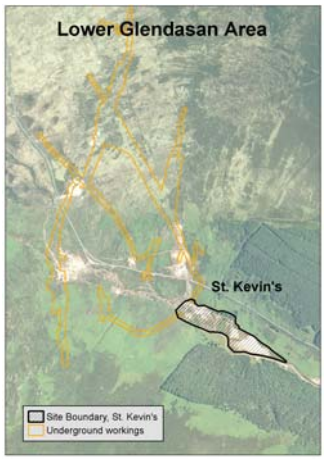
ST. KEVIN'S

Background information



Mine Name: St. Kevin's

Mine District: Glendalough

Alternative Names:

Chemicals of concern:
Pb, Cu, Zn, Cd

Project Prefix: GLD-

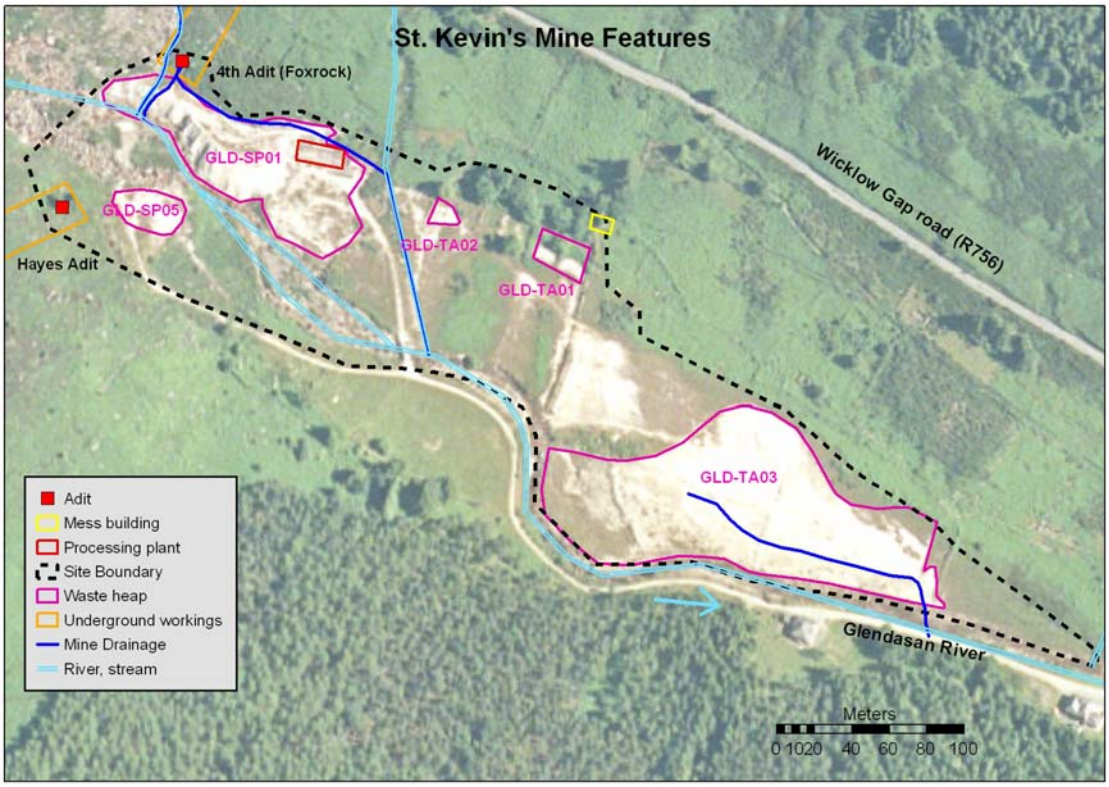
County:	**Townland:**	**Grid Reference:**
Wicklow	Camaderry; Sevenchurches	E310646, N197839

Site Description and Environmental Setting

St. Kevin's mine site is located at the base of a steep section of the Glendasan River where the valley becomes much flatter and wider. An unsealed road runs southeast along the river bank from the mine to the monastic site and hotel at Glendalough. Two hostels and a number of houses are located along this road. The southern side of the valley is covered by coniferous plantations; the northern side has rough pasture for sheep. The area site is popular with walkers and sightseers.

