

SHELTON ABBEY

Background information

Mine Name: Shelton Abbey

Mine District: Avoca

Alternative Names:
Avoca Tailings Pond

Elements of interest:
Pb, As, Cu, Zn

Project Prefix: AVO-



County:
Wicklow

Townland:
Shelton Abbey

Grid Reference:
E321289, N175686

Site Description

Shelton Abbey is the site of Avoca mine's main tailings pond. It contains an estimated 7.5 million m³ of sand-silt-grade tailings, constituting 85% of the total solid waste at Avoca mine. It is beside the Avoca River, 7km south by road from the mine and 3 km west of Arklow town. The site was chosen because it afforded a sufficiently large area of suitable ground for construction of the impoundment. The tailings were pumped from the mill along a 6km-long pipe that ran along the eastern side of the river. St. Patrick's Copper Mines Ltd. began construction of the impoundment and in the 1970s Avoca Mines Ltd. raised the height of the dam walls on several occasions. According to the GWP report for the Avoca Feasibility Study (CDM 2008), the initial walls were raised immediately beside the river or perhaps even used the original river flood bank. After the level of the tailings pond deposit had been raised by 4 – 5m above river level, the location of the dam wall position was moved inwards by 15 to 20m and new walls were raised on the tailings pond deposits. The walls were mainly constructed of tailings that were not adequately compacted. Slopes ranged from 33 to 38°. The walls reached a height of 18m above the original, outer walls beside the river. There were several failures of the dam walls leading to deposition of considerable volumes of tailings into the Avoca River (CDM 2008).

The site is bounded to the southwest by the Avoca River (Fig. 1). The northeast boundary is a cliff, apparently created in the course of construction of the tailings pond, and its top is covered by a forestry plantation that extends around to the northwestern end of the tailings pond. To the southeast is Shelton Abbey, now in use as an open prison, and beyond it the former fertilizer plant, now the site of a business park.

The tailings pond has undergone extensive remediation since closure of the mine. The surface was covered with a layer of local slate and siltstone bedrock followed by c. 0.3m of topsoil. The topsoil was seeded with grass and, in the last decade or more, there has been significant colonization by gorse and other species. Trees have been planted along the outer dam walls and provide an effective screen from the

river and main Avoca – Arklow road. The site is now used by a local gun club that rears pheasants on site.

Although the rehabilitation of the tailings pond has been broadly successful, a number of issues were identified in the course of the HMS-IRC project and the Avoca Feasibility Study. Seepages occur at several points along the toe of the inner dam wall (Fig. 1) while pH measurements in the Avoca River suggest that seepages are probably discharging from the lower, original dam along the riverside. A small backwater to the Avoca River (site 4 on Fig. 1) was found to have low pH and high metal concentrations, indicating input from seepage. Surface drainage on the tailings pond is via ditches running around the perimeter. Both lead to a drain at the eastern end of the site. This drain runs into a pipe on the flat ground east of the dam wall and thence to the river. The drains are ineffective and tend to draw water onto the tailings rather than drain it off. Extensive ponding of water has taken place at the southeastern end of the tailings pond (Fig. 1). This appears to be the result of blocking of the culvert at the northeastern end of the site where the water should flow into the northwest-southeast-trending ditch and thence to the pipe.

