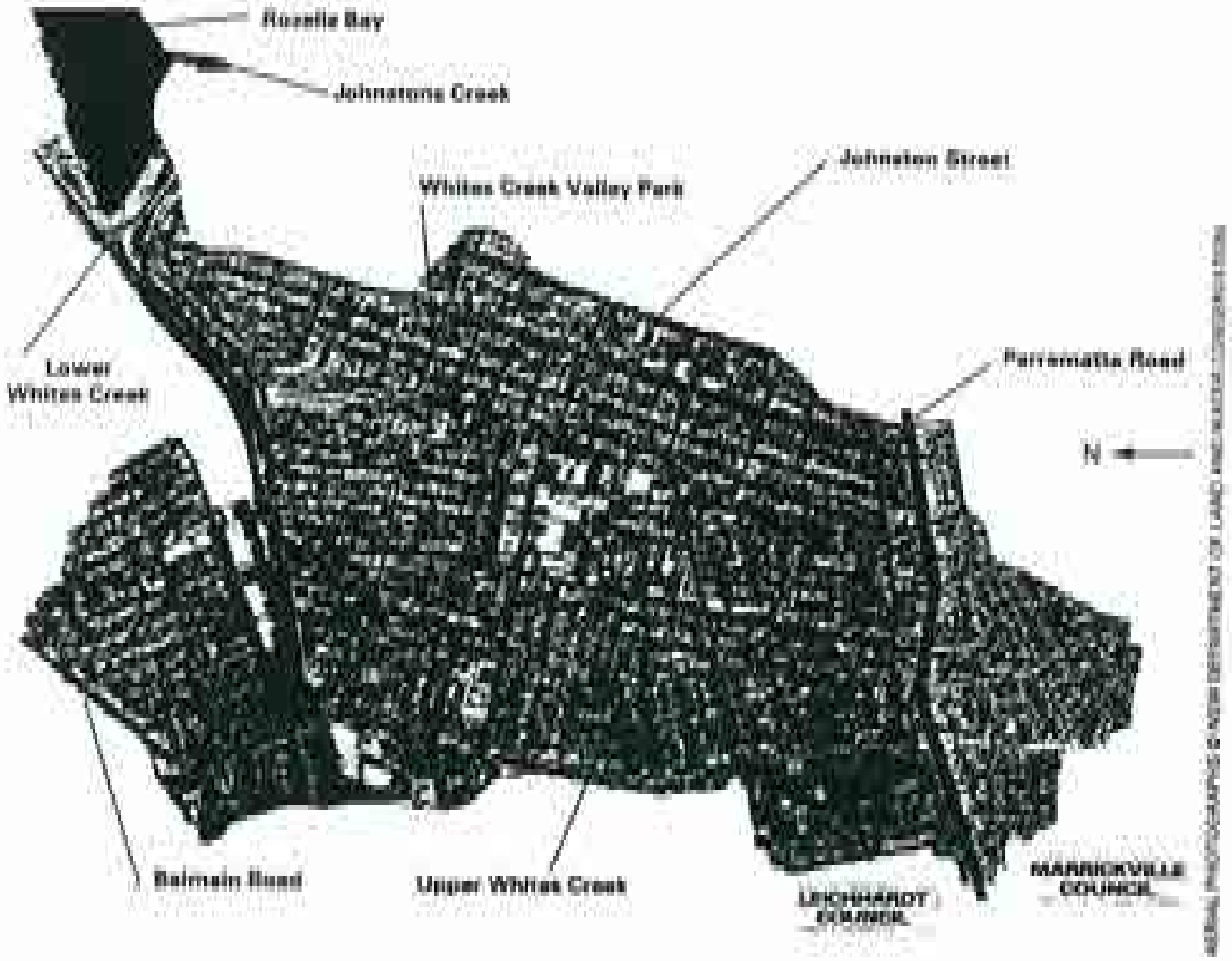
APPENDIX A
FRIENDS OF THE EARTH PROPOSAL



WATER IS LIFE **IS A SERIES OF THREE LEAFLETS WHICH DESCRIBE HOW TO HELP RESTORE URBAN WATERWAYS BY MAINTAINING HEALTHY SOILS AND FOLLOWING A TOTAL CATCHMENT MANAGEMENT PLAN**

Water is essential for all life on earth. About three billion years ago life began as small microscopic marine organisms. Nearly 300 million years ago primitive amphibians crawled out of their watery home onto dry land. Humans are a fairly recent addition — we first appeared about one million years ago. Since then our numbers have grown enormously and our way of life has had profound consequences for the water cycle, particularly in urban areas.

The water cycle begins with water being evaporated by the sun mainly from the sea, which becomes vapour and forms into clouds. Some of the cloudy vapour blows inland where it falls as rain before eventually flowing back to the sea.

The main source of fresh water is rainfall runoff, which is widely used to meet human needs. Runoff is a vital part of long-term water supply and renews all water resources be they rivers, lakes or reservoirs.

One of Annandale's wide streets suitable for converting to a green corridor

RUNOFF IS PART OF THE WATER CYCLE

The rainwater that runs off the land is an essential part of the water cycle in healthy ecosystems, and helps keep aquatic organisms alive. Rain makes its way into the soil and provides water for thirsty plants.

Runoff replenishes water in creeks, rivers, ponds, lakes, billabongs, swamps and marshes. Living water is home for fish, frogs, ducks and many other animals, be they as small as insects or as large as whales.

In spite of its crucial role in the water cycle, government authorities have long treated rainwater runoff as if it were a major disposal problem. Water has been captured in gutters, drains, pipes and canals. Runoff has been drained away as quickly as possible, as if it were a nasty infectious disease. Why is it that people in cities treat rainwater as though it is something threatening that needs to be controlled and drained away?

WHITES CREEK

Whites Creek, Annandale, is typical of many creeks and urban waterways in suburban Sydney where the catchment has been neglected and the creek is now an ugly concrete drain.

The catchment is intensely developed and, in common with many other densely populated suburbs, the importance of soils is poorly understood. Most soils have been sealed by buildings, roads, footpaths and paving. Only a little area remains where water can manage to penetrate deep into the soil, and be stored.

