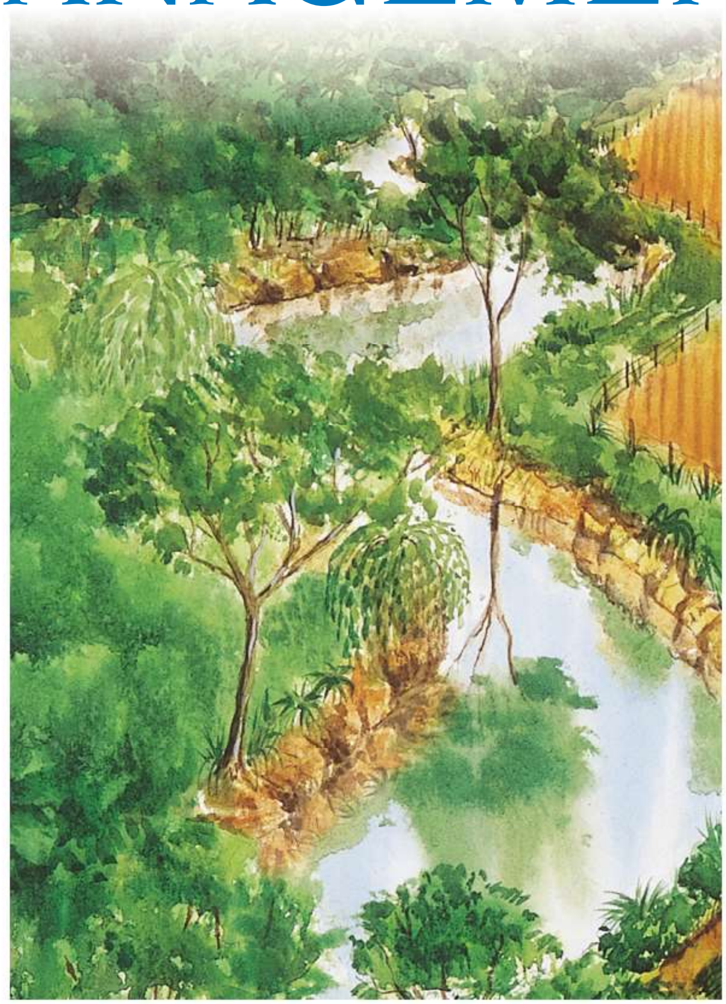
WATER MANAGEMENT



Section 2:
Water Management

The Expected Environmental Outcome for Water Management states,

All reasonable and practicable measures should be adopted, within the constraints of a sustainable agricultural system, to conserve the character and quality of waterways and water (QFF 1998).

2.1 IF IRRIGATING, USE AN EFFICIENT IRRIGATION SYSTEM

Irrigation systems used in fruit and vegetable production are diverse and include flood irrigation, sprinkler systems, (hand-shift, solid set), travelling irrigators, overhead, under tree, droppers and trickle irrigation.

Regardless of what system is in place it should be operated efficiently. An effective system will deliver smaller volumes of water more frequently to better match the crop or tree's requirements and avoid deep drainage, run-off or excess evaporation. A well-planned and maintained system will help achieve this.

Each system has positives and negatives and needs to be assessed in relation to the wider goals of the farm enterprise. Often the increased gains in water efficiency for trickle irrigation or sprinkler systems come at increased capital and maintenance costs.

Nevertheless, the use of water by rural industries will continue to come under public scrutiny. Ongoing attention to water use efficiency will lead to the wider use of efficiency indicators, like dollar returns per mega-litre of water used.

☞ ***Irrigation systems in short-term crops.***

Trickle irrigation combined with plastic mulch in short-term crops can maximise returns per unit of water used.

The short life and agronomic practices associated with some annual crops makes investment in semi-permanent irrigation systems impractical. Instead, irrigation systems such as furrows, hand shift and solid set sprinklers, travelling lines and water cannons are used.

However, water availability and security has a big influence on attitudes to water use and irrigation practice. Many of the capital-intensive short-term crops now use trickle irrigation (often combined with plastic mulch) to ensure maximum returns per unit of water used.

