Vetiver System for Prevention and Treatment of Polluted Water and Contaminated Land

Paul Truong

The Vetiver Network East Asia and South Pacific Representative

Veticon Consulting, Brisbane, Australia

Email<paultruong@vetiver.org>

INTRODUCTION

Due to its extraordinary morphological and physiological characteristics, vetiver grass has also been used successfully for environmental protection:

1. **Wastewater treatment such as seepage control, such as domestic and municipal sewage effluent, landfill leachate, industrial wastewater and mining seepage.**

2. **VS can reduce the impact of pollution caused by contaminated lands from industries and mining by land rehabilitation and phytoremediation.**

Special Characteristics Suitable for Wastewater and Contaminated Land Treatment

- **Very high capacity for N and P uptake under Dry land, Wetland or Hydroponics conditions**

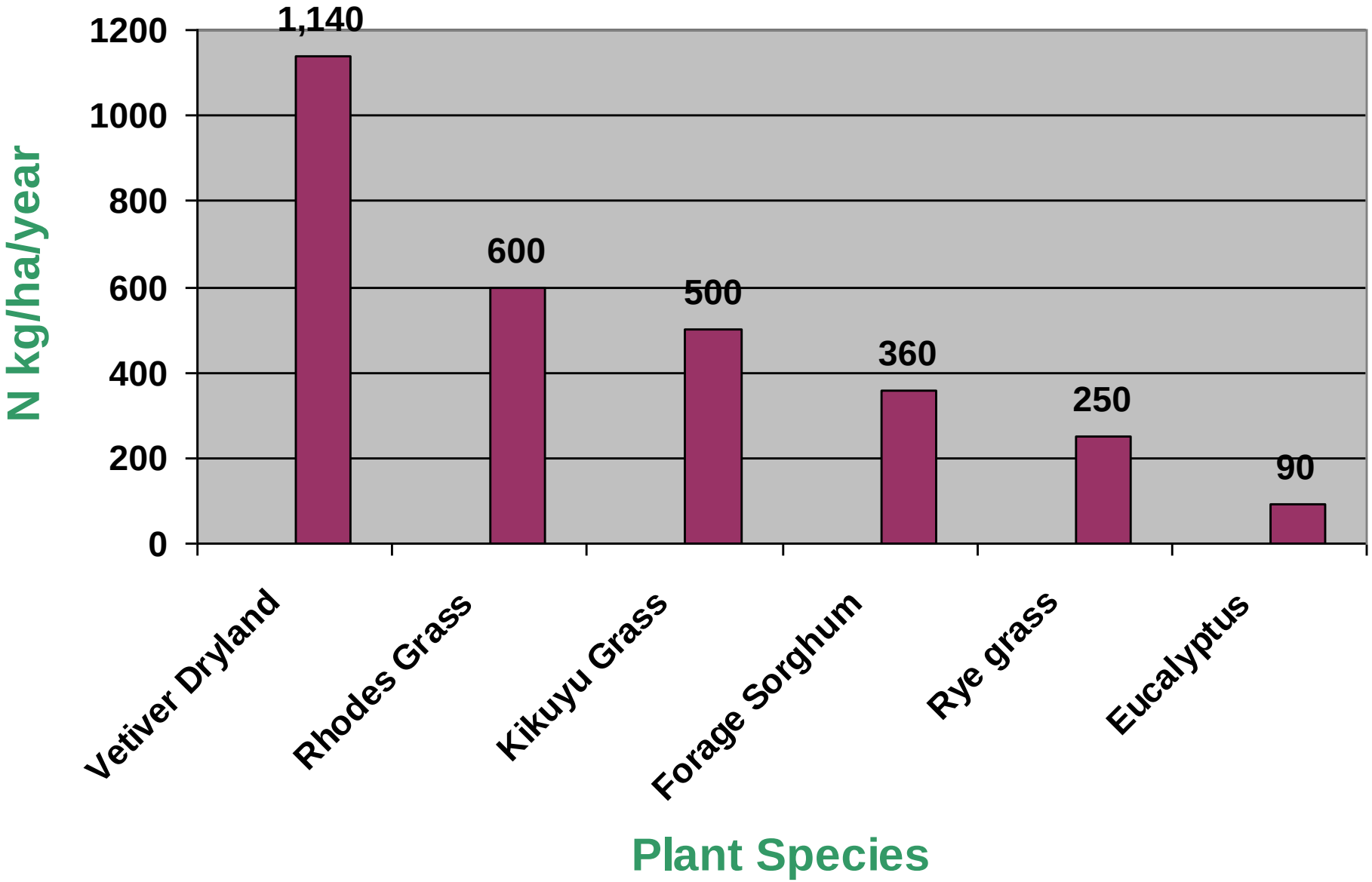
- **Very fast growth with very high water consumption under wet conditions**