When it rains, water is collected in roadside gutters. The water swiftly flows along the street, then drops down a gully pit into a pipe. Underground pipes are out of sight and out of mind, so we don't know where they are or where the water flows. By

contrast, natural creeks are at ground level and are easy to see and follow.

Eventually the stormwater pipes drop their load into Whites Creek. Two hundred years ago this was a babbling little brook. Now it is an ugly, dirty, smelly drain.

Some years ago engineers turned Whites Creek into a concrete canal. They didn't understand, or overlooked the importance of rainwater runoff in the water cycle. It was believed a concrete canal would quickly get rid of unwanted stormwater.

Today however, instead of fighting nature, total catchment management aims to live side by side with it. In cities we must work towards restoring damaged ecosystems so as to gain the benefits of rainfall. Concrete canals such as Whites Creek, could easily be converted back into natural waterways.

Management could begin in the upper reaches of the catchment. Water needs to be stored high up in the catchment, as close as possible to where rain falls, so as to reduce flooding. Flooding is a problem in some low lying areas of Whites Creek, which could be controlled by upper catchment management.

WHY SOILS ARE IMPORTANT

Healthy stable soils are a very important part of the water cycle, but in urban areas soils are poorly understood, abused and suffer from neglect.

During the water cycle rainwater lands on the soil and, if more water can enter the soil flooding can be reduced. It's also possible to reduce pollution when runoff filters through vegetation and into soils.

The process when water moves downward into the soil, is called *infiltration*.

Rain can be encouraged to infiltrate into soils. In many densely populated inner suburbs, residential backyards are the major land area available where water can directly infiltrate into soils. Council parks and gardens are also ideal places where water can be encouraged to infiltrate into soils.

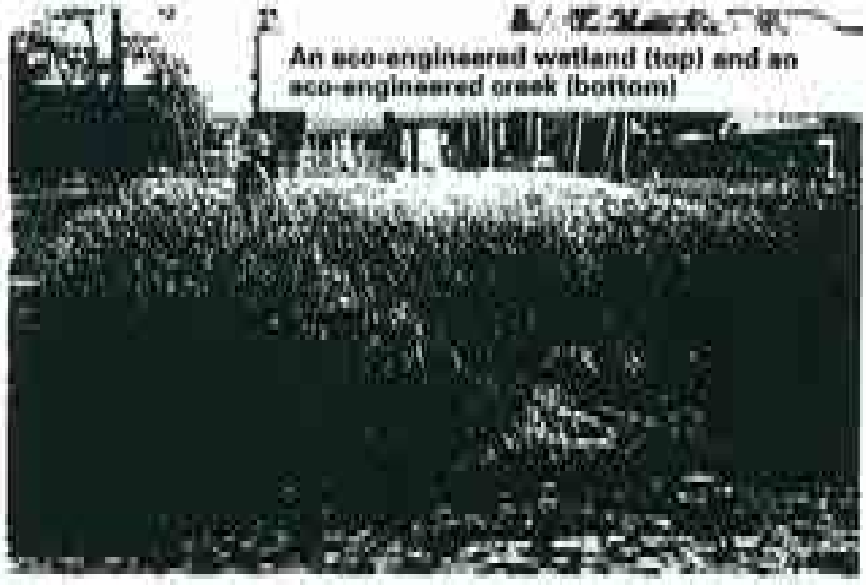
WHAT MAKES HEALTHY SOIL

If we improve the soil structure, or add organic matter and use mulches, then the soil will soak up more water. Vegetation, especially trees, also intercepts rain before it reaches the ground.

Soils are usually composed of three kinds of particles — sand, silt and clay. A healthy soil has a stable, porous structure, where the soil particles bind together in a way which allows air and water to move freely. When water can quickly infiltrate the soil, the soil is described as *permeable*.

Water makes its way easily into sandy soils and soils with a deep, loamy, topsoil, while clayey soils are less permeable.

Vegetation protects the soil from the impact of raindrops, which can break down



An eco-engineered wetland (top) and an eco-engineered creek (bottom)

Upper Whites Creek now a covered drain (top) and also an open concrete canal (bottom)

the soil's surface structure so that when it dries it forms a crust. Plant roots and organic matter improve soil structure, and allow the water to easily penetrate.

Building up a good structure helps the water infiltrate the soil. Even clayey soils are permeable if the soil has a stable, structure.

A healthy soil with plenty of organic matter encourages micro-organisms to grow, which help to form a stable structure. Soil animals, especially earthworms improve structure. Soil improvers such as gypsum can help in heavy clay soils.

WHAT NEEDS TO BE DONE

If we are serious about applying total catchment management to restore our waterways, it will require cooperation between all interested parties. This includes governments, business, industry and landowners. Local governments will need to carry out the work; state and federal governments will need to set the standards and provide funds.

The primary responsibility for managing our waterways rests with the state government, which will have to devise legislation to prevent pollution.

Most citizens are now aware of environmental problems and are prepared to help save our planet, but we need strong government leadership. It's time for governments to "do the right thing".

The **Water is Life** series of leaflets stress the importance of maintaining healthy soils so as to encourage the restoration of natural waterways.
The **Home Gardens** leaflet includes several ways to make soils more physically fertile.
Councils, the big landholders explains the important role local councils will have to play in soil management and restoring natural waterways.

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The New South Wales Government is funding this project through its Rivers reborn program

Campaigning on environmental issues in their social, political and human rights context

councils
THE BIG LANDHOLDERS

Throughout urban areas, the local council is often the single largest landholder. Councils own local streets, parks and gardens, parking lots, sporting facilities, works depots, administration buildings and many other facilities used by the local community.

It's curious how councils spend millions of dollars building concrete stormwater drains and yet completely neglect water management on their own land. Management plans for parks often contain designs for everything from bandstands to dog toilets, yet our local councils seldom see the opportunities for nurturing park lands to help make the water cycle healthier.

For many years councils have treated stormwater as if it were a problem and captured it in concrete gutters and drains.

Concrete drains are an ugly, smelly blot on our urban landscapes. There are, however, other ways councils can manage stormwater, which incorporate eco-designed wetlands and waterways.

STREETS, ROADS AND TAR

In urban areas, streets, roads and footpaths cover a large proportion of the land.

