Boliden Tara Mines Limited

Boliden Tara Mine Limited (Tara Mines), the largest operating zinc-lead mine in Europe, is located at *Knockumber, 2 km* from west of Navan in County Meath and 50 km northwest of Dublin.

The mine exploits the Zn-Pb deposit, which was discovered in 1970 by the Tara Exploration and Development Company Limited (a Company formed in Canada in 1953 by four Irishmen). Development of the orebody commenced in 1973 and production of concentrate commenced in 1977

The original ore reserves (calculated in 1971) in the entire orebody amounted to 69.9 million tonnes grading 10.09% Zn, 2.63% Pb. Tara Mines is the largest operating zinc and lead mine in Europe currently producing between 2.6 and 2.7 million tonnes of ore per annum, resulting in 400,000 tonnes of zinc and lead concentrate.

On 1st January 2004, the ownership of Tara passed to Boliden. The current estimated ore reserves are 17.0 million tonnes at 7.2% Zn and 1.8% Pb. while the projected 'life of mine plan' extends past 2018.

The Company was granted an IPC licence from the EPA on 29th May 2001, Reference No 516. This licence was granted for the extraction and processing (including size reduction, grading and heating) of minerals within the meaning of the Minerals Development Acts 1940 to 1999, where the facility involves -

(a) A metalliferous operation, or

(b) any other operation where either the level of extracted or processed minerals is greater than 200,000 tonnes per annum or the total operational yield is greater than 1,000,000 tonnes, and storage of related mineral waste.

The licence was later amended to an IPPC licence on the 9th June 2006 (Ref. No. P0516-01)

This non-technical summary gives a brief description of the activity and an outline of the changes to the operation since the original IPC Licence was granted, in May 2001.

The 'Navan' orebody

The Navan orebody lies between 50 and 1000 metres below the surface. The orebody rises to surface in the northeast and dips in a southwest direction as it extends for approximately 6.5 km. The mineable ore thickness ranges from 5 to 80 metres, with the thicker ore predominant in the eastern section.

The ore body extends over an area of 6.5 kilometres by 1.5 kilometres, and the combination of a gently dipping orebody, together with a large geographical area, requires a mining

method that utilises mobile equipment for ore haulage, rock drilling and explosives charging.

The mine is currently divided into the following sub-areas for management and planning:

- The Central Area, also known as the Main Mine or Knockumber Mine. This was the first area to be mined. At this stage it has largely been mined out.
- The South West Extension (SWEX), to the southwest of the Main Mine.
- Nevinstown, to the north of the Main Mine.

The current know extent of the orebody is illustrated in below.

The mining methods employed in the SWEX and Nevinstown areas of the mine are similar to those used elsewhere in the Main Mine i.e. principally long hole open stoping with backfill. Room and pillar methods are applied where the ore is thinner. Access to the SWEX and Nevinstown is from portals at the main mine site.

An expansion of the mine workings is currently being planned into the Liscartan and Rathaldron application areas, located to the northwest of the Main Mine area.

Figure 1 show the distinct areas of the orebody.

Figure 2 shows a cross-section through the orebody.

