paperChain

Guidelines for the implementation of the Circular Economy models.

FACTSHEET CC5

Mine waste sealing layer based on Green Liquor Dregs (GLD)

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Keywords

Guidelines	Construction material	Pulp & Paper Industry (PPI)	Circular Economy Model (CEM)	Fact sheet
assessment	requirement	standard	Waste	performance
Green Liquor Dregs (GLDs)	till	Sealing layer	leachates	mixing

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CC5 Circular Model Guidelines: Mine waste sealing layer based on Green Liquor Dregs (GLD)

CC5: Mining waste covering layers based on GLDs: CC5 demonstrates the transformation of PPI waste Green Liquor Dreg (GLD) to a functional and alternative material for covering mining wastes in mine reclamation projects. GLD and local till soil mixtures form a highly impermeable layer impeding mine wastes long-term leachates. Project developed by BILLERUDKORSNÄS (PPI), as GLDs producer; RAGNSELLS (waste manager and constructor) building the demonstrator; BOLIDEN MINERAL (Mining company), providing demonstration site, and the technical assistance on soil covers for mining waste; SP-PROCESSUM (Research Institute), and LTU (Luleå University) for scientific support. Technical and environmental performance requirements achieved, but (very) long-term performance to be assessed. Challenges: GLD and soil heterogeneity, material availability and transportation (CO_2 footprint), waste+soil mixing and compaction, environmental deep monitoring assessment. Lack of standards for GLD use as construction material. Highly specific process (till soil), but with replication potential in several mine restorations in other scenarios out of Sweden also. Figure 1 shows the CC5 Circular Case in Sweden, Figures 2-4 show the pilot demonstration, and Tables 1 and 2 the Main Items and Key Factors.

CC5 mine waste covering sealing layer based on Green Liquor Dregs, short Guidelines:

- CC5 is focused on the construction of sealing layers mixing of Green Liquor Dregs (GLDs,) from PPI -landfilled at present-, with glacial soils (tills). A greener alternative to natural sealing materials (bentonites). Challenges: material availability and homogeneity, constrained workability window (material humidity, homogeneous mixing, suitable dry weather conditions), environmental monitoring and process standardization. Construction equipment adaptation and new worker skills are required, but affordable. Lack of GLD use standards in Sweden and EU in construction applications. Very long-term performance to be assesed. Replicability of this CC5 can be suitable in Sweden and other EU countries.

