Potential for Phytoremediation of a Metalliferous Mine Site at Mt. Costigan, NSW

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CERTIFICATE OF AUTHORSHIP / ORIGINALITY

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of the requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CF	Concentration factor
DLWC	Department of Land and Water Conservation (NSW)
DMR	Department of Mineral Resources (NSW)
dwt	Dry weight
EC	Electrical conductivity
EPA	Environmental Protection Authority (NSW)
ER	Enrichment ratio
g	Gram
GBH	Tree girth at breast height
ha	Hectare
LOI	Loss on ignition
N.P.K.	Nitrogen:phosphorus:potassium ratio
NSW EPA	New South Wales Environmental Protection Authority
OECD	Organization for Economic Cooperation and Development
OM	Organic matter
RG	Reagent grade
SO_4	Sulphate
t	Tonne
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USBM	United States Bureau of Mines
± se:	Standard error of the mean
µS	microSiemen

Abstract

Mt. Costigan mine, on the Western Slopes of the Great Dividing Range, NSW, was worked intermittently (1887 – 1928) for copper, lead, zinc, silver and gold. The entire mine site was originally cleared and contaminated with mining wastes, but had naturally revegetated with eucalypt woodland in parts. However, a barren section remains despite recent remediation efforts by the NSW Department of Mineral Resources (DMR), and problems of metal contamination, acid saline seepage, erosion and the threat of contaminated runoff into the catchment persist.

This study utilized the triad approach of field ecological and chemical-impact assessment at the barren site, using revegetated woodland as a reference site, and glasshouse toxicity trials of soils from both the barren and reference sites. Copper, lead, zinc and cadmium levels in barren site soils all exceed NSW Environmental Protection Agency (residential) limits in soil. Remediation by the DMR of the barren site using biosolid amelioration while this project was being carried out resulted in decreased metal contamination at the site, without significant changes in salinity. Vegetation analysis of the barren site before and after remediation did not indicate significant changes, though this may have been due to seasonal variation in plant growth.

A glasshouse bioassay using neat site soils and several dilutions with river sand was designed to determine the dose-response relationships in native plants *Eucalyptus sideroxylon*, *Acacia hakeoides* and *A. salicina*, endemic to Mt. Costigan. The objective was to evaluate soil toxicity and the potential of native species for phytoremediation at Mt. Costigan. *Avena sativa* (oats) was included as a standard test species for phytoxicity studies, and was the only species to survive in all soils. *A. salicina* proved well suited to much of the barren site, but *E. sideroxylon* did not grow well, and was better adapted to woodland soils. Acacias and eucalypts both showed strong accumulator tendencies for copper, zinc and manganese in diluted site soils. The reverse was true for cadmium, however, with plant-tissue concentrations of this metal increasing in proportion to soil content. Most metals were selectively concentrated in root tissue, but acacias leaves showed high copper and manganese content.

Phytoremediation is likely to prove effective in a multifaceted program of physical, chemical and biological characterization and remediation. It is suggested that phytostabilization of the severely contaminated parts of the barren site be initiated by planting adaptable species such as *A. sativa,* and that less-contaminated areas be planted with *A. salicina.* This could be followed by amelioration with biosolid, mixed into top layers, before further planting with the less-tolerant *E. sideroxylon.* The resulting humic buildup and reduction in soil toxicity would allow other indigenous plant communities to return and restore ecological balance at Mt. Costigan site.