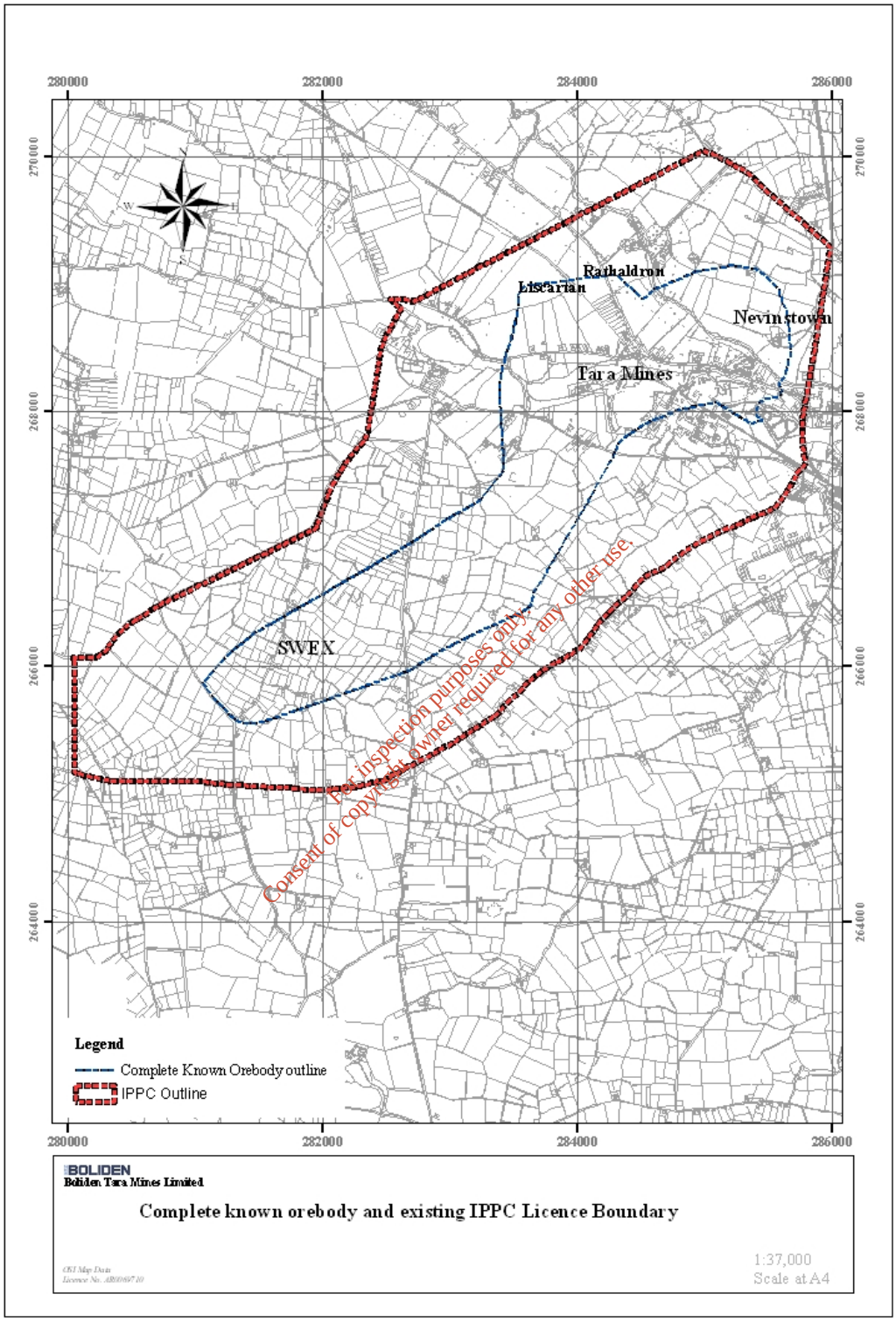

Figure 1 Orebody outline

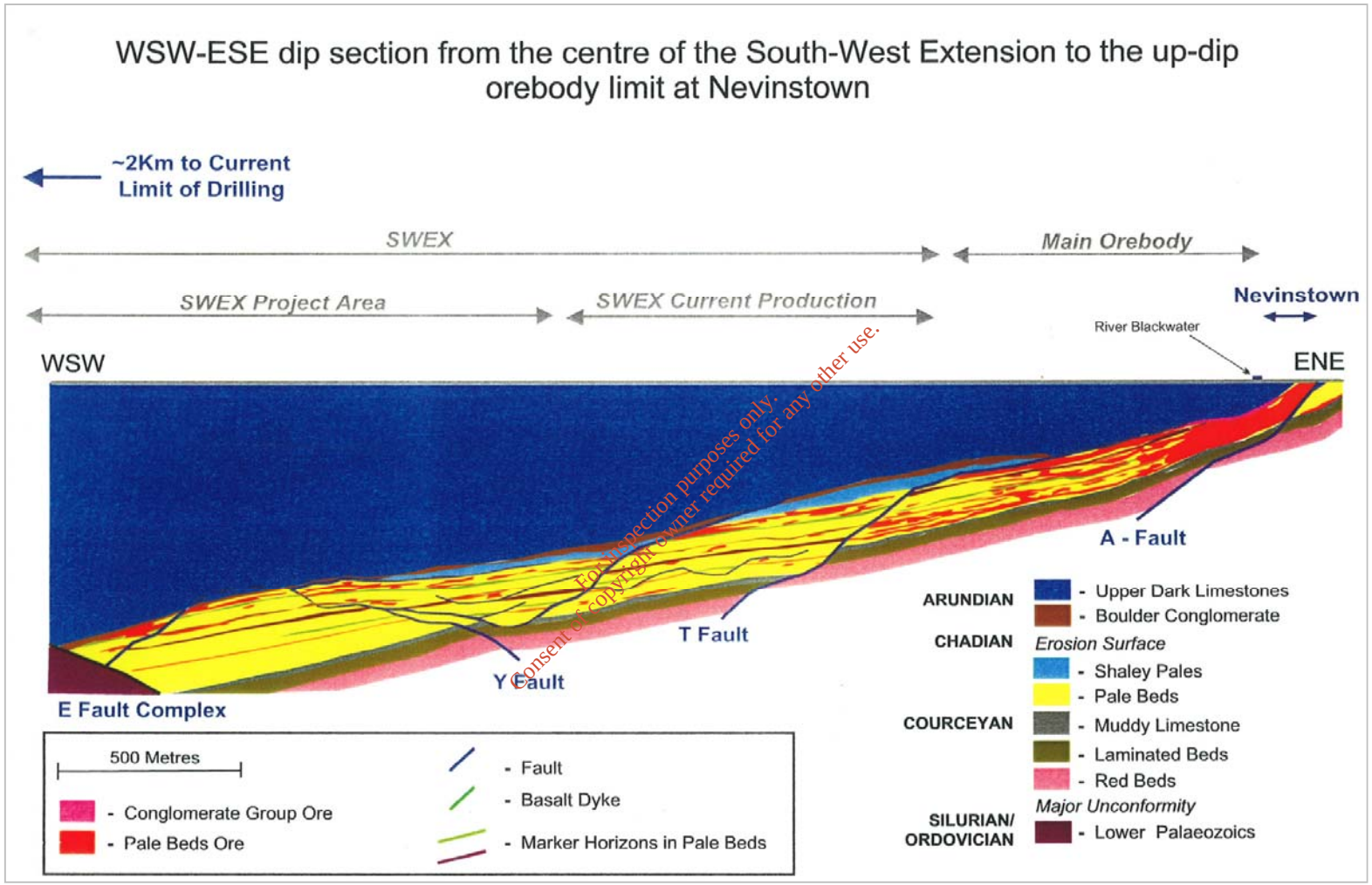

Figure 2 Cross-section through the orebody

Mine Development

Mine development involves the drilling and blasting of new tunnels or drifts to extend the mine and/or to access the orebody to prepare for the production cycle. Exploration and mine development are generally in waste rock or low-grade ore and allow initial access to mining blocks. Stope development is within the mineable ore boundary and gives access to the drilling, blasting and ore recovery from stopes and pillars. Exploration and main development extends to about 4500 metres per year and stope development is generally 6500 metres per year. Ore generated from development is approximately 400,000 tonnes per year.

Mine Production

Mine production encompasses the drilling, blasting and removal of the ore from stopes. Broken ore from both production and development is delivered to one of five underground crushers and reduced in size to less than 150 millimetres before being carried by conveyor to a 3600-tonne capacity storage bin at the base of the production shaft. Skip loading and hoisting are automatic, supplying ore to the 30,000-tonne surface coarse ore storage building.

Mine Ventilation

Fresh air enters the mine through the main travel routes and through dedicated fresh air raises linking surface to selected locations underground, fresh air passes through the mine workings and is diverted off in controllable quantities into the various mining areas.

The mine ventilation system has a maximum capacity of over 1000 cubic metres per second. Two underground axial fan stations and two surface centrifugal fan stations have been operating since the original licence application. With the expansion of the mine two additional return air raises have been commissioned. An additional return air raise is being planned.

Drainage

There are three ways in which water can enter the mine: (1) as natural groundwater, (2) as service water for the mining operation, and (3) as a transport medium for backfill. Water can be free flowing through channels or can be pumped through pipelines to collection areas. Free flowing water from the upper mine levels is collected at a central sump area where a flocculent is added to accelerate deposition of fine material for pumping of clean water to the surface. In the south-western section of the mine, water is diverted to horizontal sumps, accessed by removable section waterproof steel barriers. The fine material settles within the sump and, as an additional aid, a filtering system clarifies the overflow water prior to entry to the pump station. The pump station transfers cleaned water through a 300-millimetre pipe over a distance of more than two kilometres and a vertical lift of 500 metres.

