APPLICATION OF VETIVER GRASS IN SOIL BASED REED BEDS FOR EFFLUENT TREATMENT AT GELITA APA, AUSTRALIA

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Introduction

GELITA
ASIA PACIFIC AFRICA

- The GELITA factory extracts gelatine from cattle hide using chemical processes involving strong acids, lime and hydroxides.

- This factory is situated on a property of 170 hectares, at Beaudesert in Queensland, Australia, generates approximately 1.3 ML a day of wastewater

- The effluent from the processing plant is highly saline (average 6 dS/m), alkaline and high in N (300-600mg/L) and low in P (2 mg/L).

- The effluent is disposed off by irrigating over 121 hectares of Kikuyu and Rhodes grasses pasture.

Raw materials:

Fresh Bovine Skins (mainly face pieces)

The problems?

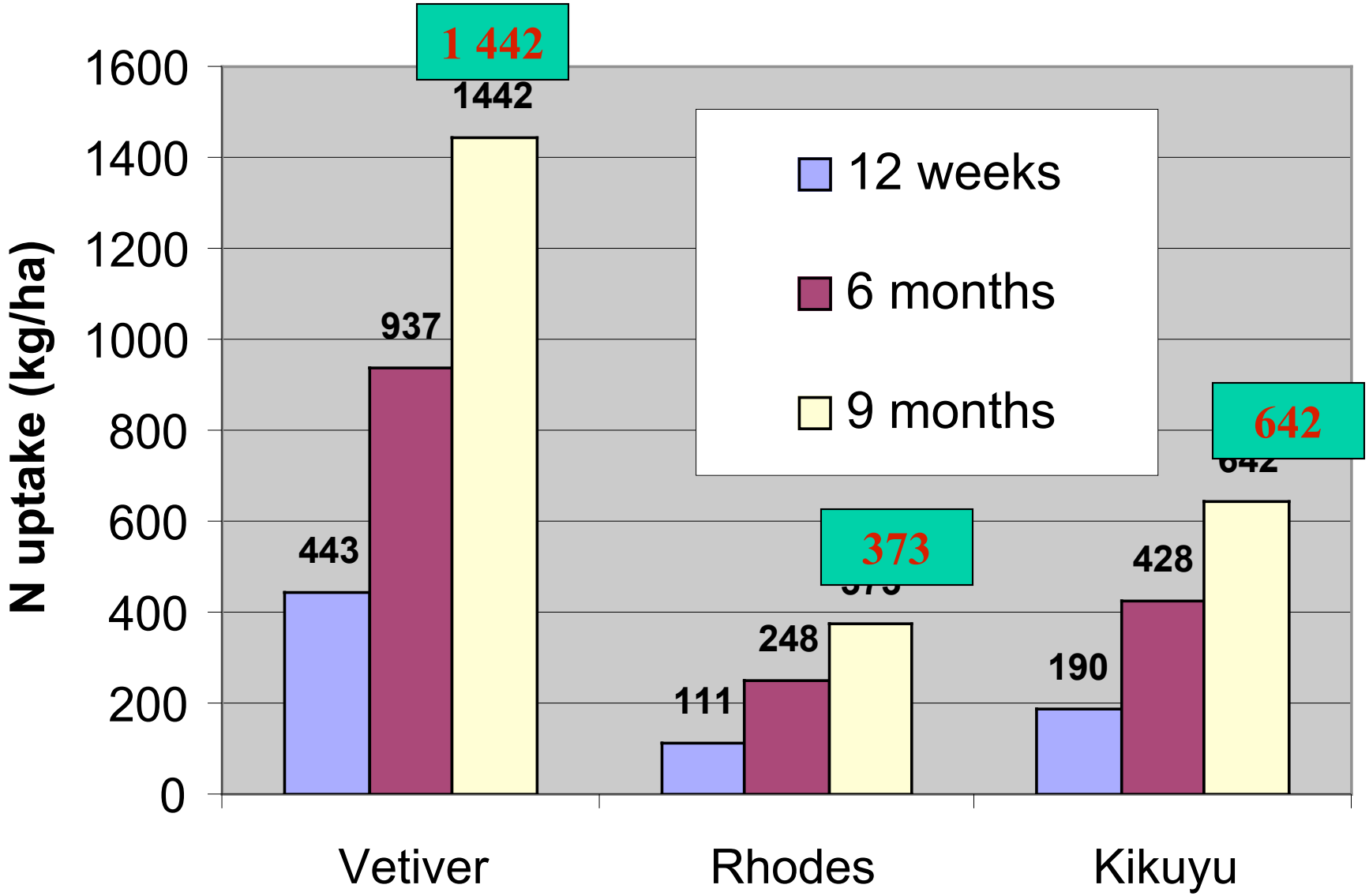
- 13 soil types with varying hydraulic conductivity
- Some saline sodic duplex soils
- Drought
- Sustainability requirements
- How to treat 1.3 ML/day of high Nitrogen wastewater to a level suitable for reuse