- **Biomass up to 132t/ha**

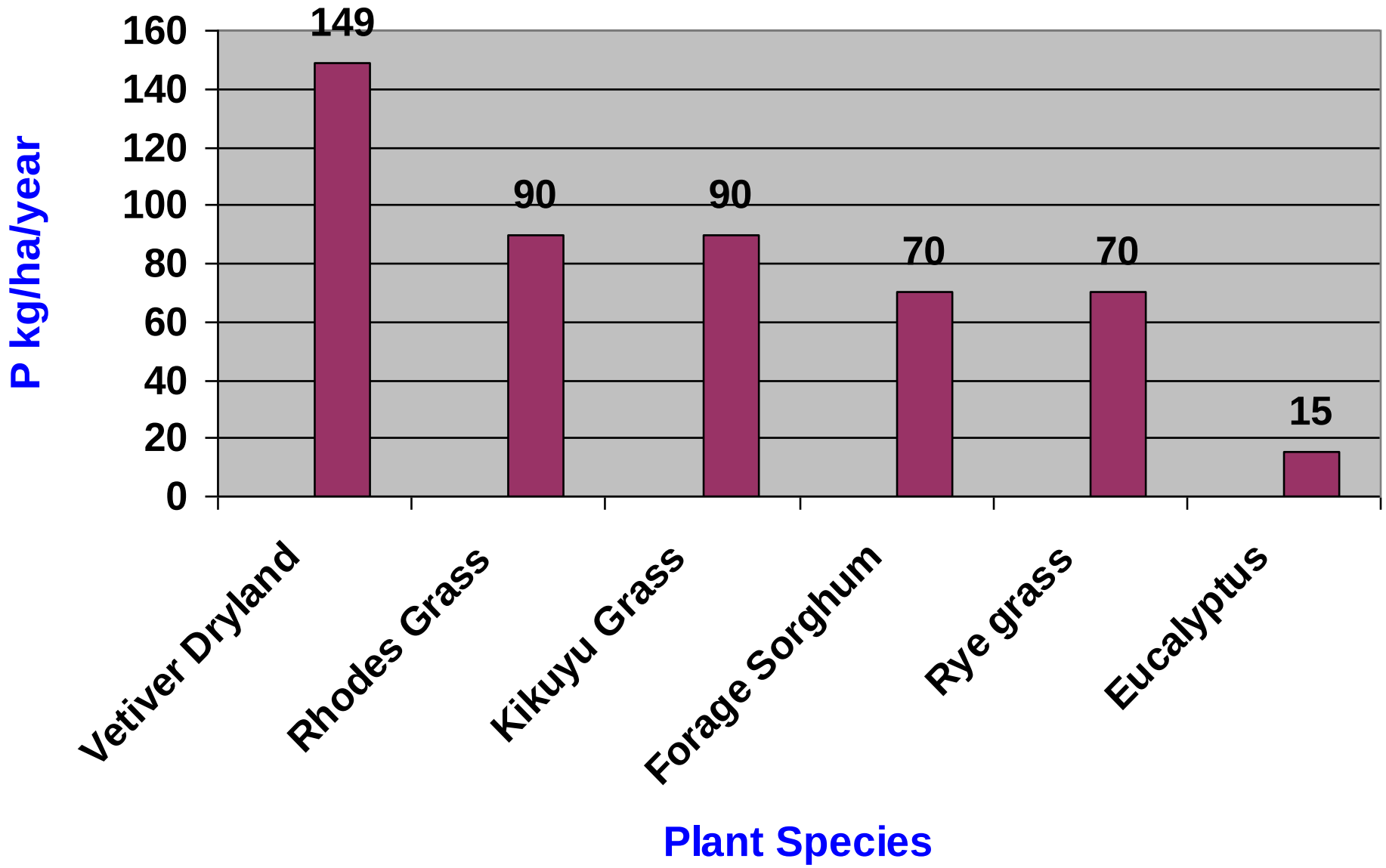
- **Tolerant high levels of herbicides and pesticides**

- **Highly tolerant to heavy metal toxicities**

NITROGEN UPTAKE



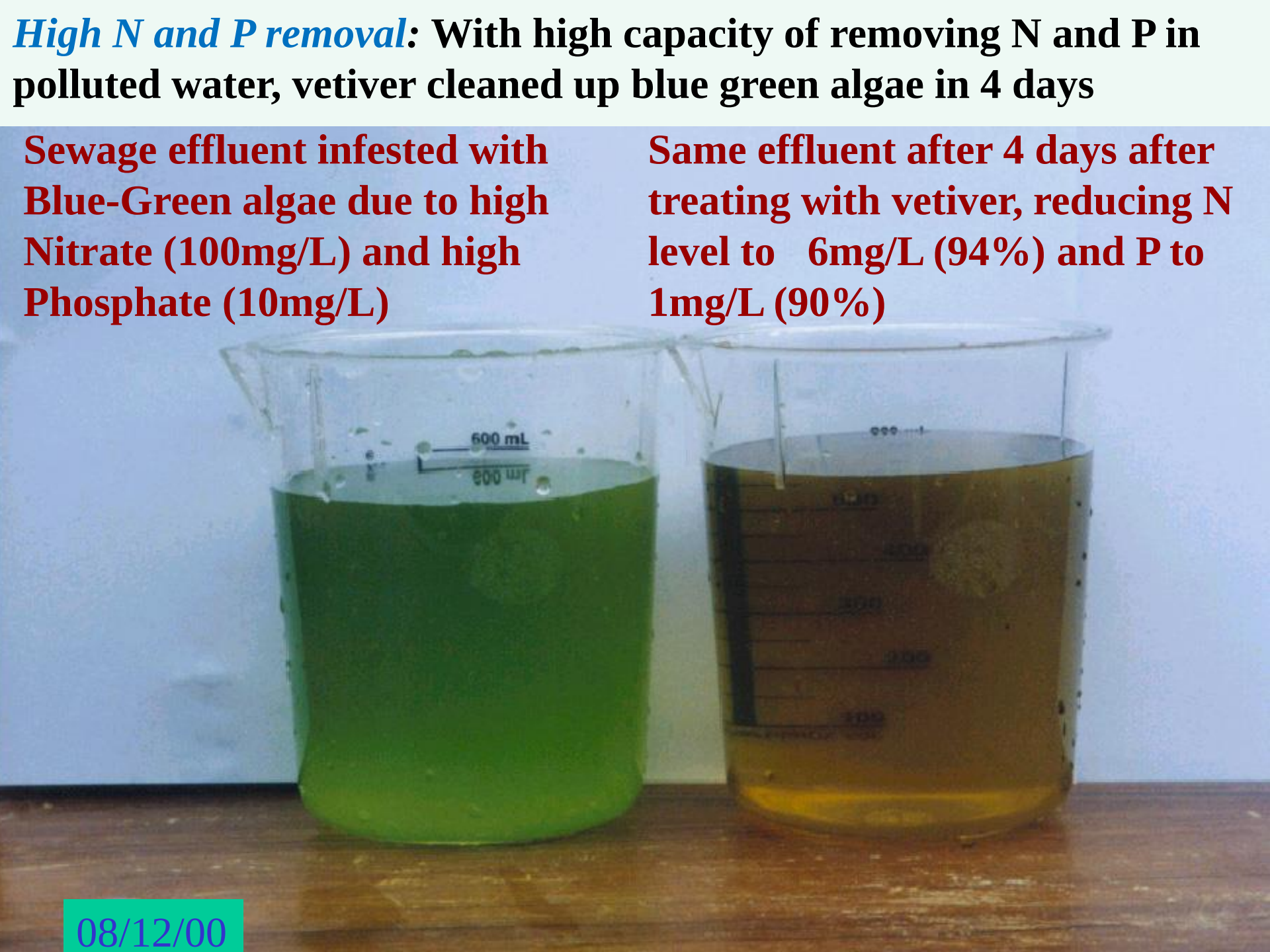
PHOSPHORUS UPTAKE



***High N and P removal*: With high capacity of removing N and P in polluted water, vetiver cleaned up blue green algae in 4 days**