The site covers an area of about 5.5 ha that includes a large area (1.3 ha) of fine waste or tailings deposited on the northern bank of the Glendasan River (left). The area was first mined in the 19th century but was reopened by the Wicklow Mining Company in the 1950s. Mining was chiefly on the Foxrock lodes accessed via the 4th Adit at the northwestern end of the site. It is not certain how much of the waste now present was produced during this later period of mining. Comparison with the old OS 1:10,560 maps suggests that the small waste ponds (TA01 and TA02) on Fig. 1 probably date from the earlier period of mining but that the main tailings deposit (TA03) is more recent. The area in front of the 4th Adit is a large spoil heap that slopes steeply to the Glendasan River (right). The Hayes Adit on the south bank of the river was not worked in the 20th century.

The 4th Adit discharges mine water to the Glendasan River. It is the deepest adit and the main drain for the extensive underground workings in the Foxrock-Hollyrock-Hawk Rock area that underlies the valley side north of the Wicklow gap road.



The only building of significance on the site is the old processing shed built in the 1950s (left). It contains the remains of some plant including a roll crusher. A 19th Century mess building is largely inaccessible in the area behind the small tailings cells. The foundations of a crusher building erected in the 1950s and the supports for a bridge that crossed the river to it are still visible beside the Hayes adit. A concrete bridge now provides access to the site from the south bank of the river. Boulders and concrete bollards restrict vehicular access.

The St. Kevin's site includes two of the largest mine waste deposits in the Glendalough District, the main spoil heap (SP01) and the tailings "pond"" (TA03) (Fig. 1). The old settling or tailings ponds (TA01, TA02) are relatively minor deposits. Fine waste has been washed off these ponds and can be seen on Fig. 1 as bare patches on the slope above the main tailings deposit. This is a thin veneer of material and is not considered further here though it does suggest that almost the entire surface area of the site within the boundary marked on Fig. 1 is covered by mine waste. The area and volume of waste heaps on St. Kevin's mine site are given in Table 1.

Table 1 Area and volume of spoil heaps at St, Kevin's site

Waste ID	Area (m^2)	Volume (m^3)
GLD-SP01	5859	12749
GLD-SP05	680	4256
GLD-TA01	493	142
GLD-TA02	149	37
GLD-TA03	12615	4534

Geochemical assessment

1. Surface water

Stream water chemistry has been described in the Glendalough District report. Samples of water from the Glendasan River in the area of the St. Kevin's site had the highest metal contents of any river/stream water sampled in the district. This mainly reflects discharges from adits but run-off from mine waste and possibly base flow along the valley may also contribute, although the latter has not been observed. The adits discharging to the river at St. Kevin's are the Foxrock 4th Adit (6.5 l/s in July 2007), the 2nd and 3rd Foxrock adits (1 l/s and 3.4 l/s, respectively, July 2007) further up the valley side and the Hollyrock adit. The 2nd and 3rd Foxrock adits drain over and through spoil heaps into a ditch along the side of the Wicklow Gap road. This ditch also collects drainage from mountain streams, rainwater and the discharge from the Hollyrock adit further up the valley. It drains to the Glendasan River at a point immediately beside the 4th Adit. The Hayes adit, on the south bank of the river, drains water but none was observed entering the river.

