

#### An Engineer's Response to Peter Andrews' 'Back from the Brink'

Version 1, October 2025

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Published by: Catchments and Creeks, Bargara, Queensland

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Witheridge G.M. 2025, *An Engineer's Response to Peter Andrews' 'Back from the Brink'*. Catchments and Creeks, Bargara, Queensland

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Cover images: A <u>tribute</u> to Peter Andrews' original book cover; featuring Grant at Adelaide, 1987 (top left); Grant and Alan inspecting gully erosion, Moonford, Queensland, 2012 (top centre); Kedron Brook post-flood bank stabilisation, Brisbane 2011 (top right); and Sandy Creek channel works, Enoggera, Brisbane, 1997 (bottom image).

Back page: Field walk during a gully erosion workshop conducted by BMRG in Moonford, Queensland on 22 June 2012.

#### **Disclaimer**

This document does not represent a multi-disciplinary or holistic response to Peter's work, but rather the opinions of just one engineer.

This document has tried to present a response to Peter Andrews' Natural Sequence Farming that would be applicable to a variety of climatic and soil regions cross Australia. However, the author is aware that the application of any land management practice must be made on a case-by-case basis, taking into consideration all relevant local issues. Therefore, the recommendations presented here may not be appropriate for all site conditions.

No warranty or guarantee, express, implied, or statutory is made as to the accuracy, reliability, suitability, or results of the methods or recommendations.

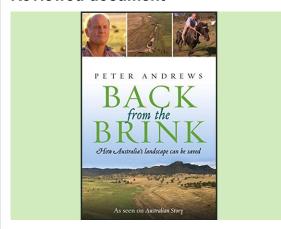
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Specifically, adoption of the recommendations and procedures presented within this document will not guarantee:

- compliance with local statutory obligations
- · compliance with local waterway objectives
- compliance with local fisheries objectives
- development of a stable landscape
- that problematic salinity issues will not return over the long-term.

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#### Reviewed document



### Back from the Brink – How Australia's landscape can be saved.

Peter Andrews, ABC Books, Sydney, NSW Reprint March 2007

ISBN: 978 0 7333 1962 4

#### Purpose of this document

This document has been prepared specifically to:

- provide an engineering response to the claims and recommendations presented in Peter Andrews' book 'Back from the Brink'
- provide an alternative, engineering-based explanation of some of Peter's observations.

The photos presented within this document are intended to represent the current topic of discussion. These photos are presented for the purpose of depicting either a preferred or discouraged outcome (as the case may be). In some cases the photo may not represent the preferred land management practice, but is simply the best photo available to the author.

The caption and/or associated discussion should **not** imply that the site shown within the photograph represents either good or bad land management practice. The circumstances, site conditions and history of each site are not known in each case, and may not be directly relevant to the current discussion.

#### About the author

Grant Witheridge is a retired civil engineer with both Bachelor and Masters degrees from the University of NSW. He has over 40 years experience in the fields of fluid mechanics, creek engineering, and soil erosion, during which time he has worked for a variety of federal, state and local governments, as well as private organisations.

In many ways, Grant's urban work experience mimics Peter's rural work experience. Grant's work focused on stormwater management and creek restoration within urban areas. Peter's work focused on improving water flow over rural properties in order to achieve Natural Sequence Farming.

#### Introduction

Given that a farmer once told me the only thing they trusted less than a snake, was an engineer, it would appear that engineering advice is not always warmly received in rural communities. So, what could a civil engineer possibly tell YOU about farming practice? Well, maybe the best that I can do is look at a selection of issues from a different point of view. Maybe I can give you an alternative explanation to one of Peter's observations that more closely aligns with your own experience.

We all know that engineers and scientists aren't always correct. And I agree that scientist and engineers are often not the most 'farm-wise' practitioners when it comes to suggesting solutions to everyday farming problems, but there is usually some wisdom in amounts all their words.

I am not asking for you to 'trust' my words. I am asking the you to follow my logic, my explanations, my diagrams, and then to compare my words with those of Peter Andrews.

I realise that Peter has demonstrated his 'outcomes' at Tarwyn Park, as well as at the many field demonstrations over the years; but, I have also demonstrated my 'outcomes' at various creek engineering projects and field workshops.

Please; just read my words, and take the time to look for the 'wisdom'. It may not always be there to your satisfaction, but take what you can when you find it.

Nobody, including myself, should fail to acknowledge Peter's success in the field. Even if I am correct in some of my challenges of Peter's explanations, those challenges do not extend to Peter's field work. Peter is an extraordinary person who has contributed a lot to our understanding of farming practices.

Let me assure everyone that even though I am in strong disagreement with <u>some</u> of Peter's explanations, I am certainly not in disagreement with all of his work. I admire Peter's skilled observations, and his drive to understand his environment. The fact that I am putting the effort into writing this review reflects my belief that Peter's work is of such valuable that it is worth getting it 'right', even if I am just smoothing-out the rough edges.

From his book it is clear that one of Peter's great loves is his horses. My interests are very different, and I am a long-time motor racing fan. In motor racing you can have a successful driver that has a detailed knowledge of the mechanics of racing cars, such as the late Sir Jack Brabham. You can also have an equally successful driver that has minimal knowledge of motor mechanics. However, at the end of the day, the success of a racing driver is not based on their knowledge of cars, but on their wins on the race track.

Similarly, the success of a land manager should be based on their actual field work, not on their knowledge of the sciences. In Peter's case, his successes in the field have rightly brought him praise.

In my opinion, Peter's book 'Back from the Brink' is a good book, but it could have been better.

In order to gain the most from Peter's book, you will need to understand a bit about Peter, the author. The need to understand the background and personality of an author is not unique to Peter's book, but is a common theme for all written documents. Readers need to understand the properties (or bias) of the writer, just a farmers need to understand the properties of their soils.

Similarly, in order to gain the most of this book review, you will also need to understand a bit about me, as the author. I have my own bias and pet interests. In comparison to Peter, I am more likely to place a focus on the <u>values of the creek</u>, rather than the <u>values of the farm</u>. I am also likely to have a greater interest in protecting the fauna and flora found along the creek, than the animals and crops found on the farm.

**WARNING:** This book review may be difficult to follow unless you also have a copy of Peter's book as a reference. Readers could try reading one chapter of *Back from the Brink* followed by my review of the same chapter. This is unlikely to be a book that you can read through quickly. The various issues may take time to understand. Bring out the optimum performance of a farm is not an easy task. There are so many variables that change from valley to valley, and region to region. Thank you.

#### Key to understanding the layout of the document:



'Image caption'

#### 'Topic' (page number in the 2007 edition)

- PA: 'extracted from Peter's book' (always shown in blue text)
- GW: Comment by Grant Witheridge (always shown in black text)
- comment
- comment
- etc.

If the page is titled 'Insert:', then the text does not relate directly to something in Peter's book, but has been included as a 'fact sheet' on a related topic.

A quick summary of my feedback	
Chapter 1 – This Land of Ours In chapter 1 we see some of the minor disagreements that I will expand upon in the	8 following
chapters.  Chapter 2 – Salinity: A Catastrophe Ahead  Lhave a more positive view about the future of our rivers than Poter has	12
I have a more positive view about the future of our rivers than Peter has.  Chapter 3 – Early Days  I think Peter is overstating the role of plants, and misunderstanding aspects of hydro	15 blogy and
thermodynamics.	
Chapter 4 – A Lesson in Biodiversity	21
This chapter discusses issues that are outside my area of expertise.	
Chapter 5 – Tarwyn Park	23
There is very little I can contribute to this chapter.	
Chapter 6 – The Remaking of Tarwyn Park	26
I question Peter's understanding of the mechanics of wetlands.	
Chapter 7 – Australia as It Used to Be	33
I have strong disagreements with Peter on what causes Australia's climatic condition making of Australia's rivers and floodplains, and so much more.	ns, the
Chapter 8 – A Hot, Dry and Very Flat Continent	47
I disagree with Peter's understanding of how water moves through a soil profile.	
Chapter 9 – The Truth About Salinity	56
I would not trust what Peter has presented in this chapter. I strongly suggest readers local expert advice.	s seek
Chapter 10 – More About Salinity	74
This chapter appears to have been let down by Peter's apparent confusion between movement of crystal salts, and the movement of dissolved salts.	the
Chapter 11 – Biodiversity	78
There is a lot that I support in this chapter, but again, I believe that Peter is overstate role that plants play in controlling salinity problems.	es the
Chapter 12 – Nature's Way: Loops, Cycles, Feedbacks	78
The information presented here is outside my area of expertise.	
Chapter 13 – The Magic of Mulch	79
I too fully endorse the magic of mulch, even on civil construction sites.	
Chapter 14 – A Layout for a Sustainable Farm	85
The information presented here is outside my area of expertise.	
Chapter 15 – Fertilisers or Just Soil Stimulants	89
The information presented here is outside my area of expertise.	
Chapter 16 – Weeds Are Allies, Not Enemies	90
Readers should be aware that Peter's definition of a weed is likely to be different from their own definition. So, be careful how you interpret each of his statements. It would appear that I hold similar views to Peter on the use of weeds; but I would have phrased my statements differently.	
Chapter 17 – Willows; Unjustly Condemned	93
In this chapter, Peter makes several statements, which I believe are baseless, and which would normally be associated with someone that does not understand waterways; however, I believe Peter does understand waterways. Consequently I can only conclude that these statements reflect Peter's distrust in governments, and his elevated interest in weeds.	
Chapter 18 – Native Trees Aren't So Sacred After All	96
Native trees will never be 'sacred' to those that don't appreciate their true contribution landscape.	on to the

#### Chapter 19 - Hedgerows: An Old Idea But a Good One

98

I kind of agree with the direction of this chapter, but for different reasons to those of Peter.

#### Chapter 20 - Australia's Deserts are All Man-made

99

I completely disagree with Peter's conclusions. I explain that most of the world's deserts are positioned at two latitudes (+/- 30 degrees) due to the effects of 'natural' atmospheric air circulation patterns.

#### Chapter 21 - Hydrology: Fancy Term, Simple Concept

107

I think this chapter demonstrates that hydrology is in fact a lot more complex that Peter makes it out to be. I find Peter's understanding of floodplain hydrology most questionable.

#### Chapter 22 - Streams the Seemed to Defy Gravity

111

For the simple reason that Peter does not believe coarse sediments can be lifted from a channel and deposited on a floodplain, we have a chapter where Peter appears to invent a completely new, and misleading, understanding of river morphology.

#### Chapter 23 - Contouring: An Option that Works

114

Contouring can be one of the 'tools' that farmers use to manage disturbed landscapes, but I do not believe contouring works the way Peter thinks it does.

#### Chapter 24 - Erosion: Our Landscape's Wasting Disease

129

In this chapter, Peter invents a new form of fluid mechanics based on his apparent misunderstanding of energy dissipation. The best I can do is direct readers to a series of *Catchments and Creeks* field guides dealing with Gully Erosion.

#### Chapter 25 - Farm Dams: Should We Damn Them or Not?

142

There is a lot I agree with in this chapter.

#### Chapter 26 – The Rights and Wrongs of Irrigation

143

Irrigation systems are not apart of my education; however, I do question some of Peter's evaporation numbers.

#### Chapter 27 - Hope Yet for the Murray and the Darling

145

This chapter returns to a lot of the waterway behaviour issues that I have already disputed in earlier chapters. Peter raises the idea of turning the Burdekin and Clarence rivers inland to aid the flow and value of the Darling River. Unfortunately this idea fails on simple geography issues.

#### Chapter 1 – This Land of Ours (Page 1 of Peter's Back from the Brink)

# Chapter 1: This Land of Ours



Effects of soil salinity (SA)



Working with saline soils (WA)



**Monitoring station (Tas)** 

#### Salinity n(p. 2)

- PA: 'Salinity is a sign of a sick landscape.'
- GW: We should remember that salinity is a natural part of our landscape; however, the salinity problems that Peter is talking about are a sign of a stressed landscape.
- Salts have been released by soils for billions of years, consequently our oceans and seas contain saltwater, not freshwater.
- I believe that water arrive on our planet as freshwater.

#### Government research (p. 2)

- PA: 'The Australian Government is spending huge sums each year on salinity programs and salinity research, but so far the money has achieved nothing of consequence.'
- GW: This statement is false.
- The sciences have learnt a lot about salinity, and how to manage salinity problems.

#### Think about this

- GW: Governments around the world have spent large sums of money on human health programs and research, but we still have diseases and health problems.
- That does not mean that this money has achieved 'nothing of consequence'.
- Yes, people still die of health problems.
- Yes, many landscapes still have salinity problems, but many landscapes exist today without salinity problems because of this research.

#### A law prohibiting the killing of plants (Page 3)



Land clearing (Qld)



Weed control (NSW)



Climbing weeds (Qld)



**Biodiversity (Tas)** 

#### A law to stop people killing plants (p.3)

- PA: I firmly believe that if a law prohibiting the killing of plants, all plants, was introduced and every Australian farmer obeyed it, the effect would be swift and dramatic.
- **GW:** There are so many parallels that can be drawn through the life of plants and the life of people.
- Just like people, plants have their germination phase, establishment phase, and their adult phase.
- Plants also have their 'bullies' and their 'invaders', plants that can poison fauna, and plants that can encourage the bullies and invaders that originate from the insect and animal world.
- Like <u>all</u> fauna, humans have caused the environment to change.
- New plants have been introduced to the Australian landscape, such as food crops and fruit-bearing plants.
- These plants have enriched our society, but with this enrichment comes responsibility—the responsibility to appropriately manage the changes we have made.

#### The likely outcome

- GW: If we as a society did not manage plants, then the plants that would dominate our planet would be the 'bullies' and the 'invaders'.
- A simple walk through the Australian bushland would result in enough barbs and seeds sticking to our cloths to hide any trace of fabric.
- The extinction of many native insects, leads to the extinction of many native birds, which leads to the extinction of many native plants.

#### A final word

- **GW:** Plants are good for the planet.
- A diversity of plants is usually better than a monoculture.
- Plants need to be managed like people need to be managed:
  - by understanding their values
  - by understanding local issues
  - by applying essential rules, but not an autocracy.

#### Understanding the science (Page 4)



Salinity exposure (NSW)



Salinity concrete damage (SA)



Salinity land degradation (SA)



Saline brickwork damage (Qld)

#### Salinity (p. 4)

- 'There are plenty of other things. though.
   that we understand only vaguely, the
   reason being that the science that would
   make it possible for us to understand them
   just isn't available yet.'
- 'No doubt it will become available one day, but until then we simply have to deal with the clinical evidence as we find it.'
- 'This applies not only to salinity but also to many of the other matters discussed in this book.'
- 'We can see what's happening in the landscape and we can see that what's happening falls into certain patterns.'
- 'From these patterns, we can deduce what is causing things to happen and we can predict with some certainty what will happen in the future.'
- 'Provided we can do this, we don't need to know the ins and outs of the science underlying it all.'
- 'In other words, we are dealing with selfevident truths.'

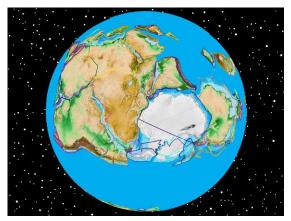
#### An engineer's response (p. 4)

- There is so much wisdom in these words.
- Yes, there are some scientists, and some engineers, that do not want to take a step forward until they have all the facts, and they know with certainty what the outcome will be.
- There will always be those that are afraid of making mistakes, or of being accused of being wrong.
- For me, the key statement in Peter's words is:

'From these patterns, we can deduce what is causing things to happen and we can predict with some certainty what will happen in the future.'

- This statement suggests that purely through our observations of 'patterns' we can predict, with some certainty, what will happen in the future.
- What I hope to demonstrate through this book review is that our observations of patterns may, unfortunately, fail to tell us what will happen when we apply these observations to landscapes located in different climatic regions of Australia.

#### Australia's ancient history (Page 5)



Gondwana (Gondwanaland)



Weeds



Inland in time of flood (SA)



Inland in time of flood (SA)

#### Gondwana (p. 5-6)

- 'Obviously, we can't turn back the clock 100,000 years and re-create the landscape as it used to exist before humans moved in and began to disrupt it.'
- 'To do that we'd have to retrieve the millions of tonnes of material that have been eroded out of the land and carried to the sea.'
- 'Once we've grasped that we then need to reinstate the plants – trees, scrub, weeds – so they can again do the job they did so successfully for so long.'

#### An engineer's response

- **GW:** I note that Peter refers here to the period before the arrival of Australia's first people some 65,000 year ago.
- I also note that Australia is a relatively 'flat' continent due to millions of years of erosion—erosion that had occurred millions of years before the arrival of Australia's first people.
- 'Weeds' only arrived in Australia with the arrival of Europeans, some 250 years ago.
- I am not aware of Aborigines moving plants across the landscape.

#### Wetlands (p. 6)

- 'The wetlands and the streams that fed them, really chains of ponds, were the very basis of the system by which the ancient Australian landscape functioned.'
- 'The journals of the early explorers are filled with descriptions of swamps and marshes throughout the Australian inland.'
- 'Ninety per cent of the wetlands have disappeared.'

#### An engineer's response

- Early European explorers noted wetlands and rivers in their journals because these are points of interest, and because these are landscapes that are difficult to cross.
- Only certain types of waterways form a pool-and-riffle system.
- Most of the waterways in Australia are ephemeral today, as they were 100,000 years ago (because of our climate).
- I know of no justification for the statement that 90% of wetlands have disappeared.

#### Chapter 2 – Salinity: A Catastrophe Ahead (Page 9)

# Chapter 2: Salinity A Catastrophe Ahead



Salt flat (NT)



**Murray River (SA)** 



**Tropical storm (Qld)** 

#### Predicting the future (p. 9)

- 'According to one estimate, the area of agricultural land under threat from salt will increase threefold – to close to 50 million acres – over the next fifty years, more than enough to cripple the national economy'
- GW: Given that the above prediction was made before 2005, and that I am drafting this response in 2025; this means some 20 years have now past since Peter made these comments, and there is still no evidence to support his claim.

#### Overstating the problem (p. 9)

- 'Rivers will be ruined, water supplies in many towns and cities rendered unfit to drink, hundreds of species of wildlife and plants wiped out of existence.'
- GW: I know of no reasons to suspect such damage to rivers by salt.
- Salt is not really a risk to our rivers; however, many wetlands in the lower Murray catchment will continue to experience salinity problems.
- Our water supplies will not be ruined, and neither will our wildlife.

#### The questions:

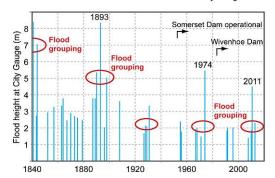
- Why do the southern states of Australia experience salinity problems, but not so much in northern regions?
- Why is it that many parts of Queensland regularly do all those things that the southern states are told <u>not</u> to do, but salinity problems don't occur?

#### The answer: High rainfall.

 In the northern states, as fast as salt is raised to the land surface, it is washed away by heavy rains—so, a 'big wet' is not the problem.

#### Impacts on our landscape (Page 10)

Historical flood levels at Brisbane River City Gauge



Historical flood records, Brisbane



Water testing (Qld)



Wet weather (Qld)



Saltpan on the lower Murray (SA)

#### Wet periods (p. 10)

- 'Wet periods seem to come along every thirty to forty years, . . .'
- GW: In very general terms, Australia's rainfall patterns follow a series of overlapping cycles, those being:
  - a 1-year cycle of summer, autumn, winter and spring; or wet season followed by dry season
  - a 10-year cycle linked to El Nino
  - a 100-year cycle which 'appears' to group major floods (> 1 in 10 yr events).

#### Salty rivers (p. 10)

- 'Ninety per cent of our rivers would be running water that was too salty to use.'
- **GW:** There is no evidence to suggest that this will be the case.
- The salt released by the rising groundwater will be completely overwhelmed by the volume of water.
- I am reminded of the old saying: 'The solution to pollution is dilution.'
- Peter's prediction has not happened, and will not happen.

#### Continued discussion

- GW: We do not need to ask whether Peter could be correct in his predictions of widespread damage to or river systems and water supply if we were to experience an extended wet period, because we already have proof that his predictions are baseless.
- Northern Australia shows us exactly what would happen if an extended wet period hit the southern states.
- The salt concentration would be diluted to a point of insignificance.

#### The wetland problem of the lower Murray

- **GW:** Salinity presents a greater threat to our wetlands, than to our rivers.
- The greatest threat to our rivers is eutrophication (excess nutrients).
- Salinity problems normally arise when evaporation exceeds rainfall.
- When saline water evaporates, the salts stay on the ground, while only the water evaporates.
- This means poorly-flushes wetlands eventually become saltpans.

#### Insert: A common misunderstanding of plants



#### Introduction

- I read with interest in various publications that certain plants need certain nutrients and minerals in order to survive.
- These statements suggest that certain plants need a selection of metals, which mean eating a simple salad sandwich could result in the consumption of a variety of metals, such as lead.

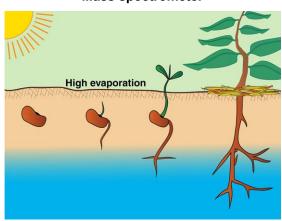
#### Element periodic table



#### Chemical analysis of plant tissue

- The chemical analysis of plant tissue can be done using a mass spectrometer.
- The fact that such an analysis detects certain metals within a plant does not mean that these metals are an essential element for growth of that plant.
- If metals enter a plant as dissolved minerals, then they will be stored within the cell structure of the plant, and the plant may never need or use these metals.

Mass spectrometer



Plant growth



Rubbish stored on a farm

#### **Evapotranspiration**

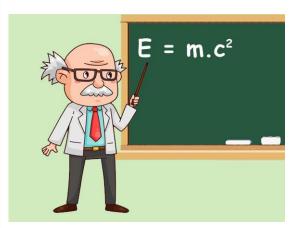
- Evapotranspiration is the processes by which water moves from the earth, through a plant, and finally to the leaf where it is released into the atmosphere.
- Plants use this process to bring water into the plant.
- Plants then take the opportunity to extract elements from the water, but also store any unneeded elements.
- Most plants use a root system to perform this task; some plants, such as Spanish Moss, use other processes.

#### Your property, your home, your bedroom

- If you were to conduct an analysis of the materials within your property, would such an analysis identify that you need old house bricks, spare tyres, ceramic dishes, and paper magazines in order to grow and maintain a healthy life? No.
- Similarly, the fact that a mineral is found in a plant does not mean that the plant needs that mineral in order to grow.

#### Chapter 3 – Early Days (Page 14)

## **Chapter 3: Early Days**



**Basic physics** 



Peter as a scientist



Camp fire

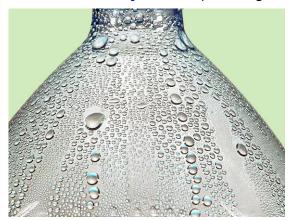
#### Heat transfer (p. 16)

- 'Later still, I came to realise that trees and other vegetation moderate the climate.'
- 'It's a matter of basic physics.'
- GW: I do not intend providing feedback on much of this chapter because it refers mainly to Peter's personal history.
- However, it does appear to me that Peter is confused about some aspects of what he says is 'basic physics', specifically in regards to thermodynamics.

#### Understanding the 'cause' and 'effect'

- **GW:** Much of science involves identifying the 'cause' and the 'effects' associated with a given observation.
- Upon reading Peter's book, I cannot help to think that Peter would have been a really good scientist, if he had chosen that path. However, without the appropriate training, Peter sometimes confuses the 'cause' with the 'effect'.
- In the example that Peter gives, it can be difficult to determine what occurred first did the cooling air cause condensation, or did the condensation cause the cooling of the air?
- Think about this example: In a camp fire, is the timber hot because it is burning, or is it burning because it is hot? It sounds like a stupid question, but finding the answer can tell you a lot about the science of burning.
- Note: You can heat timber in an oval without it catching fire, even though it may 'burn' (i.e. darken in colour); but, it is hard to burn timber without causing the timber to heat.

#### Insert: Thermodynamics (Warning: this discussion is a bit technical)



Water condensation



Compressed air duster



Foggy windows



Misty window

#### Understanding the 'cause' and 'effect'

- GW: When it comes to understanding the heating and cooling effects of plants, it is very important to separate the cause from the effect.
- Ask yourself: did the evaporation or condensation cause the change in temperature, or did an external force cause the change in temperature, which in-turn caused the evaporation or condensation of water?
- Is the evaporation or condensation the cause of the action, or the effect?

#### A can of compressed air (gas)

- When you release a compressed gas from a container, the resulting change in pressure within the container will cause a sudden drop in the temperature of the container.
- For example, spraying an insert spray for an extended period will cause the can to cool—this effect is even more noticeable when using a can of compressed air to blow dust off your keyboard.
- The drop in air pressure is the cause, and the condensation on the can is the effect.

#### The 'misting' of a car

- Just because evaporation causes a cooling effect, does <u>not</u> necessarily mean that the <u>condensing</u> of air moisture into surface water will cause the water to heat.
- It all comes down to what is causing the cooling of the air moisture.
- If the hot humid air touches a cold car windscreen, then it is a windscreen that is cooling the air, and causing the effect of condensation.
- However, if the cooling of the humid air is caused by someone turning on the car's air conditioner, then the cause of the cooling is the air conditioner, while the condensation of water on the windscreen is just an effect of this cooling. Thus the real heat transfer occurs within the car's air conditioner.
- In a forest at night, different things cool at different rates, which means the transfer of heat jumps all over the place, from surface to surface as the forest cools.
- At daybreak, there is a rapid cooling of the land caused by the inflow of cold air over the land caused by the Sun warming air to the east of that location.

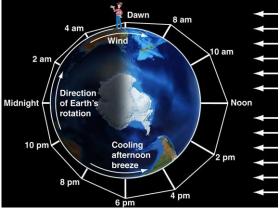
#### Insert: This text refer to Peter's discussion about plants cooling the land



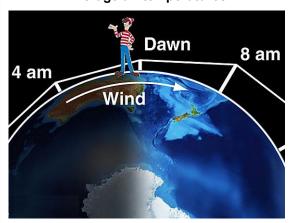
Sunrise over Bargara, Queensland



**Outdoor temperature gauge** 



Average air temperatures



Steep temperature gradient

#### The 'cool' dawn

- **GW:** I am sure most of us have at some stage felt the sudden cooling of the air just around the time that the Sun begins to rise over the horizon.
- Understanding the 'science' of this cooling is all about understanding what is causing the effect, and what is being affected.
- The question becomes: does the condensation of air moisture cause the drop in air temperature, or does the drop in air temperature cause the condensation of water (dew)?

#### Cause and effect

- Question: When the dawn breaks, does the air cause the land to cool, or does the land cause the air, and thus the people, to be cooled?
- What is doing the 'work', and what simply experiences the 'effects' of this work?

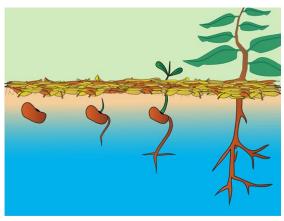
#### Temperatures in the lower atmosphere

- If we take a look at the typical air temperatures around the world at the time the dawn arrives at your home, then we get something like that shown is this diagram (left).
- From this diagram we can see that the greatest temperature gradient exists between the air west of your home, and the air east of your home (at the time of sunrise).

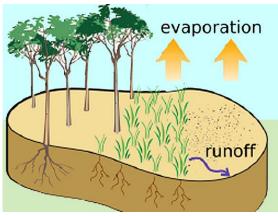
#### Rapid temperature fall just before sunrise

- People can sometimes feel a noticeable fall in the air temperature just before sunrise.
- It is said that this effect is more noticeable if the air is very dry (low moisture content).
- The cause of this effect is a combination of:
  - cold westerly winds caused by the temperature gradient
  - the morning Sun transferring more heat into the upper atmosphere, which forms a low pressure region.

#### Evapotranspiration of plants (More technical discussion, sorry)



Early plant growth



**Evapotranspiration** 



Condensation



**Evaporation** 

#### Photosynthesis (p. 16)

- 'Now, plants have to transpire when they're photosynthesising – that is, extracting carbon from the air – and in the process they release a large amount of moisture in the form of water vapour, which means, in turn, that they absorb a lot of heat.'
- 'At night, that moisture condenses, thereby releasing heat and warming the environment.'
- **GW:** Then why do plants appear very dark (i.e. very cold) in thermal imagery?

#### **Terminology**

- Evaporation is the process of liquid water transforming into water vapour.
- Transpiration is the process of water movement through a plant causes by the evaporation process.
- Photosynthesis is the chemical process of building organic matter through the effects of heat and chlorophyll.
- When a plant 'sweats', there is a transfer of energy (heat) from the plant to the evaporating water.

#### Basic physics

- GW: So, what does all this mean?
- It means that before you start claiming that plants heat and cool the climate as they condense and then evaporate water, it is important to discover if the plant is the 'cause' of this effect, or just the 'affected' party
- If we look at the early morning condensation of water, we find that the plants do <u>not</u> cause this outcome, and thus <u>do not</u> transfer heat into the environment.

#### **Evapotranspiration**

- GW: If we look at the evaporation of plant moisture from plants during the day, we find that the Sun is the cause of the evaporation; however, because the evaporation does occur on the surface of the plant, there is a small cooling effect.
- This evaporation from plants only occurs because the Sun warms the surface of the leaves.
- So, the cooling effect of the water evaporation only serves to slightly reduce this warming process, and so it does not significantly affect the local climate.

#### Insert: The complexity of thermodynamics and heat transfer



**Heat transfer** 



Car exhaust



Forest fire



**Grass fire** 

#### Are you still not convinced

- **GW:** I am sure there are a number of people that are unconvinced by the explanations that I have just given.
- Many people will firmly believe that the evaporation of moisture from the surface of a plant does in fact cool the surface of the plant, and by extension, the air that surrounds the plant.
- However, in thermodynamics, it is important to follow where the heat travels, and to make sure that the 'cooling' that you want, actually occurs.

### Consider the cooling of exhaust gases from a petrol engine

- **GW:** When exhaust gases leave an engine, they are very hot.
- The car's exhaust system will help to extract heat from these exhaust gases, and release this heat under the car.
- So, the exhaust gases are cooled as they travel through the exhaust pipe, but I am sure everyone is aware that these gases still exit the exhaust pipe as very hot gas, but just not as hot as it was when it left the engine.

#### Another example

- GW: Consider what happens when fire passes through a forest.
- The fire causes the evaporation of significant amounts of plant moisture from the forest.
- Now, this evaporation does not mean that a forest fire is a low-temperature activity, it is just that the very high temperatures of the forest fire are just slightly lower than they would have been if the forest vegetation had been very dry.

#### But there is more to the story

- **GW:** In thermodynamics, the heat is often transferred from one body to another—the aim is watch where the heat ends-up.
- Imagine a grass fire is sweeping towards your home. You jump into your water tank, and then you release the water from the tank just as the grass fire arrives.
- The grass around the tank is now flooded, but the fire boils this water turning it to steam; meanwhile, inside the empty water tank, you are 'cooking' as a result of the hot steam that now fills the air.

#### Insert: A lesson from Burra, South Australia



The treeless hills of Burra (SA)

#### Introduction

- Burra is a South Australian town that I have passed through several times on my travels between Broken Hill and Adelaide.
- Burra is one of those towns that just makes you feel good every time you arrive, and just a little sad every time you leave (i.e. it is a nice town and you should stop next time you as passing).
- Burra has a history of copper mining operating from 1845 to 1916.

Exposure of the underlying rock (SA)

#### The loss of trees

- During the operation of the mines, a maximum of some 560 people were employed, with a large supporting population.
- Trees provided the timber for cooking and heating, especially given the winter temperatures fall to 0° degrees Celsius.
- The operation of the mine resulted in the significant loss of trees (in the 1800s) from the surrounding hill slopes.



Formation of gully erosion (SA)

#### An unusual landscape

- The treeless, grass-lined hills that surround Burra look unusual to a traveller from Brisbane.
- Of course, the greater region is not completely free of trees, but many of the hills appear just as they do in the images shown here.
- The loss of this vegetation, and more importantly, the loss of the natural ground cover (leaf mulch), has resulted on a longterm increase in the rate (i.e. m³/s) of stormwater runoff.



Severe gully erosion in lower plains (SA)

#### **Gully erosion**

- Changes to the local catchment hydrology has resulted in the formation of gully erosion, which continues to stretch further and further through the hill slopes.
- Unfortunately, the gully erosion has exposed a very erodible dispersive soil, resulting in some spectacular bank erosion (see the Case Study at the end of this document).
- However, contra to Peter's claims, the loss of trees has <u>not</u> created a desert landscape.

#### Chapter 4 – A Lesson in Biodiversity (Page 21)

# Chapter 4: A Lesson in Biodiversity



Introduction

- **GW:** There is very little that I can comment on within this chapter.
- Soil chemistry is not my expertise—I will leave that discussion to the soil scientists.

