Title: Atlas of Australian Acid Sulfate Soils

Custodian: CSIRO Land & Water

Jurisdiction: Australia

Search Words: HAZARDS Mapping, SOIL Chemistry Indicators, SOIL Chemistry Mapping

Abstract:

This dataset depicts a national map of available ASS mapping and ASS qualification inferred from surrogate datasets. ASS mapping is classified with a nationally consistent legend that includes risk assessment criteria and correlations between Australian and International Soil Classification Systems.

Existing digital datasets of ASS mapping have been sourced from each coastal state and territory and combined into a single national dataset. Original state classifications have been translated to a common national classification system by the respective creators of the original data and other experts. This component of the Atlas is referred to as the “Coastal” ASS mapping. The remainder of Australia beyond the extent of state ASS mapping has been “backfilled” with a provisional ASS classification inferred from national and state soils, hydrography and landscape coverages. This component is referred to as the “Inland” ASS mapping.

For the state Coastal ASS mapping, the mapping scale of source data ranges from 1:10K aerial photography in SA to 1:250K vegetation mapping in WA and NT, with most East coast mapping being at the 1:100K scale. For the backfilled inferred Inland ASS mapping the base scale is 1:2.5 million (except Tas.) overlaid with 1:250k hydography. As at 06/08, the Tasmanian inland mapping has been re-modelled using superior soil classification map derived from 1:100k landscape unit mapping.

NOTE: This is composite data layer sourced from best available data with polygons depicted at varying scales and classified with varying levels of confidence. Great care must be taken when interpreting this map and particular attention paid to the “map scale” and confidence rating of a given polygon. It is stressed that polygons rated with Confidence = 4 are provisional classifications inferred from surrogate data with no on ground verification. Also some fields contain a “-“, denoting that a qualification was not able to be made, usually because a necessary component of source mapping coverage did not extend to the given polygon.

Lineage (Coastal ASS component):

Existing state CASS mapping was received and processed to varying degrees to conform to the NatCASS national ASS classification system. Spatially, all datasets were reprojected from their original projections to geographic GDA94. Classification of state mapping polygons to the NatCASS classification system was as follows. In the case of SA, NSW, Qld and WA it was a matter of directly translating the original state ASS classifications to the NatCASS classifications. These translations were undertaken by the creators of the state data and other experts within the respective states.

Due to the more broad classifications of the original Vic and Tas ASS mapping, polygons for these two states were initially translated to a NatCASS classification group (eg Tidal, Non-Tidal) by the data custodians then subsequently differentiated further through intersecting with other layers. These included the 3 second SRTM DEM and North Coast Mangrove mapping GIS datasets. The former being used to differentiate within the Non-Tidal zones (ie classes Ae-j and Be-j) and the latter used to differentiate the Tidal zones (ie Ab-d, Bb-d).

Mapping of the Tidal-Zone classes was augmented for all states except SA and NSW with 1:100K Coastal Waterways Geomorphic Habitat Mapping (Geoscience Australia). This dataset was used to infer additional areas of subaqueous material in subtidal wetland (class Aa & Ba) and Intertidal Flats (class Ab & Bb),

The lineage of the individual original state maps, taken from their respective metadata records or associated reports are reproduced below. Notes on state specific modifications/augmentations undertaken as part of the National Mapping process are appended to each section.

SA

State Mapping:
Landform and Lifeform boundaries for individual salt marsh complexes are interpreted form Predominantly 1:10,000 or 1:15,000 colour aerial photography (sometimes 1:40,000 aerial photography is used where the more detailed aerial photography is not available) and drafted onto a stable film base. Environmental boundaries are digitised in Map Grid of Australia (MGA) coordinates and coded with a specific

landform / lifeform code. Individual salt marsh complex data sets are then re-projected into a Lambert Conformal Conic coordinate system and appended into a state-wide data set. Acid Sulfate Soil codes were determined by CSIRO Land and Water based on field soil sampling.

Modifications for National Mapping:
State ASS codes for polygons were translated to the National codes by Rob Fitzpatrick CSIRO Land & Water. Polygons dissolved on new National codes.