For short term crops grown on beds (ie: tomatoes, irrigated melons, capsicum and strawberries), trickle irrigation and plastic mulch is industry standard practice.

Benefits from trickle irrigation include (Lovatt et al. 1997) (Vock and Greer 1997),

- a high water use efficiency
- only wetting up the root area
- the ability to supply small amounts more often
- the fact it does not splash plants and wash off sprays
- the ease of nutrient application
- irrigation application is not affected by the wind
- the ability to use poor quality water (for some crops)
- cheaper pumping costs because lower pressure is required

By combining trickle tape with plastic mulch, evaporation from the bed is reduced and lateral water movement across the bed is improved on some soil types.

In tomatoes yields using trickle irrigation with plastic mulch are equal to flood irrigation but with an 80% saving in water used (Wright 1971).

A change to drip irrigation is usually accompanied by increased management skills, better nutrition, pest and disease management, and hopefully improved produce yields and quality. These factors are usually the main impetus to changing irrigation methods, because actual savings in water use may not necessarily cover the additional expenditure associated with installing and maintaining drip systems.

☞ ***Several irrigation methods may be needed in some crops***

There may be a need to use more than one method of irrigation. For example, overhead irrigation is used in conjunction with trickle irrigation in strawberries and in some lettuce and celery enterprises.

Overhead irrigation helps with plant establishment and offers better protection from frost. It also provides a good environment for the establishment of predatory mites. Where frosts are not a problem, misters may be substituted for overhead sprinklers.

In banana production, overhead or travelling irrigation systems will still need to be used particularly where the economy of scale of the farm is smaller. Under tree sprinklers or trickle irrigation represent a large capital outlay for smaller farms and require constant, labour-intensive maintenance.

☞ ***Irrigation systems in tree crops***

The emphasis of irrigating young non-bearing trees is on growing a strong, healthy canopy of branches and leaves that will be able to produce well in ongoing years.

Under-tree sprinklers are recommended as standard industry practice for most tree crops as indicated in the relevant Information Kit in the Agrilink Series (QDPI 1998). Usually one minisprinkler per tree is used for the first few years, as in citrus for example (Vock et al. 1997).

The sprinklers can be used in microspray mode for the first 2 years to limit the spread of water. Towards the end of the second year, they can be changed back to minisprinkler mode to increase the diameter of wetting and encourage roots to spread (Vock et al. 1997).

Trickle systems are also being used in some tree crops. Usually one row of tape is laid out for young trees, followed by a second row of tape on the other side of the tree row when trees begin to bear.

2.2 IF IRRIGATING, SCHEDULE IRRIGATIONS

Irrigation scheduling is the practice of matching irrigation water supply to crop demand. Failure to schedule can lead to direct impacts on crops or trees from under-watering and over-watering.

Examples of specific impacts of poor irrigation management in citrus and melons are given below (Vock et al. 1997) (Lovatt et al. 1997).

Under-watering

- ***lower yields from restricted spring growth flush and reduced fruit set (citrus)***
- ***increased early fruit drop, particularly in Navels (citrus)***
- ***lower fruit quality from reduced fruit size, increased splitting, induced calcium and boron deficiencies and increased incidence of other fruit problems such as creasing, stylar end rot and degreening burn (citrus)***
- ***poor growth due to poor uptake of nutrients (melons)***
- ***flower and fruit abortion (melons)***
- ***low yields and small, early maturing fruit (melons)***

Under-watering in citrus can lead to degreening burn (Photo courtesy of QDPI)

Over-watering

- ***reduced yields through waterlogging (citrus)***
- ***increased incidence of root and collar rot diseases, reducing fruit quality (citrus)***
- ***leach out fertiliser (melons)***
- ***promote excessive vine growth causing low flower and fruit set (melons)***
- ***stem end break down prone to ground rots (melons)***
- ***poor keeping quality and prone to stem end rots (melons)***

Styler end rot can occur as a result of poor irrigation management in citrus (Photo courtesy of QDPI)

A range of scheduling techniques can help. Some are simple and place the emphasis on grower experience to interpret the crop or tree's water needs, while others give an indication of what is happening with soil moisture itself.

