### Title:
Effects of Bauxsol™ and biosolids on soil conditions of acid-generating mine spoil for plant growth

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### Information Source:
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### Technology Type:
Biosolids amendment

### Mine/Facility Type:
Metal mine, Al, Zn, Cu, Mn, Cd

### Study Scope:
Bench-scale/Laboratory

### Mine Name:
Mt. Carrington

### Source:
Acid mine drainage/Acid rock drainage

### Location:
Northern NSW, Australia

### Contaminant(s):
Metals, Al, Zn, Cu, Mn, Cd

### Receiving Media:
Soils/Sediments

### Keywords:
Bauxsol™; biosolids; mine spoils; metal sulfides; re-vegetation; acidity

### Abstract:
Pot trials were conducted to examine the effects of Bauxsol™ and biosolids on mine soil conditions for plant growth. Sole application of biosolids did not significantly enhance the growth of the plant because the soils remained highly acidic with soluble concentrations of many metals in excess of toxic levels. Addition of Bauxsol™ generally resulted in an increase in biomass production by effectively correcting soil acidity and metal toxicity. However, sole application of Bauxsol™ did not enable meaningful establishment of grass although the tree grew very well. The combination of Bauxsol™ and biosolids allowed the establishment of both grass and the tree and therefore had the better effects on total biomass production, compared to the control and the sole treatments.

### Reference

### Procedures
Mine spoil ranging from boulders of 100 mm or more to fine clay less than 0.002 mm was collected, air dried, and blended to form a homogenous mixture. Control drums were fully filled with spoil, and the remaining treatment drums were half filled with spoil. The pot trial experiment included one control and four treatments (each in replicates of four): (a) 16 kg of added Bauxsol™, (b) 16 kg of added Bauxsol™ plus 4 kg of added biosolids, (c) 25 kg of added Bauxsol™ plus 4 kg of added biosolids, and (d) 4 kg of added biosolids. The experiment was open to direct rainfall and sunlight. Tree seedlings were transplanted to the drums and five grams of grass seed was added to the soil surface. Soil samples were collected and soil temperature was measured monthly at depths of 15 cm and 80 cm. Leachate generated during rainfall events was collected for analysis. One drum of the control and each treatment were opened after eight months for root observation. Total actual acidity, total carbon, total nitrogen, pH, EC, metal ion concentrations, soluble phosphorus, nitrate, and ammonia were measured from the collected soil samples. The tree seedlings were measured for growth each month, and the number of leaves, stems, and branches were recorded. Representative old and young tree
leaves were collected from the control and each treatment for the determination of total foliage trace element concentration.

**Results**

For the topsoils (15 cm), pH of the control and the treatment without Bauxsol™ showed little change during monitoring, while the Bauxsol™-treated soils had increasing pH levels from about 3.6 to >6. For the subsoils (80 cm), the Bauxsol™-treated soils only exhibited a minor increase in pH. The EC of the Bauxsol™-treated topsoils was much higher than the initial EC. All amended pot trial soils have a higher total N content than the original soils, and the soils treated with biosolids all show a higher total N content than non biosolids-treated soils. Soluble Co, Al, Zn, Mn, Cu, and Cd in the pot trial soils were all lower than those in the original soil. The concentrations of these metals in both 16 kg Bauxsol™ treatments were negligible. For the remaining pot trial soils, the concentrations of soluble Al, Mn, and Cu in each soil were in the following decreasing order: 4 kgBS > Control > 25 kgBX-4 kgBS, while the concentrations of soluble Co, Zn, and Cd in each soil were in the following decreasing order: Control > 4 kgBS > 25 kgBX-4 kgBS. Total plant biomass of the control and various treatments after 8 months of trial is in the following decreasing order: 25 kgBX-4 kgBS > 16 kgBX-4 kgBS > 16 kgBX > 4 kgBS > control. Foliage metal analysis shows that the concentrations are higher in tree leaves of the control than those in Bauxsol™-amended treatments.

**Conclusions**

Addition of Bauxsol™ to mine spoil significantly raised pH and reduced soluble concentrations of environmentally significant metals. The excessive addition of Bauxsol™, as witnessed in the 25 kgBX-4 kgBS experiment, could cause re-dissolution of the precipitated metal hydroxides due to an excess of OH- in the soils. Addition of Bauxsol™ also increased salinity and had negative impacts on the physical soil structure; preparations of low NaCl Bauxsol™ have been developed to minimize this problem. Application of biosolids increased the total N in the soils, but caused an increase in environmental significant metals compared to the control. Applying Bauxsol™ with biosolids effectively eliminates the possibility of elevated soluble concentrations of these metals.

In addition to improving soil conditions, Bauxsol™ amendment also significantly enhanced plant growth, but did not significantly enhance the establishment of grasses when added without biosolids. A combination of Bauxsol™ and biosolids has a better effect on increasing total plant biomass by not only promoting the growth of the tree seedlings but also enabling the establishment of grasses. The leaves of trees grown in Bauxsol™-amended pots contained less potentially toxic metals than the control and biosolid-only treatment pots, reflecting the decreased amount of these metals in the soil. The addition of Bauxsol™ to acidic mine soils can therefore have beneficial effects on reducing the accumulation of potentially toxic metals in the food chain. The leachate from the treated soils, however, was still highly acidic and contained large amounts of toxic metals. Integrated management strategies are therefore needed for comprehensive rehabilitation of sulfidic minesites. One of the possible techniques is to contain the mine wastes in a designed impoundment enclosed by bunds consisting of Bauxsol™ blends that have the capacity to intercept soluble acid and potentially toxic metals from the out-flowing draining water, while only the upper mine wastes are mixed with Bauxsol™ and biosolids for re-vegetation.