

# BARRAVORE - BALLINAGONEEN

## Background information

**Mine Name:** Barravore, Ballinagoneen

**Mine District:** Glendalough

**Alternative Names:**

**Elements of interest:**

Pb, Zn, Cu, Cd

**Project Prefix:** GLD-

**County:**  
Wicklow

**Townland:**  
Barravore  
Ballinagoneen

**Grid Reference:**  
E306180, N194231  
E306041, N194835



## Site Description and Environmental Setting

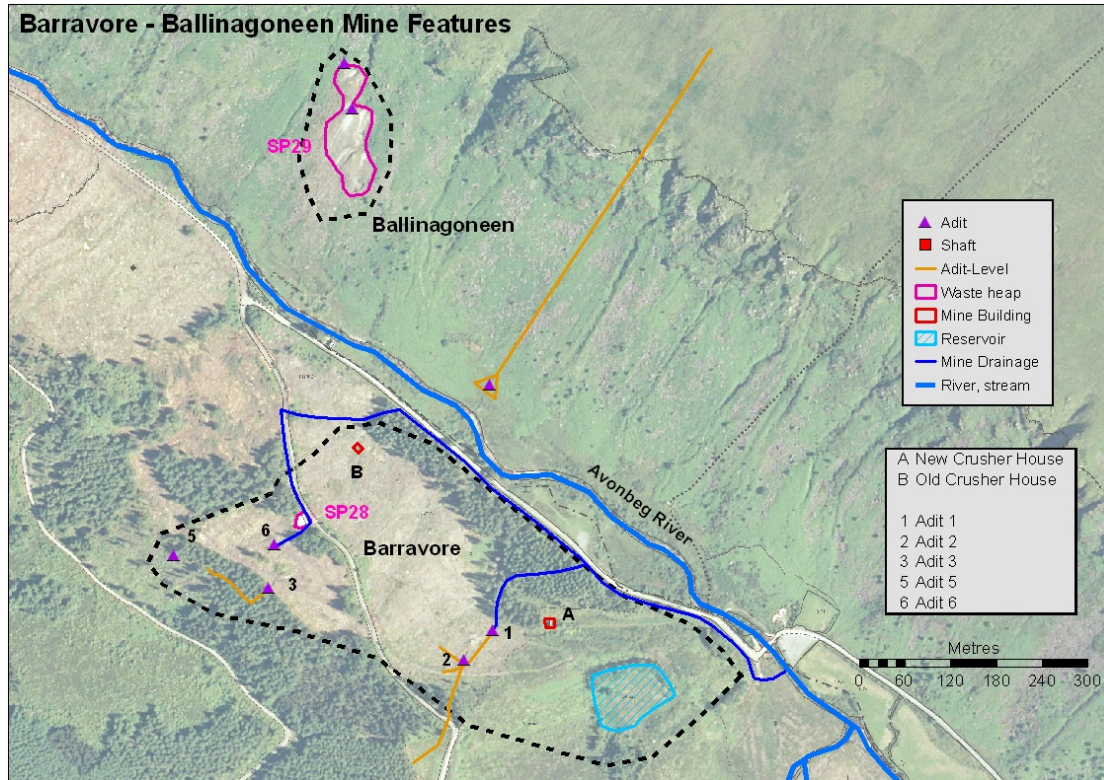
The Barravore and Ballinagoneen sites are at the northwestern end of the Glenmalure Valley. Barravore is just over 2km from the Ballinafunshoge site, on the southern bank of the Avonbeg River. Ballinagoneen is 200m north of Barravore on the northern bank of the Avonbeg River. The Glenmalure Valley is a relatively remote area with little habitation other than isolated farms. The land is used mainly for sheep pasture or commercial forestry. It is very popular with hill walkers. A youth hostel is located immediately northwest of Barravore mine site.

Ballinagoneen consists mainly of two adits with three associated solid waste heaps perched on the steep valley side (photo, right). A third exploration adit was apparently driven northeastwards from the base of the valley as a cross-cut to the lode (Fig. 1). No trace of this has been found. There is no record of significant production from Ballinagoneen though it is mentioned by Smyth (quoted by Cole 1922) as working in 1853 and subsequently by others. The solid waste heaps are the largest accumulations of mine waste in this part of Glenmalure but they are relatively thin deposits resting on a very steep slope.