■ *Experience can provide a rough guide for scheduling irrigations*

Most growers can detect changes in the growth stages of their crop and are familiar with the increased sensitivity to water stress that can occur around periods of pollination, flowering, fruit setting and fruit filling. This experience helps to assess the water requirement of crops or trees and may be combined with an assessment of soil moisture status, by squeezing a ball of soil to see if it clings together or falls apart.

The alternative approach is to irrigate at set time intervals using early symptoms of water stress in the crop or trees to fine-tune the interval. A rain gauge on farm will indicate how much water falls on the crop during rainfall events.

Both of these approaches rely on the grower's subjective assessment. It is better if this assessment is coupled with other tools for irrigation scheduling.

■ *Use irrigation scheduling tools - Water use figures, Tensiometer, Neutron Probe, Capacitance Probe*

The range of soil moisture monitoring systems for irrigation scheduling include tensiometers, the neutron probe or capacitance probes (such as EnviroSCAN®). Each system has advantages and disadvantages that are considered in more detail in the relevant Information Kit from the Agrilink Series (QDPI 1998).

☞ ***Tensiometers***

Tensiometers measure changes in soil moisture and are a cheap and reasonably effective instrument. Interpretation of readings varies for given soil types; tensiometers work better in situations where contact between the ceramic tip and soil is maintained over the wetting and drying periods for the soil. Tensiometers are very useful in shallow-rooted, short-term crops, where the soil is maintained in a relatively moist condition for most of the growing period. They need to be regularly checked and maintained to prevent faulty readings.

Topics covered in the relevant Information Kit from the Agrilink Series include the correct siting and installation of tensiometers and suggested readings for scheduling irrigation at different stages of crop or tree development (QDPI 1998). Troubleshooting tips for tensiometers are also given (QDPI 1998).

Using tensiometers to improve irrigation management of vegetable crops in the Lockyer valley was the focus of project work by the QDPI (Henderson 1997). Specific crops considered in detail include beans, beetroot, sweetcorn, potatoes and onions (Henderson 1997).

☞ ***Neutron probes***

Neutron probes are generally only used by crop consultants who offer a reading and interpretation service. The benefit compared to a tensiometer is that the indication of moisture condition is taken at many points down the soil profile. Probes are suited to deep-rooted, relatively long-term crops.

☞ ***Capacitance probes***

As with neutron probes, the capacitance probe is normally installed and interpreted with the help of a consultant.

EnviroSCAN® is a solar powered central logging facility connected by cables to probes at each site (Croptech Agricultural Research and Consultancy 1996). Probes are fitted with multiple sensors located at incremental depths down the profile. These sensors use electrical capacitance to measure the changing ratio between air and water in the soil. This reading is converted to an indication of soil moisture at that point.

A solar powered central logging facility (such as Enviroscan®) can provide soil moisture information from sensor probes throughout the crop.

Information is available in graphical form and includes the amount of water from an irrigation or rainfall, the rate of crop or tree water use, the depth of penetration of the irrigation and whether leaching of water and associated nutrients is occurring (Croptech Agricultural Research and Consultancy 1996).

For more information on how EnviroSCAN® works, what hardware and software is needed and how to make meaningful decisions from data collected, see the relevant Information Kit from the Agrilink Series (QDPI 1998).

Examples of other scheduling systems in the marketplace include Gopher® (Gopher brochure 1997) and 'Aquastation' (DRW brochure 1997). Across the State, more growers are using local consultants, to help install and interpret scheduling systems.

☞ ***General water-use information for individual crops***

In the absence of a soil moisture monitoring system, a general irrigation strategy is outlined in the relevant Information Kit from the Agrilink Series (QDPI 1998).

For example, guidance on irrigating rockmelons and honeydews from establishment through to harvest is outlined in the Melon Information Kit (Lovatt et al. 1997).

