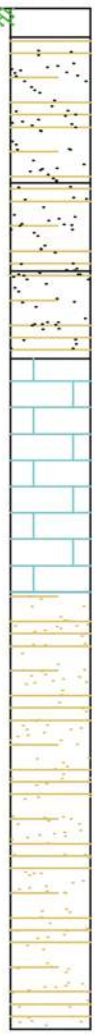
0.6m - 1.75m No core recovery as rock encountered at 0.70m and driven downwards.

1750mm
END OF HOLE



SITE ENGINEER	REES
PIEZOMETER I.D.	P7d (L)
DATE OF INSTALLATION	15/04/03
GROUND ELEVATION	279.74m AOD
MEASURING DATUM (0.08m below top of lower casing pipe)	280.37m AOD
CO-ORDINATES	296001,209716

GEOLOGICAL LOG



0m - 0.05m Grass cover with roots.

0.05m - 0.3m Light brown slightly sandy silty clay with quartz clasts up to 25mm.

0.3m - 0.45m Light grey silty clayey fine sand with quartz clasts up to 5mm.

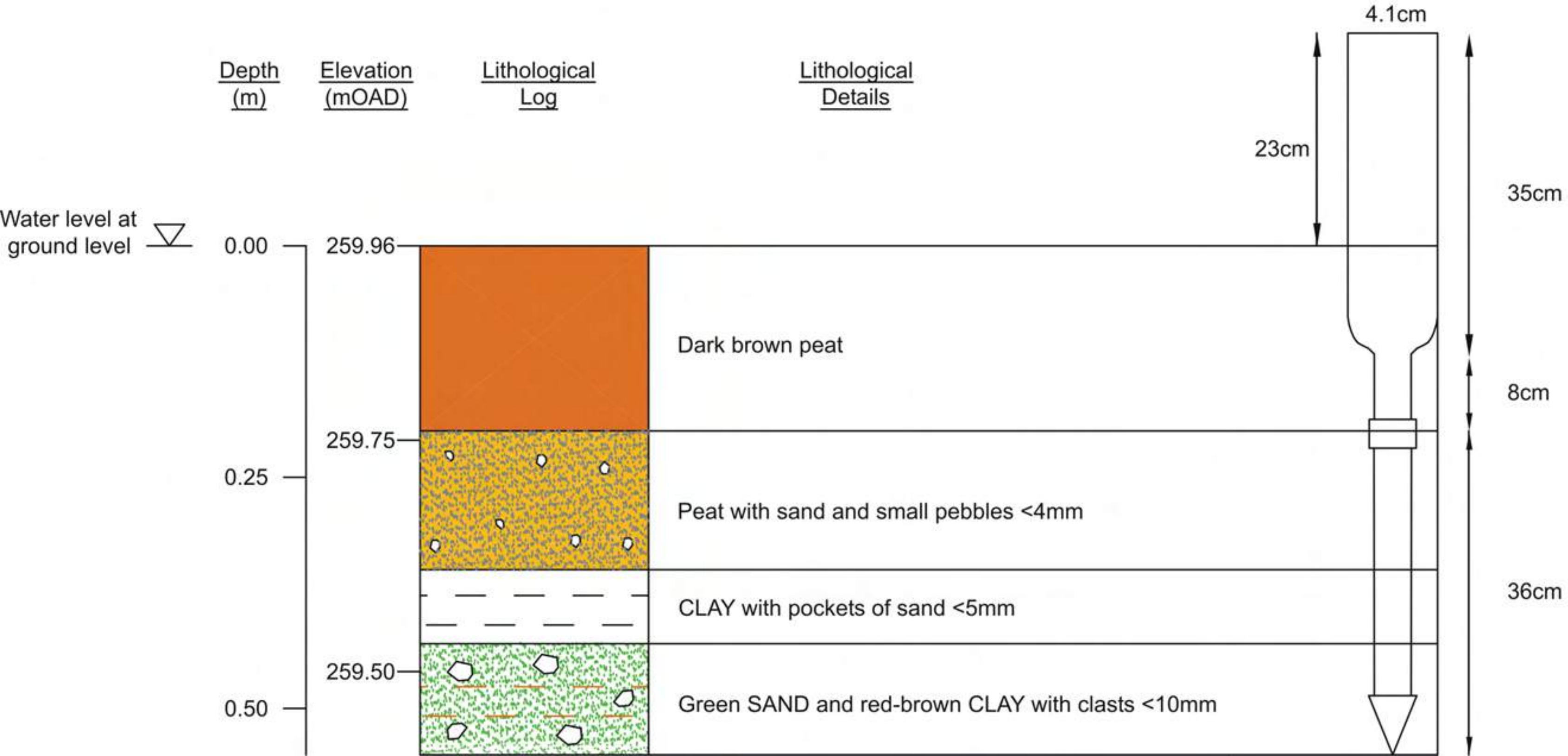
0.45m - 0.6m Light brown/tan moist sandy silty clay with rare quartz clasts up to 10mm.

0.6m - 1.00m Limestone boulder.

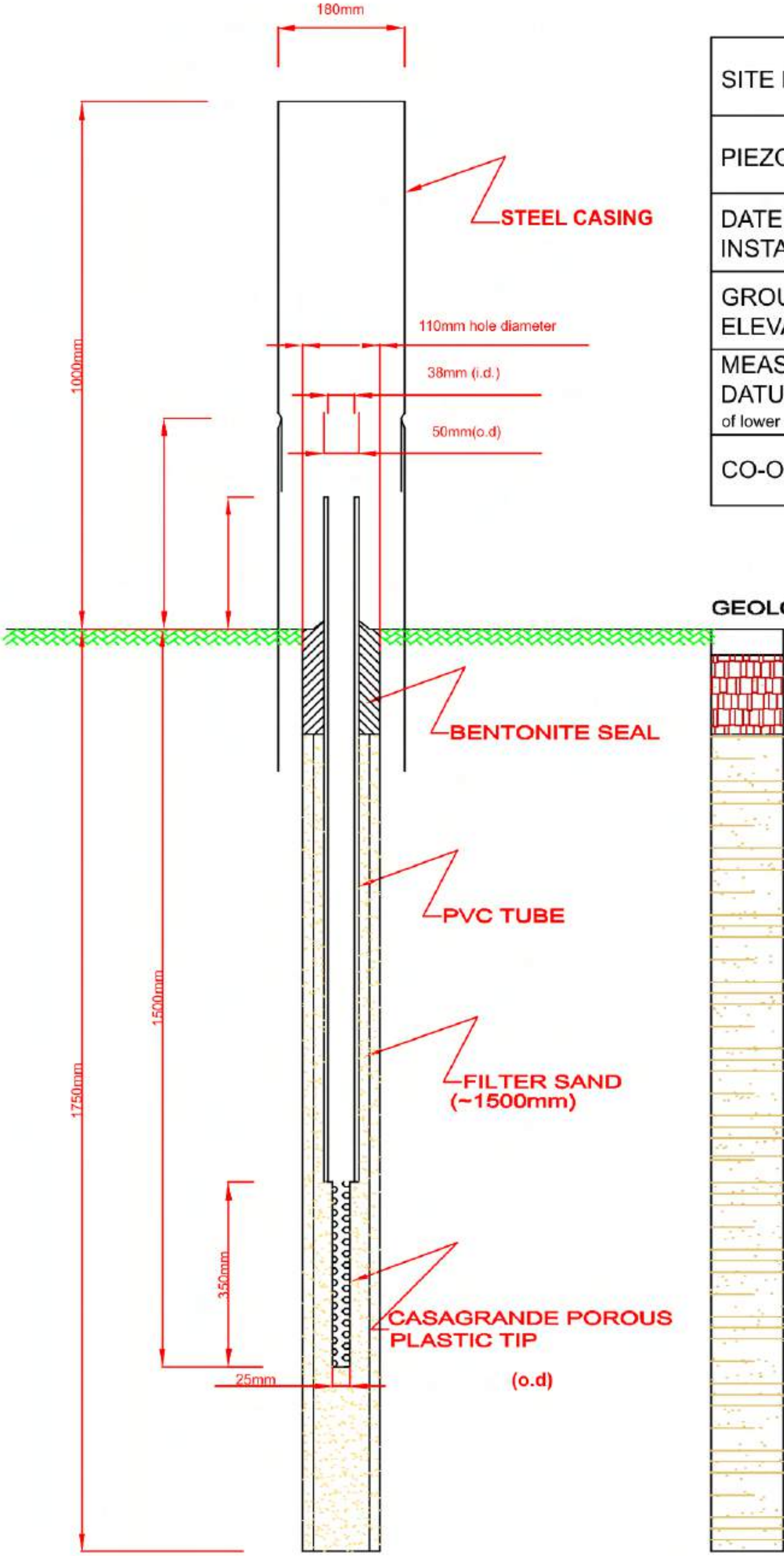
1.00m - 1.75m Dark brown wet silty sandy clay with rare angular limestone clasts up to 25mm.