The Barravore site is the more substantial of the two in that it contains five well defined adits, the remains of two crusher houses and a reservoir. Forestry clearance in recent years has helped reveal features that were previously substantially hidden. Despite the underground workings and surface processing features, there is relatively little solid waste visible on the site and it is not clear whether substantial amounts of ore were ever raised here. Records are sketchy. Chester and Burns (2001) explored some of the underground workings in recent times and the names used for adits come from their work. They suggest that Adits 1 and 2 did not produce ore and that most ore seems to have come from Adit 6, which has the largest waste heap in

Barravore. This heap, now quite small, has been reduced in size as a consequence of road building. The presence of the crusher houses and the substantial reservoir used to store water to the waterwheels may indicate that Barravore was a central processing site for both Barravore and Ballinagoneen. However, there is no direct evidence for this.



**Fig. 1 Barravore Mine Features**

The New Crusher House (photo, right) is a significant mine heritage building. Its structure is relatively intact. Chester and Burns (2001) have described the building in detail. A leat system can be followed for over 100m to the southeast from the crusher house to the large, now dry reservoir. Another leat linked the reservoir with the stream to the southeast (Chester and Burns 2001). The reservoir is estimated to have had a capacity of 18 million litres. The Old Crusher House is only partly intact but the main features, including an almost intact wheel pit, can be seen. An unsupported stone lintel above one doorway has left this building in danger of collapse (Chester and Burns 2001).



Of the five adits definitely identified in Barravore, four are open and were explored by Chester and Burns (2001). Adit 6 has collapsed, however. Adits 1, 2 and 3 are accessible for 100m or more, Adit 5 for around 30m. The floors of both Adit 3 and 5 cross deep shafts. Adit 3, in particular, is considered very unstable in places (Chester and Burns 2001). Three of the adits discharge mine water, Adit 1, Adit 3 and Adit 6.

For the purposes of the HMS-IRC project, the three waste heaps at Ballinagoneen have been merged into one, SP29. The waste heap at the entrance to Adit 6, SP28, is the only other waste source from Barravore or Ballinagoneen included in the project. Table 1 provides an estimate of areas and volumes of the two solid waste heaps.

**Table 1 Area, volume of spoil heaps at Ballinafunshoge**

<b>Waste ID</b>	<b>Area (m<sup>2</sup>)</b>	<b>Volume (m<sup>3</sup>)</b>
GLD-SP28	287	918
GLD-SP29	7110	3555

## **Geochemical assessment**

### **1. Surface water**

Water was sampled at four sites in Barravore – Ballinagoneen in both winter and summer (Fig. 2). Adit 1 (W004) and Adit 6 (W049) discharge a steady flow of water throughout the year. The flow in Adit 1 was visually estimated to be no more than 0.1 l/s in summer; it was higher in winter. The flow from Adit 6 is not easily estimated as it flows over and through the waste heap and has multiple discharge points. It is unlikely to exceed 1 – 2 l/s. Both discharges appear to flow into the drainage ditch that runs alongside the road, although in the case of Adit 1 this was not observed directly. The discharge from Adit 1 flows into the wooded area below where, in winter, the ground becomes waterlogged. This ditch drains the area upstream of the mine so that any mine water entering it is likely to be significantly diluted after mixing with water from the surrounding hills. The Avonbeg River was sampled upstream and downstream of the mine. Tables 2 and 3 summarize the results.

The composition of the discharge from Adit 1 is indistinguishable from that of the Avonbeg River water samples, with low concentrations of all elements of interest. This is consistent with the conclusion of Chester and Burn (2001) that this adit did not intersect or produce ore. Only the discharge from Adit 6 (W049) gives any indication of interaction with mineralization, with elevated Pb (22, 65 µg/l) and Zn (439, 446 µg/l). Since this discharge passes over and through a solid waste heap after leaving the adit the composition may well reflect interaction with the waste rather than a true discharge composition. Given the low volume of water discharged by the adit, the compositions measured are unlikely to have any significant impact on the surface water composition of the Avonbeg River. The Avonbeg River water sample taken upstream of the Ballinafunshoge site, 2 km downstream of Barravore, had very low metal concentrations.