Streets and footpaths cover about ten percent of the land area in many parts of the Whites Creek catchment, Annandale. The wide, tree-lined streets of Annandale are famous in the inner city, where streets are often narrow and bare of vegetation.

All rainwater that lands on tarred roads becomes runoff, flows into gutters and becomes a stormwater problem further downstream.

In local streets, the tarred area need only be wide enough for the passage of cars and just enough parking spaces for locals. The excess tar can be dug up so as to encourage water to infiltrate soils.

Water runoff from streets is a major source of diffuse pollution, especially lead, zinc and copper. Vegetation that grows beside streets acts as a filter, removing many pollutants before they enter sensitive waterways. If runoff from streets can be encouraged to infiltrate surrounding soils, it will help reduce water pollution.

Many pollutants create a much more severe problem in waterways than in soils, and many complex organic pollutants break down faster in healthy soils.

GREEN CORRIDORS

The wide streets of Annandale provide an ideal opportunity for the development of green corridors. The excess tar could be removed and replaced with native plants, which would allow more water to infiltrate the soils and reduce flooding and pollution.

Water flows very swiftly in concrete gutters, and this helps increase the height of flood peaks in downstream stormwater drains.

Concrete gutters can be converted into eco-engineered drainage lines, which use vegetation and small obstacles such as rocks, bumps and depressions to create a rough surface. The fast flowing water gets trapped by these obstacles, which act as an effective brake and slow it down. Concrete gutters, on the other hand, have smooth surfaces that allow water to flow swiftly.

Drainage lines must be protected with vegetation to reduce erosion and small banks may need to be built to act as checks and reduce water speed and erosion, especially on steep slopes.

The vegetation will form green corridors, which will act as habitat for native animals and birds and help them move through inhospitable, densely developed suburbs. Vast expenses of tar also look ugly — a little greenery will be a lot more attractive than wide bare streets.

PARKS AND GARDENS

The old idea of building concrete gutters and drains to control stormwater is now known to increase floods and pollution. Concrete drains are no longer viable and can be replaced by eco-engineered creeks. Councils now need to work with nature and restore waterways. One way of doing this is to establish wetlands in open spaces.

Local councils could install water management schemes on the large areas of public land that are used for parks, gardens and sports fields. These open spaces are ideal for water management schemes.

Streets, parks and gardens occupy a large proportion of urban land, and provide areas where water can be encouraged to infiltrate soils.

Wetlands can be built in parks if they're suitable — well designed ponds are a great attraction in parks and visitors love to sit by ponds and watch the water birds. The duck ponds in Centennial Park are a popular attraction for many Sydneysiders.

Wetlands can help to smooth out flood peaks and maintain the water flow in creeks during dry weather. Wetlands, which include swamps and ponds, provide a constant supply of water and help drought-proof creeks. They also remove some pollutants from water.

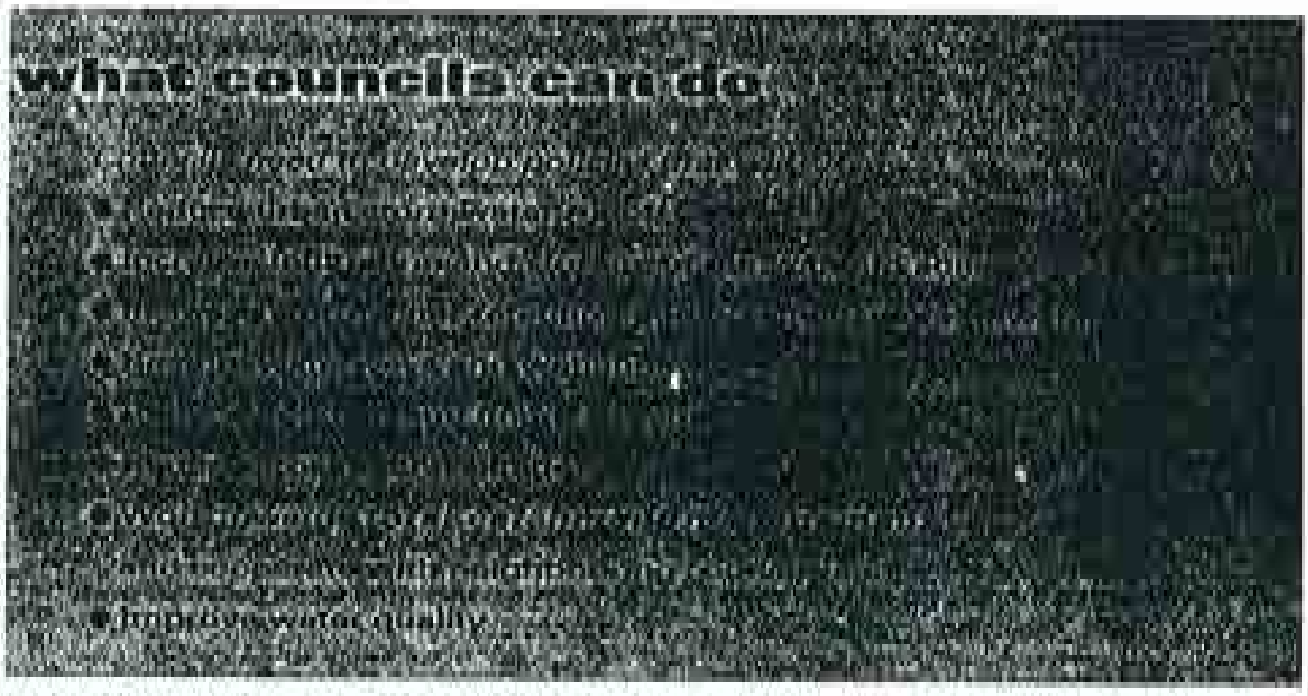
Parklands can also be designed to increase the amount of water absorbed by soils. On farmland it's common to construct banks on the contours so as to capture water runoff and reduce erosion. Absorption banks can be incorporated into the landscape design of parks and cement drains can be replaced by eco-designed waterways.

A WETLANDS SYSTEM FOR WHITES CREEK

Leichhardt Council owns several parks in Whites Creek catchment. Styles Street Playground and Whites Creek Valley Park are next to the creek, while the War Memorial Park is further up the catchment.