1750mm
END OF HOLE

PIEZOMETER ID:	**P15c(L)**
CO-ORDINATES:	**295391,209306**
ELEVATION: (mAOD)	**259.96**



SITE ENGINEER	REES
PIEZOMETER I.D.	P16a(L)
DATE OF INSTALLATION	15/04/03
GROUND ELEVATION	262.71m AOD
MEASURING DATUM (0.08m below top of lower casing pipe)	263.15m AOD
CO-ORDINATES	295451,209648



GEOLOGICAL LOG

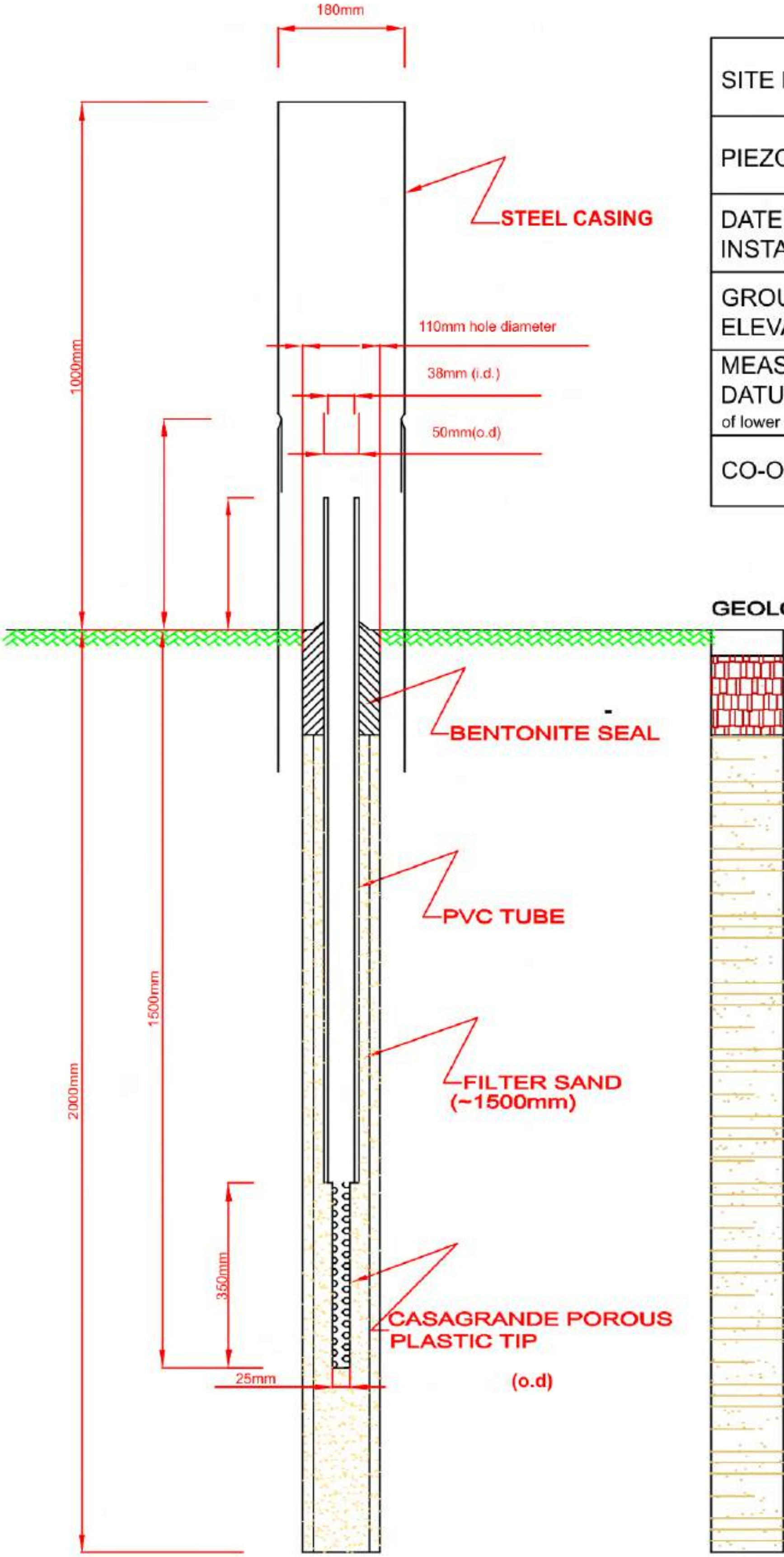
0m - 0.05m Grass cover with roots.
0.05m - 0.2m Dark brown humic (peaty) material with roots. Slightly sandy silty clay with quartz clasts.

0.2m - 1.00m Light brown moist slightly clayey silty sand with patches of red and yellow due to iron redox chemistry.

1.00m - 1.75m Boulder encountered. No further core recovered.

1750mm
END OF HOLE

SITE ENGINEER	REES
PIEZOMETER I.D.	P17a(L)
DATE OF INSTALLATION	16/04/03
GROUND ELEVATION	265.57m AOD
MEASURING DATUM (0.08m below top of lower casing pipe)	266.02m AOD
CO-ORDINATES	295603,209694



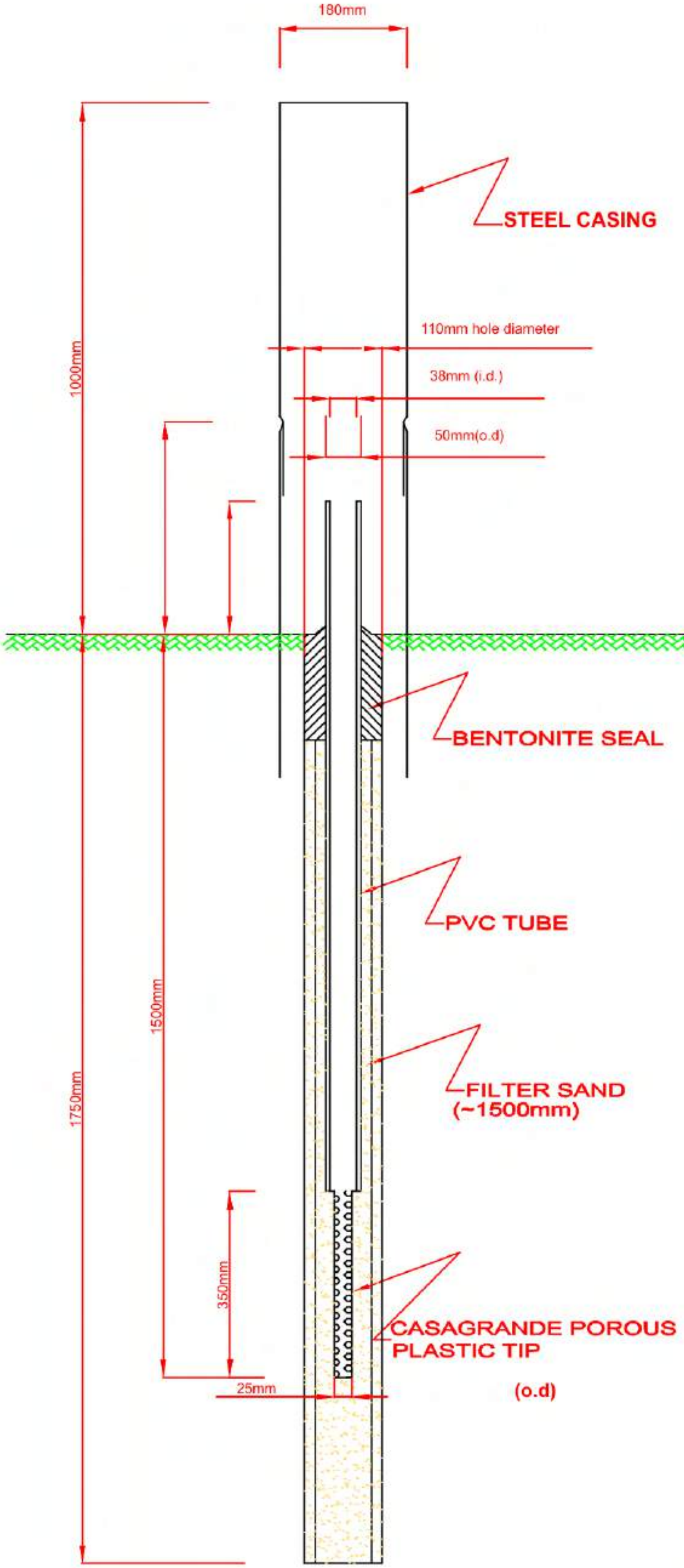
GEOLOGICAL LOG

0m - 0.05m Grass cover with roots.

0.05m - 0.3m Dark brown moist humic (peaty) material with roots. Slightly sandy silty clay with small rare clasts of quartz .

0.3m - 2.00m Light grey/tan with patches of red and yellow due to iron chemistry. Fine - medium grey slightly clayey silty sand with angular clasts of quartz and sandstone. Very clayey and grey towards base. Core is consolidated in places.

2000mm
END OF HOLE



SITE ENGINEER	REES
PIEZOMETER I.D.	P18a(L)
DATE OF INSTALLATION	16/04/03
GROUND ELEVATION	281.12m AOD
MEASURING DATUM (0.08m below top of lower casing pipe)	281.56m AOD
CO-ORDINATES	296289,209806