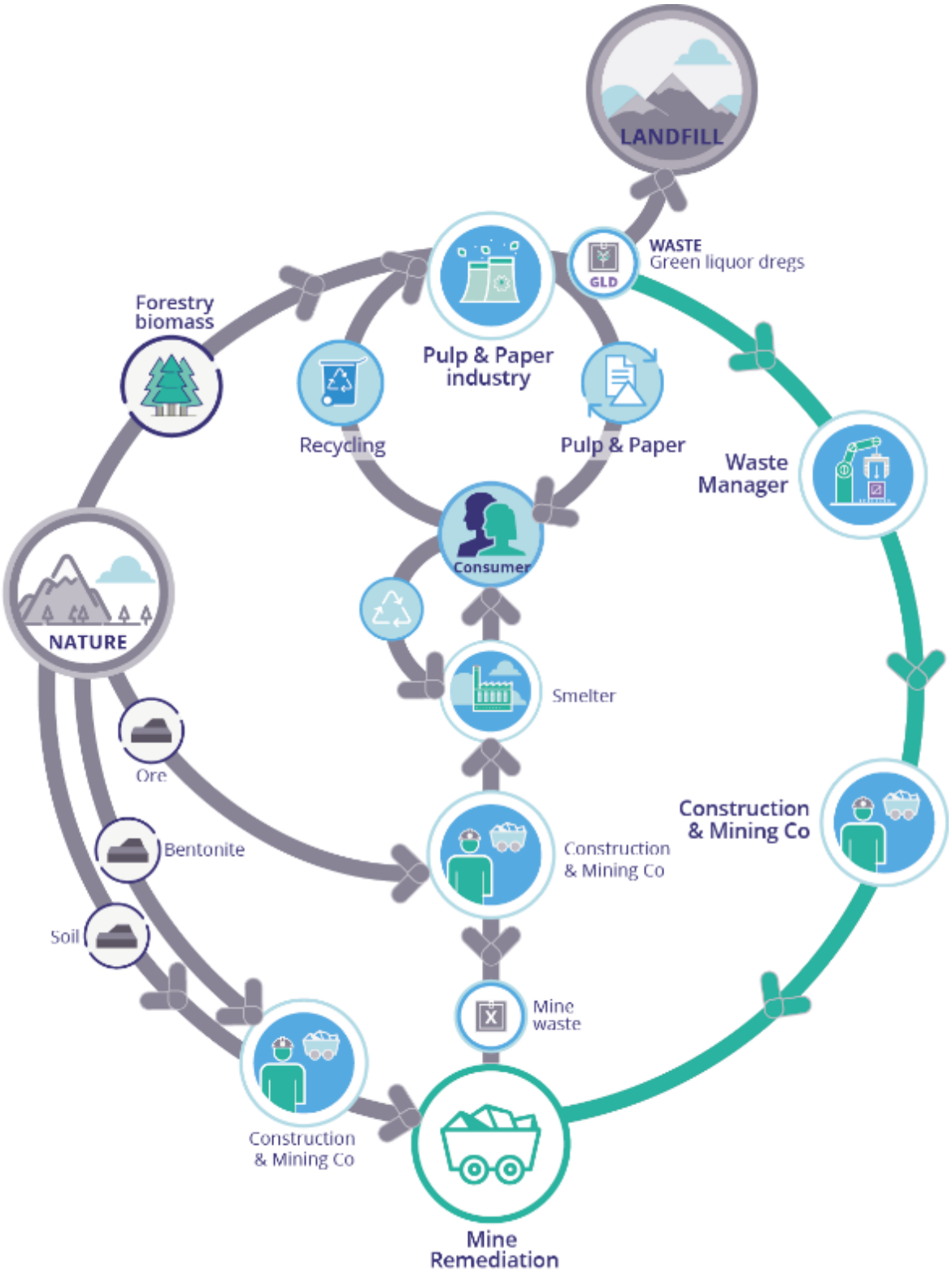

FIGURE 1 – CC5 CIRCULAR CASE (SWEDEN)– MINING WASTE COVERING LAYER WITH GLDS.

FIGURE 2 – WASTES: GREEN LIQUOR DREGS (GLDS).

FIGURE 3 – PROCESS: MIXING AND LAYER CONSTRUCTION BASED ON GLDS AND TILL (SOIL)

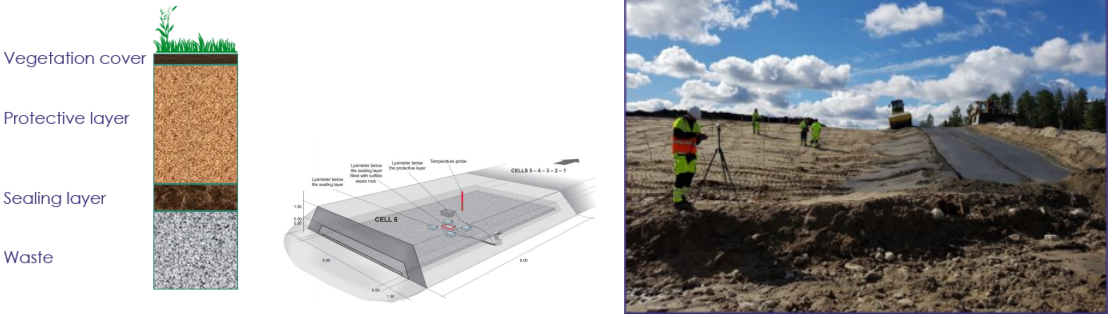

FIGURE 4 – APPLICATION: MINING RESTORATION WITH GLD BASED IMPERMEABLE LAYERS.

TABLE 1 CIRCULAR CASE 5: MINING RESTORATION – SEALING LAYERS; MAIN ITEMS

item	*Description*
PAPERCHAIN STAKEHOLDERS	BILLERUDKORSNÄS (pulp mill), RAGNSELLS (waste manager and constructor), BOLIDEN MINERAL (Mining company), SP-PROCESSUM (Research Institute), and LTU (University) for scientific support.
LOCATION	BOLIDEN facilities at Näsliden (north of Sweden).
WASTE	Green Liquor Dregs (GLD)
PRODUCT	Impermeable layer based on GLD mixed and compacted with local soils (Till).
APPLICATION	Mining wastes covering sealing (impermeable) layer based on GLD and Tills for mining waste covering in mining reclamation works.