Soil scientists doing what they do (Qld)



My travel and accommodation in the USA



Site inspection (Qld)

#### Travelling overseas to learn from others

- GW: Similar to Peter, I also travelled to America (1995) to compare Australian practices in stormwater management and soil erosion with American practices.
- On these trips you learn a lot, and you can meet people who have independently come to the same conclusions as you have, which can give you confidence in your work.
- Remember; it is just as important to learn what not to do, as it is to learn what to do.

#### The 'value' of weeds.

- GW: Similar to Peter, I also have a slightly different attitude to 'weeds' than the general population.
- However, where I may differ from Peter is that I eventually want to replace the weeds with native plants—that is, native plants that can perform the same 'good' work that the weeds were performing.
- I never had the pleasure of owning horses, so my experiences are different from Peter's.

#### Insert: My experiences in managing weeds along waterways



Excessive weed control along one bank

### Closed-minded weeders

- GW: During my career I have met my fair share of closed-minded weeders—those people that believe weeds have no value and must be removed ASAP.
- These can be dangerous people, and their actions can trigger significant bank erosion problems if left to their own devices.



The resulting bank erosion weeks later

#### Creek rehabilitation

- **GW:** When you are rehabilitation a portion of a creek, one of your first tasks may well be the removal of weeds.
- However, if you were to remove all the weeds, and then try to re-establish native vegetation, you may experience:
  - excessive soil erosion
  - the release of a controllable pollutant
  - the loss of many newly planted trees.



Removal of a weed tree, leaving the roots

#### The use of weeds in creek rehabilitation

- GW: If weeds have established along a waterway, then that means they are surviving the forces of the waterway.
- This means the weeds are likely to be controlling soil erosion, and surviving the stress of flood events.
- That means these weeds are currently performing a 'useful' task.
- NEVER remove a weed that is performing a useful task unless you have a replacement plant that can perform the same task.



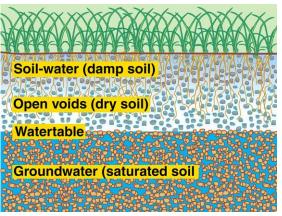
Poisoned grass ready for new plants

#### Using weeds to control weeds

- GW: In the world of creek management, there are weeds that are easy to remove, and other weeds that are very difficult to remove.
- There may be times when, instead of immediately replacing a weed with a slow-growing native, you may choose to:
  - replace the difficult weed with an easyto-control weed, then
  - later kill the easy-to-control weed, and plant a slow-growing native into the stable (dead weed covered) soil.

#### Chapter 5 – Tarwyn Park (Page 27)

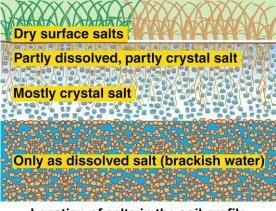
## **Chapter 5: Tarwyn Park**



#### Salinity (p. 30)

- 'Plants maintain a layer of fresh water in the topsoil which stops the salt from surfacing.'
- GW: I do not see how a layer of freshwater could stop the saline groundwater from reaching the surface.
- If the saline groundwater wants to reach the surface due to hydraulic pressure, then no layer of water is going to stop it.
- This discussion fails basic physics.

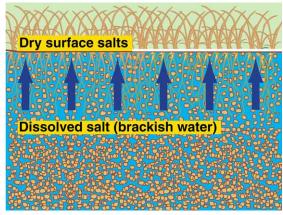
#### Groundwater and soil-water



#### Stratification of water bodies

- GW: It is true that stratification can occur within any waterbody where water rests in layers based on the density of each layer.
- In lakes, stratification most commonly occurs as a result of variations in the water temperature.
- A temporary stratification can occur in bays when floodwater flows over the denser saline water that normally fills the bay.

#### Location of salts in the soil profile

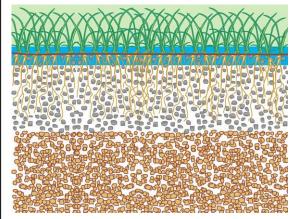


Rising watertable and salt

#### The movement of saline groundwater

- However, groundwater moves through the earth in response to the pressures, not density differences.
- If water pressures acting on the groundwater increases to the point where the watertable is lifted up to the ground surface, then no 'freshwater lens' will stop such water movement.

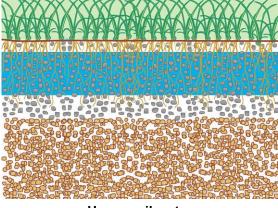
#### Insert: The forces that control each region of soil-water



#### Surface water

- Surface water either rests on the soil, or exists within the top centimetre of the soil.
- The forces that dominate over the movement of any surface water are:
  - gravity
  - temperature-affected evaporation
  - wind-affected evaporation.

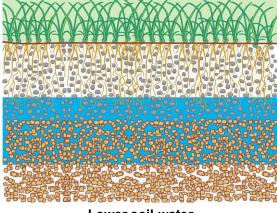
Surface water



#### Upper soil-water

- Just below the soil surface lies a region that is usually dominated by fresh soilwater that is attached to the soil grains and organic matter through the actions of surface tension.
- It is this surface tension that prevents this freshwater from being carried by gravity down towards the watertable.
- This soil-water is not held near the soil surface by plant roots.

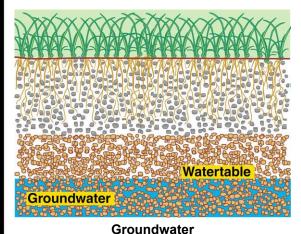
Upper soil-water



#### Lower soil-water

- The ability of surface tension to hold water at a given elevation within the soil profile depends on the soil's texture.
- If most of the soil grains, or peds, have a similar size (i.e. a uniform soil texture), then a significant quantity of soil-water can be held within the soil.
- As the grain size increases, the total surface area of the soil grains decreases, which means less water can be held in the soil by surface tension.

Lower soil-water

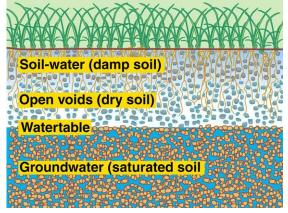


#### Groundwater

- If the soil contains large open voids, then gravity can dominate the system, and the soil-water can be drawn down into the groundwater.
- Plant roots can extract water from the groundwater; however, not all plant roots wish to exist within the groundwater region, even if they can reach the groundwater.

Page 24

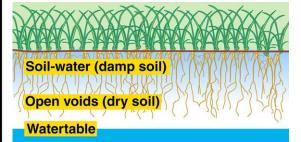
#### Insert: Explaining the existence of soil-water and brackish groundwater



Introduction

- On the previous page, this diagram was used to identify the standard soil conditions of:
  - soil-water in the upper soil
  - open voids (containing air and/or water) in a region of soil between the upper soil layer and the groundwater
  - the lower groundwater level.
- A layer of rock may exist above or below the groundwater.

#### Groundwater and soil-water



Groundwater (saturated soil

#### Looking at just the liquid components

- This diagram shows the above soil profile, but with the soil crumbs removed.
- During extended periods of rainfall, or periods of flood inundation, fresh soilwater can saturate the soil all the way down to the watertable.
- During such periods, the plant roots may not be able to access oxygen from the soil, which, over an extended period of time, can damage or kill some plants.
- Plants typically up-take oxygen at night.

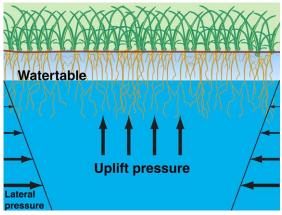
#### Soil particles removed



#### Water potentially used by plants

- Plants can access any water that their roots can reach, which means if the water is 'bad', then the plant will access bad
- The quality of the groundwater can vary from 'fresh' to 'brackish' to 'saline', the latter case being rare, except in coastal regions.
- It is noted that mangroves require (desire) a regular surface flushing of freshwater in the form of stormwater runoff.

Oxygen breathing mangrove roots



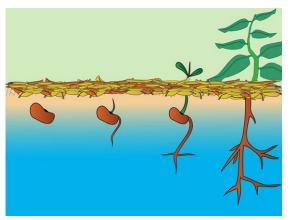
The lifting of groundwater

#### Plant getting access to the groundwater

- During extended periods of rainfall, or periods of flood inundation, the upper region of the soil can become saturated.
- If a brackish groundwater exists in the region, then:
  - plants may be able to access the groundwater if their roots are deep enough, but they will not be able to lift the watertable
  - only hydraulic pressure can lift the watertable, and bring groundwater up to the surface.

#### Chapter 6 - The Remaking of Tarwyn Park (Page 36)

# Ch 6: The Remaking of Tarwyn Park



Mulching growing plants



Earth worms



Composting

#### Mulching (p. 39)

- 'I decided to do this as an experiment and see what effect, if any, it had. The results were encouraging. Just one application of the mulch made a marked difference to the land's fertility.'
- **GW:** Adding organic matter to your soil is like adding fuel to your car.
- It is not just because the fuel can make your engine run, it also helps charge your car's battery, and runs your alternator, which gets all the other things in your car working.
- When you add organic matter to soil, you give the soil the food it needs to build new organic matter.
- In addition, the organic matter feeds the microbes (bugs) in the soil, which allows some minerals (that were previously tied to the soil) to become freely available to the growing plants.
- Think about it like you are feeding the workers on your farm, which allows them to be more productive, which allows the farm to be more productive.
- Don't just feed the soil, feed the microbes (the workers) that live in the soil.

#### The problem of weed seed

- GW: The biggest problem with imported, or farm-generated mulch, is the potential weed seed content, which can spread unwanted plants.
- We can solve the weed-seed problem by composting the mulch to 'burn-off' (kill) the seed, but it will retain the organic content of the seed (no longer a viable seed).
- Composting can be achieved by setting up an on-farm processing system, which can allow you to incorporate animal waste.

#### Insert: Potential use of a compost blanket



Compost blanket with early grass cover



Application (different site)



Park prior to application with bare soil



Application of treated wastewater sludge

#### Introduction

- A 'compost blanket' is the term commonly used in engineering to describe the spreading of compost over disturbed soil.
- Compost blankets are useful:
  - when the eroded slope is too steep for the replacement of stripped topsoil; or
  - if the topsoil that was stripped from the soil contains excessive weed-seed content (in some cases the stripped topsoil can be treated with organic matter in a composting process).

#### On-site generation

- **GW:** Mulch can be generated by slashing grasses, lucerne, or some weeds.
- Properties that have a widespread weed and/or soil-health problem, can establish a long-term production system that passes waste soil or organic matter through a composting process that produces either:
  - composted mulch
  - composted topsoil mix.
- Significant on-site soil treatment can be achieved with a bit of lateral thinking.

#### Commercial source of compost

- GW: Mulch may also be obtained by approaching local businesses; chicken farms, sugarcane trash, etc.
- Wastewater treatment plants can be approached for the supply of treated (composted) sewage sludge.
- The science exists to convert 'bad' organic matter into 'good' organic matter, and 'poor' soils into 'good' soils—farmers should not focus solely on farming produce, but also 'farming the farm'.



Grass growth post application

#### **Insert: Farming the farm**



An engineering perspective

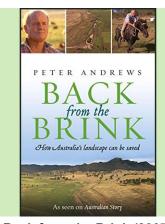
#### Disclaimer

- Given my limited work experience on farming practices, I feel grossly unqualified to give the following advice.
- Readers are encourage to seek their own expert advice.



#### The problem

- The problem is that there are those farmers that focus solely on their 'product', whether that product is crops, feed, timber or animals.
- These farmers focus on feeding their product, watering their product, sheltering their product.



Back from the Brink (2007)

#### Farming the farm

- A lot of what Peter is talking about in his book: *Back from the Brink*, is a change of focus towards:
  - feeding, watering and nurturing those things that feed, water and nurture your product.
- Feeding and protecting the microbes that live in your soil can help them to make the plant-food, that already exists in the soil, more available to the plants.



My old hoop pine (Qld)

#### The story of the sick hoop pine

- Years ago I had a sick hoop pine in my backyard.
- An arborist suggested I make up a watery mixture of Vegemite and molasses, and then pore it around the base of the tree.
- Over the next few weeks my dear old hoop pine came back to good health.
  - What was the Vegemite and molasses doing, it was feeding the soil microbes sugar—I gave the soil a burst of life so that it would bring life back to my pine tree.

#### Rising salt (Page 41)



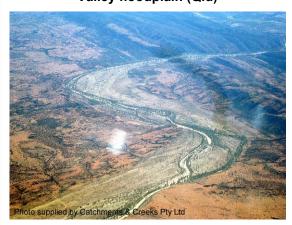
Lucerne bales



Surface salt (NSW)



Valley floodplain (Qld)



Floodplain in central Australia (NT)

#### Lucerne (p. 41)

- 'Lucerne is an unusual plant. Like weeds, it has a deep tap root that mines the deeper soil and brings up carbons and salts, but, unlike weeds, it is edible during its growing cycle.'
- GW: This just does not make sense to me.
- A plant, any plant, can only 'bring up' carbon and salt through its root system.
- Once in the plant's roots, this matter is not ejected from the roots at the soil surface (unless the plant dies).

#### What carries salt through the soil profile

- GW: Salts move through the soil as a result of the movement of water.
- Groundwater can lift salts towards the soil surface, where water evaporation by the wind or Sun, or plant uptake, can cause some of those salts to remain near the soil surface.
- Plants don't bring salts to the soil surface.
- Freshwater can wash salts back down.
- Groundwater can also carry salts downwards.

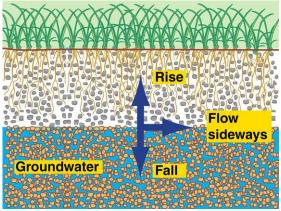
#### Floodplains (p. 43)

- 'I'd already begun to notice that this was a standard pattern: floodplains all over Australia consisted of a series of steps, each with wetlands at the top and bottom.'
- GW: I have just spend 40 years working as a creek engineer, which has resulted in me visiting floodplains all over Australia, and I have seen no evidence that would suggest the above statement is correct.
- To begin with, not all floodplains contain wetlands—it usually depends on the soil type.

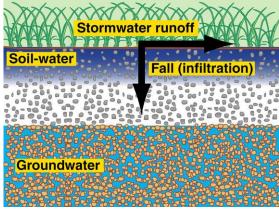
#### Creation of floodplains (p. 43)

- 'Now, the formation of the floodplain steps was an automatic process which in each case would have been triggered by some chance occurrence in the landscape.'
- GW: I am sure some floodplains have 'steps', but this is not how floodplains are formed.
- The discussion presented in Peter's book appears to suggest that the creek or river arrives first, followed by the formation of the floodplain—this is like saying the chicken came before the egg!

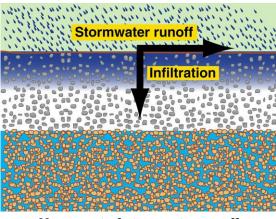
#### Insert: How salts can move through the landscape



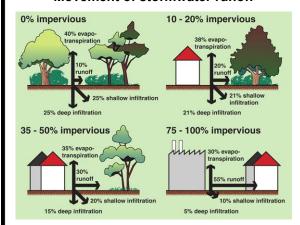
#### Movement of groundwater



Movement of soil-water



#### **Movement of stormwater runoff**



Typical evaporation rates

#### Introduction

- GW: It is water that causes salt to move through the landscape.
- Water, in the form of groundwater, soilwater, infiltrated stormwater, and stormwater runoff.
- Groundwater can lift salts up through the soil, and carry salts down through the soil, but always as <u>dissolved</u> salts.
- Groundwater can also carry salts laterally through the soil, either down the side of a hill, or across a floodplain.

#### Soil-water and infiltrated stormwater

- GW: Free soil-water can carry salts down through the soil, but only in the form of dissolved salts.
- Non-free soil-water is that water that is trapped by the soil and plants through the effects of surface tension.
- Soil-water generally moves along a nearvertical path as a result of gravity.
- Only when the soil becomes saturated can water pressures move the water laterally through the soil.

#### A few definitions

- **GW:** While the rain is in the air, it is termed rainfall, or rainwater.
- A tank that collects the rain before it touches the soil is called a rainwater tank.
- Once the rain touches the land, it is called stormwater (stormwater runoff).
- A tank or pond that collects surface runoff is called a stormwater tank or pond.
- Stormwater runoff can carry salts laterally over the land surface.

#### The retention of salts

- GW: Even though it is water that carries salts through the soil, or across the soil surface, it is evaporation that causes water to separate from the salts, and cause the crystal salt to remain on the land.
- Evaporation can result from heat and wind.
- Freshwater can be extracted from saline water through the process of evaporation, followed by condensation.

#### Insert: Looking at how wetlands can become salty



A wetland on the edge of a dam (Qld)

#### Introduction

- What distinguishes a wetland from a pond, or even a dam, is either:
  - the waterbody primarily has shallow water, or
  - the waterbody is dominated by aquatic plants, or
  - the waterbody operates as a wildlife reserve.
- For these reasons, part of a lake, pond or dam can operate as a wetland.

#### The collection of sea salt

- Crystal sea salt has traditionally been produced through the process of evaporating water from shallow pond that have been filled with seawater.
- If a pond is not regularly flushed by stormwater runoff, or floodwater, then the retained water will become increasingly saline, and if the annual evaporation exceeds the annual rainfall, then eventually the pond will turn into a saltpan.



Salt works (Qld)



#### Wetlands of the lower Murray

- Along the floodplains of the lower Murray in South Australia, there are numerous saltpans that use to exist as 'freshwater' ponds or wetlands.
- Community groups organise to develop new ponds and wetland in order to provide habitat for birds, fish and plants.
- These wetlands can be rich in wildlife, and can contribute significantly to the local environment.

#### Paiwalla Wetland (SA)



Saltpan of the lower Murray (SA)

#### Saltpans of the lower Murray

- Unfortunately, all of these off-stream ponds and wetland will eventually follow the same pathway to becoming a saltpan.
- This outcome is not the result of actions by the South Australian government, or something that should shame the local community.
- It is solely a result of large river system
  passing through a very dry climatic region
  of Australia—the system is controlled by
  the frequency of flood events, not
  domestic water extraction.

#### Contour banks (Page 44)



Traditional contour banks (Qld)



Possible example of Peter's banks (Qld)



Leaky weir (NSW)



**Grade control structure (SA)** 

#### Works done on Tarwyn Park (p. 44)

- 'I decided to run a series of channels across the land from the creek, which I did by digging banks along contour lines.'
- **GW:** Contour banks have been used on farms for many years.
- What makes Peter's contour banks different from most is in the detail of how the water is meant to flow.
- Traditional contour banks are designed to reduce the risk of rill erosion, but not necessarily to hold water on the soil.

#### Peter's contour banks

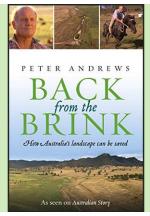
- GW: From what I understand, and from what I have seen on farms that have adopted this approach, Peter's contour banks have the following features:
  - the banks are near continuous, which allows local stormwater, or floodplain flows, to pool behind the banks for extended periods
  - the water is held on the floodplain for longer periods, which increases the volume of water that can infiltrate the soil.

#### Affect of creek erosion (p. 44)

- 'Instead of running down the eroded creek bed as it had been doing, the water could now be spread right across the land.'
- GW: It is important to note that this type of floodplain contouring must work in partnership with the local waterway.
- If the volume of local rainfall is low enough (i.e. in southern Australia), there will be flow attenuation effects created by the increased storage of water on the floodplain. This can reduce the risk of creek erosion.
- If the volume of local rainfall is large (i.e. in northern Australia), then excess stormwater runoff will still enter the creek, but now the flow velocities will be higher due to the contour banks blocking part of the normal flow path—A PROBLEM!
- of a flood event (i.e. distant rainfall), then the same creek erosion problems can occur, unless the creek has been stabilised with grade control structures, and/or leaky weirs.

#### Chapter 7 – Australia as It Used to Be (Page 46)

# Chapter 7: Australia as It Used to Be



Back from the Brink (2007)



Rejection of sound logic



**Confronting reality** 

#### Introduction

- **GW:** Of all the chapters in Peter's book, Chapter 7 is the one closest to my heart, because it addresses the issues most closely associated with my 40 years as a creek engineer.
- In my opinion, and it is just an opinion, this chapter reflects Peter's 'wishes', rather than his observations.

#### You decide

- GW: If you are the type of person that can listen to different points of view, then you don't need me to tell you who is right, and who is wrong—you will be able to decide yourself.
- However, if you are the type of person that will never trust the point of view of an engineer, or worse, a city engineer, then you won't be paying any interest in my comments.
- If the latter, then that is fine—just skip this chapter.

#### Overstating the beauty of the past

- **GW:** We should not elevate the 'past' to a standard that only exists in our dreams.
- If we are unable to look upon the past with open eyes, then we fail to learn the truths that the past can teach us.
- We should not pretend that the world before humans was some type of 'Eden' that defied the laws of nature.
- In the past, entropy was moving the world towards increasing disorder, as it still does today.

#### Australia as it used to be (Page 46)



Australia



Mount Conner (Artilla or Atila) (NT)



Kings Canyon (NT)



Dry creek bed, Kings Canyon (NT)

#### Before humans arrived (p. 46)

- '... since the Australian landscape functioned perfectly well on its own for millions of years, we ought to be able to solve the landscape's current problems by somehow reinstating whatever it was that enabled the landscape to function so efficiently then.'
- GW: Unfortunately this statement reflects how Peter uses, what appears to be simple logic, to describe an issue that I believe he does not fully understand.

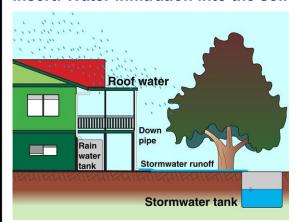
## Did Australia's landscape function perfectly well all those years ago?

- GW: I first read Peter's book some 15
  years ago. My copy of his book has grown
  a bit brown around the edges, and there
  are many notes written in the margins.
- Before I step into this chapter again, let me describe my understanding of Australia's landscape history.
- Before human interference, Australia's landscape:
  - was constantly eroding, sending salt and sediment out into the surrounding oceans, which resulted in the lowering of both the mountain ranges and general land elevations
  - the land was burnt uncontrollably as a result of lightning strikes
  - there was ongoing extinction of plants and animals species that could not cope with the ever-changing climate
  - and foreign plants entered the landscape by wind and bird travel.
- Now, you may, or may not, claim that this outcome represents 'perfection', as Peter claims

#### A dynamic or static environment

- GW: It is a false narrative to suggest that the Australian landscape, at any stage, existed in a state of equilibrium.
- The existence of creeks and rivers is evidence of ongoing erosion.
- Of course, this historic state of constant change should never be used as an excuse for today's much more rapid rate of change.
- We need to accept that we live in a dynamic environment, not a static environment.

#### Insert: Water infiltration into the soil



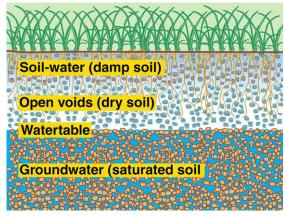
Rainwater vs stormwater



Stormwater infiltration



Floodwater infiltration



Groundwater and soil-water

### Understanding the mechanics of water infiltration into the soil

- GW: In general, there are three types of water movement <u>into</u> a soil;
  - stormwater infiltration
  - floodwater infiltration
  - irrigation water.
- Reminder: While the rain is in the air, we call it rainwater. Once it hits the ground we call is stormwater.

#### Stormwater infiltration

- **GW:** The factors that can influence the rate of stormwater infiltration include:
  - soil permeability (not soil porosity)
  - degree of hydrophobic (water-repelling) soil properties
  - depth of soil profile
  - depth of watertable
  - depth of stormwater sitting on the soil
  - duration that the water sits on the soil
  - slope of the soil surface
  - type of vegetation cover.

#### Floodwater infiltration

- **GW:** Floodwater is stormwater runoff that has arrived from a distant location (i.e. not from your property).
- The factors that can influence the rate and volume of floodwater infiltration include:
  - soil permeability (not soil porosity)
  - depth of soil profile
  - depth of watertable
  - depth of floodwater sitting on the soil
  - duration of the flood inundation
  - type of vegetation cover.

#### The components of Peter's inground water

- **GW:** Peter does not provide a definition of what he means by the term 'inground water', but logic would suggest it is any water contained within the ground.
- Such water would include:
  - plant-available soil-water
  - non-plant-available soil-water
  - groundwater.
- Groundwater exists only within the region of saturated soil.

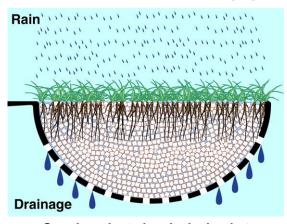
#### Inground water (Page 46)



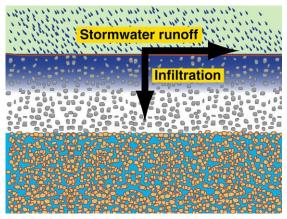
Vegetation on Brighton Beach dunes (Qld)



The author in central Australia (NT)



Growing plants in a leaky bucket



Movement of stormwater runoff

#### Growing plants in pure sand (p. 46)

- 'Let's say you were to take a bucket of sand, stick a plant in it, put it out under the sun and count on whatever rain that fell to make it grow. Would it survive?'
- GW: What Peter is suggesting here is the placement of a plant in pure sand, such as what happens in coastal dunes all around Australia.
- Would it survive? Well, yes it would, if it was an appropriate species of plant that has adapted to sandy soils.

#### Vegetation in sandy deserts (p. 46)

- In most areas of Australia it wouldn't have a hope. The first time it went a week without rain the plant would be dead.'
- GW: Well, there are beaches and vegetated sand dunes all around Australia, which would cover most of Australia's climatic conditions.
- In addition to that, vegetated sand dunes also exist across most of Australia's arid centre.

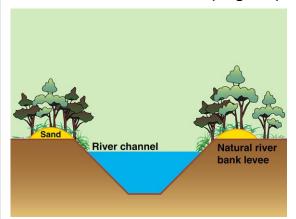
#### Inground water (p. 47)

- What does the sand in those paddocks have that the sand in the bucket doesn't? There can only by one answer: inground water.'
- GW: This 'answer' does not really provide us with any real insight because, for most plants, the water that it survives on will always come from the ground, even though it may have entered the ground from many different sources.
- It is assumed that all water that is within the ground, is 'inground water'.

#### Recharge areas (p. 47)

- 'In the broader floodplain, water entered the ground through sandy, gravelly 'recharge areas' and was stored in the layer of sand and clay that underlies much of the continent.'
- **GW:** This is a half-truth.
- Water soaks into the ground through any permeable surface, <u>not</u> just through sandy, or gravelly, recharge areas.
- Sand and clay layers do not exist under much of the Australian continent.

#### Ancient creeks and rivers (Page 47)



River with natural levee banks



Outback river system (NSW)



Floodplain river system (Qld)



Outback river flooding (SA)

#### Elevated waterways (p. 47)

- 'In the floodplains themselves, water travelled in creeks and rivers that, for reasons which will be explained later, were elevated above the surrounding sediment.'
- GW: I agree that water travels along creeks and rivers, but it is totally false to suggest that prior to human existence within Australia, our waterways were elevated above the floodplain.
- Remember, we are talking about a time when there were no human records.

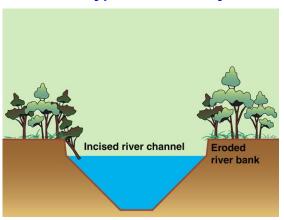
#### Creeks and rivers flowing over floodplains

- 'Rivers and creeks did flow across the floodplains, but they weren't rivers and creeks as we know them. They hadn't gouged out a channel. They flowed over the surface of the plain, not through a channel, which meant that, whenever there was enough water, they'd spread across the plains on both sides, which, as we have seen, were lower than they were, and the water would soak into the ground.'
- **GW:** I struggle to find anything in the above statement that I can agree with.
- Further to that, I am totally confused as to how 'we have seen' evidence that supports these claims, when none of us were around to see any of these actions.
- I can say with absolute certainty that creeks and rivers have always flowed along incised channels.
- However, because many rivers do form natural flood levees on one or both sides of the main channel, there could be times when parts of a river channel were elevated above the adjacent floodplain.

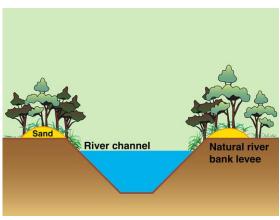
#### Eroded river channels (p. 47)

- Because our rivers and creeks now run through deep eroded channels that are lower than the surrounding land. The floodplains rarely get flooded.'
- GW: Our rivers and creeks have always run through deep eroded channels—that is how a waterway is formed.
- Most of our floodplains will begin to flood during a 1 in 10 to 1 in 20 year flood event, which is only slightly less frequent from what we expect to be a 'natural' flood cycle.

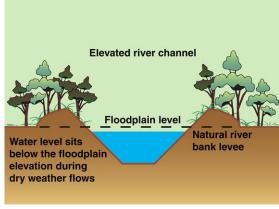
#### Insert: The types of waterway channels



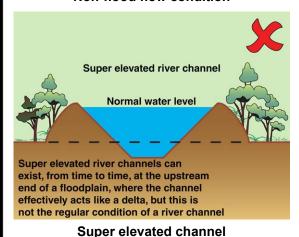
Incised river channel



River with natural floodplain levees



#### Non-flood flow condition

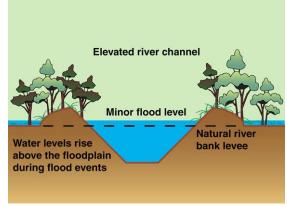


#### Incised river channel

- Most of the waterways that we are likely to interact with, are likely to be incised channels that have experienced years of altered catchment hydrology.
- It is difficult to place 'common' or 'typical' features on waterway channels, but we could expect the original channel to have a bankfull capacity of between the 1 in 2 yr and 1 in 5 year flood events.
- An incised channel could have a bankfull capacity of between the 1 in 5 year and 1 in 10 year flood events.

#### River with natural floodplain levees

- Rivers that carry a lot of sand (typically located in sandstone or granite country), can form natural levee banks made from the deposition of sand.
- Many of the northern rivers of NSW display this characteristic.
- Wetlands can sometimes be found behind these natural levees.
- In most cases, the non-flood water level will be below the elevation of the adjacent floodplains (below, left).

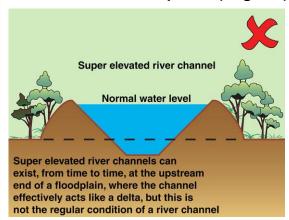


#### Minor flood flow condition

#### Elevated channels

- Only during minor floods will the river level rise above the floodplain elevation (above, right).
- During my 40 years as a waterway engineer, I have never seen the type of waterway channel that Peter believes existed everywhere across early Australia.
- This (left) super elevated channel just does not make sense, except in isolated locations near a river delta—I am yet to be convinced!

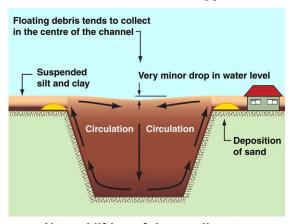
#### The creation of floodplains (Page 49)



Unlikely flow condition!

# Which came first?

The chicken or the egg



Natural lifting of river sediments



Removing river sediment from homes

#### Elevated waterways! (p. 49)

- 'Don't be too surprised at the idea of streams running in elevated watercourses across the ancient floodplain. If you think about it, the floodplains could not have been formed unless water did flow on the higher ground.'
- **GW:** Oh dear, where do I start? Wrong, wrong, wrong!
- The following pages provide a description of just some of the ways that floodplains can be formed.

#### The chicken or the egg! (p. 50)

- 'The floodplains didn't precede the water, they weren't there at the outset, waiting for the streams to flow through them: it was the streams that created the floodplains.'
- GW: This discussion is like arguing over which came first, the chicken or the egg.
- It is not really correct to say the 'stream' formed the floodplain, because it is the 'flood events' that creates the floodplain.
- Floods bring water and sediment. Streams only assist in draining away the last of the floodwater.

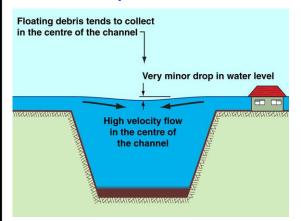
#### The role of sediment (p. 50)

- 'Water laid down the sediment that the floodplains are made of. Now, since water always moves downhill, it couldn't have laid down a floodplain unless it was running through the highest part of the floodplain.'
- GW: Yes, this is true; but, this does not prove that ancient streams were higher than the floodplain.
- It only proves that floodwater passed over the top of floodplains—not all floodwater arrives within a stream channel!

#### The movement of sediment during floods

- 'Sand can't move uphill, after all. Sand could not have been laid across the floodplain if the water was running in a hollow. The water had to be running on the highest part of the floodplain and spreading the sand below.'
- GW: The truth is that sand, silt and clay can, and does, get lifted out of a waterway channel during a flood event (see over page).
- Floods today have shown this over and over again.