NSW

State Mapping:
The maps predict the distribution of Acid Sulfate Soils (ASS) based on an assessment of the geomorphic environment. This assessment has involved mapping of the environments in which they are likely to be found, being the coastal lowlands up to approximately 10m AHD and carrying out fieldwork to establish field relationships between landform, elevation and occurrence of ASS. Landform elements were used as the basic mapping unit. These provide a basis for land use planning and allow the application of elevation classes so that the depth of occurrence of ASS within a landform element can be estimated. It allows the prediction of soil management problems in other areas with similar landform and soil characteristics. ASS maps are not intended to provide site specific ASS information. The information derived from the maps cannot be used in the assessment of the potential to effectively manage ASS in a particular development. When using ASS maps, it must always be remembered that that there can be expected to be extreme variations in the nature and distribution of of ASS and that the depth to the ASS layer can be highly variable. The depths given in the map key should be used as a guide only and not used for a specific assessment of development potential. It is recommended that all land use activities likely to disturb ASS require appropriate soil investigations and a management plan to avoid environmental degradation.

Modifications for National Mapping:
State ASS codes for polygons were translated to the National codes by experts in NSW DIPNR (see acknowledgements), Polygons were then dissolved on new National (NatCASS) codes.

Qld

State Mapping:
ASS for Southeast Qld was interpreted from 1:100K topographic maps with ground truthing

Ground truthing has been carried out at an intensity of one site per square kilometre. Potential acidity has been assessed by laboratory testing and actual acidity is indicated when field pH is < 4.0. Potential acidity from soil sulfides has been assessed principally by the Total Oxidisable Sulfur (TOS) method (Method 20). A selection of samples has been tested using the POCAS method (Method 21 - Ahern et al 1998).
Limited or no field checking has been carried out on disturbed lands. The outer boundary of estuarine ASS is established using limited field checking together with use of contour lines and geological map boundaries. The NS2 unit is not ground truthed at 1:100 000 scale and it should be noted that certain lithologies within it may contain sulfidic material of non estuarine/holocene origin.
Base Map: Infrastructure, hydrographic and relief data supplied courtesy of AUSLIG.

ASS classes for the remainder of the Qld coast were interpreted from 1:100K mangrove mapping. Landsat TM imagery was digitally classified and interpreted with colour 1:50 000 aerial photography and ground truthing.

Modifications for National Mapping:
State ASS codes from the SE QLD ASS mapping dataset and Mangrove polygons were translated to the National codes by experts in QNRM (see acknowledgements). Coverage was augmented with the Coastal Waterways Geomorphic Habitat Mapping for Qld dataset that had also been translated to National codes (see end of section). Polygons were then dissolved on new National codes.

Vic

State Mapping:
Assessment of geological records, analysis of digital elevation models, aerial photo interpretation, extensive field work and laboratory analyses of soil samples were used to produce acid sulfate soil risk maps. A set of 1:100 000 scale maps of coastal acid sulfate soils is presented for the purposes of land management and environmental planning in landscapes in coastal Victoria.

Modifications for National Mapping:
Polygons in the Vic ASS mapping were assigned a NatCASS code by expertis in Vic DPI on a 1:100K mapsheet basis. The SRTM DEM was used to further differentiate the Vic ASS polygons coded to the height dependent NatCASS codes in Non-tidal zones (e-j). THe DEM was also used to differentiate Tidal zone

classes (b & c) in the cases where the Vic translations have not been specific (ie Geelong, Western Port & Warragul mapsheets). t). Coverage was augmented with the Coastal Waterways Geomorphic Habitat Mapping for Vic dataset that had also been translated o National codes (see end of section). Polygons then dissolved on new National codes.

NT

State Mapping:

No State (Territory) mapping utilized for NT. Coastal ASS component was derived entirely from Coastal Waters Geomorphic Habitat Mapping

WA

State Mapping:
Swan Coastal Plain

Classification of map units in 1:50 000 Urban Geology (UG) and Environmental Geology (EG) map series (Department of Mineral and Petroleum Resources) conducted by Department for Planning and Infrastructure (2003) under advice from Department of Environment. Classification of existing environmental and urban geology map units updated with information from on-ground mapping program. Mapping of ASS risk around Peel-Harvey Inlet was conducted using a combination geology, soil land-scape mapping and surface contour information guided by on-ground soil survey information and aerial photography. Soil-landscape mapping used for this process consisted of Department of Agriculture 1:50 000 soil-landscape map sheets Peel Harvey north, Mandurah-Murray, Peel-Harvey South and Harvey-Capel.

