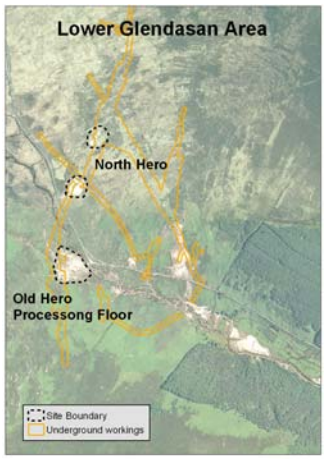
HERO

Background information



Mine Name: Hero

Mine District: Glendalough

Alternative Names:

Elements of interest:
Pb, Zn, Cu, Cd

Project Prefix: GLD-

County:	**Townland:**	**Grid Reference:**
Wicklow	Camaderry	E309848, N198158

Site Description and Environmental Setting

The Hero site consists of two parts, one to the north and the other to the south of the Glendasan River adjacent the lay-by on the Wicklow gap road, 3km northwest of the monastic site and interpretative centre at Glendalough.. A concrete bridge across the Glendasan River, closed off to vehicular traffic by large boulders, provides access to the Old Hero Processing Floor site south of the river. A short track leads up from the Wicklow Gap road to two waste heaps that make up North Hero site. The moorland of this part of the Wicklow Mountains National Park provides grazing for sheep and is also popular with walkers and sightseers.

The 2.5 ha Old Hero site acted as a central processing area during the 19th century for various mines in Glendasan. Water was drawn via a ***leat***, or wooden conduit, from the Glendasan River to power machinery and for ore separation processes. A track, interpreted as the foundation of the leat, is all that remains of this. Cobbing was done by hand in the cobbing yard (Fig. 1) before the ore was crushed in the crusher house (photo, above). On the lower part of the site closer to the river, the ore was then crushed to a finer size by the stamps before being passed to the buddles (photo right, outlined). Buddles were circular tanks in which water was used to separate the lighter impurities from the heavier ore. Immediately beside the river is an accumulation of ***slimes*** (finely ground material produced during ore processing) in what was presumably once the location of a slime pit.

The upper floor of the site contains the ruins of a number of buildings. The most substantial are those of the cobbing house or yard, where waste material was removed from lumps of ore by hand using hammers ("cobbing"). Two buildings beside this were presumably offices or stores. The walls of the crusher house are still standing and, beside them, the wheel pit for the water wheel. An area of gravel waste in front of the crusher house is apparently a residue of the material produced by the crusher. On the lower floor of the site, the iron-oxide coated mortar stones of the stamps (photo, left) are present above the buddle area. The circular outlines of the buddles are still visible. Two shallow pits in this area (Fig. 1) may be related to the stamps.

The southern edge of the site is covered by spoil, the waste rock left after mining of the Old Hero lode. Vertical wooden poles in the spoil are supports for a former ramp that led down to the adit from which the ore was raised. This was probably the Old Hero adit that was situated 40m south of the site boundary on Fig. 1. The extensive underground workings on Old Hero lode lie mainly below the western part of the site (Fig. 1). Several shafts are marked on old maps but none are visible today. There is one opening where a stope has broken through to the surface (photo, right).