The Strawberry Agrilink Information Kit looks at advantages and disadvantages of different irrigation monitoring systems. With scheduling, water reductions of up to 40% have been achieved without affecting yield and fruit quality (Vock and Greer 1998). Average figures are given for water use with either overhead or trickle irrigation.

Irrigation information for lettuce, potatoes and onions is provided in the respective Agrilink Information Kits.

Help with irrigation rates and timing is also outlined for tree crops in the relevant Information Kit from the Agrilink Series (QDPI 1998). General irrigation requirements across each season are outlined for young maturing trees and also for mature bearing trees. However, it is not able to take rainfall or very dry weather into account.

2.3 MINIMISE CONTAMINATION OF WATER

■ *Potential groundwater contamination from nutrients and pesticides*

Soluble nutrients and pesticides may contaminate groundwater if they are leached beyond the root zone into an aquifer. Whether this will happen depends on many factors including soil type, the crop or tree's rooting depth, rainfall intensity, the rate and chemistry of applied product, irrigation efficiency and the depth of the aquifer.

Nitrate nitrogen is the nutrient of particular concern. Nitrogen is required by crops and trees in relatively large amounts (compared to other nutrients) and is the form most readily available for plant uptake. Nitrate is very mobile and can easily leach through permeable soil.

Many pesticides that are highly water-soluble can also be moved up and down the soil profile (eg. 2,4-D, chlorfenvinfos and atrazine). A combination of certain conditions may enable them to leach and contaminate groundwater.

Dams built on permeable soils can lose large amounts of water. Alluvial soils adjacent to drainage lines, creeks and streams, groundwater recharge areas and aquifers need to be protected against contamination. Dams built in such substrates should be sealed against leakage.

■ *Potential surface water contamination from nutrients, pesticides and turbidity*

Excess nutrients and pesticides may also degrade the quality of surface water.

Phosphorus and some pesticides are easily bound to soil particles. Erosion can transport these particles over large distances, depositing them in rivers and creeks. Finely suspended particles in rivers and creeks can release nutrients and pesticides as well as causing increased turbidity and siltation.

Poorly stabilised banks along creeks and rivers may also contribute to degraded water quality. Poor or no riparian vegetation will not allow sediments and soluble nutrients to be captured and filtered before entering waterways. Banks can then be subject to erosion by fast flowing water, causing them to subside, and leading to greater turbidity and siltation of the water body.

The preservation and rehabilitation of riparian vegetation will provide bank stability and provide a buffer between agricultural activity and sensitive waterways.

Well-vegetated creek banks can trap/filter nutrients and sediment, provide bank stability and promote greater protection of water ways.

Poorly designed creek crossings can increase bank erosion by concentrating surface flows and allowing them to scour out banks next to water bodies, causing fish habitat destruction. Any works in a watercourse should be designed in consultation with the QDNR.

The efficient application of fertilisers and pesticides will help reduce water contamination. Preventing leaching and erosion will stop the transportation of residual nutrients and pesticides to water resources.

Transporting and storing pesticides safely is a pro-active way to avoid the risk of a pesticide spill.

Example:

Careful nitrogen management in pineapples

Nitrate levels in pineapples are monitored closely because of the potential processing problems faced by pineapples with excess nitrate concentrations (Col Scott pers. com.). The use of soil analysis for nitrate levels helps to tailor-make the amount of nitrogen applied to the crop.

Yellowing of leaves can indicate possible nitrogen deficiency in Pineapples

2.3.1 Apply fertilisers and pesticides efficiently

Efficient fertiliser application involves applying the right form of product at the right time and in a way that quickly taken up by the crop or trees. Section 1.3, ‘Practice good fertiliser management’, covers the principles relevant to efficient fertiliser uptake.

Efficient pesticide application is dealt with in section 4.3. Alternatives to pesticides for pest management are covered in section 7. The total load of pesticides applied to the agricultural environment can be reduced when pesticide use is integrated with cultural, biological and mechanical means of control.