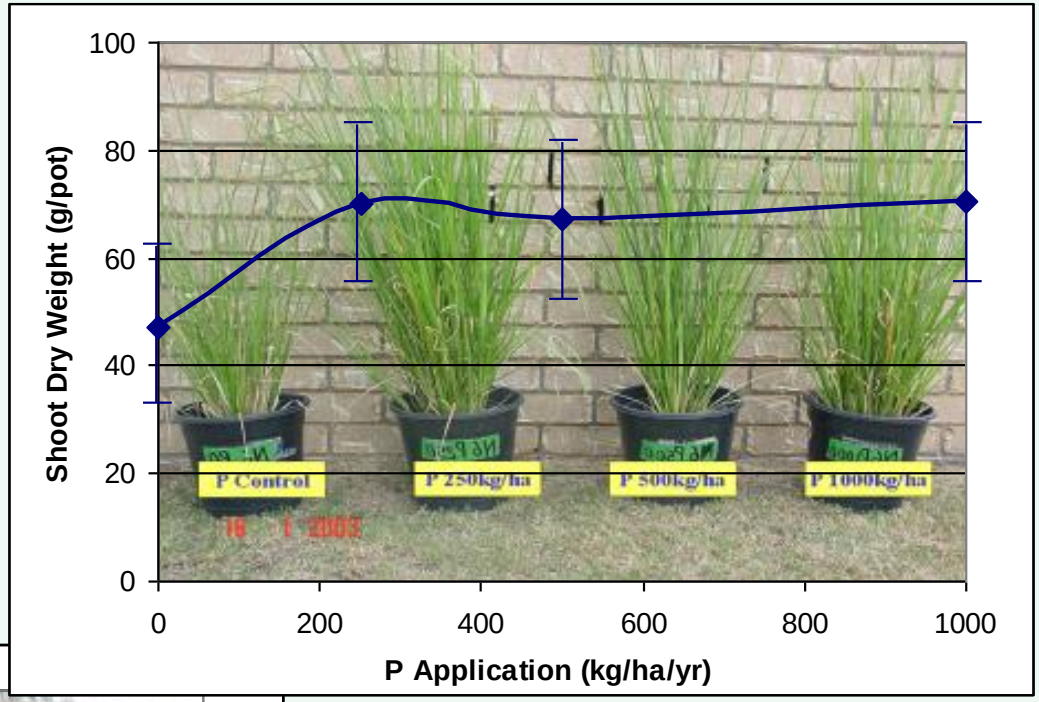
Sewage effluent infested with Blue-Green algae due to high Nitrate (100mg/L) and high Phosphate (10mg/L)

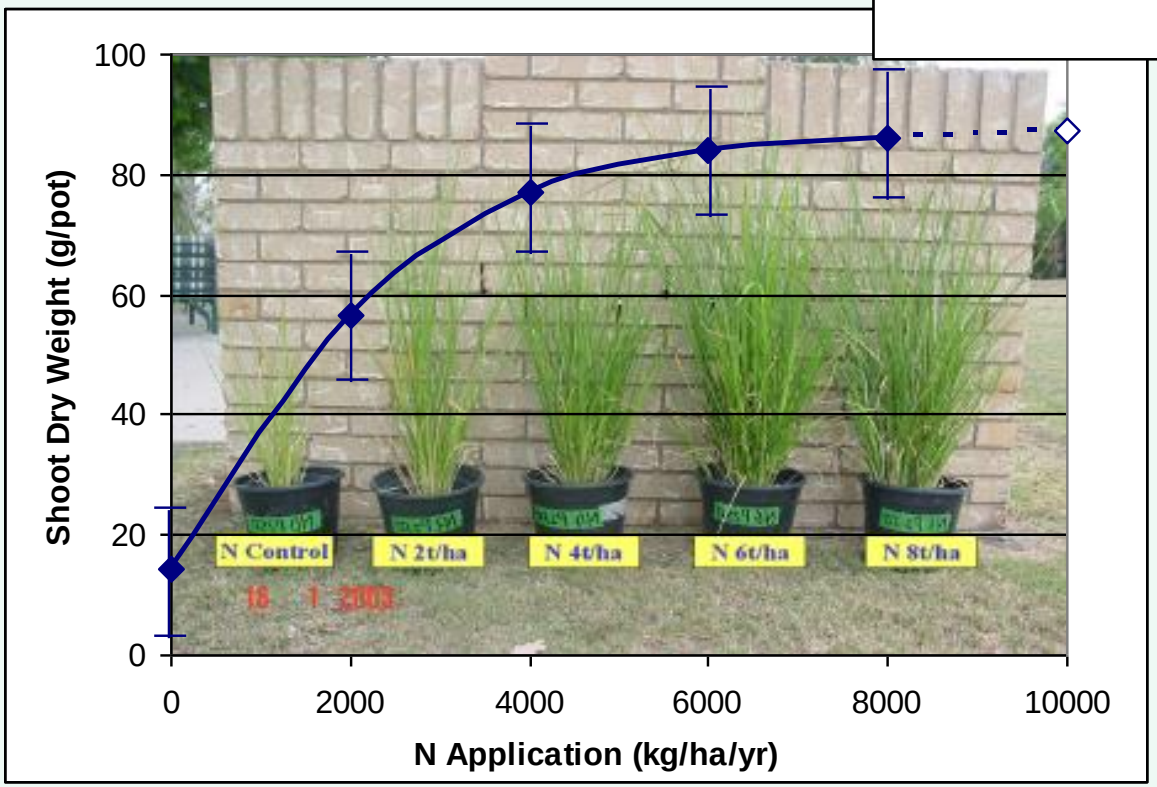
Same effluent after 4 days after treating with vetiver, reducing N level to 6mg/L (94%) and P to 1mg/L (90%)