NorthWest WA

Classification of 1:100 000 NW coastal wetland map units (obtained from the WA EPA from work undertaken for the NorthWest Shelf Coastal Wetland Mapping, 1999-2000) was undertaken by Brad Degens. 1:100 000 geology mapping was sourced from the Department of Industry and Resources, WA Pre-European Vegetation mapping data was sourced from the WA Department of Conservation and Land Management (2002).

Modifications for National Mapping:
State ASS codes from the SE QLD ASS mapping dataset and Mangrove polygons were translated to the National codes by experts in QNRM (see acknowledgements). Coverage was augmented with the Coastal Waterways Geomorphic Habitat Mapping for WA dataset that had also been translated to National codes (see end of section). This augmentation was applied only to areas outside the original NorthWest mapping extent. Polygons were then dissolved on new National codes.

Tas

State Mapping:
ASS polygons delineated based on desktop evaluations of geology, geomorphology, soil type, soil chemical data and surface water chemistry. This baseline information was used for targeting field investigation laboratory analysis and reconnaissance mapping of acid sulphate soils. A total of 137 sites were investigated and 115 core samples collected. (Ref Gurung, S2001. Tasmanian Acid Drainage Reconnaissance. Map 4. Distribution of Acid Sulphate Soils in Tasmania. Mineral Resources Tasmania)

Modifications for National Mapping:
The SRTM DEM was used to differentiate Tasmanian ASS extent polygons into the three height bands of the Non-Tidal Sandplains and Dunes classes, i.e. < 2m, 2-10m and > 10m for NatCASS classes 1h, 1i and 1j respectively Coverage was augmented with the Coastal Waterways Geomorphic Habitat Mapping for Tas dataset that had also been translated to National codes (see below). Polygons were then dissolved on new National codes.

Augmentation of state mapping of Coastal ASS

Coastal Waters Geomorphic Habitat Mapping:

This layer was used to augment the coverage of coastal ASS risk for **NT, WA, Qld, Tas and Vic only**. SA and NSW were not augmented as their state ASS mapping was, by and large, already inclusive of these environments. Coastal Habitat Classes were translated to the NatCASS codes as follows.

Coastal Habitat Class	**Inferred NatCASS code**

Central Basin	Aa (subaqueous materials)
Fluvial Delta	Aa (subaqueous materials)
Flood & Ebb-tide Delta	Aa (subaqueous materials)
Channel	Aa (subaqueous materials)
Mangrove	Ab (intertidal flats)
Intertidal Flats	Ab (intertidal flats)
Saltmarsh/Saltflat	Ad (extratidal flat)

All Subscripts = p, Confidence = 3 for Qld and NT. Confidence = 4 for Vic, Tas and WA. Does not apply to SA and NSW.

Lineage (Inland ASS component):

Provisional Inland ASS classifications are derived from National and (in the case of Tasmania) state soil classification coverages combined with 1:250K series 3 Hydrography and Multiresolution Valley Bottom Floor Index (MrVBF). A matrix devised by Dr. Rob Fitzpatrick was used to translate combinations of Soil Order and landscape “wetness” to NatCASS inland ASS codes as follows.

ASC Soil Order	Topo 250K Waterbody	MrVBF Wet / Riparian*	No Water/MrVBF	X factor 1	X facto
Anthroposols	A	A	B		
Calcarosols	A p	A p	C p **		
Chromosols	A n	B n	C n		
Dermosols	A n	B n	B n		
Ferrosols	D	D	D		
Hydrosols	A m	A m	A m		
Kandosols	A q	B q	C q		
Kurosols	A q	B q	C q		
Organosols	A l	A l	A l		
Podosols	D	D	D		
Rudosols	A q	B q	C q	Rock outcrop = D	
Sodosols	A n	A n	B n		
Tenosols	A q	B q	C q		
Vertosols	A o	B o	C o		
Lakes	A k	A k	A k		

Inland ASS matrix based on ASC soil Type and "wetness" inferred from Topo lake coverage and other spatial Datasets.
H = high, M=medium, L = low, D = No probability of occurrence. k, l, m, n, o, p & q = Upland ASS mapunits from Legend (see additional metadata section)
*** Defined as within 20m of Perennial watercourse and in Valley bottom (MrVBF gridcode = 8 or 9)**
**** Changed from B -> C in Dec 2007**

Topo250K hydrography theme waterbody classes used:

Land subject to inundation	
Marine Swamp	
Saline Coastal Flat	
Swamp	
Foreshore Flats	
Pondage Areas	
• Aquaculture Area	
• Salt Evaporation Pan	
• Settling Pond	
Lakes	Perennial & Non-Perennial
Reservoirs	
Watercourse Areas	
Canal Areas	

Positional accuracy (Coastal ASS component)

Data has been captured at varying scales depending on location. Data collection scale for the respective areas are as follows.