Rhodes grass pasture at GELITA

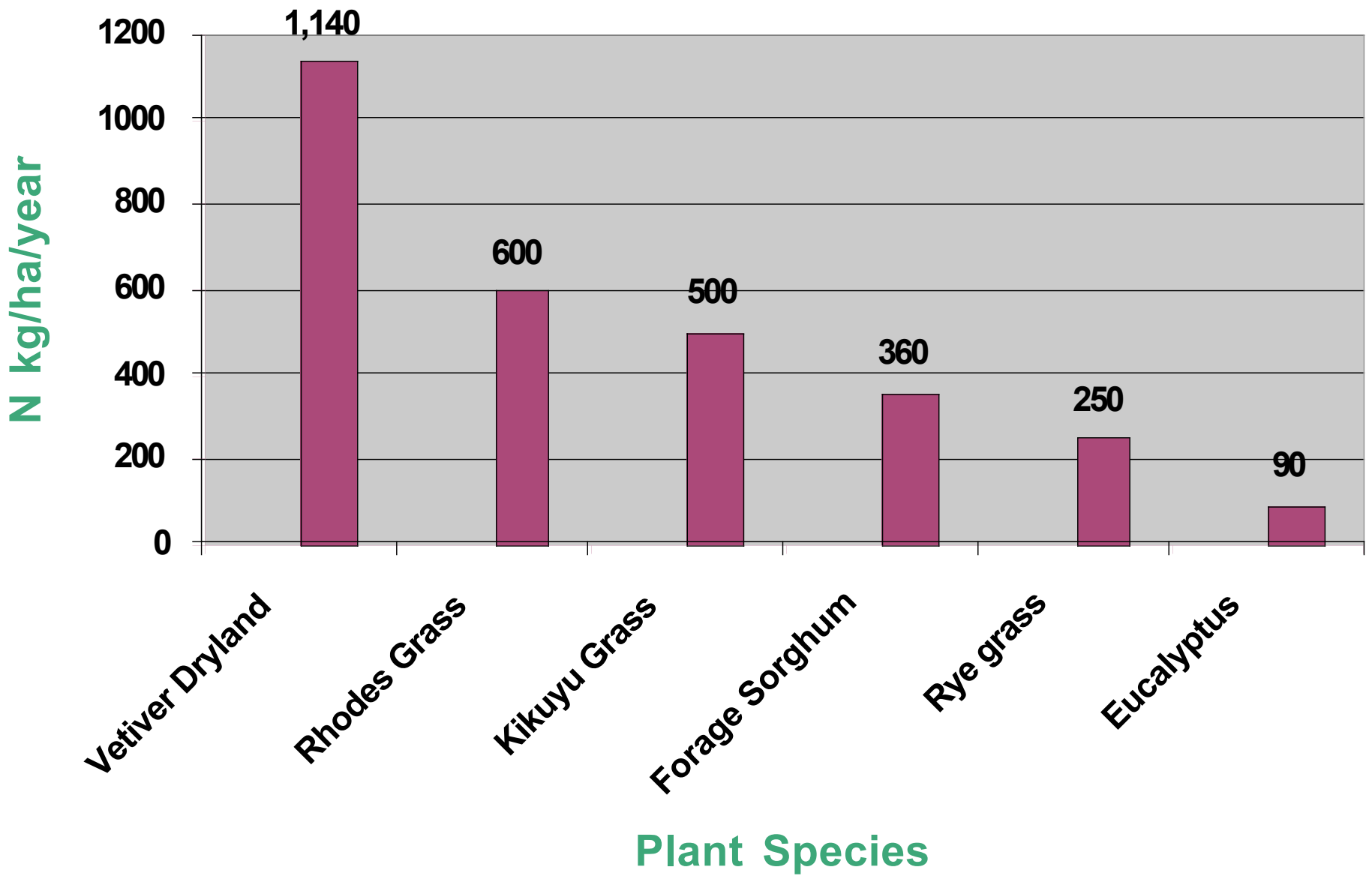
Irrigated pasture: long term issues

- Nitrogen disposal requires plant uptake to exceed application to be sustainable
- Suppressed soil pH
- Inadequate Nitrogen uptake in rhodes or kikuyu pasture
- Eucalypt plantation not suited

Comparative N uptake between vetiver, Rhodes grass and Kikuyu grass



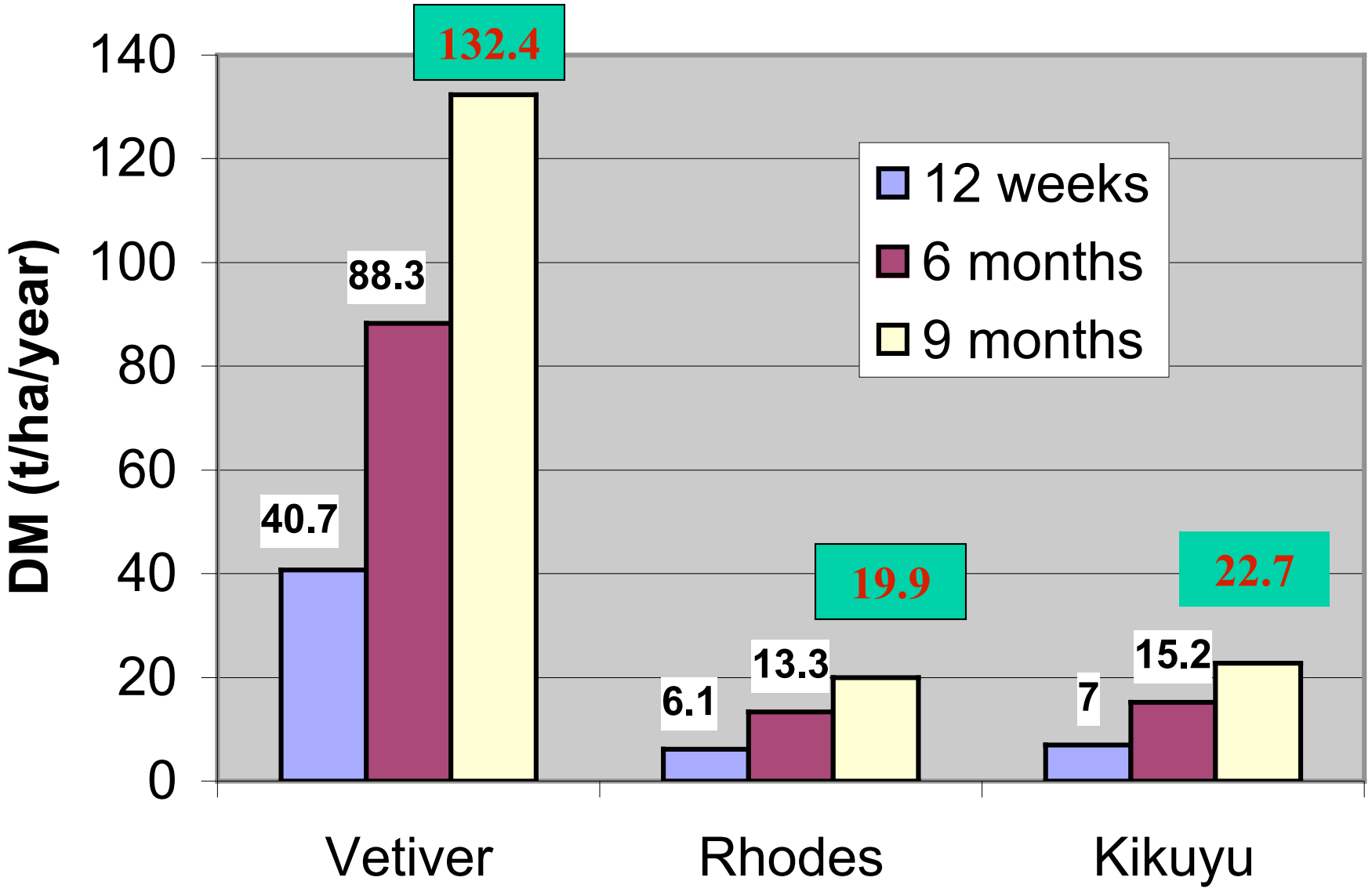
NITROGEN UPTAKE



Biomass=nitrogen export

- Typical pasture grasses do not generate enough biomass to reduce Nitrogen loading to soil
- However, Vetiver annual biomass production is approximately 132/t/ha