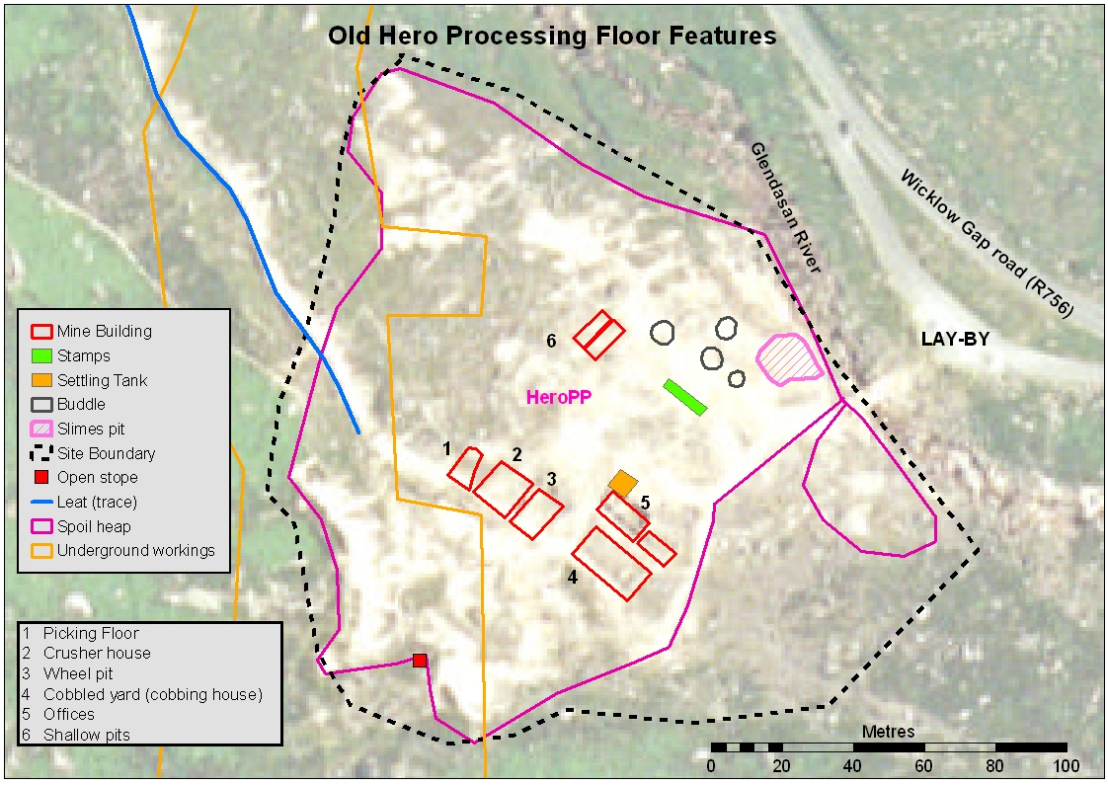


Fig. 1 Old Hero Processing Site features

Virtually all of the area within the Old Hero site boundary on Fig. 1 is underlain by mine waste. Though it varies greatly in composition and texture, reflecting the various degrees of processing it has undergone, the waste on the processing area is considered as one here for the purpose of volume calculations.

The North Hero site lies along the strike of the Hero Lode, north of the Wicklow Gap road (Fig. 2). Two waste heaps occupy positions in front of the sites of now-unseen adits and shafts. Each heap was created from waste dumped at the entrance to an adit. Table 1 gives the area and volumes of both heaps along with those of the processing area.

Table 1 Area and volume of spoil heaps at Old Hero

Waste ID	Area (m^2)	Volume (m^3)
GLD-HEROPP	18,965	9,529
GLD-SP04	5,816	6,316
GLD-SP06	5,971	16,916