GEOLOGICAL LOG

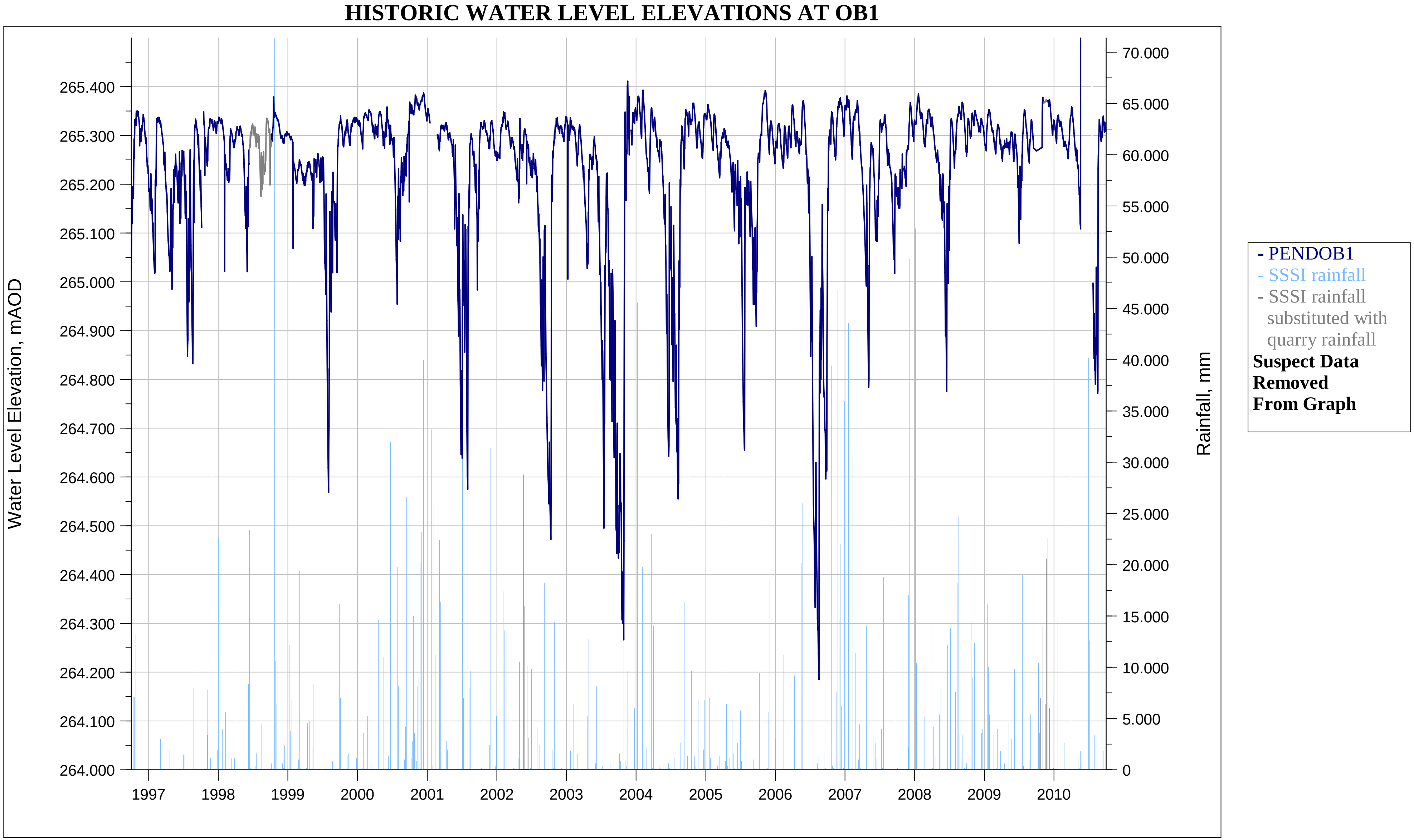
0m-0.05m Grass cover with roots.
0.05m - 1.0m Very soft, dark brown moist humic (peaty) material. Core recovery ~ 50% as ground compacted during drilling.

1.00m - 2.00m Same as above but ground conditions wetter as piezometer is located on flood plain.