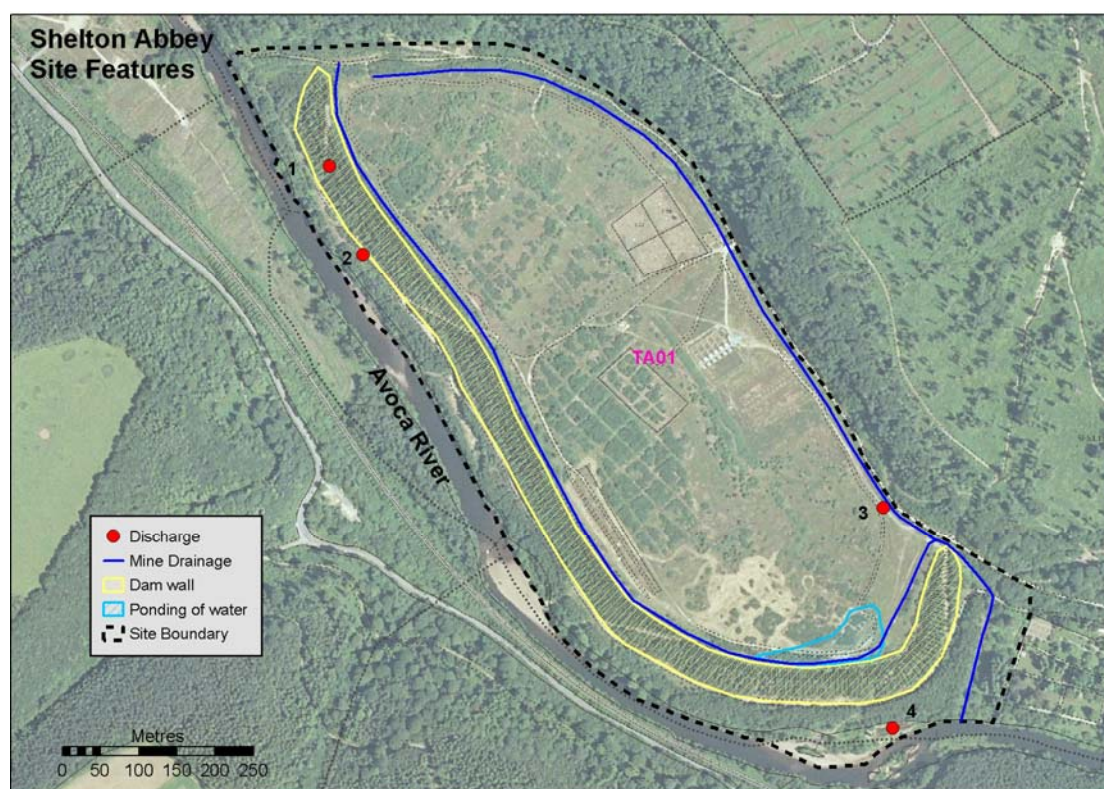


Fig. 1 Shelton Abbey: site features

GWP concluded (CDM 2008) that despite the deficiencies in dam construction techniques, the Shelton Abbey tailings pond exhibited no signs of current instability. The main risk to stability could come from dam erosion by floodwaters of the Avoca River. Drilling on the pond as part of the HMS-IRC geochemical programme indicates that only the top 1m or so of tailings is dry – below this the tailings consist of a grey plastic mud that becomes progressively less viscous with depth. Failure of the dam wall would, therefore, have potentially serious consequences.

Estimates of the volume of tailings at Shelton Abbey are complicated by the mode of construction, with an earlier outer dam wall replaced by a later inner wall. The

material within the inner wall was estimated for the HMS-IRC project to be just over 7,000,000 m³ (Table 1). A total volume of 7,500,000 m³, apparently including material along the river bank outside the inner wall, was estimated for the Avoca feasibility Study (CDM 2008).

Table 1 Area and volume of tailings Shelton Abbey

Waste ID	Area (m ²)	Volume (m ³)
AVO-TA01	443,880	7,547.387

Source: GWP (CDM 2008)

Geochemical assessment

1. Surface water

Several surface water samples were taken from the Avoca River at the southeastern end of the tailings pond, mostly in November 2006, with one additional sample in June 2007. The small backwater apparently affected by seepage from the tailings pond was also sampled as was the water draining from the surface of the pond. Results are summarized in Table 2 where they are compared to the Avonmore River sample also taken in November 2006.

Table 2: Data for surface water, Shelton Abbey*

	Pb (tot) µg/l	Cu (tot) µg/l	Zn (tot) µg/l	Ni (tot) µg/l	Cd (tot) µg/l	Cr (tot) µg/l	pH	Acidity mg/l CaCO ₃
1. River downstream	3	9	135	2	<1	<1	6.7	9
2. Backwater	14	244	2186	160	3	122	3.7	294
3. River downstream	35	9	101	5	<1	4	6.8	8
4. Surface drainage	2	<1	32	2	<1	<1	5.9	12
5. River downstream (June 07)	6	38	284	5	<1	5	6.2	12
Avonmore River	4	58	<1	4	<1	3	6.7	8