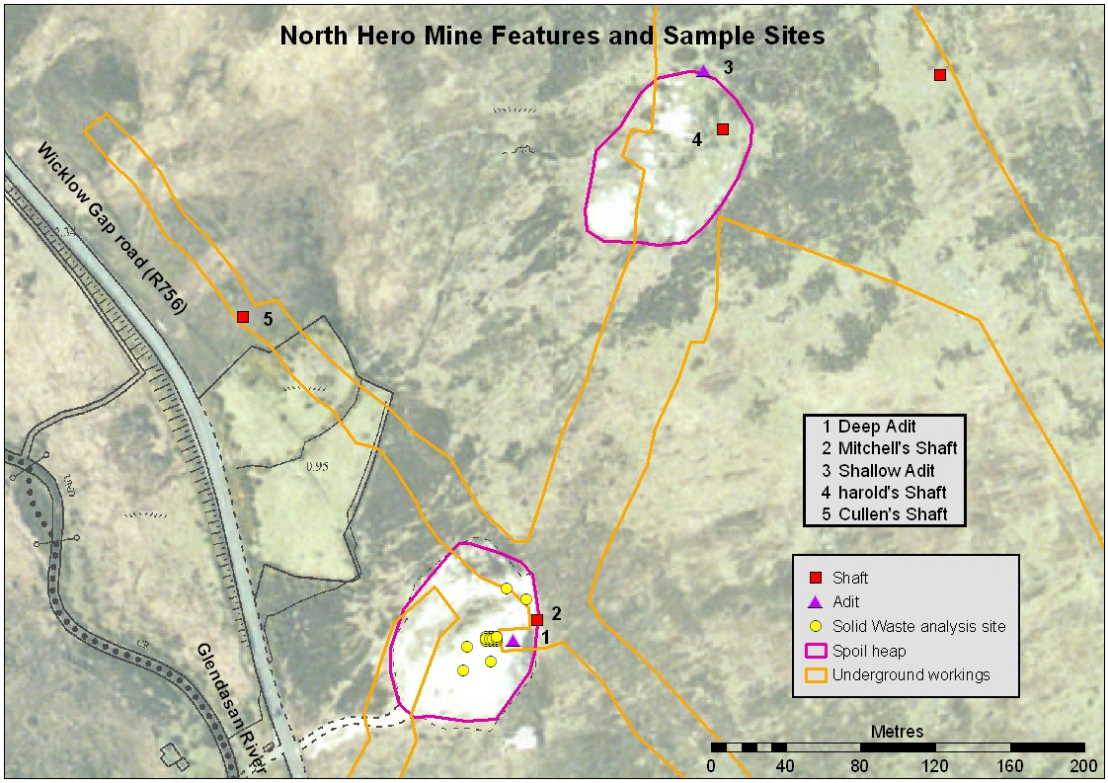


Fig. 2 North Hero mine features and solid waste analysis sites

Geochemical assessment

1. Surface water

Stream water chemistry has been described in the Glendalough District report. There are no adit discharges in the area and no run-off samples were collected. The nearest downstream surface water sample was taken from the Glendasan River immediately upstream of St. Kevin's site, 500m downstream of Hero. It had 105 µg /l Pb and 292 µg /l Zn in July 2007.

2. Groundwater

No groundwater sources were sampled for the HMS-IRC project. A leachate test on an aggregated sample of material from the site had 6080 µg/l Pb, 2112 µg /l Zn and 358 µg/l Cd (dissolved metal in each case).

3. Stream sediments

Stream sediment chemistry is described in detail in the Glendalough District report. One sample was collected 300m upstream of the Hero site, one 80m downstream and a third 500m downstream, immediately above the St. Kevin's site. All samples have high concentrations of metals, with the sample taken 500m downstream having the highest measured concentrations: 2.8% Pb, 6.9% Zn, 634 mg/kg Cu and 251 mg/kg Cd. The upstream sample, which is itself downstream of other mine sites such as Ruplagh and Luganure, had 1.8% Pb and 0.4% Zn.

4. Solid Waste

Field XRF analyses were carried out at 79 locations on the Old Hero Processing site, including one section analysed in a vertical profile of five points, so that a total of 83 analyses were completed on this site. A further 17 analyses were carried out on quartz-rich waste in SP04, the waste heap immediately north of the road (Fig. 2). Fig. 3 shows the distribution of samples on the Old Hero Processing site, categorized by waste type. Waste analysed included quartz-rich spoil heaps on the southern part of the site, typical of spoil in the Glendalough District, crusher waste from in front of the crusher house, material from the stamps area and fine waste from settling tanks, buddles and slimes pit..

Fig. 4 and Tables 2 and 3 summarize the data for Old Hero. The major elements detected were Pb and Zn, with lesser and variable amounts of Cu, S and Cd. Although As appears in XRF analyses to levels exceeding several thousand mg/kg, in 12 samples re-analysed by MA-ES the maximum measured As was 150 mg/kg. The high As measured in XRF analyses is thus considered to be a consequence of the high concentration of Pb in the samples, causing peak overlap and grossly exaggerated As values. Therefore, on the basis of the evidence available, As is not considered to be a major element of the mine waste at Old Hero.

In Fig. 4 the distribution of Pb is consistent with the observed distribution of different waste types on site, with lowest Pb corresponding to the quartz-rich spoil heaps near the old adit on the southern part of the site. The processing floors, particularly the lower (northern) one where the finer material was processed (stamps, buddles, slimes), have the highest Pb concentrations.