1750mm
END OF HOLE

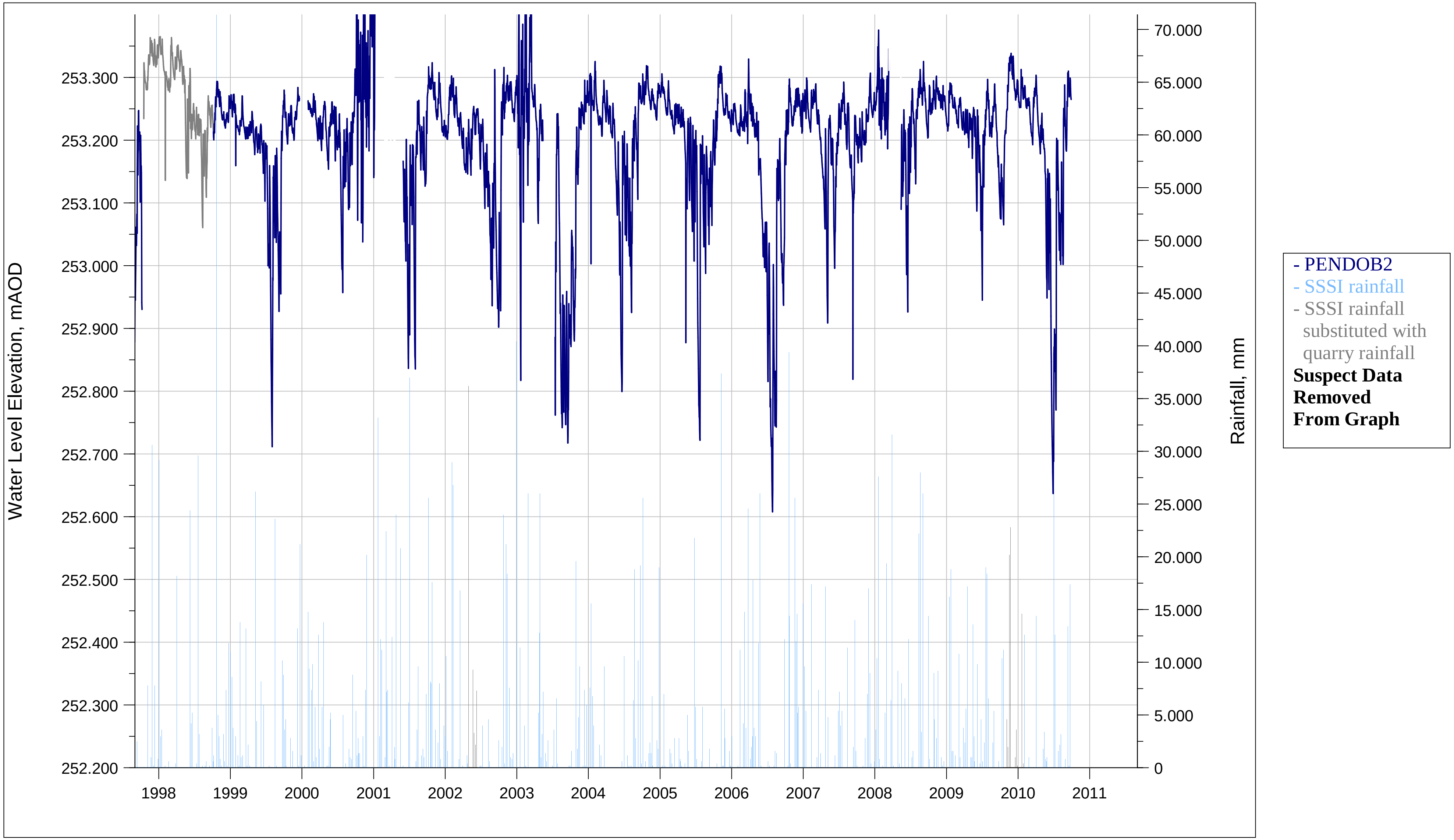
Appendix C

Borehole And Piezometer Hydrographs

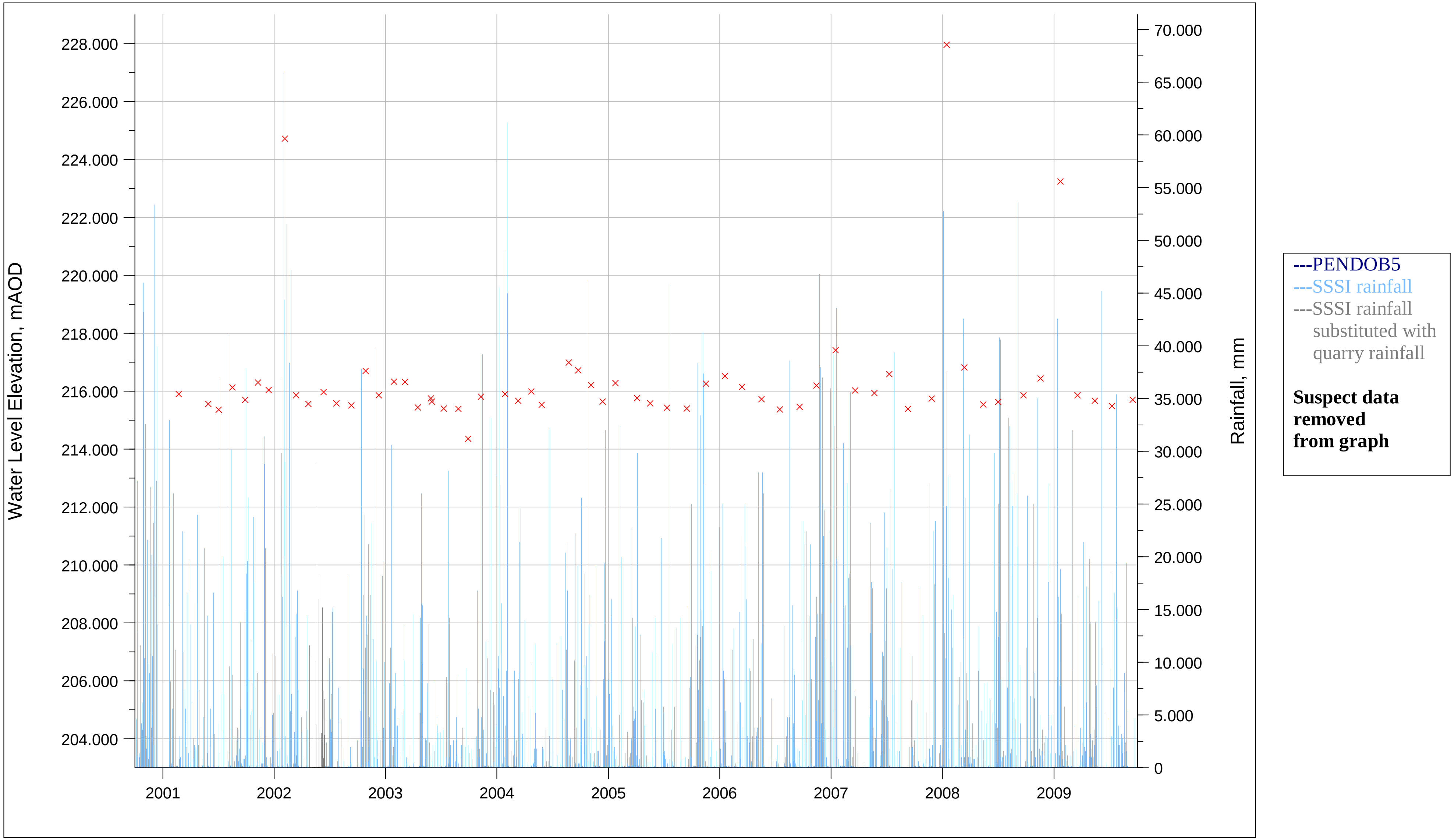


X:\REPORTS\App A1\OB1_A1_graph.hrf

HISTORIC WATER LEVEL ELEVATIONS AT OB2



HISTORIC WATER LEVEL ELEVATIONS AT OB5



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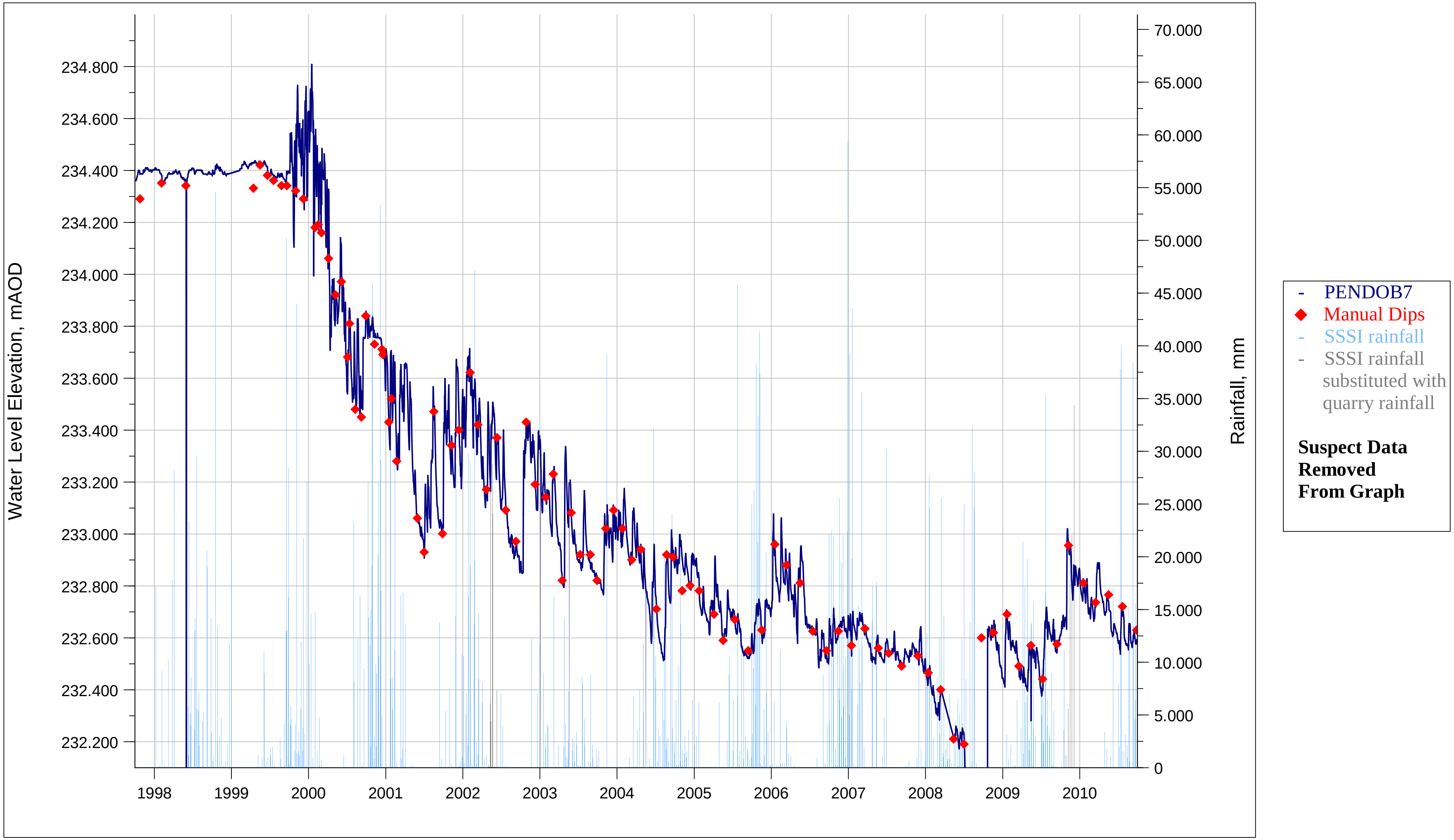
HISTORIC WATER LEVEL ELEVATIONS AT OB7