Processing

Tara ore is in the form of zinc and lead sulphides while the host rock is limestone, containing both calcite and dolomite. The objective of ore processing is to separate and recover the zinc and lead minerals into two separate saleable grade concentrates.

Grinding

Mineral particles must be physically liberated from the host rock in order to selectively recover the lead and zinc metal. Initially, the ore passes through an underground crusher reducing the particle size to less than 150mm and is then hoisted to the surface. The ore then passes to the Autogenous grinding circuit and is mixed with water. The Autogenous grinding circuit reduces the ore particle size to less than 120 microns, a size range where the mineral particles and the host rock can be separated. Autogenous Mills use large particles of ore instead of steel balls for grinding media. The finely ground ore slurry is then pumped to the floatation stage of the process where the lead and zinc minerals are recovered respectively.

Flotation

The flotation circuit consists of a series of cells. Each cell is equipped with a rotating agitator, which disperses the air and maintains the mineral particles in suspension. Various chemicals are added to the lead and zinc flotation circuits. The valuable minerals are 'collected' and carried by air bubbles, which form a froth phase on the top of each cell.

After floatation the zinc minerals must undergo a process known as leaching, using sulphuric acid, to purify the zinc concentrate.

Dewatering

The final products are pumped to separate dewatering circuits. Concentrates are dewatered separately using thickening and filtration in pressure filters. The new Mesto pressure filters drying system has a very positive impact on the environment as it has eliminated the use of thermal drying, which resulted in emissions to the atmosphere, and the use of nitric acid as a cleaning agent for the old filter plates.

Lead concentrate contains approximately 67% lead metal and the zinc concentrate contains 56% zinc metal.

Tailings and Backfill

When the valuable minerals have been recovered in the flotation process, the remaining material is known as tailings. Slimes and fine particles are removed using cyclones and are pumped to the tailings pond, which is located five kilometres from the mine site. The suspended solids settle out and clean water is recycled to the mine site for re-use in various processes.

The remaining coarser sandy tailings particles from flotation are stored in sand tanks. When backfill is required underground, water and cement are added to the sand, which is then

pumped through boreholes into open stopes. Each year in excess of one million tonnes of tailings sand are pumped into the mine as backfill.

Concentrate Transportation

Concentrates are transported by rail to a storage and ship loading facility at Dublin Port from where it is shipped to smelters in Finland, Norway, Spain, Italy and Germany.

Hours of operation

The operation is run on continuous 24/7 basis. Essential mining services including water pumping and ventilation are maintained 365 days per year.

Raw and auxiliary materials, other substances and the energy used in or generated by the installation

The purpose of the facility is to produce zinc and lead concentrates, which are transported by rail to Dublin port and shipped overseas to various smelters in Europe for further processing into the pure zinc and lead metals.

The main resource used in the process is energy for the operation of the underground mine and the above-ground processing facility.

Energy

Mining consumes substantial amounts of energy – between 15% and 17% of total production costs are energy related

Tara's Energy objectives are integrated with its environment, health, safety, quality and cost objectives in order to minimise the environmental impact of energy use and to improve competitiveness

The Company is committed to continual improvement in energy efficiency and investigation of alternative and renewable sources of energy. The Company's Energy Management System is accredited to the EN 16001 energy standard

Employment

Boliden Tara Mines Limited currently employs a total of 680 employees and it is estimated that there are 3 additional jobs indirectly supporting each job.

Proposed technology and other techniques for preventing or, where this is not possible, reducing emissions from the installation.

Under the terms of Tara's IPPC licence No P0 516-01, all environmental aspects of the Company's activities are monitored including continuous monitoring for noise, blast vibration, ambient air, total dust deposition and discharge to the River Boyne. Routine monitoring of groundwater, surface waters, soil and vegetation is carried out in the environs of the mine site and the tailings management facility.

Waste management
Procedures are in place for the prevention and recovery of hazardous and non-hazardous waste. Facilities and services are provided to enable the proper segregation and safe storage of waste materials on site. The onsite landfill has not been used for the disposal of waste, since 2001. Only pre-approved, licensed waste contractors remove waste materials from site.

Sources of emissions from the installation

Atmospheric emissions

Air emissions from the facility include combustion fumes and particulates as a result of ventilating the underground workings where the work is carried out by diesel power mobile equipment. Emissions from the processing plant are limited to a single remaining point source ventilation stack on the concentrate storage building. Minor emissions include central heating boilers. There is also the potential for diffuse dust emissions.