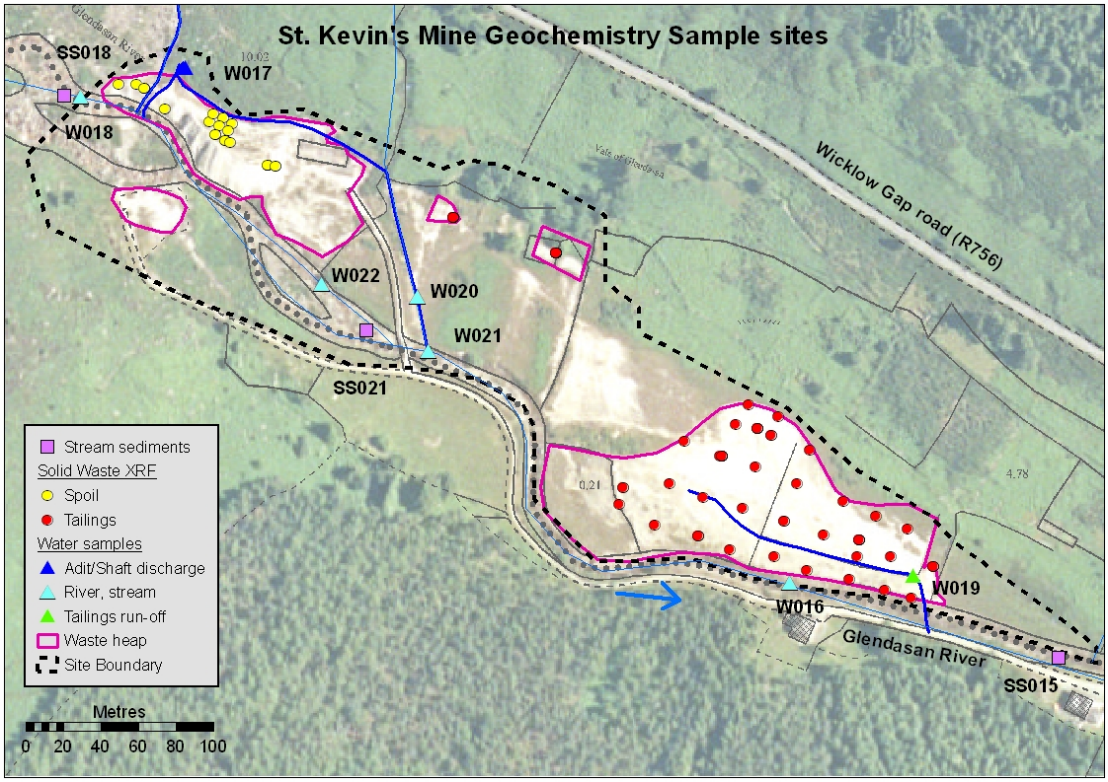


Fig. 2 Geochemical sample sites, St. Kevin's Mine site

As indicated in the district report, the chemistry of the water samples did not vary greatly between winter and summer sampling periods. Table 2 summarizes chemical data for the samples taken on site in Winter 2006/2007, selected because a tailings run-off was sampled at that time. Samples were collected in December 2006 except for the adit discharge (W017, Table 2) which was collected in March 2008. Samples are as numbered on Fig. 2. The "u/s" sample, given as a comparison, is the furthest upstream sample in the Glendasan River, above the Ruplagh mine site.

Table 2: Summary statistics for water samples, December 2006, St. Kevin's Mine site

Sample (Fig. 2)	Flow l/s	pH	Acidity mg/l $CaCO_3$	Pb (tot) µg/l	Zn (tot) µg/l	Cu (tot) µg/l	Cd (tot) µg/
W017	6.0	7.9	-58	254	1678	40	11
W018	n/a	7.3	-4	33	112	4	<1
W022	n/a	7.2	-6	40	156	4	1
W020	n/a	5.2	6	48	72	<1	<1
W021	n/a	7.3	-3	110	177	7	1
W016	n/a	7.2	-10	76	368	6	2
W019	n/a	6.2	2	3486	15840	27	71
u/s		6.0	21	4	153	18	<1

Note: a negative acidity reading indicates an alkalinity test result.