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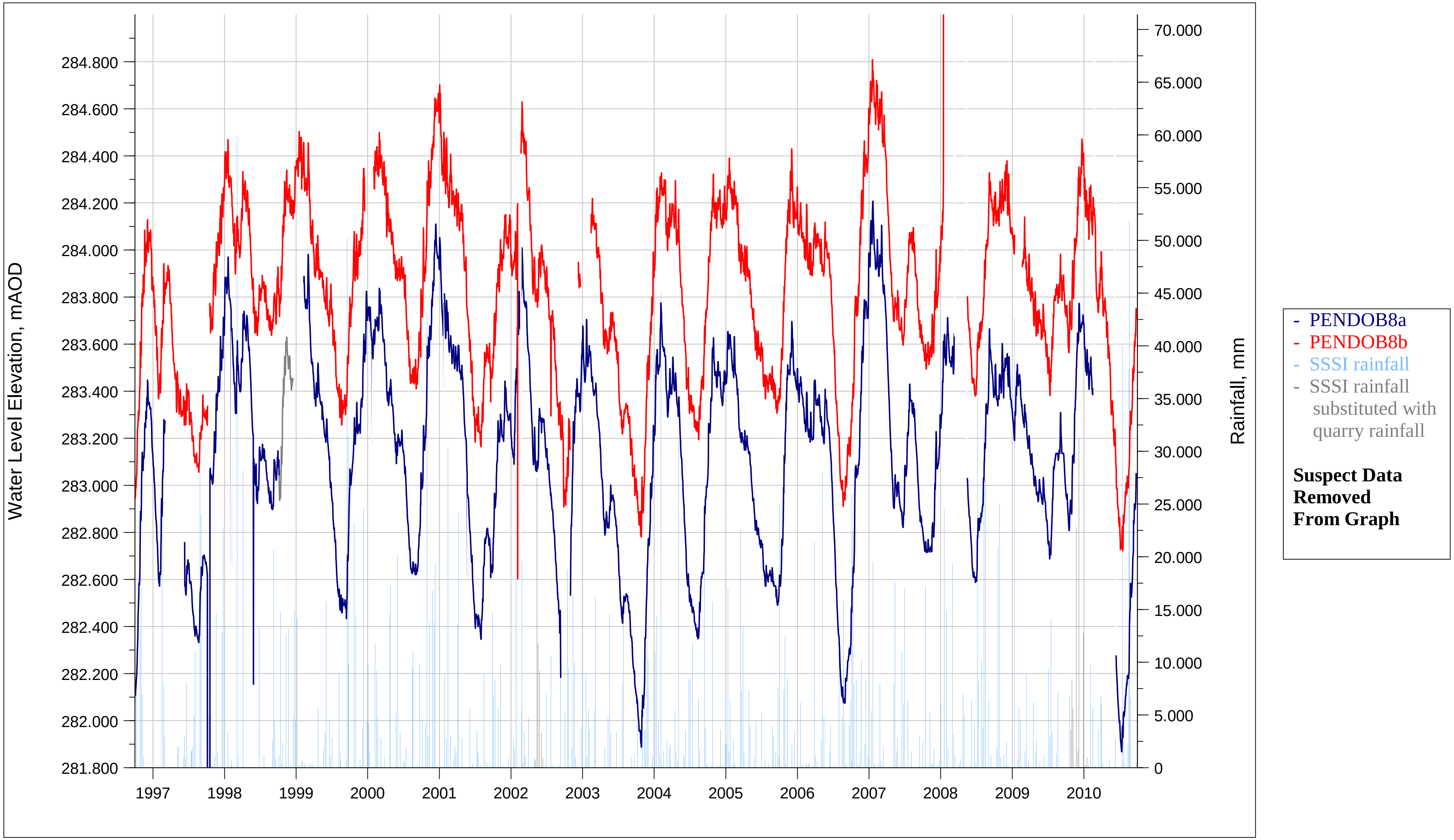
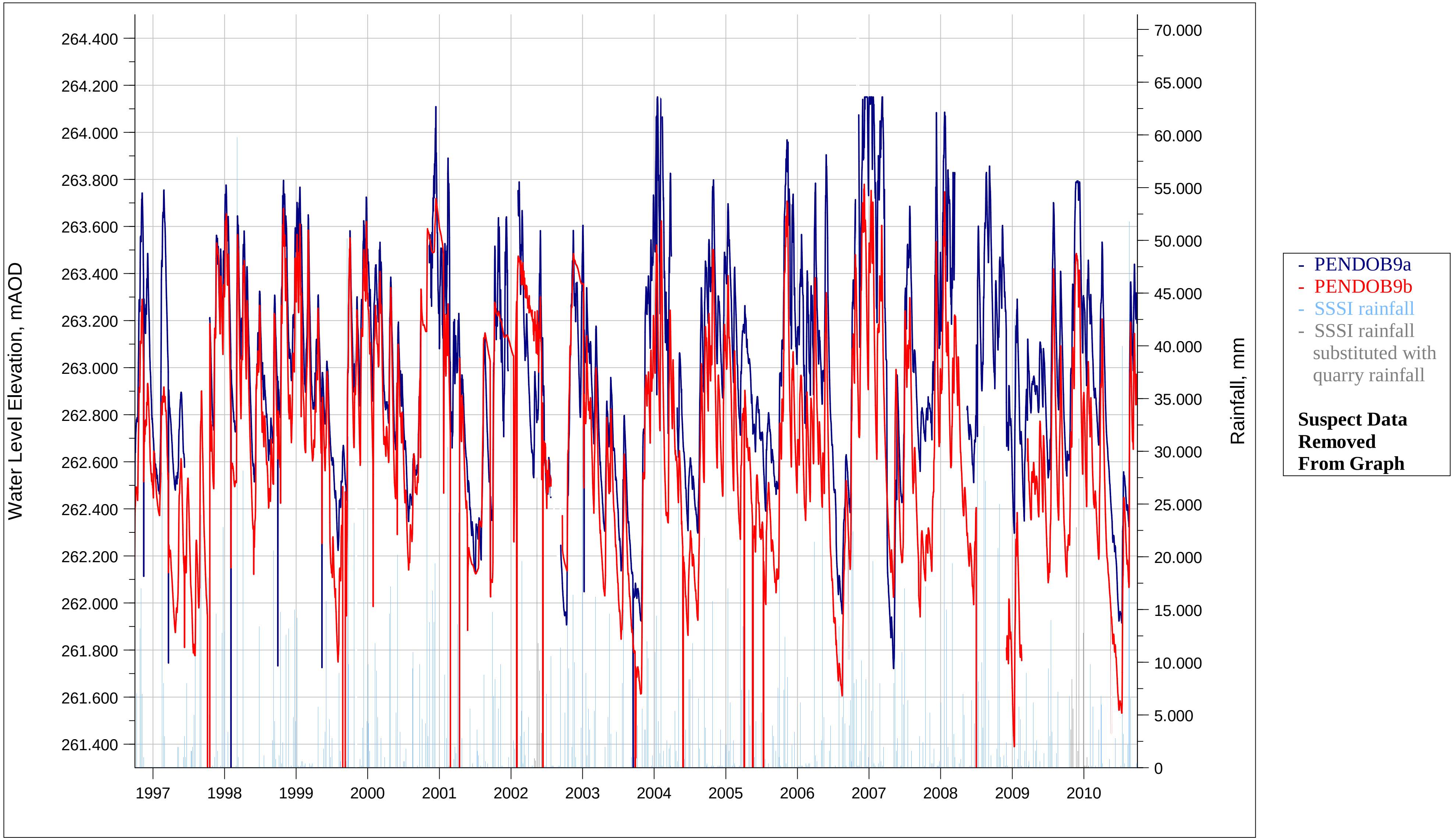
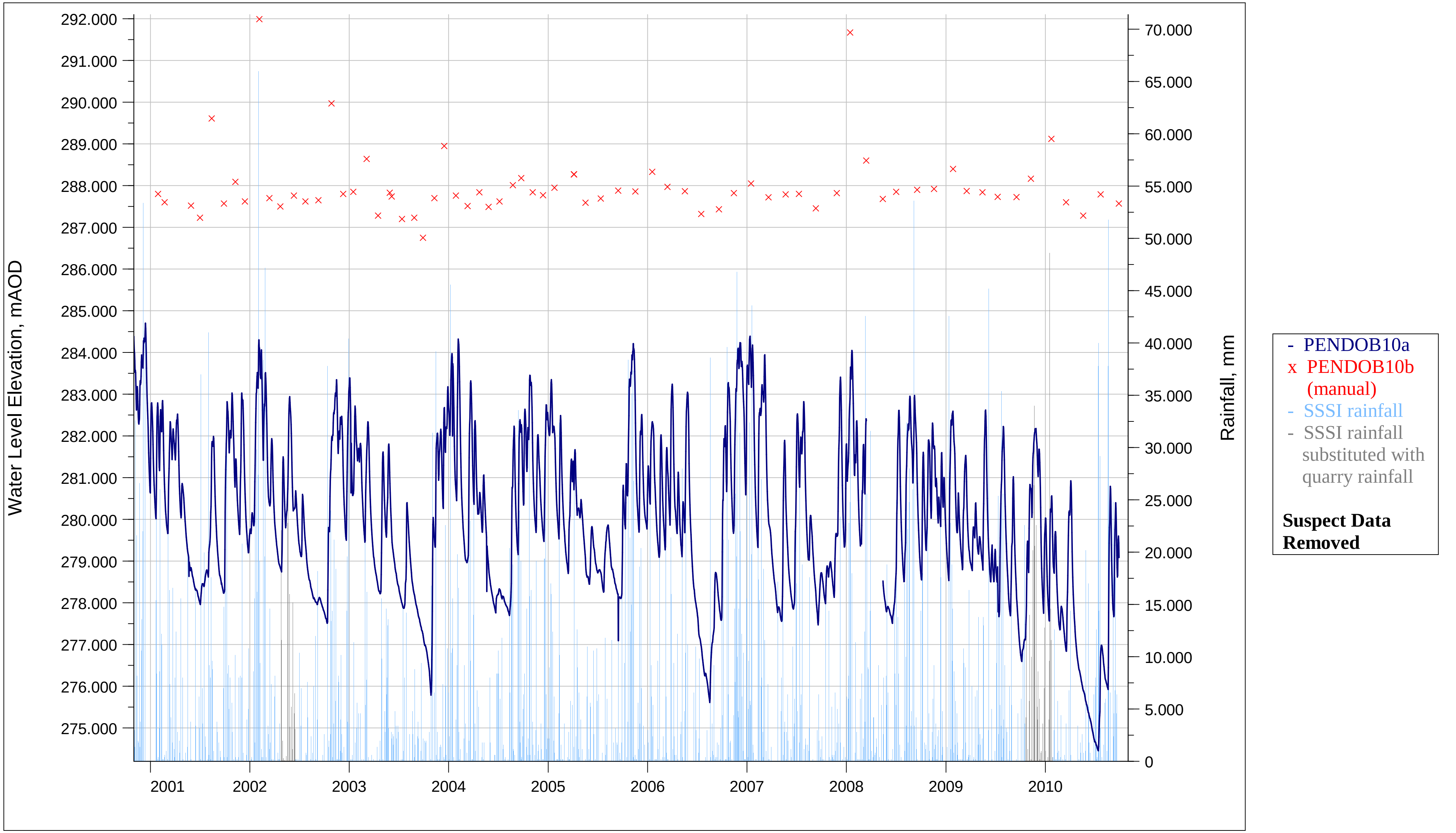
HISTORIC WATER LEVEL ELEVATIONS AT OB8



