BALLYHICKEY

Background information:

Mine District: Clare Lead Mines

Mine Name: Ballyhickey

Alternative Names:

Elements of interest:
Pb, Zn, Cu, Sb, As, Ag, S

Project Prefix: BHCK-

County:	**Townland:**	**Grid Reference:**
Clare	Ballyhickey	E141735, N176868

Geology and Mineralization

Ballyhickey is 7km east of Ennis and 3km north of the village of Quin in east Clare. It is one of three closely spaced but separate Pb mines in east Clare, the other two being Ballyvergin, 6km to the northeast, and Kilbricken, 2km to the westsouthwest. It is underlain by the massive calcareous mudstones of the Waulsortian Limestone Formation. The mineralization consisted of argentiferous galena (PbS), occurring in large calcite veins with pyrite (FeS_2), sphalerite (ZnS) and chalcopyrite ($CuFeS_2$) (Sleeman and Pracht 1999; Cole 1922). According to Cole (1922) the main vein or bunch was 5 to 6m wide and consisted of "almost pure galena". He quotes grades of 77% Pb and 15 oz/ton Ag and states that Ballyhickey was by far the most important of all the Clare lead mines.

Production and Mining History

According to Cowman (1992) the mineralization was discovered by Taylor in 1834 who was seeking an extension of the lode at Kilbricken, 2 km to the southeast. Between 1834 and 1838 a steam engine and engine house (photo, right) was erected on site and 2500 tons of ore were extracted from an opencast. The opencast was 30m deep and 60m long (Cowman 1992). The ore was shipped from Clare port to Dee, via the river Fergus. Mining appears to have died out rapidly after 1838 and by 1840 production had declined to around 40 tons per month with the ore considered to have been nearly "worn out" (Cole 1922). However, there are records of minor production up to 1846 (Cole 1922). The works were reopened in 1853 and cleaned out but no ore was produced and these trials probably finished some time in 1854 (Cowman 1922).

Site Description and Environmental Setting

Most of the 2.5-ha Ballyhickey site (Fig. 1) is now grassed over and has been in use as a pasture field, although no evidence for recent use was observed during site visits for the HMS-IRC project. It is bordered on two sides by a commercial forest. The engine house chimney (photo, above) is largely intact although some bricks have fallen from the top. Part of one wall of the engine house is still standing. It is around 2m high and less than 4m long. The open pit is flooded to within 1 m of the surface and is securely fenced (photo, right). A rope from the old pulley system remains stretched across the width of the pit. Some coarse-grained mine waste lies around the base of the chimney and the remains of the engine house but most of the solid waste on the site is covered by soil and grass (SP01, Fig. 1). Removal of the grass and soil cover reveals coarse fragments of vein calcite. At the northwestern corner of SP01 a 1m-deep ditch has cut into fine-grained, grey-green tailings-like material. Table 1 provides an estimate of the area and volume of solid waste on the site, based on an assumed thickness of 0.5m.

