



# Coastal Acid Sulfate Soils: National Atlas and Future Scenarios



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## What are Acid Sulfate Soils (ASS)?

- Mechanisms, formation and types
- Impacts of coastal Acid Sulfate Soils

## National Atlas of Acid Sulfate Soils

### ***Completed work – coastal outcomes***

#### **Stage 1:** Co-ordination via NatCASS

- Project team, state, territory and federal partners
- Consistent format/ approach across the nation
- Data delivery via ASRIS website

### ***Future work – next stages (in progress)***

#### **Stage 2:** Refinement of National Atlas of coastal ASS

- via representative case studies and databases
- NHT funding via NatCASS (CSIRO, DPI and SCU)

#### **Stage 3:** National ASS Atlas **adding** inland ASS

## Summary and Future Scenarios

# What are Acid Sulfate Soils?

Soils and sediments that contain **iron sulfides** (mostly pyrite),

When drained or disturbed  
(exposed to oxygen)

They form **sulfuric acid**



# Horizons, materials and layers in ASS

## Sulfuric horizon

(Has become acidic after disturbance)

pH < 3.5

Oxidised iron sulfides

- with yellow mottles
- jarosites



A photograph of a soil profile with a measuring tape on the left. The tape is marked from 0 to 12. The soil is dark and appears to be a mix of organic matter and mineral material. The text 'Sulfuric horizon' is overlaid in yellow on the right side of the image.

Sulfuric horizon

Sulfidic material

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## Sulfidic material

(If disturbed becomes acidic)

pH 6.5-7.5

Unoxidised iron sulfides

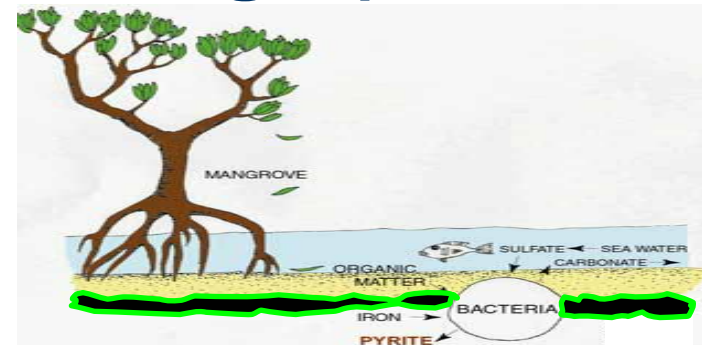
- black



# Three types of ASS

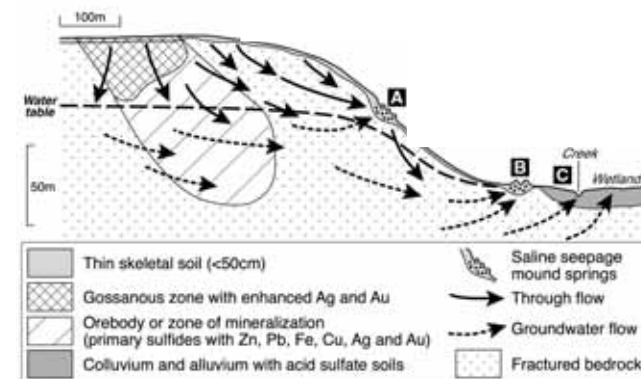
## 1 Coastal or seawater settings (below 5 m)

- Tidal
- Estuarine
- Mangroves



## 2 Inland/upland or freshwater settings

- Non-tidal
- Saline sulfate-rich groundwater
- Dryland salinity
- Drains and irrigation channel



