

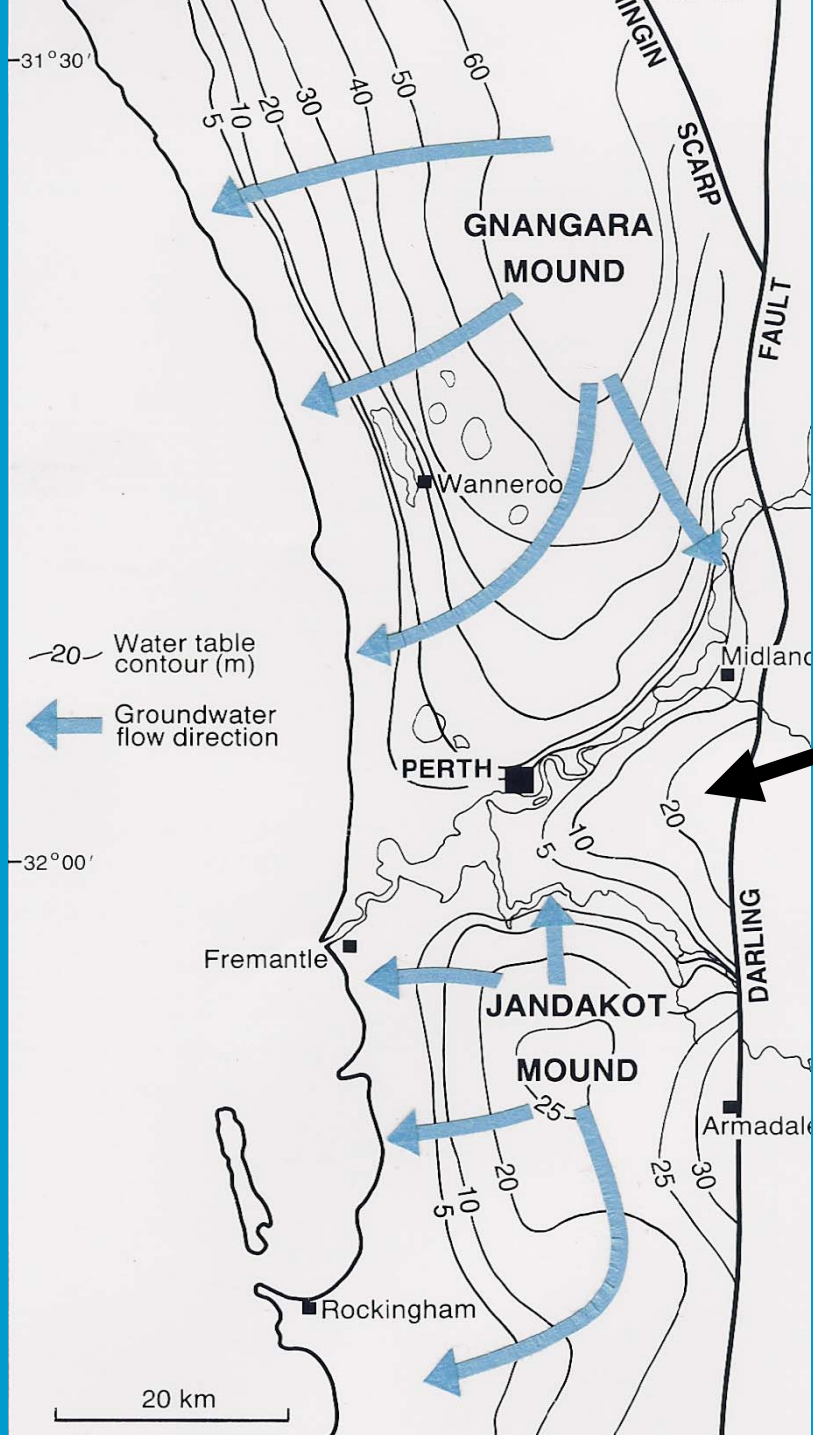
**HYDROLOGY OF
WETLANDS AT PERTH
AIRPORT AND A
POSSIBLE
MANAGEMENT
FRAMEWORK**

Outline

- Geological factors influencing wetlands
- Possible effects of land use changes
 - flooding, rising watertable
 - drainage, acidification
- Influence of falling rainfall
- Effect of land use changes on pollutants and possible impact on wetlands
- Management framework