Whites Creek Valley Park is an ideal site to construct a wetlands system. At the head of the system a gross pollution and silt trap could be installed to catch soil, sand and grit as well as litter and garbage. Water could then flow into a small artificial swamp and pond, while downstream an eco-engineered creek could meander through the park.

Initially the system would only manage to receive small flows of water. It will take several years for the new wetlands to become established and have enough vegetation to protect the creek's banks.



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home gardens

In urban areas, like Whites Creek in Annandale, the waterways and wetlands which were part of the water cycle have disappeared or are very sick. To bring back life to urban waterways the whole catchment needs to be improved through total catchment management.

Total catchment management means we need to understand how what happens in one part of the catchment will cause effects downstream. It will require cooperation between all interested parties if we are to restore the environment.

THE DISAPPEARING SOIL

The majority of urban land is covered with hard impervious surfaces such as concrete pavements, bituman roads and buildings. This has reduced the amount of land that's available to soak up rainwater, and so when it rains the water runs off the land and into the nearest creek, river or sea. This is what happens in the inner city suburb of Annandale, where 90 percent of the land is sealed by roads and buildings, and rainwater runs off into Whites Creek.

Most of the land in the suburbs where water can be soaked up by soils is found in home gardens. When rainwater infiltrates deep into a garden soil, the water is retained and available to growing plants during dry weather. The more rainwater is stored in soils, the less tap water is required to water gardens.

HOW YOUR GARDEN CAN HELP

Home gardeners can help reduce flooding and stormwater problems by storing water in rainwater tanks and in the soil. Rainwater tanks are now being used to store water that's collected from the rooftops of houses. This helps conserve water as it saves using tap water and reduces the demand for stored water from the dams that house Sydney's water supply.

Every home gardener can help restore the water cycle and bring back life to waterways like Whites Creek. Water can be encouraged to infiltrate garden soils so that instead of flowing into concrete gutters and drains it's soaked up and absorbed within our gardens. This helps thirsty plants to grow and can also reduce flooding.

The Water Cycle

ALTERNATIVES TO PAVING

Concrete paving prevents any water from infiltrating soils, and can cause flooding on the home block and in creeks and rivers downstream. A household garden can be a little oasis of nature rather than a bare slab of concrete.

A home garden may need a small amount of paving where people often walk, such as from the front gate to the front door. And although car driveways need to be solid, they don't have to be slabs of concrete several metres wide. All that's really needed are two narrow strips of paving, wide enough for the car's wheels. The rest of the driveway can then be planted with low growing plants or lawn.

Timber decking can be used in backyards instead of paving. It provides a solid base for areas that are heavily used, such as near the back door or where there's outside furniture. Timber decking that's laid with small gaps between the boards allows rainwater to drip onto the ground below and infiltrate the soil.

Trees are often planted in spots where they are surrounded by impermeable paving. Plant roots need to breath and oxygen is essential for healthy growth, but air can't circulate in any soil which lies under paving and the tree's growth will be restricted.

Soils covered with paving aren't healthy or fertile. Healthy soils are dynamic and full of life and sustain plants growing on the surface. The plants add leaf litter to the soil, which then provides food for earthworms, slaters, micro-organisms and all the other numerous creatures who live in the soil. All this activity makes a *living* soil, while soils covered with concrete soon become sterile.

HEALTHY GARDEN SOILS

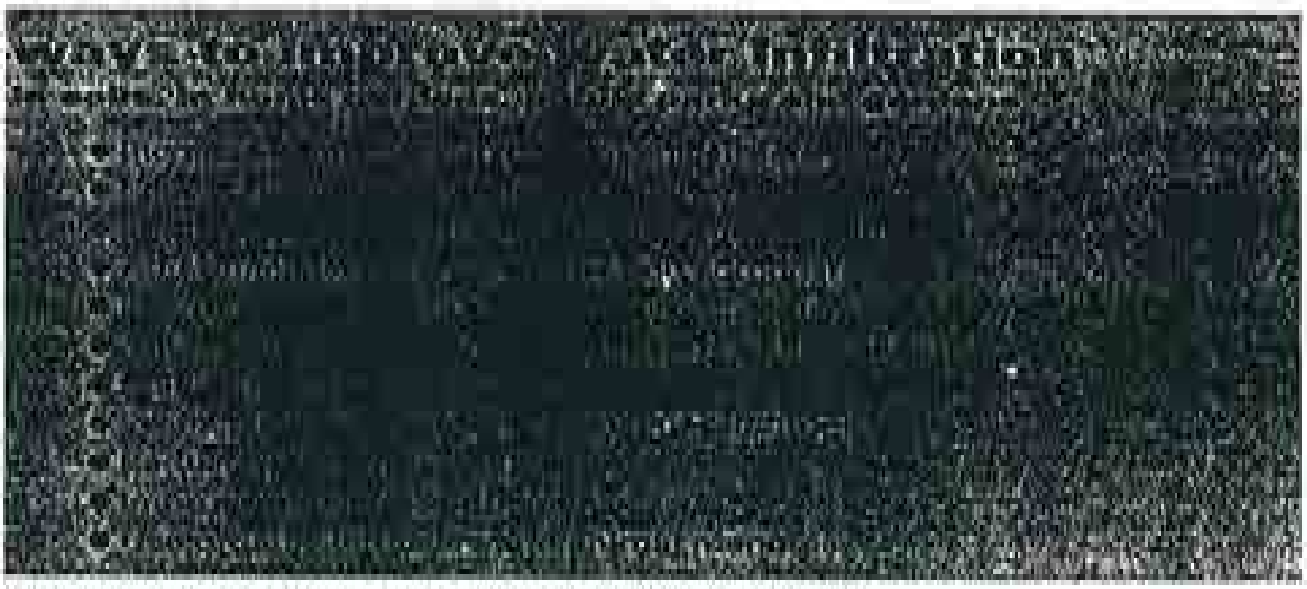
Most gardeners know it's important to have a fertile soil for healthy vigorous plant growth. A healthy fertile soil not only contains all the nutrients necessary for plant growth, it also needs to be physically fertile.

A physically fertile soil has plenty of air and holds moisture. It will allow plant roots to penetrate and seedlings to emerge and grow with ease. A very important factor is whether water can quickly penetrate deep into a soil. When this happens, the soil is described as permeable, or is said to have a high infiltration rate.