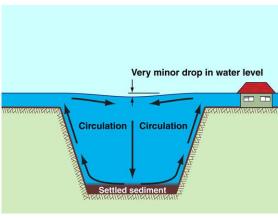
#### Insert: The deposition of sediment from waterways into floodplains



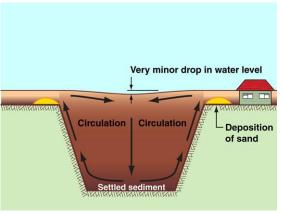
The effects of high central velocity



The riverside 'Drift Cafe', Milton



Circulation patterns



The lifting of bed sediment

#### Introduction

- Fluid mechanics teaches us that water pressures decrease as flow velocities increase.
- During a flood event, the highest flow velocities can be found in the centre of the channel.
- These high flow velocities 'try' to cause a slight lowering the water level in the centre of the channel.
- Thus floating debris tends to move towards the centre of a flooded river (below left and right).



Debris concentrated in centre

# The creation of circulation patterns within the flooded river channel

- The potentially minor lowering of the water level along the centre of the river channel causes surface water to move towards the centre of the channel.
- This movement of surface water causes a downward, central flow of water, which causes an up-flow near the banks.
- These circulation patterns are hard to identify in the field due to all the other turbulence that is happening within a flooded river.

#### The lifting of old settled sediments.

- Between flood events, sediments of various particle sizes will settle along the bed of the river.
- The high-energy, high-turbulent flow that occurs during a flood event will begin to lift this sediment into the water column.
- The weak circulation patterns established by within the channel will, over time, cause some of the sediment to spill-out over the floodplains—with the heavier sands settling near the edge of the channel banks.

#### Insert: Case study of the Brisbane's 2011 flood



Brisbane River, Brisbane, 2011

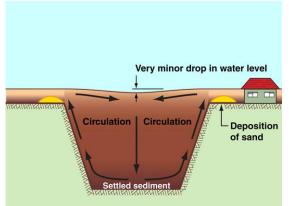
#### Introduction

- Even though it is very hard to see from this one image (left), the floodwater of the 2011 Brisbane River flood had a slight 'green' colour while it was within the river, but more of a 'brown' colour once the water entered into the floodplains.
- The green colour comes from organic matter being stirred-up within the channel, while the brown colour results from the fact that this organic matter settles-out quickly once the floodwater enters the lower turbulence of the floodplains.

#### The deposition of sand and 'heavy' logs

- It is the heavier, coarser material that will settle-out of the floodwater first.
- Logs and sand will often be found on the floodplain, close to the edge of the river channel.
- In some cases, small beaches will form at isolated locations along the river particularly on the inside of channel bends.

Sand particles are between 0.02 and 2 mm in equivalent diameter.



The lifting of bed sediment

#### The deposition of silts and organic matter

- The next material to settle-out of the floodwater will be the silts and organic matter.
- This material will normally settles on the ground of the floodplain, and also the lower levels of buildings.
- This is the material that typically 'stinks', and can smell like raw sewage, once it is exposed to the air.

Silt particles are between 0.002 and 0.02 mm in equivalent diameter.



Muddy, smelly, silt (Brisbane, 2011)

#### The deposition of clay

- The clays are the last of the soil particles to settle-out of the water column.
- Dispersive clays (i.e. sodium-rich clays) may only begin to settle-out when the floodwater mixes with saltwater.
- So, floodwaters can change from a dark brown in the upper catchment, to a greenbrown (in the lower river), to a brown (in the floodplains), to a light brown when entering the ocean.

Clay particles are smaller than 0.002 mm in equivalent diameter.



**Brown floodwater enters Moreton Bay** 

#### Insert: Evidence of an ancient Bargara creek



Bargara, Queensland



- My career enabled me to visit, and present training courses, within every state and territory of Australia.
- During my travels I kept an eye out for my future retirement location; a place where I could move to when my work and travels ended.
- I love Tasmania, my favourite city is Adelaide, and who could not enjoy the northern rivers of NSW, but eventually I settled in Bargara, Queensland.

#### Bargara's volcanic history

- The 'Hummock', Bargara's volcanic reminder was formed 900,000 years ago in the Pleistocene period, with outpourings of the Hummock and Berrembea Basalts in the Bundaberg–Wallaville area.
- Past volcanic activity caused the deposition of basaltic rock over the area between the Hummock and the coastline.
- The underlying rock is sometimes exposed under the sands of Kelly's Beach.



Volcanic rock exposed by beach erosion

# Photo supplied by Catchments & Creeks

Exposed volcanic rock (Qld)

#### Bargara's petrified creek channel

- On the edge of Kellys Beach, adjacent to the current sand dunes, sits a section of volcanic rock, which the author suspects could be the result of molten lava spilling into an ancient creek channel.
- The exposed rock face appears to be the 'negative image' of a creek bank, including horizontal erosion lines, and evidence of bank undercutting.
- If this is evidence of an ancient creek channel, it would show that creek channels existed thousands of years ago.



Exposed volcanic rock 'possibly' showing an ancient creek alignment (Qld)

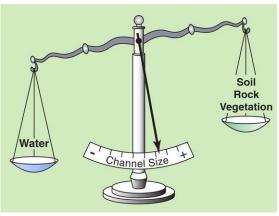
#### Ancient creeks and rivers (Page 50)



Note salt at edge of drying pond (Qld)



Salty wetland (SA)



System out-of-balance



Waterway as a series of ponds (Qld)

#### Observations of Charles Sturt (p. 50-51)

- On the edge of the wetlands the water was too salty for the horses to drink, and on several occasions the horses almost perished before they could find fresh water.'
- GW: These inland wetlands were ephemeral, meaning they would grow and shrink with the weather conditions (and I do not mean climate change).
- This story suggests to me that it had been some time since the last major flood event.
- It sounds like the wetland was in the process of drying-out (even though it may have had some minor inflows).
- As a wetland shrinks in size due to evaporation, it is the water around the edge of the wetland that will be the first to become salty.
- If the wetland contains a lot of reeds, then the winds cannot circulate the water effectively, which means the fresh and saline water stays separated, which is also helped by the density difference between the fresh and saline waters.

#### A 'balanced' system (p. 51)

- 'So here was salty water and fresh water coexisting in a balanced system in the same wetland.'
- GW: Natural processes never exist within a 'balanced system'; otherwise, evolution could not have occurred.
- Everything exists within a constant state of change—what humans have done is alter the <u>rate</u> of these changes.

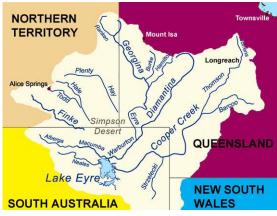
#### A river of ponds (p. 52)

- 'This point needs to be stressed: in the ancient landscape there weren't rivers in our sense of the term flowing in a channel carved out across the plain. A river was just a trail of reeds and ponds along which the water would flow when the rain in the catchment was heavy enough.'
- **GW:** This is simply not true.
- The passing of time does not change the basics of hydrology, river morphology, and hydraulics. Rivers functioned back then the same as they do today!

#### Australia's rivers and floodplains (Page 52)



**Exclamation** 



Lake Eyre catchment map



An 'assumed' healthy floodplain



Fire (NSW)

#### Geological evidence! (p. 52)

- 'There's plenty of geological evidence to confirm this, as well as descriptions by early white settlers and explorers of surviving floodplains.'
- GW: I can assure all readers that such 'geological evidence' does not exist.
- The suggestion of such evidence is simply the result of a misinterpretation of the evidence.
- I am positive that diary notes by early explorers could be easily explained.

#### Floodwater travel times (p. 54)

- 'The fall in the Darling River system is only 5-centmetres a kilometre, so when the river was in its pristine state the water probably took twelve months just to get from Longreach to Menindee'
- GW: I assume this is a simple dictation error, because the Thomson River that flows through Longreach, does <u>not</u> flow into the Darling River, or Menindee Lakes. It flows into central South Australia.
- In any case, the statement implies something that is not true.

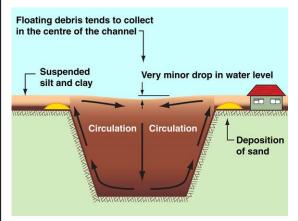
#### Collapse of floodplains (p. 54)

- 'Since then, the floodplain systems have collapsed in most parts of Australia. What caused this to happen? The destruction of vegetation by Aborigines was the start of it.'
- GW: I have seen no evidence of the 'collapse' of floodplains across Australia.
- In my experience, it is common for people to overstate a problem in order to bring attention to an issue they consider to be important.

#### Burning of vegetation (p. 54)

- When the Aborigines arrived and began setting fire to the landscape, vegetation in most areas was burned off at regular intervals. There is no doubt that this happened.'
- GW: I think we can all agree that Aborigines burnt the land at regular intervals, but so did lightening strikes, long, long before Aborigines arrived.
- Our vegetation is more closely linked to our climate, than to burning practices.

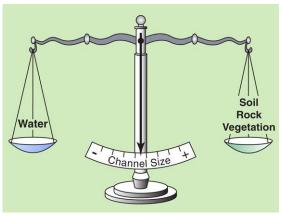
#### The formation of floodplains (Page 56)



**Natural lifting of river sediments** 



Sand extraction from Penrith Lakes (NSW)



A balanced system (short-term)



Cracking clay (SA)

#### Formation of floodplains (p. 56)

- 'Well it has to be remembered that the floodplains consisted entirely of sand at first.'
- **GW:** Floodplains can form from clay, silt, sand, or any combination of these.
- There is no logical basis for the argument presented by Peter.
- Floodplains form from whatever type of sediment flows down a waterway. This will depend on the parent rock of the mountains being eroded (see over page).

#### The deposition of different size sediment

- 'Clay beds were formed in the floodplains only later by plants trapping clay carried in the water and, since the plants were growing in the lower ground, that was where the clay beds were formed. The higher ground remained sandy and therefore better able to take in water.'
- GW: It is normal for the floodplains in the upper reaches of a waterway to contain more sand than the lower reaches, especially if the waterway extends into tidal waters (see over page).

# Once again, Peter is trying to overstate the value of plants (p. 56)

- 'So plants were the key. They controlled everything.'
- GW: Plants are almost always an important player in the shaping of our waterways and their associated floodplains, but if we fail to recognise the importance of the many other factors, then we will not be gaining the full picture.
- The key players are: topography, water, soils (geology), plants, and climate.

#### Cracking soils (p. 59)

- 'Why have I referred to them [cracks in the soil] in the past tense? Because today they hardly exist. Cracks close up and disappear wherever there are hard-footed animals treading on them.'
- GW: Cracking soils are linked to high shrink–swell clays, which still exist today. Clays such as, brown and grey cracking clays, are high in montmorillonite.
- The cracks quickly close when the soil becomes wet due to the natural swelling of the montmorillonite clay.

#### Insert: What influences the likely soil properties of floodplains



Raindrop impact erosion (Qld)



Clayey soil (Qld)



Silty clay soil (Qld)



Sandy soils (Qld)

#### Introduction

- The soils that make-up a floodplain can originate from various sources.
- The most obvious source of floodplain soil (or sediment) is erosion within the upstream waterway, but this is not always true.
- Over a long period of time, the size of the waterway channel does not really change that much (excluding human influences).
- Which means this erosion is actually the lateral movement of the river.

#### When the parent rock is metamorphic

- Continuing the discussion from above, if the source of sediment comes from the ongoing lateral movement of the upstream channel, then the downstream floodplain is formed from the erosion of the upstream floodplains.
- What forms the upper catchment floodplains is the erosion of the upper catchment hills and mountains, or more correctly, the parent rocks that forms these slopes.
- Clay comes from rocks like schist.

#### When the parent rock has been modified

(Geologists, please forgive me!)

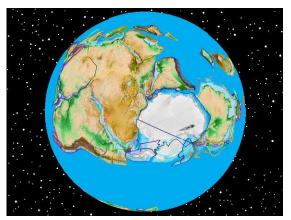
- Rapid-cooling lava forms small crystals in the form of metamorphic rock, which erodes to form clay.
- Slow-cooling lava forms large crystals in the form of igneous rock, which erodes to form sand.
- If either metamorphic or igneous rock is modified by heat or pressure, then the erosion of this modified rock forms silt.

#### When the parent rock is igneous

- People may think that sand originates from the erosion of sandstone; however it is the other way around—sandstone originates from the layering and compression of sand.
- Sand comes from the slow cooling of volcanic rock, which allows large crystals to form (meaning that sand crystals are much larger than clay crystals).
- Typically sand is found in catchments that contain granite rock, such as the northern rivers of NSW.

#### Chapter 8 – A Hot, Dry and Very Flat Continent (Page 60)

# Ch 8: A Hot, Dry and Very Flat Continent



Gondwana (Gondwanaland)



Murray-Darling basin



Moreton Bay, a submerged ancient valley

#### Gondwanaland (p. 60-61)

- 'The rivers that created Australia's floodplains flowed from the mountains of Antarctica, rivers that were left behind when Australia, with its floodplains, broke away. Thus, the floodplains were now separated from the rivers that created them.'
- GW: I am unaware of any information that could support Peter's claim. I cannot say for certainty that Peter is wrong, but I highly question the accuracy of his statement.

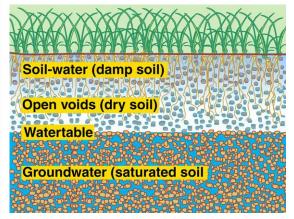
#### Our ancient river systems (p. 61)

- 'I am convinced there were hardly any rivers as such before the Aborigines began burning out the vegetation that had previously prevented erosion in the waterways.'
- **GW:** I am unaware of any information that could support Peter's claim.
- I can assure all readers that if you have drainage catchments, then you will have rivers, and Australia has always had drainage catchments.

#### River delta systems (p. 61)

- 'Why am I so sure there were no rivers as we now know them before the coming of the Aborigines? Because, if there had been, we would surely have big delta systems at the mouths of our rivers as most other parts of the world.'
- **GW:** Because the Australian tectonic plate moved at a different time to the other tectonic plates, the ocean levels were different, which means most of our ancient deltas are currently submerged under ocean water, such as Moreton Bay, and the Continental Shelf.

#### Clay horizons in the soil profile (Page 63)



Groundwater and soil-water



Questionable statement



Clayey soil



Ephemeral, sand-based waterway (Qld)

#### Local effect vs regional effects (p. 63-64)

- 'In a landscape where the water can take years to move from place to place and where fertility has to be recycled, how could processes possibly vary from one area to another?'
- GW: The problems with Peter's logic can be summarised as:
  - Peter appears to confuse, or merge, the role of groundwater with surface flows
  - fertility movement is primarily a local process, and a surface water process, but not a groundwater process.

#### The formation of clay layers (horizons)

- 'We also know that certain plants produce an enzyme that stimulates the clay particles to coagulate and form the clay layer.'
- GW: This is all a mystery to me. I have never heard of this during my 40 years of work. I will need to get clarification from a soil scientists.
- Clay layers (soil horizons) are formed by the sedimentation process that occurs during and after flood events.

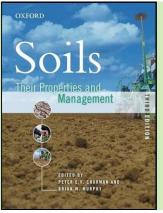
#### Clay layers (p. 65)

- 'In a dry climate such as Australia's, the capacity of the clay to store water is vital to the survival of plant life. Fortunately, the clay can hold up to five times as much water as the topsoil.'
- **GW:** Clay is not good at storing water.
- What is worse, clay can hold onto its water very tightly, making it less available for plant uptake.
- Topsoil can hold more water per volume; but it will not be as deep at the clayey soil horizon.

#### Groundwater recharge (p. 65)

- 'Did the river and creek beds themselves enable water to enter the ground? Very little. These stream beds were sealed by the clay that the water constantly laid down and very little water got through there.'
- **GW:** I am sorry, but this claim is just wrong.
- I am sure there are isolated examples of what Peter has said, but in general there is no justification for such a claim.

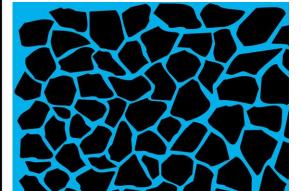
#### Insert: The water-holding capacity of different soil types



☐ Soils, Their Properties and Management



- My reference:
  - Understanding Soil Ecosystem Relationships, 1992, Department of Primary Industries, Queensland, ISBN 0 7242 4987 7.
- Alternative reference:
  - Soils, Their Properties and Management, Charman, P.E.V., and Murphy, B.W., 2007, Oxford Uni Press, ISBN 9780195517620.



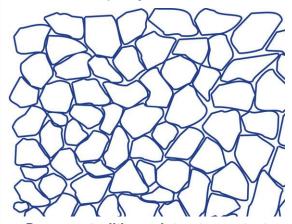
Field capacity water content

#### Field capacity

- The field capacity represents the amount of water held in the soil after free water drains from the macropores.
  - Sand = 9 cm/m
  - Loam = 23 to 34 cm/m
  - Clay = 38 cm/m
  - Well-structured soil = 50 cm/m
- When Peter states that a 'clay can hold up to five times as much water as the topsoil', he is referring to the field capacity, not the plant-available water content (PAWC).

## Permanent wilting point

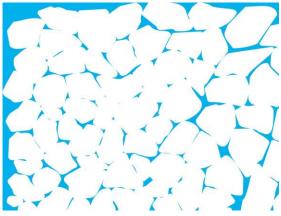
- The permanent wilting point represents the stage when soil-water is held too strongly for the plant to extract it, which causes the plant to permanently wilt.
  - Sand = 2 cm/m
  - Loam = 9 to 12 cm/m
  - Clay = 24 cm/m
  - Well-structured soil = 30 cm/m
- This water is held in place by the water's surface tension capabilities (not by the plants).



Permanent wilting point water content

#### Plant available water content (PAWC)

- The Plant Available Water Content represents the amount of water in the soil that is available for plant uptake.
  - Sand = 7 cm/m
  - Loam = 14 to 22 cm/m
  - Clav = 14 cm/m
  - Well-structured soil = 20 cm/m
- A well-structured soil is likely to contain equal amounts, by volume, of sand, silt and clay, along with organic matter.



Plant available water content

#### Groundwater recharge (Page 66)



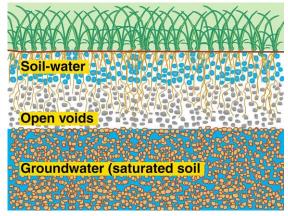
**Questionable statement** 



Floodplain water storage (SA)



**Questionable statement** 



Groundwater is usually too deep!

#### Eroded floodplains (p. 66)

- 'As we have seen, once the vegetation in the creeks and rivers was burnt out or eaten out and the stream became increasingly eroded, floodwater no longer spilled across the floodplains and so no longer entered the ground through these intake areas.'
- GW: This is a trick that writers often use to convince their readers in believing a certain issue by making statements like: 'as we have seen', when in fact nobody has seen any such evidence.

#### Floodplain cease to fill (p. 66)

- 'In other words, the water storage within the floodplains ceased to be filled. Instead, the water rushed down through deeply eroded channels to the sea.'
- GW: Floodplains will continue to feed groundwater into creeks and rivers, and creeks and rivers will continue to feed water back into floodplains somewhere else along the waterway.
- I agree that groundwater recharge will decline as waterways erode, but the process still continues.

#### Floodplain destruction (p. 66)

- 'This marked the beginning of the destruction of Australia's ancient floodplain system.'
- GW: I know of no justification for blaming Aborigines, and the burning of the countryside by Aborigines, for any significant damage to the function of Australia's floodplains.
- This sounds like an attempt to deflect blame away from non-indigenous people, and at the same time claim that vegetation does all the heavy lifting in Australia.

#### Author's note

- GW: There are obvious truths in some of what Peter is saying, but the problem is that Peter often takes what would be considered a 'minor factor' in the system, and then elevates its role to the point where the reader would think that it is a critical factor.
- Yes, vegetation is important, and groundwater recharge is important, but few plants can extract water from the groundwater table because it is usually too deep.

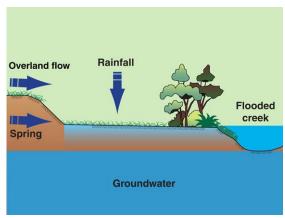
#### Insert: The movement of water into, and out-of, waterway channels



#### Introduction

There are numerous ways that water can pass into, and out-of, floodplains and waterway channels.

Overland flow spilling into a channel

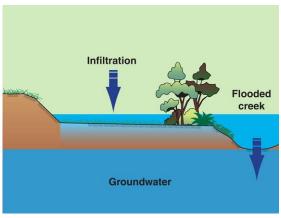


Stormwater can enter the soil profile of a floodplain as a result of:

Stormwater entering floodplain soil

- overland stormwater runoff arriving from higher (non-floodplain) ground
- the build-up of stormwater on the floodplain as a direct result of rainfall
- floodwater from the waterway channel spilling over the floodplain
- sub-surface lateral inflow of spring water, and
- direct infiltration from the channel.

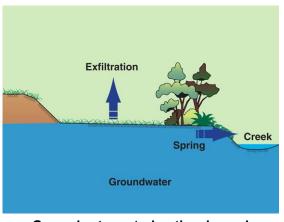
#### Stormwater entering floodplain soil



#### Channel water entering the groundwater

- Waters from the waterway channel can enter the groundwater by:
  - infiltrating through the bed or banks of the channel.
- In addition, during a flood event, channel water can spill out of the floodplain, enter the upper soil profile, then be carried by gravity down into the saturated groundwater layer.

#### Channel water entering the groundwater

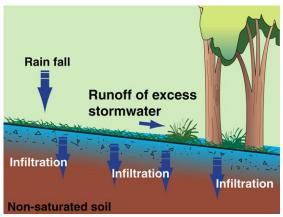


Groundwater entering the channel

#### Groundwater entering the waterway channel

- Groundwater can enter the waterway channel as a result of:
  - spring flows passing through the channel banks, and
  - uplift through the channel bed.
- In addition, during severe storm events, groundwater can saturate the floodplains, and eventually spill as overland flow into the channel.

#### Insert: Factors affecting the infiltration of stormwater into soils

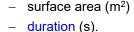


Stormwater runoff

#### Introduction

- Some people have defined stormwater runoff as the surface flow of stormwater over a saturated or impervious surface.
- The problem with such a definition is that it fails to recognise that stormwater runoff can also occur over non-saturated soil.
- Once the rainfall exceeds the current infiltration rate of the soil, then the excess stormwater inflow will spill away from the soil, assuming the stormwater fully contained (i.e. is free to move).

# The total infiltration of water into the soil is a product of:

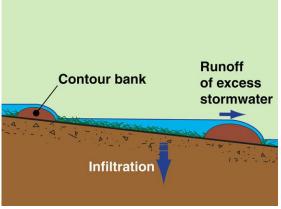


Effects of 'duration'

- You can increase the duration that the
  - stormwater is held on the soil by:

rate of infiltration (m³/s/m²) or (L/s/m²)

- roughening the soil surface
- planting non-clumping ground cover
- pooling the water with contour banks.



Use of contour banks (long-section)

#### Effects of 'water depth'

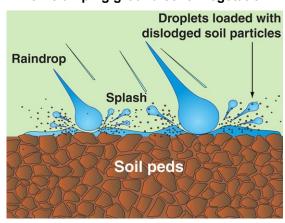
- The infiltration rate of water into the soil is influenced by:
  - the soil permeability (not porosity)
  - the planting ground cover
  - the depth stormwater.
- You can increase the depth of the stormwater by:
  - roughening the soil surface
  - planting non-clumping ground cover
  - pooling the water with contour banks.



Non-clumping ground cover vegetation

#### Effects of 'raindrop impact'

- Raindrop impact erosion can:
  - separate clay particles from soil crumbs and peds (aggregates)
  - explode clay particles into the air (that may cause a brown stain on the side of buildings)
  - cause these clay particles to fill all the cracks and pores in the soil surface, thus preventing, or at least slowing, the infiltration of stormwater.



Raindrop impact erosion

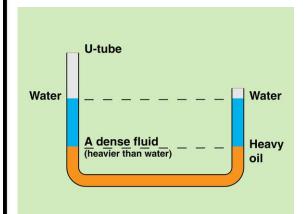
#### Insert: Hydrostatics



Fluids of different densities, at rest

#### Introduction

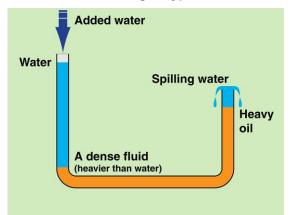
- Hydrostatics is the study of fluids, and their properties, while the fluids are stationary.
- Hydrodynamics (my area of interest) is the study of fluids in motion.
- Fluids, or liquids, include: water, oil, air, and to some degree, outer space.



#### Fluid static in a U-tube

- When two fluids of different densities are placed in a U-tube, the heavier fluid will naturally fill the lower portion of the container.
- Both fluids remain at rest.
- In this example (left), the same quantity of the lighter fluid currently exists within both sides of the U-tube.

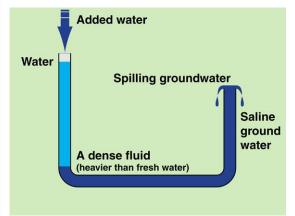
#### U-tube containing to types of fluids



#### Adding more of the lighter fluid

- If more of the lighter fluid (say freshwater) is added to one side of the U-tube, then a new hydrostatic balance will be achieved.
- The air pressure on both sides of the U-tube are identical (atmospheric).
- The liquid pressure across the base of the U-tube is uniform (equal) once a new static condition is reached.

#### More of the lighter fluid added

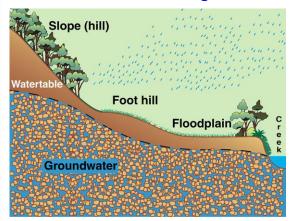


The spilling of the lighter fluid

#### More of the lighter fluid added

- If even more of the lighter fluid (say freshwater) is added to one side of the Utube, then eventually all of the lighter fluid can be pushed out of the container by the heavier fluid (say, saltwater).
- In the same way, an addition of freshwater to the upper slopes of a landscape can raise the groundwater in the lower landscape, causing all the soil-water to be pushed out onto the soil surface, and the underlying brackish groundwater to reach the soil surface.

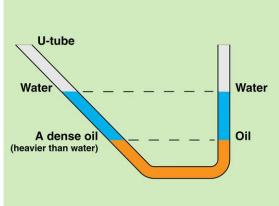
#### Insert: The movement of groundwater down a slope



#### Introduction

- A landscape with a variable surface elevation (a slope), usually has a watertable with a variable elevation.
- A gradient in the surface of the watertable (i.e. the top of the groundwater), is generated by dynamics of the system (i.e. the system is constantly changing with time due to the constant inflow of more stormwater).

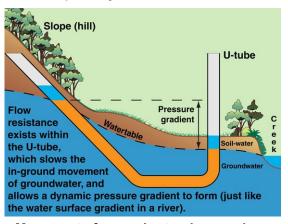
Typical land profile



U-tube

- In a static system, the surface the fluid remains constant across both sides of the U-tube.
- If the U-tube is filled with two or more fluids that don't mix, then:
  - the heavier fluid will fall to the bottom
  - the atmospheric (air) pressure will be equal both sides
  - the surface level of the heavier fluid will depend on how much of the lighter fluid is in each side of the U-tube.

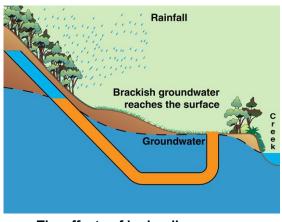
U-tube partially filled with oil and water



#### **Groundwater movement**

- In a dynamic system (i.e. changing with time), a pressure gradient can exist between one side of a U-tube, and the other side.
- This gradient represents the in-ground flow of groundwater, and the soil's resistance to any such flow.
- The watertable, and thus the underlying groundwater, normally has a direct link to the elevation of any permanent water in an adjacent watercourse.

#### Movement of groundwater down a slope



The effects of hydraulic pressure

#### Groundwater reaches the surface

- If rainfall places additional freshwater into the soil on the upper slopes, then this can:
  - pressurise the groundwater under the hill slope, which can
  - pressurises the groundwater under the floodplain, which can
  - cause an uplift in the watertable, and the fresh soil-water to be expelled from the floodplain.
- Unfortunately, plants CANNOT stop this process, they can only slow it down.

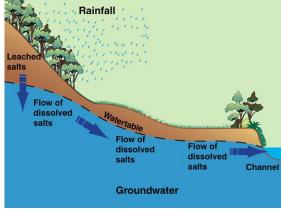
#### Insert: The potential movement of salts through the ground



#### Introduction

- How water moves through our landscape depends on whether that water remains as a liquid, or if has been converted into a gas, liquid mixture, or a solid.
- Similarly, the movement of salts through our landscape depends on whether the salt is travelling as:
  - crystal salt (a solid)
  - dissolved salt (a liquid)
  - blended salt in the farmer's lunchbox.

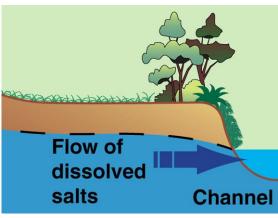
#### Surface salt (NSW)



Movement of salts with the groundwater

- Salt water, brackish water, and freshwater can move through soils with equal ease.
- Salts dissolved into the groundwater will move wherever the groundwater moves, which includes:
  - up
  - down
  - left. and
  - right.
- Few things can interfere with the natural movement of groundwater.

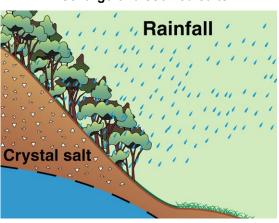
#### Leached salts



#### Movement of salts into channels

- There will be times when groundwater trickles into waterway channels, and times when channel water infiltrates into the earth to join with the groundwater.
- It is NOT true that most waterways have a clay based that prevents the channel water from infiltrating into the soil.
- If a drainage channel is constructed through saline soils, then these soils will leach saline water into the excavated channel.

Discharge of dissolved salts



Retained crystal salts

#### The retention of salts within drying ground

- Rainfall and the resulting stormwater runoff can wash most of the crystal salt from the land surface.
- Stormwater infiltration can leach some of the crystal salts from the soil—a little each time, but remember, after millions of years, the salts are still there.
- These in-soil salts are NOT replenished by the salt content of rainwater.

#### Chapter 9 – The Truth About Salinity (Page 70)

# Chapter 9: The Truth About Salinity



Water tank support structure (SA)



Salt damage to brick wall (Qld)



Salt affected vegetation (SA)

#### Rising salt (p. 70)

- 'Salt doesn't rise.'
- **GW:** Salt most definitely can rise, fall, and move sideways through the soil profile.
- Salt can also rise from the ground and move up into buildings.
- It is important to remember that salt does not move as a crystal, but as a dissolved salt.
- Remember: wherever groundwater can flow, saline groundwater can flow.

#### Rising salt water (p. 70)

- 'Whenever salt water rises, it's because some other source of energy has forced it up. True, capillary action can raise a limited amount of salt a limited distance, but it can't be responsible in this case [salt climbing a brick wall].'
- GW: There will always be some type of force required to make anything change its speed or direction of movement. We call this Newton's first law of motion.

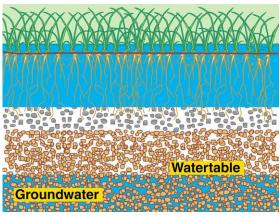
#### Lifting forces (p. 70)

- 'If salt breaks out of a masonry wall there has to be some other force pushing it up, and that force can only by the wall's own weight and the weight of the structures that the wall supports.'
- GW: Peter does not appear to have provided a reason why capillary action cannot lift salt to such a height.
- Similar forces can cause water to be lifted to the top of trees, and cause dissolved salts to be lifted high into a tree, crystallise, and then kill the tree.

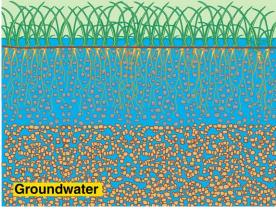
#### Insert: The water that plants use



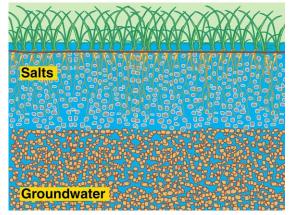
Soil moisture inspection



Plant's access to soil-water



Plant's access to 'groundwater'



Salts lifted by groundwater

#### Introduction

- Plants can only access water that:
  - can gravitate towards the plant's roots
  - and that it can extract from the soil using the effects of vapour pressure (not surface tension).
- It is not surface tension that lifts water from the ground to the upper leaves, it is the much more powerful vapour pressure, which tries to keep water molecules linked together without particle separation occurring.

#### The use of soil-water

- To a large degree, soil-water (i.e. the water held in the soil profile <u>above</u> the watertable) is able to resist the downward force of gravity due to the effects of surface tension.
- The power of surface tension is directly related to the soil texture, i.e.
  - the soil grain size (the smaller, the stronger the surface tension)
  - the range of soil grain sizes (the more uniform the soil grains (crumbs), the stronger the surface tension).