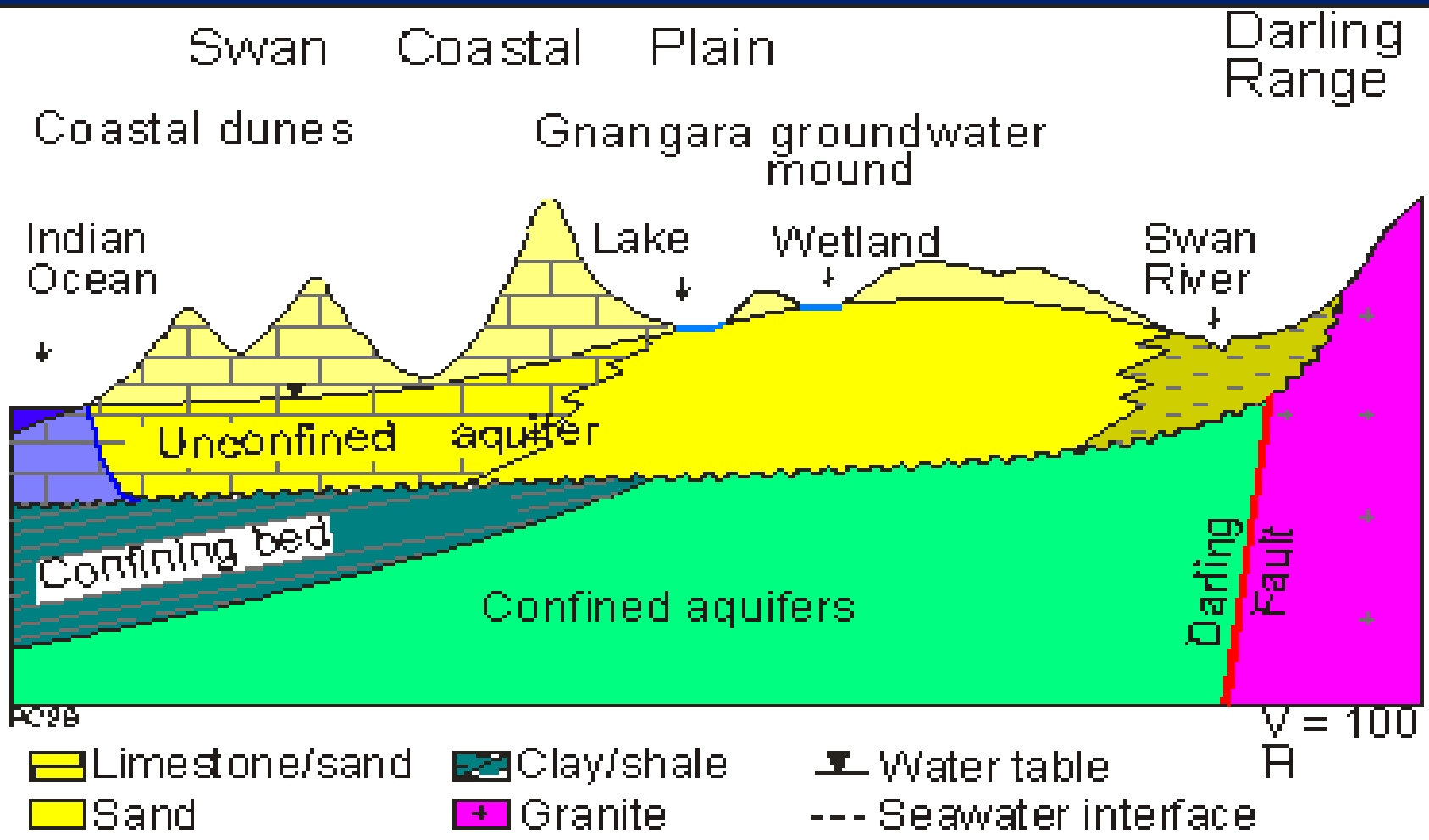
Setting of Airport

- Located on the Cloverdale Groundwater Flow System
- Shallow groundwater mostly occurs in a veneer of Bassendean Sand over Guildford Clays, some sand units in clay
- Local geological factors exert a strong control on the nature and distribution of wetlands, vegetation communities in the area