Emissions to surface Water

There is currently only one point 'diffuse source emission' to surface water, SW1 to the River Boyne. This discharge includes treated process water, excess mine water and surface water captured in the water management system. Excess, treated water is discharged at a flow dilution ratio of 100:1. It is planned to develop a second surface water discharge to the river Blackwater (SW-2). This discharge will consist of clean, uncontaminated groundwater.

Noise emissions arise from general site activities

Noise emissions are minimised through proper design and operating procedures. Noise emissions are monitored at four permanent monitoring stations on the periphery of the mine site. Temporary noise monitoring is carried out as required during the construction phase of the tailings facility extension.

Ground vibration monitoring is carried out at four fixed monitoring stations and at a number of temporary monitoring stations on a needs be basis.

SIGNIFICANT DEVELOPMENTS SINCE THE ORIGINAL IPC LICENCE WAS GRANTED IN 2001.

Extension of the mine workings into the Nevinstown orebody, January 2004
The extension of the mine into the Nevinstown orebody is essentially a northern extension to the existing mine. This development gained access to the Nevinstown orebody via the existing underground mine and involved no additional surface infrastructure and no additional environmental emissions.

Planning permission for the development was granted by *An Bord Pleanala* on the 15th January 2004 subject to 16 conditions.

Mine Extension into the SWEX (South West Extension) orebody, July 2004
SWEX is a southwest extension of the existing mine. This development also involved the construction of two vertical ventilation raises from the underground workings to surface.

The Fresh Air Raise (FAR) is simply an air intake point through which fresh air is drawn into the mine. This facility has a negligible environmental impact. The second raise is an exhaust air vent, or return air raise, referred to as RAR No. 5. In this facility the air (primarily with diesel fumes) are fan extracted out of the mine.

Planning permission for the development was granted by Meath County Council on 26th August 2004 subject to 12 conditions. The air emissions from the new ventilation raise (RAR 5, A2-10, have been monitored as part of the IPPC monitoring schedule since the facility was commissioned.

Proposed Mine Extension into the new areas of the Liscartan and Rathaldron orebody.
The proposed development involves the mining of proven ore reserves in the townlands of Liscartan and Rathaldron. The surface characteristics and features of the 'mining area' will not be altered by mining activity and there will be no surface infrastructure facilities in this area.

The Liscartan/Rathaldron section of the 'Navan orebody is an uninterrupted extension of existing mine workings that are currently being mined by Boliden Tara Mines Limited (Tara Mines). The Liscartan/Rathaldron section of the orebody dips to the southwest and strikes to the northwest in common with the general characteristics of the orebody, giving a depth below surface ranging from 150m to 575m with ore thickness ranging from 4m to 12m. Mining follows a cyclic pattern resulting in the removal of ore underground followed by the filling of the voids using cement and waste sand material that remains after the ore treatment process. The surface characteristics and features of the Liscartan / Rathaldron townlands will not be altered by mining activity and there will be no surface structure / infrastructure facilities in the area. The expansion of the mine workings into the Liscartan & Rathaldron areas will be accessed from the existing underground workings and will use similar mining methods to those currently being employed. The total reserves and resources in Liscartan and Rathaldron amount to 1.1 million made up of 0.9 million tonnes of inferred resources.

Planning permission for this development was lodged with Meath County Council on 16th September 2010.

Return Air Raise (RAR) No. 4 - (Emission Point Ref No. A2-9)
This facility was commissioned in 2003 and involved the conversion of a Fresh-air Intake Raise to a Return Air Raise to remove air and fumes from the underground mining activity.

The installation consists of 2 fans which operate in parallel each with a fixed speed of 1500RPM. The fans are located 80 m below ground and vent to the atmosphere via a 3.6 m diameter raise. The emissions to surface from the raise are re-directed towards the ground through a deflection hood measuring 6.7m x 3m.

The specification and emission details for RAR No 4 are included in section E.

Return Air Raise (RAR) No. 5 (Emission Point Ref No. A2-10)
This facility, commissioned in December 2006, is located approximately 5 km southwest of the main mine site in the townland of *Ardbraccan*. The installation consists of 4 fans which operate parallel each with a variable speed range of 0 - 1500RPM. At a maximum operating speed of 1500 RPM airflow of 370m^3/s is generated. The fans are located in excess of 650m below ground and vent to the atmosphere via a 4.5m diameter raise.