#### The use of groundwater

- Plants can only access the groundwater if:
  - a lifting of the watertable brings the groundwater in close proximity to the plant's roots, or
  - the soil profile becomes saturated in a manner that effectively causes the watertable to reach the soil surface, even though the upper soil-water may have different properties from the lower soil-water.

# The problems caused by rising groundwater levels

- There are two types of soil saturation that regularly occur:
  - the upper soil becomes saturated without full saturation occurring all the way down to the watertable
  - soil saturation occurs all the way down to the watertable.
- The second case can also occur when the watertable is lifted up to the ground surface, which can cause the lifting of the salts.

#### Movement of salts through the soil profile (Page 71)



Sandy soil (Qld)



Clacking clay (Qld)



Water quality monitoring (Qld)

#### The Truth About Salinity

pushing it up, and that force can only be the wall's own weight and the weight of the structures that the wall supports. Most walls stand with their feet in clay – and clay always contains salt. Now, we know clay contracts and expands as it dries and gets wet, so it stands to reason that this pulsing effect, under pressure from the weight of the wall, would pump salt up the wall. But the salt couldn't have risen of its own accord. Salt doesn't rise in the landscape, either, but it can move in a lateral plane. Where there are salt outbreaks, it's because the lateral plane in which the salt is moving has intersected with the ground's surface.

Another common misconception about salinity is that it's the fault of the water table. A water table is commonly defined as

#### **Book margin notes**

#### Salty clay (p. 71)

- 'Most walls stand with their feet in clay and clay always contains salt.'
- **GW:** I am sure the news that most walls stand with their feet in clay will come as a shock to the residence of Perth.
- Yes, technically there will always be some percentage of clay, but sometimes it is so small it cannot reasonably be detected.
- Yes, technically there will always be some percentage of salt in clay, but in most clayey soils the level will be very low.

#### Shrink & swell clays (p. 71)

- 'Now, we know clay contracts and expends as it dries and gets wet, so it stands to reason that this pulsing effect, under pressure from the weight of the wall, would pump salt up the wall.'
- GW: This expansion and contraction (shrink and swell) of clays is really only linked to certain types of clay.
- Even if the clay could generate such pressures, this would only lift the salt to ground level (Sorry, there is not enough room to fully discuss this issue).

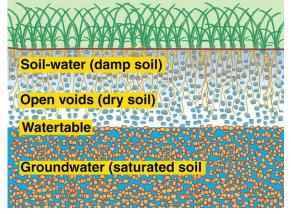
#### Salt in the landscape (p. 71)

- 'Salt doesn't rise in the landscape either, but it can move in a lateral plane.'
- **GW:** At this point it is unclear to me why it is important to Peter to believe these ideas.
- It is not possible to visually observe salt being lifted up to ground level because it travels as dissolved salts (i.e. water).
- It is only after the water has evaporated that the crystal salt become visible.
- You can detect the salt with instruments.

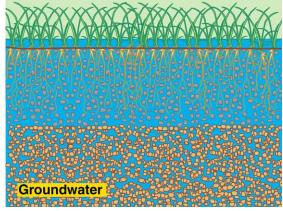
#### Salt outbreaks (p. 71)

- 'Where there are salt outbreaks, it's because the lateral plane in which the salt is moving has intersected with the ground's surface.'
- GW: Salt outbreaks can occur because of the reasons Peter suggests, but many other causes do exist.
- In my copy of Peter's book, I can see the word 'Rubbish' written in the margins all over this chapter as a reminder of my reaction to my first reading of the book.

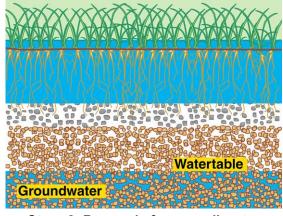
#### The watertable (Page 71)



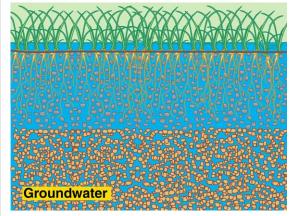
Groundwater and soil-water



Stage 1: Saturated upper soil profile



Stage 2: Removal of some soil-water



Stage 3: Rainfall refills the soil profile

#### Watertable (p. 71)

- 'Another common misconception about salinity is that it's the fault of the water table. A water table is commonly defined as the top of a horizontal zone in the ground that is full of water.'
- GW: No it isn't! A watertable is the water surface that defines the top of the saturated zone in an unconfined aquifer at which the pressure is atmosphere.
- A upper surface of the watertable can be, and usually is, inclined (not horizontal).

#### The job of a tree cover (p. 71)

- 'According to this view, in days of yore, when the landscape was still covered with timber, the trees sucked enough water out of the ground to keep the water table down.'
- **GW:** Even though Peter disagrees with this logic, I can assure the readers that, in essence, the statement is true.
- But the trees cannot stop the watertable from reaching the surface in all circumstances; they just reduces the frequency of such outcomes.

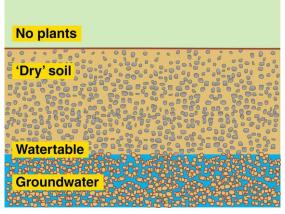
#### Keeping the water table down (p. 71)

- 'What's wrong with this theory? Just about everything. In the first place, trees don't necessarily keep the water table down.'
- GW: As I said; trees don't necessarily keep the watertable down, but they do reduce the number of times that saline groundwater is able to reach the surface.
- Trees extract and use the soil-water (freshwater) that sits between the soil surface and the watertable, which means it will take more rain to re-saturate the soil profile.

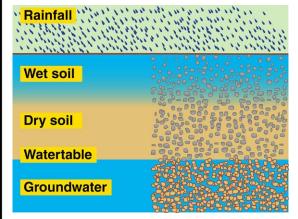
#### Boggy ground (p. 72)

- 'I'd gone to Dubbo to put in a 5-kilometrelong contour line but had to stop work when it rained. We started up again with the bulldozer when the weather cleared, and, although the ground was still damp, the bulldozer got bogged in only one place.'
- GW: The cause of the boggy soil was NOT because the watertable had risen, but because the rain had saturated the upper soil-water layer, and the shading had slowed the evaporation rate.

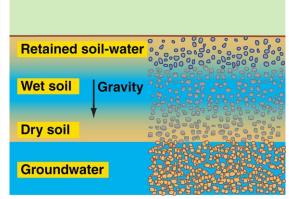
#### Insert: The movement of water through a soil profile - NO PLANTS



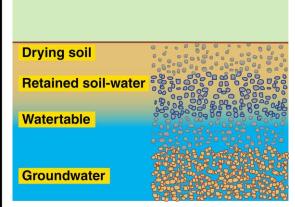
Dry soil with no plant cover



Light rainfall



Rain stops



Dry period

# Consideration of water movement within a soil profile without vegetation cover

- Consider a soil with the following soil profile:
  - the upper soil, possible consisting of the A-horizon and B-horizon soil
  - the middle soil, which is likely to be below the root depth of most plants
  - the lower soil region that is likely to contain groundwater, which could be fresh, but is more likely to be slightly brackish.

#### Light rainfall

- Light rainfall can wet the upper soil region.
- The soil still has some degree of stability because of the drier middle soil region (i.e. the soil remains relatively stable if a light vehicle drove over the soil).
- Any stormwater that infiltrates the soil will slowing fall through the soil profile due to the effects of gravity.

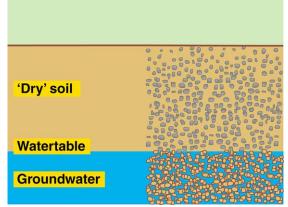
#### Rain stops

- The rain stops, and any stormwater that had infiltrated the soil either:
  - evaporates
  - stays attached to the soil particles due to the effects of surface tension (most of this water, but not all, would remain available to plants if they were in place)
  - or otherwise, the water would continue to fall through the soil profile towards the watertable.

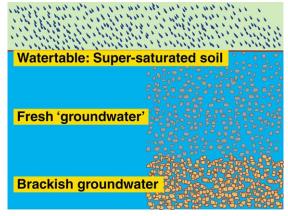
#### Dry period

- Without plant cover, evaporation would be high, and could dry the soil to a depth of several centimetres.
- The middle region of soil may retain some attached soil-water due to surface tension.
- Most of the water would continue to descend until it reaches the watertable (and joins with the groundwater).
- Technically, the 'watertable' temporarily rises to the top of this incoming water, which may, or may not, have absorbed salts on its travels through the soil.

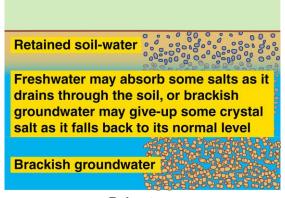
#### Insert: The movement of water through a soil profile - NO PLANTS



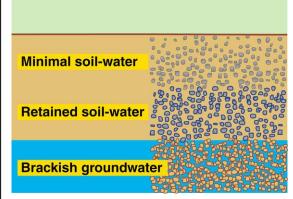
#### Extended period of dry weather



Heavy rainfall



Rain stops



Extended period of dry weather

#### Extended period of dry weather

- If the dry weather continues, then the soil profile could eventually return to its fully 'dry' condition.
- However, the soil is not completely dry because there will be some water that remains attached (adsorbed) to the surface of the soil grains.
- The finer the soil grains, the greater the volume of water that can remain trapped in the soil due to the effects of surface tension.

#### Heavy rainfall

- If the soil profile is subjected to heavy rainfall, then the soil can become saturated from the ground surface, all the way down to the permanent groundwater.
- Technically, this places the position of the watertable at the soil surface.
- The soil profile is now super-saturated.
- The soil usually looses its structural strength, and becomes boggy.
- The upper region of groundwater is fresh and does not mix with the brackish water.

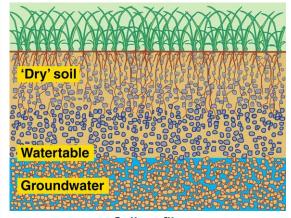
#### Rain stops

- The rain stops, and the retained soil-water either:
  - evaporates
  - stays attached to the soil grains, or
  - continues to fall through the soil profile towards the long-term groundwater level.
- The fact that fresher water sits on brackish water does not mean that salts will be lifted up into this upper 'freshwater'; however, some limited mixing can occur.

#### Extended period of dry weather

- If another period of dry weather follows this heavy rainfall, then the soil profile will likely become:
  - upper dry soil
  - middle layer of soil with some retained soil-water, which cannot evaporate, or fall under gravity
  - lower soil region, which likely contains the permanent watertable and groundwater.

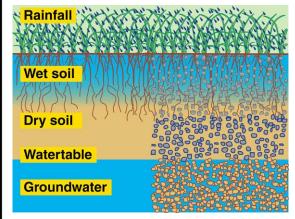
#### Insert: The movement of water through a soil profile - WITH PLANTS



# Consideration of water movement within a soil profile with vegetation cover

- Consider the same soil profile as before, but with plant cover:
  - the upper soil, possible consisting of the A-horizon and B-horizon soils
  - the middle soil, which is likely to be below the root depth of most plants
  - the lower soil region, which is likely to contain groundwater, that could be fresh, but is in this case is brackish.

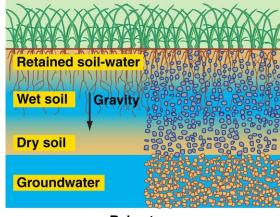
#### Soil profile



#### Light rainfall

- With vegetation cover, the differences are:
  - less soil erosion on the land surface
  - lower rates of evaporation
  - slower runoff velocity, which means stormwater is held on the land for longer periods, which increases the percentage of stormwater that has time to infiltrate the soil.
- The depth of soil wetting depends more on the duration of rainfall, than the intensity of rainfall.

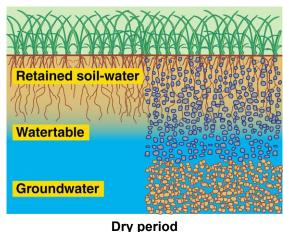
Light rainfall



#### Rain stops

- With vegetation cover, the differences are:
  - lower rates of evaporation from the upper soil layer
  - some soil-water from the upper soil layer is taken-up by the plants
  - as air re-enters the upper soil layer, the plants will be able to extract oxygen from the soil during the nights.
- The plant roots are unlikely to reach to the depths of the watertable and underlying groundwater; however, this will not be the case at every location.

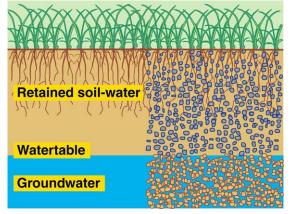
#### Rain stops



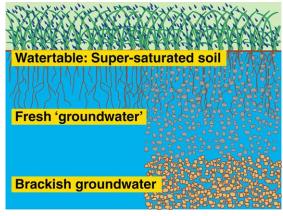
#### Dry period

- After an extended dry period, if vegetation cover still exists, the differences are:
  - lower rates of evaporation from the upper soil layer
  - the plants continue to extract oxygen from the upper soil region during the nights.
- Any stormwater that falls past the root zone will continue to fall towards the groundwater.

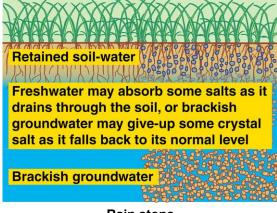
#### Insert: The movement of water through a soil profile - WITH PLANTS



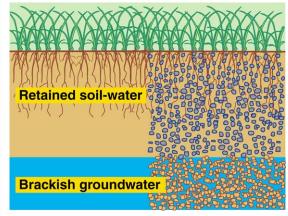
#### Extended period of dry weather



Heavy rainfall



Rain stops



Extended period of dry weather

#### Extended period of dry weather

- Plants DO NOT lift the soil-water up to the land surface, except for the water that is fully contained within the plant's roots.
- Plants DO lift metals, minerals and nutrients from the upper and middle soil regions up into the structure of the plant.
- Leaf mulch dropped by plants ultimately results in these materials helping to form new topsoil.
- When the plant dies, if left in place, the minerals and metals will enter the topsoil.

#### Heavy rainfall

- After heavy rainfall, and with vegetation cover, the differences are:
  - plant roots can provide limited structural strength and stability to the saturated soil, which can reduce the risk of land slips
  - this increased soil strength can assist in dealing with limited pedestrian traffic during this period of soil saturation.
- Some large trees can become unstable if subjected to strong winds.

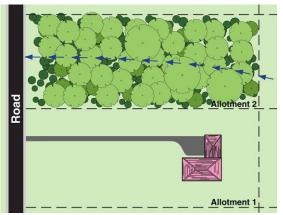
#### Rain stops

- Vegetation cover does not really change this phase of soil-water movement.
- Salts are only likely to be lifted up into the middle soil regions in situations where the brackish groundwater is lifted up into these regions, possibly as a result of:
  - extended periods of rainfall increasing the lateral flow of groundwater towards a waterbody
  - extensive land clearing that similarly, increases the lateral flow of groundwater towards a waterbody.

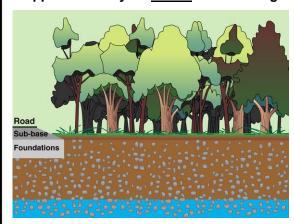
#### Extended period of dry weather

- After an extended dry period, if vegetation cover still exists, the differences are:
  - lower rates of evaporation from the upper soil layer
  - soil-water continues to be taken-up by the plants from the upper and middle regions
  - the plants continue to extract oxygen from the upper soil region during the nights.

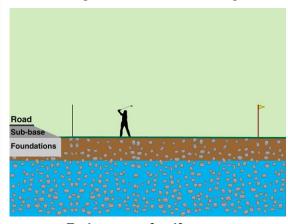
#### Insert: The story of the private 3-hole golf course



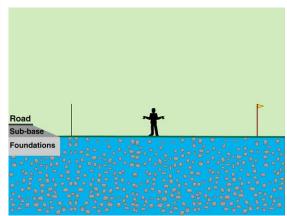
Approximate layout before land clearing



Pre-golf course land clearing



Early years of golf course



Watertable reached the land surface

#### **Background**

- The following discussion outlines the key findings from a stormwater investigation the author performed while working for Brisbane City Council in the early 1990s.
- The council had received a written complaint about some recent road maintenance work.
- The complaint suggested that these road works had caused the ongoing saturation of a private 3-hole golf course located upslope of the road.

#### Land use prior to the road works

- The landowner owned two large adjoining properties in a rural-residential region of the council, which were located on the high-side of a council road.
- The landowner had a home on the allotment that had previously been partially cleared of trees.
- The adjoining allotment was heavily wooded, and it contained a natural overland flow path (i.e. no creek or formal drain existed).

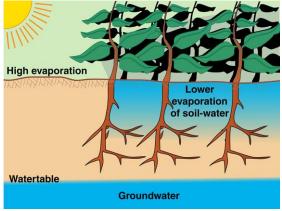
### The cause of the problem according to the landowner

- A few years before the road maintenance works were conducted, the landowner had cleared the adjoining property of all trees, and built a 3-hole practice golf course.
- Shortly after the road works had been completed, the landowner had found that his golf course was becoming increasingly saturated, to the point of no longer being useable.
- The landowner believed the road works had stopped the natural groundwater flow.

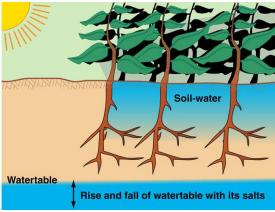
# My assessment of the cause of the problem

- My investigations identified the following:
  - the road works would not have altered the natural groundwater flow
  - the allotment in question was previously heavily wooded (from aerial images)
  - the clearing of the allotment had caused the watertable to slowly rise towards the surface
  - natures next step would have been to erode a low-flow channel through the allotment.

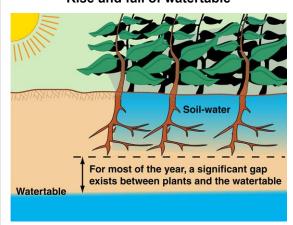
#### **Groundwater (Page 72)**



#### Effect of shading



Rise and fall of watertable



Typical separation of roots from watertable



Draining away salts (SA)

#### Evaporation (p. 72)

- 'Trees also shade the ground, cooling it and so reducing evaporation. In this way, they can actually raise the water table.'
- GW: Reducing evaporation helps to retain soil-water in the upper soil profile, but it is unlikely to impact groundwater levels.
- Besides direct shading, one of the influences trees have on evaporation is through the reduction in the air movement (wind) near the ground.

#### Draining saline groundwater (p. 72)

- '... pumping water out of the ground to reduce the water table won't cure salinity.
   Sure, it will remove a certain amount of salt water from the landscape, but what happens when it rains again and the water table rises to where it was previously?'
- **GW:** If it rains, and the watertable rises to an elevation that is below the plant's roots, then nothing bad happens.
- By draining away the saline groundwater, we are reducing the risk of the groundwater rising to problematic levels.

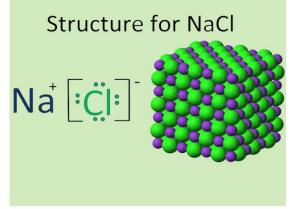
#### The water that plants actually want (p. 72)

- '... why would anyone want to pump away a water table that plants depend on for survival in the dry times?'
- GW: Very few plants, including trees, depend on groundwater for their survival.
- In problem areas, the groundwater is likely to be too saline for plants.
- What we don't want is a rising, saline, watertable to lift the plant-available freshwater (soil-water) out of the ground, and have it wash away with the stormwater.

#### The wrong advice (p. 73)

- 'There is too much evidence available to show that digging drains only makes the problem worse.'
- **GW:** Unfortunately, Peter does not provide any evidence of this 'too much evidence'.
- I believe that government bodies have presented clear evidence that the current measures do work.
- We will always have a salt problem in Australia because the problem cannot be cured; it can only be managed.

#### Salt (Page 73)



#### Salt



#### Salt concentrations (parts per thousand)



Salt affected plants (SA)

#### The origin of salt (p. 73)

- 'By and large, though, the salt causing our salinity problems today has been introduced to the landscape by rain. It arrives dissolved in rain.'
- **GW:** Peter has returned back to the eternal argument: What came first, the chicken or the egg?
- Unfortunately for Peter's argument, our oceans didn't deliver salt to our land, it was the salt leaving the land that made our oceans saline.

#### Is this concentration of salt bad?

- 'Sixty parts per million of rain consists of salt.'
- **GW:** My best research found:
  - rainwater has 20 ppm or less
  - natural freshwater has 20–1000 ppm
  - irrigation water, 200–800 ppm
  - brackish water > 1000 ppm
  - seawater approximately 35,000 ppm
  - saline groundwater, 35,000 to 100,000.
- So, 60 ppm is considered 'fresh' water.

#### The misunderstanding of salt (p. 74)

- 'So salt doesn't rise, water tables don't cause salinity and rain is mainly responsible for bringing in the salt.'
- **GW:** Salt can be pushed up and down through a soil profile.
- Soil-water can move salts, drain salts away from a soil, and leave salts behind when the water evaporates.
- I believe Peter has completely misrepresented the facts about salt and its movement.

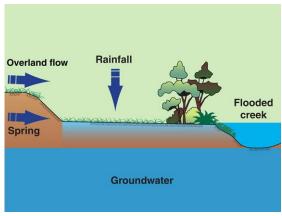
#### Do plants need salt? (p. 74)

- 'Its the same with plants. They need sugar, which they produce by photosynthesis, and they need salt.'
- GW: Living organisms that have a nervous system need salt in order to generate their communication system.
- I am not aware that plants have a nervous system, or why they would <u>need</u> salt, but this is not my area of expertise.
- Salt is damaging to plants. Some plants can tolerate salt, but that does not mean they need it.

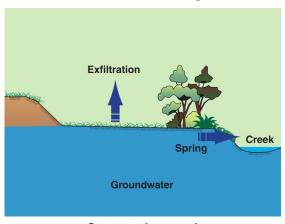
#### The role of plants (Page 74)



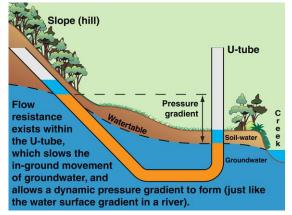
Working the soil (NSW)



'Normal' non-saturated ground



Saturated ground



The effects of water pressure

#### The importance of plants (p. 74)

- 'If you disrupt the balance by burning or ploughing a paddock and getting rid of the plants, you'd end up with an excess of salt.'
- **GW:** I see no justification for anyone to make such a statement.
- Most plants take-up so little salt that you would not be able to measure it.
- Even salt tolerant plants take-up so little salt that they cannot be used commercially to remove salt from salt-affected land.

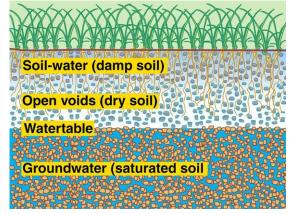
#### Overstating the role of plants (p. 74)

- 'Salinity has nothing to do with water tables, but it has everything to do with plants – or, rather, the absence of them. Plants are the key. They alone manage the landscape, including its salinity.'
- GW: I see no justification for anyone to make such a statement—It is all wrong. Just so wrong!
- However, we can say that plants do play a major role in controlling soil-water, which is the freshwater found above the watertable.
- Plants do take-up this fresh soil-water.
- Therefore, it is the action of plants that helps to remove water from the soil profile above the watertable.
- Because of this, it takes a lot more stormwater infiltration, or lateral groundwater inflow, in order to re-saturate the soil profile.
- If the lateral inflow of groundwater is sufficient to raise the watertable up to the soil surface, then salts will be lifted up to the plants, and possibly crystallise on the soil surface.

#### The lifting of brackish groundwater (p. 74)

- 'This salt water cannot possibly surface as long as there's a layer, or lens, of fresh water above it – that is, just below the surface. The fresh water will always keep the salt water suppressed . . .'
- **GW:** This statement does not comply with the laws of fluid mechanics.
- Saltwater can lift freshwater, just as it can lift boats—all it takes is sufficient pressure, which it gains from the adjacent topography, which Peter's diagram on his following page clearly shows.

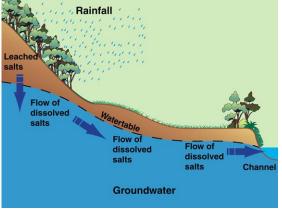
#### Insert: How groundwater can lift salts up to the soil surface



#### Introduction

- In-ground salts can only move through the soil while in a dissolved form.
- Of course, crystal salts can move <u>with</u> the soil during a landslip.
- While the salts are dissolved in the soilwater, or groundwater, these salts are able to move wherever the water moves.

#### Normal dry-weather soil profile



#### The lateral movement of groundwater

- The upper surface of the groundwater is referred to as the 'watertable'.
- The watertable is rarely 'flat', but instead it typically has a gradient in all directions, which causes the lateral movement of the groundwater, including any dissolved salts.

(In this publication I have adopt the singleword term; 'watertable' as adopted by the Macquarie dictionary, and Australian Standard.)

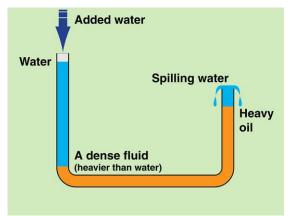
#### Lateral movement of saline groundwater



# The lifting of the watertable at low points in a landscape

- The watertable is often found close to the land surface at:
  - depressions in the landscape
  - at a sudden change in land gradient, such as the base of a hill slope.
- Increased hydraulic pressures can lift, and expel, a freshwater lens just as easily as it can lift the actual groundwater.

#### A temporary rise in groundwater



Freshwater displaced by groundwater

# Rising groundwater levels pushing fresh soil-water out of the soil profile

- The relative density of freshwater and groundwater is:
  - relevant to the positioning of one water type above and below another water type, but
  - irrelevant to the ability of hydraulic pressures to lift such waters.
- Rainfall on an adjacent hill-slope can increase internal hydraulic pressures, which can raise groundwater, and expel near-surface water.

#### Insert: The case of the always green, sometimes saturated, nature strip



#### Saturated road verge (nature strip)

**Bedrock** 

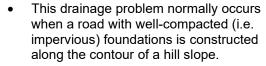
#### Introduction

- Readers may have noticed that some urban road verges (nature strip, footpath):
  - always appear 'greener' than others
  - have soils that often appear saturated
  - may have groundwater weeping over the edge of the concrete kerb.
- Or maybe it is only stormwater nerds like myself that notice these things—anyway, what is the cause of this action?

#### The movement of soil-water down a slope

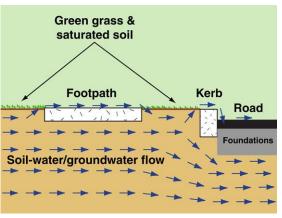
verge

Road



- On hill slopes, both fresh soil-water and brackish groundwater slowly flow down the slope, at the same time the fresh soilwater continues to move closer to the groundwater.
- However, things change if either of these flows meet an impervious barrier (e.g. the foundations of a road or house).

## The movement of soil-water at a verge



Saturation of the grass verge

# The reason for the 'sometimes saturated' grass

- On hill slopes, there can be water movement just below the surface of the soil.
- If this water movement confronts a roadway and deep road foundations, then the soil-water must either pass under, or over this impervious barrier.



**Broadleaf 'Carpet Grass'** 

# Note the existence of a broadleaf grass in hot, dry climate

- Often these 'saturated' areas of ground can be found:
  - at the base of a slope where the land slope suddenly flattens
  - on the up-slope side of a road that has been built along the contour.
- In these areas, high-water usage, broadleaf grasses often appear, as compared to the thinner, low-water usage grasses that are located across the rest of the suburb.

#### The role of plants (Page 76)



Difficulties of planting in saline areas (WA)



Saline-affected trees (SA)



Saline-affected trees (SA)



Salt-tolerant grasses (SA)

#### The role of plants (p. 76)

- 'Since plants prevent salinity, the obvious thing for farmers to do is grow more plants by improving the soil's fertility.'
- **GW:** I know of no evidence that proves that plants 'prevent' salinity!
- Certainly, plants are a major player in the fight against salinity, but if human activities force a change in the landscape, then plants alone cannot prevent the consequences. Instead, we will need to address the changes in the landscape and hydrology that caused the salinity.

#### He cannot wait for trees (p. 76)

- 'I stress the need for quick results we simply don't have time to wait for trees to grow.'
- GW: Peter's words were written in 2006.
- It has been some 19 years since 2006, which is enough time for most trees to have reached a mature stage in their life, and the Australian landscape has not collapsed from salt intrusion.
- Yes, things are still bad in some locations, but not the doom and gloom that Peter predicted.

#### Plants taking-up salt (p. 76)

- 'The one effective way to get rid of salinity is to improve fertility by adding carbon to the soil. This not only ensures there are enough plants to maintain the freshwater lens in the soil, but it also results in the plants taking up more salt.'
- GW: Plants shouldn't take-up salt.
- If dissolved salts enter a plant, and then crystallises, the expanding (growing) salt crystals can damage the plant.

#### The role of grass (p. 77)

- 'Grass always struggle to grow beneath them [gum trees] – and grass is more successful at suppressing salt than any plant I know.'
- GW: I just cannot understand what Peter could have observed that would make him suggest such an outcome.
- It is a real shame that Peter has not provided any justification for these claims, other than to suggest that it is what he 'knows', or what he has observed.

Page 70

#### The movement of salts (Page 77)



Salt removed by drainage (SA)

#### Only plants (p. 77)

- 'The point needs to be emphasised again: only plants can extract salt from the soil.'
- **GW:** Our oceans, which are filled with salt water, would question the truth to this statement.
- Obviously something other than plants extracted the salt from the sediment; unless of course you are suggesting that algae in the oceans extracted the salt.
- Water is effective at extracting salts!

#### Draining away the salt (p. 77–78)

- 'You can't do it by digging trenches and draining water away. That achieves nothing. If you drain away the water all you've done is stop the salt moving, for obviously the salt can't move when there is no water to move it.'
- **GW:** I am really struggling to understand Peter's logic.



Drainage of saline soils (SA)



Drainage of saline soils (SA)

#### But, water can carry salts! (p. 78)

- 'But it's still there which is why another big wet will bring disaster upon us. If we already have a salinity problem in a dry period, what's going to happen when it rains for two or three years.'
- GW: Salt crystals love to dissolve in water.
- Once it is dissolved, the salt solution can move freely with the brackish water.

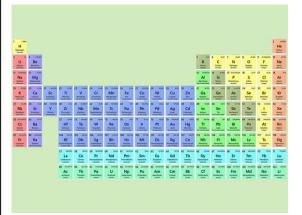


Pineapple farming (Qld)

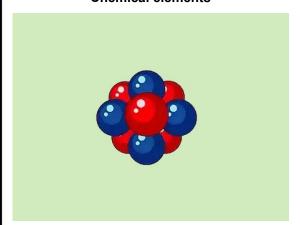
#### Raising salts (p. 78)

- 'Every plant on the planet uses its roots system to raise a certain combination of minerals and salts to the surface.'
- GW: Pineapples don't. Succulents don't (well, at least the ones I know, don't), and algae doesn't.
- It all depends on whether you are harvesting the plants (and thus taking away the minerals), or if the plant eventually dies and becomes part of the topsoil.

#### Insert: Create, destroy, change and remove



#### Chemical elements



Chemical compound



Earth worms



Harvesting produce (Qld)

#### Introduction

- If there were a training course called: 'An Introduction to Farming', then the course would likely discuss the topics of:
  - creating and destroying matter
  - changing matter
  - removing matter.
- Science tells us that we cannot create, nor destroy, matter.
- However, on a farm, you can 'create' matter by importing it from another location.

#### **Changing matter**

- When managing a farm, it is not sufficient to just know the chemical and matter content of your soil; you need to understand what products are readily available to the plants.
- A nutrient is of no immediate value if it currently is locked away in a chemical compound.
- If a bricklayer ask you for some 'sand', you wouldn't give them a block of sandstone; similarly, plants need nutrients that they can readily access.

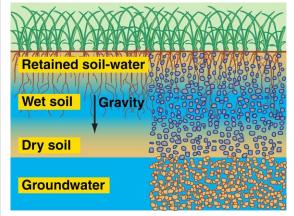
#### The role of earth worms and soil microbes

- Soil compounds can be 'changed' in a number of ways.
- Some compounds can be changed chemically, such as adding gypsum to a sodium-rich soil.
- Some compounds can be changed by having something consume the compound, and then letting their digestion system change the compound.
- Earth worms consume soil, then poo soil, but a much-changed soil.

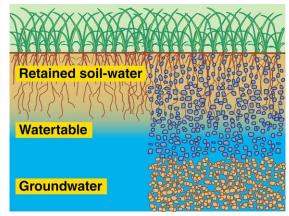
#### **Removing matter**

- Farming practices differ from natural systems because 'products' are constantly added and removed from the land.
- If a plant takes-up metals, salt and nutrients, and the plant is harvested and removed from the property, then metals, salt and nutrients are also removed from the property.
- In natural forests, if a plant takes-up compounds from deep in the soil, then these compounds will be released into the topsoil when the plant dies.