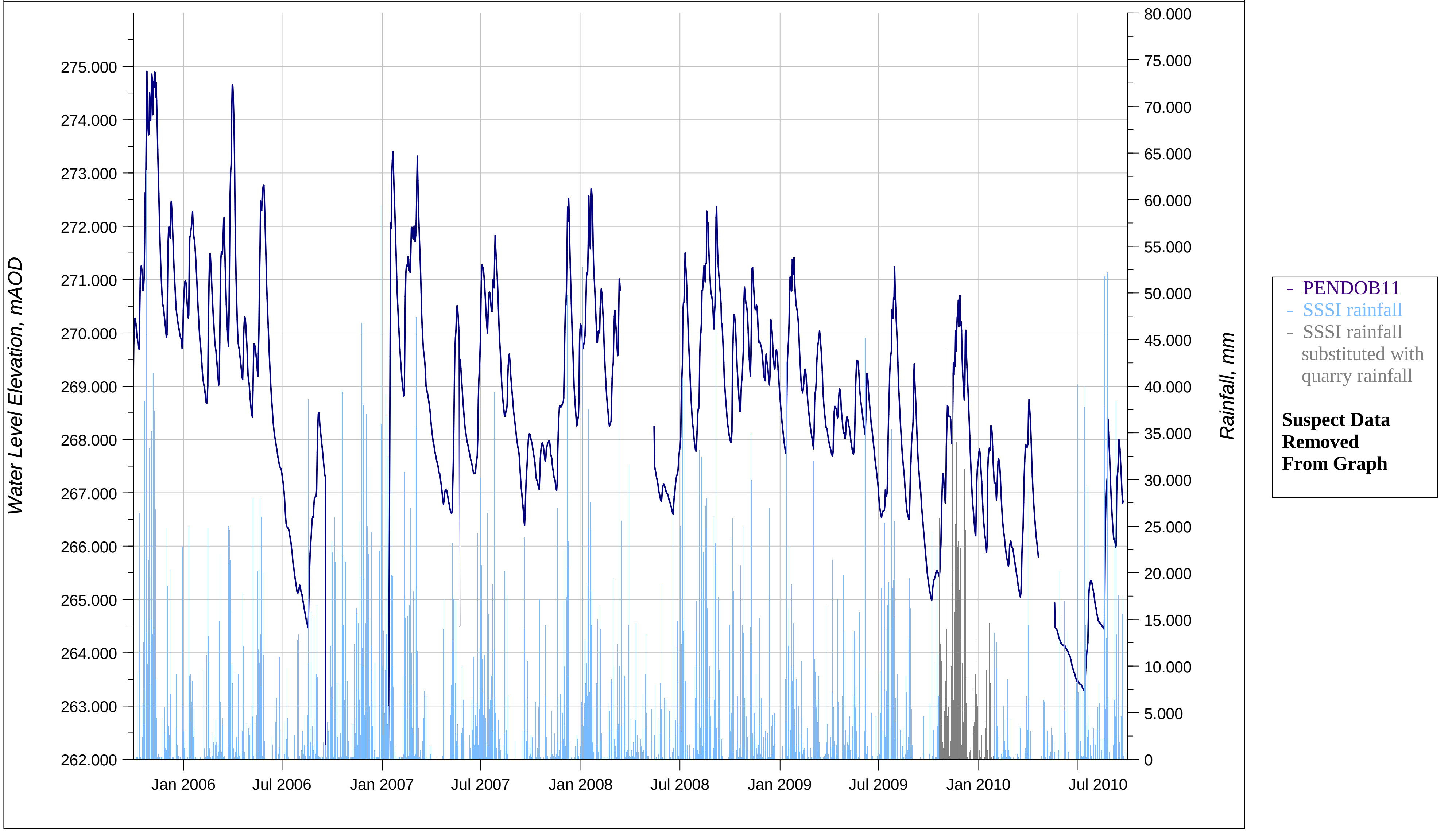
HISTORIC WATER LEVEL ELEVATIONS AT OB9



HISTORIC WATER LEVEL ELEVATIONS AT OB10

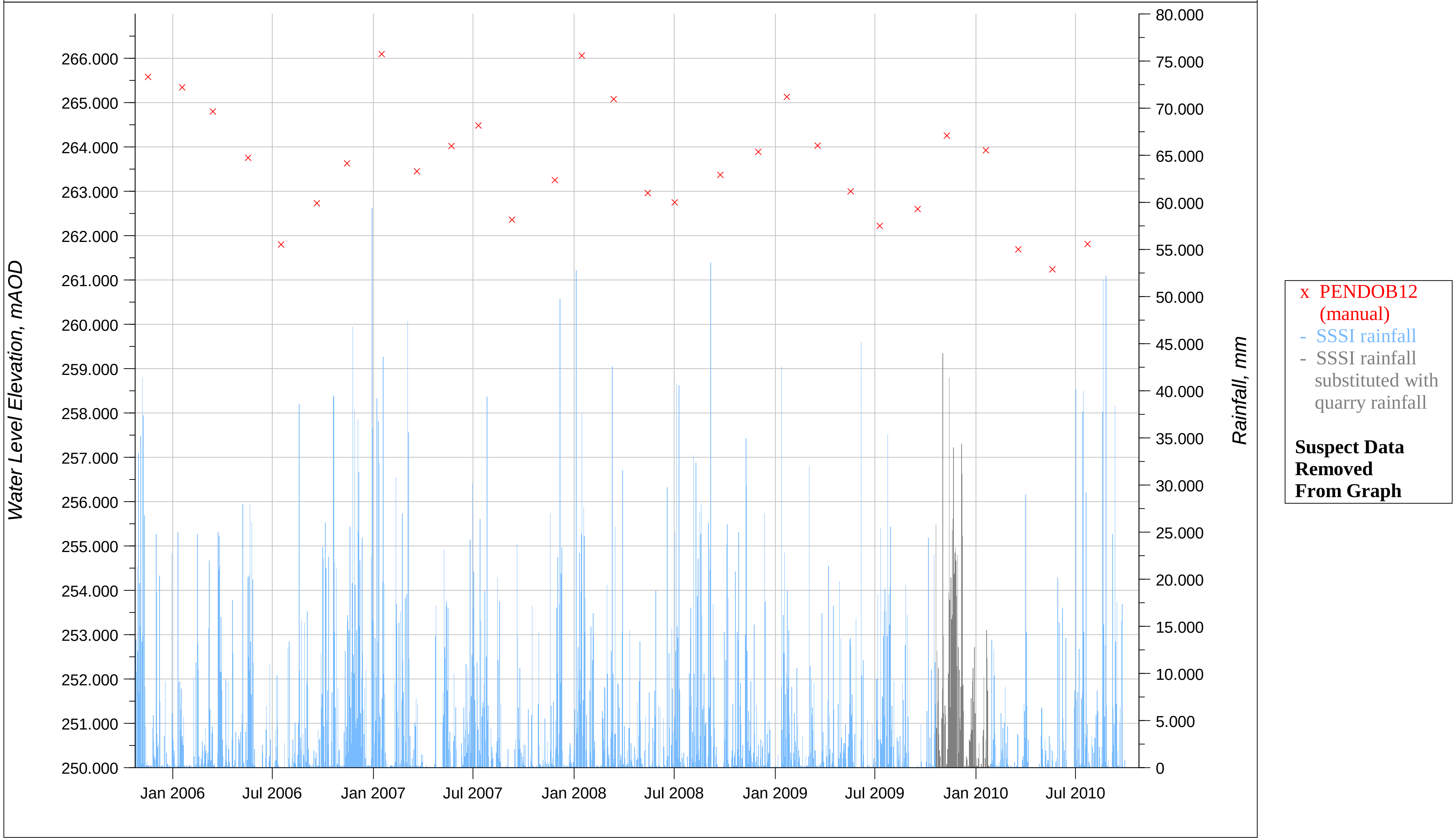


HISTORIC WATER LEVEL ELEVATIONS AT OB11



X:\REPORTS\App A1\OB11_A1_graph.hrf

HISTORIC WATER LEVEL ELEVATIONS AT OB12



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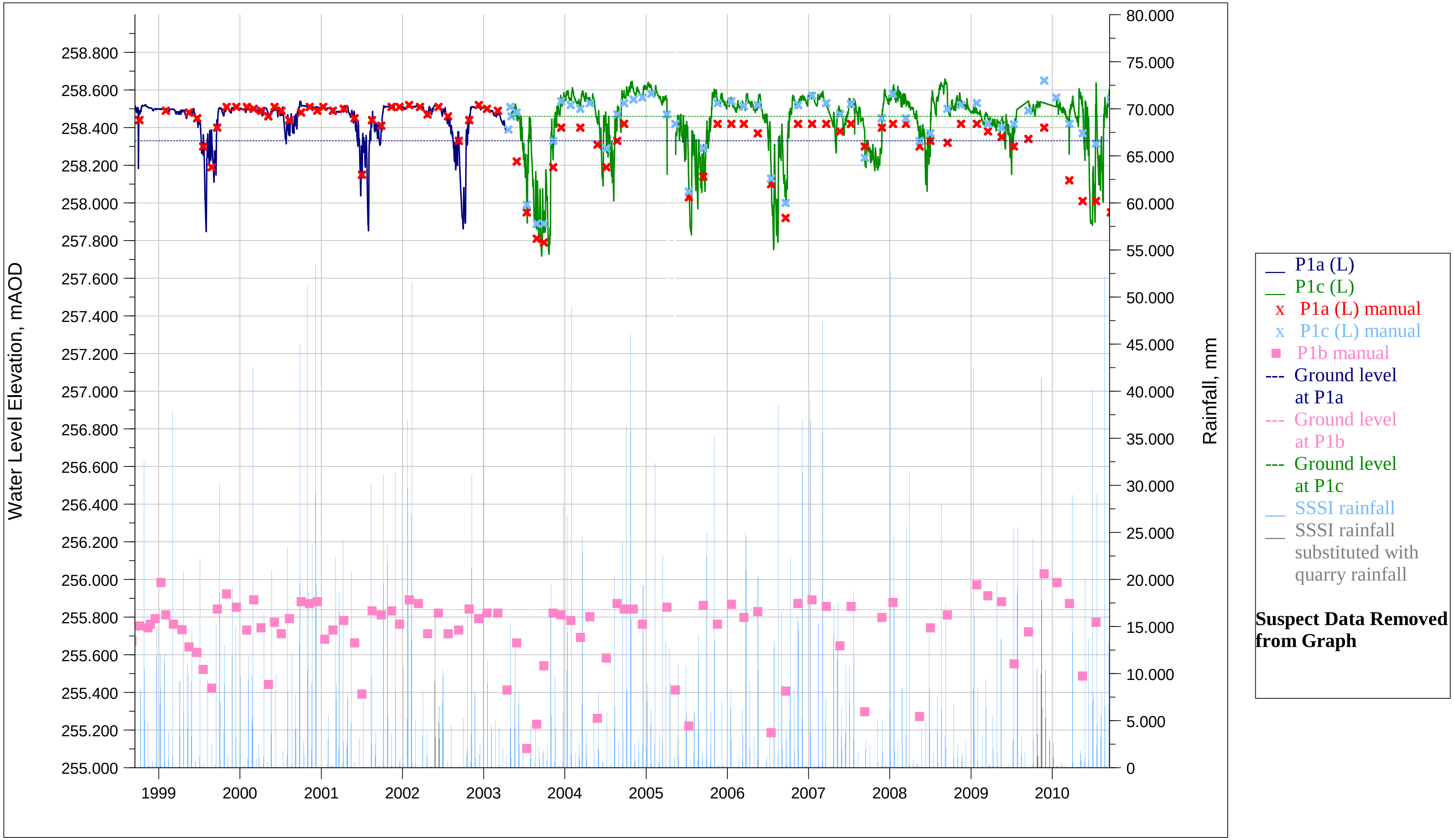
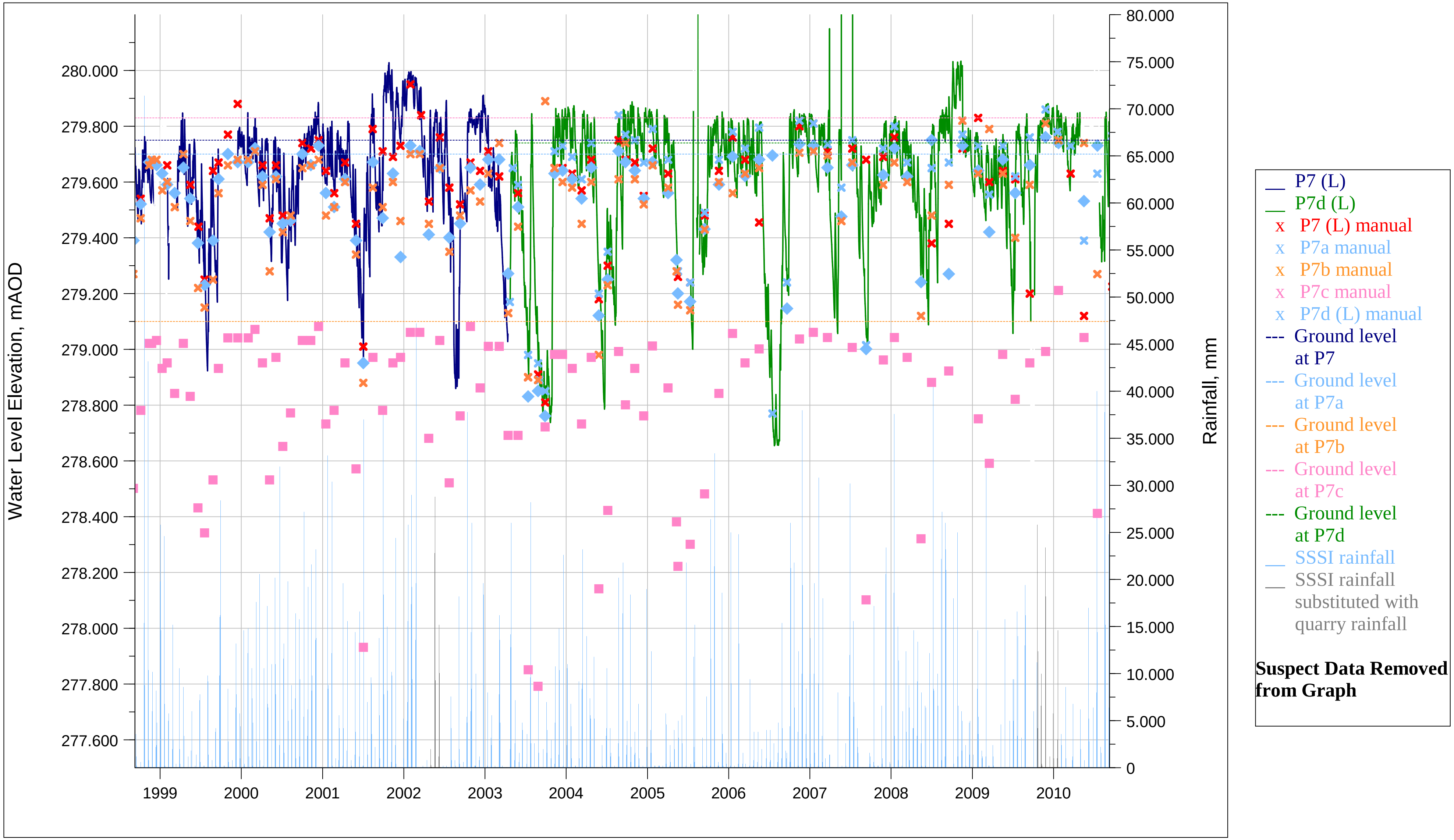
HISTORIC WATER LEVEL ELEVATIONS AT P1