## 3 Mine spoil settings

- e.g. coal or base metals

# Negative impacts – East Trinity



Drained and  
scalded areas

Dead  
mangroves  
from acid  
drainage







# Negative impacts - environmental

Dissolved aluminium  
released





# **Economic impacts**

## ***Some examples:***



### **NSW fish and oyster death**

- >\$2 million pa

### **Corrosion cost Tweed Heads Shire Council**

- \$4 million infrastructure replacement

### **ASS treatment /management cost in Qld**

- \$180 million/year





# National Atlas of Acid Sulfate Soils



**Previously: No consistent national format**

**Now: ASS Project - National Atlas in progress**

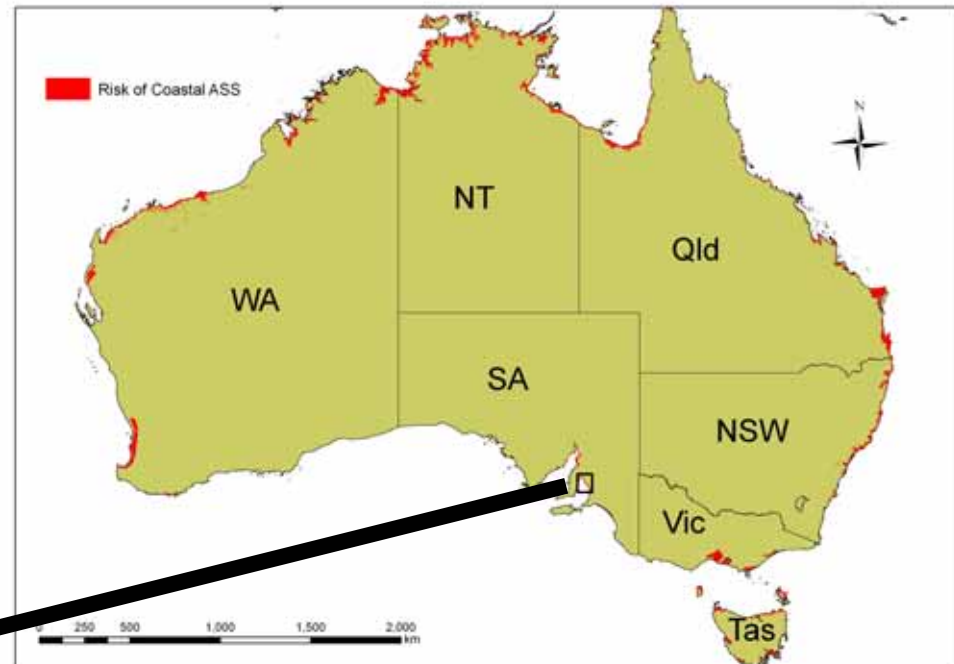
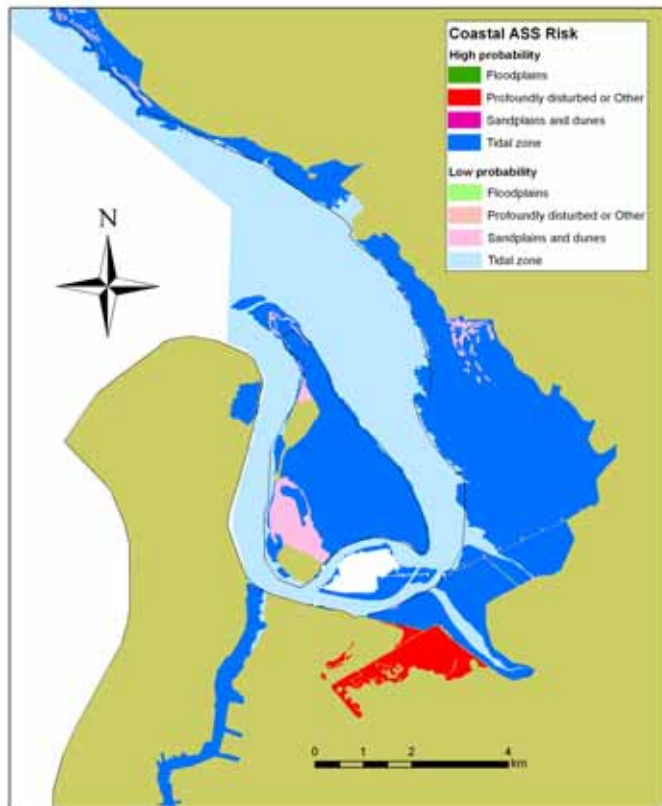
- **Consistent national map** - partnership with states and territories
- **Where ASS data inadequate**
  - other data was used  
(e.g. coastal vegetation, Digital Elevation Maps)
- **Result – Standardised national map  
(including computer formats e.g. Internet and GIS)**