SA: 1:10K, 1:15K and 1:40K aerial photography
Qld: 1:100K vegetation and topographic mapping, 1:100K Estuaries mapping
Vic: 1:63K and 1:250K geology mapping, 1:100K soil-landform mapping and DEM derived from 1:25K topographic mapping, :100K Estuaries mapping.
NSW: 1:25K maps.
WA: 1:50K soil-landscape and geological mapping (Swan Coastal Plain) 1:100K geology and wetland mapping, 1:250K vegetation mapping (Northern WA) and 1:100K Estuaries mapping.
NT: as per Coastal Waters Geomorphic Habitat Mapping (see below)
Tas: 1:100K Estuaries mapping and unspecified Geological/geomorphology/Soil base maps, presumably 1:250K

ASS polygons derived from Coastal Waters Geomorphic Habitat Mapping

> Geomorphic habitat uni t boundaries have horizontal positional errors up to 100 metres, as they were digitised over 30 metre resolution Landsat TM 5 imagery. Positional accuracy checked by on-screen comparison of the data to Landsat TM 7 imagery. Coastal waterways with consistent errors greater than 100 metres block-shifted, to more accurately match Landsat 7 imagery. Inconsistent errors greater than 100m do exist in these data, when compared to Landsat 7 imagery; due in part to changes in coastal waterway morphology over time.

Attribute Accuracy (Coastal ASS component)

Attribute accuracy is as per the source data. Notes on the attribute accuracy of the respective areas taken from original metadata and associated documents are as follows. These state specific notes pertain to the original state ASS mapping layer received. For SA and NSW the polygon coverage is unaltered save for the dissolving of neighbouring polygons having the same NatCASS classification. For the rest, original state coverage has been modified or augmented with other layers.

Attribute accuracy notes on those follow.

SA

Classification based on aerial photo interpretation, survey data, ground truthing and expert knowledge.

NSW

Mapped codes were checked as part of the GIS capture quality assurance procedures, including a visual check of polygon tags against field sheets following digital capture. Soil samples were taken in the field and analysed in the laboratory. During the field work phase, field meetings were held with ASS surveyors to ensure consistency in site selection strategies, soil profile description methods and soil sampling techniques. Quality control and consistency in the mapping and coding of landform elements were also maintained by field checking by other ASS surveyors in the team and regular meetings to discuss and review the process

Qld

SE Qld: Occasionally, land has been mapped where there is actual acidity, but the oxidisable sulfur percentage may not exceed the `action level`. The reliability of elevation data is variable across the study area.

Mangroves: approximately 80%

Vic

The mapped extent of probable ASS is based on a combination of knowledge and data, including formation processes, height above current sea level, geological mapping, soil mapping and site assessment. Due to the state of flux of the environment in which ASS form, and due to the processes that have occurred since their formation, the actual distribution of ASS is difficult to accurately predict. What is mapped is the most likely occurrence of the formation of ASS.

WA

Good - all populated content for physical and environmental categories are known and verified by custodian.

NT

As per Coastal Waters Geomorphic Habitat Mapping described below

Tas

Verified by lab analyses.

ASS polygons derived from Coastal Waters Geomorphic Habitat Mapping

The classification scheme divides coastal waterways into 9 easily identifiable geomorphic habitat environments, representative for all Australian coastal waterways. The classification was defined by Heap et al. 2001. Further information is available from Ryan et al. 2003. The classification scheme was applied by subjective interpretation of Landsat imagery and aerial photography. Attribute values were checked y comparing the digital data to the original hand drawn interpretations. No ground truthing was performed to check interpretation accuracy. Attributes: feature Feature type ufi Unique Feature Identifier - unique number for each polygon gh_symb Geomorphic habitat symbol gh_type Geomorphic habitat type est_num Estuary number est_name Estuary name state State Heap A., Bryce S., Ryan D., Radke L., Smith C., Smith R., Harris P., and Heggie D. 2001. Australian estuaries and coastal waterways: a geoscience perspective for improved and integrated resource management: a report to the National Land and Water Resources Audit theme 7: ecosystem health. AGSO Record 2001/07. Australian Geological Survey Organisation, Commonwealth of Australia, Canberra. (Available from the OzEstuaries website - http://www.ozestuaries.org) Ryan, D. A., Heap, A. D., Radke, L., and Heggie, D. T. 2003. Conceptual models of Australia's estuaries and coastal waterways: applications for coastal resource management. Geoscience Australia Record 2003/09. Geoscience Australia, Commonwealth of Australia, Canberra. 135pp.

