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A Comprehensive Study of the Styx River and River Catchment with regard to its Recreational Value.

Submitted to fulfil the requirements of the

Major Design Study

for the Diploma in Landscape Architecture

at Lincoln College, University of Canterbury.

by Gordon Griffin. (B.Hort.Sc.)

Time of Study: July 1974 to January 1975

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INTRODUCTION

The city of Christchurch is proud of its rivers, the Avon and Heathcote. Although a conspicuous element within the city, their real potential is largely unrealized. Urban development along the upper portions of these rivers and their tributaries has caused the rivers to become largely inaccessible to the public. Roads and buildings dominate the river because of their closeness to it. The opportunity of emphasizing the rivers in developing the city has been largely ignored. A green space pattern might have been used to divide neighbourhoods, to provide a rural atmosphere within the city linking it to the countryside, to provide a logical pattern to sports-fields placement, and to emphasize the character of the city.

The Styx river, situated immediately north of Christchurch, is already being subjected to urbanization. At a time when Government is preparing a "Come Alive" campaign, encouraging New Zealanders to fulfil mental, spiritual and physical needs outside their daily obligations, it is fitting that a study of the Styx river area should be conducted, with emphasis on its recreational possibilities.

Now that we have the benefit of daylight saving, new opportunities exist for the recreational use of the evening. The closeness of the Styx river area to Christchurch would mean that this area could be used for evening leisure activities as well as during weekends and holidays.

The increasing size of the urban population is another factor in planning for recreational areas. The Regional Park concept, in which natural areas of sufficient size and beauty close to urban populations are preserved for recreational use, could be conceived for Christchurch, and should consider the Styx area.

GENERAL DISCUSSION

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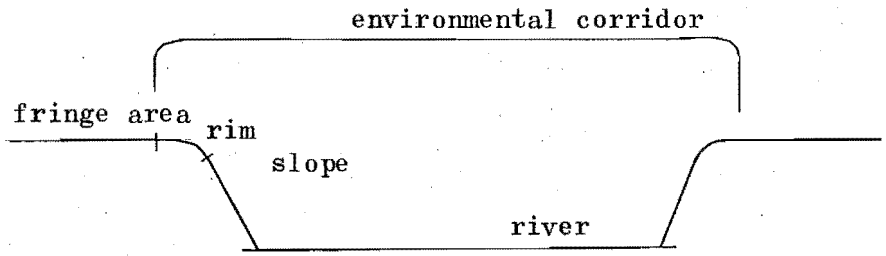
i. THE RIVER CORRIDOR LANDSCAPE

The river corridor is a distinctive and familiar landscape entity. Its basically linear form provides one of the few natural elements capable of creating unity in the landscape. Because of the continuance of river processes, it is an abiding resource and, if unaffected or in harmony with man, a self maintaining one.

In cross section the river can be divided into distinct zones[1]



The fringe area can best accommodate development where this is proposed. Development should respect the processes of the river. Down-cutting, flooding, aggrading and terracing imply the evolution of the river, a changing process.

ii. LANDSCAPE CHARACTER

Character involves the identification of the landscape atmosphere. This is a reflection of the emotional response of people to the environment. Character derives from interactions of form, colour, texture, space and enclosure, light and shade, and reflectivity. Other factors such as historical or nostalgic sources, and the often transient factors which affect the senses in every-day life - sounds, smells, falling rain or leaves - influence the character of the landscape.

The landscape may be imposed and not indigenous. This is the transformed landscape.(2) If excessively humanized its character becomes dominated by man. Where such a landscape occurs in a river corridor, there should remain adequate breadth of vista and vantage points for the river to retain its character and to thereby enrich that of the humanized landscape.

Having surveyed the river in general terms, there emerges a series of distinct river landscapes, distinguished by differing character. These separate landscapes have an overall sense of unity, but they are not entirely coincident with local district boundaries.

Character from reflectivity, movement, clarity, sound;
Potential walkway area, Upper Styx River.

iii. USES

Demands are put on the river and river corridor for a wide spectrum of uses. These include driving, recreation (picnicking, swimming, walking, fishing, bicycle riding, horse riding), camping, industrial uses such as for cooling and waste disposal, and development associated with tourism and with urbanization.

Driving - Design of the road should be in sympathy with the landscape and appropriate to the main purpose for which the road is used. In the case of a road used primarily for pleasure driving, the exploitation of scenery, of changes in the driver's visual experience, are at least as important as where the road is going to.

The provision of variety in a river corridor environment can be obtained by varying the space and enclosure about the road, exposing views, screening, and using other techniques to enrich the experience. The road should approach the river,[3] accompany it, leave it, and perhaps repeat this pattern further on.

Recreation - Water-based activities are the most popular form of recreation. As well as visual amenity, the river and adjacent land may sustain a variety of recreational uses. The presence of water magnifies the recreational experiences of walking, picnicking, riding and other leisure activities.

Camping - This may be considered ahead of building second homes as it enables greater use and retention of the area in a relatively unchanged state.[4]

Industrialization - Inadequate planning and foresight permit the erosion of environmental quality through both urban and industrial development. The river may be used for waste disposal, for cooling plants, or in consumptive uses in which water is not returned. Reduction in the quality of the water and in the quality of the river corridor degrade the environment.