# Outcome of Stage 1: Coastal ASS

Originally ~40,000km<sup>2</sup>



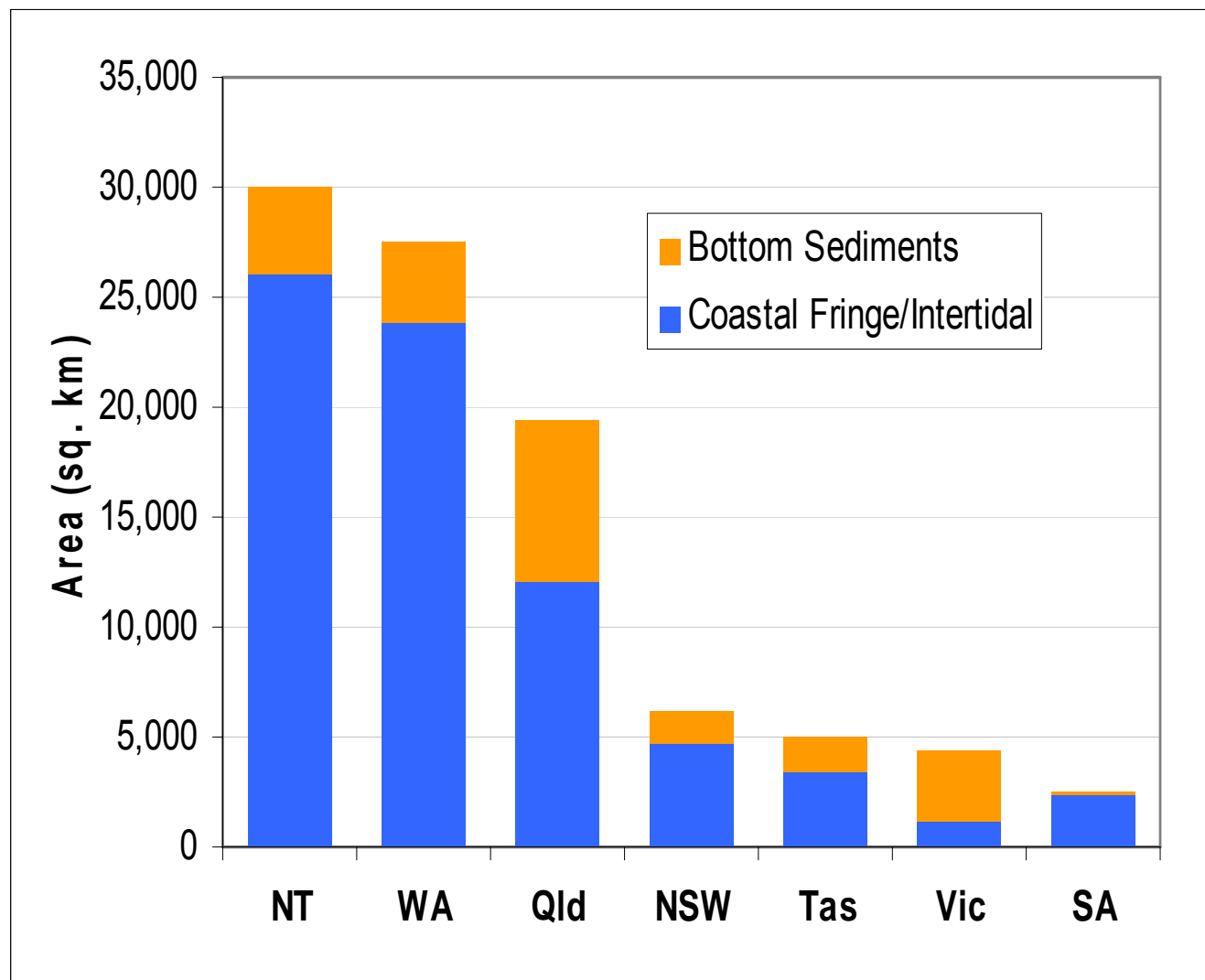
**Now - Stage 1 Coastal ASS ~ 95 000 km<sup>2</sup>**  
**= two billion tonnes of sulfidic material**  
**(Potentially 3 billion tonnes sulfuric acid)**



**Revised map shows:**

- **Consistent national classification of ASS**
- **Various different types of coastal ASS**  
e.g. high and low probability, disturbed (acidic), bottom sediments, intertidal flats (mangroves), non-tidal (sandplains & dunes)

# Distribution of coastal Acid Sulfate Soils



**~95,000km<sup>2</sup> of coastal ASS**

***Of which:***

**21,000 km<sup>2</sup> as bottom sediments below low tide**

***and***

**74,000 km<sup>2</sup> on coastal land,**

**- over 1,000 km<sup>2</sup> already disturbed and acidified**



# Coastal ASS estimate doubled! WHY?

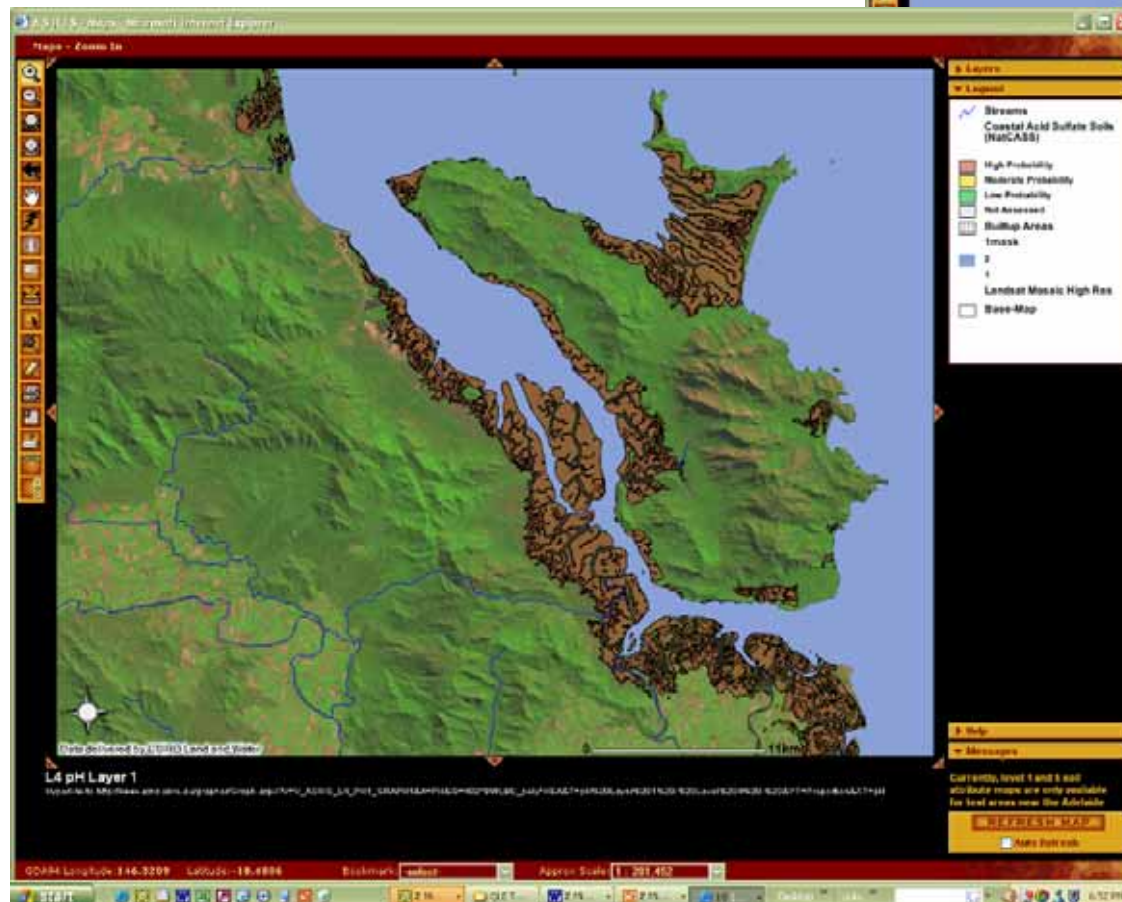
## Due to:

- **Improved ASS data interpretation using advanced electronic mapping (GIS)**
- **Inclusion of submerged ASS sediments below the low tidal mark**
  - - - has potential impact on water quality

# Web-based Map via ASRIS

(Australian Soil Resource Information System)

Web accessible map  
[www.asris.csiro.au](http://www.asris.csiro.au)



Zoom in

# **ASS Management Options**

- **Avoid or minimise disturbance**
- **Reflood to curtail oxidation**
- **Neutralise acidity**
- **Bury ASS under clean fill**
- **Manage or contain discharge of acid and toxic waters**

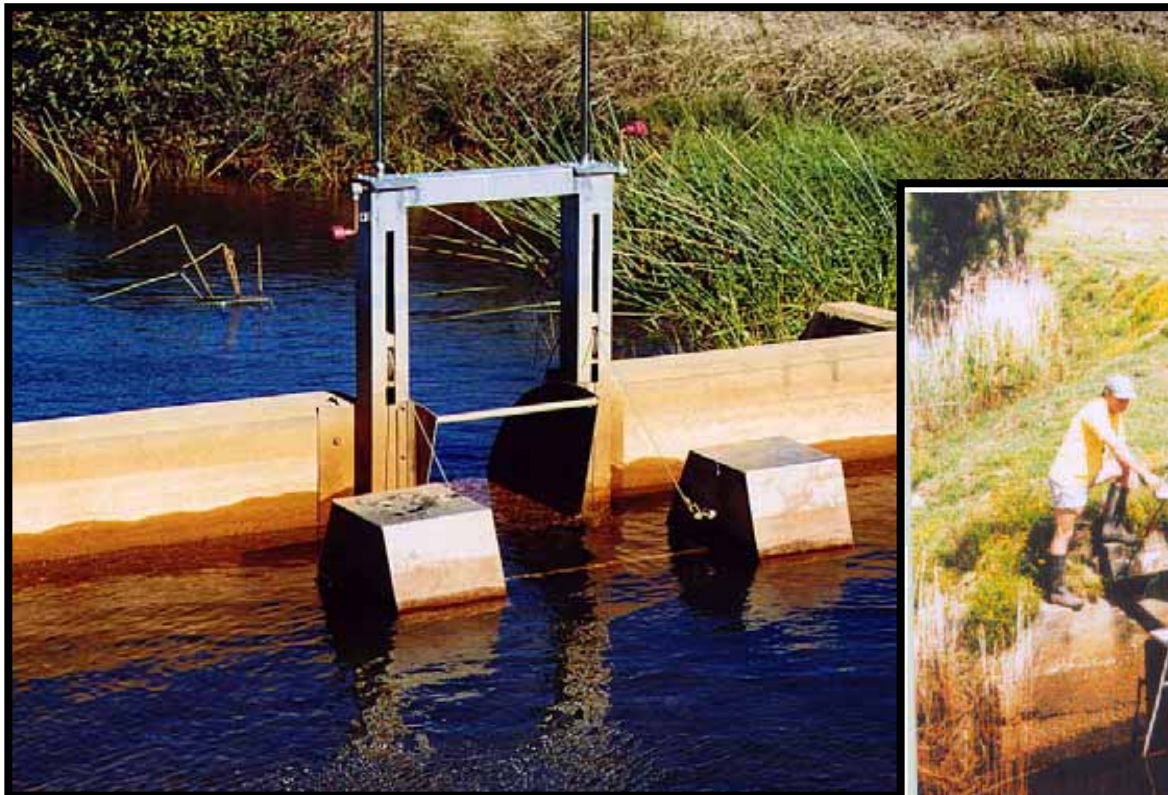


# Strategies to avoid ASS problems

- **Education**
- **Extension**
- **Regulation**
- **Knowledge from previous NHT and NLWRA funded work contributed to ASS management options/strategies and Stage 1 ASS map**
- **ASS map defines areas that are at risk**