CLOVERDALE GROUNDWATER FLOW SYSTEM

Swan Coastal Plain, geological cross section



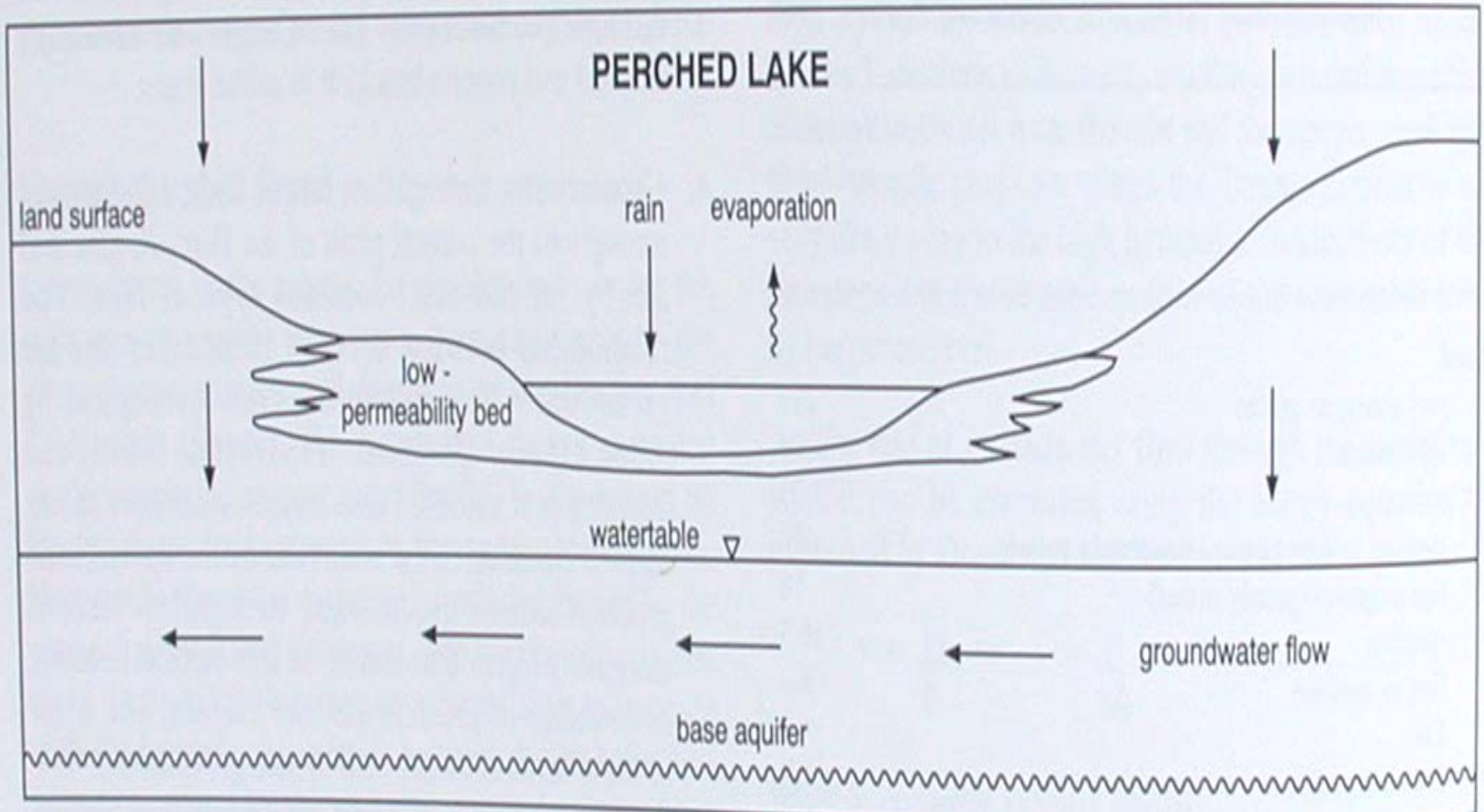
Highly variable groundwater salinity



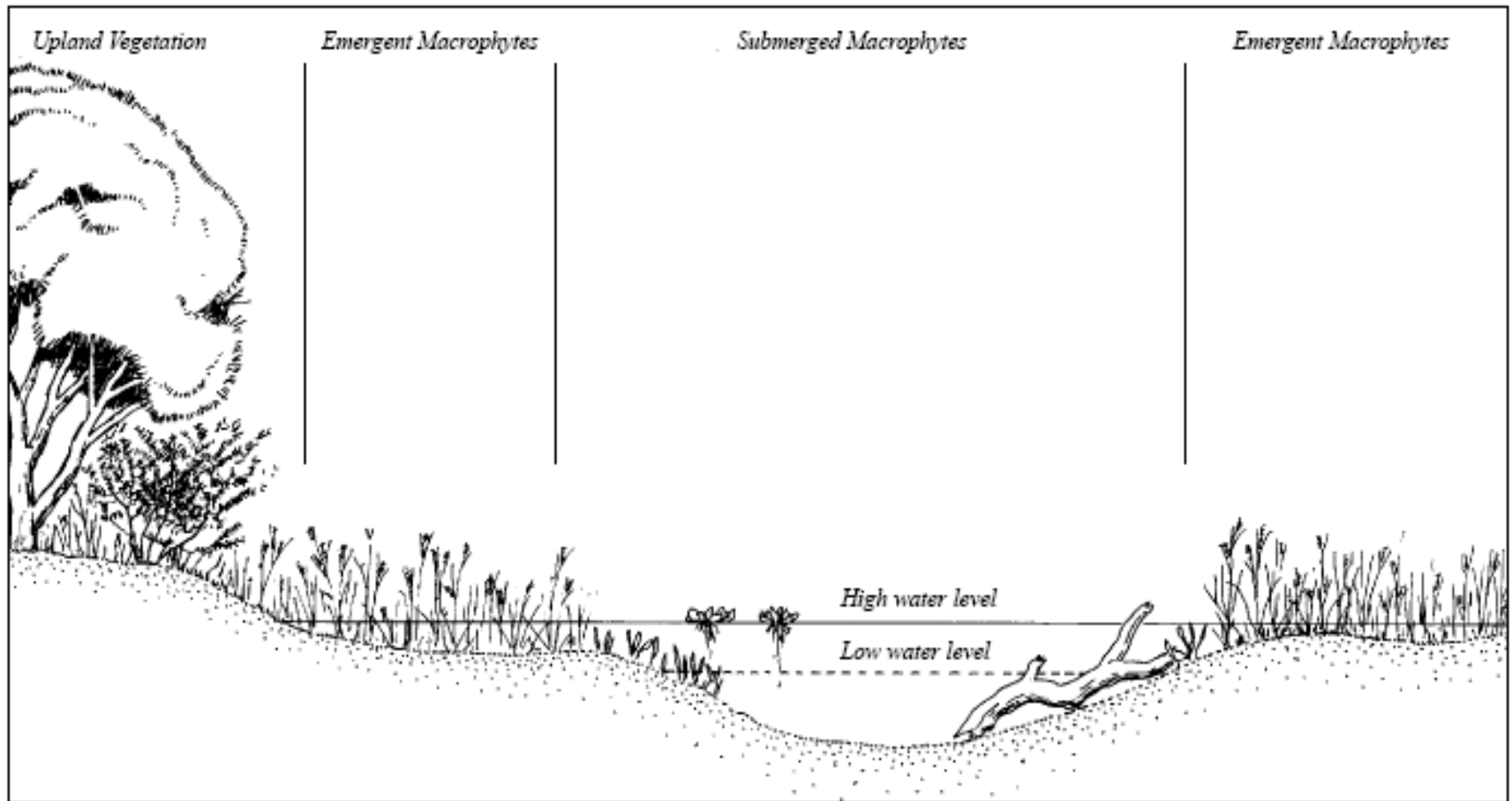
Water balance in the Cloverdale Groundwater Flow System

- Low recharge (about 5% rainfall) compared to Gnamagara, Jandakot Mounds (typically 15%)
- Low groundwater storage (800 million cubic metres) compared to Gnamagara Mound (21000 million cubic metres)
- i.e. ***VERY SENSITIVE TO CHANGES IN RECHARGE AND DISCHARGE***
- Changes in water balance can affect both groundwater quantity and quality

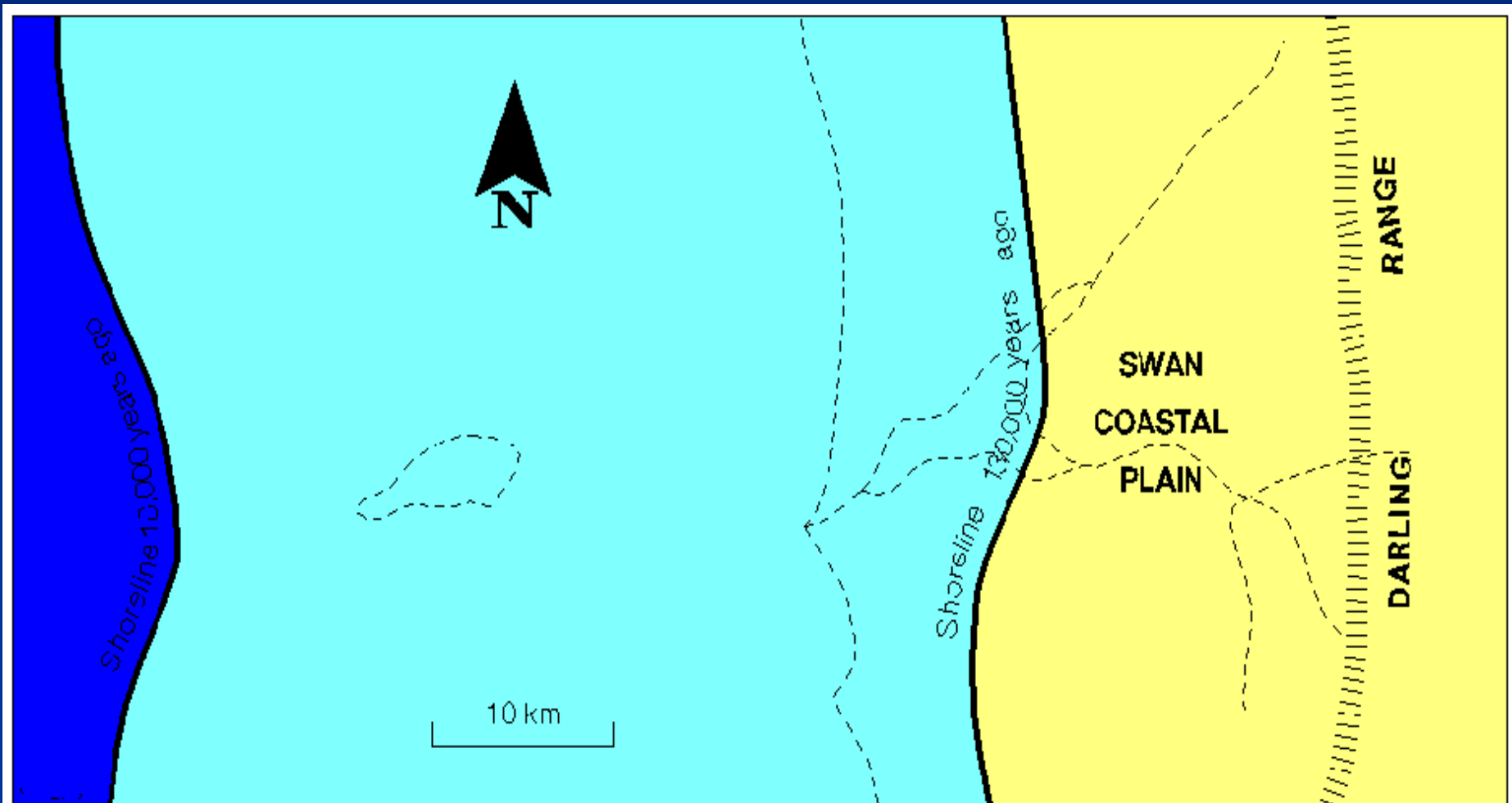
Groundwater-wetland interactions: perched lakes especially vulnerable to salinity changes, drying out