Many factors can help make soils more permeable. Infiltration is reduced by clay and increased by sand. A healthy soil has a stable, porous structure, where the soil particles bind together into *aggregates* in a way which allows air and water to move freely.

A careful gardener can help build up and maintain a good stable soil structure. Organic matter binds soil particles together and vigorous plant growth adds organic matter to soils. Extra organic matter can be added by applying composts, animal manures, green manures such as weeds which can be dug in, and mulches made from straw, leaves or bark chips.

Many soil animals help form structure, especially earthworms. Micro-organisms are also important for binding soil particles together. For example, fungi have long hair-like *filaments*. Soil organisms need organic matter to feed on and well aerated soil. Artificial chemicals need to be used with great care and as little as possible as they can harm many soil organisms.



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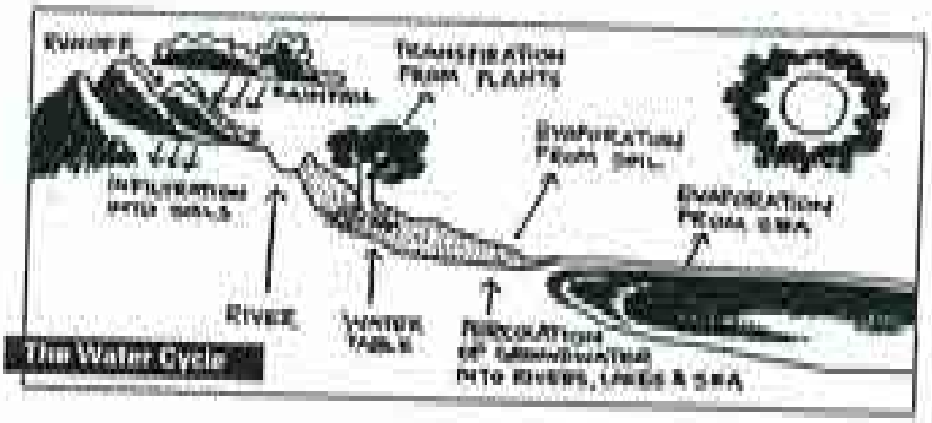
Upper Catchment Management Whites Creek

Ted Floyd



The Water Cycle

Friends of the Earth
Sydney

Upper Catchment Management Whites Creek

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URBAN WATER CYCLE

A Friends of the Earth Project

The Urban Water Cycle is a project of ***Friends of the Earth***, Sydney aiming to restore the natural water cycle in inner-city areas.

Many creeks, especially inner city creeks have been converted to concrete drains. Natural wetland areas have been filled in and many wetlands have been converted to sporting fields. Often garbage or contaminated soils were used as fill in wetlands. Wide streets, sealed from gutter to gutter often have an excessive expanse of tar above the needs of motor vehicles. Sealed areas, including buildings and roads prevent water from infiltrating into the soil. Excessive tar and concrete gutters should be replaced with vegetation creating green corridors with grass waterways.

The growth of cities causes many adverse effects on the water cycle. Flood peaks increase and urban runoff is polluted. Even water runoff from the roofs of buildings and roads is polluted. Habitat and biodiversity of aquatic eco-systems is lost. Many inner city children do not experience the joy of running creeks with minnows, tadpoles and ducks.

Friends of the Earth, Urban Water Cycle Project will aim to bring back to the city many of the features of natural water eco-systems. Habitat for aquatic species will be provided and biodiversity increased. Native plants and animals will help to improve amenity for the residents of our cities. Well designed water eco-systems will reduce water pollution and flash flooding.

A series of leaflets "**Water is life**", produced by ***Friends*** , describe how to help restore urban waterways by maintaining healthy soils. A small leaflet has been produced on the "**Urban water cycle**".

Friends are now preparing plans to construct a series of wetlands alongside Whites Creek, Annandale. These wetlands will act as a blueprint for inner city councils restoration plans.

A team of volunteers is now working towards the construction of the Whites Creek wetlands. The University of Technology is acting as technical advisor and preparing an engineering feasibility study.

The total cost of the project is estimated to be between $200,000 - $300,000. Work carried out by volunteers including technical advice from the University of Technology will help reduce the total cost.

To enable this project to be successfully completed, considerable help will be needed. Donations to ***Friends of the Earth*** are tax deductible. Volunteers with a wide variety of skills are needed. Commercial Business may wish to provide goods or services in kind.

This is an exciting project which has many innovative features demonstrating how the waterways of Sydney can be made environmentally sound. If there is any way you can help this project to succeed please do not hesitate to call ***Friends*** at our Sydney office.

Ted Floyd

Convenor, ***Friends of the Earth***, Sydney

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Summary

Friends of the Earth are investigating ways of solving stormwater problems in urban areas. Whites Creek catchment in the inner Sydney suburb of Annandale is being used as a test case.

Restoration of the water cycle is critical for the reduction of pollution and flooding. Many urban water problems can be solved by mimicking nature, including: reduction of impermeable surfaces, improving soil infiltration, decreasing velocity of overland flow, and the restoration of wetlands.

Treatment of urban runoff should begin in the upper reaches of the catchment. Water should be stored high up in the catchment, close to where rain falls. Many small scale treatments should be utilized in the upper catchment. Conversely many treatments utilise large scale engineering structures, lower down the catchment, where the problem is serious, but often after the problem has been created.

Treatment needs to begin where rain comes to earth. The maximum amount of rain should be encouraged to infiltrate into soils. Healthy stable soils are a very important part of the water cycle. In many densely populated inner suburbs, residential backyards are the major land area available where water can directly infiltrate into soils. Council parks and gardens are also ideal places where water can be encouraged to infiltrate into soils.

Water runoff can be a major source of pollution in urban areas. Runoff from streets and roofs contain high levels of heavy metals especially lead, zinc and copper and oil based pollutants. In urban areas a high proportion of the area is sealed, little water infiltrates into the soil and this greatly increases the volume of runoff.

In urban areas water flows swiftly down gutters and drains causing flash flooding. ***Friends*** advocate the construction of eco-creeks with slowly flowing water and lower flood peaks.