# Low cost treatment

**Use seawater to flood below the crop  
root zone to curtail oxidation and  
neutralise some acidity**



# High Cost - Chemical Neutralisation

## Applying lime - Very expensive!

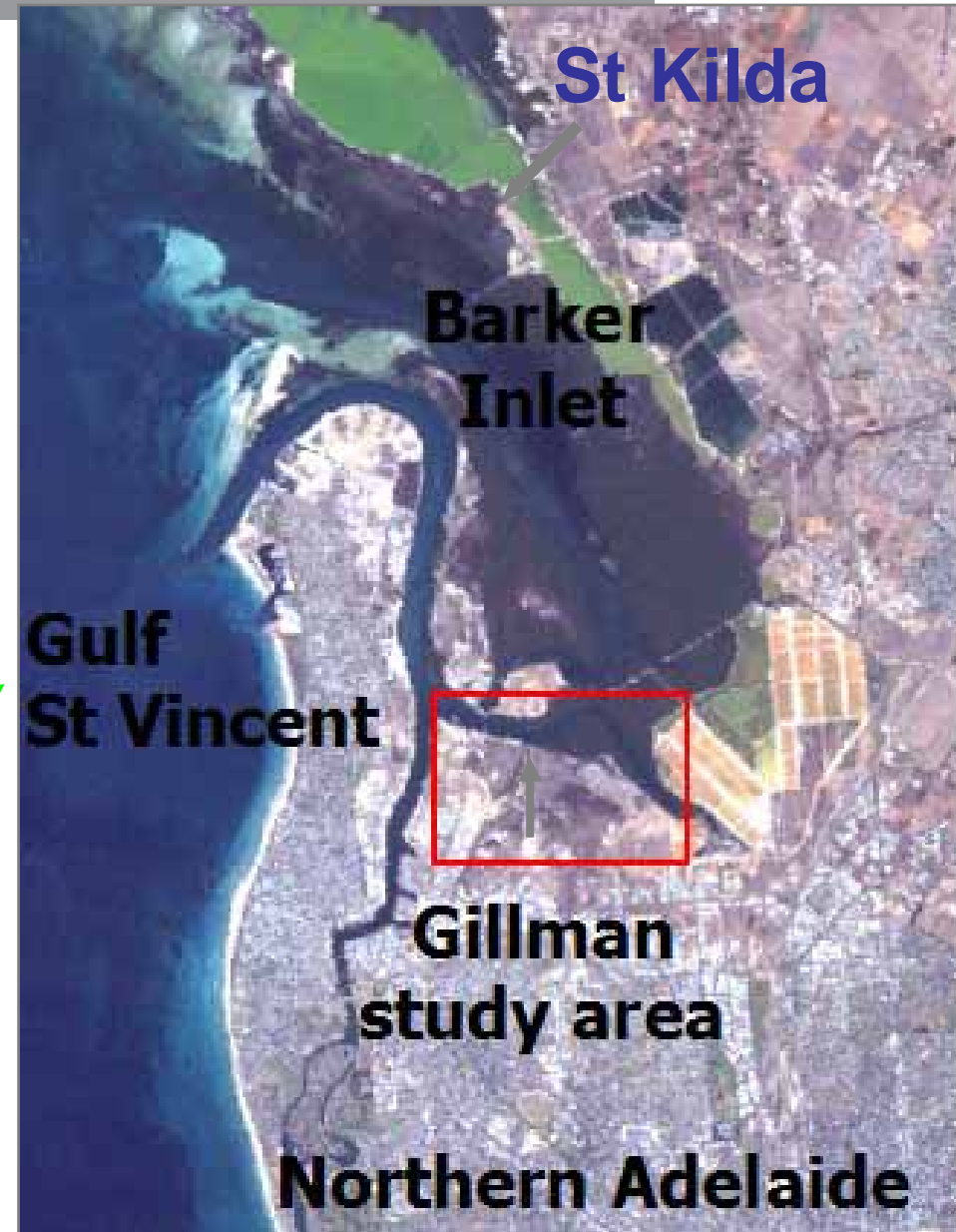
- (e.g. 600 tonnes of lime per hectare incorporated to 2.5 m depth) -
- restricted to high value sites