08/12/00

Tolerance to extremely high levels of nutrients





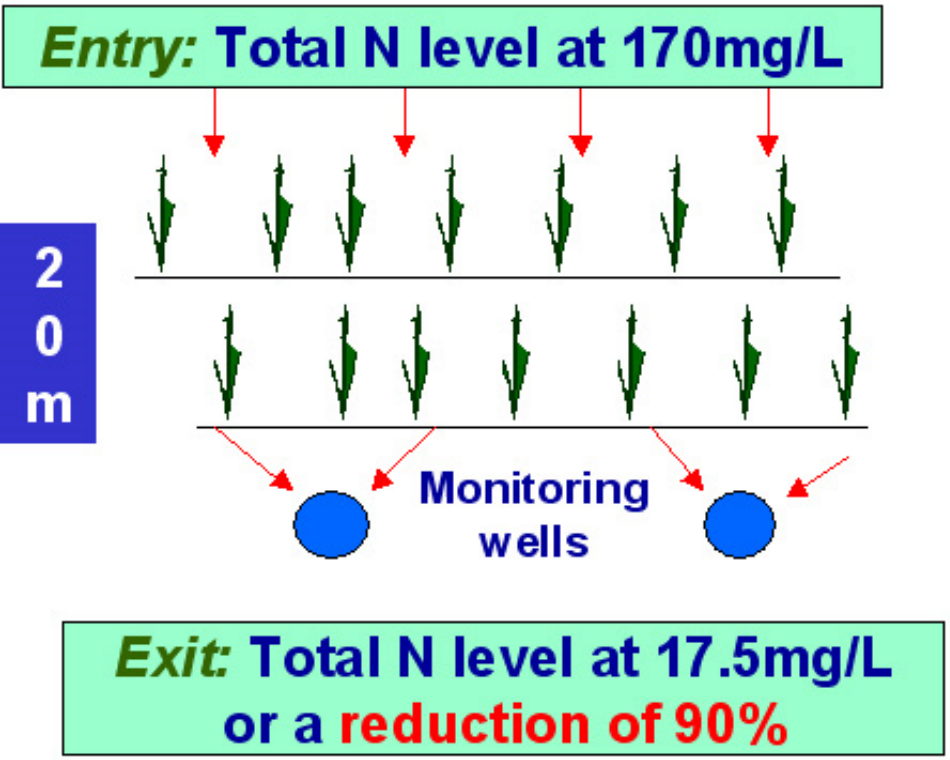
Prevention, Treatment and Disposal of Contaminated Water

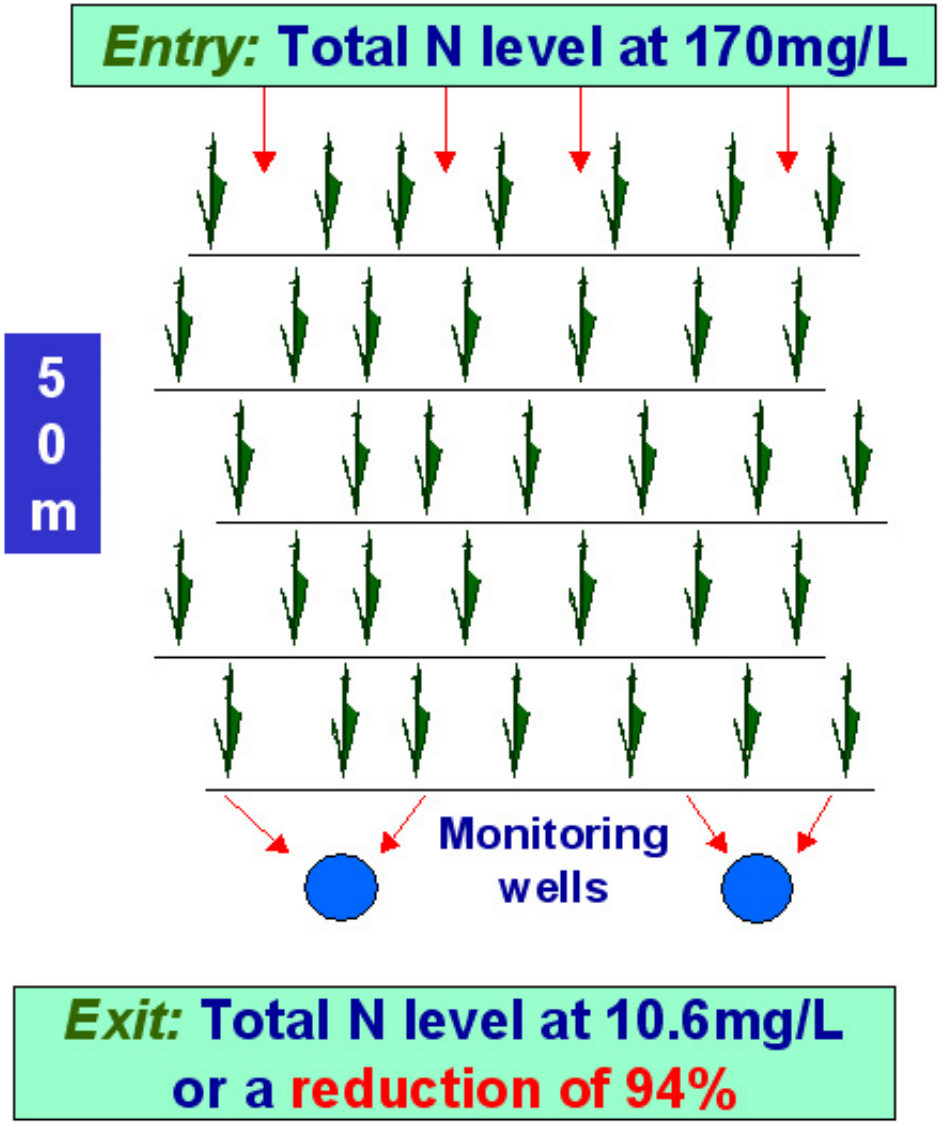
- **Disposal of domestic and municipal sewage effluent**
- **Disposal of industrial wastewater**
- **Disposal of landfill leachate**
  - ***Case study in Australia***
  - ***Case study in the USA and Mexico***
- **Disposal of landfill leachate**
  - ***Case study in Australia***
  - ***Case study in the USA and Mexico***
- **Future Trend**

Disposal domestic effluent in Australia

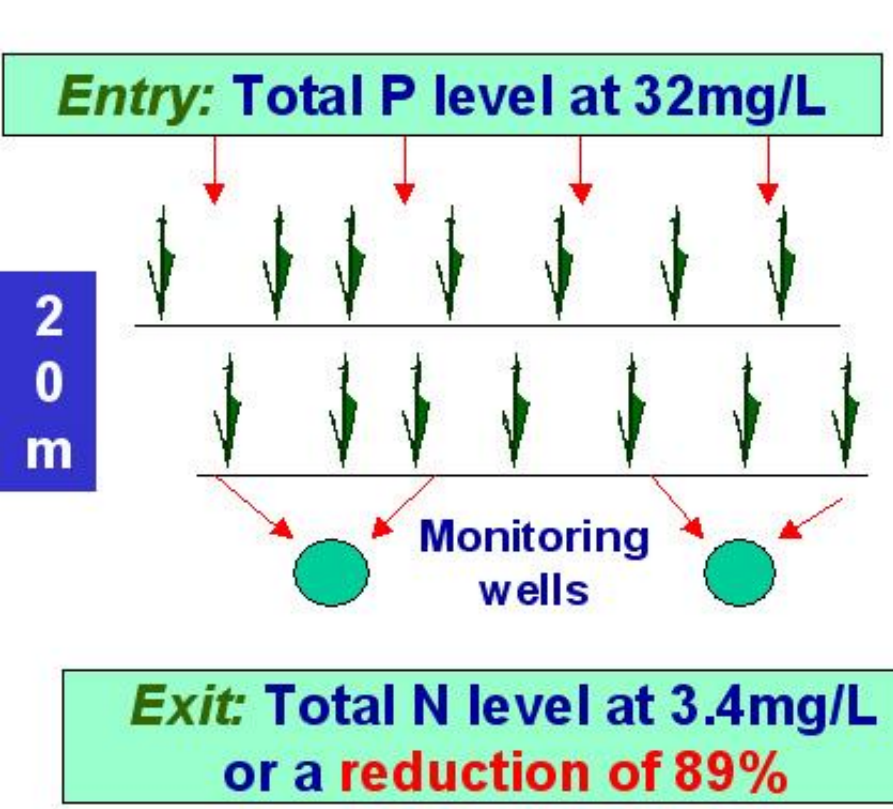
Six months after planting this stand of 100 plants absorbs all the discharge from the toilet block