TABLE 2 CC5 GLD BASED SEALING LAYERS. KEY FACTORS AND LESSONS LEARNT

Key Factor	*Fact*	*Lessons learnt*
Waste (GLD)	GLDs are non-hazardous waste from the filtration and recirculation of chemicals (green liquor) in the process. GLDs contain sodium and calcium minerals, black carbon and many other elements. low content of leachable metals. Retrieved through filtration, GLDs are fine grained (silt, clay), have a high-water content (wet), and high-water retention capable.	GLDs can contribute by its properties to hinder oxygen transport to mine waste and can replace bentonite. GLDs can be very variable in its nature, humidity % and water absorption capacity. Optimum Quality Control (testing) need to be implemented. Each mill generates different GLDs qualities.
Regulatory framework	Lack of standards for the use of GLDs in construction applications. Untill now GLDs are landfilled. There is no formal regulation on whether the GLDs can be used in	There is no general rule for all mining sites and each mining operation must be approved under specific environmental permitting regarding emissions and pollutants release to surface and ground

	mine waste remediation in Sweden or not, neither in EU	waters. Sealing layers must fulfil specific (local) functional requirements. New standards for their use in construction applications should be developed for a widespread use.
Proceedings	GLD storage and handling require some specific facilities: mixing and application construction under rain conditions are not suitable or not desirable. Workability Window: a good quality control on mixture physical-mechanical properties and humidity is critical and may be a challenge. Organizational and technological changes are required respect a standard material based construction.	Providing a regular GLD and soil quality can be a challenge: regular and homogeneous GLD and Soil can be very changeable, and then, it can affect relevantly to the process effectivity. Frequently, the soil can be more heterogeneous than the waste itself. Optimal till soils for mixing may be scarce, and are provided as a waste originated from excavation works in the building sector (houses, roads, etc.). The application should be enough flexible to adapt to available soil qualities, usually very heterogeneous for several scenarios. Soil quality and origin (avoiding polluted or altered soils), should be check in each case. Mixing process may be complicated for achieving a homogeneous mixing product, and therefore, determining exhaustively a workability window for each case is fundamental. Layer performance achievement can be difficult if raw materials are not well selected and mixed and works are done out of the workability window. Raining periods must be avoided for the construction process. Changes in supplies and adptation in mixing equipment introduce operational changes, then skilled workers on new process and long-term monitoring are needed.

Barriers	Total Organic Carbon (TOC) excess may difficult its valorization supposing a potential barrier. Distance of waste producer to mining sites. Economic feasibility, carbon footprint. Soils heterogeneity requires an specific dosage in each application. GLD production at this moment is smaller than mining restoration material needs. Concerns on long-term environmental performance and liabilities.	Detected TOC has more relationship with the black carbon content and on the analytical methodology usually applied. Experience using and monitoring GLDs based layers will probably demand a better sorting and an improvement of the generated pulp residue and the soils, implying new treatment solutions and dedicated personnel for the PPI industry. Long-term Paperchain Pilot monitoring showed a preliminary good performance achieving expected requirements set by the end-user, long-term performance is still to be demonstratated and will need several years of monitoring in order for a definite conclusion to be established.
Enablers	Effect of the leachate (percolating precipitation) on the underlying mine waste and the recipient, monitoring those parameters (metals and anions) according to regional laws.	Environmental performance as the effect of the leachate (percolating precipitation) on the underlying mine waste and the recipient, monitoring parameters (metals and anions) according to regional laws. Technical performance as the mechanical properties of the layer achieving mining operator requirements.
LCA/CO2 footprint	Positive effect, as mining waste reduced by another waste.	CO_2 footprint dependant on waste and soil transportation distance.

Exploitation	Site mine restoration project requirements may require very high-specific solution, increasing the costs. Standard and well known solutions (geotextiiles) are competitive and easy to adopt. There may bg resistence for changes. Customers an Public may be suspicious of the effectivity long-term of the protective layers, since they are performed by SRMs. Enough technical long-term evidences wouls support the solution.	Financial return highly dependent on the distance from source materiales to working site more than applying the technologies developed in PAPERCHAIN. Monitoring costs can suppose an important cost for this application unless standardization is developed. Provision of quality GLD and Till soils may constrain a widespread exploitation.
Replicability potential	During the project 500 m^2 pilot lead to the valorisation of 75 tonnes of GLD in the production demo. At the site monitored in the first two years of the project, 3000 ton of GLD were valorised.	Replication: the global production of mine wastes is estimated at 15.000 – 20.000 million tons of solid waste each year. The consumption of natural resources such as soil and clay to cover this amount of material is huge which open opportunities for GLD utilisation. Boliden operates many other mining operations where the technology can be quickly and easily replicated. Other alternative applications scenarios with different soil mixtures are to be evaluated.