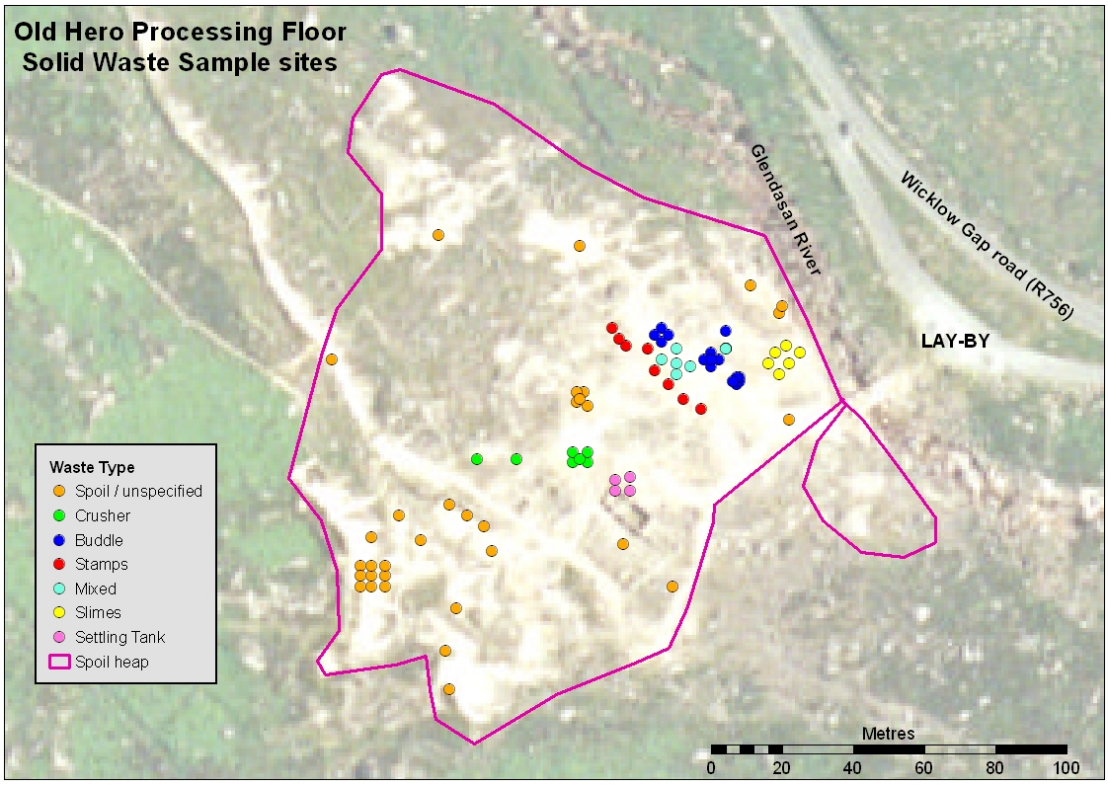


Fig. 3 Old Hero Processing Floor sample sites, field XRF analyses

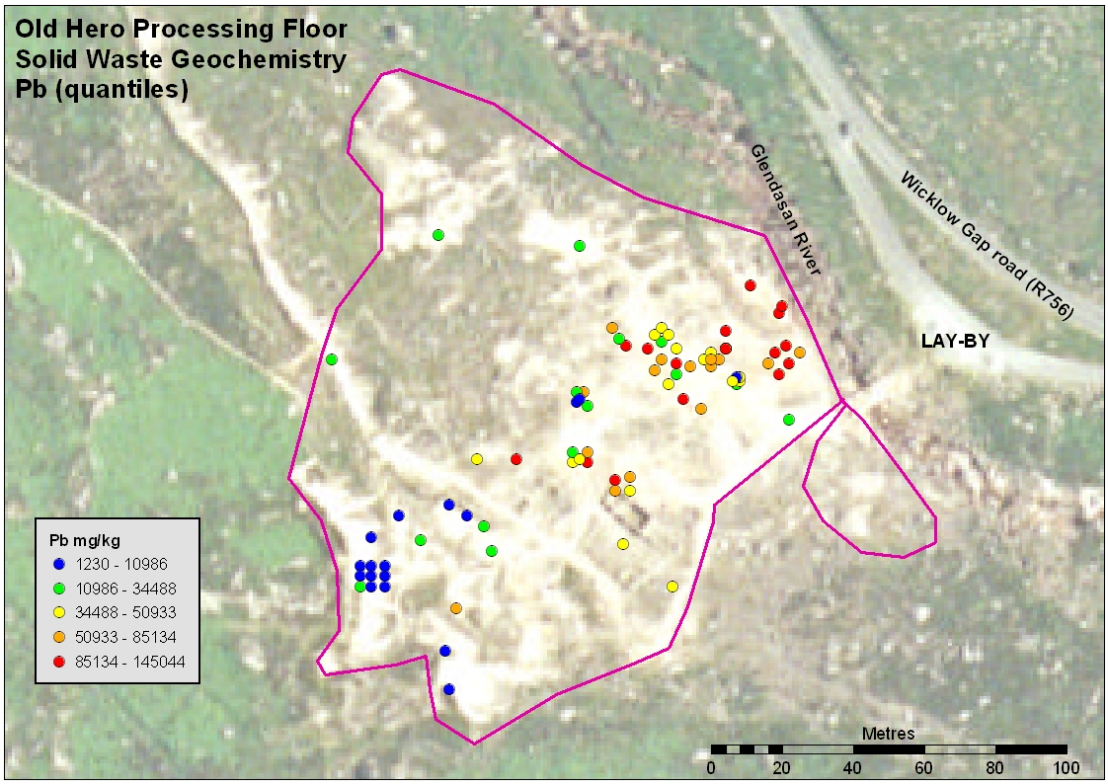


Fig. 4 Old Hero Processing Floor: distribution of Pb, field XRF analyses

Summary statistics for all samples on the Old Hero Processing site (Table 2) indicate maximum Pb concentration of 14.5% and Zn concentration of 19.3%. The relevant samples were from the slimes pit. The sample with 14.5% Pb gave a measured concentration of 11.7% when assayed by OMAC Labs, confirming that very high

concentrations of Pb are found on this site. The same sample with 14.5% Pb also had a measured field concentration of 19% Zn as well as a Cd concentration of 658 mg/kg, the latter confirmed by MA-ES analysis. Such a high Cd concentration is noteworthy not least because Cd concentrations exceeding 100 mg/kg are relatively unusual in mine waste samples analysed for the HMS-IRC project. The detection of Cd in the waste is consistent with detection of Cd in adit discharges. There is a broad linear relationship between Cd and Zn in solid waste in the Glendalough District, consistent with the presence