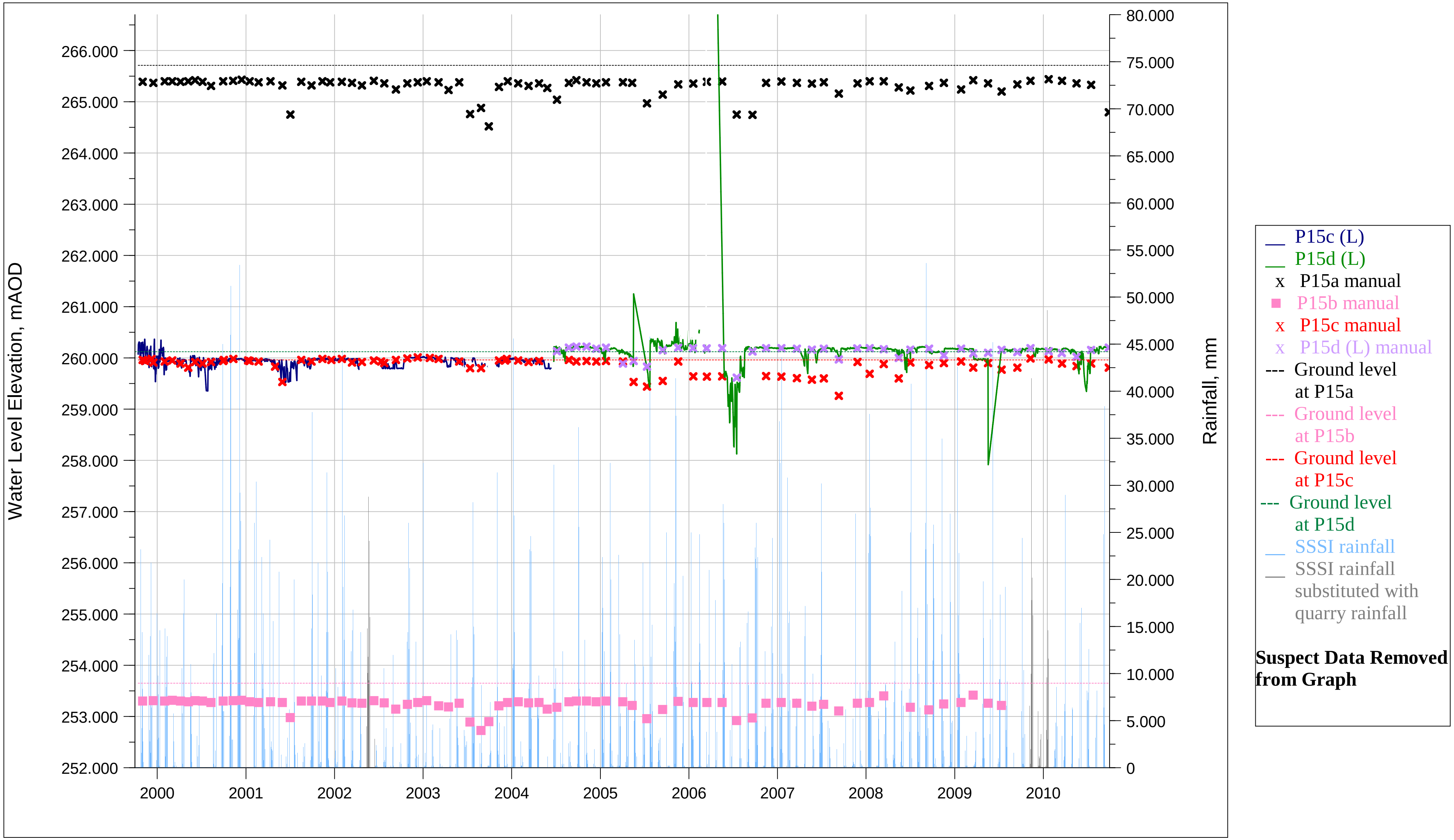


X:\REPORTS\App B1\Elevation\P1(L)_B1_Elev_graph.hrf

HISTORIC WATER LEVEL ELEVATIONS AT P7



HISTORIC WATER ELEVATIONS AT P15



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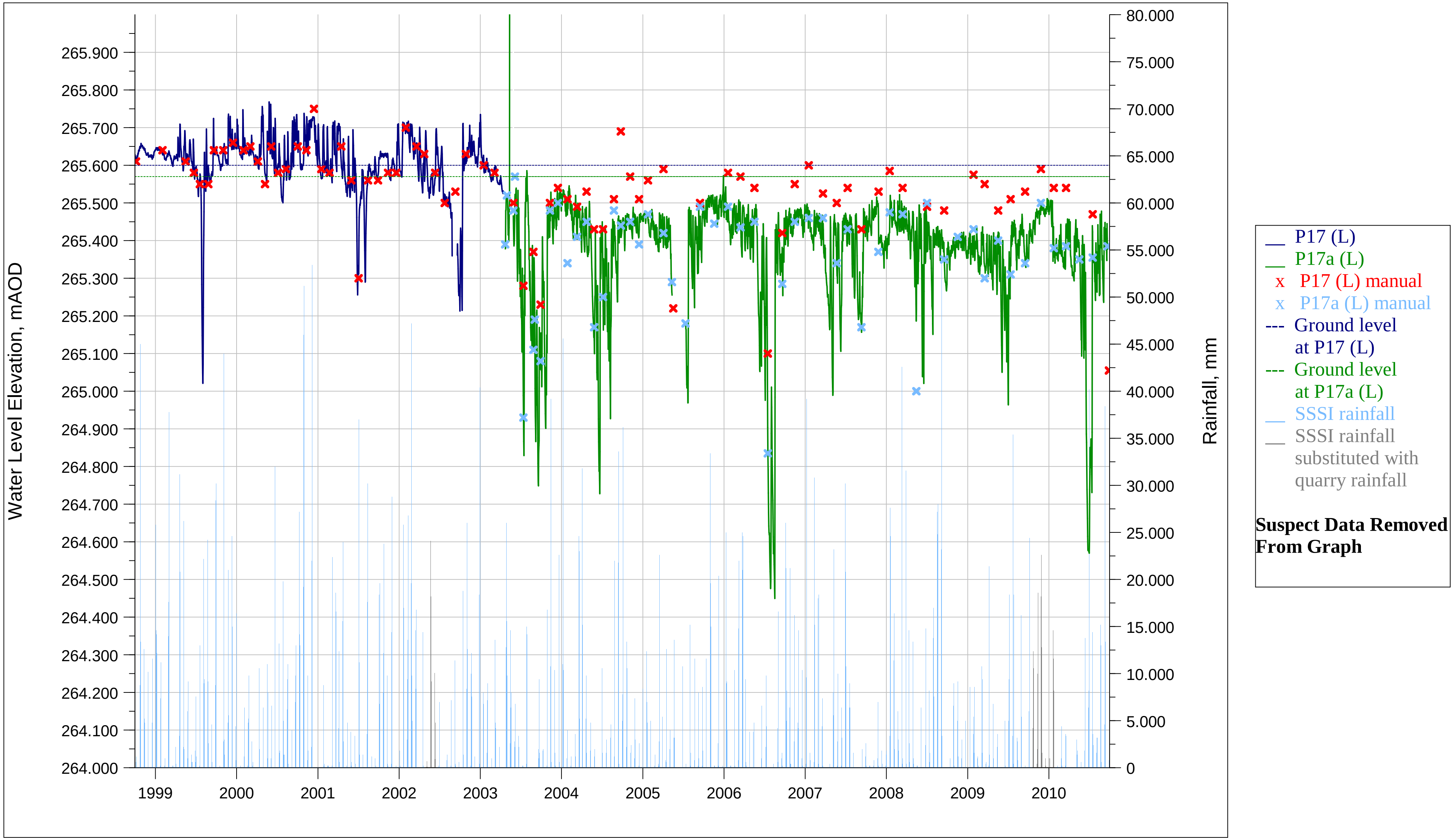
HISTORIC WATER LEVEL ELEVATIONS AT P17