*Samples taken in November 2006 unless stated; site numbers in left column refer to Fig. 2

The backwater sample is clearly affected by seepage from the tailings pond – low pH, high acidity, high Zn and Cu are all consistent with such an event. The surface drainage sample shows reduced pH compared to normal river water or rainwater and may reflect interaction with the exposed tailings. However, none of the metal concentrations suggest that this interaction, if it is occurring, is happening to a particularly significant extent. The river water samples do not suggest significant contamination from any mine-related source. One has a measured Pb concentration 35 µg/l Pb, another 284 µg/l Zn. Both these results are suggestive of some input from mine drainage, i.e. tailings seepage.

2. Groundwater

No groundwater sources were sampled for this project. A composite sample of tailings was subjected to a leachate test. High Cu (2798 µg/l) and Zn (2322 µg/l) and significant levels of Pb (61 µg/l) and Cd (9.3 µg/l) were measured. Water from a single monitoring well, located at the toe of the dam wall immediately north of site 2 on Fig. 2, had 150 µg/l Cu (total), 21 µg/l Pb (dissolved), 3690 µg/l Zn (dissolved) and 130 µg/l Ni (total) (CDM 2008). These results suggest that groundwater in the immediate vicinity of the tailings pond is contaminated by leachate from the pond. Concentrations of metals in the monitoring well water are considerably lower than concentrations found in some monitoring wells at Ballygahan and Tigoney West.

However, the leachate test demonstrates the potential for higher concentrations of metals in groundwater at Shelton Abbey.