Plant communities determined by depth and variability of the watertable



Characteristics, water balance of wetlands change over short time periods (geological)



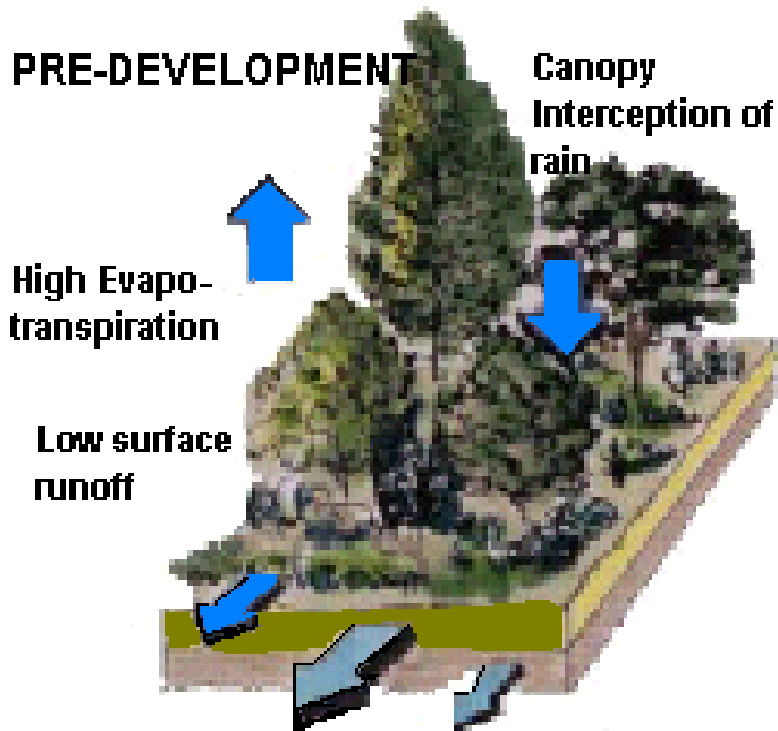
Effect of increasing urban development on water balance –high *RATE* of change

- Large increases in recharge (x 2) possible because of clearing, runoff from paved surfaces, infiltration basins
- This may increase need for drainage to prevent flooding
- Groundwater abstraction coupled with drainage can lead to local lowering of the water table.
- Can get large variations in water budget in close proximity – i.e. both too little *AND* too much water at the same time

Excessive runoff caused by urbanization can lead to wetland flooding, plant deaths, change in vegetation communities