2.3.2 Reduce drainage past the root zone

The use of an efficient irrigation system (section 2.1) and scheduling to determine when to irrigate (section 2.2) both help ensure that irrigation water is applied efficiently.

Scheduling water application to meet crop or tree requirements helps ensure that excess water does not pass beyond the root zone, leaching out nutrients (like nitrate nitrogen) and pesticides (Olsen and Keating1997).

If fertigation is used for applying fertiliser, frequent application with a small amount is the best way to prevent nutrients being leached below the root zone (Olsen and Keating 1997). Fertigating towards the end of an irrigation event will also help (Olsen 1995).

The use of plastic or alternative forms of impermeable mulch in relevant crops can also help minimise leaching from rainfall and increase nitrate uptake efficiency. An impermeable mulch will assist nitrogen found in the inter-rows to move laterally back towards the bed-centre following rainfall (Olsen 1995).

In fruiting small crops such as tomatoes, capsicums and squash, reduce nitrogen applications towards and during harvest to prevent nitrate leaching through the root zone (Olsen and Keating 1997).

Example:

Managing leaching in banana production

A study of downstream effects of agricultural practices, found that leaching and volatilisation were the major pathways of nutrient loss for bananas in the Johnstone River catchment. Up to 30% of applied nitrogen was lost through leaching.

This highlights the importance of correct placement and timing of fertiliser application and irrigation scheduling to match peak periods of crop or tree uptake.

Project work in bananas is looking at optimising fertiliser rates to produce quality fruit while minimising the loss of soluble nutrients by leaching (Prove and Lindsay 1996). The importance of fertigation systems to deliver post planting fertiliser and irrigation scheduling are also being assessed (Prove and Lindsay 1996).

If small crops have been grown, they can be followed in the rotation with deep-rooted nitrogen clean-up crops to help recycle nitrate back into the upper soil horizon (Olsen and Keating 1997). Examples include sugar cane, forage sorghum, maize or oats after a tomato, melon or vegetable crop.

2.3.3 Manage soil erosion

Section 1.2 'Minimise erosion of soil', considers the relevant principles for reducing soil erosion. This will reduce the downstream impacts of soil erosion on waterways.

2.3.4 Protect riparian zones

Riparian zones need to be stable to ensure both farm and ecosystem viability. Maintaining or planting wide buffer strips of native vegetation along both sides of a watercourse and major gullies leading into the watercourse will improve bank stability. Deep-rooted vegetation can provide long term stability, protecting the beds and banks against scouring, erosion and overland flood flow.

Clearing of vegetation along rivers and creeks will encourage infestation by weeds and grasses (such as guinea grass and para grass in North Qld) (Hastie and Bell 1996) and requires an assessment by the QDNR prior to any works.

At present there is no definitive standard available for the width or riparian vegetation (Dawson 1997). Conditions vary markedly between catchments in Queensland depending on adjacent land use, the needs of local terrestrial and aquatic fauna and local discharge and erosion rates.

■ *Use groundcover to slow and filter water before it enters a water body*

Groundcover will act as a final filter for soil sediment before run-off enters rivers and creeks. Grassed or vegetative areas should be placed between the watercourse and 'high risk' activities like animal yards, cropping areas, packing sheds and 'wash down' areas.

Do not allow drains and waterways from risk areas to flow directly into a watercourse. Direct them into a filter area and spread the water. Check banks can be used to intercept and spread run-off before it enters a filter area.

Well grassed orchards will help slow and filter water before reaching a water body

■ *Minimise impacts on water quality from livestock activity*

Stock access to creeks and rivers can be a problem. Stock stir up the water as they drink, pollute the water with excreta, and significantly damage stream banks by trampling.

Try to manage stock away from stream-banks and buffer strips, by providing watering points at some distance. If this is not possible, provide access via properly constructed rock or concrete pads, or allow stock to cross in stable areas away from steep banks.

Other activities around the riverine environment are covered by the Riverine Environment Guidelines developed under the Water Resources Act 1989. Examples include construction of fence-lines, vehicle crossings, pumping installations and the removal of gravel. These guidelines should be referred to for further direction.