Comparative yield between vetiver, Rhodes grass and Kikuyu grass



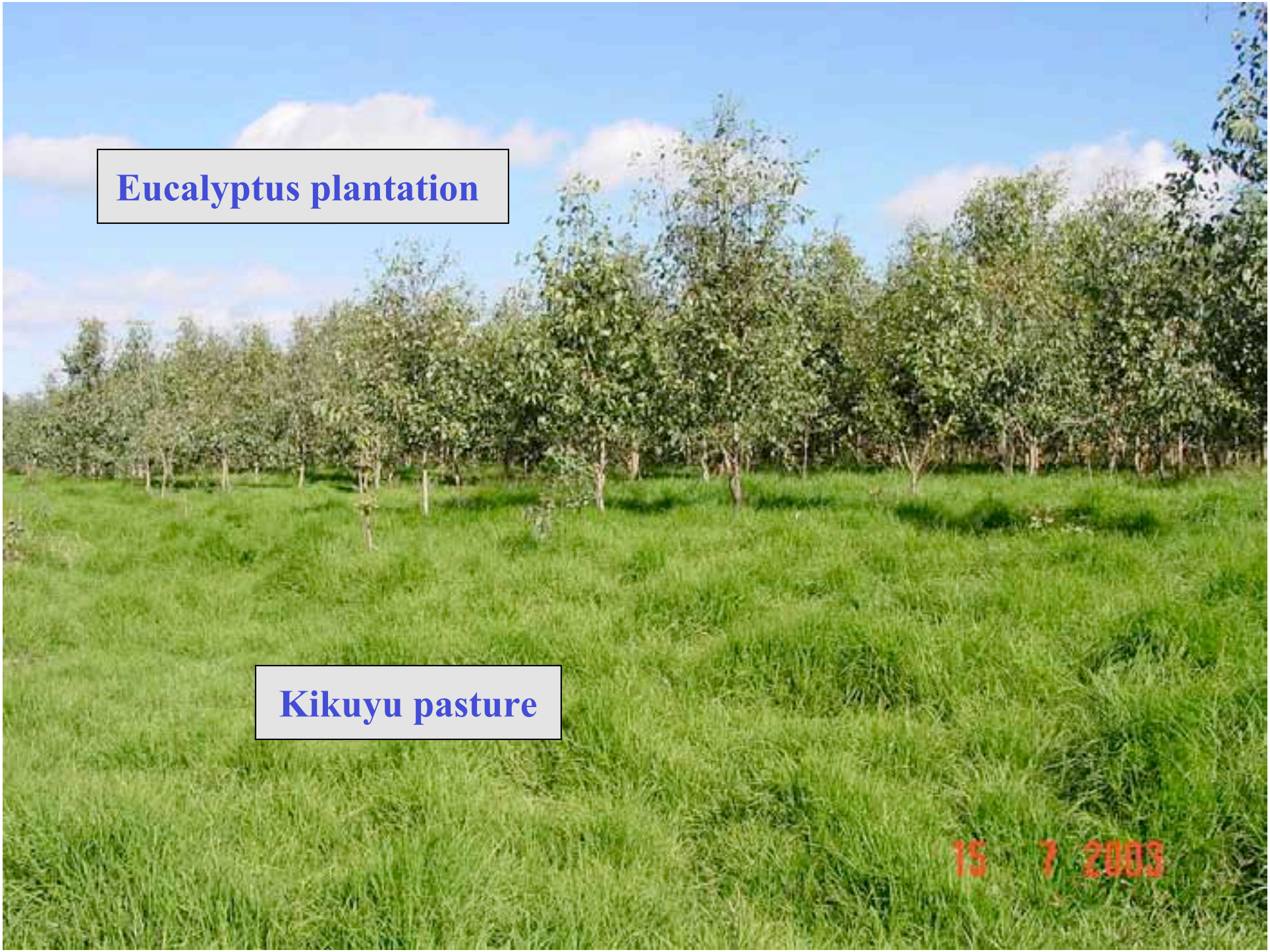
Kikuyu grass pasture

Vetiver grass paddock

Constraints

The Queensland government has applied strict regulations regarding the disposal of this wastewater. In order to meet these regulatory requirements and to fulfil expectations of Ecologically Sustainable Development, GELITA has undertaken a comprehensive research program to develop optimal disposal methodologies.

Due to extreme climatic variations over the eleven years of operation the planting of typical pasture and annual crops has not provided a viable outcome.