The data in Table 2 indicate significant Pb and Zn concentrations in the Foxrock 4th Adit (W017) and somewhat elevated levels in the Glendasan River. The concentration of metals in the adit discharge are greatly exceeded by those in the tailings run-off (W019), though the latter is ephemeral and of low volume. The discharge rate from the tailings run-off, during heavy rain, was of the order of 1 l/s. Of particular interest is the relatively high Cd concentration of 71 ug/l. The 4th Adit discharge also has slightly elevated Cd. Both these results are consistent with the elevated Cd values found in mine waste and leachate from Old Hero Processing site.

2. Groundwater

No groundwater sources were sampled for the HMS-IRC project. A leachate test on a spoil sample from SP01 2027 µg/l Pb, 504 µg /l Zn and 2.9 µg/l Cd (dissolved metal in each case). An aggregated sample of tailings from TA03 yielded 3196 µg /l Pb, 3912 µg /l Zn and 26.6 µg /l Cd.

3. Stream sediments

Stream sediment chemistry is described for the Glendasan valley as a whole in the Glendalough District report. The sample taken 70m downstream of the tailings area (SS015, Fig. 2) had extremely high measured concentrations of Pb (72031 mg/kg or 7.2%), Zn (50875 mg/kg or 5.1%), Cu (911 mg/kg) and Cd (179 mg/kg). Contamination of sediments in the Glendasan River persists for at least 4km downstream of the St. Kevin's site.

4. Solid Waste

Field XRF analyses were carried out at 51 surface points on spoil and tailings on St. Kevin's mine site. An additional 18 analyses were done on tailings material in vertical profiles at eight of these sites, giving a total of 69 analyses. Table 3 and Fig. 3 summarize the data. The major elements detected were Pb and Zn, with lesser and variable amounts of Cu and Cd. Sulphur is present in concentrations of 1 – 2% in some tailings samples.

Fig. 3 shows the Pb distribution on St. Kevin's site. The values shown relate only to the samples from St. Kevin's, i.e. samples from elsewhere in the district were not included when estimating quantiles. Though both spoil and tailings yielded high Pb values, the tailings deposit clearly has higher metal concentrations than the spoil heap. Table 3 indicates median values of Pb and Zn in tailings to be at least twice those in spoil. A rough zoning of Pb distribution in the main tailings deposit (TA03) is suggested in Fig. 3, with the northern part having higher Pb concentrations.

Table 3 Field XRF data, spoil and tailings, St. Kevin's mine site

mg/kg	Pb	Zn	Cu	Cd
Spoil (n = 21)				
Minimum	99	430	0.0	38
Maximum	23472	13125	182	95
Median	3518	2692	75	57
Mean	5974	3556	83	58
Tailings (n = 48)				
Minimum	1113	241	0.0	0.0
Maximum	61800	80407	3993	660
Median	10334	8917	214	40
Mean	13637	12394	323	56