Surface water geochemistry is discussed further in the Glendalough District report.

**Table 2: Summary data, water samples, November 2006, Barravore-Ballinagoneen**

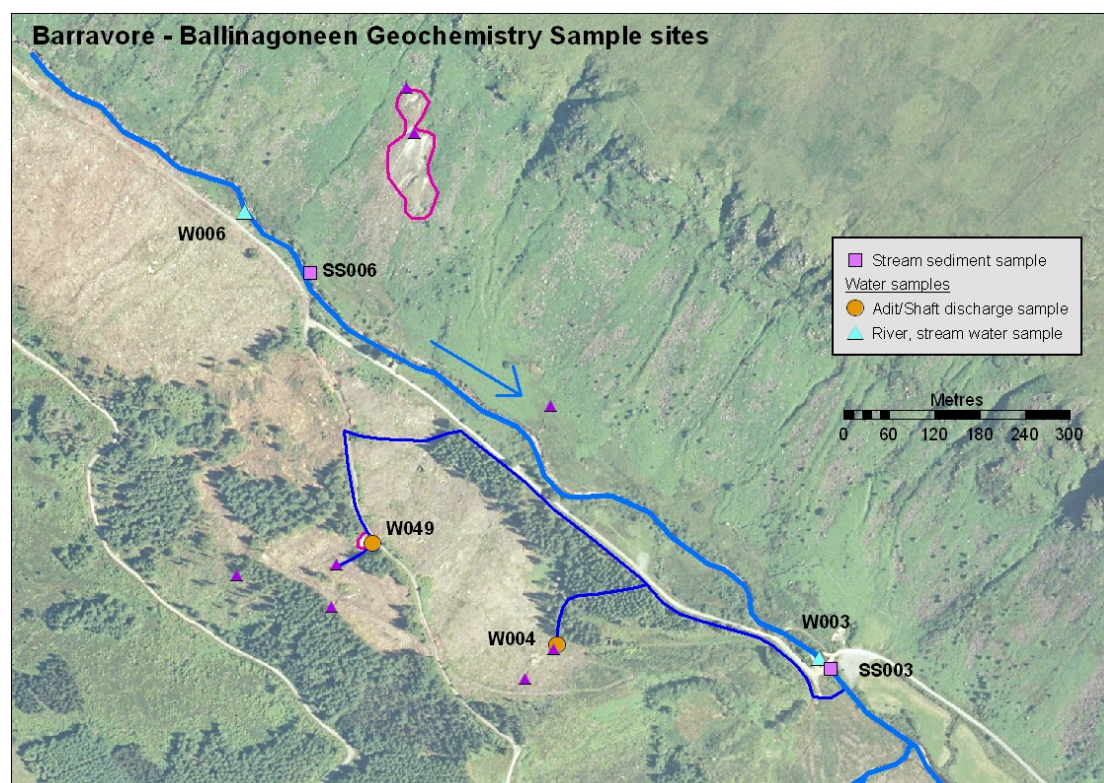
Sample (Fig. 2)	Flow l/s	pH	Acidity mg/l CaCO <sub>3</sub>	Pb (tot) µg/l	Zn (tot) µg/l	Cu (tot) µg/l	Cd (tot) µg/l
W004	n.d.	6.57	n.d.	<1	40	<1	<1
W049	n.d.	6.59	n.d.	65	446	9	2
W006	n.a.	4.80	n.d.	7	33	<1	<1
W003	n.a.	5.08	n.d.	2	55	<1	<1

n.d.: not determined; n.a.: not applicable; flow rate for W001 determined on 01 March 2007

**Table 3: Summary data, water samples, July 2007, Barravore-Ballinagoneen**

Sample (Fig. 2)	Flow l/s	pH	Acidity mg/l CaCO <sub>3</sub>	Pb (tot) µg/l	Zn (tot) µg/l	Cu (tot) µg/l	Cd (tot) µg/l
W004	0.1	6.20	13	3	71	14	<1
W049	n.d.	6.16	18	22	439	22	2
W006	n.a.	4.64	11	4	90	27	<1
W003	n.a.	4.88	16	7	80	20	<1

n.d.: not determined; n.a.: not applicable



**Fig. 2 Geochemical sample sites, Barravore - Ballinagoneen**

## 2. Groundwater

No groundwater sources were sampled for the HMS-IRC project nor were any leachate tests carried out on solid waste from Barravore or Ballinagoneen.