Eucalyptus plantation
Kikuyu pasture
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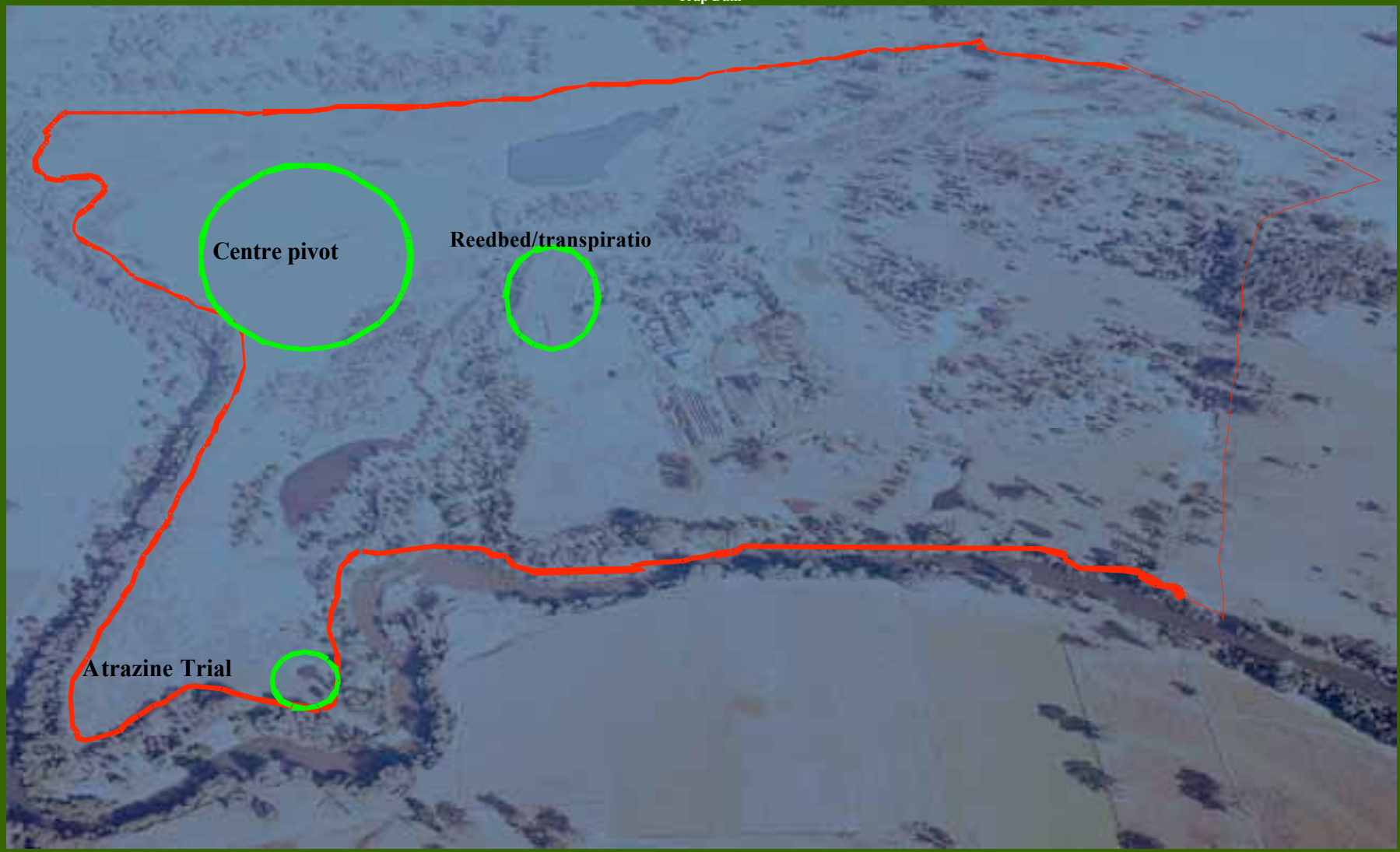
Aerial view

----Trap Dam



Options and Solutions

- Alternative solutions such as chemical treatment and transportation to sewage treatment plant were considered but both of these are impractical and most importantly, very costly to build and to operate.
- Tree planting was one of the earlier options considered, it has been trialed for several years but has not provided an effective solution to the problems faced by the company.
- Application of the Vetiver System for wastewater treatment is a new and innovative phytoremedial technology and VS was identified as having the potential to meet all the criteria.
- The vetiver option using MEDLI as a model offers a practicable and cost effective solution.

The MEDLI Computer model

MEDLI is a Windows based computer model for designing and analysing effluent disposal systems, which use land irrigation, for a wide range of industries such as piggeries, feedlots, abattoirs, sewage treatment plants, and food processing factories.

Land area required for irrigation and N disposal

Plants	Land needed for irrigation (ha)	Land needed for N disposal (ha)
Vetiver	80	70
Kikuyu	114	83
Rhodes	130	130

ADVANCED APPLICATIONS

Although MEDLI has reduced the planting area from 130ha to 70ha, this model is designed as an effluent disposal method.

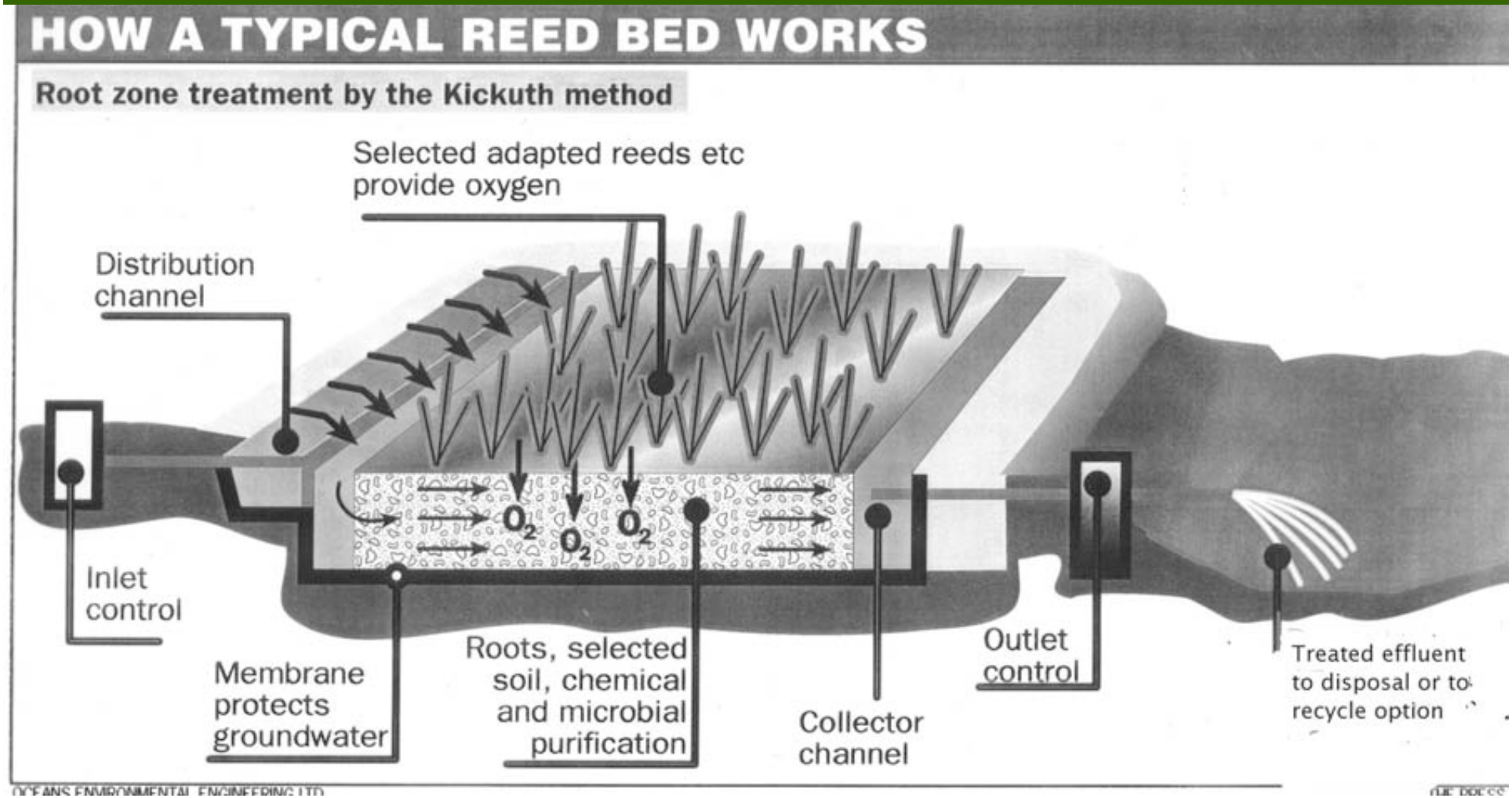
GELITA is interested in more advanced applications of VS in effluent treatment and the company is currently conducting research in development of Soil Based Reed Beds with the aims of:

- reducing this planting area further and
- recycling of the wastewater

Soil Based Reed Beds (SBRB)

The SBRB system has three simple components:

- **A shallow bed of soil**
- **A suitable plant**
- **Micro-organisms (fungi and bacteria)**



RESEARCH OBJECTIVES

GELITA Australia initiated field research in order to:

- **Demonstrate the suitability of vetiver grass for use in the SBRB system to treat nitrogen rich industrial effluent**

- **Use the research findings in order to develop and establish a SBRB system that is capable of purifying GELITA's wastewater to a satisfactory level and**

- **Develop a SBRB system using vetiver grass suitable for Australia and world wide.**

WHY VETIVER GRASS INSTEAD OF PHRAGMITES?

Traditionally *Phragmites australis* is the preferred species in reed bed planting.

Phragmites has:

- **a relatively shallow root system, typical feature of wetland plants**
- **a slow recovery growth after harvesting as it relies on the growth of new shoots from rhizomes and seeds instead of the old shoots.**
- **a major weedy pest in all wetlands and waterways due to its prolific seeding habit**

WHY VETIVER GRASS INSTEAD OF PHRAGMITES

Vetiver:

- Has a prolific and deep root system
- Proven tolerant to high level of pollutants, including heavy metals and nutrients particularly N and P
- Has high capacity of absorbing these pollutants
- Grows well under extremely adverse conditions such high salinity, high acidity and alkalinity and sodicity
- Is sterile and producing no seeds therefore no weed potential

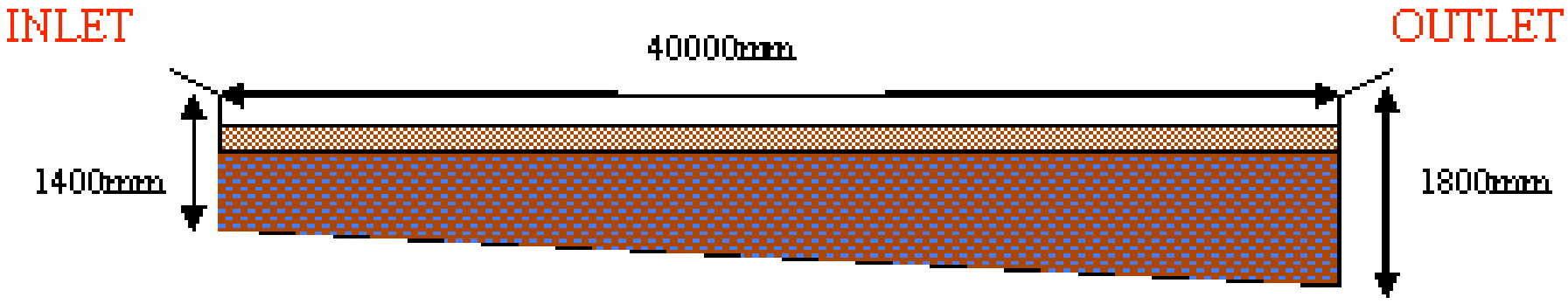
VETIVER GRASS IN REED BEDS

Summerfelt *et al* (1999) used vetiver grass in a study for the removal and stabilization of aquaculture sludge, has found that Vetiver removed:

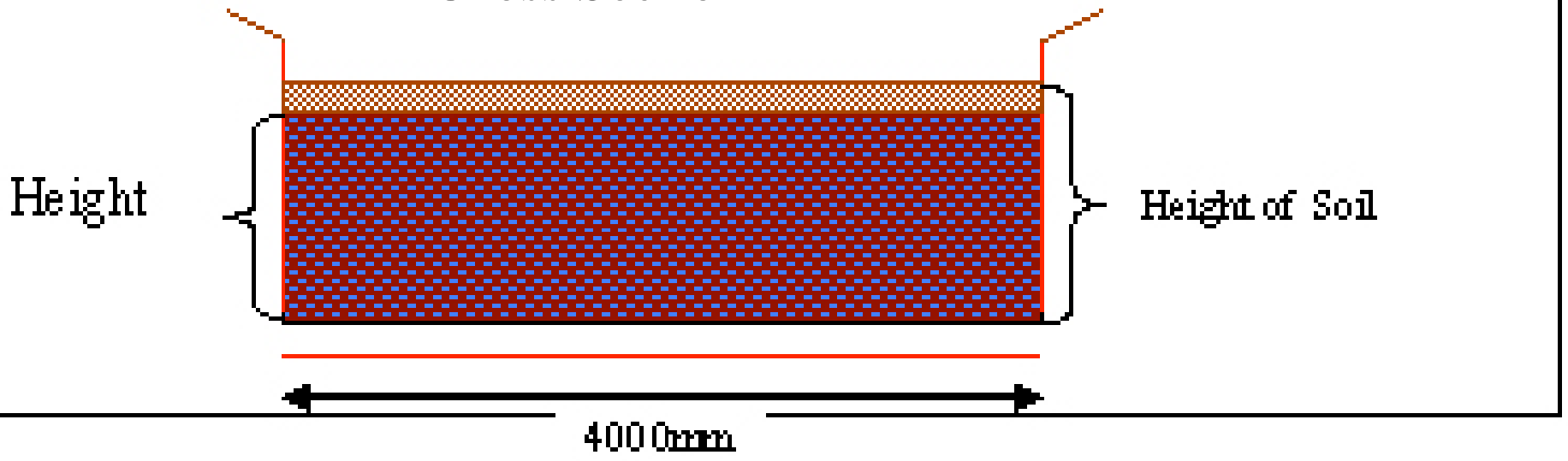
- **Total Suspended Solid 96- 98 %**
- **Total COD 72- 91 %,**
- **Dissolved COD 30-81%**
- **Dissolved phosphate, total Kjeldahl nitrogen, and total phosphorus 82_93%**