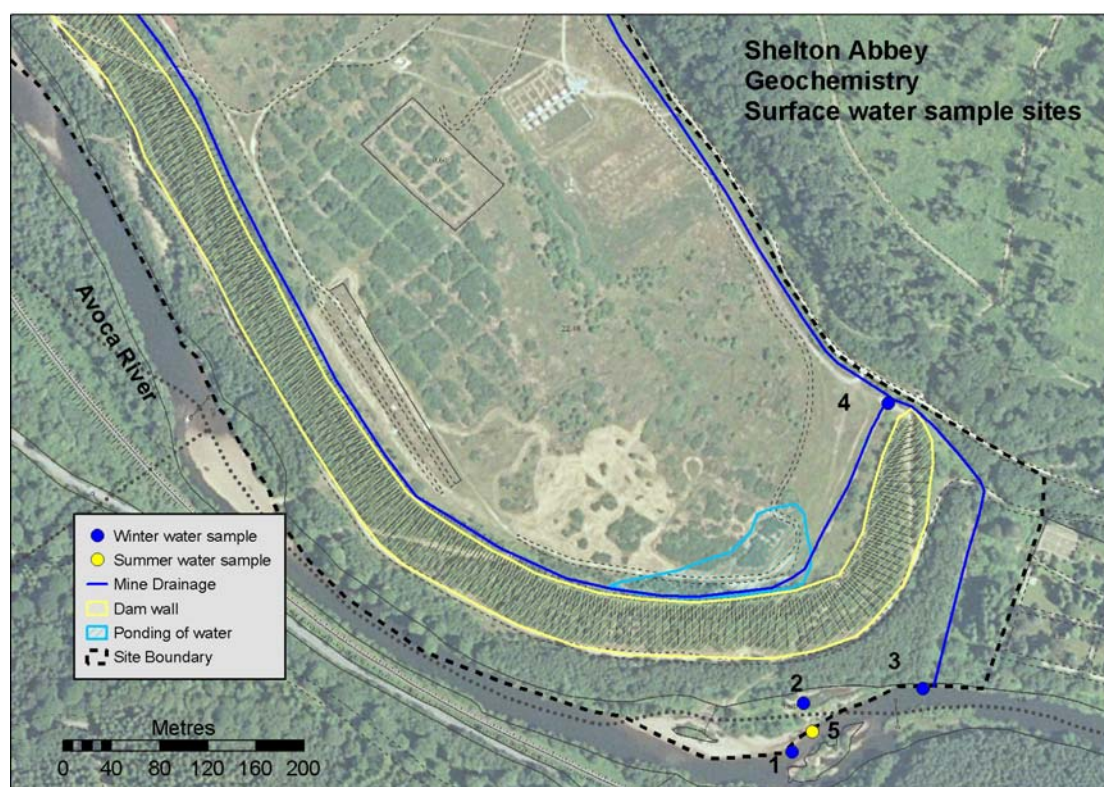


Fig. 2 Location of surface water sampling sites, Shelton Abbey

3. Stream sediments

Two stream sediment samples were collected in the vicinity of Shelton Abbey as part of a district survey. Details of all stream sediment sampling and analyses for the HMS-IRC project are contained in the Avoca District report. One sample was taken beside site 1 on Fig. 2, another 1 km downstream beside the site of the former fertilizer plant. In general, concentrations of Cu, Pb and Zn in stream sediments in the Avoca River decrease with increasing distance from the mine site. The samples at and downstream of Shelton Abbey conform to this general trend, as can be seen in Table 2, with the exception of Zn. It is not possible on the basis of this evidence to suggest that the stream sediment data reflect significant contamination by material from the tailings pond. The gradual decline in sediment metal concentrations from the mine area to the site downstream of Shelton Abbey can be interpreted reasonably as reflecting the declining influence of contamination generated at the mine site itself, without influence from the Tailings Pond.

Table 2 Data for stream sediments, Shelton Abbey

mg/kg	Pb	As	Sb	Cu	Zn
Woodenbridge (u/s Shelton Abbey)	411	60	<DL	256	572
Shelton Abbey	257	47	<DL	224	784
1 km downstream of Shelton Abbey	239	52	<DL	177	611
District Median	411	52	<DL	257	573

DL: detection limit

4. Solid Waste

The tailings pond was sampled using a trailer-mounted auger drill. The grass and soil cover was stripped back at 37 sites before drilling and samples were retrieved from nominal depths within the tailings material itself of 0.5m, 3.0m and 5.5m. Below c. 1.0m the tailings change from grey-green sandy material to a grey, plastic mud that becomes less viscous with depth. Table 3 summarizes the data for elements of interest; median values are given for each of the three different depths sampled. Fig. 3 – 5 shows the distribution of Cu in the tailings pond for each of the three different depths.

Table 3: Summary statistics, field XRF analyses of tailings, Shelton Abbey

mg/kg	Pb	As	Sb	Cu	Zn
n	111	111	111	111	111
Minimum	41	0.0	0.0	67	0.0
Maximum	537	208	0.0	1028	387
Median	175	57	0.0	197	87
Mean	199	59	0.0	234	103
Median 0.5m depth (n = 37)	148	49	0.0	153	42
Median 3.0m depth (n = 37)	190	59	0.0	234	114
Median 5.5m depth (n = 36)	211	56	0.0	213	120
Median Avoca Spoil (n = 230)	2846	660	0.0	443	105

Table 3 suggests that Pb, Cu and Zn concentrations in tailings increase below a depth of 1m in the tailings pond. However, as the comparison with Avoca spoil medians shows (Table 3), absolute concentrations of these metals within the tailings are relatively low in the context of the Avoca site as a whole.