of Cd in solid solution in sphalerite. The two metals occur in the same column of the periodic table and are isostructural. Only rarely does Cd form minerals in which it is the predominant metal – in sulphide ore deposits it is typically hosted by sphalerite.

Table 2: Summary statistics for field XRF analyses of solid waste, Old Hero

mg/kg	Pb	Zn	Cu	Cd	S
n	83	83	83	83	83
Minimum	1230	305	0.0	0.0	0.0
Maximum	145044	192785	3030	658	31420
Median	44246	9077	517	80	11620
Mean	49953	17435	693	111	11925

Table 3: Median values for different solid waste types, Old Hero

mg/kg (median)	Pb	Zn	Cu	Cd	S
Spoil	11212	3608	203	58	0.0
Crusher	50237	22365	498	141	16940
Settling Tank	66741	7431	1349	72	18807
Buddles	47006	10241	525	78	9977
Mixed (buddle/stamps)	50185	17134	774	97	16666
Stamps	73602	12698	981	109	21950
Slimes	119096	62412	1762	298	21832

The variation in chemistry among different mine waste types is summarized in Table 3 and illustrated in Fig. 5 for Pb and Zn. Spoil generally has the lowest concentration of Pb and Zn with crusher waste, buddle waste, stamps waste and slimes having very high median concentrations of these metals.