Emissions to surface from the raise are re-directed towards the ground through a deflection hood measuring 5.7m x 5.7m.

The fans operate in an efficient manner to provide sufficient ventilation with minimum energy consumption. RAR No 5 is inaudible at 100m from the surface discharge point. The design maximum 24 hour daily emissions equates to 3.2 x 10^7 Nm^3.

The specification and emission details for RAR 5 are include in section E.

Planning permission for the development was granted by Meath County Council on 26th August 2004 as part of the South West Mine Extension proposal.

<u>Proposed</u> Return Air Raise (RAR) No. 5 - 2 (Emission Point Ref No. A2-11)
This proposed facility will be located approximately 80 meters North-west of the existing RAR 5 (A2-10) ventilation raise south-west of the main mine site.

The installation will be identical in specification to RAR 5 i.e consisting of 4 fans which operate parallel each with a variable speed range of 0 - 1500RPM. At a maximum operating speed of 1500RPM, an airflow of 370m^3/s is generated. The fans are located in excess of 650m below ground and vent to the atmosphere via a 4.5m diameter raise.

Emissions to surface from the raise will be re-directed towards the ground through a deflection hood measuring 5.7m x 5.7m

The design maximum 24 hour daily emissions equates to 3.2 x 10^7 Nm^3. The specification and emission details for RAR 5-2 are include in Section E.

This development will be subject to planning permission.

Decommissioning of Zinc Dryer / Elimination of Emission Point Ref. No. A2-1

In September 2006 the thermal system for drying / dewatering zinc concentrate was replaced by a mechanical pressure filter system. In this process, concentrate material which is in a slurry form with a very high moisture content (approx. 30% solids by weight) is pressed between cloths under hydraulic pressure. Moisture is compressed out of the concentrate to produce a final product containing 8% moisture. The filtrate water is collected and returned to the concentrate thickeners. This process imparts zero emissions to atmosphere.

This development has resulted in many positive benefits / impacts with the most significant being the elimination of thermal dryer stack emissions of particulates, metals and gases to atmosphere.

Total mass emissions of metals to air have been reduced by 98% since 2005 (refer to Table 1 below).

Table 1 Emissions to atmosphere from thermal zinc dryer stack 2005 (Emission point Ref. (A2-1)

Parameter	**Mass Emission Kg 2005**
Particulates	6,175
Zinc	1,538
Lead	500
Cadmium	<16.4
Arsenic	<13.7
NOx (asNO_2)	30,140
SO_2	26,359

Other positive Impacts:

- Elimination of heavy fuel oil usage (approximately 2000m^3 per annum, which was used to run the burner system operating the thermal dryer)
- Reduction in operating costs, more consistent tonnage throughput and residual moisture content
- Elimination of wet scrubber
- Reduction in electric power consumption
- Cleaner air quality in the workplace
- Lower noise levels

Decommissioning of Lead *Hoesch* Ceramic Pressure Filter Drying System and replacement with *Metso* Pressure Drying System

The *Metso* Pressure Filter System replaced the Lead *Hoesch* pressure filter system, which did not incorporate an air emission. The positive aspect of this development was the elimination of the use of Nitric acid, which was used to clean the *Hoesch* filter plates. The volume of nitric acid used annually was approximately 150 tonnes.

De-commissioning of Emission Point Ref. A2-3 on the concentrate loadout building

Lead and Zinc concentrate is stored in the Concentrate Loadout Building. The Loadout system was upgraded following the installation of the new zinc pressure filter drying system.

A recent improvement in the concentrate drying technology has resulted in less dust generation within the building. The larger ventilation stack (Emission Point Ref. A2 –3) has been de-commissioned and the smaller ventilation stack (Emission Point Ref. A2-4) has been re-commissioned. The re-commissioned ventilating fan will only operate when train loading is in progress.

New Grinding System - Autogenous Grinding- Elimination of Atmospheric emission point A2-2

This project involved the installation of an Autogenous grinding mill circuit to replace the existing crushing plant and primary grinding circuit.