Table X.1 Area and volume of spoil heaps at Ballyhickey

Waste ID	Area (m^2)	Volume (m^3)
BHCK-SP01	8425	4212

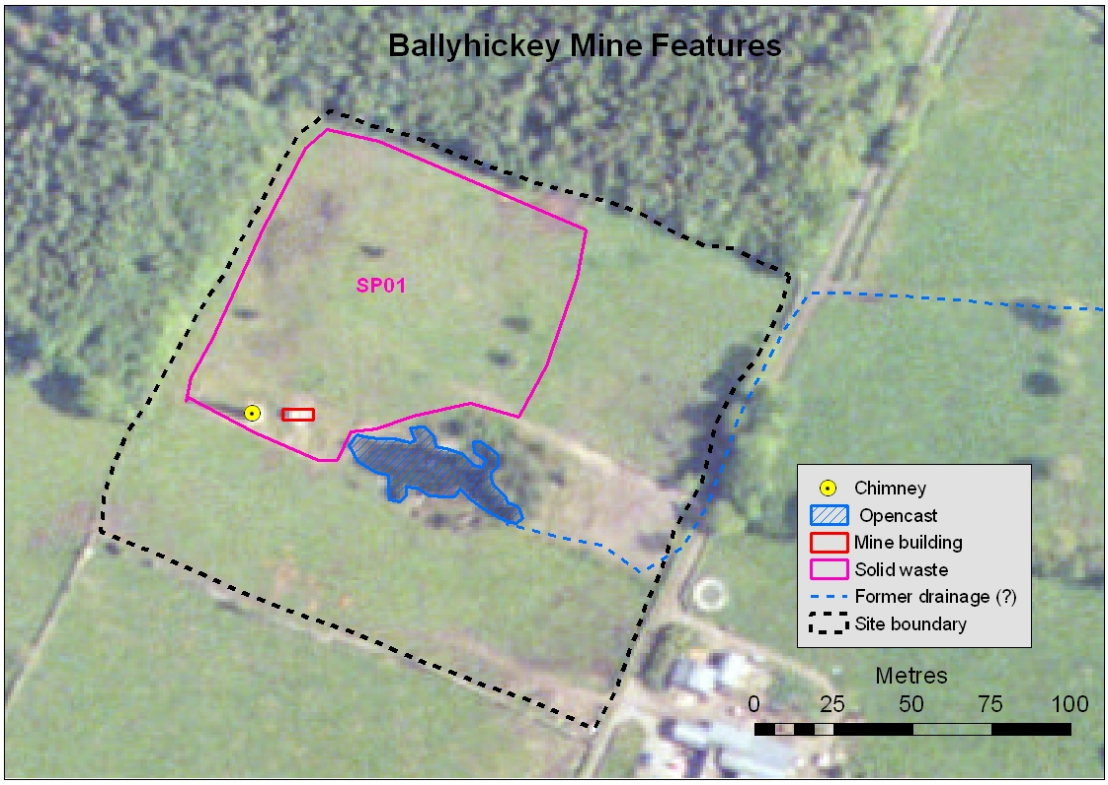

Fig. 1 Ballyhickey: mine features

Geochemical assessment

1. Surface water

Aside from the open pit lake, no surface water was evident during sampling at the Ballyhickey site in summer 2007. No trace of the stream or drainage channel marked on the OS 1:50,000 maps (Fig. 1) was observed in either summer 2007 or autumn 2008 and it is assumed to no longer exist. The Waulsortian Limestone in east Clare has undergone karstification and this may play a role in the lack of obvious surface water courses. There was no safe access to the open pit lake so it was not sampled.

2. Groundwater

No groundwater was sampled at Ballyhickey for the HMS-IRC project. A leachate test was carried out on a composite sample of the tailings material. High concentrations of dissolved Pb (941 µg/l) and Zn (2057 µg/l) were present in the leachate, along with relatively high Cd (21 µg/l) and Sb (8 µg/l). The leachate test suggests that there is potential for groundwater contamination at Ballyhickey.

3. Stream sediments

In the absence of any streams in the vicinity of the mine, no stream sediments were collected.

4. Solid waste

Solid waste analysed *in-situ* at Ballyhickey included the spoil lying around the engine house site, soil overlying the former processing area and the tailings material. In addition, two analyses were made on the mortar of the engine-house wall where it is stained orange-red. Table 2 summarizes the data for all analyses and Fig. 2 shows the distribution of Pb on the site.

Table 2 Solid waste analyses, Ballyhickey

mg/kg	Pb	Zn	Cu	As	Sb	Ag	S
n	14	14	14	14	14	14	13
Minimum	40	57	0.0	0.0	0.0	0.0	0.0
Maximum	259168	42641	6118	17293	2093	234	78625
Mean	46338	10616	1001	2359	290	46	12140
Median	25025	7022	405	994	44	0.0	0.0
Median Soil (n=6)	19437	4129	523	1106	0	0	0
Median Spoil (n=3)	7771	13237	394	476	88	0	0
Median Tailings (n=3)	43201	13101	1852	252	292	68	20829

The soil was analysed at the base of the grass root layer. The measured Pb concentrations in all samples ranged from 400 mg/kg to 18%. Although the highest Pb concentrations were measured in the tailings, concentrations in the soil were also consistently high, with a median Pb concentration in six samples of almost 2%. Zinc

concentrations exceeded 4% in one tailings sample and were generally high (median 1.3%) in spoil. However, the soil samples contained much lower concentrations of Zn (median 4129 mg/kg). The concentrations of other elements of interest were much lower. Apparently high concentrations of As reflect peak overlap by Pb in the XRF spectrum, leading to false high measured As concentrations. Peak analysis suggests the presence of some As in the samples but not as much as indicated in Table 3. A single analysis of one sample from Ballyhickey by ES in an outside laboratory gave 1077 mg/kg As against an XRF concentration of 4127 mg/kg. This analysis also suggests that Sb concentrations measured by XRF may be exaggerated.