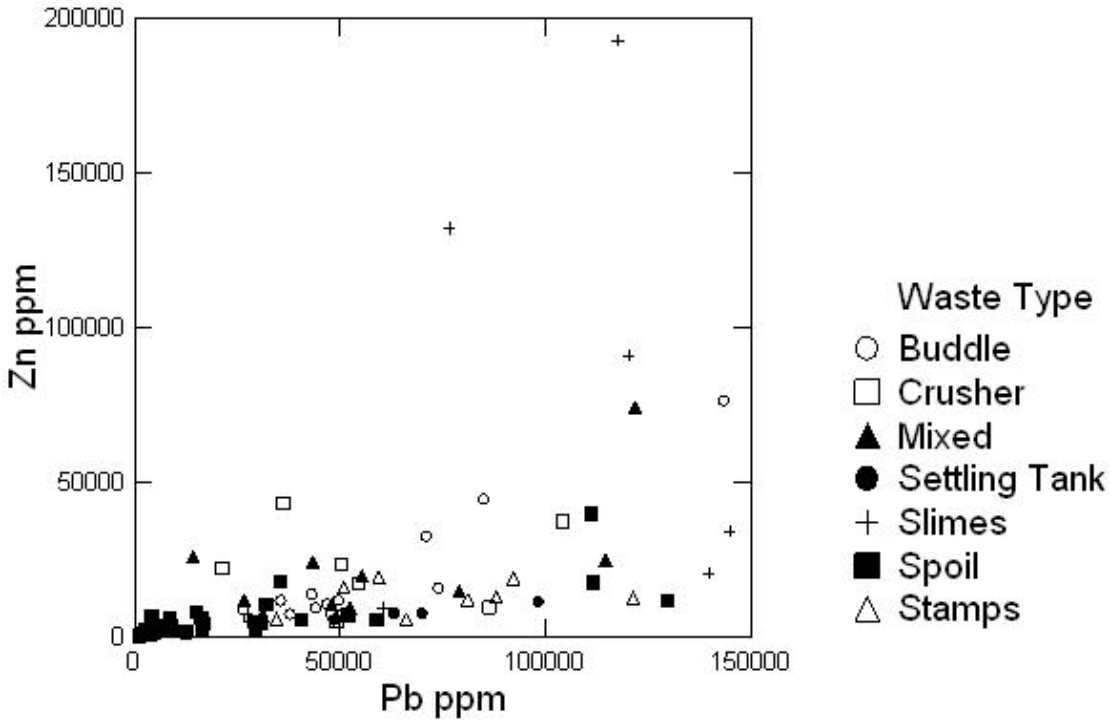


Fig. 5 Zn v Pb (field XRF) for various mine waste types, Old Hero

Table 4 summarizes the data for SP04 on the Hero site across the river from the Old Hero Processing site. This waste is typical of the quartz-rich waste found in waste heaps along the Glendasan valley. The concentrations of Pb, Zn and Cd are distinctly lower than those for spoil on the Processing site but the median Cu concentration is higher.

Table 4: Summary statistics for field XRF analyses of solid waste, North Hero

mg/kg	Pb	Zn	Cu	Cd
n	17	17	17	17
Minimum	559	980	154	0.0
Maximum	4297	3857	576	53
Median	2818	2187	333	25
Mean	2576	2185	330	19

5. HMS-IRC Site Score

The total site score for the Hero site is 183, comprising 176 for the Old Hero processing site and 7 for the North Hero spoil heaps (Table 4). The Old Hero site is considered as one site for the purposes of scoring. It is not a particularly extensive or voluminous waste heap but its high score follows from the very high median concentration for Pb (4.4%).

Table 5 Site Scores, Hero site

Waste	HeroPP	SP04	SP06	Total
1. Hazard Score	**323**	**22**	**33**	**378**
2. Pathway Score				
Groundwater	30.42	0.92	1.21	32.55
Surface Water	81.93	1.70	2.58	86.21
Air	7.55	0.03	0.02	7.60
Direct Contact	56.25	0.24	0.29	56.78
3. Site Score	**176**	**3**	**4**	**183**