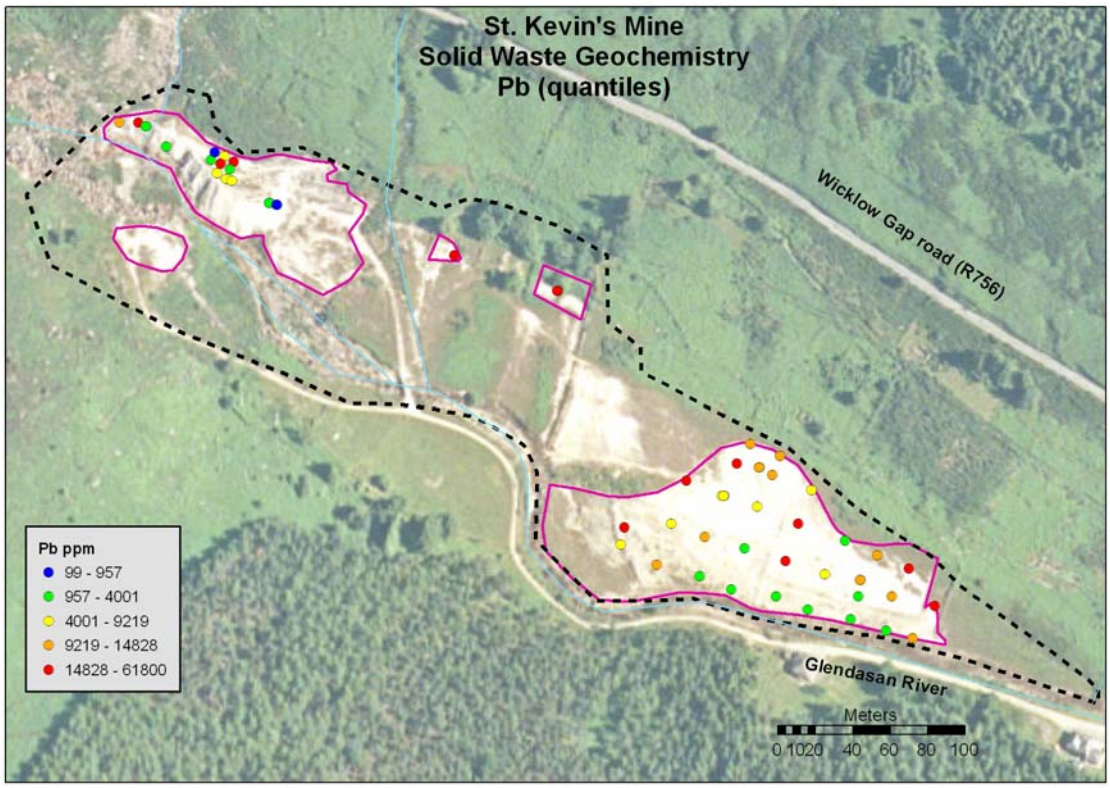


Fig. 3 St. Kevin's Mine sample sites, field XRF analyses

Vertical profiles of spoil show no systematic textural or chemical variation in the spoil heap. However, similar profiles in tailings reveal significant variation with depth in the tailings deposit. The tailings deposits at St. Kevin's site have a maximum thickness of about 2m but are typically 0.2 – 1.0 m thick. The upper part of the tailings is typically sandy in texture. Near the base of the deposit the tailings takes on the form of a grey plastic mud, forming a layer typically 0.1 -0.2m thick (right). This mud is generally Pb- and Zn-rich (1 - 6% in samples analysed). The soil below the tailings generally contains a few hundred mg/kg Pb.

5. HMS-IRC Site Score

The total site score for St. Kevin's mine site is 129 (Table 4). Data for SP01 was used to score SP05, which was not analysed. The main contributors to the score are the tailings deposits which account for 76 (58.9%) of the total. The spoil heaps contribute 26 (20.2%) and the 4th Adit discharge 27 (20.9%). Fig. 4 provides a visual summary of the respective waste source contributions. The spoil heaps have much greater volume than the tailings (Table 1) but the latter has a much higher score because of higher median Pb concentration (9219 mg/kg v 3518 mg/kg) and a very high surface area which helps give the main tailings deposit (TA03) a very high Direct Contact pathway score. The score for the 4th Adit is the lowest of the three Foxrock adit discharges despite this adit having the highest discharge rate. The main reason is the lower Pb concentration in the 4th Adit (maximum 319 µg/l) compared to the other two adits (1827 and 708 µg/l Pb in the 2nd and 3rd Adits, respectively). A concentration of 708 µg/l Pb in the 4th Adit discharge would have given a HMS-IRC score of 54; a concentration of 1827 µg/l Pb would have given a score of 131.