The old crushing and grinding system (consisting of 3 cone crushers, primary ball mill, secondary ball mill, regrind ball mill and rod mill) generated fine dust and requires a dust collection system (wet scrubbing plant and air exhaust to atmosphere Emission Point Ref No. A2-2).

Autogenous mills operate mechanically similar to the rod and ball mills but differ in that the media they use to break and grind the ore. Autogenous Mills use large particles of ore instead of steel for grinding media. This single mill, which rotates in an enclosed circuit, has a maximum operating capacity of 400 tonnes/ per hour and does not require an emission to atmosphere.

This development was granted planning permission on the 18th July 2008 by Meath County Council with no conditions.

Positive Impacts:

- Elimination of dust generation - Elimination of Emission Point Ref. No. A2-2. The old crushing plant generated fine dust, which had to be controlled using a combination of dust collection systems (wet scrubbing plant and air exhaust to atmosphere). Autogenous grinding will eliminate dust generation as it is an enclosed circuit and will thereby greatly enhance the working environment.
- The main noise sources from the existing grinding system will be decommissioned (3 Cone Crushers, Primary Ball Mill & Rod Mill).
- Removal of the old conveyor system

Concrete batching plants

There are two separated concrete plants, also known as batching plants, operating on site. Both plants combine various ingredients to form concrete products.

The primary source of material to the plants is the surplus mine rock. Other inputs include water, binding agents and cement. There are no air emissions from the plants as all dust is collected in filters and returned to the mixer.

One plant is utilised for the production of large concrete blocks used for underground construction while the other plant produces shotcrete. Shotcrete is used for rock stabilisation purposed. The quantity of shotcrete used has increased in recent years as the mine progress deeper into the south western sector of the orebody.

Positive impacts

- Reuse of surplus mine rock
- Reduction in road traffic as rior to the development of the plants all concrete was imported from an external source.

Proposed vertical extension to the Tailings Storage Facility; Stage 5

On an annual basis the Company is mining and processing between 2.6 and 2.7 million tonnes of ore. This results in resulting in approx 400,000 tonnes of zinc and lead concentrate. The remaining portion known as mine tailings is considered a surplus by-product.

Historically, approximately 50% (~ 1,000,000 tonnes) of the tailings produced from processing the ore has been pumped through a 630mm diameter high-density polyethylene pipeline and discharged into the Tailings Storage Facility (TSF) located 3km north of the mine site at Randalstown.

The tailings facility has been constructed and operated in five stages, Stages 1, 2, 3 and the more recent Stage 4A and 4B upstream raises, using combinations of temporary and permanent embankment walls. The TSF is constructed as a ring-dike configuration, enclosed by earth-fill embankment walls. The embankment walls are constructed of low permeable glacial clay till and armoured with a layer of coarse material on the upstream slope. The TSF, enclosing a footprint area of approximately 171 ha, serves as containment for tailings to settle and consolidate, as well as a storage area for water that is circulated back to the processing plant at Knockumber

The proposed development, to be known as Stage 5, will be a 4 meter vertical extension to the existing embankment wall. The proposed method of raising an embankment wall on previously deposited tailings which is a common practice in the mining industry and is termed the upstream method was utilised successfully in the Stage 4 extension. The present average height of the wall is 20m meaning the proposed development will result in an

average height of 24 meters above ground level. A cross section of the embankment wall is illustrated below.

The raise will be implemented in two phases over a five to six year period. The first phase will be the construction of Stage 5A the second phase will be the construction of Stage 5B wall within the Stage 4B facility. The design for the Stage 5 construction is based on the proven design developed for the Stage 4 extension.

The extension will be constructed using a low permeability glacial till, which will be sourced locally from the adjacent borrow areas (Northern Borrow Area and Seven Field Borrow Area). Preloading the footprint of the wall will be carried out to reduce settlement beneath the embankment wall and increase the shear strength of the foundation tailings. The granular material required for this process will be imported from the surplus rock stockpile at the mine site.

The options that were considered for the Stage 5 facility were:

- Extend the area of the existing tailings Storage facility (lateral extension)
- Construct a vertical extension on the existing facility
- Construct a totally new facility

Each of these options was appraised for both conventional slurry disposal and paste disposal technology.

It was concluded from the exercise that;

- The construction of a vertical raise is the option which satisfies the requirements for additional tailings deposition whilst having the least impact on the environment.
- There would be an adverse environmental impact from a change from conventional slurry disposal to paste disposal.