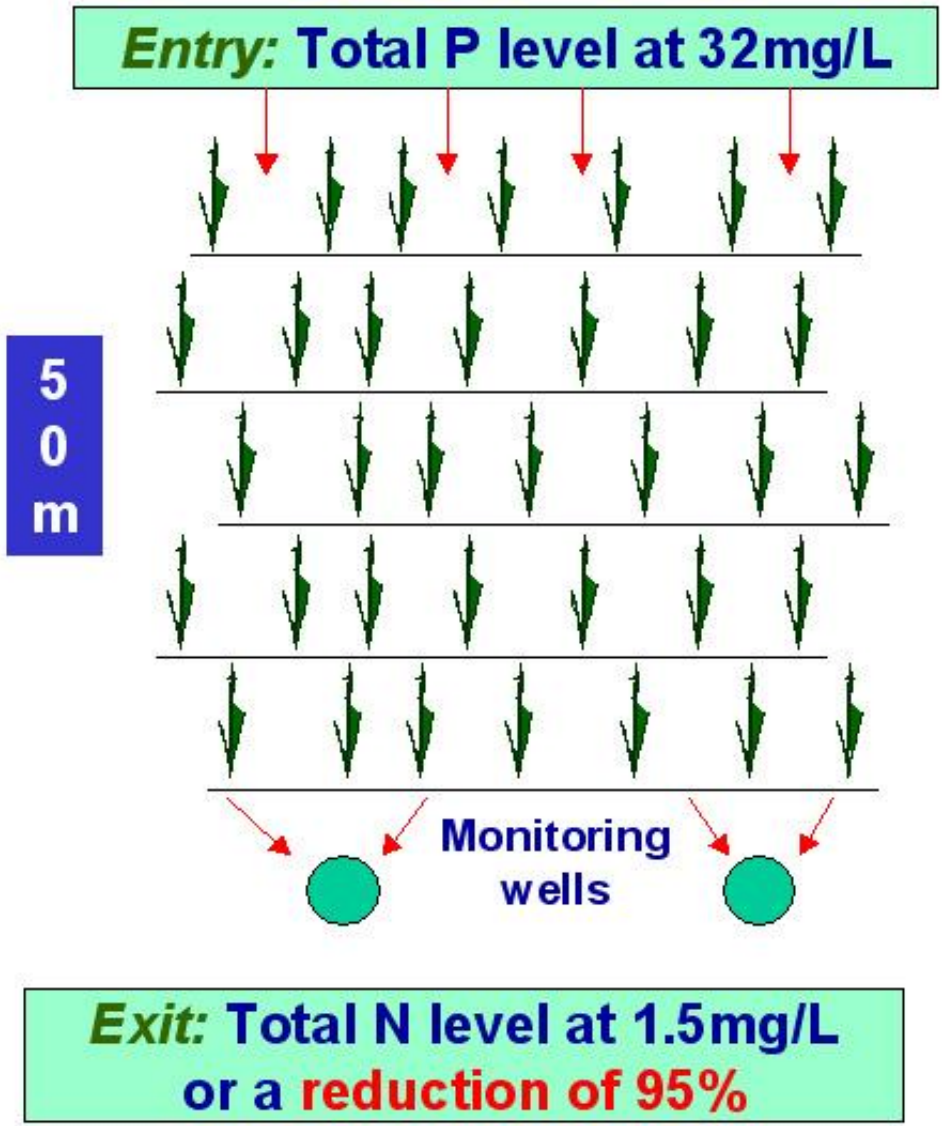
High capacity for N absorption





High capacity for P absorption





Disposal of municipal sewage effluent in Australia

First step: Hydroponics treatment of effluent in ponds

Second step: Ephemeral Wetland treatment of municipal sewage effluent

Ten months after planting

Test results of sewerage effluent

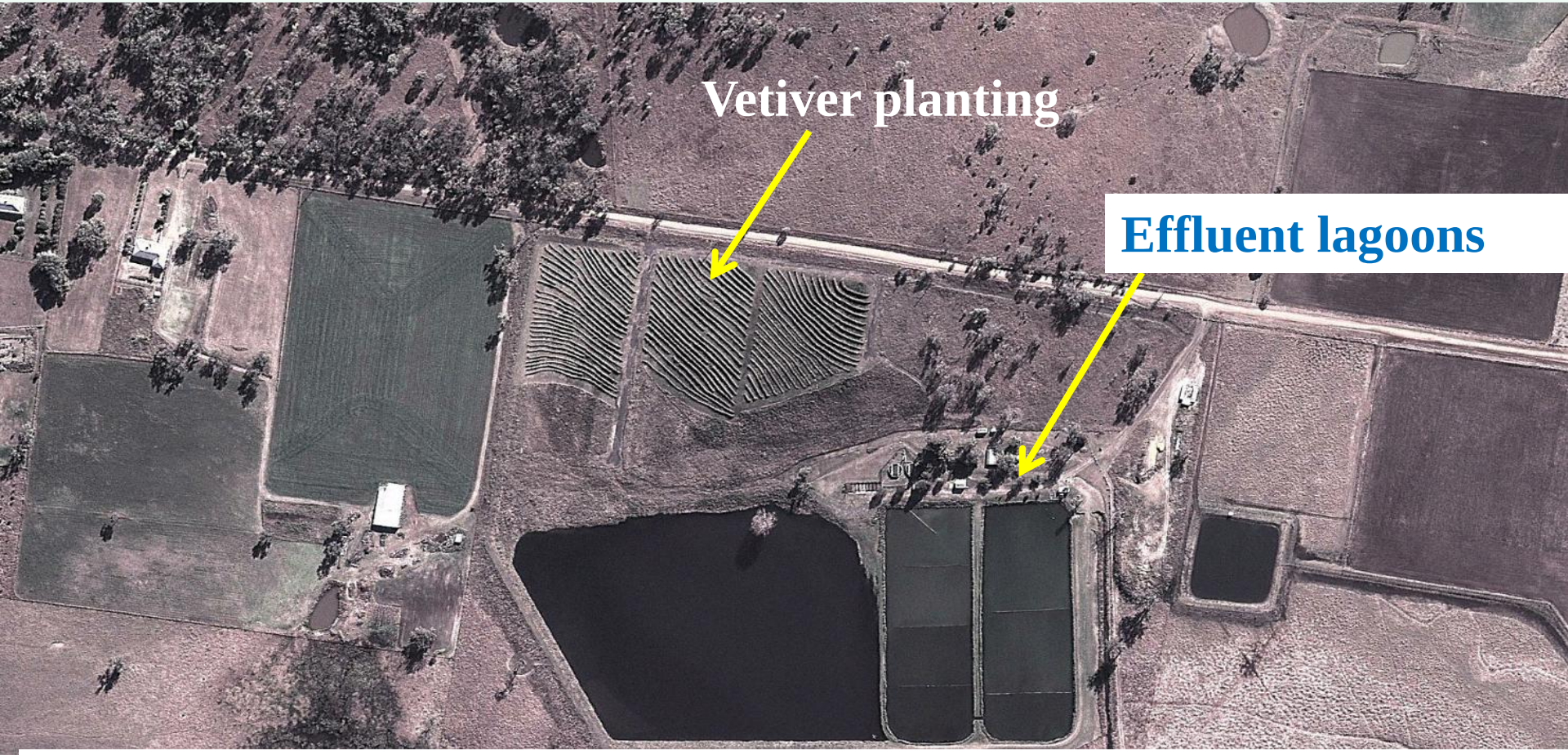
(License Requirements in Brackets)

Tests	Plant Influent	2002/03 Results (9 month old)	2003/04 Results (18 month old)
PH (6.5 to 8.5)	7.3 to 8.0	9.0 to 10.0	7.6 to 9.2
D. Oxygen (2.0 minimum)	0 to 2 mg/L	12.5 to 20 mg/L	8.1 to 9.2 mg/L
5 Day BOD (20 - 40 mg/l max)	130 to 300 mg/L	29 to 70 mg/L	7 to 11 mg/L
Suspended Solids (30 - 60 mg/l max)	200 to 500 mg/L	45 to 140 mg/l	11 to 16 mg/l
Total Nitrogen (6.0 mg/l max)	30 to 80 mg/L	13 to 20 mg/L	4.1 to 5.7 mg/L
Total Phosphorous (3.0 mg/l max)	10 to 20 mg/L	4.6 to 8.8 mg/L	1.4 to 3.3 mg/L

Disposal of Municipal Sewage Effluent

- **This plant serve a small rural town in Queensland, Australia, with the capacity of dispose 500 000L sewage effluent per day.**
- **Vetiver Phytoremediation was adopted to reduce both construction and maintenance cost in upgrading this plant to comply with EPA new regulations**
- **EDVI model was used in the design of this plant**