2.3.5 Handle, transport and store pesticides safely

Comply with the Rural Chemicals Code

The Code of Practice for the Storage and Use of Chemicals at Rural Workplaces, (Rural Chemicals Code 1994) gives guidance on assessing and managing the risks associated with the storage and use of chemicals.

Transport chemicals with care

Many chemicals used in rural workplaces are classified as Dangerous Goods. The 'Carriage of Dangerous Goods by Road' Act sets out the following conditions for the transport of dangerous goods (Rural Chemicals Code 1994):

- separation from foodstuffs and incompatible substances,
- signs and equipment for the vehicle,
- dangerous goods licensing for the driver that includes training for action to take in an emergency.

Generally, these strict requirements will not apply to the transportation of chemicals by a grower straight to their property (Rural Chemicals Code 1994). However, if the farming operation is large, the exemption limits in the Australian Code for the Transport of Dangerous Goods by Road and Rail should be referred to.

Growers may also be able to use rural merchandise agents to deliver large quantities of chemicals to their farm. If transporting chemicals personally, they should ensure that the chemicals are secure and not carried in vehicle cabins.

Store pesticides with care

Storing chemicals poses risks to people and the environment, because of the potential for an accident. The Rural Chemicals Code provides the following guidelines to help minimise the chances of an accident occurring:

- quantity stored should usually be no more than one season's chemical requirements
- the design of the storage should take ventilation, floors, door sills and walls into consideration
- care should be taken with location, security and access to the storage
- separate the storage from work and living areas
- there should be clear procedures for controlling emergency incidents and cleaning up

NSW Agriculture outlines the features a farm pesticide store should have (Spray Sense #6 1995). These include:

- a separate, well ventilated cupboard or building, used only for this purpose
- preferably fireproof and located well away from houses, pumps, tanks, water supplies and domestic animals
- no food, safety equipment, seeds, stock feed or fertilisers should be stored there as well
- pesticides should be stored in their original registered containers with label.

- the store should be cool and dry with temperatures between 5 - 30(C
- there should be some form of spillage containment or bunding (ie: able to hold 25% of the quantity of liquid pesticide stored or a minimum of 100% of the largest container)
- shelving made of impervious material rather than something absorbent like timber
- liquids should not be kept stored above solids
- not located in an area likely to flood or with a water table close to the surface
- always kept locked
- clearly signposted with a notice that it is dangerous or a chemical store. A no smoking sign for combustible pesticides is also advisable
- should be proofed against children, animals and intruders
- should allow herbicides to be kept apart from other farm chemicals (insecticides and fungicides)

2.4 MINIMISE SALINITY IMPACTS ON WATER

Water quality may be affected by salinity in much the same way soils are (see section 1.5). Extensive tree clearing on recharge areas (generally on higher slopes) can result in saline groundwater, which may go on to be used for irrigation.

Examples include the Lockyer Valley in southeast Queensland and Euri Creek near Bowen in North Queensland. Close to the coast, rapid depletion of coastal aquifer supplies can cause salt-water incursions resulting in water unsuitable for irrigation, town water supply and other uses (eg: Bundaberg).

Dilute salty water and use efficiently if it has to be used for irrigation

It is recommended that the use of saline irrigation water be avoided or minimised. If it is to be used, it will require the use of salt tolerant crops. Water of good quality will often be mixed with saline water to lower the salt concentration to a level acceptable to plants. Irrigating with saline water can increase the level of soluble salts found in the soil profile. Where water tables are within 1 to 2 metres of the surface this water can be drawn to the surface through evaporation and soil capillary action.

If saline water is to be applied, then the irrigation method used should concentrate application to the root zone rather than wetting foliage. For example, the use of trickle irrigation under plastic mulch can allow water with a higher salt content to be applied to tomatoes compared to using overhead irrigation.

When saline water is applied over a long time period it can contribute to salt accumulation in the profile. The need to flush salt water out of the root zone pre-disposes the soil to the leaching of salts at depth and is often difficult in impermeable soils.