Table 4 HMS-IRC Site Score, St. Kevin's mine site

Waste	**SP01**	**SP05**	**TA01/2**	**TA03**	**4th Adit**	**Total**
1. Hazard Score	31	23	130	60	91	335
2. Pathway Score						
Groundwater	3.75	2.57	16.59	6.10	10.37	39.38
Surface Water	10.69	7.97	24.96	14.64	17.00	75.25
Air	0.06	0.01	0.08	1.55	0.00	1.69
Direct Contact	0.47	0.05	0.58	11.52	0.00	12.62
3. Site Score	**15**	**11**	**42**	**34**	**27**	**129**

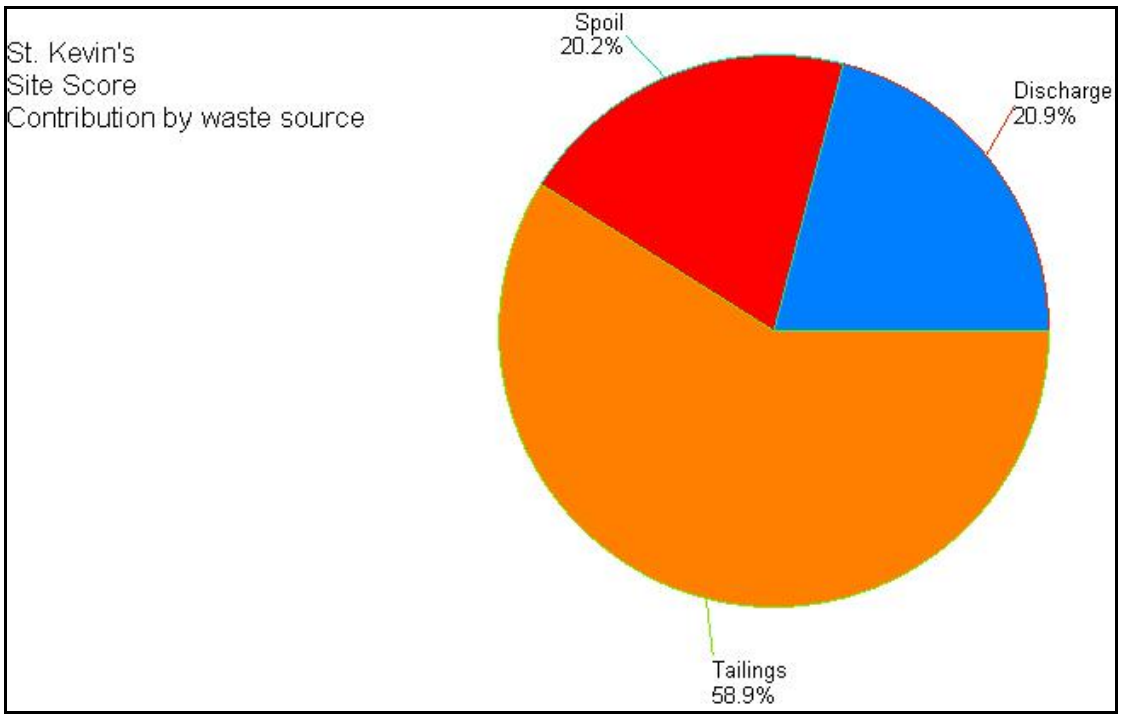


Fig. 4 HMS-IRC Site Score, St. Kevin's mine: contribution by pathway

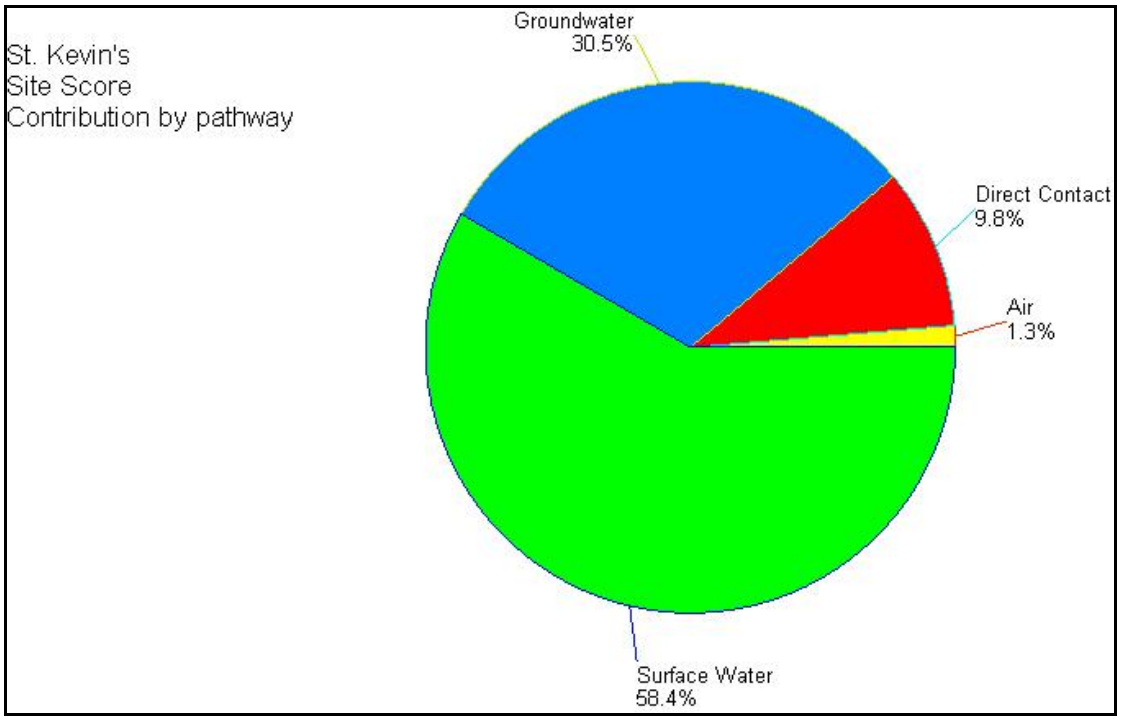


Fig. 5 HMS-IRC Site Score, St. Kevin's mine: contribution by pathway

Fig. 5 shows the contribution of the different pathways to the total site score at St. Kevin's. 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 (58.4%) is the main contributor to the site score. This reflects proximity to the Glendasan River, in which the concentration of some elements exceeds the water standards, as well as factors such as poor aquifer quality and low population density, and hence few wells, that minimize the groundwater pathway score (30.5%). The

Direct Contact pathway is relatively high for St. Kevin's when compared to other sites in the Glendalough District. The large surface area of the main tailings deposit, the site's accessibility and the popularity of the area with visitors are the main reasons for this high score.

6. Geochemical overview and conclusions