Constructed wetlands

Wetlands with growing plants reduce levels of nutrients (phosphorus and nitrogen). Oil/grease pollution from streets is reduced when water filters through vegetation. Still water in wetlands allows heavy metals and silt to settle out. Wetlands have value as wildlife habitat, especially for aquatic fauna and flora including waterbirds.

Friends have developed plans to divert water from Whites Creek by pipe from the main channel into a series of constructed wetlands which will flow parallel to and then re-enter the main channel. The wetlands will only receive minor flows, and a small controlled proportion of major flows. The wetlands will consist of: silt trap, grass pollution trap, shallow wetlands, lake, eco-engineered creek and an additional silt trap before the water re-enters the concrete channel. The creek bed and banks will need to be securely stabilised with rocks and vegetation.

Contents

Upper Catchment Management

Catchment management should begin in the upper reaches of the catchment. Water should be stored high up in the catchment, as close as possible to where rain falls. The basic principle of using many, small scale treatments, at the catchments source, should be followed. Conversely many conventional catchment management treatments utilise large scale engineering structures, lower down the catchment, where the problem is serious, but often after the problem has been created.

Catchment treatment needs to begin where the rain comes to earth. Initially, the maximum amount of rain should be encouraged to infiltrate into soils. Healthy stable soils are a very important part of the water cycle, but in urban areas soils are poorly understood, abused and suffer from neglect. In many densely populated inner suburbs, residential backyards are the major land area available where water can directly infiltrate into soils. Council parks and gardens are also ideal places where water can be encouraged to infiltrate into soils.

Water runoff can be a major source of pollution in urban areas. Runoff from streets and roofs contains high levels of heavy metals especially lead, zinc and copper and oil based pollutants. In urban areas a high proportion of the area is sealed, little water infiltrates into the soil and this greatly increases the volume of runoff.

Wetlands with growing plants reduce levels of nutrients (phosphorus and nitrogen). Oil/grease pollution from streets is reduced when water filters through vegetation. Still water in wetlands allows heavy metals and silt to settle out.

Wetlands have value as wildlife habitat, especially for aquatic fauna and flora including waterbirds.

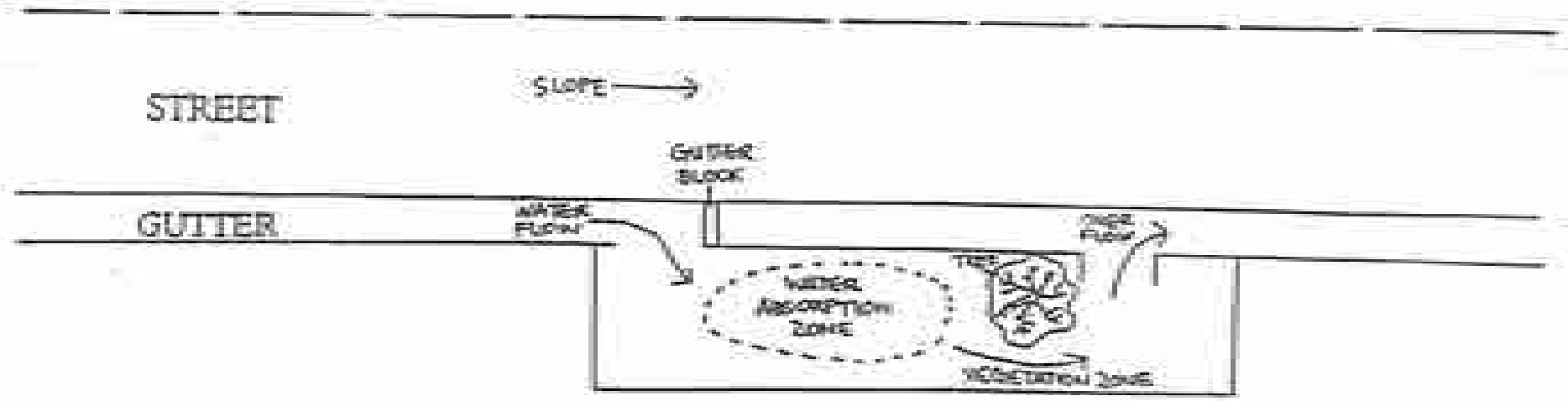
Inner city areas like Annandale, have no natural freshwater systems. Young children never see in there local area, freshwater flowing in a babbling brook. This project will act as an important life experience for children who only see polluted concrete drains.

Water Cycle

When rain falls on the earth, it is intercepted by vegetation which covers the land. A small proportion of the rain is evaporated directly from the plants surfaces. Even during rainfall evaporation occurs, especially from tall trees.

With many tree species water is collected in the upper canopy and flows down the stems and eventually down the trunk into the soil. In many urban