WATER BALANCE

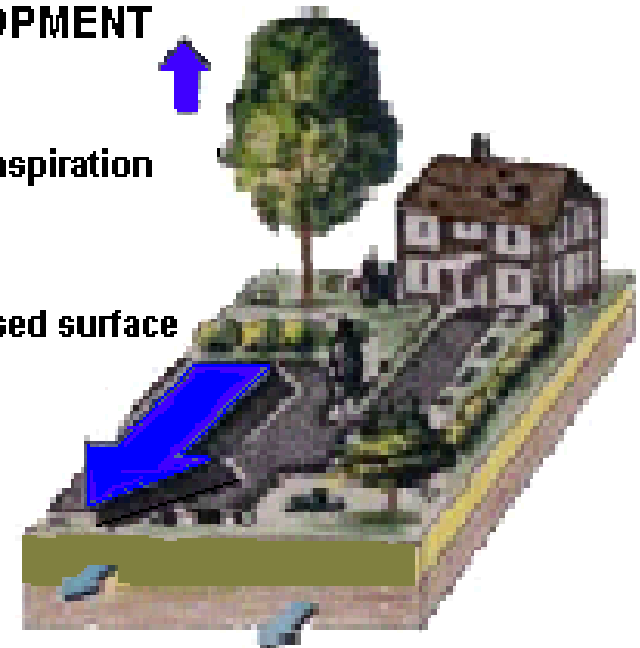
PRE-DEVELOPMENT



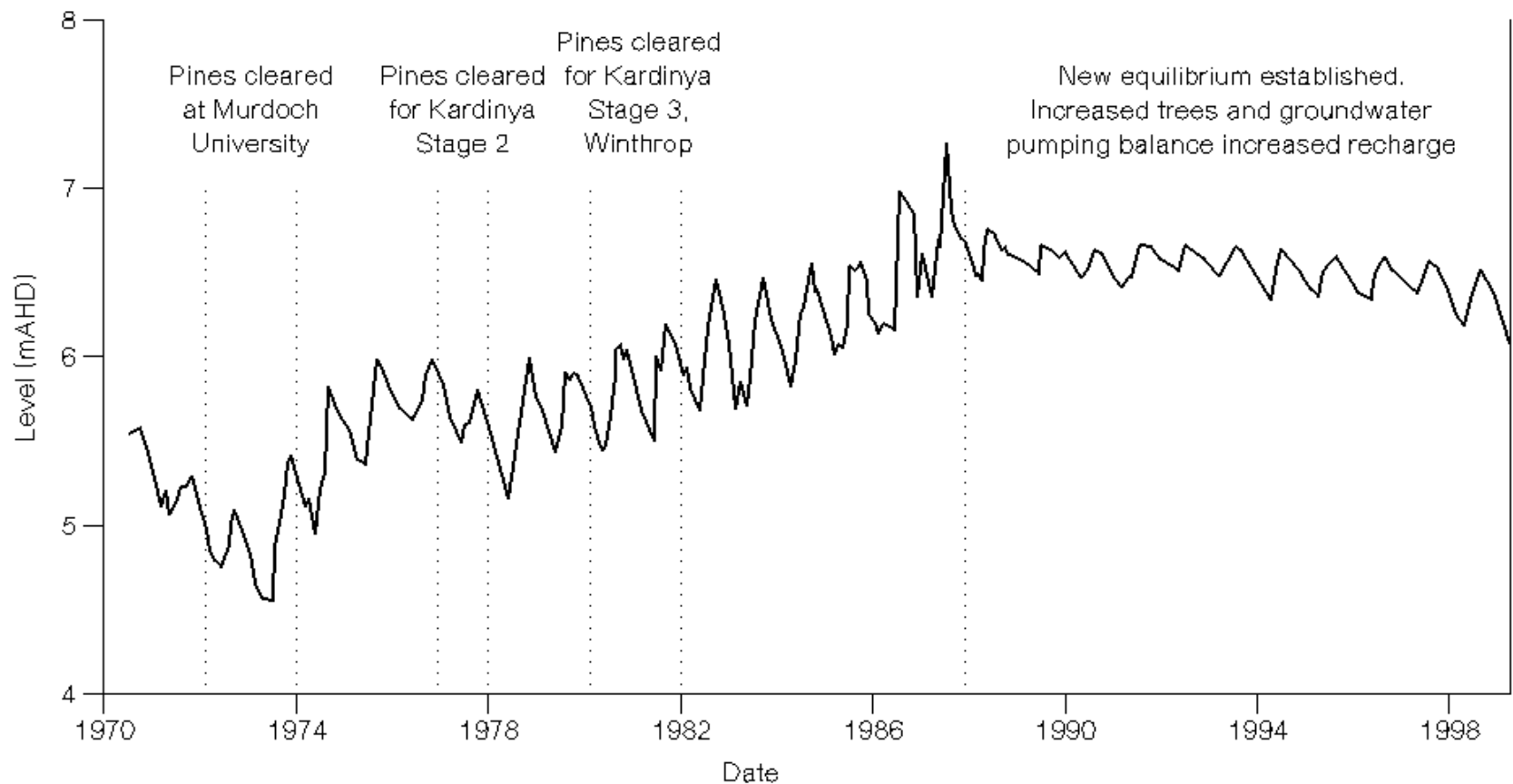
POST-DEVELOPMENT

Reduced Evapo-transpiration

Increased surface runoff



Rising watertable due to increased recharge – changes to wetland hydrology



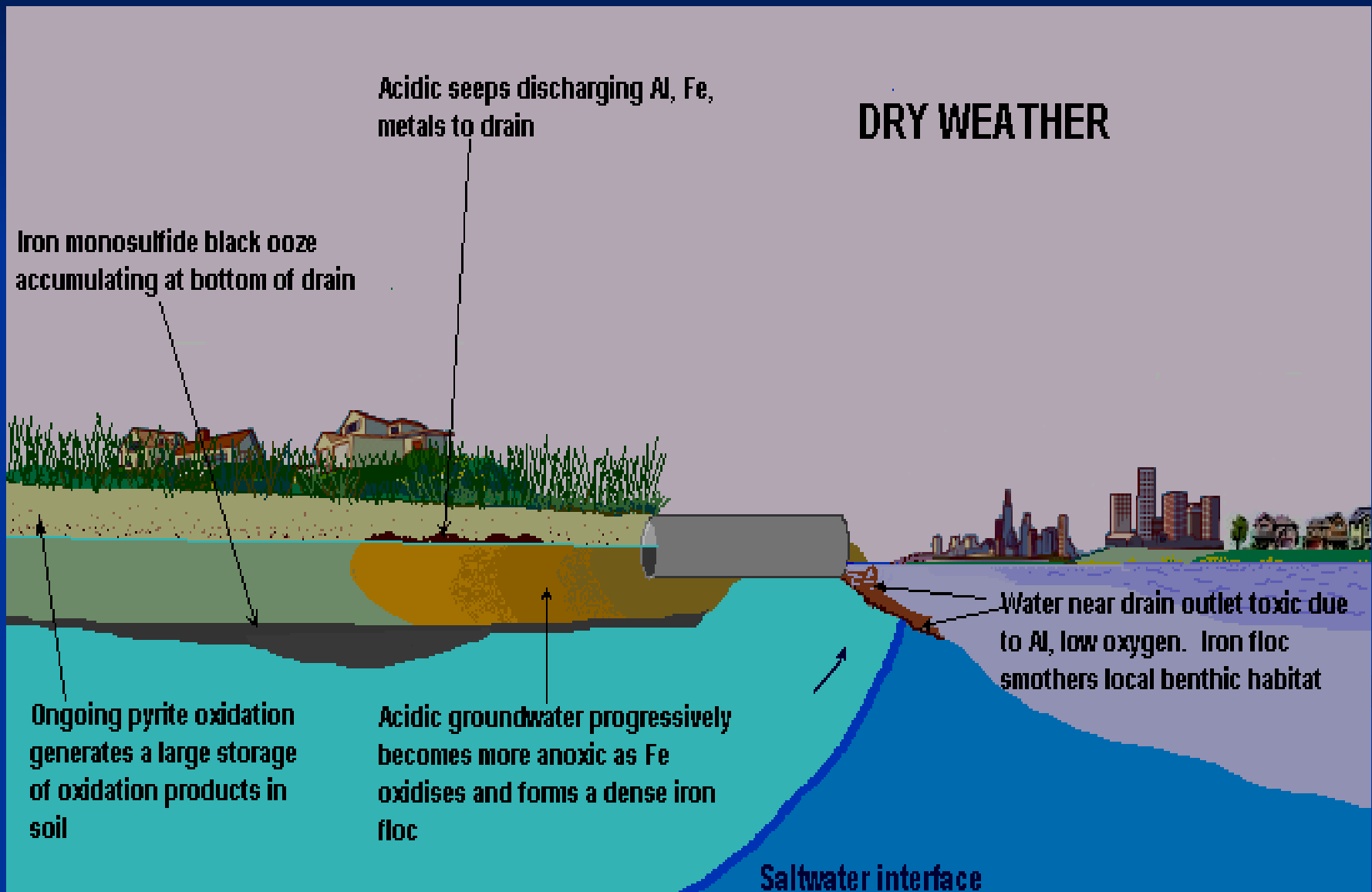
Wetland “drowned” by rising watertable



Wetland “drowned” by rising watertable



Urban drainage and acidification



Urban drainage and acidification

ONSET OF RAINY WEATHER

Large slug of acidity released into drainage water from soil storage

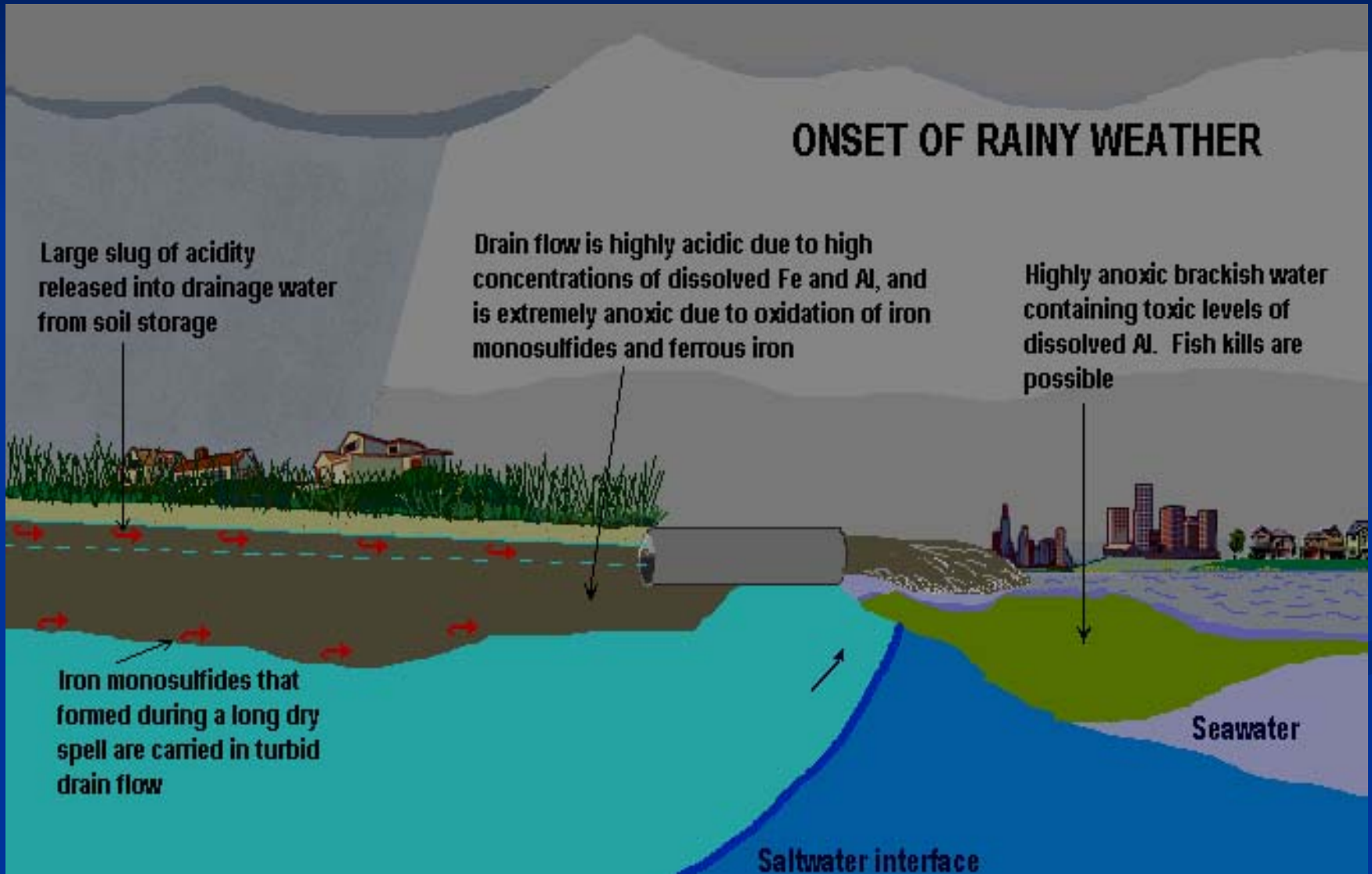