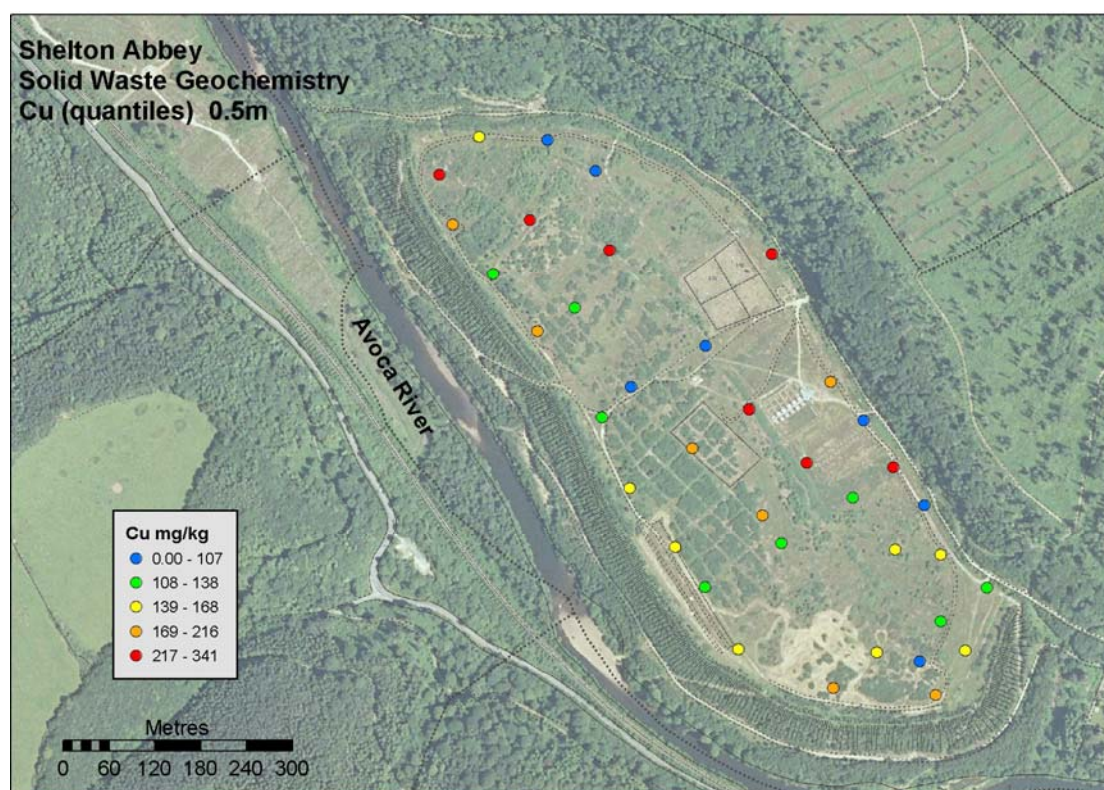


Fig. 3 Distribution of Cu in tailings, Shelton Abbey: 0.5 m depth

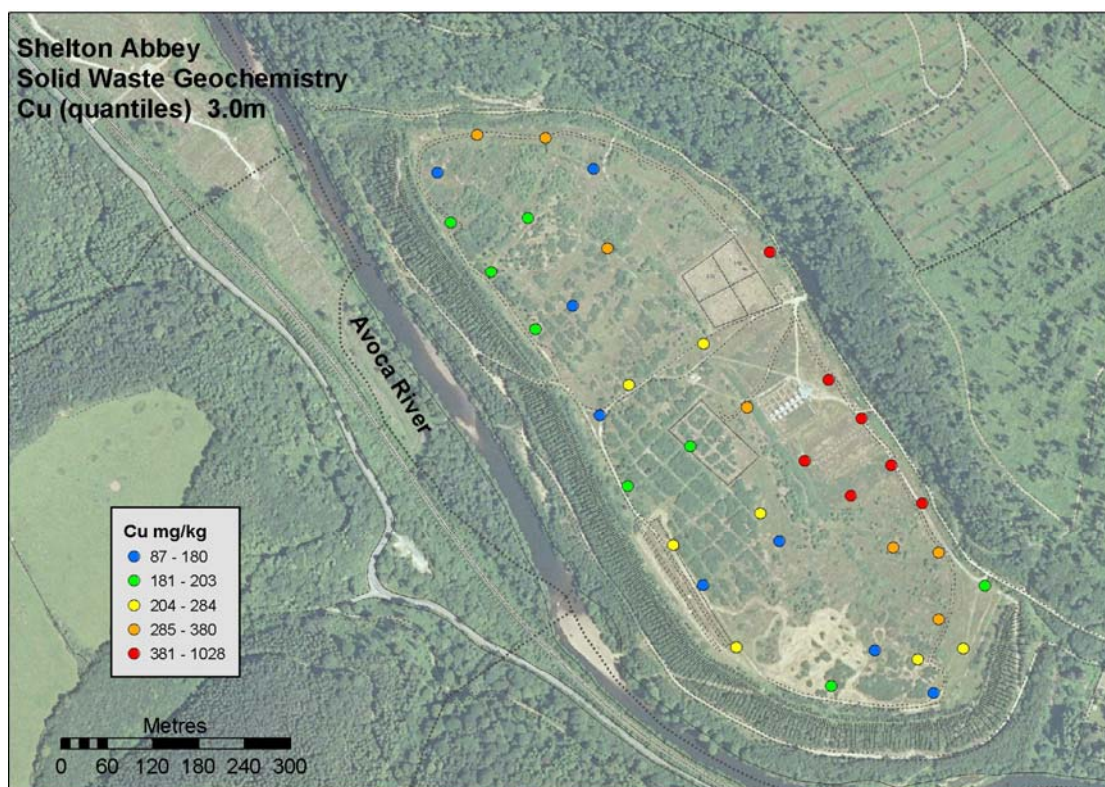


Fig. 4 Distribution of Cu in tailings, Shelton Abbey: 3.0 m depth

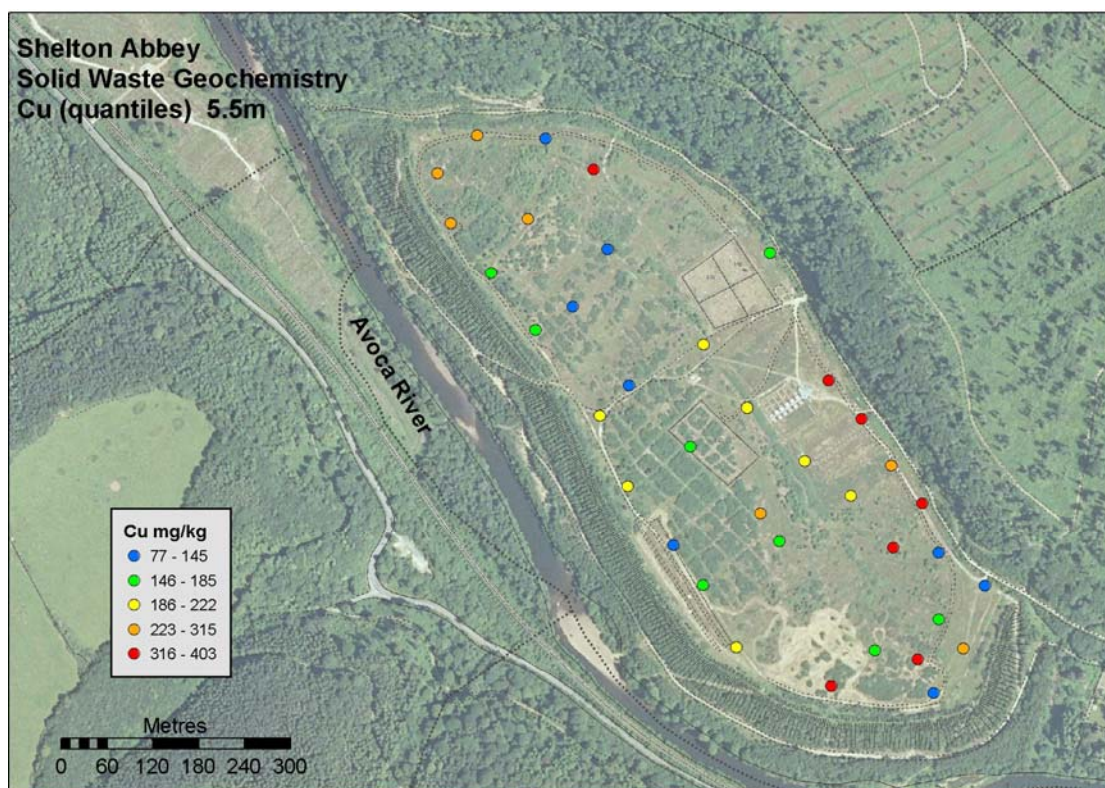


Fig. 5 Distribution of Cu in tailings, Shelton Abbey: 5.5 m depth

5. HMS-IRC Site Score

Table 4 HMS-IRC Site Score, Shelton Abbey

Waste	TA01
1. Hazard Score	85
2. Pathway Score	
<i>Groundwater</i>	34.21
<i>Surface Water</i>	15.24
<i>Air</i>	0.27
<i>Direct Contact</i>	14.77
3. Site Score	64

The total site score for Shelton Abbey is 64 (Table 4). The total score for the Avoca District as a whole is 2438, of which the solid waste score is 979. Thus the tailings pond at Shelton Abbey, although it makes up 85% of the total volume of solid waste at Avoca, contributes only 6.5% of the score that is attributable to solid waste. This is simply a consequence of the much higher concentrations of metals found in spoil heaps at East and West Avoca. For example, Mount Platt (SP20) in Cronebane, with c. 11% of the volume of the tailings pond, contributes a score of 368.