Boonah Sewage Effluent Treatment Plant



This plant serves a small rural town in Australia, to dispose 500KL sewage effluent per day. Vetiver Phytoremediation was adopted to reduce both construction and maintenance cost in upgrading this plant to comply with EPA new regulations

Eight months after planting

One year after planting

18 months after planting

Disposal of Industrial Wastewater

Case study in Australia

GELITA is a manufacturer of Gelatine, Vetiver was planted to dispose 2.3Ml/day of highly contaminate effluent

Excellent growth, up to 2m in 18 months at Gelita

Disposal of Landfill Leachate

Case study in Australia

SEEPAGE CONTROL: Landfill leachate is highly polluted with heavy metals

Vetiver planted on seeping leachate.

Six months after planting, excellent growth, unaffected by heavy metals.

One year after planting, landfill leachate was completely dried up

LAND IRRIGATION: Vetiver planted on the top of the mound and irrigated with untreated leachate after planting

Three months after planting: good growth and establishment

Thirteen months after planting. This site disposed 4ML/month in summer and 2ML/month in winter

Disposal of landfill leachate

Case study in the USA

First ever application of its kind in Western Hemisphere

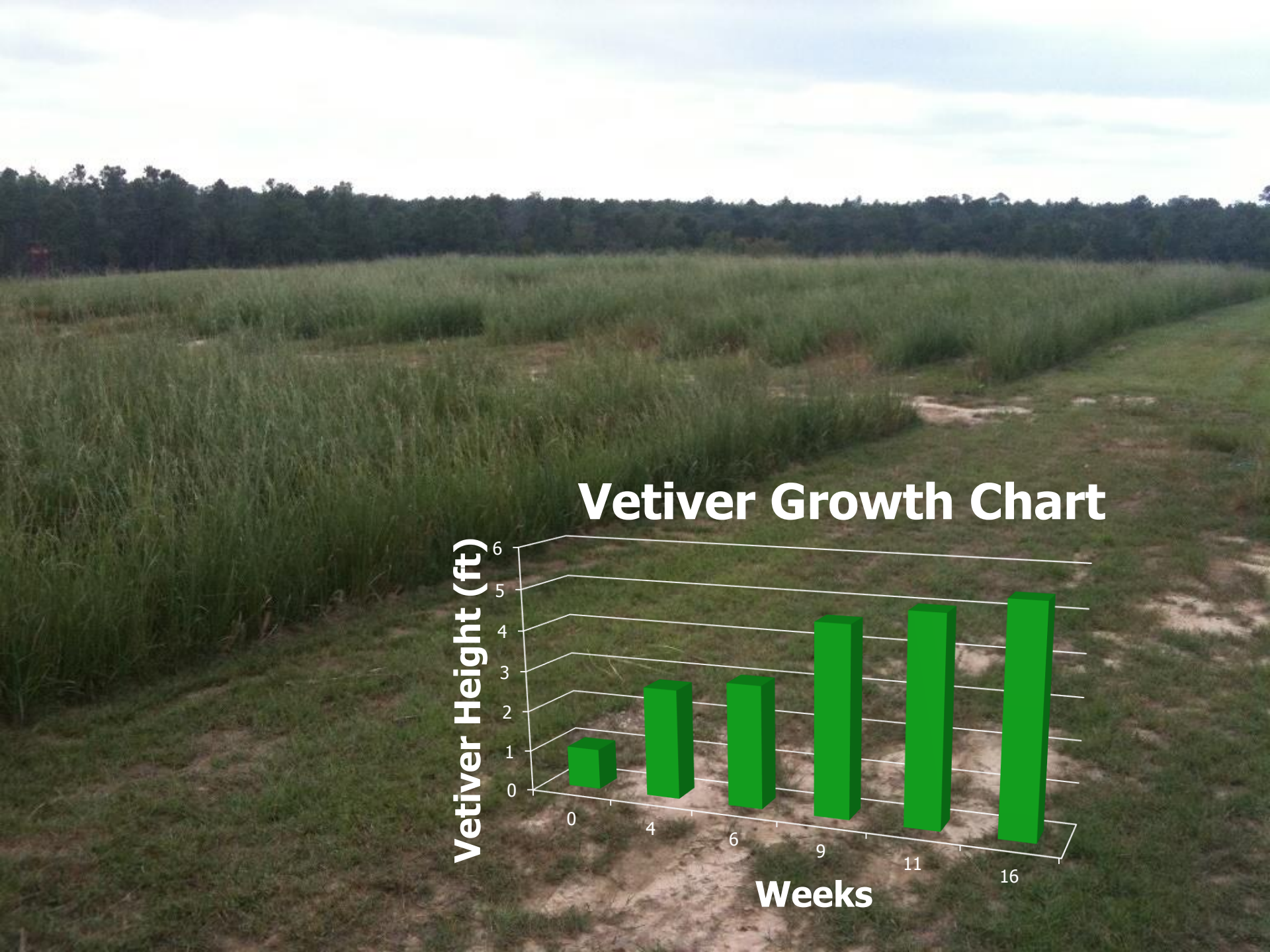
Gulf Pines Landfill, Biloxi, Mississippi