Drain flow is highly acidic due to high concentrations of dissolved Fe and Al, and is extremely anoxic due to oxidation of iron monosulfides and ferrous iron

Highly anoxic brackish water containing toxic levels of dissolved Al. Fish kills are possible

Iron monosulfides that formed during a long dry spell are carried in turbid drain flow

Seawater

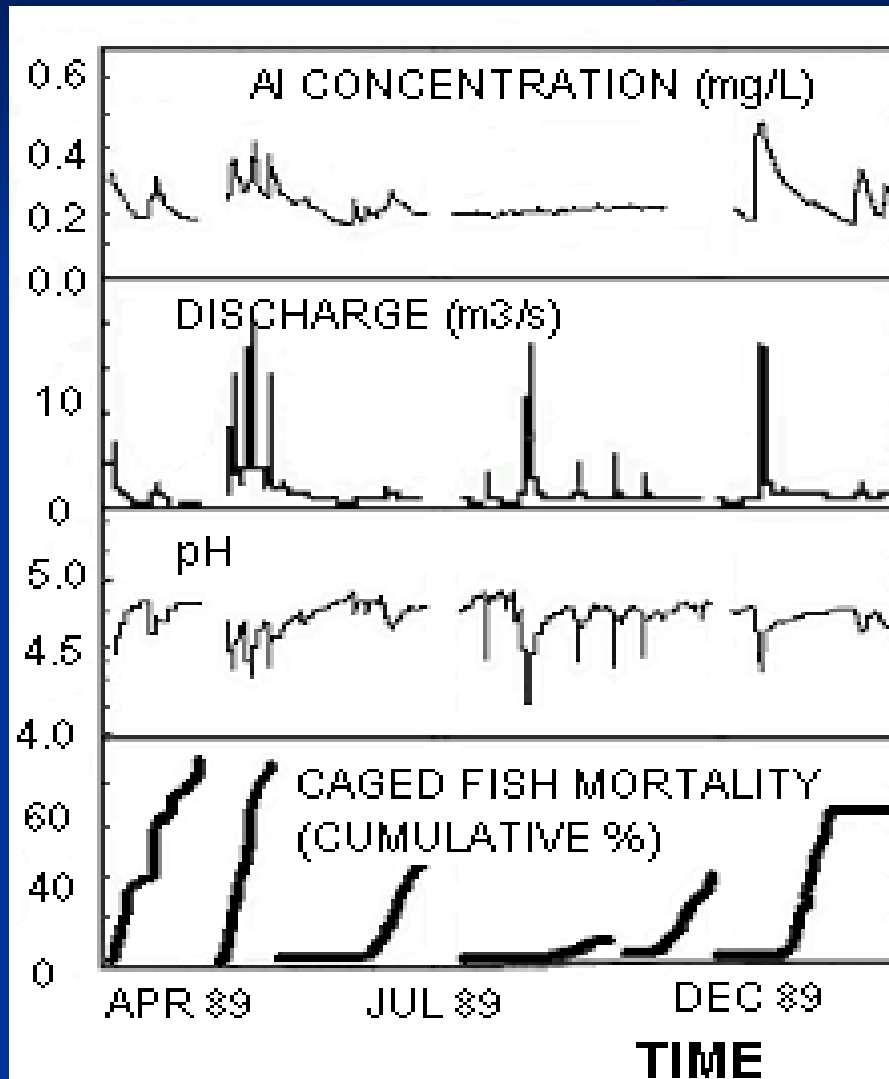
Saltwater interface



Impacts on wetlands

- Plant deaths due to aluminium phytotoxicity
- Loss of biodiversity due to ammonium, aluminium toxicity, low oxygen
- Risk of arsenic and heavy metals - bioaccumulation