#### A failure to understand fluid mechanics (Page 78)



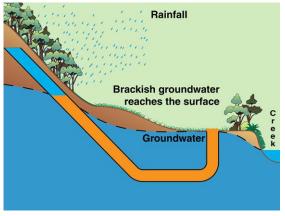
Recently infiltrated water descends



Freshwater blends with groundwater



**Questionable information** 



The uplift of groundwater

#### A (p. 78)

- 'Water soaks into the surface and proceeds to sink vertically through the soil under pressure of gravity. In effect, water at the surface has a head of pressure – gravity pressure – and as such possesses energy.'
- GW: At the soil surface, water has only the potential energy of all stationary bodies resting on the Earth surface.
- When it sinks down to the layer of salt water it will have enough energy to displace the salt water, forcing it sideways.'
- GW: Soil-water gains no additional energy as it descends down through the soil profile (due to the effects of friction).
- 'Whatever rainwater does eventually sink to the layer of salt water will have lost so much energy that it will no longer be capable of displacing water in the saltwater layer.'
- **GW:** But this goes against what Peter said earlier on this page—what Peter is saying does not make sense.

#### A (p. 79)

- 'In a healthy landscape, this upwards pressure exerted by the plants balances the downwards pressure exerted by gravity, thus preventing water that has soaked into the ground after rain from sinking to the lower layer of salt water.'
- **GW**: Rubbish!
- I am sorry; but, there are times when you have to call it as you see it.

#### A (p. 79)

- 'In this way, the plants maintain a freshwater lens above the layer of salt water. This freshwater lens acts like a lid, preventing the salt water from coming to the surface.'
- **GW**: Rubbish!
- If the hydraulic pressures felt by the brackish groundwater are sufficient to lift the watertable to the surface, then these pressures can **easily** displace any 'freshwater lens'.

#### Chapter 10 – More About Salinity (Page 81)

# Chapter 10: More About Salinity



**Professor Wilhelm Ripl** 



**Biodiversity and Hydrology Workshop** 



**Habitat Brisbane Workshop (Qld)** 

#### Rehabilitation of lakes (p. 81)

- 'You can't rehabilitate a lake, he [Prof Wilhelm Ripl] decided, until you rehabilitate the catchment, because the problems you find in a lake are merely the problems of the catchment.'
- GW: I completely agree.
- If I choose to be petty, then I would point out that you can rehabilitate a lake before you rehabilitate the catchment, it is just that you will be wasting your money, which is what a lot of urban councils do on an annual basis.

#### My input

- GW: It may surprise some readers, but I generally support the work that Peter does.
- I believe that Peter has made a positive contribution to Australia's land management practices.
- What I do <u>not</u> support is Peter's explanation of the 'science' of what he has observed, and what he suspects is occurring within the landscape.

#### The rehabilitation of waterways

- **GW:** While Peter's work was primarily based in rural catchments, my work was focused on urban waterways.
- In my workshops and training courses I pushed the following concepts:
  - creeks are a product of their catchment
  - you cannot maintain a 'natural' creek in an unnatural catchment
  - if you want to have a clean waterway, then you must have clean drains.

#### Insert: The wonderful city of Adelaide (only if you are interested)



Adelaide's linear park (Torrens R.)

#### Introduction

- By far, my favourite city in Australia is Adelaide. I just feel good every time I visit Adelaide
- I find it to be a wonderful city for walking.
- The Torrens River, and its associated 'linear park', are wonderful assets for the people of Adelaide.



**Torrens Lake** 

#### Adelaide's unhealthy city lake

- In November 2006 I attended a conference in Adelaide, which focused on the Torrens River and the Torrens Lake.
- During that conference I stated that 'this was not a city with a river problem, but a river with a city problem' (Adelaide ABC Radio, Grant Cameron, 20th November 2006).
- In my opinion, the solution to Adelaide's lake and river problems will not be found in the river, but in the city and suburbs.



**Dust storm (Murray Bridge, SA)** 



Road runoff

#### Adelaide's city problem

- The 'problem' that Adelaide has, and the problem that it has passed onto the Torrens Lake, is NOT the fault of Adelaide, or the people of Adelaide.
- It is a 'location' problem.
- Due to the fault of nobody, Adelaide experiences a significant inflow of dust.
- Dust blows in from the arid north (along with some very hot winds).
- Dust particles are of a size that finds it easy to attach themselves to nutrients (collected from rural and city locations), and metals collected from roads.
- The dust settles evenly over the city and the rest of the Torrens River catchment.
- Stormwater runoff carries this dust, and the attached nutrients and metals into the streams that feed into the Torrens River, and eventually into the city's lake.
- In my opinion, the best way to manage pollution within the Torrens Lake is to manage pollution runoff from the greater Torrens River catchment, which I must add, is generally the approach that Adelaide councils have adopted.

#### Insert: Maintaining the health of lakes (only if you are interested)



Control the food supply

#### Control the food supply

- While speaking at the Torrens River conference in 2006, I mentioned that anyone that maintains a fish tank, will have a good idea of how to manage a
- The management of fish tanks consist of:
  - control the food supply
  - aerate the water
  - clean the water
  - clean the tank.



- In a fish tank, aeration adds oxygen to the water for the benefit of the fish, and may be used to carry a stream of water to a
- In lakes, introduced aeration systems can:
  - add oxygen to the water
  - prevent stratification within the lake
  - reduce the risk of odours
  - reduce the risk of blue-green algae.

Cleaning the fish tank water can improve the tank's visual appearance, improve the

improve the health of the aquatic life reduce the risk of a toxic build-up within

reduce the cost and health risk of lake

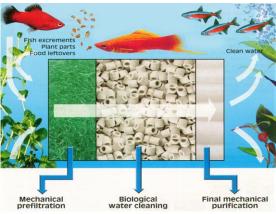
In lakes, cleaning the water can: improve the lake's appearance

the settled sediment

de-silting activities.



Aerate the water



Clean the water

#### Clean the tank

Clean the water

health of the fish.

Cleaning the fish tank improves it visual appearance, but can also reduce a potential food source, including a diversity of foods.

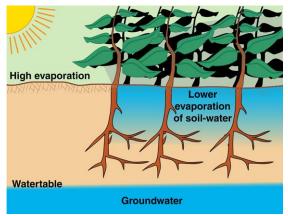


- removing excessive sediment
- removing toxic sediment
- removing litter from the water and surroundings
- removing surface pollutant from the lake's shorelines.

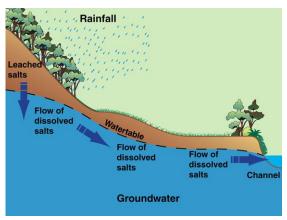


Clean the tank

#### The management of groundwater (Page 82)



#### Plant growth



Movement of groundwater



**Questionable information** 



**Questionable information** 

#### Biological compounds (p. 82)

- 'Plants create the fertility by converting sunlight into biological compounds.'
- GW: I am sure this was just a 'slip of the pen', or just lazy wording, but biological compounds are not created from sunlight.
- Sunlight is used as the source of energy for the production of biological compounds from biological materials.
- This statement also fails to recognise the role of micro-organisms in the soil.

#### Managing water in the ground (p. 82)

- 'Plants control salinity by managing the movement of water in the ground.'
- GW: Plants are involved in managing the movement of water through the soil, but they do not 'manage' the process.
- This claim is a bit like saying that your children manage the finances of your home because they play a (major) role in the use and movement of your money.

#### Stationary water (p. 82)

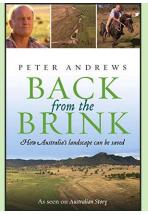
- 'Contrary to popular belief, whenever you impose a layer of fresh water over a layer of salt water, the salt water will always obey the law of gravity and, being heavier, will remain as a layer at the bottom provided the water is still.'
- GW: When you look carefully at this statement you can see that it provides no value to the current discussion.
- It is saying that IF the water is still, then the saltwater cannot move above, but that is what 'still' means!

#### Fresh and salt water (p. 83)

- 'Fresh water can move quite rapidly through the soil over top of the salt layer without the salt moving. The salt does move laterally, but it does so very slowly.'
- **GW:** This statement is just wrong!
- Freshwater and saltwater have virtually the same viscosity, which means they will move through a soil profile at exactly the same rate.
- I think Peter is confusing crystal salts in the soil with dissolved salts.

Chapter 11 - Biodiversity (Page 88), Chapter 12 - Nature's Way (Page 95)

### **Chapter 11: Biodiversity**

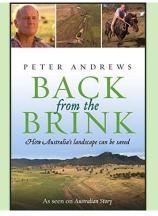


Back from the Brink (2007)

#### Introduction

- **GW:** At this point in Peter's book we begin to step away from my expertise.
- I have learnt a lot about plants from many people (R. Friend, J. Leask, & D.Bolton), but my knowledge falls well below that of Peter Andrews in most cases.
- I share Peter's interest in biodiversity; however, how plants actually interact with salt is possibly a bit different from what Peter thinks.

# Ch 12: Nature's Way Loops, Cycles, Feedbacks



Back from the Brink (2007)

#### Introduction

 GW: This chapter also steps away from my area of expertise.

#### Chapter 13 - The Magic of Mulch (Page 102)

### Chapter 13: The Magic of Mulch



Straw mulching demonstration (NSW)



Mulch treatment of a compacted soil (Qld)



**Eutrophication of waterways** 

#### Introduction

- GW: I am in favour of the use of mulches to improve the protection, strength, and fertility of soils.
- In the civil construction (my industry), mulch can be a very useful tool to:
  - control raindrop impact erosion
  - reduce the cost of watering programs
  - improve new grass growth over soils that have become compacted by heavy pedestrian traffic.

#### Using mulch to soften compacted soil

- GW: Mulch can also be used to help break-up a heavily compacted soil.
- The mulch, itself, does not work directly on the soil; instead, the mulch encourages biological activity within the soil (i.e. within soil microbes), which leads to:
  - the break-up of the soil, and
  - the initial formation, or restoration of, 'topsoil' properties within the soil.

(This property is discussed in more detail over the page.)

### The reasons why 'mulch' can be classified as a pollutant

- **GW:** When used properly, mulch can be a very good soil and farming asset.
- When used <u>without</u> due care, or knowledge of its consequences, mulch can become a major waterway pollutant.
- Mulch is organic matter (except for the various rock mulches), which means it can contribute to the eutrophication of water hodies
- Eutrophication means: over-feeding.

#### Insert: Using mulch to soften compacted soil



Introduction

- Clayey soils that are subjected to a lot of vehicular or even human traffic, can become very compacted and hard.
- Grasses struggle to establish or even survive in such soils.
- An urban park with very limited grass cover can quickly become an unusable public space.

Compacted clay soil (2003)



#### Placement of recycled wastewater sludge

- This park was dressed with treated sludge from the council's wastewater treatment plants (my understanding at the time).
- The treated sludge is just another type of organic mulch—a very useful product, and most definitely not a 'waste' product.

Placement of treated mulch (2003)



Re-established grass cover

 The resulting healthy grass cover has rejuvenated the public's usage of the park.

(This was 'my' local park back when I was living in Brisbane.)

Grass growth (2005)



Grass growth (2018)

#### Ongoing grass cover

- However, one drawback of the healthy grass cover is an increase in annual cost of grass mowing for the council.
- Note; some of the trees did suffer wind damage during a later severe storm.

(Three cheers to the Parks Department of Moreton Bay Regional Council)

#### Insert: Using mulch to improve the structure of 'plastic' soils

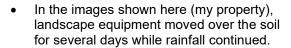


**Excess working of saturated soils** 

#### Introduction

- Soils should not be worked when they are either:
  - too wet, or
  - too dry.
- If a heavy clay soil is trafficked (worked) when it is saturated, then the soil can develop 'plastic' properties.
- This means a clump of the soil can be squeezed through your finger in a manner that produces a long continuous ribbon.

#### Feeding the bugs



- If not properly treated, and these high-clay content soils were allowed to dry, then the soil would be left in a compacted condition that would be near impervious.
- Instead, my soil was covered with a thick layer of sugarcane mulch (while the rain and equipment disturbance continued).



Heavy mulch cover (during a storm)

### • Ai ha in



Established grass cover

#### Farming the farm

- After the rain and all equipment movement had stopped, the remaining mulch was integrated (mixed) into the clayey soil.
- Integrating the mulch into the soil is expected to achieve the following:
  - improved soil structure
  - improved soil drainage (as the organic mulch decomposes, it leaves behind fissures in the soil)
  - increased organic content.

#### Weeds can be used to improve the soil

- Within months of the landscaping works being completed, the grass was reestablished, and the soil drained as well as it did before the works had commenced.
- This was a good outcome!

#### Insert: The reasons why we control the use of mulch near waterways



#### Introduction

Dumped organic matter can become a pollution hazard.

Dumping of cut grass in creek bank



Placement of mulch on creek banks

- When a garden is weeded and rehabilitated, it is common for the garden to be re-dressed with a heavy layer of mulch.
- However, if that 'garden' consists of the riparian zone of a waterway, then the mulch needs to be appropriately anchored to prevent it from being washed into the waterway.

Mulching of creek bank



Algae-covered turtle (Qld)



#### Loss of oxygen from waters

on rocks and aquatic life.

**Eutrophication of waters** 

Eutrophication is the process of

An excess of nutrients, such as

enrichment of a water body by nutrients.

phosphorus, can lead to excessive algal growth, or other water quality problems. These nutrients can originate from the decomposition of organic matter (mulch).

A loss of oxygen from these waters can, and often does, result in fish kills.

Eutrophication of waters can lead to reduced oxygen levels, and algae growth



Fish kill due to low oxygen in water (Qld)

#### Insert: The techniques we can use to anchor loose mulch



**Tub-grinder mulch production** 

#### Tub grinding mulch production

- Vegetation can be mulched using either:
  - a cutting action (chipper), or
  - hammer-action (tub grinder).
- Chipping the vegetation produces a mulch that can be easily spread with a 'blower', but can also be easily washed away by stormwater runoff.
- Tub grinding produces a more stable mulch that is less likely to be displaced by stormwater runoff.



- Loose mulch can be anchored with:
  - a light coating of anionic bitumen
  - mechanical crimping
  - jute mesh

Non-re-wettable glues

blankets.

wire mesh (long-term application).

Non-re-wettable glues (tackifiers) can be used to temporarily anchor loose mulch.

The natural gums from various trees, such as pine trees, can be diluted to form a

Such glues are used in commercial applications such as hydromulching, bonded fibre matrix, and compost



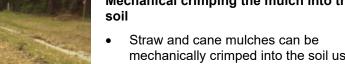
Bitumen spray (NSW)



Organic glues (Qld)

Mechanical crimping the mulch into the

Straw and cane mulches can be mechanically crimped into the soil using farming equipment.



homemade tackifier.



Crimped straw mulch (USA)

#### Insert: Bush and forestry mulchers



Integration of mulch into soil

#### **Forestry mulchers**

- Forestry mulchers that use a hammer action can be used to create a splintered much that resists displacement by wind and flowing water.
  - PTO driven mulchers
  - Skid steer mulchers
  - Tractor-mounted mulchers.

(No, this is not a paid advertisement)



Mulching



Stump grinding



Stump grinding



Splintered mulch



Rotor head



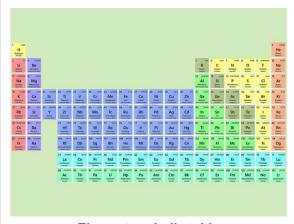
**Rotor hammers** 

#### Chapter 14 – A Layout for a Sustainable Farm (Page 109)

# Ch 14: A Layout for a Sustainable Farm



**Questionable information** 



Element periodic table



Application of fertilizer (USA)

#### The gravity flow of plant fertility (p. 110)

- 'As we saw before, fertility generated by trees and scrubs on higher ground will seep into the productive country below; it's gravity that makes this happen.'
- GW: I believe that it is inappropriate for Peter to claim that 'we saw' proof of this concept in earlier chapters when, to the best of my observations, no proof was provided—it was just Peter telling us that his theories were true.

#### The mobility of plant fertility

 GW: The mobility of plant nutrients through soil is presented below.

#### **Primary nutrients**

- Nitrogen (mobile in soil)
- Phosphorus (<u>not</u> mobile through soil)
- Potassium (somewhat mobile)

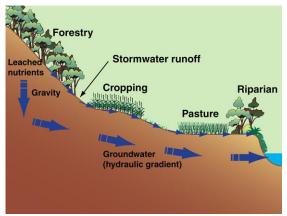
#### Secondary nutrients

- Calcium (somewhat mobile)
- Magnesium (<u>not</u> mobile through soil)
- Sulfur (mobile in soil)

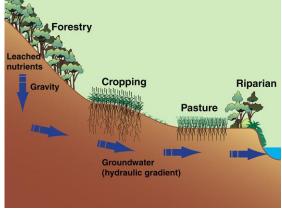
#### **Micronutrients**

- Boron (mobile)
- Chlorine (mobile)
- Copper (not mobile through soil)
- Iron (not mobile through soil)
- Manganese (mobile)
- Molybdenum (somewhat yes)
- Nickel (somewhat yes)
- Zinc (not mobile through soil)
- So, not all nutrients are likely to move down a slope through the soil, but can move along the surface.

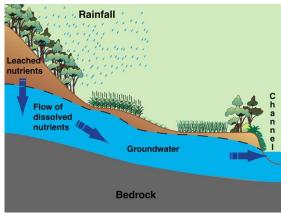
#### Insert: Subdividing slopes into forestry, cropping and pasture



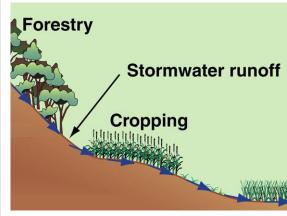
Possible nutrient movement



Leached nutrient passing under crops



Groundwater flow at base of hill slope



Nutrients carried by stormwater runoff

#### The power of gravity

- **GW:** The key to Peter's discussion here is the progressive movement of nutrients from the up-slope forestry region, down to the mid-slope cropping region, and possibly farther down the slope to the pasture region.
- However, these nutrient can only move through the force of water flow, which means either:
  - as surface runoff (near-horizontal), or
  - as sub-surface flow (vertical).

#### Sub-surface leaching of nutrients

- Any stormwater that infiltrates into the forest floor will potentially leach forest nutrients vertically downwards towards the watertable, and the underlying groundwater.
- Such nutrient flow will NOT move laterally down the slope until it reached the permanent groundwater.
- If the groundwater passes under the root zone of the adjacent cropping plants, then these nutrient are lost from the system!

#### Land at the base of a hill slope

- As Peter does suggest throughout his book, there are some landscape conditions that do encourage the watertable to move close to the soil surface, which potentially means that any nutrients carried by the groundwater may come into contact with crop roots.
- The most common example of this is at the base of a significant hill slope.
- Low-gradient land at the base of hill slopes may benefit from the type of nutrient flow that Peter is discussing.

### Nutrients and organic matter displaced by stormwater runoff

 If the hill slope is subjected to regular stormwater runoff events, then any location where this stormwater runoff 'pools' will be an area that may benefit from nutrient inflow.

#### Insert: Capturing nutrients carried by stormwater runoff



Mulch displaced by stormwater runoff

#### Introduction

- The layout of Peter's farm is going to rely on up-slope nutrients being carried by stormwater runoff to lower paddocks.
- Therefore these lower paddocks will need to have some means of capturing these nutrients.
- This nutrient capture usually relies on:
  - contour banks (as discussed by Peter in his book)
  - horseshoe ponds, or similar, or
  - contour wetlands.

#### **Contour banks**

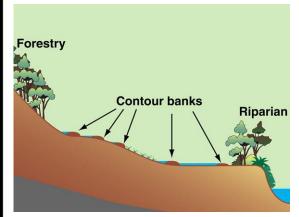
 Contour banks can be used to capture, hold and infiltrate minor stormwater runoff.

Horseshoe ponds (water bunds)

stormwater runoff.

Horseshoe ponds can also be used to capture, hold and infiltrate minor

For more images, refer to the **Insert** section between chapters 23 and 24.



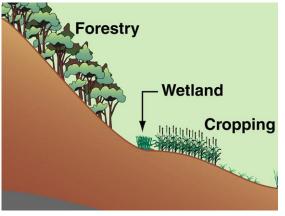
**Contour banks** 



Semi-circular water bunds

#### Wetlands

 Wetlands can be used to capture, hold and then release nutrient-rich water along a contour.



Wetland nutrient trap

#### Insert: Stormwater treatment systems



Algae growth within an inland waterway



What is a 'limiting' nutrient?

downstream waters.

- The two main nutrients are:
  - nitrogen

Introduction

bodies.

- phosphorus.
- Some waterways are more sensitive to nitrogen, while others are sensitive to the inflow of phosphorus.

Nutrients and organic matter can be very valuable to the land, but it can also become a pollutant for downstream water

If the farm layout aims to move nutrients across the landscape, then there is an obligation to ensure that these nutrients don't becomes a pollution hazard in

- What determines the critical pollutant is an action known as the 'limiting nutrient'.
- The limiting nutrient is the nutrient that a water body is going to deplete first if it starts to produce large amounts of algae.



Algae growth (Qld)

#### Stormwater treatment in coastal regions

- For most coastal waterways, the 'limiting nutrient' is usually nitrogen.
- If algae begins to choke a coastal waterway, then it is likely to be the amount of nitrogen in the water that limits the volume of algae growth.
- Thus stormwater treatment systems should target the capture of nitrogen, which means coastal catchments typically employ a lot of wetland systems to treat stormwater runoff.



Stormwater treatment wetland



Stormwater infiltration system

#### Stormwater treatment within inland regions

- For most inland waterways, the 'limiting nutrient' is usually phosphorus.
- If algae begins to choke an inland waterway, then it is likely to be the amount of phosphorus in the water that limits algae growth.
- Thus stormwater treatment systems should target the capture of phosphorus, which means inland catchments usually employ treatment systems that aim to filter stormwater through the ground or earth filters.

#### Chapter 15 – Fertilisers or Just Soil Stimulants (Page 121)

# Ch 15: Fertilisers or Just Soil Stimulants?



Superphosphate

#### Superphosphate (p. 121)

- 'They [superphosphate] are soil stimulants rather than fertilisers. There are eightynine elements in nature, nearly all of which play some role, however small, in sustaining plant life, and only a tiny handful of those eighty-nine elements are present in an artificial fertiliser such as superphosphate, which can hardly be said, therefore, to add fertility.'
- **GW:** I am sorry; but I am completely lost as to the logic of this statement.



Concrete mixing plant (NT)



Bye

#### A strange argument

- GW: Imagine you run a concrete plant. A concrete mix typically consists of:
  - 1 part cement
  - 2 parts sand
  - 4 parts aggregate (or gravel)
  - plus water.
- If 'sand' is not your current limiting element, then ordering more sand will not increase your potential concrete production. Similarly, the benefit of adding a nutrient depends on whether it is, or is not, a 'limiting nutrient'.

#### Sorry, I cannot help you guys on this topic

• **GW:** Unfortunately, the rest of this chapter steps away from my area of expertise.

#### Chapter 16 – Weeds Are Allies, Not Enemies (Page 126)

# Ch 16: Weeds Are Allies, Not Enemies



Partial removal of weed tree from creek



Wave bye bye



**Thistle** 

#### Weeds (p. 127)

- 'If there were other plants that performed the essential functions that weeds perform and were more acceptable to farmers, then, sure, I'd be all in favour of using them instead of weeds.'
- GW: I agree.
- In regards to creeks, I would to tell my students that you should never remove a weed from a creek bank unless you have a native ready to plant that will do the same job that the weed was doing.

#### Allies, not enemies

- **GW:** Just like in war time, you may:
  - invite your allies (weeds) to join you in the fight
  - invite your allies (weeds) to cohabit with you during the fight
  - insist your allies (weeds) leave your habitat once the fight is concluded.
- And, just like in war time, you need to be very careful not to invite weeds into your landscape that, once in, don't want to leave.

#### Defining what is a 'weed' (p.128)

- 'In a rural context, weeds can be defined simply as plants that farmers don't like for whatever reason.'
- **GW:** This is Peter's idea of what farmers mean by the term, 'weed'.
- However, Peter's own definition is slightly different.
- So, rather than referencing to whether or not the plant is native, the term refers to whether or not the plant is beneficial to the farm's productivity.

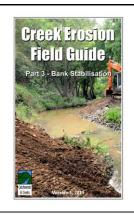
#### Insert: Using weeds to aid in creek stabilisation



Brisbane Botanic Gardens, Mt. Coot-tha



Brisbane Botanic Gardens, Mt. Coot-tha



Creek Erosion Field Guide, Part 3



Interim stage of weed removal (Qld)

- In 2010, I presented a talk at the Brisbane Botanic Gardens, Mt Coot-tha, titled: 'Weeds - Good Plants not so good, or Bad Plants not so bad!'
- I arrived at the Gardens to find an audience ready to throw rotten tomatoes at me.
- How dare I speak of such a thing!
- How dare an 'engineer' even speak at the **Botanic Gardens!**

#### How to Win Friends and Influence People

- At the start of my talk I asked the audience of mostly Botanic Gardens volunteers, if they could define what a 'weed' is.
- Severe members were eager to express their definition of a 'weed', and their typically definitions centred around the idea of a plant that is not locally endemic.
- I then turned, pointed to the gardens, and said: 'Welcome to Brisbane's largest, government sponsored, collection of weeds', because few of the plants within the gardens are locally endemic.

#### Using weeds to stabilise creeks

- Weeds can be very effective in stabilising waterway banks—it is just that we would prefer natives do that job.
- If you are faced with an active erosion problem following a flood event, then you may consider using a fast-growing weed to stabilise the immediate erosion issues.
- And then slowly replace these weeds with native plants at a rate that allows the natives time to establish while they too are being protected by the remaining weeds.

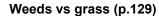
#### Using weeds to help remove weeds

- If the creek has an existing weed problem, but the rapid removal of the weeds would likely cause erosion issues (because the native plants would take too long to establish), then:
  - consider replacing the difficult-toremove weeds with weeds you known you can readily control, then
  - slowly replacing the newer, easy-toremove weeds with native plants that can perform the same task.

#### Weeds vs grass (Page 129)

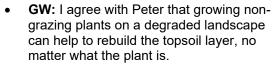


**Grass paddock** 



- 'Grass, when it is grazed, uses up fertility and minerals in the top layer of soil.'
- GW: I agree in terms of farming.
- Growing any plant that can be eaten by commercial stock, such as cattle, means that some fertility and minerals will leave the farm when the stock leave the farm.
- But, how does this volume of biomass compare to the total biomass that is excreted back onto the paddock's surface.

### Growing non-grazing plants on degraded land



- Of courses, it is not just about finding plants that sheep and cattle don't want to eat, it is also about finding plants that wildlife do not want to eat, such as birds and kangaroos.
- Always remember to farm the farm.



Kangaroos grazing



**Treated timber** 

#### Looking for waste organic matter

- **GW:** If you have degraded land, then you should look for almost any waste organic matter you can get your hands on.
- If I could I would even take the timber frame from an abandoned house, including old workers cottages from your own farm.
- BUT, I would <u>not</u> take any 'treated timber', including old telegraphy poles, timber bollards, etc.



Commercial composting service

#### **Commercial composting services**

- GW: I fully realise that my contribution to Australia's farming productivity will eventually be little more than my total biomass, but if I could make one useful suggestion it would be that every rural community should have at least one:
  - Pub
  - Asian restaurant
  - Community centre & fair ground
  - Community composting service.

#### Chapter 17 – Willows: Unjustly Condemned (Page 139)

# **Chapter 17: Willows Unjustly Condemned**



Gwydir River, Moree (NSW)



Murray River, Murray Bridge (SA)



Willow removal (Qld)

#### Chapter overview

- GW: In this chapter, I believe that Peter has failed to justify any of his statements with either facts, or compelling arguments.
- Peter justifies most of his statements by either saying that some 'authority on the subject' is correct in their reported discussions with Peter, or saying that another expert in the subject is incorrect in their disagreement with Peter's arguments.
- In my opinion, this chapter stands without substance.
- However, I have also failed in presenting any justifiable arguments against Peter's claims.
- Based on my own standards, I am in no position to tell my readers to believe in my claims, or to not believe in Peter's claims.
- It would simply take me too much time and effort to collect the information that I would need to disprove Peter's beliefs.
- All I can say is that I spend 40 years dealing with waterways, and it is my belief that willow removal is justifiable.

#### Removing willows (p. 139)

- 'Why do they do it? The stated reasons are that willows consume a vast quantity of water; that willows dump a massive volume of leaves into streams each autumn, lowering oxygen levels in the water; and that willows block streams and so can cause flooding.'
- **GW:** I am sure a lot of willow removal is done the wrong way, and by the wrong people, but that does <u>not</u> mean that properly managed people cannot perform the task properly.

#### Willows (Page 139)



Early stage of creek rehabilitation (Qld)



Later stage of above creek restoration



Murray River, Murray Bridge (SA)



Removal of topsoil (Qld, 2011)

#### Consider the restoration of urban creeks

- GW: I would like to discuss the attributes of removing willows from rivers by comparing such a task with the job of restoring degraded urban creeks.
- I have spend the best part of 40 years involved in the industry of rehabilitating urban waterways.
- I believe that my time has not been wasted.
- I believe that the general aims of restoring the values of urban creeks are justifiable, and supported by the general population.
- · However, I also recognise that:
  - some creek restoration projects are performed for the wrong seasons
  - some are performed by the wrong people
  - some projects are designed with the primary intention of delivering a recreational park with a water feature running through it, rather than restoring the potential values of the waterway.
- I would remind my readers that you don't judge good things done well, by focusing on good things done poorly.

#### Another reason (p. 139)

- 'Another reason, often unstated, is that willows aren't natives.'
- GW: In my opinion, you should never remove a weed from a creek bank unless you have a native ready to plant that will do the same job that the weed was doing.
- Yes, willows can do some good things; but unfortunately, they often do these 'good' things in a bad way.
- Natives, can do the same good things, but in a good way.

#### Why not—reason number 1 (p.140)

- 'Before I deal with all this, let me suggest a few reasons why willows should never be cut down. One is that, they do block streams, but in doing so they slow the water flow and thus slow the loss of fertility compounds from the land that get washed down to the sea.'
- **GW:** I have to disagree with Peter's logic.
- Willows can result in increased overbank flooding, and it is this land flooding that carries away fertility.

#### Willows (Page 140)



Bank slumping around a willow (SA)



Exposed tree roots under a willow (SA)



Creek shaded by native trees (Qld)



Shaded pool on Marne River, SA

#### Why not—reason number 2 (p.140)

- 'A second is that they prevent erosion of creek beds. This in turn means they prevent water tables being lowered (water tables are always determined by the depth of creek and river beds), which is important because lowering water tables disrupts the land's normal water patterns.'
- GW: Willows can help control bank erosion; but unfortunately, they often do this 'good' things in a bad way.
- Natives, can do the same erosion control, but in a good way.

#### Why not-reason number 3 (p.140)

- 'A third is that, by shading streams, willows prevent evaporation.'
- GW: However, because they produce the type of shading that limits the growth of native ground cover plants under the willow; and
  - because ground cover vegetation is the best form of vegetation to control soil scour;
  - bank scour erosion can occur under willows.

#### Evaporation (p. 141)

- '... once the willows are no longer there to shade and cool the stream, the evaporation rate soars.'
- **GW:** But, only for the short period while the replacement natives are growing.
- This growth period is less than the time between the release of Peter's book, and the release of the book review you are currently reading.

#### Replacing willows with natives (p. 142)

- 'What if the willows are immediately replaced by natives, such as swamp oaks? . . . it could be fifteen to twenty years before they provide the protection from evaporation provided by the willows before they were ripped out.'
- GW: I repeat; this growth period is less than the time between the release of Peter's book, and the release of this book review.

#### Chapter 18 – Native Trees Aren't So Sacred After All (Page 146)

### Ch 18: Native Trees Aren't So Sacred After All



Native and introduced tree species (SA)



**Dragonfly (NSW)** 



Eastern Sedgefrog (Qld)

#### Native plants (p. 146)

- 'Australia has been infiltrated by so many foreign plants and animal species that it serves no purpose now to pursue a nativeonly policy when planting trees.'
- **GW:** I completely disagree. This is just an excuse for poor behaviour.
- Peter spends so much time in his book discussing how important it is to maintain the soil's fertility balance; yet, the idea of maintaining the correct food balance for native fauna seem to elude him.
- Native plants provide:
  - the correct food balance for native fauna
  - the right food supply, at the right time of year, to balance the supply of other foods at other stages of the yearly weather cycle
  - the best habitat balance for native fauna
  - the best opportunity for native fauna to recover from extreme weather events.