STREET TREES

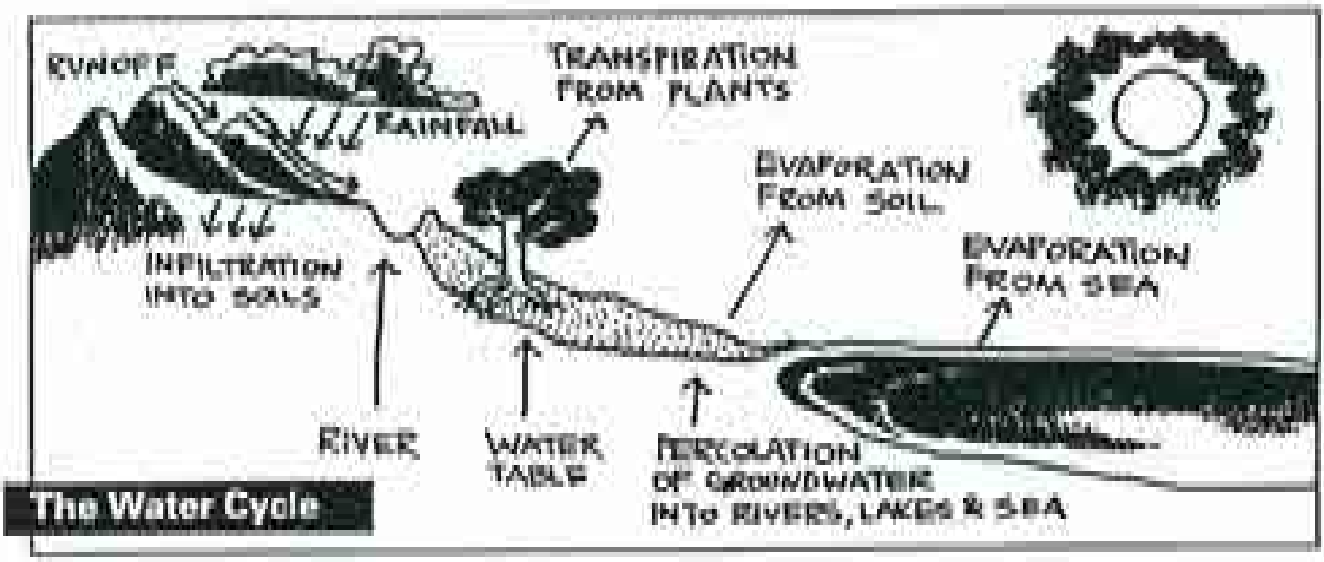


FOOTPATH

Trees planted alongside urban streets should be surrounded by an ample area of permeable soil. Water should be diverted from gutters onto the permeable soil surrounding trees. Tar or concrete, surrounding trees, restrict water penetration and air circulation.

situations this process could be of major significance. The supply of water to the roots of a tree can be restricted by impermeable paving surrounding the tree. Water collected by the canopy and flowing down the trunk into the soil will help to increase water infiltration into the soil and to counter balance the restriction of water infiltration by impermeable paving.

During rain, water is stored on the surfaces of leaves and stems. When it ceases to rain water will continue to drip from a tree. This can help to even out a rainstorm and to reduce flood peaks.



The Water Cycle

During the growth of vegetation, water is removed from the soil by transpiration. The rate of transpiration is roughly proportional to the growth rate, the mass of vegetation or leaf area. Trees have a large mass and generally have a higher transpiration rate than many other forms of vegetation. Transpiration of water from the soil helps to dry out the soil. During rain water will infiltrate more readily into a dry soil. The removal of water from soils by transpiration allows more water to enter the soil during rain and this will reduce water runoff and lower flooding.

In certain situations the removal of trees has resulted in the rise of the water table. This has caused great problems when there is salt in the subsoil. A rising water table brings the salt to the surface and this can kill vegetation and in urban areas salt can cause damage to buildings.

The vegetation covering the land is a very important component of the water cycle. When vegetation is removed or reduced the checks and balances in the water cycle are disrupted. Trees are large, with deep roots having a major role in maintaining a balanced water cycle.

Water which does not infiltrate into the soil becomes runoff which flows downhill eventually concentrating in rills, streams and rivers. A small amount of water is trapped in puddles and becomes depression storage.

Easy water entry into soils helps reduce flooding. Helpful advice on how to improve water infiltration into soils can be found in the leaflets, "Water is life", produced by ***Friends***.

An important factor determining the height and duration of floods is the time of concentration. The travel time from the most remote point of the catchment to the outlet is the time of concentration. The shorter the time of concentration the higher the flood peak and when the time of concentration is longer, flood peaks are less intense and last for an extended time.

Time of concentration is related to the velocity of overland flow. In urban areas water flows at a high velocity down roofs, roads, gutters and concrete drains. In urban areas the time of concentration is shorter compared to natural eco-systems. Flood peaks are higher in urban areas because there are more impermeable surfaces and water flows faster down concrete drains.

Water flowing in a concrete gutter flows about three times faster than in a grass waterway. Eco-designed waterways which meander increases the length of the waterway and reduce the slope. Waterways incorporating natural features will increase the time of concentration and reduce flood peaks.

Factors affecting flooding varies in different catchments and during different rain periods. During heavy storms, flood peaks are high and surface characteristics have only a minor effect on flood heights.

Friends advocate the simulation of natural eco-systems to help control stormwater problems. Wetlands are only one measure which can be used. The total catchment should be treated, and treatment of the upper catchment is of utmost importance.

Pollution

Pollution may originate from industries but there are only a small number of light industries in Whites Creek catchment. Pollution entering drainage systems from commercial premises can and should be prevented.

In Sydney successful trials have been carried out where surveys were carried out on small commercial premises. The surveys were followed up with advice on how to reduce pollution entering the drainage systems. These trials have been successful and adequate funding is needed to cover all of Sydney including Whites Creek.

Litter is an ugly visual form of pollution. Considerable litter enters Whites Creek and a floating boom has been installed at the mouth of the creek. The major source of the litter is fast food and beverage containers. Education

programs such as 'do the right thing' have failed. Legislation is now needed to introduce deposits on beverage containers. Dry street sweeping reduces litter in drainage lines. Leaf litter is increasing because more trees are being planted.

Sewage overflows are known to be a major pollution source and Sydney Water needs to solve sewage overflow problems.

Roads, car parks and car related commercial premises are an important source of diffuse pollution. Major car related pollutants include lead and oil based products. Washing cars in streets contributes to phosphorus pollution and is illegal.

Pollution from buildings and houses is a significant source of diffuse pollution. Aerial deposition of lead and other pollutants onto roofs is washed into waterways during rain. Galvanised iron is a source of zinc pollution. Copper pollution can originate from copper pipes. Pesticides used by home owners can pollute waterways. Chlordane which is used to control white ants has been found in high levels in the sediments of Rozelle Bay. Lead paint contributes to lead pollution. Fertilisers add to the nutrient load of waterways.