# 15 representative case studies with management options

Example:-













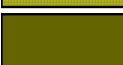









# Example case study to refine ASS maps & ASS database

## Soil acidity (ASS risk map)

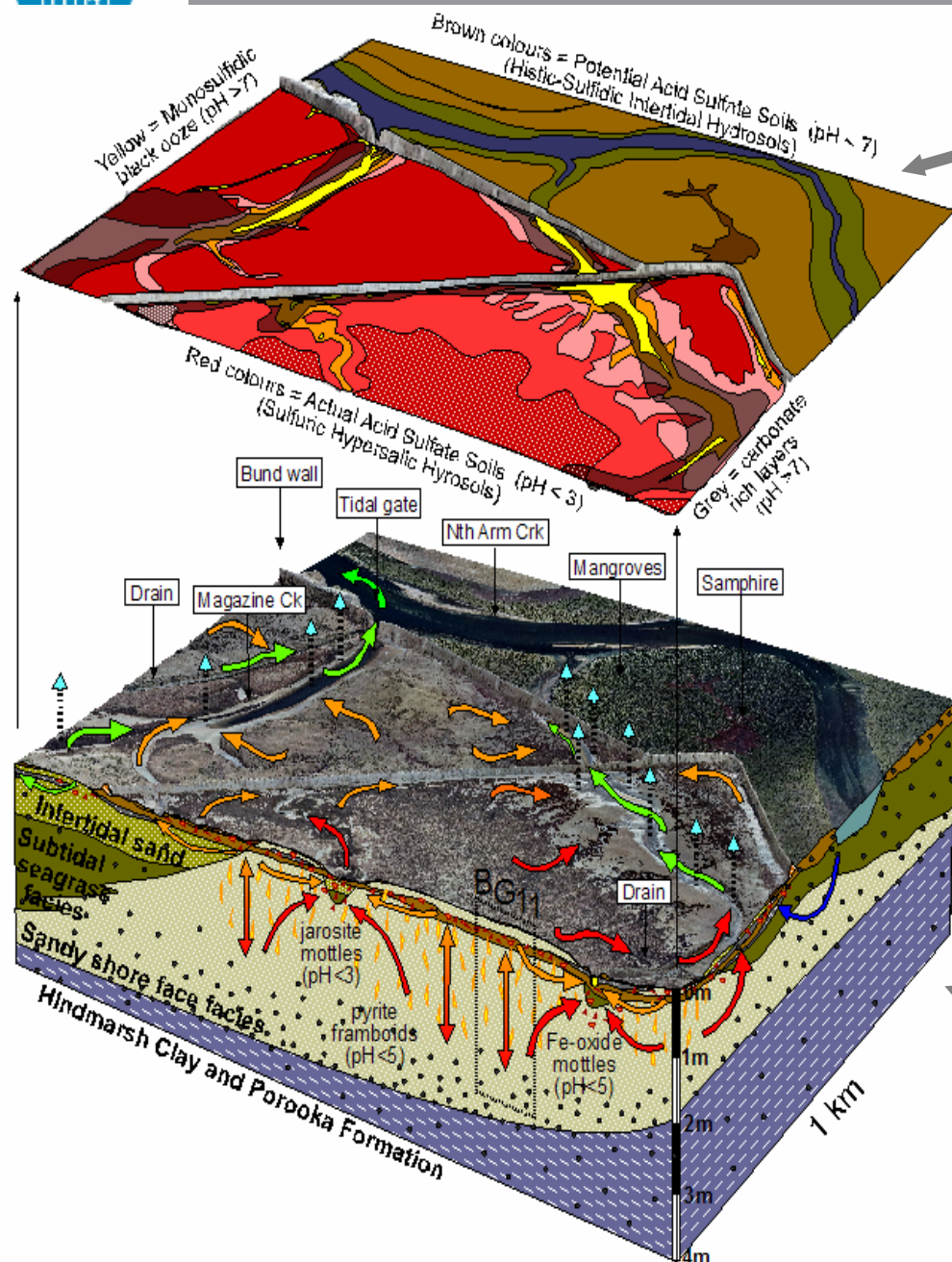
### Soil categories

Undrained	Drained
 110	 Perminately reduced MBOs
 -95	 Carbonate rich layer
 110	 Seasonally Oxidised MBOs
 62	 Samphire facies
 32	 Mangrove facies
 41	 Intertidal sand flat facies
 40	 Intertidal seagrass facies
 58	 Back barrier sand
 20	 Glanville Formation (with calcrete cap)

NAPG (Net Acid Generating Potential)  
(kg H<sub>2</sub>SO<sub>4</sub> /tonne of soil)

*Depositional facies, location of pyrite oxidation and the movement of acidic and contaminants*