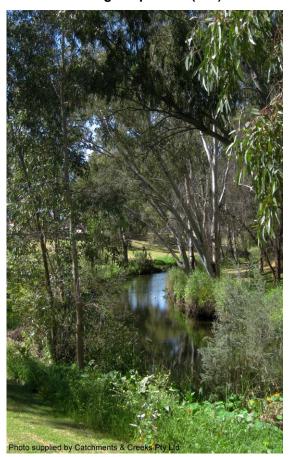
#### Foreign species (p. 147)

- '... foreign species of trees are often more effective than natives in today's environment.'
- GW: If you viewed this issue only through the issue of biomass, then Peter would be correct.
- But you shouldn't view nature with one eye deliberately closed.
- From a holistic point of view, foreign species are <u>never</u> more effective than natives at performing the tasks they are required to perform.

#### Native vs deciduous trees (Page 147)



Rolling-hill pasture (Qld)



Torrens River in 2014 (SA)



**Questionable information** 

#### Grassed pastures (p. 147)

- 'None of the people who insist we should plant only native trees ever try to argue we should have only native pastures. So what's the difference?'
- GW: The difference is that in each case we are looking for the best <u>overall</u> outcome.
- Native trees provide:
  - improved land stewardship
  - improved native food supply
  - improved native microbe health.

#### Deciduous trees (p. 149)

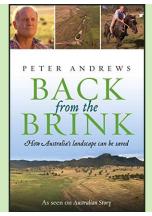
- 'Nobody could have convinced me then –
   and nobody has convinced me since –
   that those English trees didn't have a
   more beneficial effect on the land around
   them than any eucalypts that might have
   been growing there instead.'
- GW: It constantly annoys me when people reject an idea, or an argument, <u>before</u> they have heard it.
- Comments such as: 'Nobody could have convinced me then', are statements that openly reject any possible argument before it has been presented.
- Why would you reject an argument before you have heard the argument? You should always listen, then decide, not decide then listen.
- The statement: 'beneficial effect on the land', suggests that Peter is limiting his consideration of beneficial effects to just the 'land'.
- Ideally, consideration should be given to the farm, the farmer, the farm stock, the wildlife, the soil, the insects that the wildlife feed on, and all the components of the land.

#### 60,000 Years ago (p.150)

- 'Sixty thousand years ago, just before the Aborigines arrived, Australia had a forest mix very different from today's. One-third of the trees were palms, one-third conifers and the other third consisted of variety of tree types, only one of which was eucalypt.'
- GW: I am not aware that there is any information that could support such a claim.
- I find this statement highly questionable.

Chapter 19 – Hedgerows: An Old Idea But a Good One (Page 153)

## Ch 19: Hedgerows, An Old Idea But a Good One



Back from the Brink (2007)

#### Introduction

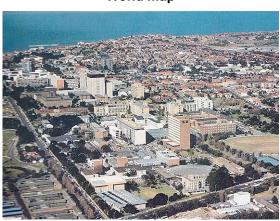
- GW: This chapter steps away from my area of expertise.
- However, my interest and knowledge of the following chapter more than makes-up for my sorrowful contribution to this chapter.

#### Chapter 20 – Australia's Deserts are All Man-made (Page 159)

## Ch 20: Australia's Deserts are All Man-made



World map



**University of NSW** 



Oh dear!

#### Introduction

- Have you ever asked yourself: What causes deserts to form?
- Is it just a lack of rainfall?
- Did each of the countries that have a desert do something wrong that caused the formation of their desert?
- Have you ever looked at a map of the world and noticed that all of the world's deserts lie approximately along two latitudes?

#### My knowledge of this topic

- The key to understanding the world's deserts is to understand the forces that drive the world's climatic conditions.
- My training in coastal engineering (Uni of NSW) introduced me to the forces and actions that drive the world's climate.
- I later went on to lecture coastal engineering at Griffith University, Qld.
- Consequently, I believe that I have a clear understanding of what causes the formation of deserts.

#### Peter's claim

- Peter's claim is that Australia's deserts exist because of a consequence of past human activity.
- Is he correct?
- He presents some clear logic.
- His claims sound truthful.
- Unfortunately, there is no basis for his claims, and the actual cause of Australia's deserts is well known, and has nothing to do with current, or past, human activities.

#### Falsely blaming Aborigines for our current land management issues



Opening statement (p. 159)

- 'The popular belief is that Aborigines lived off the land for ten of thousands of years without impacting on it in any way. If only that were true. If it were, our landscape wouldn't be as sick as it is today.'
- **GW:** I found no justifiable evidence in Peter's book that could justify such a conclusion.
- I consider this to be a grossly inaccurate and misleading statement.

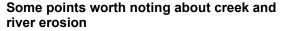
Fire



**Outback cattle life** 

Don't put the blame on us! (p. 160)

- 'On the basis of the evidence I believe that the burning [by Aborigines] reduced the biodiversity of this country to perhaps onethird of what it had originally been. That being so, it can by argued that the Australian landscape had been wrecked even before the Europeans arrived with their cattle and sheep.'
- **GW:** On the basis of the evidence I gained at university, I believe that Peter is wrong about the impact Aborigines had on Australia.



- **GW:** All creeks and rivers are formed by erosion; consequently, there is no such thing as a 'yet-to-be-eroded creek bed'.
- Australia had experienced millions of years of widespread erosion long before humans appeared on Earth—that is why Australia is so flat.
- Creek and river erosion exists within all countries, not just the country inhabited by Australian Aborigines.



Natural river erosion



I don't agree

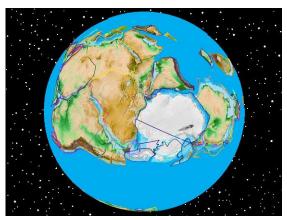
#### If they did all this harm!

- **GW:** Note the use of the following phrases in this chapter:
  - 'That being so, . .'
  - 'If Aborigines reduced biodiversity . .'
- These statements make it appear to the reader that the current discussion is based on known facts, when in reality it is just speculation.
- In my opinion, this chapter presents a false view of Australia's history.

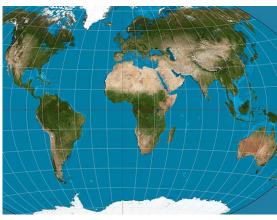
#### Australia's historic rainforests (Page 162)



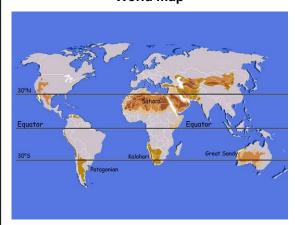
Rainforest (Tas)



Gondwana land mass



World map



Location of the world's deserts

#### Rainforests (p. 162)

- 'It's worth noting that rainforests don't necessarily need a lot of rain. There are rainforests in Australia living happily in areas that receive no more than 500 millimetres (around 20 inches) of rain a year, and that's because they're extremely efficient at recycling water.'
- GW: These rainforests survive because they exist in a microclimate, usually caused by the local topography—not because the recycling of water, which they don't do.

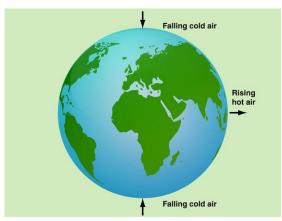
#### Rainforests in central Australia (p. 162)

- 'We know there were once arid rainforests in Central Australia that survived on as little [as] 125 millimetres of rain (around 5 inches) a year. The Aborigines destroyed them with fire, and where these rainforests once stood there is nothing now but desert.'
- **GW:** I believe, with 100% certainty, that Peter is not 100% correct in his statement.
- Rainforests are believed to have existed across the land that now constitutes central Australia, back in the early Jurassic period, some 180 million years ago. The land mass that existed back then has been termed 'Gondwana'.
- Australia began to separate from Gondwana some 23 to 66 millions years ago (the movement across the surface of the Earth took many millions of years).
- The ancestors of Aboriginal people began to migrate into Australia some 65,000 years ago, i.e. many millions of years after climate change had removed these rainforest and caused the formation of deserts!

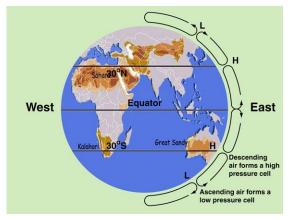
### Statements that readers should accept as factual

- **GW:** Rainforests did, at some stage, exist in central Australia.
- These rainforests disappeared millions of years before human evolution.
- The spinning action of the Earth causes circulation patterns in the upper atmosphere, which causes deserts to form under the downdraft of some of those circulation patterns, at or around 30-degrees from the Equator.

#### Insert: The creation of the world's deserts



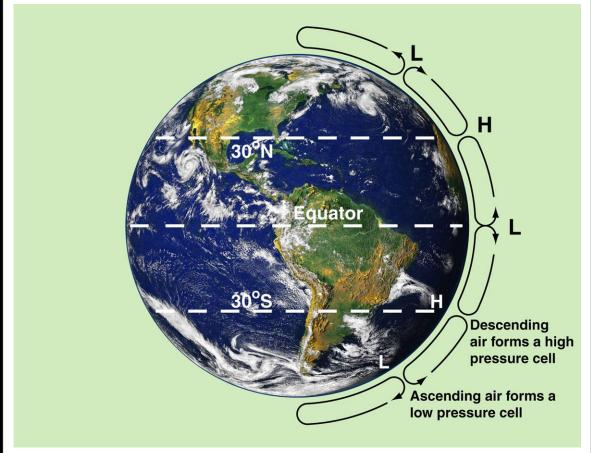
Rising and falling air



Typical air circulation patterns

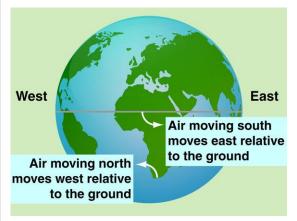
#### The rise of warm air, and the fall of cold air

- Most people are aware that warm air rises above cold air because the warm air has a lower density.
- So, on an average day, the air that is heated in the tropics, will tend to rise towards the upper atmosphere, while the colder air at the poles will begin to fall.
- As the saturated tropical air rises, it releases its water content as rainfall (i.e. tropical rainfall).
- Thus the warm equator air enters the upper atmosphere in a 'dry' condition, depleted of most of its moisture.
- This warm dry air is constantly being pushed out of the way (either north or south) by more and more rising air.
- The cold air that descends near the poles also get pushed north or south, within the lower atmosphere—it is this air movement in the lower atmosphere that you see on weather maps.
- Eventually three 'main' circular air patterns are established, which results in hot, dry air descending at a latitude of around +/-30-degrees, which creates dry, desert-like, climatic conditions.

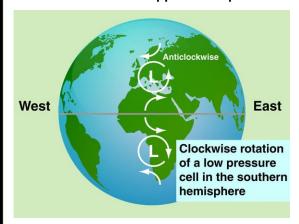


On average, hot dry air descends through high pressure cells around the 30° latitude

#### Insert: The rotation of high-pressure and low-pressure cells



Movement of the upper atmosphere



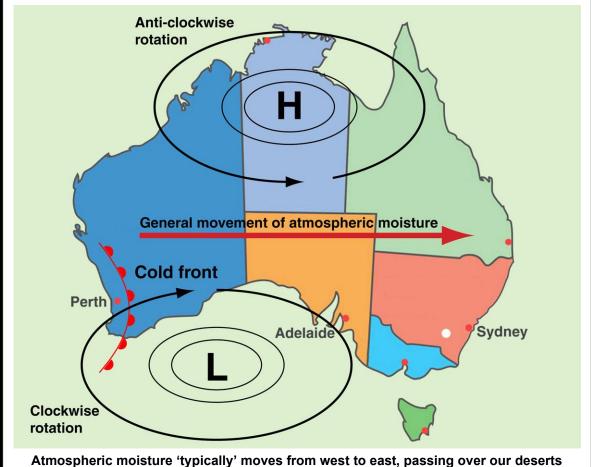
Formation of a low pressure cell

© Catchments & Creeks

#### Initial movement of the upper atmosphere

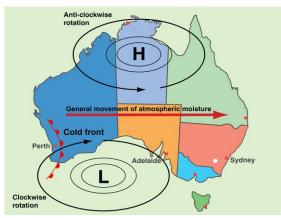
- Due to the Earth's rotation, the air above the equator travels faster than the air north or south of the equator.
- Therefore, if air in the northern region of the southern hemisphere were to be pushed southwards towards a low pressure cell, then this air will arrive with a forward velocity (i.e. towards the east) that is faster that the surface of the Earth.
- If air were to be pushed upwards towards a low pressure cell, then this air will arrive with a slower forward (easterly) velocity.
- Consequently, in the southern hemisphere, the air north of a low pressure cell arrives with a faster easterly velocity, while air from the south arrives with a westerly velocity.
- This variation in velocity causes low pressure cells in the southern hemisphere to rotate in a clockwise direction.
- In Australia, high pressure cells are often found in the north of the country (but not always), with low pressure cells in the south, which causes winds to 'typically' move in an easterly direction over inland Australia (see diagram below).

Page 103

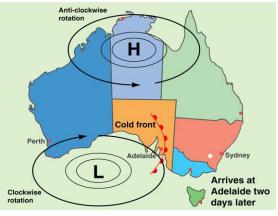


V1, October 2025

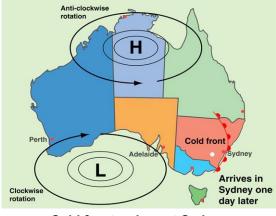
#### Insert: The movement of atmospheric moisture over Australia



**Cold front arrives at Perth** 



Cold front arrives at Adelaide



**Cold front arrives at Sydney** 



**Great Dividing (mountain) Range** 

#### A map of Australia

- If you were to take a casual glance over a map of Australian, you may notice some interesting facts:
  - Adelaide at a latitude of 34° is north of Canberra at a latitude of 35°
  - Perth at a latitude of 32° sits north of Sydney at a latitude of 33°.
- Meaning that if wet weather arrives at Perth on Monday, it is likely to arrive at Adelaide on Wednesday, then at Sydney on Thursday (approximately).

#### Movement of air over Australia

- It is common for weather conditions to pass over Perth after originating in the Indian Ocean.
- Two days later, the same weather passes over Adelaide, followed by Sydney just one day later.
- But, of course, things don't always follow this simple pattern.

**Note:** I am sure that any descent hydrologist would likely break-down and cry based on my simplification of Australia's weather.

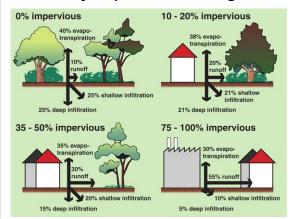
#### Movement of air moisture over Australia

- In Australia, it is common for weather fronts to move in an easterly direction.
- It is also common for the air moisture that generates rainfall over much of Australia, to have originated in the Indian Ocean.
- This means, large volumes of air moisture pass over our central deserts.
- One reason for rain not falling on our central deserts is the lack of necessary topographical features to cause the moist air to rise and fall.

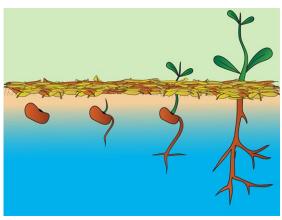
### Rainfall west and east of the Great Dividing Range

- The Great Dividing Range passes down the eastern coast of Australia.
- This topographical feature promotes rain fall on both the eastern and western sides of the mountain range.
- A lot of the rain that falls west of the mountain range, originates in the Indian Ocean (but not always), while a lot of the rain that falls east of the range originates within the Pacific Ocean (but not always).

#### The ability of plants to manage water (Page 162)



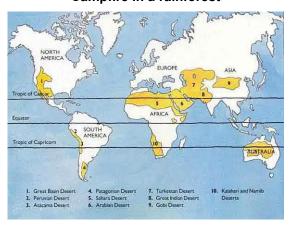
#### Evaporation as a component of hydrology



Early plant growth



Campfire in a rainforest



World's deserts

#### Plants as water managers (p. 162)

- 'Plants manage the water in the landscape, so if you burn off or otherwise eradicate plant species and thereby create a gap in the biodiversity, the plants will no longer be able to manage the water.'
- GW: Plants carry water from the soil, up to their leaves, and then they release the water in an uncontrolled manner through evaporation.
- Once the water is evaporated, it is effectively lost from the system, which places Peter's claims in serious doubt.

#### The loss of water from the system (p.162)

- 'The water will be lost and the land will not recover.'
- GW: Removing plants can:
  - reduce the shading of the soil
  - reduce the generation of leaf litter that can also shade the soil further reducing evaporation.
- Plants rely on the 'removal of water from the system' in order to survive—it is called 'evapo-transpiration'.

#### Questionable statement

- 'It is a sobering fact that there were no deserts in Australia before the Aborigines arrived.'
- GW: I know of no justification for this statement.
- I consider this statement to be false.
- Deserts covered vast regions of Australia before humans first appeared on Earth.
- Similarly, Australia's first people were <u>not</u> responsible for the extinction of dinosaurs.

#### False statement

- 'Australia's deserts are all man-made.'
- **GW:** I know of no justification for this statement.
- Humans were not responsible for the creation of:
  - Peruvian Desert
  - Patagonian Desert
  - Sahara Desert
  - Arabian Desert
  - Gobi Desert
  - Katahari and Namib deserts.

#### The value of plants (Page 163)

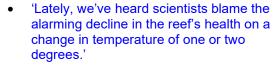


**Mineral extraction** 

#### The value of plants (p. 163)

- 'By photosynthesising the energy they draw from the sun, plants manufacture the compounds on which everything else depends.'
- **GW:** This statement is an overreach. Plants are not responsible for the minerals we, and other fauna, use.
- Plants did not produce the water or the carbon that we use. Plants may use water and carbon, but they didn't produced it.

#### Damage to the reef (p. 164)



- 'I would suggest that the reef has experienced temperature changes on this scale a dozen times in its lifetime – and it's still kept on growing.'
- GW: The reef has experience much greater temperature changes and sea level changes, but at a MUCH slower rate that allowed the reefs to migrate.



Sun bleaching of the reef

#### Clearing of coastal forests (p. 165)

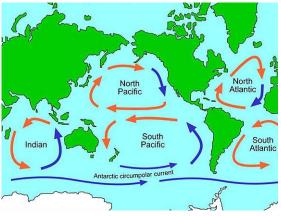
- 'Each evening the forests used to cool the air over the land faster than it was cooled over the sea, which had the effect of sucking moist air from the sea over the land.'
- GW: I know of no basis for this claim.
   During the day, forests can cool the air by shading, but this does not happen at night.
- The total matter content of a forest would retain heat, which is why deserts, without such matter, cool so fast at night time.



Forest meets the ocean (Qld)

#### The movement of cool & warm air (p. 165)

- 'When the forests were cleared the reverse happened: the air over the sea now cools faster each evening than the air over the land, which sucks the air in the other direction.'
- GW: The transfer of heat around the planet is largely controlled by ocean currents—oceans can deliver heat to a coast, or take it away.
- I am not convinced that Peter's claims can be justified given the long-term evidence of onshore winds.



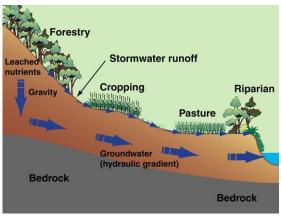
Heat transfer by ocean currents

#### Chapter 21 – Hydrology: Fancy Term, Simple Concept (Page 166)

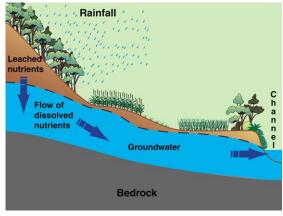
# Ch 21: Hydrology, Fancy Term, Simple Concept



A landslip (Tas)



**Sub-surface flows** 



**Sub-surface flows** 

### Someone forgot 'gravity' and 'volcanic action' (p. 166)

- Wind is one of the landscape's two transport systems. Water is the other: water travelling through the landscape can move the various components of the landscape about. Nothing else but wind and water can move them, apart from animals and birds . . .'
- **GW:** I would add 'gravity' and 'volcanic action' to the transport systems. Also, fire, and the resulting smoke, is not a form of 'wind', but it can also transport ash.

#### Sub-surface flows (p. 166)

- 'The water transport system works in two ways. One, subsurface water flows through the topsoil over the top of the clay layer below – more than 70 per cent of Australia's landmass has a layer of clay beneath it.'
- GW: This statement suggests that subsurface water moves near-horizontally through the topsoil (i.e. moving parallel to the underlying layer of clay).
- In general, this statement is <u>not</u> true. Not all clay layers are impermeable.

#### **Hunter Valley (p. 167)**

- 'Measurements in the Hunter Valley suggest that water moves through the soil there at no more than 2.5 metres a year.'
- GW: I have no idea where Peter would have obtained such information, and unfortunately, Peter does not provide much in the way of reference material.
- Whatever this flow velocity represents, it is not relevant to the sub-surface movement of nutrients.
- Water moves through soil much faster than this.

#### Plants, nutrients and floodplains (Page 168)





### Floodplains (p. 169)

roots.'

'In a true floodplain, fertility depends on an interaction between the topsoil and the water table.'

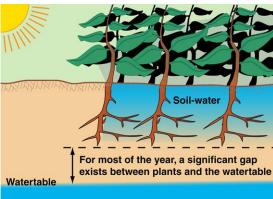
Can plants perform magic? (p. 168)

'The plant's job is to lift nutrients to the surface where they are accessible to their

**GW:** Plants can only lift nutrients 'to the elevation of the surface' within their roots.

This means that plants CANNOT lift nutrients to an elevation where they can be accessed by 'other' roots because the nutrients will already be in their roots. Roots can use a bit of surface tension to lift water, but only in certain soil structures.

- **GW:** In 99.9% of cases, the topsoil has no contact with the watertable.
- I assume the problem here is that Peter has his own unique definition of the term 'water table'.



Separation of plants from the watertable



Sand extraction from Penrith Lakes (NSW)



Sand-based river (Qld)

#### The making of floodplains (p. 169)

- 'Floodplains began as areas of sand, for sand is what the floodwaters initially deposited there. Only later did a layer of clay begin to accumulate.'
- GW: I am sure there is at least one floodplain out there somewhere, where this statement is true, but alas, this is not the case for most floodplains.
- A lot depends on what the catchment's parent rock is made of.

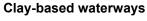
#### Creek beds (p. 172)

- 'Like all creeks and rivers, it had a bed of clay that let hardly any water into the ground, and . . .'
- GW: This is just not true.
- Our creeks and rivers can have either a clay-based bed, sand-based bed, gravelbased bed, or a rock-based bed.
- Water passes through all the bed types, except for the rock-based beds.

#### Insert: A classification system for minor waterways (creeks)



Clay-based waterway (Qld)



- The bed and banks of clay-based waterways are primarily formed from clayey soils.
- These are 'fixed bed' waterways that typically have minimal natural sediment flow or bed movement—this allows mature woody vegetation to establish close to, or even on, the channel bed.
- Typically these waterways have a Ushaped or V-shaped channel profile (i.e. not a wide, flat channel bed).



Sand-based waterway (Qld)

#### Sand-based waterways

- Deep, loose sand dominates the make-up of the bed.
- The depth of the sand can exceed the depth of the root systems of much of the bed and bank vegetation.
- These are alluvial waterways that experience significant bed movement (sand flow) during both minor and major flood events.
- Bed vegetation (if any) typically consists of quick-response, short-lived, non-woody species.



**Gravel-based waterway (NSW)** 

#### **Gravel-based waterways**

- Bed material is made-up mostly of wellrounded gravels, cobbles or boulders.
- These are alluvial waterways that often feature pools and riffles, which can completely reform during severe floods.
- The movement of the bed material during major floods means the channel bed is usually flat (similar to sand-based rivers).
- Woody vegetation can struggle to form on the channel bed if the bed movement is significant—which may not be the case in the upper reaches of the waterway.

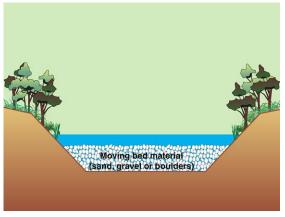


Rock-based waterway (Tas)

#### **Rock-based waterways**

- The bed material of rock-based waterways is made-up of exposed rock outcrops, often separated by sections of clay, sand or gravel-based channels.
- These are fixed-bed, 'spilling' waterways usually containing waterfalls or riffles followed by deep pools within which energy dissipation occurs.
- These waterways are sometimes referred to as 'rocky-spilling' or 'steep pool-fall' waterways.

#### Insert: Alluvial (sand & gravel-based) vs clay-based rivers



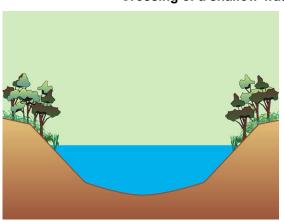
Flat-bed alluvial waterway

#### Alluvial (moving bed) rivers

- If you have ever watched a Western movie showing wagon trains heading west, or the U.S. cavalry chasing down 'bad guys', then you would have probably seen horses, cattle and covered wagons, crossing rivers.
- If the river is wide, but the depth of the water is near-constant across the river bed, then this is almost certainly an alluvial waterway.
- Meaning the bed material is very mobile and self-levelling (i.e. sand or gravel).



Crossing of a shallow-water alluvial waterway (USA)



V or U-shaped channel profile

#### Clay-based (fixed bed)rivers

- However, there are times in these period movies when horse riders are forced to take a barge across a river (e.g. the movie 'True Grit'), or where the water is so deep that horses and cattle are required to swim.
- These waterways are likely to be claybased waterways that do not experience significant bed flow relative to alluvial waterways.
- Or they could just be very deep alluvial waterways!



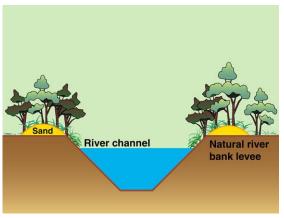
Raft crossing of a deep-water waterway

#### Chapter 22 – Streams the Seemed to Defy Gravity (Page 173)

# Ch 22: Streams that Seemed to Defy Gravity



It is just not true!



Natural sand levee banks



**Bushfire (Vic)** 

#### Flowing on elevated ground (p. 173)

- 'The idea that in the ancient Australian landscape water ran naturally on elevated ground is completely foreign to most people.'
- GW: It is foreign to most people because it simply is NOT TRUE!
- As a civil engineer, who specialised in water engineering, and eventually worked as a creek engineer, I can say with 100% certainty that this idea is complete fantasy.

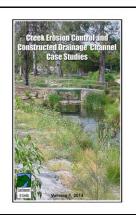
#### Lachlan River (p. 174)

- 'He [John Oxley] couldn't understand how any tributaries could flow into the Lachlan River, since the surrounding land seemed lower than the river.'
- GW: Many rivers, particularly rivers that pass through granite country, can form natural levee banks.
- These natural levee banks are usually formed from sand, which quickly becomes stabilised with vegetation—examples can be seen in the northern rivers region of NSW.

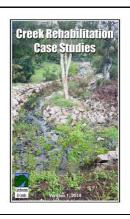
#### Blame the Aborigines again! (p. 186)

- 'Australia's floodplains were formed continuously over a very long period. This vast construction process faltered when Aborigines began burning, and it was brought almost entirely to a halt when white farmers arrived with cattle and sheep, with the result that the formation of floodplains in Australia has now all but stopped.'
- **GW:** I am sorry, but this is all just makebelieve. I can see no basis for Peter's discussions throughout this chapter.

Insert: Suggested alternative C&C reading material



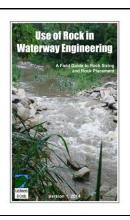
Creek Erosion Case Studies, 2014



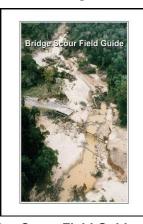
Creek Rehabilitation Case Studies, 2014



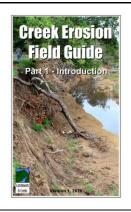
Public Guide to Living with Floods, 2014



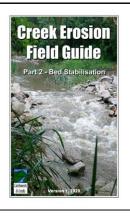
Use of Rock in Waterway Eng, 2014



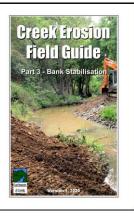
Bridge Scour Field Guide, 2020



Creek Erosion FG, Part 1, 2020

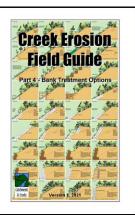


Creek Erosion FG, Part 2, 2020

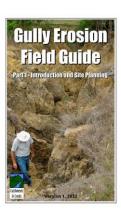


Creek Erosion FG, Part 3, 2020

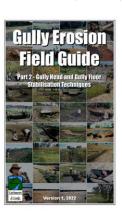
#### Insert: Suggested alternative C&C reading material



Creek Erosion FG, Part 1, 2021



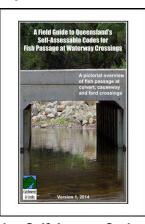
Gully Erosion, Part 1, 2022



**Gully Erosion, Part 2, 2022** 



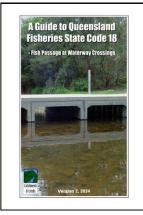
**Gully Erosion, Part 3, 2022** 



Fisheries Self-Assess Codes, 2014



Fish Passage Glossary of Terms, 2017



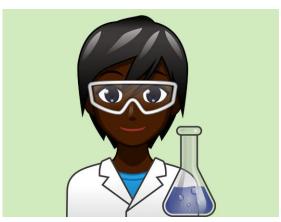
Queensland State Code 18, 2024



Fish Passage Culvert Design, 2025

#### Chapter 23 – Contouring: An Option that Works (Page 187)

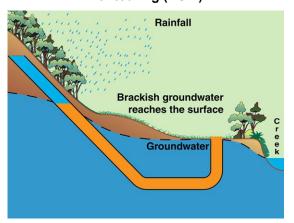
# Chapter 23: Contouring, An Option that Works



The sciences



Contouring (NSW)



The effects of hydraulic pressure (p. 62)

#### Simulating nature's way (p. 187)

- 'While we may not be able to re-create exactly what existed before, we can introduce systems that simulate the systems in the landscape long ago.'
- GW: It is clear to me that Peter does not understand the processes that existed in Australia years ago.
- So, who's advice should we follow: Peter's, because he has imagined a whole new science; or scientists, who have developed their understanding over many years of research?

#### Contouring (p. 188)

- 'The system of contouring I have devised is very different in types and serves a very different purpose.'
- **GW:** Traditional contouring controlled stormwater runoff (hydrology) in order to control soil erosion.
- Peter's contouring controls hydrology (stormwater runoff) in order to control fertility loss through a process of controlling soil erosion—that does not sound 'very different'.

#### A lens of freshwater (p. 188)

- 'A contouring system allows us to maintain a lens of fresh water above the layer of salt water below, which, as explained before, acts like a lid to prevent the salt water breaking out at the surface.'
- **GW:** But, unfortunately, as I demonstrated in Chapter 9, it is <u>not</u> physically possible for this 'lid' or 'lens' of freshwater to 'prevent the salt water breaking out at the surface'.
- I believe that Peter's theory is wrong.

#### Insert: One of the problems experienced on contoured land



Failed contour bank drainage



Minor storm runoff



Major storm runoff and erosion



Introduced high-flow drainage path

#### Introduction

- One of the first rules in hydrology is: 'there will always be a bigger storm'.
- When it comes to contour banks, there will always be a storm that will overtop the bank at some point.
- It may be possible to build a contour bank with a perfectly level top-of-bank (i.e. a crest that would produce an even overtopping flow depth), but over time, the bank will experience uneven settlement, or stock damage, which means overtopping events will concentrate the flow at a few points along the bank.
- During minor storms, the contour bank should be able to handle 'minor' overtopping events.
- However, during the next major storm, the concentration of overtopping, or bypass flows, can initiate gully erosion down-slope of the bank, which can then migrate up through the bank.
- The eventual hydraulic failure of the bank usually results in expensive and damaging gully erosion.

#### Major storm runoff and erosion

- If contour banks are installed, then appropriate consideration must be given to the management of major storms.
- The problem can be managed by:
  - installing several shorter banks
  - constructing a stabilised overland flow path (this is usually left with a cover of long grass)
  - constructing smaller horseshoe ponds.

#### The Western Australia problem

- In some locations, such as Western Australia, these contour systems have relied upon the high infiltration rates of very sandy soils in order to reduce the risk of bank overtopping.
- However; as stated above, there will always be a bigger storm, and if no allowance is made for such overtopping events, then the resulting storm damage can be significant.

#### Insert: We have a problem!



The unknown

#### Introduction

- GW: Have you heard the saying: 'A little bit of knowledge is dangerous'
- Well, this simple expression sums up most of my concerns about the advice Peter is giving to farmers in parts of this book.
- There is no doubt that what Peter 'knows with clarity' is very useful to farmers.
- However, it is Peter's knowledge of issues that he does not have expertise in that causes me concern.

### A revised saying:

- Allow me to present an alternative saying: 'No knowledge can be amusing.
  - A little bit of knowledge can be dangerous. A lot of knowledge can be boring.

An awareness of your knowledge limits can help you avoid public embarrassment.'