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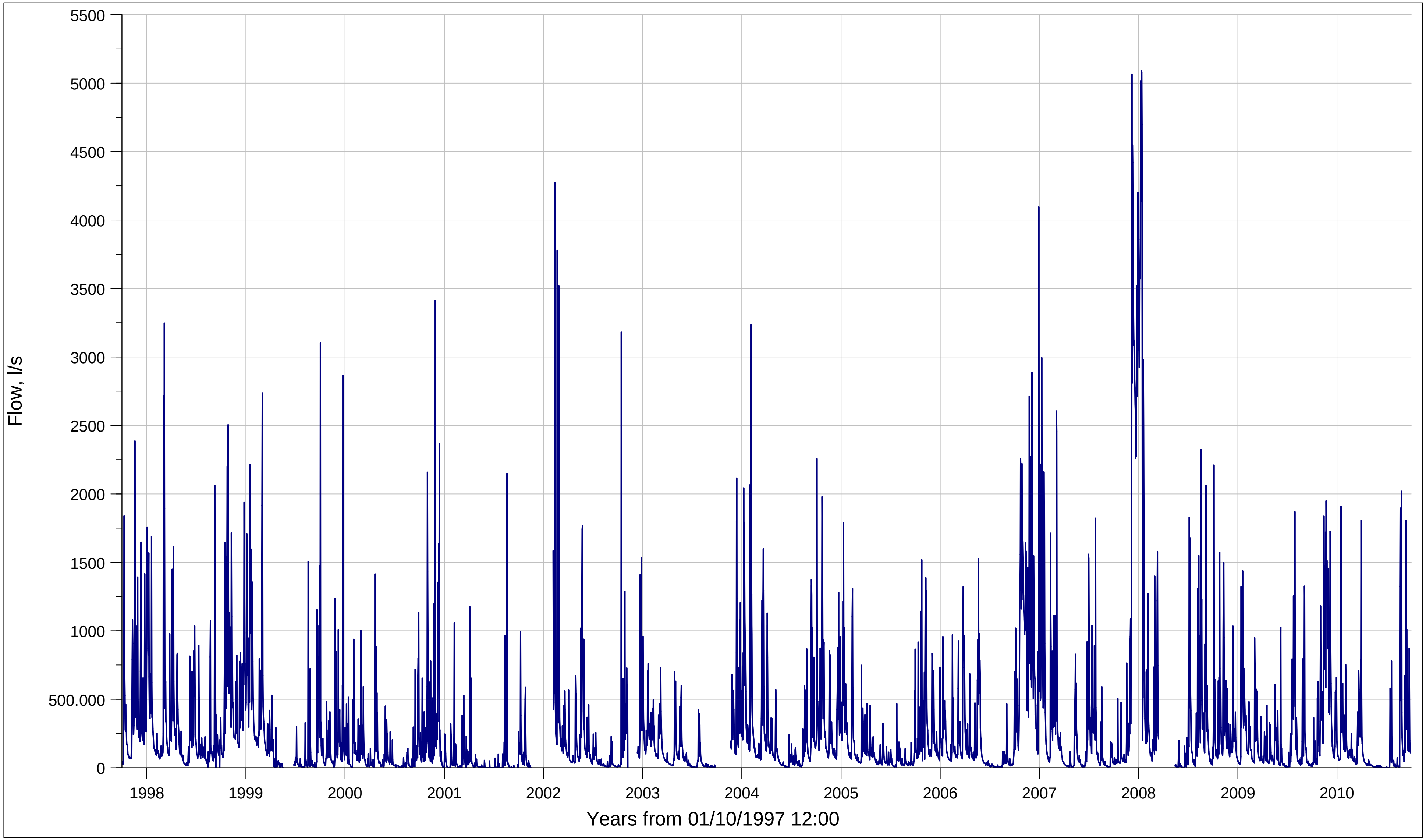
Appendix D

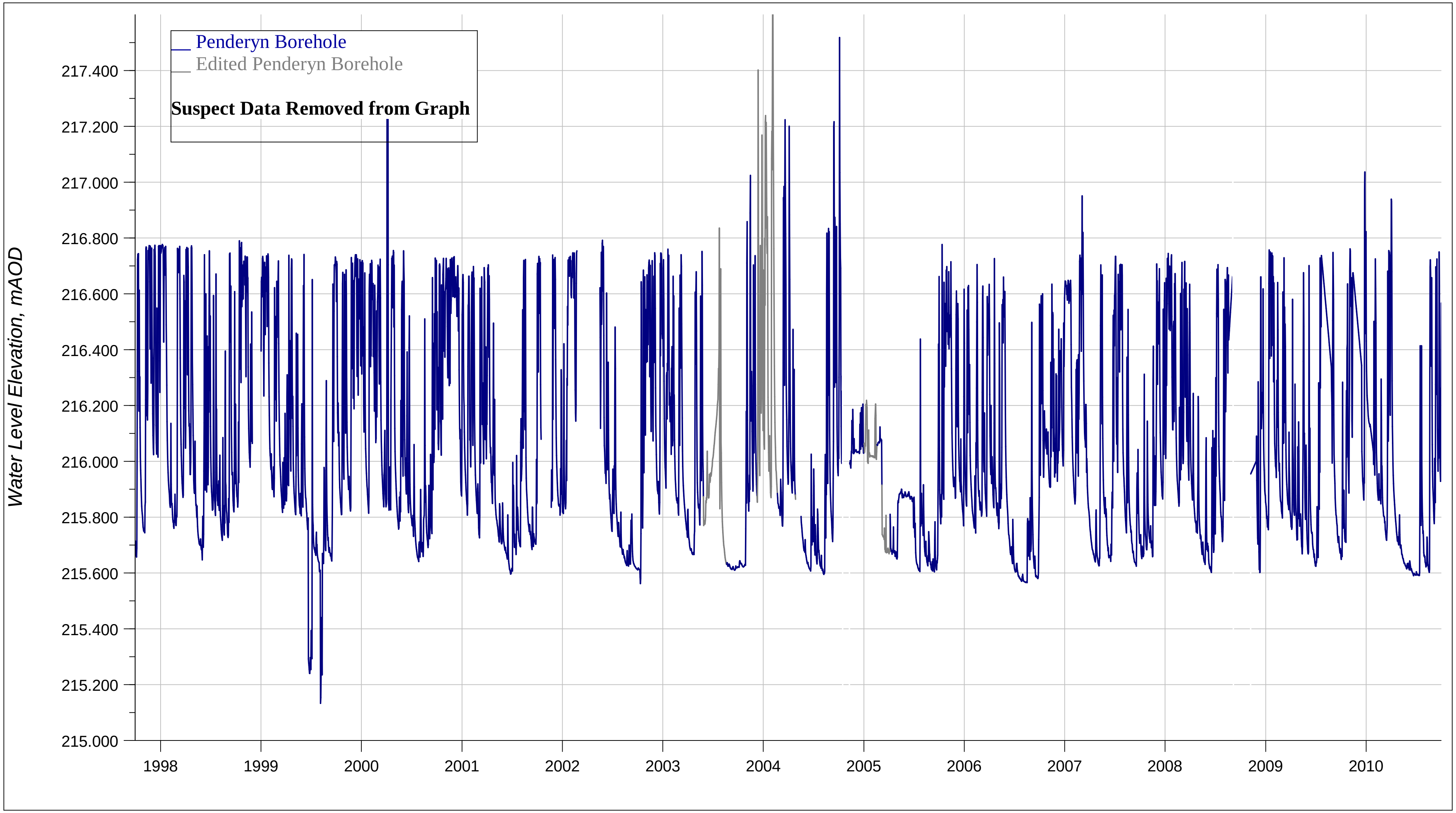
Hydrographs for the Nant Cadlan and the Penderyn Borehole

HYDROGRAPH OF FLOW IN THE NANT CADLAN AT THE CULVERT



X:\REPORTS\Other Appen\Nant_Cadlan_Flow.hrf

HYDROGRAPH OF THE PENDERYN BOREHOLE



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Name/Title	Company	Copy	Date	Authorised by
Graham Jenkins	WYG	E	6th Jan 2011	James Bellin
Roger Griffiths	Hanson Aggregates	E	6th Jan 2011	James Bellin
Mark Frampton	Hanson Aggregates	E	6th Jan 2011	James Bellin

Approval Signature: James Bellin

Appendix I

Letter of Authorisation

Hanson
HEIDELBERGCEMENTGroup

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Environment Agency Permitting Support Centre
Water Resources Team
Quadrant 2
99 Parkway Avenue
Parkway Business Park
Sheffield
S9 4WF

6 June 2019

Dear Sirs,

Water Act 2003 Applications
Transfer Licences and Abstraction Licences
Applicant: Hanson Quarry Products Europe Limited

We hereby authorise Barnaby Harding (Technical Director) and Chris Woodhouse (Senior Hydrogeologist) of Stantec UK Limited – Company number 1188070 of Buckingham Court, Kingsmead Business park, London Road, High Wycombe, Buckinghamshire, HP11 1JU to sign on our behalf, forms relating to the submission of new transfer licences and full abstraction licences.

Please note this authorisation lapses on 31 May 2020.

Yours faithfully

For and on behalf of
Hanson Quarry Products Europe Limited

Wendy F Rogers

W F Rogers
Company Secretary