Episodic discharge of toxicants, low DO, low pH



Acidic drainage, Air Freight Depot, Perth International Airport



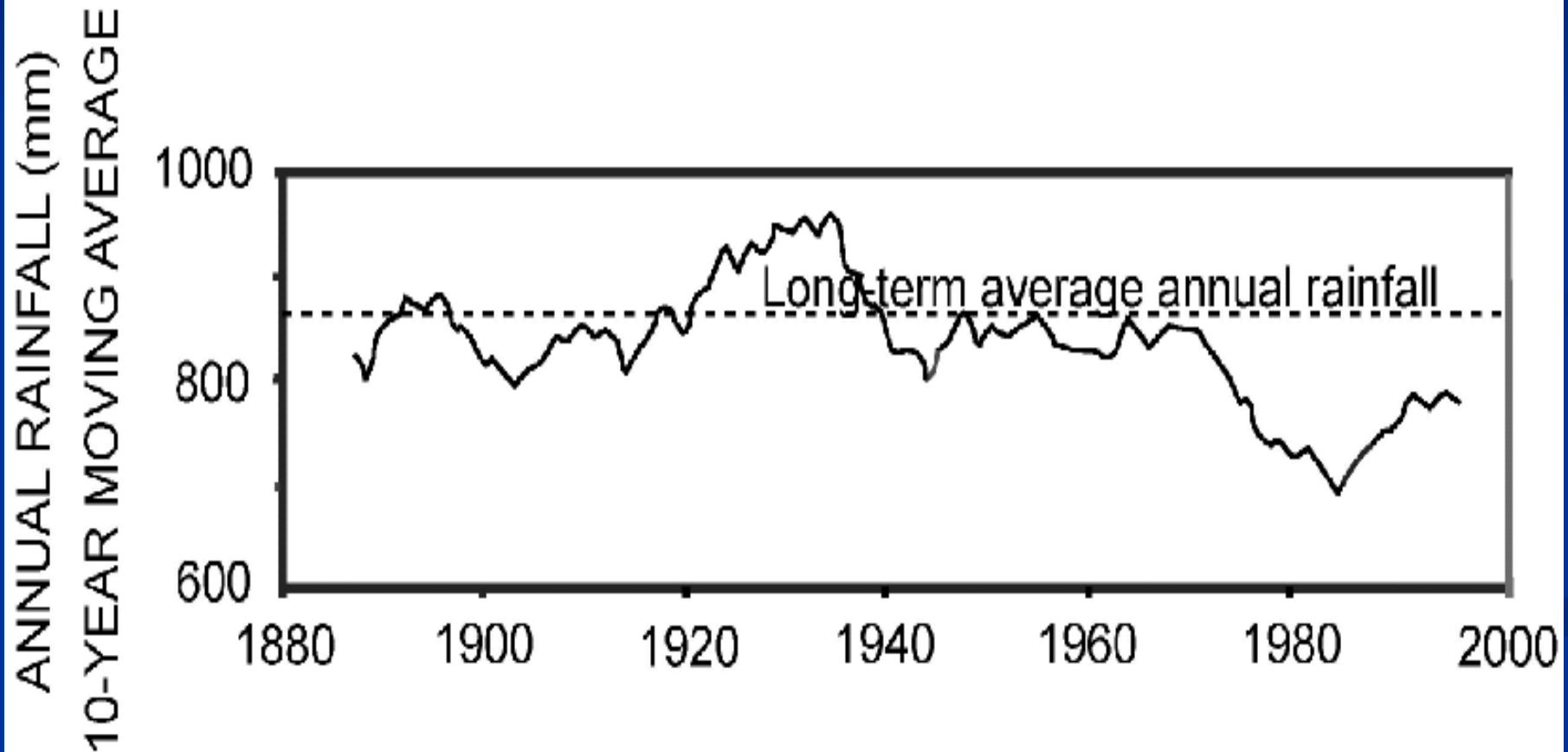
Acidic drainage, Air Freight Depot, Perth International Airport



Acidic drainage, Air Freight Depot, Perth International Airport



Effects of drainage and groundwater use exacerbated by declining rainfall

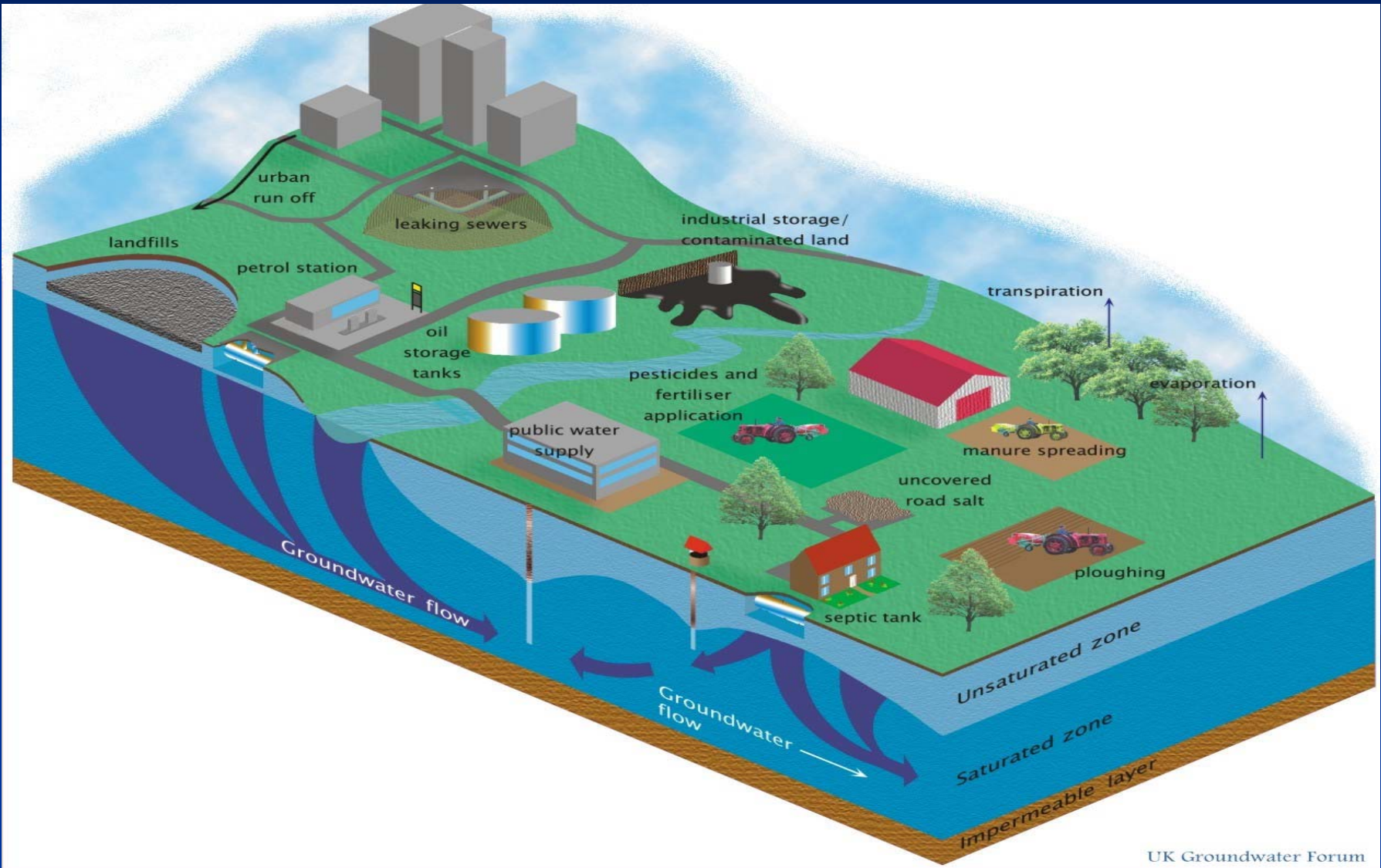


Effects of drainage and groundwater use exacerbated by declining rainfall

E.g.