A person's greatest asset can simply be a finely-tuned awareness of their surroundings, and their potential interaction with these surroundings.

An awareness of your surroundings, is the ability to focus on the little things, while also being able to stand-back and see the

An awareness of your potential interaction with your surrounding, is the ability to understand how things work, and how your actions can benefit, or harm, your

Becoming a better person (farmer)

bigger picture.

surroundings.

opened mind.



The awakening



**Farmer** 

So what!

Well, if you have got this far into this book review, then you are possibly open to me correcting Peter's knowledge of hydrology and geotechnical engineering.

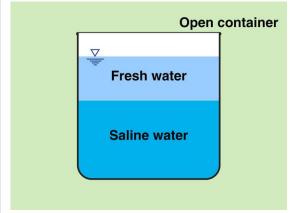
Open eyes and open ears need an

So, over the following pages I will go back to explaining the basics of water movement through soils, and my understanding of how Peter's double trench will, or will not, work.



Geotechnical engineer

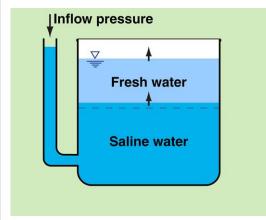
#### Insert: An introduction to groundwater engineering



#### Stratification of fresh and saline water

- Fresh water has a density of around 1000 kg per cubic metre.
- Salt water has a density of around 1025 kg per cubic metre.
- While in a static condition, fresh water will rest above the heavier saline water.

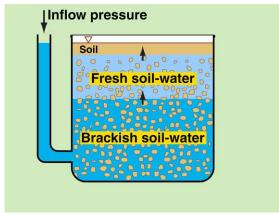
#### Stratification of fresh and saline water



#### Pressured inflow of saline water

- If pressure, in the form of an inflow, is increased within the saline water, resulting in an increase to the volume of saline water, then:
  - the interface between the fresh and saline water will rise
  - the fresh water 'lens' will rise
  - if the fresh water reaches the top of the open container, then fresh water will spill from the container.

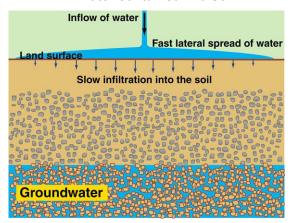
#### Pressured inflow of saline water



## Same case but with the container first filled with soil

- If the open container is first filled with soil, then the saline water is added, allowed to settle, then topped with fresh water, we will effectively have the <u>same</u> hydrostatic situation as above.
- If pressure is increased within the saline water, resulting in an increase to the volume of saline water, then:
  - the interface between the fresh and saline water will rise
  - the fresh water 'lens' will rise.

#### All water contained in a soil

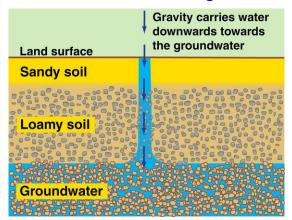


Water introduced to land surface

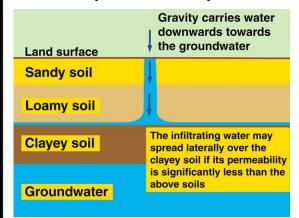
#### Movement of water over the land surface

- If water is discharged over the ground, then the water will spread laterally because:
  - 'air' provides less flow resistance than the 'soil'.
- Water will slowly infiltrate into the soil, with the rate of infiltration being:
  - proportional to the depth (head) of water above the soil, and
  - the flow resistance of the soil.

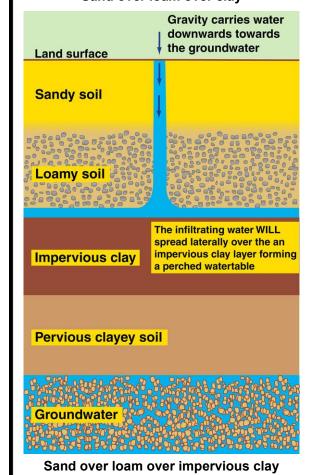
#### Insert: An introduction to groundwater engineering



#### Sandy soil over a loamy soil



#### Sand over loam over clay



## Infiltration through a sandy soil into a loamy soil

- If a soil profile consisted of a sandy soil overlaying a loamy soil, overlaying the watertable and groundwater, then:
  - stormwater will normally be able to infiltrate the soil at any location where water collects on the surface
  - water will normally descend vertically through the soil profile
  - water will keep falling until it reaches the watertable.

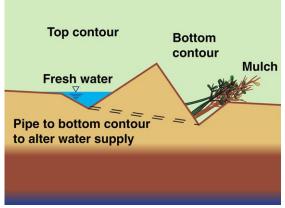
## Infiltration through a sandy soil into a loamy soil, then into a clayey soil

- If a soil profile consisted of a sandy soil overlaying a loamy soil, overlaying a clayey soil, overlaying the watertable, then:
  - stormwater will normally be able to infiltrate the soil at any location where water collects on the surface
  - when the water reaches the clayey soil, it may pool, spread, or infiltrate, depending on how permeable the clay layer is.

# Infiltration through a sandy soil into a loamy soil, then spreading over an impervious clayey soil

- If a soil profile consisted of a sandy soil overlaying a loamy soil, overlaying an impermeable clay soil, overlaying a permeable clay soil, overlaying the watertable and groundwater, then:
  - stormwater will normally be able to infiltrate the soil at any location where water collects on the surface (Note: the diagrams show the infiltrating water as a narrow column, but that is just for visual clarity—this 'column' would be as wide as the wetted land surface)
  - water will normally descend vertically through the soil profile
  - the water will spread and pool above the impervious clay in a manner that forms a perched watertable.
- If a landowner were to drill down into this perched watertable, they would find water, but the volume of this water would be very limited compared to the 'permanent' watertable.
- Drilling can find water at different elevations within the soil profile.

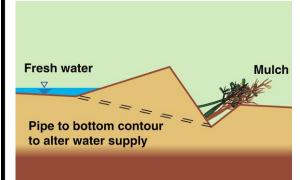
#### Peter's contour bank system (Page 189)



Reproduction of Peter's drawing on p.190

#### Two contour channels (p. 189)

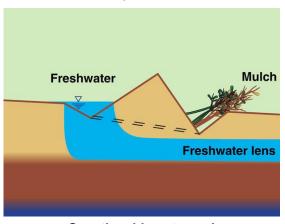
- 'First, create two water channels, one a few metres above the other, along the contour of the land in question,'
- **GW:** Peter displayed this double channel system as two excavated channels in a diagram on page 190 of his book (2007 edition).
- I have reproduced Peter's diagram opposite (slightly changed).



**Back-push banks** 

# Back-push banks (p. 189)

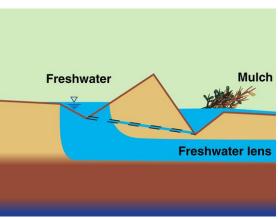
- 'Preferably, these channels should be created not so much by cutting a channel into the ground as by pushing up a bank from below the channel.'
- **GW:** A traditional back-push bank consists of an up-slope bank (formed mainly from topsoil), and a down-slope excavated channel (that is likely to have exposed the more erodible sub-soils).
- Caution should always be taken if the subsoil is dispersive (sodic).



Questionable outcome!

#### The upper channel (p. 189)

- 'The upper channel is meant for fresh water only. . . Because the purpose of the upper channel ( . . . ) is to create a freshwater lens under the whole contour area.'
- GW: I do not believe a freshwater 'lens' will occur in most cases.
- Such an outcome would only occur if the underlaying clay layer was impermeable, which would mean brackish groundwater would not be a problem!

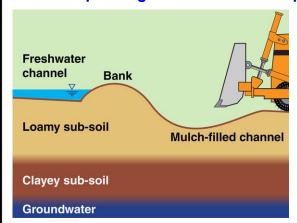


Questionable outcome!

The lower channel (p. 189)

- 'Then, when fertility is added to the lower channel in the form of mulch or some other type of organic refuse, the water that has picked up fertility in the lower channel will spread across the land below [the surface, but] above the freshwater lens . .'
- **GW:** Water would need to be fed into the lower channel through the connecting
- I question how much nutrient flow this system will produce.

#### Insert: Explaining what I think will happen with Peter's twin channels



#### Peter Andrew's twin contour channels

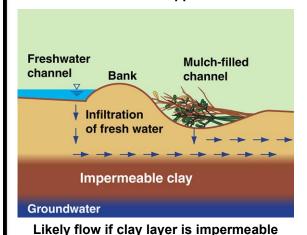
- I have reproduced Peter's double channel system (left), only I have shown the upper channel as just a 'contour bank', not as an excavated channel.
- This may be what a farmer would do if the sub-soil is dispersive (sodic).

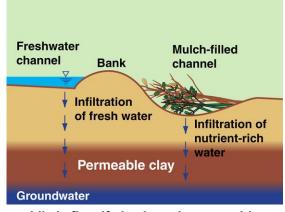
(I am sorry if this sounds all too complicated, but there are a lot of different outcomes that can occur depending on the type of soils that any given farmer may have.)

Back-push bank



Excavated upper channel with down-slope of contour bank (Qld)





Likely flow if clay layer is permeable

#### Likely flow if clay layer is 'impermeable'

- A 'freshwater lens' would only occur if the underlying soil is impervious, or nearimpervious.
- If this were the case, then I do not see the purpose of forming the freshwater lens because the brackish groundwater would not be able to rise up through the impervious soil layer.

#### Likely flow if clay layer is 'permeable'

- The most likely outcome would be for all the infiltrated water to descend vertically until it reaches the watertable.
- Any nutrients that are leached from the mulch would also descend vertically until they reaches the watertable.
- The only nutrient-rich water that would flow down the slope would be surface water runoff, which is unlikely given the existence of the contour bank, which reduces the effective catchment area.

#### Insert: Visual identification of dispersive soils

#### Dispersive soils

- Dispersive soils are highly unstable when wet, resulting in severe, deep rilling (known as *fluting*), tunnel erosion, and/or gully erosion.
- Soils with a hard setting surface, and a high sodium content (sodic soils or Sodosols), are very prone to erosion.
- Dispersive sub-soils are a problem because they can quickly turn any cut drain into gully erosion.



Effects of raindrop splash (Qld)



Dispersive soil creek erosion (NSW)



Invert rill erosion (Qld)



Dispersive soil bank erosion (Qld)



Creek bank erosion (Qld)



Gully erosion (SA)



Gully erosion (NSW)

#### Insert: Field testing for dispersive properties (Aggregate Immersion Test)



Slightly dispersive soil

#### **Aggregate Immersion Test**

- The Aggregate Immersion Test can be used as an 'indicator' of dispersive soils.
- This test involves filling a dish with distilled water (generally available at petrol stations and supermarkets) to a depth sufficient to cover the soil samples.
- Several dry, hard clumps of soil are gently placed in the water.
- The water is then observed for colour changes (<u>after</u> all the air has escaped).



Non-dispersive, non-slaking soil

#### Non-dispersive soil

- If the water remains clear and the boundary of the soil clumps remains clearly defined, then the soil is likely to be non-dispersive.
- If the original soil clumps were loose or heavily disturbed, then these clumps will likely separate into smaller pieces when initially placed into the water—this does not indicate that the soil is dispersive.
- Air escaping from the soil can also cause the clumps to fall apart.



Dispersive soil

#### Dispersive soils

- If the water discolours both horizontally and vertically around the soil clumps, then the soil could be dispersive.
- Highly dispersive clumps of soil will collapse in less than 10 minutes.
- Caution: using tap, tank, or groundwater, can sometimes mask the dispersive reaction due to minerals and/or chemicals in the water—hence the reason for the distilled water.

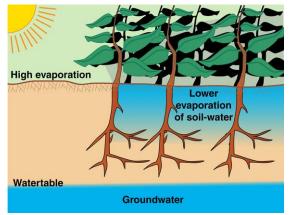


Slaking soil

#### Slaking soils

- Slaking soils are soils that readily collapse in water, but do not necessarily cloud the water.
- If the water remains clear, and the clumps completely collapse and spread horizontally, then the soil could be a slaking soil.
- Slaking soils commonly occur within landscapes that contain granite rock.
- These soils can be highly erodible, especially if disturbed by digging.

#### Freshwater lens (Page 189)



#### Controlling evaporation



**Plant roots** 



Erosion of a dispersive sub-soil (SA)



Tunnel erosion under a bank (Qld)

#### Freshwater lens (p. 189)

- 'Remember that the freshwater lens will be maintained only if plants are there to do it.'
- GW: I disagree with Peter's theory that plants can hold a freshwater lens in place, just below the surface.
- What plants <u>can do</u> is reduce evaporation, which helps to retain soil-water.
- But, plant roots don't act like magnets.

#### A (p. 190)

- 'As explained earlier, it's the upwards pressure that plants exert in the soil as they drag nutrients to the surface through their root systems that prevents freshwater in the topsoil from sinking and thus maintains the freshwater lens.'
- GW: I believe this statement is wrong.
- Plants do not seek nutrients from the soil.
   Plants take water into their roots, and if there are minerals or nutrients in that water, then the plant will take those elements from the water.

#### A (p. 190)

- 'The channels certainly shouldn't be cut deeper than half a metre.'
- GW: The deeper the cut channel, the greater the risk of the channel turning into a gully erosion problem.

#### A (p. 190)

- 'At the same time, one or more pipes should be laid beneath the bank from the bottom of one channel to the bottom of the other.'
- 'By opening or closing these pipes, a farmer can determine how much water is held in the upper channel and how long it sits there. This is important, because if the water sits in the channel too long it can cause an outbreak of salt downhill from the contours.'
- GW: Potential for tunnel erosion.

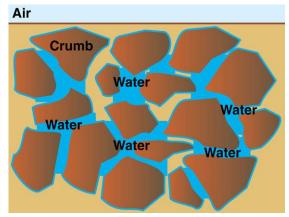
#### Insert: Understanding how plants feed (general discussion)

#### Introduction

I am fully aware that most of the people reading this document will know more about plants and plant growth than myself. Having 'me' tell YOU about plants would be as useful as telling a farmer which end of a cattle dog has teeth.

The point that I wish to raise is that you can't just place food and water in front of a plant, and expect the plant to pick and choose what it needs. Plants don't have a brain. Plants cannot see a bit a potassium in the soil and say: I may need that in the future, so I will grab it now and store it up here in my plant pantry until I need it.

Plants use 'automated' mechanical processes. Evaporation produces a pressure gradient that causes a plant root to absorb water. Anything that is dissolved in that water will enter the plant, whether it wants it or not, whether it needs it or not. However, anything that exists in particulate form within the water (i.e. not fully dissolved), could be blocked from entering the plant's roots depending on the type of plant, and the type of root.



Soil-water

#### Feeding on water

- It must be a painful part of farming to know that a plant needs water, and that the soil has water, but the plant cannot extract that water from the soil.
- Water can be held in soil due to the power of surface tension, but water can also be held by much more powerful chemical bonds.
- Plants can only use what is effectively, vapour pressure (atomic bonds) to extract the water from the soil—and this force may not always win.

#### Feeding on nutrients and minerals

Plants don't carry a shopping list. They also don't have the resources of a workshop and chemical laboratory. When it comes to the supply of nutrients, the critical factors are: the right nutrient, at the right time, and in the right form.

Think about this: If a brick layer wanted sand to help make a cement mix, then the brickie would not appreciate being supplied with several slabs of sandstone. Yes, it maybe made of pure sand, but it is not in a form that is readily available for use by the brickie.

The same applies to plants. If the minerals are tied-up in compounds that the plant cannot readily access, then these essential minerals can be stored in the plant, but they can remain completely untouchable by the plant.

It may be necessary to feed the plant with several different forms of that one critical nutrient until you find the 'form' (chemical composition) that that particular plant can manage. A plant that needs potassium, can die from a lack of potassium even though the soil has an excess of the wrong form of potassium.



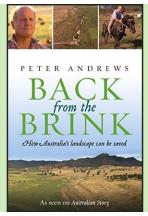
Element periodic table

#### Feeding on metals

- If you performed a chemical analysis of certain vegetables you will find that each vegetable contains different trace elements, including metals.
- Just because a metal is found in a plant does not mean the plant <u>needed</u> that metal (Yes; the term is 'metal', NOT 'heavy metal').
- I am sure the lettuce does not need lead to grow, just as fish don't need mercury to grow—it is just a by-product of their local environment.

Improving stormwater infiltration (A fact sheet on stormwater infiltration)

# Insert: Improving Stormwater Infiltration



Back from the Brink (2007)



Minor stormwater runoff over grass (Qld)



Flooded floodplain (SA)

#### Introduction

- I have inserted this discussion about stormwater infiltration because this issue is discussed in a number of the chapters of Peter's book; 'Back from the Brink'.
- The following is not a detailed discussion about the management of stormwater on farming properties, nor is it a detailed discussion about the management of floodplain soils.
- This insert is presented as just general discussion.

#### The infiltration of stormwater

- Stormwater is classified as local runoff—it is water that has most likely fell as rain directly on your property.
- Local stormwater runoff is likely to pass over your soil at a velocity that is likely to have been determined by the slope of your land, and the roughness of the soil surface (including vegetation).
- Increasing stormwater infiltration normally involves: modifying the soil, increasing the surface roughness, and/or widening the width of flow.

#### The infiltration of floodwater

- Floodwater is classified as storm runoff from distant properties, or distant storms it is water that most likely had not fallen directly on your property.
- Floodwater is likely to move at a much slower velocity over your land (but not always), and its velocity is usually determined by the slope of the water surface (i.e. the 'backwater' effect).
- Increasing floodwater infiltration normally involves: capturing and holding floodwater on the land for a longer period.

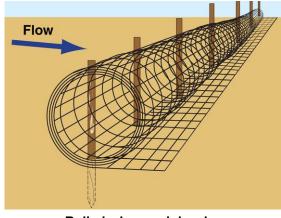
#### Insert: Looking a ways to improve stormwater infiltration into soils



Woody ground cover



**Brushwood barriers** 



Rolled wire mesh barrier



Stakes / Rakes

#### Introduction

- One message that both Peter and myself agree upon is:
  - where necessary, farmers should take appropriate steps to increase the percentage of stormwater runoff that is able to infiltrate into the soil.
- Of course, all farmers must be aware of the potential impacts their activities can have on their surroundings, which includes the potential for your increased infiltration to cause salinity issues on down-slope properties.

#### The infiltration of stormwater into soils

- The critical infiltration factors are:
  - duration of flow, which is linked to the depth and velocity of runoff
  - the depth of runoff (sheet flow or channelled flow)
  - the velocity of runoff, which is linked to the surface roughness
  - the surface roughness
  - the volume of stormwater retained on wetted surfaces (e.g. mulch) that can latter drip into the soil.

## Techniques for increasing stormwater infiltration

- Techniques include:
  - woody ground cover
  - mulching
  - contour banks
  - artificial surface roughness, such as: brushwood barriers, leaky weirs, horseshoe bunds, stakes, rakes, contour wetlands, rolled wire mesh, low-set wind breaks and/or fencing.



Fencing

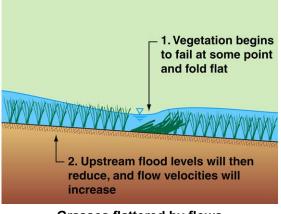
#### Insert: The effects of soft grass and still grass ground covers



Crop cover

## The problem with non-woody ground covers

- Covering land with vegetation can add surface roughness to the land; but, nonwoody plants have a tendency to fold flat when subjected to high-velocity flows, or floodwater that exceeds a depth of around 300 mm.
- The collapse of these plants can cause storm runoff to concentrate, which results in very little infiltration of water into the soil





Stiff grass (Vetiver grass) (Qld)



Pile filed (just one example)



Concentration of flows through grass

#### Stiff grass barriers

- Stiff grasses, such as Vetiver (tall), or Lomandra (medium height), can form a fence-like barrier, which can be used to slow the movement of overland flow.
- Great care must be taken when establishing a stiff grass barrier in order to make sure it achieves the desired effect.
- Planting one or two parallel rows of plants can be effective at 'slowing' flows, while planting a thicker barrier can cause flows to be diverted, or the trapped water to spill like a weir.

#### Stakes, rakes and pile fields

- The name of this technique varies from guideline to guideline, and state to state.
- The concept is simply a well-spaced grid of either metal stakes, fence posts, or reinforcing (reo) bars.
- The spacing of the 'stakes' varies with the local need, but typically the spacing must allow for the movement of all necessary farm vehicles.
- During floods, the stakes capture organic debris, which slows the progression of the floodwater.

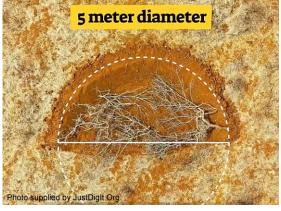
#### Insert: Semi-circular water bunds (images represent Kenya trials)



**Excavate bund** 

#### Semi-circular horseshoe bunds

- Constructed along the contour.
- Alignment of each bund with the land contour is not critical because of the large number of small bunds.
- The earth bund can also be built to operate as a 'leaky weir' (if desirable).
- Each pond area is grass seeded, treated with gypsum if the soil is dispersive, and then partially covered with organic matter (but only if such matter does not cause a flood debris problem).



Approximately 5 m diameter



Open on the up-slope side



Grass seed the bunds



**Collection of runoff** 



Can be formed as leaky weirs



Rehabilitated landscape

#### Chapter 24 – Erosion: Our Landscape's Wasting Disease (Page 196)

# Chapter 24: Erosion, Our Landscape's Wasting Disease

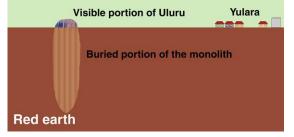


**New Zealand** 



**Galapagos Islands** 

A major shock water generated by an asteroid strike causes soil liquefaction, and a wave of saturated soil to approach the rock, causing it to tilt



The vertical re-alignment of Uluru

#### **Historical erosion**

- 'Erosion in the Australian landscape was virtually non-existent before people interfered with the natural systems that controlled the movement of water across the land.'
- GW: Australia is known to be one of the oldest, and most eroded landscapes.
- Australia is not necessarily old in terms of the age of its parent material, but it is viewed as being old because there has been very little geological renewal.
- Let me give you an analogy:
  - Imagine you are at a farm equipment museum. You see three tractors sideby-side. All three started life as the same model, and all were sold in the same year.
  - One tractor has consistently been undated with modern alterations, and a new paint job—that is New Zealand, with its new rock and reformed landscape.
  - One tractor has all new parts, and stands as a fully rebuild tractor—that is the Galapagos Islands.
  - One tractor has all its original, very old, and very worn, parts—that is Australia.

#### Uluru

- GW: Uluru (Ayers Rock) is a sedimentary rock that was formed while it layed at approximately 90-degrees to its current standing.
- Experts tell as that at some point in Australia's history this sandstone monolith was turned vertical, with most of the rock being buried below current land level.
- That means the soil depth in central Australia is enormous! It also means that a lot of erosion has occurred in order to develop such a depth of soil.

#### Land and waterway erosion (Page 197)



**Questionable statement** 



Murray River weir (Vic)



Extreme flood event (Qld)



Very-loose mobile bed sediments (Qld)

#### Brake-out streams (p. 197)

- 'These stream would rejoin the main watercourse at the end of the floodplain and, because they'd arrive from opposite directions, most of the energy they possessed would be cancelled out by each other.'
- **GW:** This statement, and the rest of this paragraph, are just wrong.
- These discussions have no basis in scientific theory, or hydrologic engineering.

#### Weirs (p. 198)

- 'Around Australia various structures, mainly weirs and the like, have been built with government money to control water flow and prevent erosion, but from my own observations I would suggest that 90 per cent of them incorporate none of the deenergising components needed to cope with really big volumes of water.'
- **GW:** These waterway structures are not built to stop all erosion, but instead to return erosion conditions back to a 'natural' (pre-European) conditions.

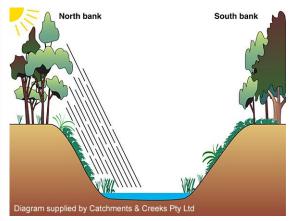
#### The Big Wet (p. 198)

- When the next big wet occurs and we're due for one before long – most of these structures may well be washed away.'
- GW: I very, very much disagree with the idea that most of these structures may well be washed away.
- There will always be significant structure and waterway damage during extreme flood events, but that does not make the existence of these waterway structures invalid.

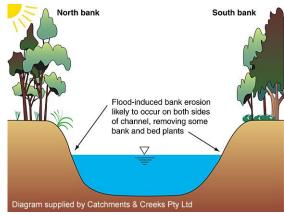
#### Movement of bed material (p.199)

- 'But they're wrong. The body of sand in the creek bed doesn't move.'
- **GW:** Almost everything I have read in this chapter (so far) is just wrong.
- The alluvial material on the bed of creeks and rivers most certainly <u>does</u> move along the bed with each flood event.
- It is because of this alluvial movement that many of our water supply dams are slowly filling with alluvial sediments.

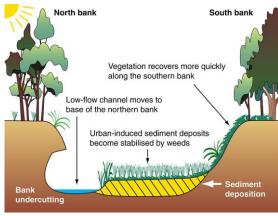
#### Insert: Reeds and the north bank problem



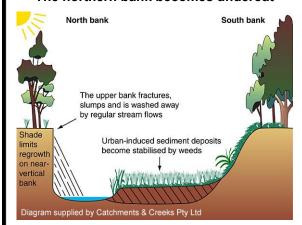
#### Partially shaded northern bank



#### Floodwaters cause plant loss & bank scour



#### The northern bank becomes undercut



Bank erodes to a near-vertical face

#### Stage '

- South of the Tropic of Capricorn, the sun will always appear in the northern part of the sky, shading the northern bank (i.e. the bank that faces south).
- This means that the type of plants, and the plant density, that establishes along the northern bank can be different to that observed along the southern bank.
- Channel banks that face east or west can also be shaded for part of the day, but there is usually a better balance of light and shade on these banks.

#### Stage 2

- If the waterway experiences a significant flood, or a series of high-velocity flows, then the resulting channel erosion can cause a temporary enlarging of the channel, and a loss of bank vegetation.
- Erosion could occur along both banks, but the northern bank is likely to experience more intense erosion due to the reduced vegetation strength.
- In some cases this can be the final stage of the erosion problem, but in other cases sedimentation can complicate the issue.

#### Stage 3 (may not occur on each site)

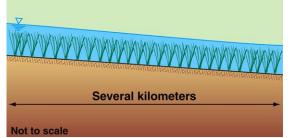
- Sediment released by urbanisation or instream erosion can settle along the bed of the waterway.
- In urban areas this sediment can be rich in nutrients, which can result in rapid weed growth stabilising the sediment.
- This can cause the existing low-flow channel to move towards the base of the northern bank, which can result in the further undermining of this bank.

#### Stage 4 (may not occur on each site)

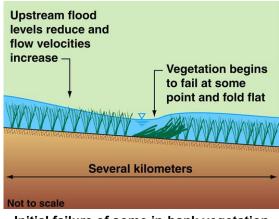
- Earth slumped from the bank is usually washed away by stream flows.
- This can cause the northern bank to establish a near-vertical face, which increases the effects of bank shading.
- This means the northern bank struggles to revegetate, and as a result, it can slowly migrate north further into the floodplain.
- If the northern bank forms the <u>inside</u> of a channel bend, then the erosion associated with a channel bend will usually dominate over this 'north-bank problem'.

#### Insert: Reeds and the flash flood problem

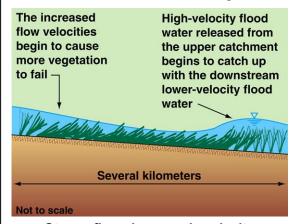
Early stages of a flood with in-channel vegetation still standing vertical which cause higher flood levels and lower velocities within the waterway channel.



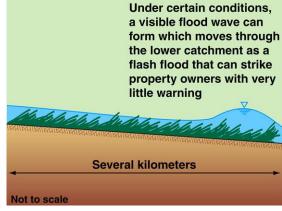
#### Waterway conditions prior to failure



#### Initial failure of some in-bank vegetation



#### Stream flows increase in velocity



A visible flood wave is formed

#### Introduction

- First of all it is important to note that the following discussion refers to a very rare type of flood event.
- It is likely that very few people will ever witness such a flood condition.
- This discussion is being presented simply to demonstrate one of the potential effects caused by changes in vegetation roughness.

#### Initial failure of in-bank plants

- As flood flows increase, in-bank plants will begin to bend in the direction of the flow.
- However, at a certain velocity, some branches will begin to snap, and some non-woody plants will fold flat over the bed and banks.
- I have used the term 'in-bank' (in-channel) to mean all plants located along the bed and banks of a waterway channel, as opposed to instream vegetation, which normally refers only to aquatic plants.

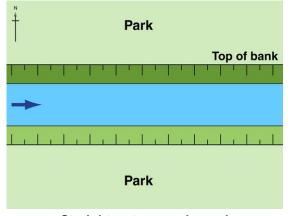
#### Mass failure of in-bank plants

- As flow velocities continue to increase, eventually large sections of the channel will experience the flattening of plants.
- This sudden reduction in channel roughness will cause a rapid lowering of upstream flood levels, and a resulting increase in flow velocities.
- The increase in flow velocities will further damage in-bank plants, and changes in the hydraulic properties of the channel will begin to accelerate.

#### Creation of a flood wave

- The acceleration of velocities in the upper catchment causes this floodwater to catchup with the slower moving floodwater in the lower reaches of the waterway.
- In a 'perfect' storm, these conditions can result in a visible flood wave forming within the waterway.
- Such flood waves can be very difficult to reproduce in numerical flood models because these models normally do not take account of the potential changing roughness of in-bank vegetation.

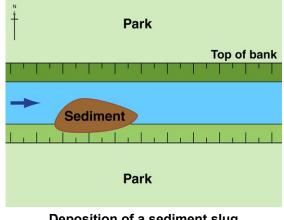
#### Insert: Reeds and the channel meander problem



#### Introduction

- In order to understand the potential impacts of sediment slugs on waterway behaviour, please consider the following scenario.
- Imagine a relatively straight channel, possibly a creek passing through a heavily-modified urban park.
- It could be assumed that this creek had at some stage been straightened in order to maximise public usage of the park.

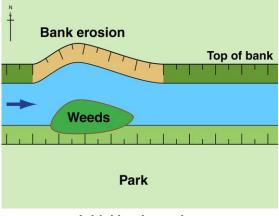
#### Straight waterway channel



#### Creation of a sediment slug

- Now consider the situation where sediment has began to collect on the bed of the creek just downstream of say, a footbridge (i.e. where stream flows expand and slow after passing under the footbridge).
- Add to this situation an extended drought during which time the only in-channel vegetation to remain in a healthy condition are the reeds that were beginning to establish within the sediment slug.

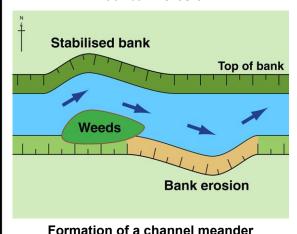
#### Deposition of a sediment slug



#### Resulting bank erosion

- When the drought finally breaks, it breaks with the occurrence of a local flood, which confronts the vegetated sediment slug head-on.
- Channel flows are now deflected around the weed-covered sediment slug.
- In order to pass around the sediment, the channel flow cuts into the 'northern' bank, which initiates the beginnings of a channel meander.

Initial bank erosion



#### Channel meander

- After passing around the sediment, the channel flow now deflects towards the opposite bank, and begins to cut into this bank.
- Over time, the flow would have (if it had not been stopped) formed a series of channel meanders through the remainder of the park, and into the downstream property.
- The author witnessed this very case.

#### **Energy dissipation (Page 200)**



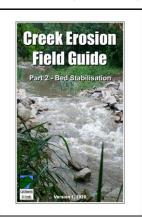
**Questionable statement** 



15 November, 1978, Adelaide, SA



Aquatic habitat, Adelaide, SA



Creek Erosion FG, Part 2, 2020

#### Energy dissipation (p. 200)

- 'Getting two flows of water to meet headon like this is nature's standard method of de-energising water.'
- GW: This statement, and all of the previous paragraphs, are examples of Peter's misunderstanding of hydrology.
- It suggests that Peter has just spent his time seeing the answers he wants to see, rather than fully understanding what he was actually seeing.

#### **Another analogy**

**GW:** This time I will use a motor racing analogy.

- Imagine you had a choice between two motor mechanics to work on your race car.
- One mechanic knew all about racing, and his car was currently winning races.
- The other mechanic was professionally trained, but he wasn't the best driver.
- Well, Peter Andrews may be able to operate a good farm, but he lacks proper training in fluid mechanic.

#### Waterway values

- **GW:** What 'values' should a farmer or government apply to waterway?
  - Are the 'functions' of a waterway only those functions that the landowner wishes to assign to the waterway?
  - Is a 'value' only a value when a human is benefiting from it?
- It is my belief that Peter and I would have vastly different answers to these questions.
- For me, the values include wildlife habitat.

