

APPENDIX 4

CASE STUDY DETAILS: DRY RIGG

Name:	<u>Dry Rigg Quarry</u>
Site location:	6 km north of Settle (Craven district/Yorkshire Dales National Park)
Elevation:	c 230 mAOD
Natural area:	Yorkshire Dales

Abiotic characteristics

The site lies in the far west of the study area near Horton in Ribblesdale in the Yorkshire Dales National Park (at an altitude of some 224 mAOD). Dry Rigg Quarry is situated at an intermediate elevation in Ribblesdale but within an upland valley landscape in the west of the Yorkshire Dales. Lafarge currently extracts and crushes gritstone to produce a high specification aggregate (**Figures DR1 and DR2**).

Geology

The quarry extracts gritstone from the easterly striking Horton Formation, which dips to the south at approximately seventy degrees. The formation is part of the folded sequence of Carboniferous strata which outcrop in the area, including limestone formations with associated karstic features.

Hydrology

The gritstone itself has low primary porosity and the quarry receives a very limited input of groundwater from fractures. Superficial deposits comprise thin coverings of soil and glacial Boulder Clay plus an extensive cover of peat to the north east of the quarry. There is no direct hydraulic continuity between the quarry void and any of the surrounding hard rock or superficial deposits. The site receives significant rainfall, measured as some 1,836 mm/yr at the Fountains Fell gauging station (7 km distant). For this reason there is sufficient water to meet the sites evapotranspiration requirements throughout the growing season.

Current pumped discharge rates from the quarry are estimated to average 2 l/s to the Swarth Beck to the south of the site. Following the final development and restoration of the quarry average surface water/rainfall inflows to the entire site after subtraction of ET are estimated to be 12 l/s, which subsequent to the filling of the quarry lake will discharge via an outfall to the Swarth Beck.

A deep pit has been created which will be allowed to flood as part of the restoration to form a ~60 m deep lake. The process of flooding via rainfall run-off (estimated as some 8.4 l/s) may take in the order of 13 years to complete after which water will discharge to an adjacent brook.

Water Quality

The following water chemistry data have been recorded from Swarth Moor SSSI, which adjoins the quarry:

Variable/Location	Date	pH	Electrical conductivity
Swarth Moor SSSI (fen)	27/03/2006	7.2	390
Swarth Moor SSSI (raised mire)	27/03/2006	5.6	40

Table A4.1: Water chemistry data at Dry Rigg Quarry

Historical and landscape context

Dry Rigg Quarry is located on the western flank of Ribblesdale, immediately overlooking the glacial hollow in the valley bottom which supports the complex of raised bog and valley fen designated as Swarth Moor SSSI. An almost intact, ombrotrophic raised mire with a classic dome profile has developed to the north-east of the quarry, characterised by mixtures of hare's-tail cotton-grass (*Eriophorum vaginatum*), purple moor-grass (*Molinia caerulea*), cross-leaved heath (*Erica tetralix*) and *Sphagnum* mosses with associated flora including cranberry (*Vaccinium oxycoccus*), bog rosemary (*Andromeda polifolia*) and bog asphodel (*Narthecium ossifragum*). Fen areas fed by surface and ground water are more base-rich, being characterised by bottle sedge (*Carex rostrata*), common sedge (*C. nigra*), sharp-flowered rush (*Juncus acutiflorus*) and marsh cinquefoil (*Potentilla palustris*). Within the fen there are open pools and small patches of willow scrub.

A small area immediately west of the quarry access road lies outside of but almost contiguous with the SSSI. This had been used for materials storage in the past and is now being restored as mire habitat.

Ownership and management arrangements

Dry Rigg Quarry is operated by Lafarge Aggregates. As part of the planning conditions for continued operation, a Restoration and Aftercare Management Scheme was agreed with the LPA in 2004. This provides the framework for the management of the quarry workings and ancillary land and will be supported by a series of more detailed plans covering the different phases of restoration. These plans will be subject to consultation and the approval of a Management Committee including representatives of Lafarge, Yorkshire Dales National Park Authority, Natural England and independent advisors.

Ecological objectives of site restoration and management

The restoration scheme will incorporate wetland habitats which have been identified as priorities for conservation in the UK or Local (Yorkshire Dales) Biodiversity Action Plans:

Feature	UKBAP Priority	YDNP BAP Priority
Purple moor-grass and rush pastures	•	•
Small upland wetlands		•

Table A4.2: Habitats supported

The Restoration and Aftercare Management Scheme emphasises the need to relate restoration objectives to the interests of the adjacent Swarth Moor SSSI and the wider surrounding landscape. Preliminary work, started in 2006, aims to establish mire vegetation on a former stockpiling area outside the quarry void. Eventual restoration within the quarry

will include small areas of upland fen in addition to open water, acidic grassland/heath and moorland-fringe woodland. National Vegetation Classification (NVC) communities have been used to plan habitat creation, with the caveat that establishment of key plant species appropriate to the prevailing edaphic and hydrological conditions is more important than attempting to exactly replicate NVC communities. Habitat creation methods will include landforming, manipulation of substrates and a combination of natural colonisation and seeding/planting using local sources.

Biodiversity interest

Dry Rigg Quarry is still fully operational and work to restore a former stockpiling area to mire has only begun recently. The developing biodiversity interest of this area is being monitored by Lafarge and Natural England.

Potential for wetland restoration

Initial proposals to create acidic bog as part of the restoration scheme had to be revised when it was found that the water supply was more nutrient- and base- rich than originally expected. This may be due to a combination of calcite dissolution from the gritstone matrix, possibly related to the large surface area associated with quarry fines, or percolation from the Carboniferous limestone which outcrops above the Horton gritstone.

A trial is underway involving re-wetting compacted peat in a former stockpiling area adjoining the quarry access road. This is being wetted by overflow from a ditch which carries water discharging from the quarry to Swarth Beck. The discharge pools in the shallow peat basin to provide conditions for the growth of fen vegetation. Initial results have been promising with spontaneous colonization of several rush and sedge species, probably from the soil seed bank. Some introduction of local-provenance seed has also been carried out. It is hoped that this area will develop into mire or poor-fen habitat complementary to the minerotrophic mire components of Swarth Moor SSSI, e.g. NVC S27 bottle sedge and marsh cinquefoil tall-herb fen, M25 purple moor-grass and tormentil mire or M23 sharp-flowered rush and marsh thistle mire.

It had also been intended to create a seepage habitat by distributing some of the outflow water through a permeable bund using a perforated pipe. Discharge from the quarry passes through a manifold which distributes water within a permeable substrate from which it seeps out onto the surface of the peat with the objective of encouraging the development of flush vegetation. Initial results have been disappointing with water tending to drain downwards to the base of the bund, and revised designs are currently under consideration.

The main quarry void will form a slow-filling but ultimately deep upland lake. It is unknown how the water quality of the quarry lake will evolve over time. It is understood that only limited quantities of sulphide minerals are present within the rock and acidification of the lake is unlikely to occur.

Other elements of the restoration scheme will include exposed rock faces, upland ash woodland and acidic grassland.

Ecohydrological issues

Hydrological issues relating to the quarry and Swarth Moor SSSI have been carefully monitored and are discussed by Wardrop et al (2001).