The highest concentration of Pb measured at Ballyhickey was in the mortar of the engine house wall. This orange-red material gave measured Pb concentrations of 25.9 and 2.8 % Pb and up to 2.2% Zn and almost 8% S. The material is presumably a Pb-Zn sulphosalt formed as an alteration product of the original ore.

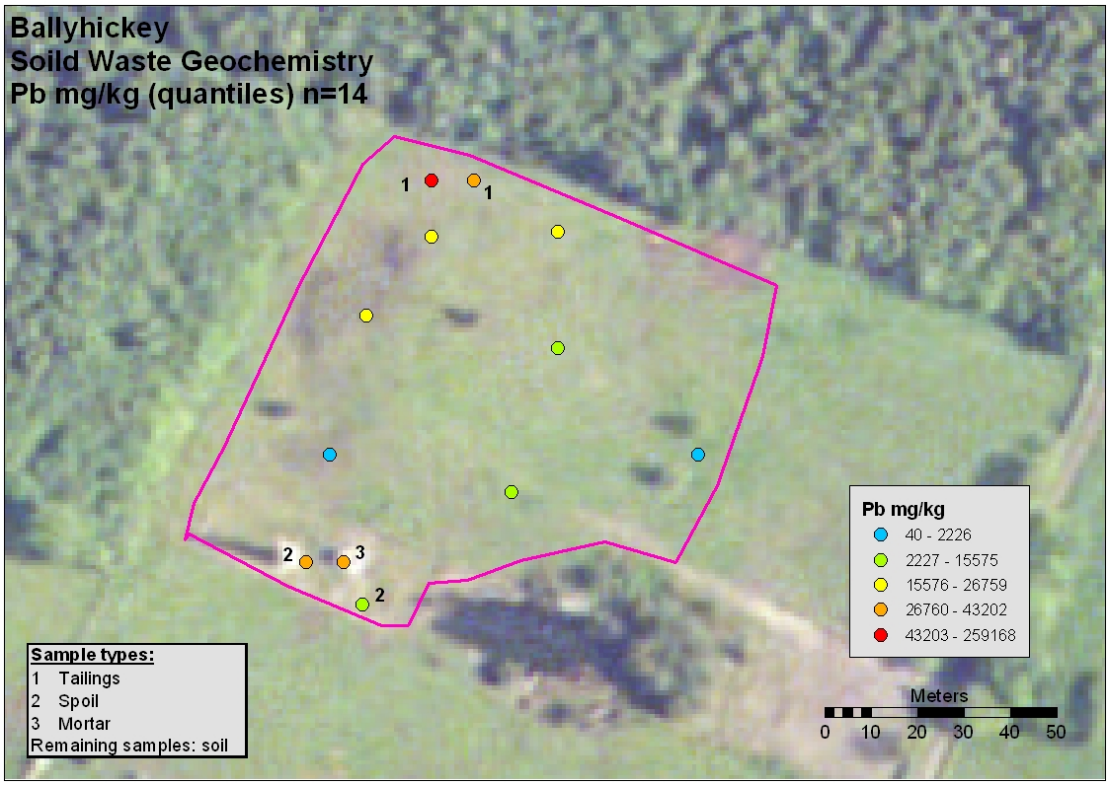

Fig. 2 Ballyhickey: Solid Waste Geochemistry

5. HMS-IRC Site Score

The HMS-IRC Site Score for Ballyhickey is 19 (Class V), contributed wholly by SP01 (Table 3). The mortar analyses were excluded when calculating the median composition of solid waste for use in the scoring system. The very high concentrations of Pb recorded on the site would typically lead to a high site score but several factors limit the final score at Ballyhickey. The estimated volume of waste, calculated by assuming a thickness of 0.5m, in the absence of any thickness measurements, is not particularly high. The lack of any surface water courses reduces almost entirely the contribution of the surface water pathway and eliminates the potential for a direct contact (livestock), i.e. stream sediment, pathway score (Fig. 3).