The St. Kevin's site contains one of the largest spoil heaps in the district as well as its only significant accumulation of tailings. The Foxrock 4th Adit, the main drainage adit for most of underground workings in Lower Glendasan, discharges directly to the Glendasan River at the western end of the site. This part of the valley is popular with walkers and there are no barriers to prevent access to the site.

The spoil chemistry is typical of quartz-rich mine waste found in the district, with Pb concentrations typically of the order of 500 – 4000 mg/kg with a maximum in excess of 2%. Zn is also present in high concentrations but other elements of interest are not significantly enriched. The tailings material generally has higher concentrations of Pb and Zn; a layer of grey, plastic mud that typically forms the base of the tailings deposit has Pb concentrations exceeding 5% in some cases. Cd was recorded at levels of 102 – 660 mg/kg in several tailings samples. The tailings deposit has an extensive surface area that can become very dry in summer, with potential for dust blows. In wet weather, it is a source of metal-rich leachate that flows into the Glendasan River.

The Foxrock 4th Adit discharges constantly into the Glendasan River; the pH of the mine water is close to neutral, acidity is low and metal concentrations are of the order of 200-300 µg/l Pb and 1500-2000 µg/l Zn. The Glendasan River has consistently elevated Pb and Zn concentrations downstream of the site, although the 4th Adit is unlikely to be the sole source of this contamination given that other adits in Foxrock drain into the river nearby. Stream sediments immediately downstream of the tailings deposit have extremely high concentrations of Pb (7.2%), Zn (5.1%) and Cd (179 mg/kg).