Water in the Avoca River shows no apparent impact from the tailings pond whereas a leachate test confirms the potential for groundwater contamination, something that agrees with the composition of water in a monitoring well at the tailings pond. This, together with the large volume of the waste, gives the groundwater pathway has a much higher score than other pathways (Fig. 6). The large volume of waste and the proximity of the site to the river ensure the surface water pathway score is also substantial. The large surface area of the tailings pond and the use of the site by a gun club, both for breeding pheasants and shooting, which emphasizes the attractiveness of the site for recreation, have resulted in a relatively high direct contact pathway score. Revegetation of the surface of the pond means that the potential for dust blow is minimal, resulting in a very low air pathway score (Fig. 6).

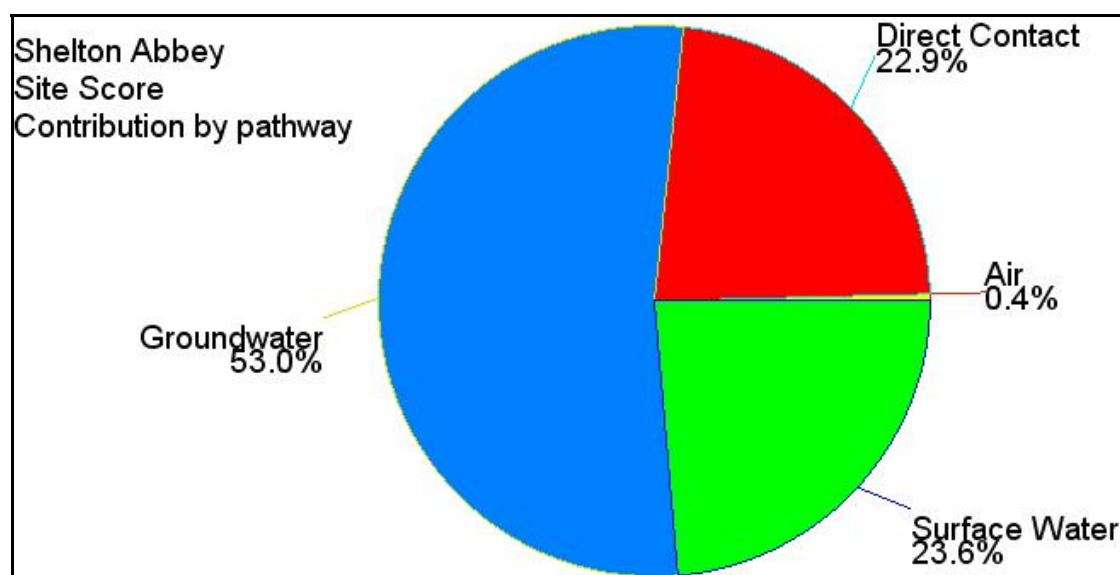


Fig. 6 Shelton Abbey Sites Score: contribution by pathway

6. Geochemical overview and conclusions

Concentrations of elements of interest are relatively low in the tailings pond at Shelton Abbey compared to the composition of solid waste elsewhere on the Avoca mine site. However, a leachate test, data from well monitoring and analysis of surface water that is apparently contaminated by seepage suggest that the tailings have the potential for significant groundwater contamination. Analysis of surface water, both the Avoca River and drainage from the surface of the tailings pond, suggest a very limited impact from the tailings pond, chiefly from seepages. The site scores for Shelton Abbey reflect these results with the groundwater pathway contributing over 50% of the total site score.

References

CDM(2008) Feasibility Study for management and remediation of the Avoca Mining site, CDM.