Finally consideration was given to the '*do nothing*' option. The consequence of this would be the cessation of mining operation in 2013 resulting in an inefficient utilisation of natural resources and a loss of a significant economic benefit to the local and national economy.

Planning permission for the development was granted by Meath County Council on 15th May 2010 subject to 32 conditions.

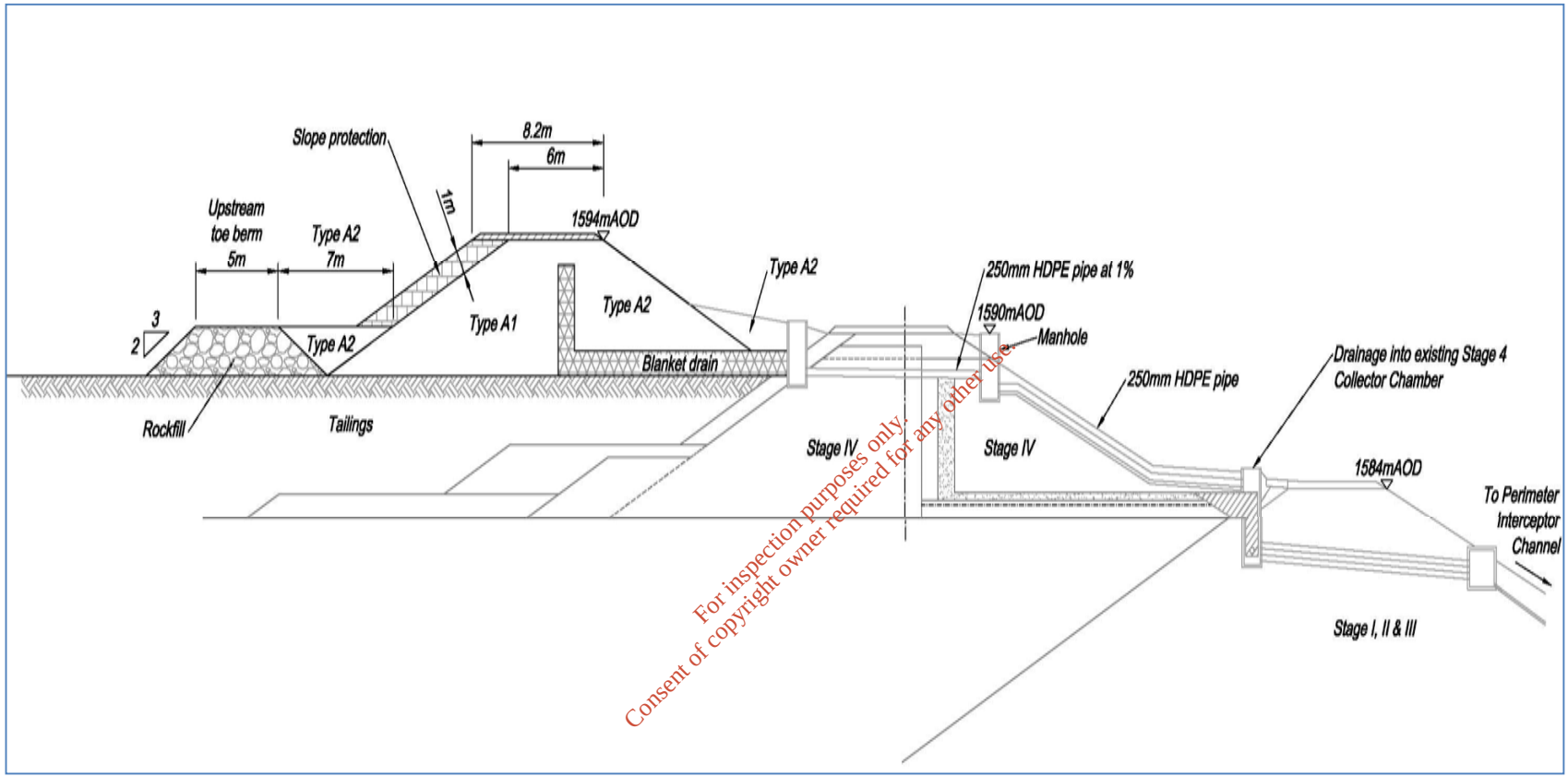

Figure 3 Cross-section through tailings embankment wall showing the proposed stage 5 extension