LEGEND for Australian Atlas of Acid Sulfate Soils[1] (ASS) map

Developed by Rob Fitzpatrick (CSIRO/ NatCASS), Steve Marvanek (CSIRO) and Bernie Powell (QNRW/ NatCASS) with input from several workers across Australia and overseas (2nd June, 2008)

Code and Map Unit	Distinguishing soil/sediment properties, vegetation, landforms, or other characteristics
PROBABILITY OF OCCURRENCE OF ASS[1]	
A High Probability of occurrence	>70% chance of occurrence in mapping unit
B Low Probability of occurrence	6-70% chance of occurrence in mapping unit
C Extremely low probability of occurrence	1-5% chance of occurrence in mapping unit with any occurrences in small localised areas
D No probability of occurrence	<1% chance of occurrence in mapping unit (e.g. thick outcrops of hard rock, ferricrete, calcrete, silcrete)
MAP UNIT (area scaling factor)	
PROFOUNDLY DISTURBED	
x Disturbed ASS[1] terrain (1.0)	ASS[1] material present below urban development, or present in former tidal zones inside bund walls (e.g. dredge spoil, ponds, major excavations) or as anthropic[5] ASS or fill material > 0.3 m thick.
u Unclassified	Insufficient information to classify map unit
SUBTIDAL ZONE[7] SUBAQUEOUS MATERIALS[6]	
a Subaqueous material in subtidal wetland[7] (1.0)	PASS[2] material and/or MBO[4]. Often seagrasses.
TIDAL ZONES[8]	
b Intertidal[9] flats (1.0)	PASS[2] generally within upper 1 m. Often with mangroves.
c Supratidal[10] flats (1.0)	ASS[1] generally within upper 1 m. Halophytes (mainly samphire), salt marsh, salt pans.