2.5 MANAGE DRAINAGE TO MINIMISE HARM TO THE ENVIRONMENT

All land development affects the natural systems of a catchment by altering the quantity and quality of surface and groundwater. It is important that, when making modifications to improve drainage condition on agricultural land, hydrological and ecological processes of the catchment be taken into account.

Floodplains play an important role in drainage for a catchment. Floodplains are defined as the lower parts of drainage basins; characterised by reworked alluvium, relatively flat and low-lying land, and areas where watercourses frequently break their banks (Dawson 1997).

River corridors and low-lying parts of the floodplains are particularly important to agriculture because they (Dawson 1997),

- provide natural drainage and groundwater recharge
- moderate flood flows, smooth out peaks and act as detention basins absorbing large volumes of water
- provide water for agriculture and associated industry
- provide wildlife and bird habitat and corridors by linking remnant bushland areas

Artificial wetland design should mimic natural drainage systems as much as possible.

Natural drainage systems may be inadequate in some areas to satisfy agricultural drainage requirements. An example is the Wet Tropics where flat and low-lying flood plains are combined with high intensity rainfall events.

On-farm drainage should take into account the local catchment

On farm planning for drainage should be consistent with the local catchment management plan to ensure that individual development takes place within the perspective of the entire catchment and floodplain. Planning should give consideration to (Dawson 1997),

- farm drainage and artificial wetland design
- retention of natural wetlands and terrestrial habitats including watercourses, lagoons and riparian vegetation
- identification and management of preferential flow paths
- mapping soils and agricultural suitability
- minimising stream bank erosion

In some natural drainage systems the hydraulic capacity may be insufficient to meet the drainage requirements from agricultural areas.

Rather than extensively modifying the natural drainage systems, consider providing a parallel system to augment drainage requirements (Dawson 1997). Minor changes to improve waterway capacity, such as selective removal of overhanging branches or isolated silt and debris deposits can also be acceptable (Dawson 1997).

If artificial drainage systems need to be created, these should mimic natural systems as much as possible. For example, by retaining existing vegetation or re-establishing riparian vegetation adjacent to a constructed waterway (Dawson 1997).

The straightening or damming of creeks and watercourses requires approval from the QDNR under the Water Resources Act 1989 (Canegrowers 1997).

The blocking of freshwater and tidal creeks or waterways requires an authority under the Fisheries Act 1994.

Developments in or adjacent to wetlands (eg: fresh, brackish or marine, including mangrove areas, mudflats, sandflats, sandy beaches, seagrass beds and tidal marshes) are considered designated developments under the Local Government (Planning and Environment) Regulation 1991, and may require an Environmental Impact Statement (Canegrowers 1997).

2.5.1 Manage potential acid sulfate soils with care

Along 6500km of Queensland coastline there are an estimated 2.3 million ha of potential acid sulfate soils (ASS) (QDNR 1997). These occur in many low-lying areas, embayments and estuarine floodplains of coastal Queensland, generally less than 5m above sea level (QDNR 1997).

ASS are defined by a layer of iron sulfide at depth in the soil profile that remains harmless as long as it is starved of oxygen (normally these soils are waterlogged because of the shallow water table).

If iron sulfide is exposed to air because of drainage or other disturbances, it reacts to produce sulfuric acid. This acid can move through soil, acidifying soil water, groundwater and surface water.

Growing fruit and vegetable crops on potentially acid sulfate soils may involve drainage or disturbance. Where tests show that acid sulfate soil layers are within 0.5 m of the surface, such soils should be avoided.

These soils need special laboratory tests and management to neutralise existing and potential acidity and to minimise the export of acid leachate off site. Soils can be managed by (Canegrowers 1997),

- knowing at what depth the potential acid-sulfate soil layer exists,
- making sure that any cultivation will not expose or bring up the potential acid-sulfate soil layer,
- not permitting drains to penetrate potential acid-sulfate soil layers,
- keeping natural water table levels above the acid-sulfate soil layer.