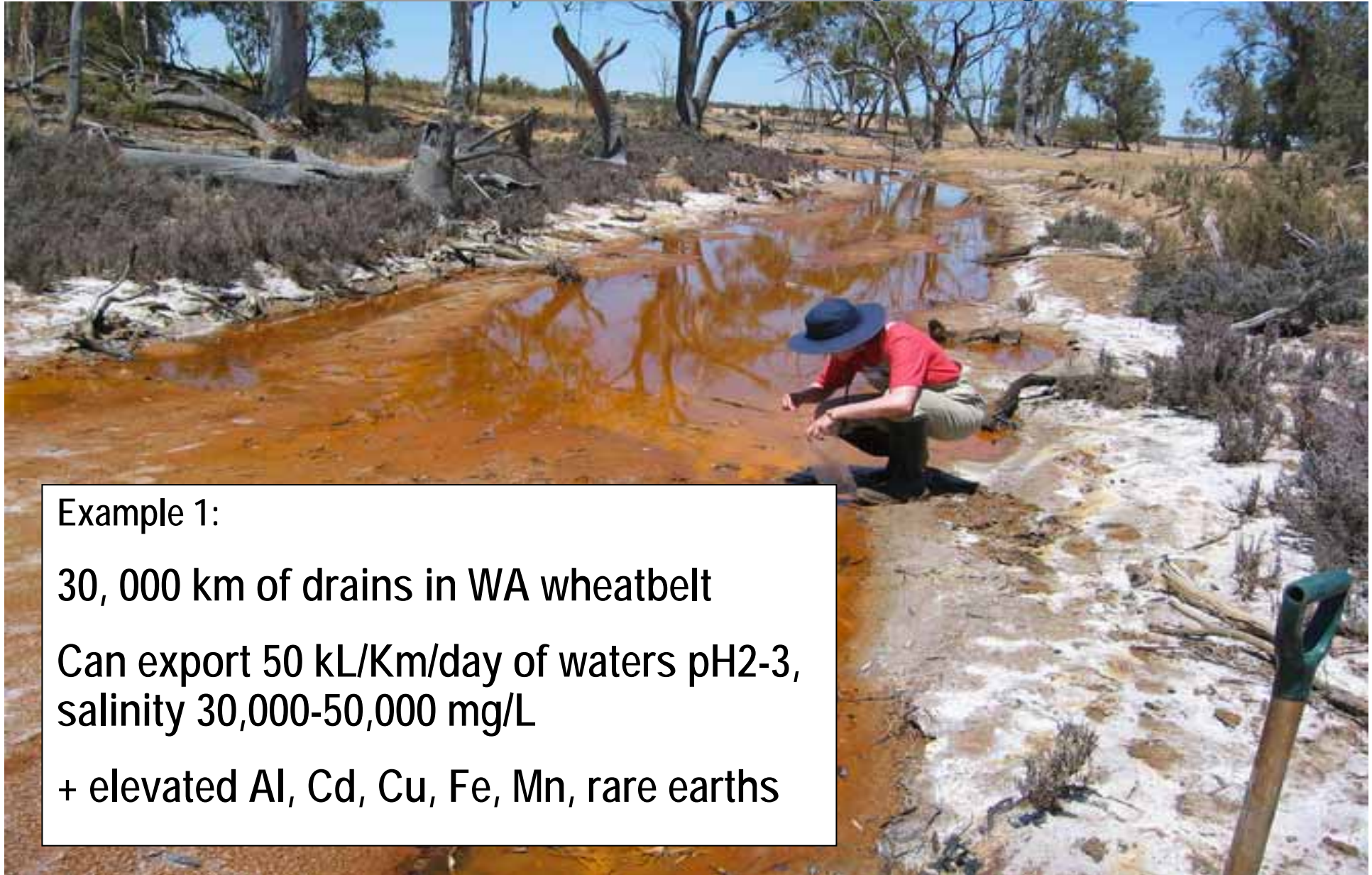
520,000 tonnes H<sub>2</sub>SO<sub>4</sub>  
has been produced







## Stage 3: Adds inland ASS to map via CRC LEME, State and Industry funding



Example 1:

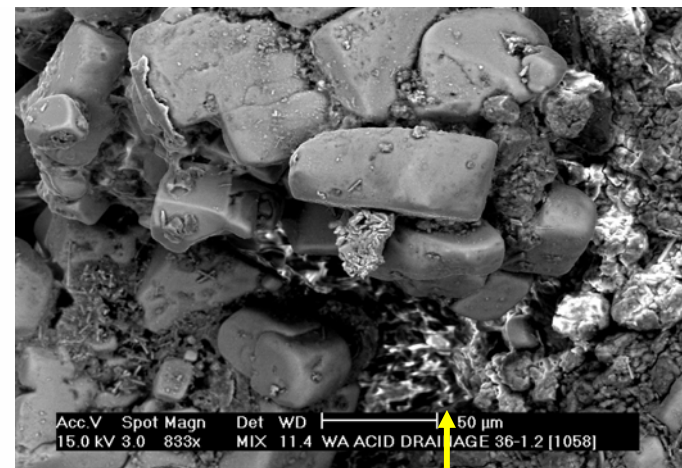
30, 000 km of drains in WA wheatbelt

Can export 50 kL/Km/day of waters pH2-3,  
salinity 30,000-50,000 mg/L

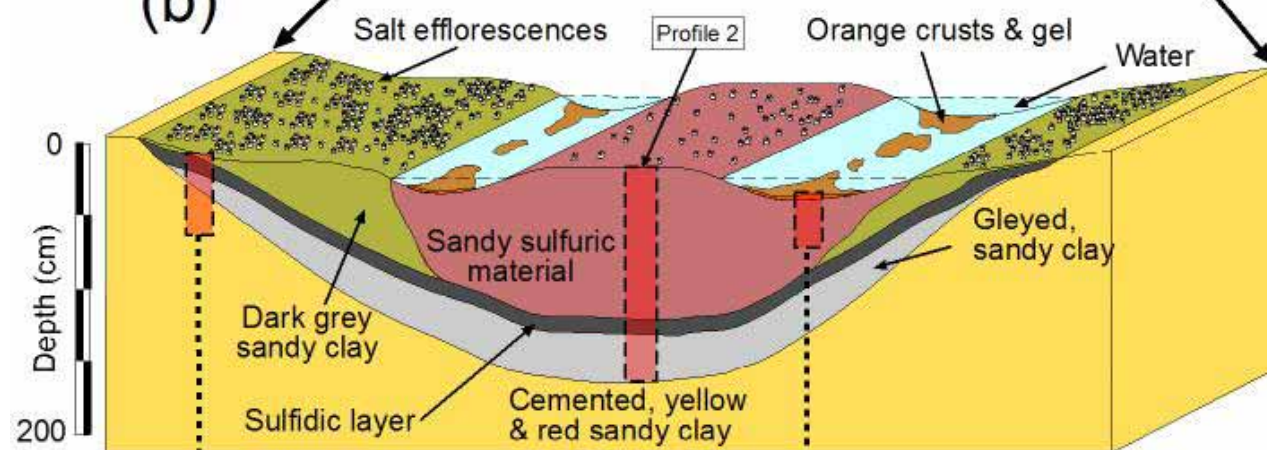
+ elevated Al, Cd, Cu, Fe, Mn, rare earths



(a)



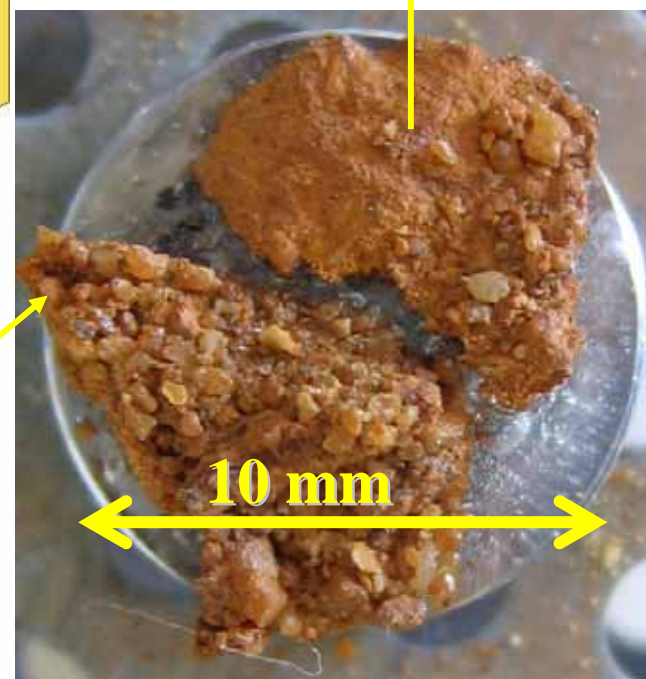
(b)



(c) Profile 3



(d) Profile 1





Undisturbed



Cattle grazing



Disturbance

## Changes:

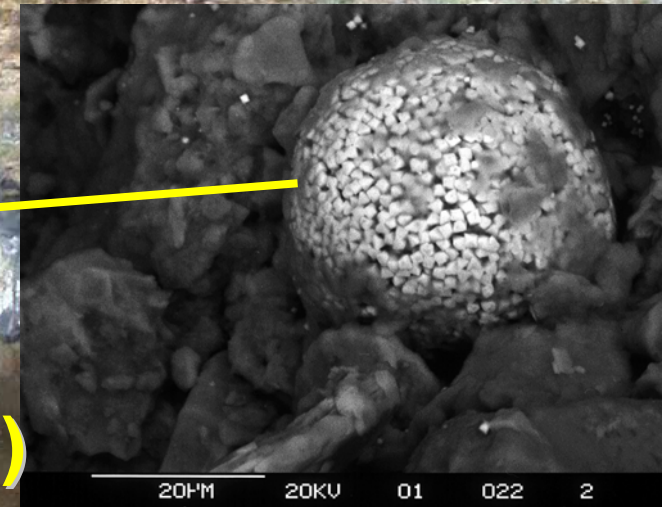
- pH 7.0 → 3.5
- Soils aerated
- Unhealthy vegetation
- Soil unstable, churned, eroded
- Heavy metals released to waterways
- Heavy metal halo left around wetland



# Inland acid sulfate soils

- **Black sulfidic material**
- **Secondary pyrite (framboid)**
- **Buried swamps beneath alluvium**
- **Exposed after streambank erosion**

**Draining gives a water quality problem!**





## **Summary: National Atlas of ASS – the potential problem is getting bigger!**



**National Atlas of ASS is an approach to develop:**

- **a standard classification of all types of ASS**
- **Australia-wide ASS risk coverage in a single map**

**There is a dramatic upward revision of**

- **extent**
- **potential severity**

**Estimated area has more than doubled  
Management policy not fully developed**

**(- each state has particular strengths and weaknesses)**



# Future Scenarios

## National Atlas of ASS:

- is a tool to support the National ASS Strategy, aims to avoid disturbance of all types of ASS
- provides database and knowledge of ASS distribution, which is critical to successful:
  - nationally consistent policy development
  - adoption of land & water management options
- is an example of Australian governments working together for betterment of communities