Table 3 HMS-IRC Site Score, Ballyhickey

Waste	SP01
1. Hazard Score	80
2. Pathway Score	
Groundwater	12.99
Surface Water	0.24
Air	0.23
Direct Contact	5.59
Direct Contact (livestock)	
3. Site Score	**19**

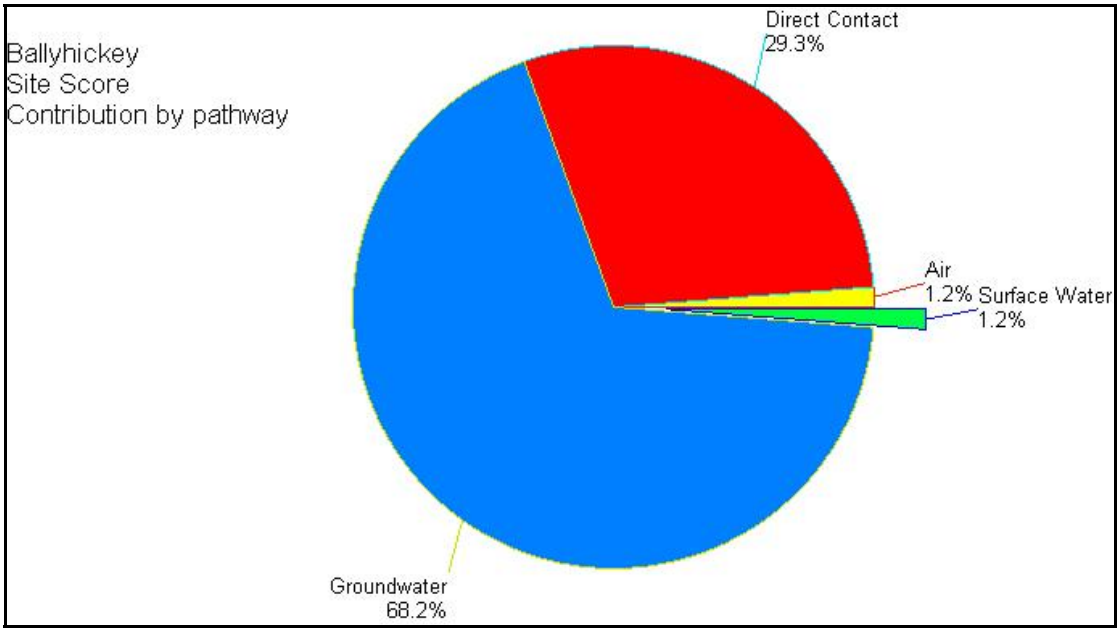

Fig. 3 HMS-IRC Site Score, Ballyhickey: contribution by pathway

6. Geochemical overview and conclusions:

The solid waste at Ballyhickey is covered by grass and soil in a field that has been in use, at least in the past, for pasture. Both the waste and the soil that covers it have very high concentrations of Pb and high concentrations of Zn, Cu and As. Small amounts of solid waste around the remains of the engine house are also enriched in Pb and other elements of interest. The lack of nearby surface water courses limits the potential impact of the site on the surrounding environment and gives it a relatively low HMS-IRC Site Score of 19. The clearest potential risk is to livestock that might use the site for grazing. The composition of water in the open pit is unknown. Ballyhickey is underlain by Waulsortian limestone that is known to be karstified in the vicinity of the mine site. There is therefore a potential for contamination of groundwater from contact with water in the open pit lake.

References

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Cowman, D. (1992). The Mid-Nineteenth Century Lead Mines of County Clare. *North Munster Antiquarian journal,* Vol. XXXIV, 67-78.

Sleeman, A.G. and Pracht, M. (1999) The Geology of the Shannon Estuary. A geological description of the Shannon Estuary region including parts of Clare, Limerick and Kerry, to accompany the bedrock geology 1:100,000 scale map series, sheet 17, Shannon Estuary. Geological Survey of Ireland, Dublin.