SBRB DESIGN AT GELITA

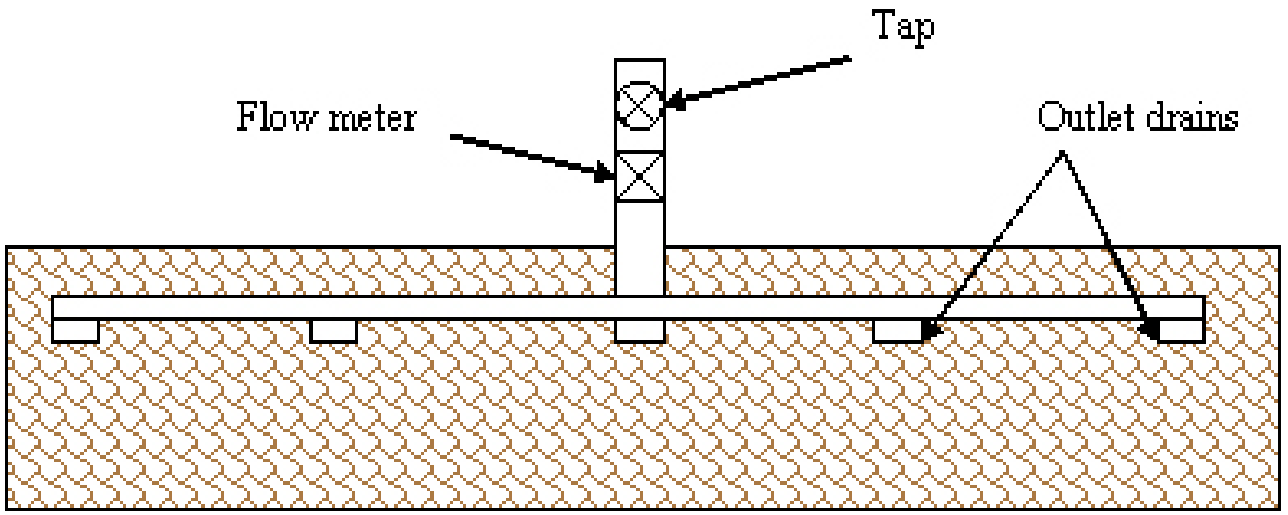
Longitudinal Section



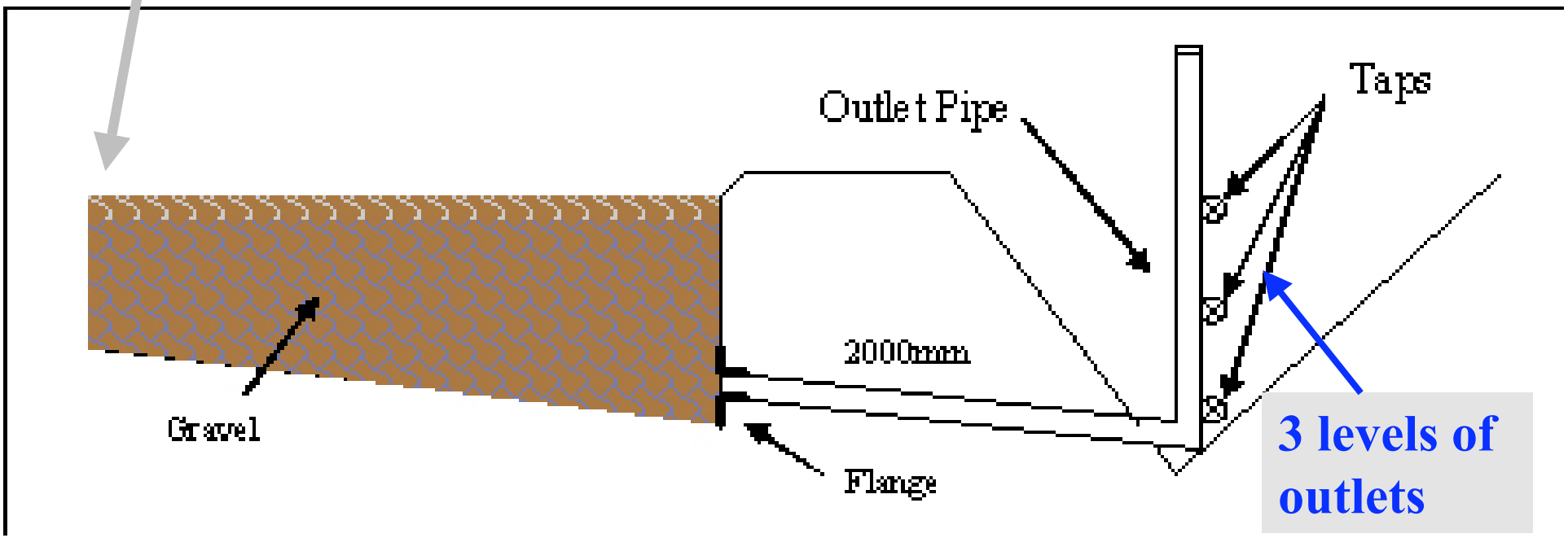
Cross Section



Inlets at top end of bay



Outlets at low end of bay



3 levels of outlets

THE SOILS

Three types of soil were used:

1- Gravely soil 2- Sandy loam 3- Black cracking clay

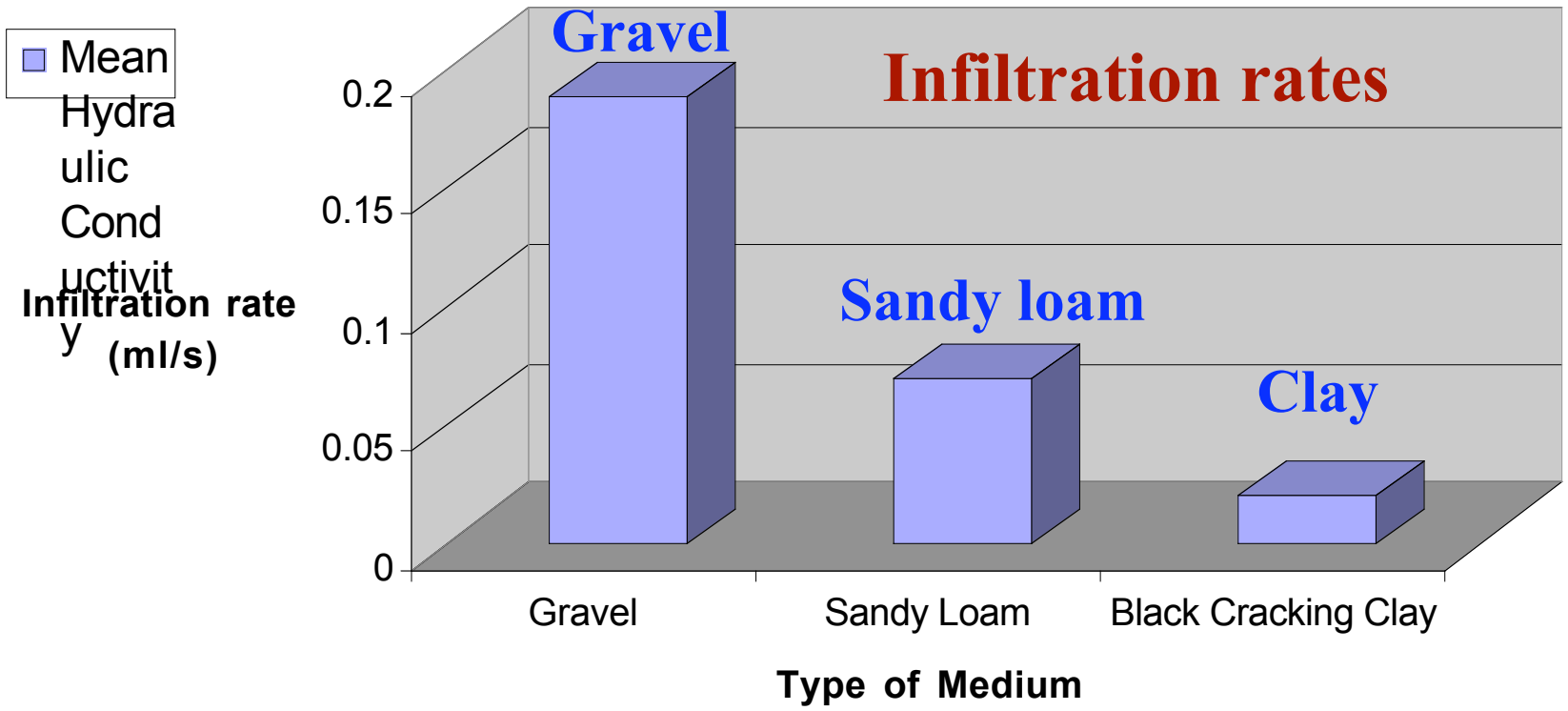
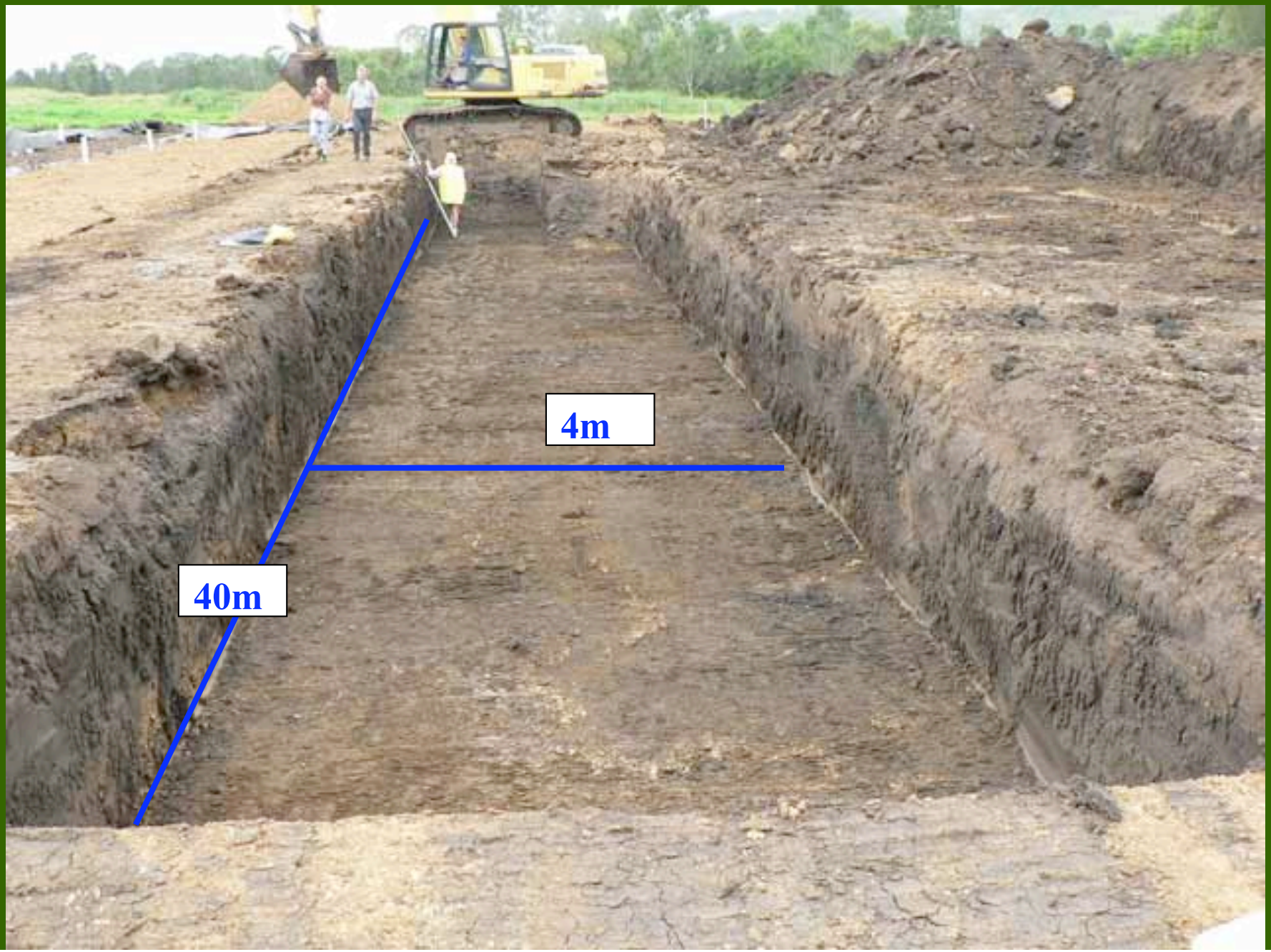