d Extratidal[11] flats (0.8)	ASS[1] generally within upper 1 m.
NON-TIDAL ZONES **Floodplains**	
e Floodplains < 2 m AHD[12] (0.8)	ASS[1], generally within upper 1 m. Grasslands, reedlands and wetland forests (e.g. *Melaleuca*, *Casuarina*). Includes backplains, backswamps and interbarrier swamps.
f Floodplains 2 - 4 m AHD[12] (0.7)	ASS[1], generally below 1 m from the surface. Generally wetland forests (e.g. *Melaleuca*, *Casuarina*). Includes plains and levees.
g Floodplains > 4 m AHD[12] (0.7)	ASS[6], generally below 3 m from the surface. Generally forests. Includes plains and levees.
NON-TIDAL ZONES **Sandplains and dunes in coastal[15] landscapes**	
h Sandplains and dunes, <2 m AHD[12] (0.7)	ASS[1], generally within 1 m of the surface. Often wet heath. Holocene or Pleistocene.
i Sandplains and dunes, 2 - 10 m AHD[12] (0.7)	ASS[1], generally below 1 m from the surface. Heath, forests. Holocene or Pleistocene.
j Sandplains and dunes, > 10 m AHD[12] (0.7)	ASS[1], generally below 1 m from the surface. Heath, forests. Mainly Pleistocene.
Inland (i.e. not coastal[15]) landscapes (> 10 m AHD[12]) in wet / riparian areas[13] associated with:	
k Subaqueous material in lakes[14] (1.0)	ASS[1] material and/or MBO[4]
l Organosols (0.8/0.05)	ASS[1] generally within upper 1 m in wet / riparian areas with Organosols (Isbell 1996)
m Hydrosols (0.8/0.1/0.05)	ASS[1] generally within upper 1 m in wet / riparian areas with Hydrosols (Isbell 1996)
n Sodosols, Chromosols and Dermosols (0.5/0.05)	ASS[1] generally within upper 1 m in wet / riparian areas with Sodosols, Chromosols and Dermosols (Isbell 1996)
o Vertosols (0.5/0.05)	ASS[1] generally within upper 1 m in wet / riparian areas with Vertosols (Isbell 1996)
p Calcarosols (0.5/0.05)	ASS[1] generally within upper 1 m in wet / riparian areas with Calcarosols (Isbell 1996)
q Kandosols, Ferrosols, Tenosols, Rudosols, Podosols and Kurosols (0.5/0.05)	ASS[1] generally within upper 1 m in wet / riparian areas with Kandosols, Ferrosols, Tenosols, Rudosols and Podosols (Isbell 1996)
SUBSCRIPTS TO CODES	
(a) Actual ASS (AASS)[3]	Actual acid sulfate soil (AASS) = sulfuric material (Isbell 1996, p.122.)
(p) Potential ASS (PASS[2])	Potential acid sulfate soil (PASS) = sulfidic material (Isbell 1996, pp. 121-122)
(m) MBO[4], significant occurrence	Monosulfidic Black Ooze (MBO) is organic ooze enriched by iron monosulfides (Bush *et al*. 2004).
CONFIDENCE LEVELS (after Isbell 1996) Map polygon contains ASS, and:	
(1) All necessary analytical and morphological data are available	
(2) Analytical data are incomplete but are sufficient to classify the soil with a reasonable degree of confidence	
(3) No necessary analytical data are available but confidence is fair, based on a knowledge of similar soils in similar environments	
(4) No necessary analytical data are available and classifier has little knowledge or experience with ASS, hence classification is provisional	
OPTIONAL DESCRIPTORS	
f Fill materials	Undifferentiated fill material between 0.5m and 3 m thick, overlays ASS materials
h Hypersaline or gypseous horizons generally within 10 cm of the surface	Hypersaline is equivalent to hypersalic as defined by Isbell (1996, p 47). Saltpans are common, average annual rainfall is generally < 400 mm, and the vegetation is dominated by halophytes (samphire, salt bush, blue bush) Gypseous is equivalent to gypsic as defined by Isbell (1996, p 114).
o Organic material	Organic, as for organic materials defined by Isbell (1996, p 116; including sapric, and hemic material). Average annual rainfall is generally > 400 mm, and the vegetation is mainly grassland (e.g. saltwater couch, *Phragmites*)
n Self neutralising sulfidic material	Self neutralising sulfidic material (PASS material) confirmed by field observation, sampling and laboratory analyses (commonly carbonate rich).
D Deep variant ASS	ASS generally deeper than the depth specified in the legend
P Pleistocene	Based on dating or stratigraphic evidence
e Excavation feature	Excavated drains, canals, lakes, dams and other water accumulating structures within which modern ASS forms.
d Desiccation cracks	Desiccation cracks usually expressed as irreversible trans-horizon polygonal cracks, often with coarse columnar ped structures, which usually forms as a result of desiccation and dewatering of clayey or peaty subaqueous soils and sediments during drying and wetting cycles.
c Clayey material	Clayey material (>35% clay; light, medium and heavy clay)
s Sandy material	Sandy materials (sand, loamy, sand, clayey sand texture groups)

Examples (i): **Ae (p1) h** Polygon with high probability of ASS occurrence in a floodplain < 2 m AHD, with potential ASS confirmed by analytical and morphological data, that also contains a hypersaline and gypsic horizons.

(ii): **Bx (a2) f** - Polygon with low probability of ASS occurrence in a disturbed environment with actual ASS. Analytical data are incomplete but are sufficient to classify the soil with a reasonable degree of confidence. The actual ASS is now covered by 0.5 to 3 m of undifferentiated fill material.

[1]Acid Sulfate Soils (ASS) are all those soils in which sulfuric acid may be produced, is being produced, or has been produced in amounts that have a lasting effect on main soil characteristics (Pons 1973). This general definition includes: (i) potential, (ii) actual (or active), and (iii) post-active ASS, three broad genetic soil types that continue to be recognized (e.g. Fanning 2002). ASS form in coastal, estuarine, mangrove swamp and marsh environments because these waterlogged or highly reducing environments are ideal for the formation of sulfide minerals, predominantly iron pyrite (FeS_2). Soil horizons that contain sulfides are called sulfidic materials (Isbell 1996; Soil Survey Staff 2003) and can be environmentally damaging if exposed to air by disturbance. Exposure results in the oxidation of pyrite, with each mole of pyrite yielding 4 moles of acidity (i.e. 2 moles of sulfuric acid). This process transforms sulfidic material to sulfuric material when, on oxidation, the material develops a pH of 4 or less (Isbell 1996); note that a sulfuric horizon has a pH of 3.5 or less according to Soil Survey Staff (2003).