- **Leachate production = 3 to 4 million gallons / year**
- **Annual Cost $270,000 to $360,000 (@ $0.09/gal)**
- **Active gas recovery system**
- **Residential to north and east**
- **Active recycling facility and transfer station on site**

Pre-Installation
Pre-Installation

Three months after planting

Eight months after planting


Vetiver Growth Chart
Vetiver Height (ft)
0
1
2
3
4
5
6
0
4
6
9
11
16
Weeks

Results

- Zero Discharge
- 1.3 million gal processed
- $8 million expected savings over 30 years
- Low maintenance, automated system
- Pre-phyto leachate disposal = $0.09
- Post-phyto leachate disposal <$0.01/gal
- Return on initial capital investment of only 2 – 3 years

2012 National Award Winner

AMERICAN ACADEMY OF ENVIRONMENTAL ENGINEERS®

Excellence in Environmental Engineering®

"Grand Award" for First Place in Category

Disposal of landfill leachate

Case study Mexico

- **City of Leon**
  - **Population 1.4 million, metro 1.6 million**
  - **Elevation 1,800 meters (6,000 feet)**

- **Site Characteristics**
  - **Leachate volume = >13 million gallons stored in lagoons and producing 7-9 million gallons/yr**
  - **Very concentrated, phyto-toxic leachate**


Pre-construction Conditions


Vetiver planting


Six months later

CITY OF POZA RICA

Leachate disposal and erosion control

TREATMENT AND REHABILITATION OF CONTAMINATED LANDS

Mine Rehabilitation and Phytoremediation

VS could be used as an integrated technique for environmental management of mining activities.

- **Firstly, solid mining wastes such as tailings and waste rocks could be stabilized by vetiver to control or reduce air and water erosion, then reduce the release of heavy metals to surroundings.**
- **Wastewater including acid mine drainage (AMD) could be purified by phytofiltration.**
- **The surrounding lands contaminated by heavy metals could be further cleaned up by phytoextraction.**

Case study: Bentonite waste in Australia.

This waste dump is highly sodic and erodible. Vetiver established well and promote the return of native grasses

Case study: Coal mine waste in Australia.

This coal mine waste rock dump remains barren after 50 years, it was highly erodible.

Vetiver planting successfully stabilise this dump

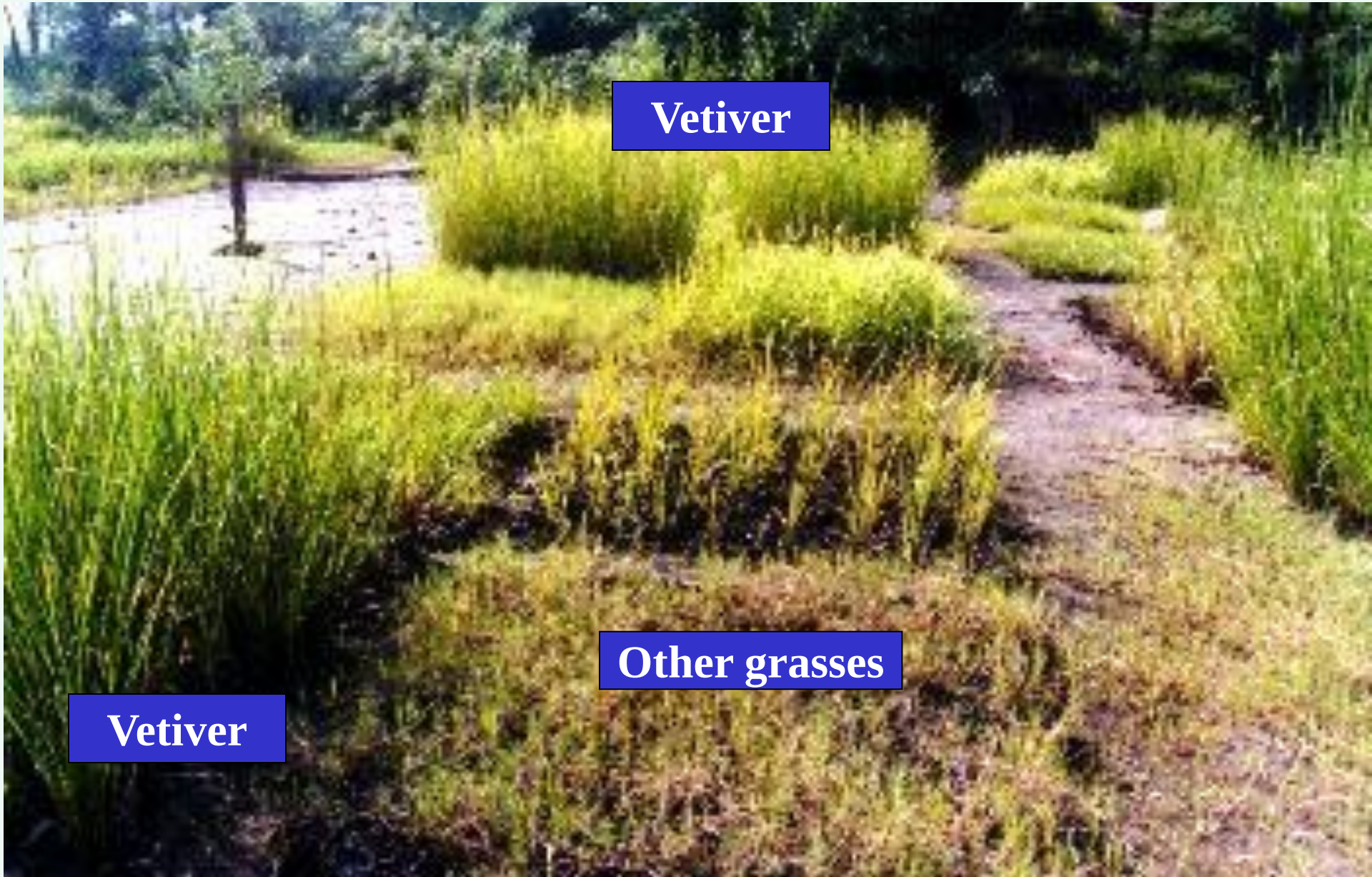
Case study: Gold mine tailings in Australia.

