THE VETIVER SYSTEM FOR INFRASTRUCTURE STABILISATION IN AFRICA

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Hydromulch (Pty) Ltd. introduced the Vetiver System (VS) to many Engineers on road and environmental projects in several African countries, namely DR Congo, Ghana, Guinea, Benin, Malawi, Mozambique, Ethiopia, South Africa, Kenya, Uganda, Gabon, Lesotho, Swaziland, Tanzania and the Indian Ocean Islands. They are now realising the erosion control potential Vetiver grass has in road batter protection. The VS has over time been overwhelmingly successful in various projects. Where severe erosions were once the norm, one can now see the effectiveness of the VS.

BCEOM, a Consulting Engineers Company from France who operates in many African countries have specified Vetiver grass for side slope embankment protection in many countries since their introduction to the VS by HYDROMULCH (Pty) Ltd.

Rio Tinto have likewise on their Ilmenite project in Madagascar with EPCM (Fluor/Hatch JV), the Iron Ore project in Guinea with EPCM (Senet), the Sherritt Mining Ambatovy Nickel Slurry Pipeline in Madagascar with EMCP (SNC Lavalin), specified the use of Vetiver (VS) for erosion and sediment control for road embankment stabilisation.

Stabilisation Projects using VS conducted by Hydromulch

- ***Kinshasa, Democratic Republic Congo***

The erosion control & vegetation establishment requirements of the Selembao project in Kinshasa, initially, made no provision for Vetiver grass. BCEOM, after due consideration, amended the existing specification to incorporate Vetiver. Heavy rainfall during the initial stages of the Vetiver program resulted in excessive erosion occurring which was slowly rectified as time progressed.

- ***Madagascar South***

Rio Tinto specified the use of Vetiver & hydroseeding for sediment control and embankment stabilisation to stabilise the coastal dune at their Ilminite project at Fort Dauphin Fluor/Hatch JV.

- **Guinea**

Rio Tinto has likewise specified the use of Vetiver & hydroseeding for sediment control and embankment stabilisation on their Iron Ore Simandou project. Vetiver was planted into 70° gradient insitu lateritic sub soil material with little or no amelioration on various slopes along the haul roads. This resulted in an enormous saving to Rio Tinto as they no longer had to cut back the slopes to accommodate conventional vegetation practices.

- ***Mozambique***

Many of the critical road batter slopes of the newly constructed road near the town of Nampula had been successfully stabilised by the VS.

Madagascar East

Sherritt Mining's 220 km long Ambatovy nickel slurry pipeline was introduced to the VS as well as the hydroseeding technique for the erosion/sediment control and vegetation establishment requirements on the project.

Case Study:

Rio Tinto/QMM Ilmenite Project at Fort Dauphin, Madagascar

- ***The site and its problems***

The project involved sand fixing, erosion control and slope stabilisation along newly constructed roads. Wind blown sand was a major issue and a decision was made to use barrier netting and Vetiver Grass hedgerows as an erosion control protection of the slopes of the excavated Ehoala dune, prior to hydroseeding with locally harvested and commercially available grass seed species.

This was part of the mining company's environmental obligation and responsibility to the Malagasy government. Rio Tinto, appointed Hydromulch to undertake soil erosion control and revegetation of areas disturbed during the construction phase.

The rehabilitation project involved various erosion control techniques and the reinstatement of vegetation to approximately 48 ha of disturbed land along newly constructed roads and other embankment areas.

The Ehoala Dune section of approximately 8 hectares in size, was a major environmental rehabilitation project on its own, as it required innovative ideas to address the extensive wind erosion problems.

The haul road from the quarry to the site of the new harbour involved major earthworks through this primary dune, and wind blown sand resulting from the high winds was of major concern in this area. The cutting of 8 ha in extent, **with the cut slope 160m in height and the fill slope 90m in height.** The sides of the haul road from the processing plant to the harbour were less problematic as they were not fully exposed to the severity of the prevailing winds.

Experimentation with local grass species resulted in proof that these grass species were unable to withstand the wind strengths on the exposed excavated side slopes above the haul road, as the lifting of the sand particles decapitated the young plants. The intensity of the prevailing winds, which has been known to blow for up to 40 continuous days at times in excess of 30 knots, often snapped the support poles of the wind barrier netting.

- ***Application of the Vetiver System***

The decision was made to use vetiver grass for its abilities in sand fixing, erosion control and slope stabilisation – and **to create a sheltered microclimate in the harsh terrain for the establishment of hydroseeded indigenous grass species and hand-planted pioneering dune species, which will allow natural succession to take place over the course of time**.

Three specific vegetation zones and related soil types were identified:

1. an area of 'old forest' comprising wooded vegetation,
2. a grassed coastal dune area and
3. an intermediate sandy agricultural area between the mountains and the sea.

Laboratory soil tests confirmed that the soils were acidic in the old forest areas and alkaline throughout the dune areas.

- ***Implementation***

The erosion control and vegetation establishment of the two major road projects were carried out progressively as the main contractor proceeded with the earthworks. The areas to be vegetated were topsoiled from the preserved stockpiles. The cut side slopes of the excavated Ehoala dune were not topsoiled. Wind control barrier netting in blocks of 500m2 was erected to provide initial shelter from the excessively windy conditions.