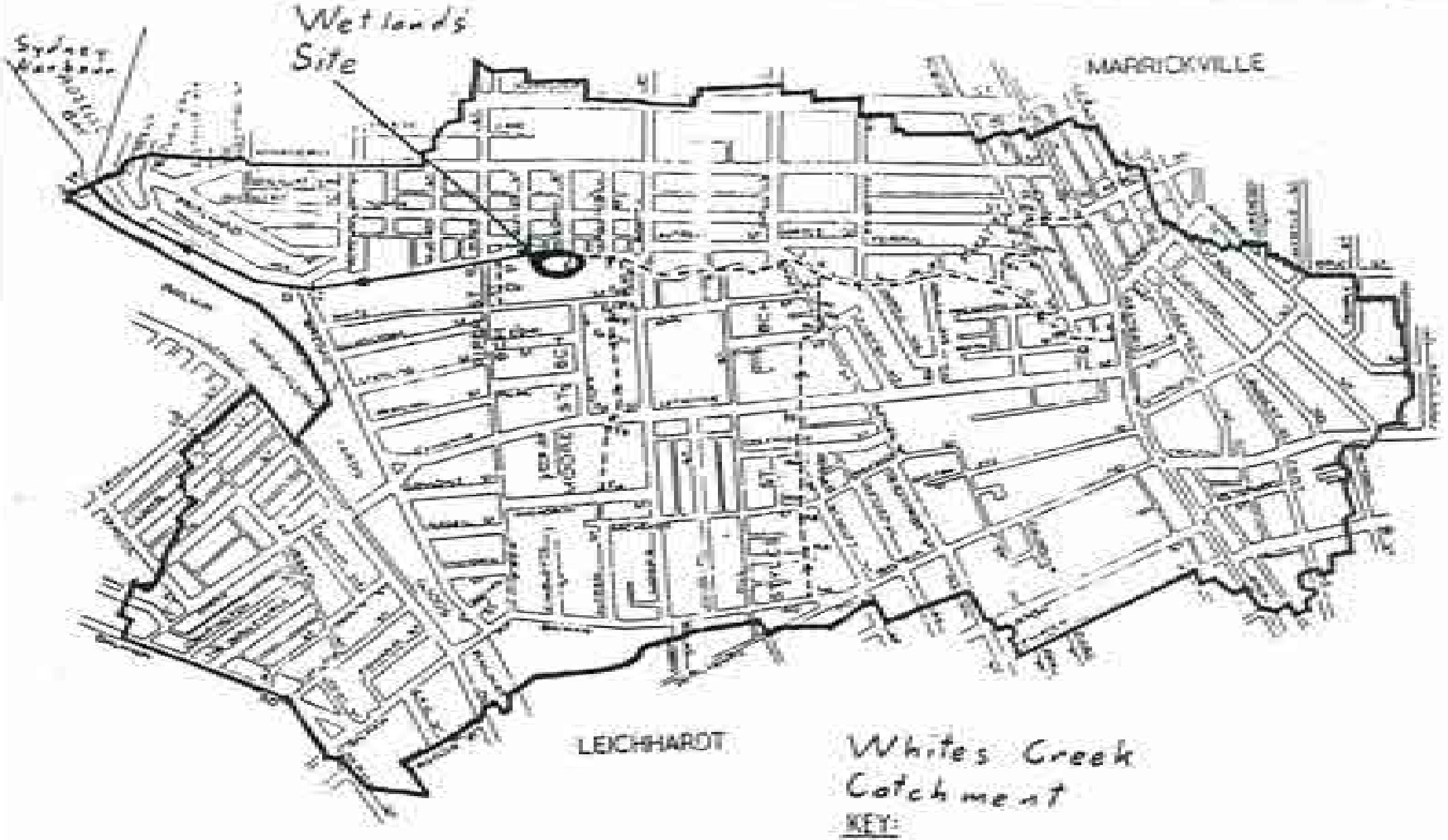
Pet faeces contributes to the nutrient load of waterways. A considerable proportion of the faecal bacterial count in Sydney Harbour originates from pets. 100 tonnes of dog dung is produced in Sydney per day. It is interesting to note studies have indicated a large proportion of the bacterial counts in Sydney Harbour originate from non-human sources (cats and dogs).

In the inner Sydney region their are many contaminated soil sites. Old industries, which have ceased to operate and are forgotten, have left their footprint in the soil. Each industry produces its own particular forms of pollution and so the type of contamination varies greatly between different sites.

Sometimes contaminated soil has been used as fill. Some of the foreshores of Rozelle Bay have been filled in with contaminated soil. Many inner Sydney soils are contaminated with lead from leaded petrol or lead based paints. Contaminants from soils may be leached into waterways, or eroded and washed into waterways.

Sediment Pollution

Inner city drainage lines can be polluted by a variety of chemicals. The amount of pollution carried in the silt layer can be high and many pollutants are more abundant in the solid phase than in the liquid phase. Lead and other heavy metals precipitate and settle into the sediments. Some pollutants are adsorbed onto the surface of fine particles e.g. phosphorus can adsorb onto clay surfaces. Polluted sediments accumulate in bays and coves where tidal


Wetlands Site
MARRICKVILLE
LEICHHARDT
White's Creek Catchment
KEY:
262 ha.
N

flushes are only minor. Whites Creek flows into Rozelle Bay which suffers from polluted sediments.

The proportion of phosphorus found in sediments can be high, especially if the water is alkaline. Soluble phosphates combine with cations of calcium, aluminium and iron to form insoluble compounds which precipitate and settle into the sediments. Phosphorus is adsorbed onto clay surfaces and can form insoluble complexes with humic substances.

Some pollutants are expected to be more abundant in the water phase. Nitrogen is very soluble and little nitrogen would normally be found in the sediment layer. Many oily pollutants float on the water surface. Soluble pollutants would not be removed by settling in a silt trap.

Recent studies on Sydney Harbour have highlighted the significance of pollutants in the silt on the bottom of the Harbour. Often the highest level of sediment pollution is found near the mouth of stormwater drains including the mouth of Whites Creek.

Pollution in a stream may be either soluble and dissolved in the water or insoluble. Silt includes sediment on the channel bed and smaller insoluble suspended particles in the main body of water. The rate at which particles settle in water depends on the particles size and density. Swiftly flowing turbulent water will carry heavy silt loads. There is no definite division between sediments on the channel bed and suspended solids. There is a gradual progression from large bottom sediments to smaller suspended particles.

Polluted sediments are now recognised as being very important. In the long term pollution in sediments may have greater adverse effects than soluble pollution. Homebush Bay is an extreme example, where highly polluted sediments prevented dredging. Plans for ferries to enter Homebush Bay during the Olympics had to be abandoned. Many sediments in the bays and coves of Sydney Harbour are polluted with heavy metals, lead, copper, zinc and cadmium. Insecticides and PCBs are found in some sediments. Once pollutants lodge in harbour sediments they stay intact for many years. Flushing of sediments takes many years while flushing of Harbour water only takes days. The Whites Creek wetland will be designed to capture a large proportion of the silt in a cost effective way.