Figure 5.2: Summary of Infiltration rate for gravel, sandy loam and black cracking clay

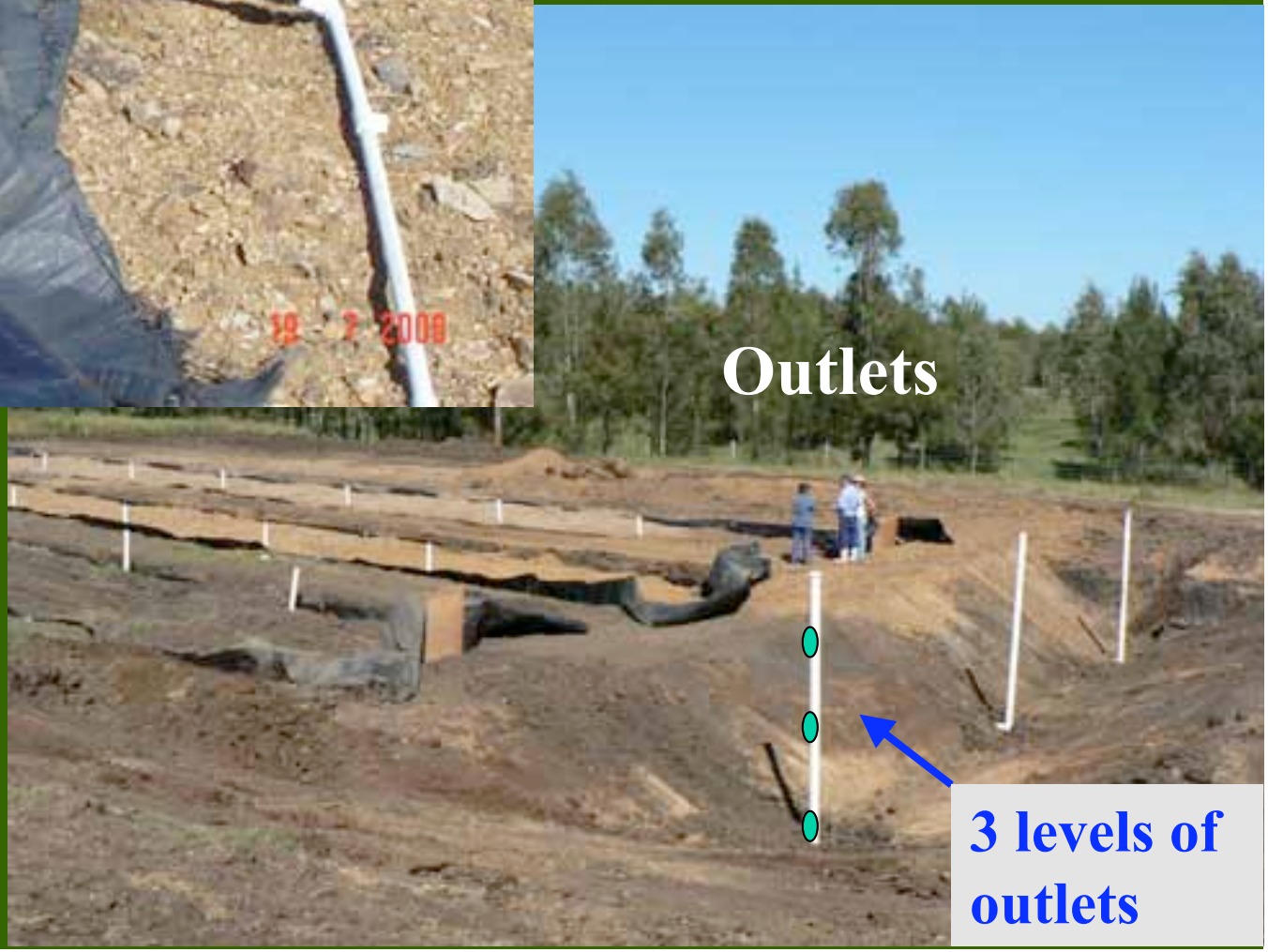
Reed bed construction



Reed bed construction:

- **Lining with thick waterproof membrane**
- **Fill in with soil/sand or gravel**

Inlet and outlets



New planting on sand bed

Preliminary results

Based on a six day hydraulic retention time

Root depth approximately 60cm

Soils colloidal adsorption effect not yet at steady state

	pH	EC (micro siemens)	NOx mg/L	PO4 mg/L	TN mg/L
Tap water	7.71	454	n/a	n/a	n/a
Clay	6.12	3780	3.8	1.1	28
Gravel	7.43	3240	20.4	0.2	20
Sand	6.87	1265	6.4	0.8	8
Effluent in to reed bed	**7.71**	**7100**	**21.7**	**2.2**	**452**

Soil Based Reed Beds set up