1. Acid sulfate soil (ASS) may include PASS or AASS + PASS.

2. Potential acid sulfate soil (PASS) = sulfidic material (Isbell 1996, pp. 121-122)
3 Actual acid sulfate soil (AASS) = sulfuric material (Isbell 1996, p.122.)
4. Monosulfidic Black Ooze (MBO) is organic ooze enriched by iron monosulfides (Sullivan et al. 2002).
5. Anthropic material is profoundly modified soil material, the term being derived from the soil order Anthroposol as defined by Isbell (1996, p 18).
6. Subaqueous materials: Soil materials that form in sediment found in shallow permanently flooded environments. Excluded from the definition of these soils are any areas "permanently covered by water too deep (typically greater than 2.5m) for the growth of rooted plants (Stolt 2006).
7. Subtidal wetlands: Permanently inundated areas within estuaries dominated by subaqueous soils and submerged aquatic vegetation. Subtidal: (adjective) continuous submergence of substrate in an estuarine or marine ecosystem; these areas are below the mean low tide (Stolt 2006).
8. Tidal zone or flat: An extensive, nearly horizontal, barren or sparsely vegetated tract of land that is alternately covered and uncovered by the tide, and consists of unconsolidated sediment (mostly clays, silts and/or sand, and organic materials) (Stolt 2006).
9. Intertidal zone is that between mean lower low water (MLLW) and mean higher high water (MHHW) (see MHL).
10. Supratidal zone is that above mean higher high water (MHHW), but below the extratidal zone. Spring tides will reach the lower part of the supratidal zone, the average spring tidal level being that known as mean high water springs (MHWS). See Isbell (1996, p 47) and MHL
11. Extratidal zone and the supratidal zone boundary is defined by vegetation community, i.e. grassland v saltmarsh (see Isbell 1996, p 47).
12. Australian Height Datum (AHD) approximates mean sea level. AHD is a surface based on mean sea level adopted in 1971, and described in Special Publication 10 -Australian Geodetic Datum Technical Manual, Division of National Mapping, for the National Mapping Council.
13. Riparian/wet zones: integration of topographic wetness index (TWI), which defines the "riparian/wet" zones and the "deposition/sedimentary" zones through Multiresolution Valley Bottom Floor Index (MrVBF) (Gallant and Dowling, 2003). MrVBF data from Dr John Gallant (CSIRO) for national MrVBF and TWI coverage (250 m cell size).
14. Lakes: Waterbodies from GEODATA TOPO 250K Series 2 Topographic Data, Hydrography Theme, Geoscience Australia http://www.ga.gov.au/meta/ANZCW0703005458.html.
15. Coastal zone: Includes coastal waters and those areas landwards of the coastal waters where there are processes or activities that affect the coast and its values. Natural Resource Management Ministerial Council (2006) – Glossary of terms Page 50. Commonwealth of Australia Department of the Environment and Heritage, Canberra, ACT. . National Cooperative Approach to Integrated Coastal Zone Management: Framework Implementation Plan. ISBN 0642550514.

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Gallant JC, Dowling TI (2003) A multiresolution index of valley bottom flatness for mapping depositional areas. Water Resources Research 39, 1347

Isbell, R.F. (1996). The Australian Soil Classification. CSIRO Australia.

NOTE 1: Most subaqueous soils are classified in current ASC as Hydrosols. There is a proposal under development (led by Rob Fitzpatrick CSIRO) to include a new suborder of Hydrosols (and possibly Organosols) called "Subaqueous" to accommodate subaqueous soil materials.

Manly Hydraulics Laboratory (MHL): http://www.mhl.nsw.gov.au/www/tide_glossary.htmlx#IZ

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NOTE 2: Most subaqueous soils are classified in current Soil Taxonomy as Aquents or as Histosols. There is a proposal under development (led by Dr. Mark Stolt at the University of Rhode Island) to include a new suborder of Entisols (and possibly Histosols) called Wassents (Wassists) to accommodate subaqueous soils. A draft version of the great groups of Wassents is provided later in this document.

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