A typical large gold mine fresh tailings pond, highly susceptible to wind erosion

The dust is highly contaminated with heavy metals such as Arsenic, Copper etc

Vetiver hedges provided a low cost and permanent wind barrier unaffected by strong winds, provided excellent protection for crop establishment

Case study: ZN/Pb mine tailings in China.




2003 9 23

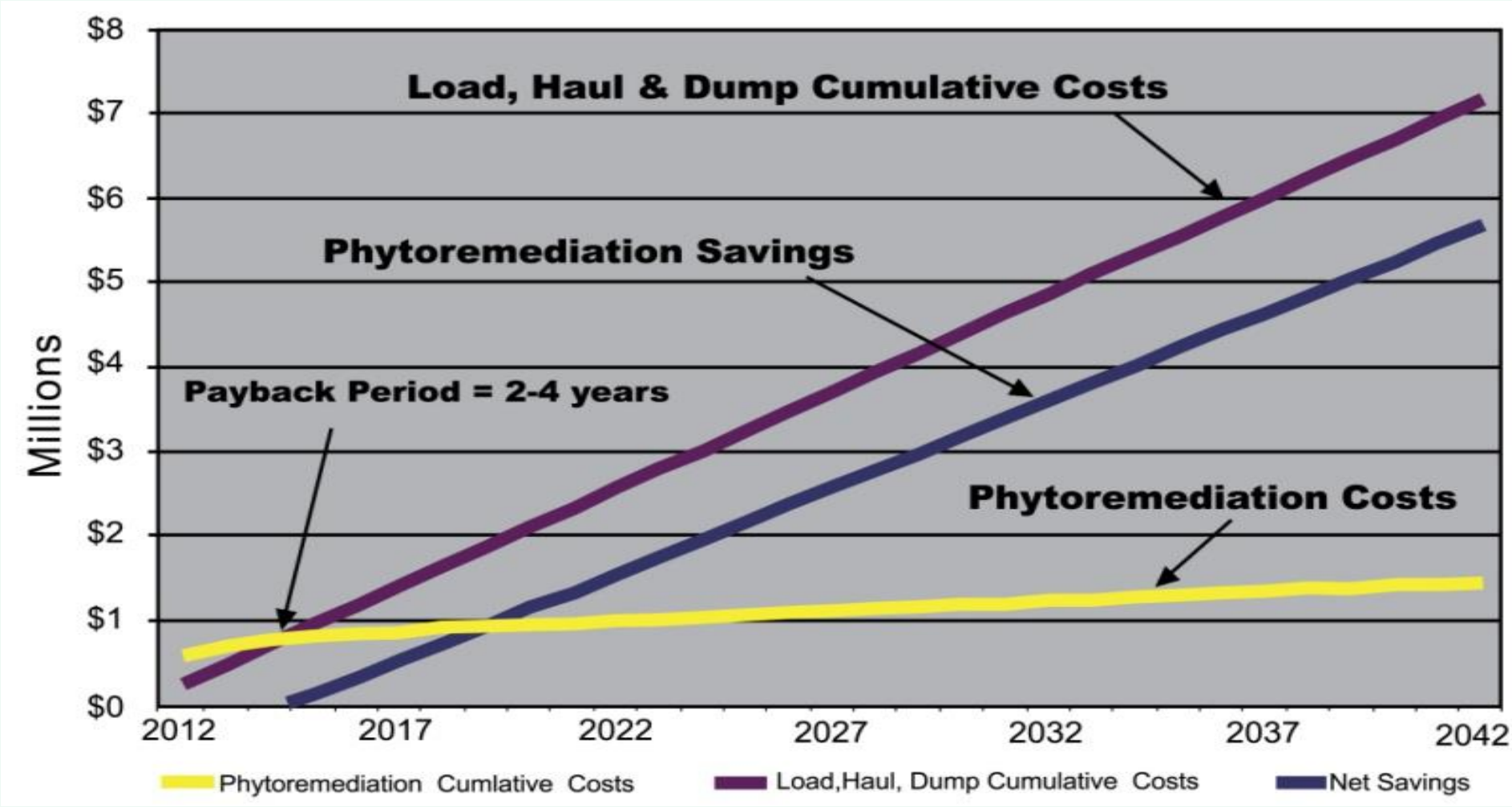
CONCLUSION AND FUTURE TREND

The information presented above clearly demonstrates that the Vetiver System is a very efficient and low cost method for treating sewage effluent and leachate from both domestic and industrial sources.

When properly designed and applied, the VS will certainly play a key role in minimising the impact of the imminent global clean water shortage.

FUTURE TREND

As cost effectiveness is the overriding factor, phytoremediation using VS will be increased in the future



OVERALL ADVANTAGES OF VETIVER SYSTEM

1. **Simplicity: VS is much simpler than conventional methods**

2. **Low cost: Phytoremediation with VS costs a fraction of conventional methods such as chemical or mechanical treatment.**

1. **Minimal maintenance: When properly established, the VS requires practically no maintenance to keep it functioning**

THANK YOU