### 3. Stream sediments

Stream sediment sampling is discussed in the Glendalough District report and samples from the Barravore - Ballinagoneen sites are compared to those elsewhere in the district. Two stream sediment samples were collected in the immediate vicinity of Barravore and Ballinagoneen, one upstream and one downstream of the site (Fig. 2). Another sample (SS025) was collected 1.2 km downstream of Barravore, midway between it and the Ballinafunshoge site. Table 4 summarizes the data.

There is a clear increase in Pb, Zn and Cu downstream of the mine sites, at the sampling site just above the ford (SS003) where measured Pb and Zn concentrations were 1035 and 261 mg/kg, respectively. The concentration of Pb (234 mg/kg) in the upstream sample (SS006) is higher than might be expected in a background sample. For example, the median Pb concentration in stream sediments from sites overlying the Leinster Granite (GSI unpublished data) is 61 mg/kg (see Glendalough District report). There is a possibility of some contamination of this site by solid waste from Ballinagoneen. This was the only site available with sufficient fine material. It is also possible that there is unrecognized Pb mineralization further upstream. In any case, there is clear mine-related contamination of stream sediments downstream of the Barravore and Ballinagoneen sites and this contamination persists for at least 1km further downstream where the Pb concentration in stream sediment was measured at 575 mg/kg. A further 1 km downstream, 150 m upstream of the Ballinafunshoge site, the Pb concentration was 850 mg/kg (SS024). However, this is not necessarily solely attributable to Barravore and Ballinagoneen, since the small Clonkeen mine was operated at a site somewhere between sampling sites SS005 and SS024 and may have given rise to contamination of stream sediments.

For livestock that use streams for drinking water, the recommended maximum stream sediment concentrations are 1,000 mg/kg Pb and 5,000 mg/kg Zn. The sample immediately downstream of Barravore exceeds this level for Pb. However, the recommended limits refer to the total stream sediment fraction whereas only the fine (<150 µm) fraction was analysed for the HMS-IRC project. Metals tend to fractionate into the fine fraction so concentrations of elements in the total fraction are generally significantly lower than those recorded for the corresponding fine fraction. It is unlikely, therefore, that stream sediments in the Avonbeg River below the Barravore and Ballinagoneen sites actually exceed the recommended limits for livestock. However, they are likely to represent a greater risk to aquatic species and possibly birds that may be much more sensitive to elevated metal concentrations.

**Table 4: Summary statistics, stream sediments, Barravore-Ballinagoneen**

Sample	Location	Pb (mg/kg)	Zn (mg/kg)	Cu (mg/kg)
SS006	u/s	234	156	31
SS003	d/s	1035	261	72
SS005	1.2 km d/s	575	201	34

#### 4. Solid Waste

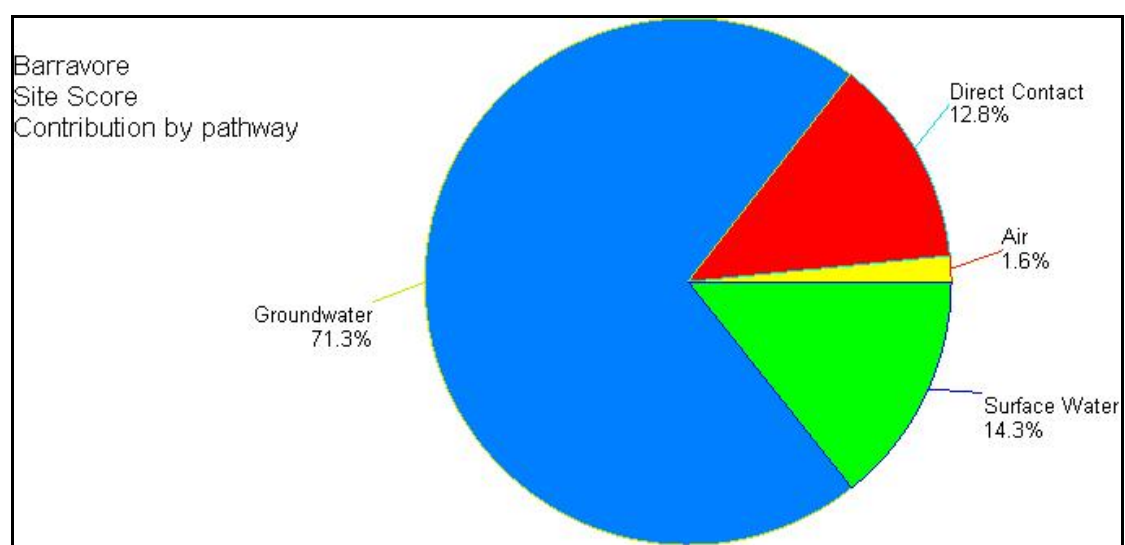
No field XRF analyses were carried out at Barravore or Ballinagoneen, owing to time constraints. In order to include the waste heaps at the sites in the HMS-IRC Site Scoring process, the median concentrations calculated for the waste heap SP027 at Ballinafunshoge were used for both SP028 and SP029. This waste heap was chosen because it consists of similar coarse waste to that observed at Barravore and Ballinagoneen. The other heap at Ballinafunshoge includes a high proportion of metal-rich processing waste, none of which was observed at Barravore or Ballinagoneen.