#### Sediment movement (p. 202)

- 'So the thing to do is prevent the fill [sediment] moving downstream, which is what the obstruction below the stream is meant to do.'
- **GW:** It would be virtually impossible for instream 'obstructions', such as described in Peter' book, to stop sediment flow.
- In my opinion, energy dissipation systems need to be fish-friendly if in a fish habitat, and person-friendly if in a public open space (refer to document, left).

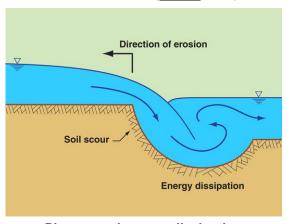
#### Creek stabilisation (Page 202)



Shock, horror!



Stawell, Victoria (before case)



Plunge pool energy dissipation



Questionable statement

#### Backfilling channels (p. 202)

- 'Later on, when I came to understand the mechanics of erosion better, I used a bulldozer to fill in the eroded channel for 5 kilometres along the creek.'
- GW: If the channel is part of a 'gully' (i.e. a non-mapped watercourse, and non-fish habitat), then OK. (refer to my Gully Erosion field guide on the next page).
- If the channel is part of a 'creek' (i.e. a mapped watercourse, or fish habitat), then please 'no'—besides, it is against State waterway and fisheries legislation.

#### Backfilling channels (p. 202)

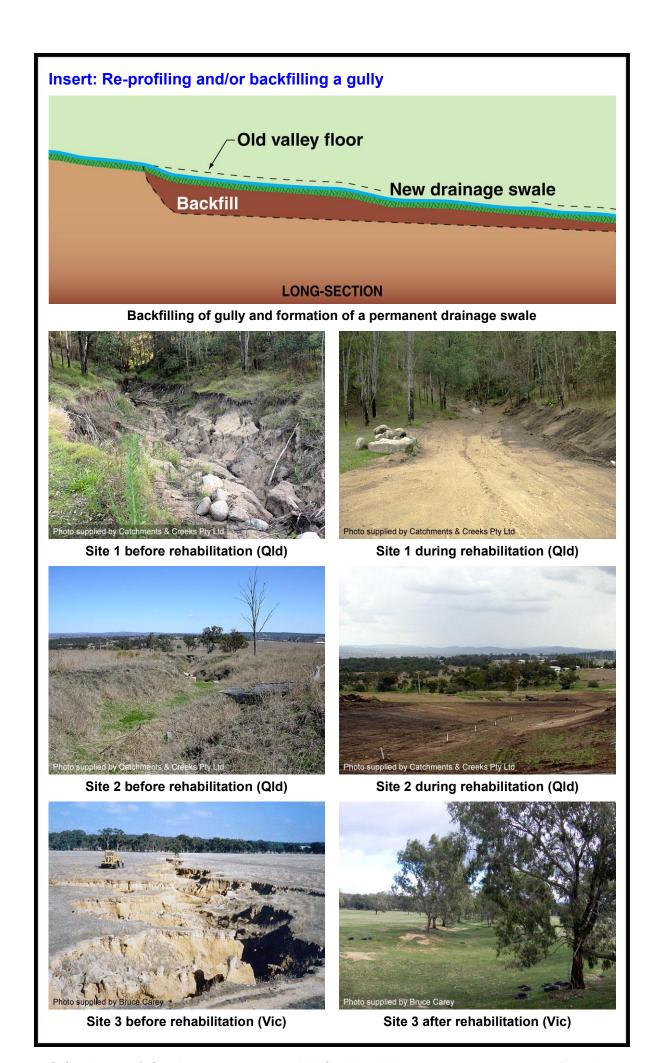
- 'So what can ordinary farmers ( . . . ) do of they have a badly eroded creek? Can they fill in the channel with a bulldozer? Yes.'
- GW: In most states, if not all states and territories, such action is unlawful, and can result in large fines—particularly in NSW, the home of Tarwyn Park, and the rest of the Hunter Valley.
- It is best to ask questions before you go too far.

#### Energy dissipation (p. 203)

- Water loses virtually all its momentum when it pours into a pond, when it emerges from the pond it takes a while to get up speed again.'
- **GW:** If Peter's meaning of 'a while' is less than 1 metres, then I agree with Peter.
- However, I do not believe that this is what Peter means by 'a while'.
- It all depends on the slope of the water surface (not the slope of the channel, in this case).

#### Wetlands (p. 205)

- 'The ultimate solution to Australia's erosion problems is to reinstall the wetlands that were once found everywhere in Australia and through which virtually all creeks and rivers used to flow.'
- GW: Wrong!
- There are very few cases where a river would flow through a wetland, except on very, very, very flat country.
- In my opinion, this statement represents a gross misunderstanding of waterways.



#### Waterways (Page 205)



Riparian vegetation

#### Riparian vegetation (p. 205)

- 'Until recently, trees and other vegetation were prohibited along certain rivers in Australia.'
- **GW:** This sounds very questionable.
- Further information is required here.
- It sounds like a gross distortion of the facts.

Constructed pool-riffle sequence (Qld)



- Wetlands (p. 206)
- 'Can wetlands be re-created in the landscape? Is this really feasible? Of course it is.'
- **GW:** It all depends on the slope of the valley.
- I have been involved in the creation of several pool–riffle systems on medium grade channels.
- Each of these 'pools' would likely be viewed as a 'wetland' by Peter.



Unset

#### Constructed wetlands (p. 207)

- 'How do we do this? First, by letting the plants grow, especially weeds and willows.
   We can also reshape our streams to give them more of a wetland profile.'
- GW: Please don't!
- If you don't know what you are doing, then
  planting woody species, or even reeds, in
  a channel can just result in the channel
  migrating around these plants, resulting in
  more bank erosion.



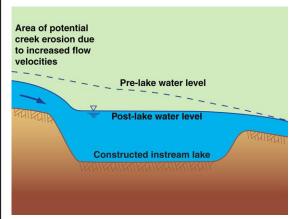
If only!

#### Flooding (p. 207)

- 'So the change to the wetland profile has actually reduced the risk of flooding.'
- **GW:** Oh, I wish it were that easy.
- In my opinion, this is really poor advice, which is based on a poor understanding of river morphology.

Page 137

#### Insert: Inserting lakes, ponds and wetlands into waterway channel



Hydraulic effects on instream lake

## The creation of instream or off-stream lakes or wetlands

- Instream or off-stream lakes, and wetlands, can be created for the following reasons:
  - urban water features
  - stormwater treatment
  - rehabilitation of extractive industry land.
- Channel erosion can occur within an upstream property if the construction of these water features increases flow velocities at the property boundary.



 When an on-stream wetland or lake is constructed on a waterway, a hardengineering drop-inlet structure is usually required at the upstream end of the water body.



Upstream 'drop-inlet' rock weir (Qld)

# Photo-supplied by Catchments & Creeks Pty Ltd

Downstream rock weir (Qld)



Fishway (Torrens River, SA)

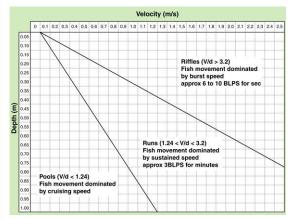
#### **Downstream channel discontinuity**

 When an on-stream wetland or lake is constructed on a waterway, a hardengineering water-level control structure is usually required at the downstream end of the water body.

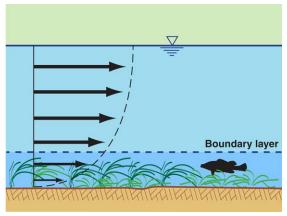
#### Fish passage barriers

 In fish habitats, a fishway is usually required at both the upstream and downstream structures to allow fish passage.

#### Insert: Waterway hydraulics and its interaction with fish passage



Typical flow conditions



**Boundary layer flow conditions** 



Whirlpool in a flooded rural creek (Qld)



Gravel-based creek with boulders (Qld)

#### **Natural obstacles**

- Creeks are rarely uniform in their crosssection and bed conditions.
- Fish passage can be obstructed by natural features, such as riffles, rapids, waterfalls, dry creek beds, and disconnected pools.
- To negotiate these obstacles, fish can use:
  - burst speed
  - jumping from the water
  - crawling over damp rocks (used by a very limited number of species).

#### Variation in flow velocities within a channel

- Fish are aided in their movement by the fact that flow velocities are not uniform across the width or depth of most channels.
- Friction and turbulence alter the <u>local</u> flow velocity, with flow velocities being reduced close to the bed and banks of creeks as a result of friction.
- This region (or layer) of lower velocity water is commonly referred to as the boundary layer.

#### The effects of turbulence

- Water turbulence can help to reduce flow velocities, but excessive turbulence can become a barrier to fish passage.
- Small-scale turbulence is most commonly associated with water flowing over rough or irregular surfaces.
- Large-scale turbulence (eddies and whirlpools) can be shed from large irregular objects, or from rapid changes in the direction of the waterway channel.

#### Small backwaters and shadow zones

- A key to good aquatic habitat and fish passage conditions is the existence of a diversity in bed conditions.
- The existence of a uniform channel crosssection means flow conditions across the channel will either be 'all good' or 'all bad'.
- Bed irregularities, such as exposed boulders, can provide fish with areas to rest and rebuild their energy prior to continuing their migration, or their search for food.

#### Insert: Fish-friendly bed stabilisation measures



Gravel-based creek (Qld)



Constructed rock ramp/chute (NSW)



Constructed rock riffle (Qld)



Bed level falling downstream of culvert

#### Desirable creek bed features

- Within fish habitats, bed stabilisation measures should generally aim to provide the following features:
  - bed roughness that simulates the natural bed roughness
  - a diversity of surface conditions that produce a diversity of flow conditions
  - random objects that can provide fish with protection from high-velocity flows
  - a suitable source of food.

#### Fish-friendly rock ramps

- Rock ramps (rock chutes) are often used to stabilise bed scour problems.
- In order to be fish friendly, these structures need to comply with certain physical and hydraulic requirements:
  - a maximum gradient of around 1 in 20 to 1 in 30
  - a maximum fall of around 500 mm
  - stable outer flanks that provide suitable fish passage conditions during elevated flows (i.e. minor floods).

#### Fish-friendly hydraulic steps

- Ideally, the 'spill height' between two layers of rocks, or any other part of a fishway, should not exceed 100 mm.
- Ideally, no hydraulic structure should be 'uniform' in its flow conditions across the full width of a channel.
- Minor variations in the positioning of rocks means fish can search for their preferred pathway during different flow conditions.
- Such diverse hydraulic conditions are commonly found in natural riffles.

#### Allowance for future changes in bed levels

- In waterways, nothing stays the same for very long, banks move left and right, creek beds can move up and down.
- In order to be fish friendly, all waterway structures must be able to accommodate expected changes in the bed and banks.
- This means:
  - extra rock may need to be placed below the current bed level, and/or
  - recessed rock check dams may need to be installed within some waterways.

#### Insert: Fish-friendly bed stabilisation measures



Habitats formed by placement of boulders



Constructed pool-riffle system (Qld)



Constructed fishway (Qld)



Fish ladder on a river weir (USA)

#### Random placement of boulders

- Rock riffles do not 'naturally' occur in all waterways.
- Similarly, rock boulders do not exist in all waterways.
- However, with the guidance of waterway and fisheries experts, the random placement of boulders can:
  - provide resting areas for fish
  - provide roosting areas for aquatic and terrestrial fauna.

#### Use of pool-riffle systems

- The construction of a series of pools and riffles is one option for the rehabilitation of head-cut erosion within a waterway.
- However, a pool-riffle system is not a natural feature in all types of waterways.
- To be fish friendly:
  - the rocks must be stable during the expected flow range (unlike natural riffles which allow the rocks to move)
  - the total fall of the riffle should not exceed approximately 500 mm.

#### Use of fishways

- Constructed fishways are often used as a component of the rehabilitation of existing non-fish-friendly waterway structures, such as culverts and weirs.
- To be fish friendly:
  - the spill height across any ridge should not exceed 100 mm
  - the design of the fishway must be compatible with the natural movement of bed material (i.e. sediment and gravels) during flood events.

#### Use of fish ladders

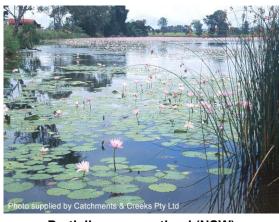
- A 'fish ladder' is a type of fishway that normally requires fish to 'jump' from pool to pool in order to ascend the fishway.
- In Australia, it is generally preferable for fishways to utilise the 'burst speed' of the fish in order to ascend the fishway, instead of the fish's jumping skills.
- Obtaining advice from fisheries experts is essential prior to the placement of any fishway within Australian waters.

#### Chapter 25 - Farm Dams: Should We Damn Them or Not? (Page 208)

# Ch 25: Farm Dams, Should We Damn Them or Not?



Parts per thousand (ppt)



Partially cover wetland (NSW)

#### Salinity of rainwater (p. 209)

- Water falling as rain contains 60 parts per million [ppm] of salt, and it would have picked up more salt from the ground before it ended up in a lake.'
- **GW:** My best research found:
  - rainwater has 20 ppm or less
  - natural freshwater has 20–1000 ppm
  - irrigation water, 200–800 ppm
  - brackish water > 1000 ppm
  - seawater approximately 35,000 ppm
  - saline groundwater, 35,000 to 100,000.

#### Off-stream dams (p. 212)

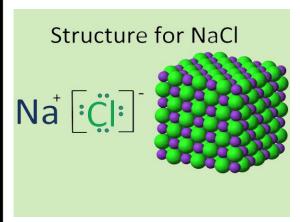
- 'A dam fed by a contour channel doesn't have the problem because water can enter the dam only via the channel. Once the dam is full of fresh water no more water gets into it.'
- GW: Off-stream dams can be a useful way of avoiding many of the problems associated with on-stream dams, including:
  - reduced sedimentation
  - no fish passage issues
  - reduced flood damage.

#### Evaporation (p. 213)

- 'Another option is to grow waterlilies or some similar plants on the dam's surface to prevent evaporation.'
- GW: Problems can arise if these plants are swept downstream into the main waterway.
- Some dam operators have trialled the use of floating PVC spheres that help to reduce evaporation and protect water quality; but again, extreme care must be taken to avoid a major clean-up bill.

#### **Chapter 26 – The Rights and Wrongs of Irrigation (Page 217)**

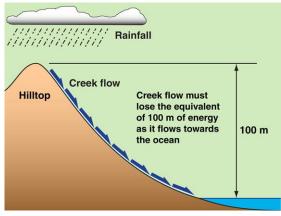
# Chapter 26: The Rights and Wrongs of Irrigation



Salt



Earth's landmass



Land erosion

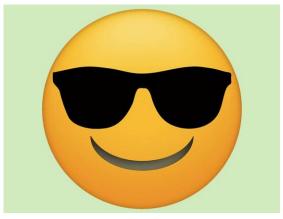
#### A salinity problem (p. 217)

- 'For millions of years Australia didn't have a salinity problem. The various components of the landscape were in harmony with each other, keeping the landscape in balance and healthy.'
- **GW:** Firstly, Peter has no way of knowing that such statements are true.
- Secondly, it could be said that Australia still does <u>not</u> have a salinity <u>problem</u>. What Peter views as a 'problem' is any issue that humans may experience while working the land.
- In simple terms; a 'problem' (in the terms of Peter's arguments) can only be experienced by humans; and, given that humans were not working the land millions of years ago, it is a logical conclusion that no 'problems' would have existed.
- Thirdly, the various components of the landscape remain in harmony today, and have always been in harmony. The issue is that this 'harmony' is inconsistent with that desired by many farmers.
- The chemical behaviour of salinity, and the mechanics of its movement, have always in harmony with respect to the laws of chemistry and fluid mechanics.

#### Oceans of saltwater

- GW: Earth is covered by land and oceans, both of which contain salt.
- It is my belief that water did not arrive on our growing planet as saltwater.
- Space 'ice' may have contained some minerals; however, the bulk of the salt in our oceans would have come from the ongoing land erosion.
- In Peter's terms, Australia, and the rest of the world, were never in balance and in good health.

#### Irrigation (Page 218)



#### Evaporation (p. 218)

- 'As much as 90 per cent of irrigation water can be lost in this way.'
- **GW:** Does this mean the problems can be eliminated simply by having farmers irrigate at night?

Cool!



Oh dear

#### Readers beware!

- 'As much as 90 per cent of irrigation water can be lost in this way.' (p. 218)
- '... as we've seen, probably 90 per cent of the water that comes out of the sprinkler will quickly evaporate.' (p. 220)
- GW: Peter often introduces a negative consequence as a possible outcome, or a maximum possible outcome; but then he uses the term: 'as we've seen', which suggests to the reader that this outcome is now considered to be a proven outcome.



Irrigation system in the Wester Downs, 2006 (Qld)

# Chapter 27 – Hope Yet for the Murray and the Darling (Page 223)

# Ch 27: Hope Yet for the Murray and the Darling



**Great Artisan Basin** 



Growths can occur in some pipes



The Darling River, Wilcannia, NSW

#### Rotten water (p. 223)

- 'For another, water travelling in pipes for long distances tends to go rotten.'
- GW: This could only be true if the water was already rotten when it went into the pipe.
- If such a claim were to be true, then the water would also become rotten, and I mean really, really, really rotten when it travels for years as groundwater, or for centuries as artisan basin water, but it doesn't!

#### Fungal and bacterial growths (p. 223)

- 'It's also likely that a pipe such as this would quickly become clogged with fungal and bacterial growths.'
- GW: Bacteria on its own is too small.
- I am unsure how much sidewall growth would occur in the total darkness of a long pipeline.
- The image shown (left) was observed by the author at a wastewater treatment plant, so there may be more to this photographed issue than I am aware of.

#### The Darling River

- 'We already have a conduit capable of moving huge volumes of water from one side of the continent to the other at virtually no cost to anyone. It's called the Darling River.'
- **GW:** This would require the Darling River to flow at near-bankfull condition for extended periods, which would:
  - kill natural bank vegetation
  - cause mass soil erosion
  - elevate salt levels in the floodplain adjacent to the river.

# The Darling River (Page 224)



Burdekin, Clarence & Murray-Darling R.



Darling River, Wentworth, NSW



Dispersive soil erosion, Burra, SA



Gully erosion down a fence line (Qld)

#### Diverting coastal rivers (p. 224)

- '... rivers such as the Burdekin and Clarence that now pour vast quantities of water in the sea, could be turned inland to feed the Darling.'
- GW: I would need to confirm this, but, I believe inland Australia is elevated above most of the coastal river catchments.
- This means you would need to elevate (pump) all this water 'up' before it could be placed in the Darling River.

#### A chain of ponds (p. 224)

- '... we'd first need to return the Darling to its original state: a chain of ponds running across the floodplain.'
- GW: I do not know how Peter could possible know that the Darling originally consisted of 'a chain of ponds running across the floodplain'.
- Nor do I believe it.
- But even if it did, why would you build this 'original' condition if you plan to operate the river in an unnatural manner?

#### Digging contour channels (p. 227-228)

- 'What has to be avoided at all costs when digging these channels is creating another erosion force – you must not allow the water in the channel to acquire energy and so erode the channel.'
- GW: This statement suggests that channel erosion can only result from flow velocity, which is linked to the flow energy.
- However, this ignores 'chemical erosion', which occurs in dispersive (sodic) soils (shown, left), which can occur at zero flow velocity.

## Placing concentrated flow near fence lines

- **GW:** This whole discussion about cutting contour channels through adjoining properties, and adjoining paddocks, can lead to erosion problems.
- Unfortunately, getting adjacent landowners to maintain an agreed movement of surface water is a difficult task.

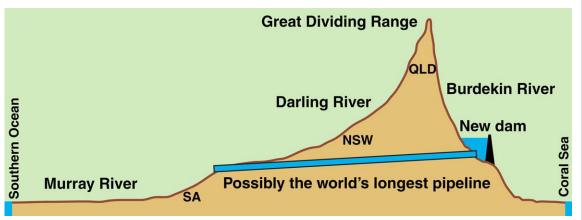
# **Diverting coastal rivers (Page 229)**



Burdekin, Clarence & Murray-Darling R.

#### Diverting the Burdekin River inland

- The current cases where rivers have been redirected are generally situated in relatively flat landscapes.
- Ideally, a gravity-based scheme would be adopted that uses gravity-fed pipes and open channels.
- Pumped systems becomes expensive and usually requires large water storages.
- To connect the Burdekin with the Darling, such a gravity pipe would become the world's largest pipeline project.



Typical river channel elevation problem between the Darling River and Burdekin River



Pipeline installation (Tas)



Pumped flow diversion system

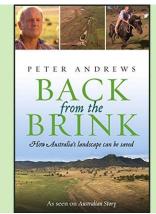
#### Option 1 - Gravity pipeline

- It would be impossible to simply cut an open channel through the Great Dividing Range because of the elevation difference between the two waterway channels.
- If flows were to travel within a gravity pipe, then the elevation difference would mean that the pipe would need to discharge near the lower end of NSW (diagram, above).
- And, the dam required at the pipe entrance would need to be around a quarter the size of Tasmania (just a guess).

#### Option 2 - Pumped pipeline

- Pumping the water over, or under, the Great Dividing Range, would require:
  - a dam to be built at the pipe entrance that would need to be around a eighth the size of Tasmania (another guess)
  - the pipe outlet to be split into several outlets, each feeding a small tributary, because no stream would exist that could handle such an inflow
  - major bed and bank stabilisation works would be required along the Darling River.

# The Murray River (or River Murray)



Back from the Brink (2007)



Cool!

#### Repeated conversations (all chapter)

- GW: This chapter is filled with the same discussion about:
  - plants being a total cure for salinity issues
  - the non-use of native plants
  - controlling salt with freshwater lenses.
- I am not going to repeat my feedback on these statements by Peter.
- If you wish, you can go back to chapters 7, 9, 10, and 16.

## Tarwyn Park (p. 230)

- 'I did it at Tarwyn Park, where I filled the floodplain from the high side, thus creating a positive inground water pressure in the floodplain. The same thing could be done in the Murray Valley.'
- GW: I don't think so!
- Firstly, water pressures can only be 'positive'. There is no such thing as a 'negative pressure', just as there is no such thing as a 'true suction' force.
- These are big ideas that are just not practical.



The Murray River, 2006 (SA)



The Murray River, 2006 (SA)

Case study: Red Banks Conservation Park, Burra, South Australia

# Red Banks Conservation Park, Burra, SA



Catchment cleared of woody vegetation

#### Introduction

- This gully is located within the Red Banks Conservation Park (Baldina Creek) near Burra, South Australia.
- Significant amounts of gully erosion exist around this region of South Australia.
- A contributing cause of the gully erosion is considered (by me) to be the extensive deforestation of the catchments during the 1800s to supply timber for heating.
- The region also has highly dispersive subsoils.



Red Banks Conservation Park, Burra, South Australia (Google)

# Red Banks Conservation Park - Types of bank erosion



Gully erosion upstream of the park

#### **Baldina Creek**

- The main creek that passes through the park (Baldina Creek) has, over recent geological time, experienced significant bed and bank erosion.
- This erosion has lowered the creek bed, and increased the height and gradient of many of its banks.
- Though technically not a gully (because the creek is not a new geological feature), the creek does display many of the features of typical gully erosion.

## Types of soil erosion found in a gully

- The types of soil erosion observed by the author at this site include:
  - raindrop impact erosion
  - soil scour (sheet and rill erosion)
  - bank slumping
  - bank undercutting
  - soil dispersion
  - tunnel erosion
  - lateral bank erosion.



**Bank undercutting** 



The southern bank of Baldina Creek known as 'The Wall'

# Red Banks Conservation Park - Types of bank erosion



**Tunnel erosion** 

- Numerous examples of tunnel erosion exist throughout the park.
- Many examples also exist where these tunnels have collapsed to form open gullies (which would then be classified as lateral bank erosion).

**Outlet of tunnel erosion** 



**Bank slumping** 

# **Bank slumping**

- Bank undercutting ultimately results in examples of bank slumping.
- Ongoing bank undercutting and bank slumping results in near-vertical gully banks.



Flatter bank slopes created by soil dispersion, raindrop impact and sheet erosion

# Red Banks Conservation Park - Types of bank erosion



Sheet erosion upstream of gully

# Arid and semi-arid regions

- The site displays several examples of sheet erosion occurring upstream of the gully head.
- Flow acceleration into the gully can cause a secondary nick point to form around the edges of the gully:
  - which can form areas of sheet erosion, rilling, or minor gully erosion
  - which can migrate away from the main gully head faster that the migration of the gully head.



Sheet erosion upstream of gully



New erosion upstream of a gully head



Main southern gully with multiple branches and gully heads (Adelaide Aerial)

# Red Banks Conservation Park – Types of bank erosion



An extreme example of lateral bank erosion

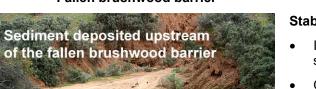


The extensive branching of alluvial gully erosion

# Red Banks Conservation Park – Natural gully stabilisation



Fallen brushwood barrier



Sediment trapped upstream of brushwood

supplied by Catchments & Creeks Pty Ltd

#### Stabilisation of the gully bed

- The park has examples of gully erosion at various stages of stabilisation.
- In some locations, stable bank slopes have been created, and a good cover of vegetation is being established.
- The slumping of some banks has resulted in woody vegetation forming natural brushwood barriers across the gully floor, which will begin to trap coarse sediments, which ultimately helps to stabilise the gully floor.

## Stabilisation of the gully banks

- In general, the gully banks cannot achieve stability until the gully floor is stable.
- Once the gully floor is stable, the toe of the gully banks will also be stable.
- Until then, the gully banks will continue to erode, which deposits more sediment onto the gully floor.
- The gully banks will continue to erode until a stable gradient is achieved allowing long-term vegetation to establish over the bank.



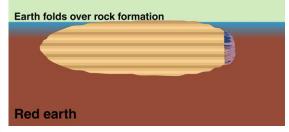
Eventually the gully banks will achieve a similar gradient to the surrounding hills

# Case study (or just another guess!): The tilting of Uluru



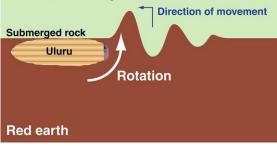
Uluru, NT (2013)

As the ongoing sedimentation process builds the rock, the ongoing slumping of the lake's banks forms an earth cover over part of the rock



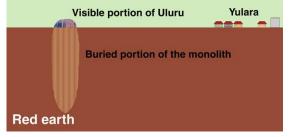
Original formation of Uluru [Stage 6]

A major shock water generated by an asteroid strike causes soil liquefaction and a wave of saturated soil to approach the rock, causing it to tilt



The rotation of Uluru [Stage 7]

A major shock water generated by an asteroid strike causes soil liquefaction, and a wave of saturated soil to approach the rock, causing it to tilt



2025 vertical alignment of Uluru [8]

#### Introduction

- People that have visited, or read about Uluru, may have noted that this large sandstone monolith stands vertically within its current landscape.
- Being a sedimentary rock, its sedimentary layers would have been deposition along a horizontal plane.
- So, at some stage in its history, this monolith was forced to rotate 90 degrees (i.e. stand up-right), with most of the rock now being located below the land surface.

#### The original formation of the rock

- Sedimentary rocks are formed by the longterm deposition of sediments, which are later buried and compressed into rock.
- Uluru was possibly formed by sediment deposition into an old meteor crater, or the like.
- Earthquakes and/or near-by meteor strikes 'could' have liquefied the earth and caused the partially-formed rock to sink deeper into the land (PTO), thus allowing further sedimentation and rock formation to occur.

#### A possible cause of the rock's rotation

- During the Hamilton, New Zealand earthquake, we saw earth liquefaction.
- It is my suggestion that a very large asteroid strike near the newly formed horizontal Uluru 'could' have caused:
  - the earth to liquefy deep within its profile
  - a wave of liquid-earth to move across the landscape, which rotated the rock.
- Just like using a shake of a table cloth to stand up-right a fallen salt shaker.

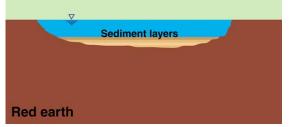
# A possible reason for most of the rock to be resting below ground level

- Even though sandstone is heavier than water, is does contain microscopic air voids, making it only slightly heavier than saturated earth, which could have existed around the rock given the expected 'wetter' climate of the time.
- When the rock rotated, it came to rest like an iceberg resting in water.

(Again, I repeat that this 'action' is just pure speculation by the author. It is NOT factual.)

# The End

Sedimentation begins to occur within the lake



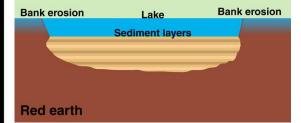
Early sedimentation process [Stage 1]

Sediment fills the lake, and the climate begins to dry



Half-rock formation [Stage 2]

Further sedimentation occurs while the steep banks of the new lake begin to erode and batter back to a stable slope



Ongoing sedimentation [Stage 4]

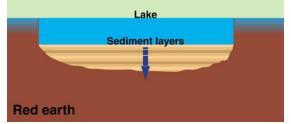


So tied!

#### A step-by-step process

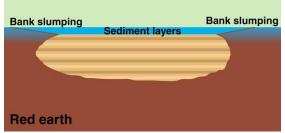
- 1. Sediment collects in a large depression.
- 2. The sediment becomes compressed by its own weight.
- 3. A liquefaction event causes the partially formed Uluru to sink further into the ground.
- 4. Sedimentation continues to form the rock.
- 5. An asteroid strike causes liquefaction of the soil and a shock wave, which rotates the rock.

The half-formed rock sinks into the earth following one or more meteor strikes that send vibrations across the saturated floodplain



Sinking rock [Stage 3]

Further sedimentation occurs while the lake continue to slump



Ongoing sedimentation [Stage 5]

#### The end

- So many diagrams that needed to be produce (193 on last count).
- So much time spent explaining complex issues (270 hours on last count).
- So many pages to review!
- But, thank you for your time, and for your interest in this subject—now, you too can take a break.

Glossary of terms

Absorb The process of sucking up, or drawing in, of a liquid by a porous

substance.

Adsorb The action of gas, liquid or dissolved substance gathering on the

surface of another substance.

Backwater effect The water of a stream kept above an otherwise expected elevation

due to some downstream influence such as floodwaters within a downstream reach or tributary, or a downstream hydraulic

obstruction.

Brackish water Slightly saline water.

Eutrophication The process of enrichment of a water body by nutrients,

Field capacity

The amount of water held in the soil after free water drains from the

macropores.

Floodwater Stormwater runoff that has arrived from a distant location (i.e. not

from your property).

Floodwater Stormwater runoff from distant properties, or distant storms.

Generally, storm runoff generated from rainfall that has not fallen

directly on your property.

Fluid mechanics The study of the physical properties of fluids in motion.

Gravity pipe A pipe that carries water flow driven solely by the force of gravity.

Groundwater The water in a confined aquifer, or contained in interconnected

pores below the watertable in an unconfined aquifer.

Hydrodynamics The study of fluids in motion.

Hydrology The study of water on the land or under the Earth's surface, its

properties, laws, geographical distribution, and so on.

Hydrostatics The study of fluids, and their properties, while the fluids are

stationary.

Limiting nutrient The nutrient that a water body is going to deplete first if it starts to

produce large amounts of algae. For most coastal waterways, the 'limiting nutrient' is usually nitrogen. For most inland waterways, the

'limiting nutrient' is usually phosphorus.

Ped An individual, natural aggregate of soil particles. May contain air

and/or water in its voids.

Permanent wilting point The stage when soil-water is held too strongly for the plant to

extract it, which causes the plant to permanently wilt.

Photosynthesis The process by which plants produce carbohydrates from carbon

dioxide, water and sunlight.

Plant-available soil-water Water in the soil that is available for plant uptake.

Rainwater Water that is falling as rain, while is in the air.

Salinity Relates to the amount of salts found in the soil; an excess leads to

damage.

Salt water Water that has a salt concentration similar to, or greater than, that

of sea water.

Sodicity A characteristic of soil with an excess of sodium which leads to a

breakdown of peds.

Soil profile The properties of soil at a given location, from the earth surface to

the nominated depth of the profile.

Soil-water The part of the soil water that exists within the upper horizons, and

which is separate from the groundwater.

Stormwater The runoff of water as a direct consequence of rainfall, whether surface flow, or flow within conduits, including any contaminants collected by the water during its passage. Transpiration The process by which water is lost from a plant through the stomates in the leaves. Watertable The water surface that defines the top of the saturated zone in an unconfined aquifer at which the pressure is atmosphere. Weed (botanical usage) A plant that is locally endemic. Weed (rural context) Plants that farmers don't like for whatever reason.' Weed (Peter's usage) A plant that is not beneficial to the farm's productivity.. Well-structured soil A soil that is likely to contain equal amounts, by volume, of sand, silt and clay, along with organic matter. □Non-plant-available soil-Water in the soil that is not available for plant uptake. water