- Acidification of wetlands on the Gnangara Mound, and changes in ecology
- Last happened 8000 years ago (near the end of the last ice age)

Increased risk of pollution due to development on airport land



Pollutants of concern

- Sediment loads in runoff
- Nutrients
- Hydrocarbons (fuel spills etc)

Management framework –

1. Identify values and objectives

- Wetlands and associated vegetation communities can have a large range of environmental and social values for communities.
- It is important that communities are able to actively participate in the process of identifying a setting management objectives for these systems

Management framework –

2. Information

- Gather technical and social information to understand the interaction of wetlands and vegetation communities with the environment, **AND SOCIETY**
- Development of models to predict impacts of land use and social changes on the system – it is OK to destroy the system in cyber space, but may not be in real space
- **MANAGEMENT NEEDS TO BE BASED ON SOUND INFORMATION**

Management framework –

3. develop management tools

- Planning controls are the most effective management measure –preventing impacts will always be more effective than trying to rehabilitate damage later (and 10X cheaper)
- Structural controls – can be expensive, and must be a commitment to long-term management
- Communities have a right to actively participate in the process of developing management tools. Extensive dialogue (and working through conflict) is necessary to develop these tools
- There are *NO* simple technical “quick fix” solutions – a range of expertise and understanding is needed, much of which comes from the community
- To reach sustainable solutions, management needs to be inclusive not exclusive.

Management measures –

4. Implement management measures

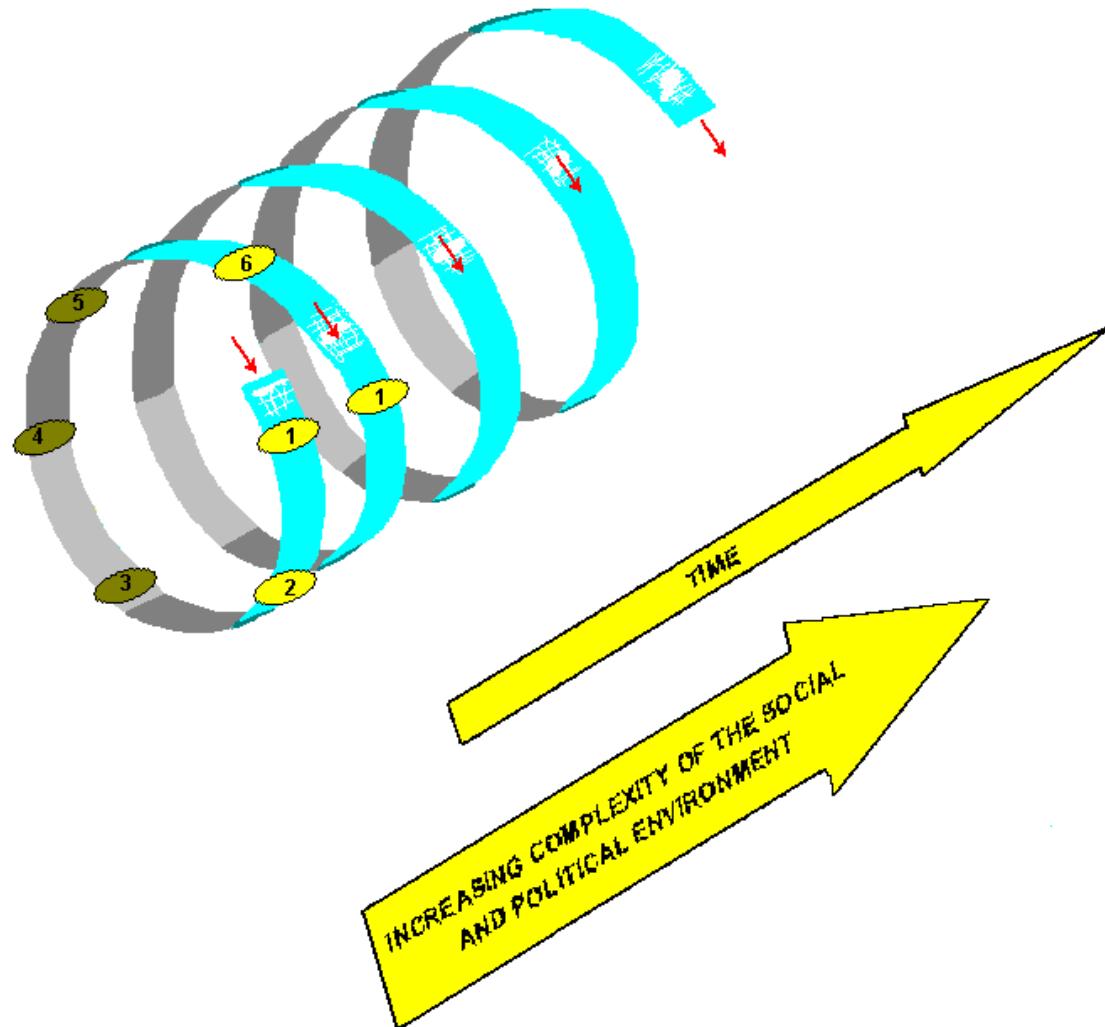
- A range of management measures is usually needed which complement each other
- There is **NO** “magic bullet”

Management framework –

5. Evaluate management effectiveness

- There is no guarantee that specific management measures will work because of uncertainty about how the system works, and **CHANGING SOCIAL EXPECTATIONS AND NEEDS**
- The complexity of technical and socioeconomic interactions means that management will always be a “suck it and see” experiment that will constantly need to adapt to changing circumstances (i.e. management will always be a journey that may never reach a final destination)
- **BACK TO STEP 1**

The Adaptive Management spiral – “Learning by doing”



Integrated Water Resources Management

- The above management process is being used (in a variety of ways) by UN agencies, NGOs throughout the developing world
- Recognises that “top down” bureaucratic processes are very often ineffective, and that management must be tailored for a specific situation.
- Has evolved from “Rio” and “Jo’ Burg” principles of natural resource management
- There are opportunities to implement this style of management at the airport