#### 5. HMS-IRC Site Score

The total site score for Barravore-Ballinagoneen is 6 (Table 5). The low concentration of metals in and low volumes of the discharges means that neither has a large hazard score, in contrast to discharges elsewhere in the district, notably Ballinafunshoge. The composition used to score the solid waste heaps, i.e. the median composition of SP27 in Ballinafunshoge, has relatively high Pb concentration (1.26%) but the low volumes of the heaps result in a low hazard score for the solid waste as well. The low hazard scores for solid and liquid waste ultimately lead to a low site score.

**Table 5 HMS-IRC Site Scores, Barravore - Ballinagoneen**

Waste	W004	W049	SP28	SP29	Total
<b>1. Hazard Score</b>	6	6	40	52	104
<b>2. Pathway Score</b>					
<i>Groundwater</i>	0.05	0.51	1.67	2.11	4.34
<i>Surface Water</i>	0.06	0.17	0.29	0.36	0.87
<i>Air</i>			0.01	0.09	0.10
<i>Direct Contact</i>			0.18	0.60	0.78
<b>3. Site Score</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>6</b>



**Fig. 3 HMS-IRC Site Score, Barravore-Ballinagoneen: contribution by pathway**

Fig. 3 shows the contribution of the different pathways to the total site score at Barravore-Ballinagoneen. Pathways are the routes by which receptors are exposed to the hazard. Because there is no apparent impact from the Barravore-Ballinagoneen mine on the chemistry of the Avonbeg River water, the surface water pathway score is very low for all waste sources. In consequence, the groundwater pathway score dominates. The relatively high proportion of the score attributable to Direct Contact pathway arises from the low surface water pathway score as well as the fact that the site is in an area popular with hill walkers and other visitors. The presence on site of visitors raises the potential for exposure of humans to mine waste by direct contact.

## **6. Geochemical overview and conclusions**

The Barravore-Ballinagoneen site is situated on both banks of the Avonbeg River. Stream sediment analyses indicate a significant impact on the river by mining activities, with the Pb concentration immediately downstream of the site in excess of 1000 mg/kg. However, existing waste sources on the site appear to pose only limited risk to the environment. No analyses of solid waste were carried out for the HMS-IRC project but the waste heaps were scored using data for solid waste at Ballinafunshoge. The volume of solid waste on the site is small so regardless of any assumptions about its composition the HMS-IRC score for the heaps is low. The two adit discharges have contrasting chemistry. The discharge from Adit 1 has a chemistry similar to that of river water, confirming indications that this adit did not intersect or produce ore. The discharge from Adit 6, where the most substantial waste heaps at Barravore are located, had elevated Pb (65 µg/l) and Zn (446 µg/l) but these concentrations are not particularly high. Combined with low discharge volumes they give rise to a low score for the discharges. The contrast with the discharge from the Deep Level adit at Ballinafunshoge, in which concentrations as high as 6,512 µg/l Pb and 15,860 µg/l Zn were measured, is extreme.