Vetiver grass hedgerows were planted for long term erosion control protection of the side slopes of the dune and in other areas with erosion potential, such as behind culvert head walls, drain outlets and along the shoulders of fill slopes. The areas between the wind barriers and Vetiver hedgerows were scarified to form horizontal drills or furrows 100-150mm apart and 30-50mm deep, prior to the placement of brushwood.

The Vetiver areas were hydroseeded with commercially available grass species: *Eragrostis curvula* and *E. tef*, *Chloris gayana*, *Cynodon dactylon, Panicum maximum, Paspalum notatum* and the exotic clover for nitrogen fixing, *Trifolium subterranean*.

Locally native grass seeds collected by local communities included *Stenotaphrum dimidiatum* (Buffalo Turf Grass), *Dactyloctenium aegyptium* (Common Crowfoot), *Imperata cylindrica* and *Cynodon dactylon* were added to the mixture.

A soil binding agent, HydroPam, an organic supplement consisting of locally sourced rice husks, cotton husks and cattle manure, NPK fertiliser along with agricultural lime and a highly concentrated blend of beneficial organisms for use on soils with low microbial activity, was incorporated with the hydroseeding mixture. FINN equipment coupled to a 4x4 truck was used for the hydroseeding application

Hand planting was done along the Ehoala dune with a selection of dune pioneer shrubs indigenous to Madagascar and after the establishment of the grasses. *Tambourissa purpura* was used as a pioneer to begin the restoration of the coastal forest areas and *Scaevola taccada*, an evergreen succulent spreading shrublet was used on the sand dunes.

It was noted that side slope areas that were not topsoiled prior to Vetiver planting & hydroseeding developed a “mono culture” or single species cover. Additional hydroseeding and hand planting of native species were necessitated as was the continuous resurrection of the barrier netting. These exposed side slopes however were completely stabilised with the Vetiver system and it was interesting to observe that the plants grew upwards as sand deposits engulfed the root systems.

- ***Results to Date***

Areas that were protected against the extremes of the prevailing winds by barrier netting and were topsoiled with viable material developed a well defined grass cover integrated with Vetiver plants.

The protected embankments of the Ehoala dune cutting (South facing slopes) demonstrated this effect compared to its opposing side slopes. The harsh environmental conditions necessitated that additional watering measures were implemented to successfully establish the Vetiver plants with an ongoing maintenance team repairing the Barrier netting.

It was noted that many of the leaves of 6 month old Vetiver plants were turning a yellowish white colour on the embankments of the MSP haul road near the Ilmenite plant area. Root and leaf samples were taken and sent for chemical analyses in order to determine the sudden change in colour and if the plants were under any form of stress.

The results of the analysis reflected the plants amazing ability to absorb heavy metals (Phytoremediation).

Metal	Leaf Analysis	Root Analysis
Cu	1.10 mg/kg	3.20 mg/kg
Fe	398.00 mg/kg	381.00 mg/kg
Mn	174.00 mg/kg	40.00 mg/kg
N	1.36 %	1.05%
P	0.43 %	0.22%

The contract was completed over a 30 month period with the final summary of activities and areas that were established.

Wind Barrier Netting	36,000 m^1
Brushwood covering	380,000 m^2
Vetiver plants propagated by local communities	3,000,000.
Vetiver Grass Hedge Rows	390,000 m^1
Areas Hydroseeded	48 hectares
Quantity seed used	2,880 kg commercial seed
	480 kg native seed (locally collected)
Lime Used	24,000 kg
NPK fertilisers	24,000 kg
Organic Supplement	24,000 kg
Soil Binder	480 kg
Mulch	12,000 kg

Conclusion

The Vetiver System (VS) application on slope embankments has provided the required erosion control necessities to ensure sediment control and the risk of invasive plant contamination. However, it is essential to integrate the VS with a sound environmental program of establishing native vegetation either by the hydroseeding system or by other means.

Keywords: Dune stabilisation, sand fixing, hydroseeding, mine rehabilitation

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Brief Introduction to the Speaker

Roley Noffke, a Director and very active member of the Vetiver Network International for the past 5 years and a founder member of the International Erosion Control Association (IECA), Southern Africa Chapter.

He was instrumental in pioneering the method of establishing "Macchia" vegetation along the coastal routes of the South African coast line during the 1980s. He has facilitated and introduced various bio-engineering techniques using Vetiver grass and other vegetative methods for erosion and sediment control together with conceptual environmental restoration approaches to many Central, West and East African road and mining projects. He provides technical information, specifications and "turnkey" proposals to leading international geo-technical and civil engineering consulting enterprises.

Roley is the managing director of HYDROMULCH (Pty) Ltd, an internationally accredited erosion control and environmental restoration contracting company which has been operating in Africa and internationally for the past 40 years.

Most notably HYDROMULCH recently completed the environmentally sensitive project on the Rio Tinto/QMM project in Madagascar, the Rio Tinto/Simfer project in Guinea and the Sherritt Mining Ambatovy project in Madagascar.