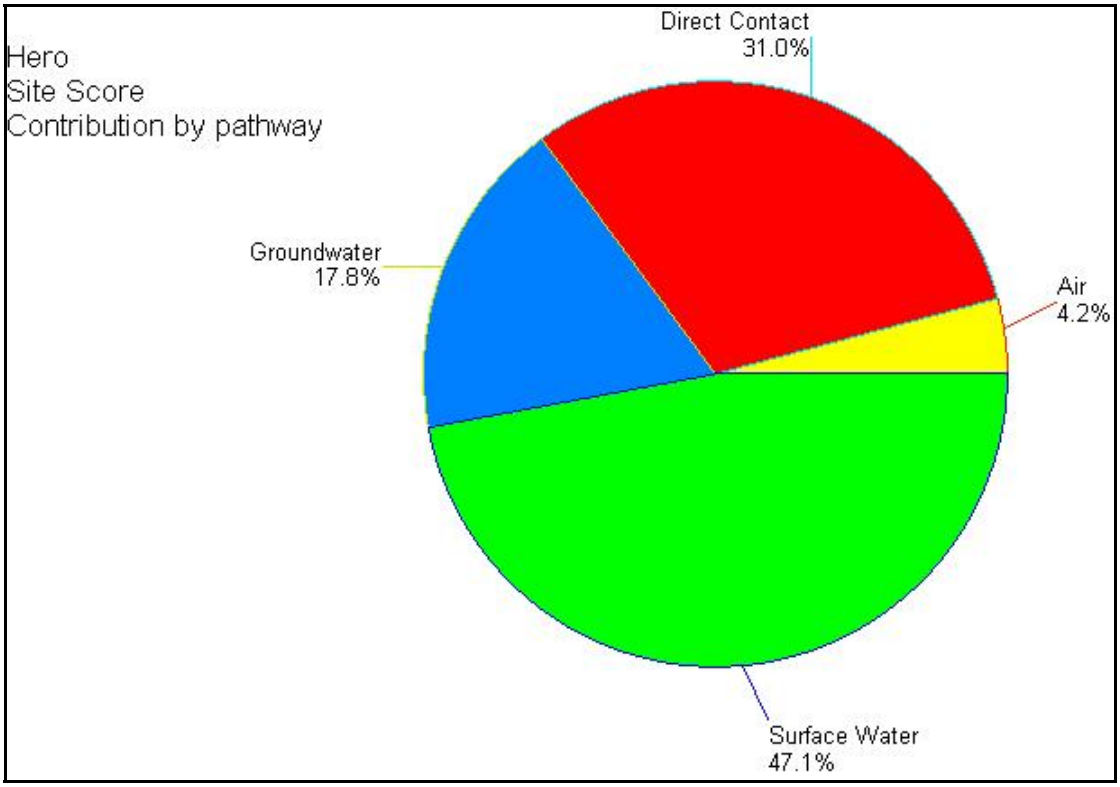


Fig. 6 HMS-IRC Site Score, Hero: contribution by pathway

Fig. 6 shows the contribution of the different pathways to the total site score at Hero. Pathways are the routes by which receptors are exposed to the hazard. As is the case for most sites in the Glendalough District, the surface water pathway (47.1%) is the main contributor to the site score, far outweighing the groundwater pathway score. This reflects proximity to the Glendasan River, in which the concentrations of Pb and Zn exceed the water standards, as well as factors such as poor aquifer quality, low population density and few wells, that minimize the groundwater pathway score (17.8%). The most unusual aspect of the site score is the very large contribution (31%) made by the direct contact pathway. Surface water and groundwater pathway scores are influenced by both the surface area and volume of the waste. The direct contact pathway is influenced only by the surface area. Where the surface area is in itself relatively large and where it is much greater than the volume, the relative importance of the direct contact pathway increases. Other factors such as the presence on site of visitors play a role but, in the case of Hero, the relatively large surface area and the 2:1 ratio of surface area to volume accounts for the large direct contact contribution.

6. Geochemical overview and conclusions

The solid waste at Old Hero Processing site includes significant volumes of fine material with exceptionally high concentrations of Pb and Zn. Cd has also been measured in relatively high concentrations. The site is a common stop-off point for visitors in the area. There are potential risks to humans as a result of direct contact with metal-rich waste and, additionally, to animals as a result of ingestion of same. The presence of fine waste such as slimes and the prevalence of westerly winds blowing through the Wicklow Gap suggest inhalation of metal-rich dust might be a factor in dry periods.

The site is on the side of the valley and during wet weather run-off drains directly into the Glendasan River. Leachate testing indicates that the dissolved metal content of run-off is likely to be high. Stream sediment samples downstream of the site have very high concentrations of Pb and Zn, though other sites in Glendasan have also contributed to this.

The HMS-IRC site score for the site is 183 and is the second largest score, after Foxrock, for a site in the Glendasan valley.