Urban development is greedy for aesthetic locations but tends to pay no heed to resulting environmental degradation. Building sites should be regulated within a zoned pattern of development. Their placement and height should respect open space, view and scale. In locating buildings in the landscape, visual considerations as well as functional ones should govern their design and placement.

iv. PRESSURES ASSOCIATED WITH USAGE

Agriculture, although initially transforming the land, provides a fairly stable and aesthetically pleasing landscape. Development of land for production is likely to ignore aesthetic and environmental values. Fertilizers, some agricultural wastes, pesticides and herbicides can affect the quality of the river and river corridor.

Urban pressures may involve encroachment on the land for development, recreational demands and resource consumption demands. Power generation, industries, sewage treatment plants, solid waste disposal, port facilities, are all activities which can involve the river.(5) All these pressures threaten the ecological and visual values. To combat these pressures the riverside should be protected from non-essential uses. The use of natural materials and colours in building, together with careful siting, will help to preserve landscape character.

The pressures on the river corridor from recreational uses generally involve an upset of the ecological balance. Recreational uses usually protect the river environment from developmental decay, and may enhance the aesthetic quality of the environment. The concept of carrying capacity should be considered. Ecological carrying capacity is a measure of the ability of the environment to accept people. When exceeded, the ecological balance is disrupted and the environment degraded. Physical carrying capacity relates to the effects of visitors on non-living elements of the environment.(6) Psychological carrying capacity refers to the reduction in the experience caused by the presence of others.

Vandalism is a destructive perversion which can occur in recreational areas. Its control is best met from perseverence, education and public outrage.

If pressures are not controlled in the river corridor, environmental degradation, both aesthetic and physical, can proceed to an end point at which the river does not support life. Ecological changes, in responding to pressures, favour the reduction of species diversity, with sometimes the proliferation of

a formerly minor species. Urbanization may proceed to the point when the river is lost, diverted into a system of underground pipes.

v. PRESERVATION

The river corridor is subjected to many stresses which can degrade its environment. Because the well being of the environment is important to the people who live in and use the area, precautions should be taken to protect it.

Zoning, whereby related land uses are associated and kept separate from antagonistic uses, can employ natural boundaries in the segregation of the different uses. The use of the natural boundaries of rivers and hills can separate areas into Industrial, Commercial, Residential and Recreational zones, thus avoiding visual and use conflicts as well as providing other benefits.

Zoning should associate compatible uses and allocate zone types in appropriate areas. Flood-prone areas are incompatible with housing, may be compatible with agriculture, and are well suited to recreation.(7) Urban development should utilize higher ground, both for flood protection and other benefits.

River corridor protection can be achieved through legislation controlling development, through design guidelines regarding development, through public aid and through acquisition and easement programmes.(8)

Urbanization restricts the availability of the river to human use and may increase flood incidence because of increased runoff and reduction in time taken for water to reach the river.(9) Afforested areas have increased infiltration rates and reduced volumes and rates of water reaching the river. Trees may be used for both aesthetic and practical benefit in the corridor fringe areas.

Flood control may also be met through the use of abandoned gravel pits or through the construction of low weirs.(10)

The processes of some natural areas may be so dynamic that a complete prohibition on man's interference may be appropriate. Similarly, prohibition may be necessary to preserve habitats of rare fauna and flora or of other special value.(11)

REHABILITATION

The process of riverside degradation may proceed unchecked. Urban and industrial development is difficult to transplant once established in the river corridor and fringe. Rehabilitation can only begin when public opinion is backed by regional planning and legislation along with industrial and urban cooperation. Rehabilitation may create new life and a new image to an area. Parks and promenades, adequate access and open space, tree planting and renewal of steep slopes, visual enhancement of buildings, can be used in developing the positive aspects of the landscape.(12)

vi. THE ROLE OF LEGISLATION IN PRESERVATION

The value of certain scenic and recreational resources has long been realised and measures have been taken to ensure their preservation. Effective legislation to prevent despoilation of the environment is sometimes inadequate or passed too late to be totally effective.

Since 1886 access along rivers of at least three metres width, around lakes in excess of eight hectares, and along foreshores has usually been provided in all alienations of Crown land. On private subdivision near rivers or the sea coast, for towns, access has been provided since 1923, and has been provided on partitions of Maori land in counties since 1967. Although present legislation in regard to access to these areas is effective, land alienated and divided before these dates does not provide for access. This problem will probably be rectified in time as closer subdivision of the areas involved takes place.

From 1948 onwards the Land Act has provided for the preservation of a strip of not less than one chain in width around every lake of area at least eight hectares.

One problem of such laws is the inflexibility of the reserve. The legislation is purely a recipe formula which can only succeed within certain limits. In some cases a much larger area must be preserved to ensure the retention of the landscape's character.

The problem of land purchased before the legislation of 1886 which preserved the one chain strip of land, is not easily solved. In cases where development has not involved urbanization, legislation and compensation for the lands dispossessed might restore recreational areas to public use. Where urbanization has occurred, the problem of removal of the development might best be implemented over a time period in which new owners are prevented from occupying the land, and those already there must sell to the Crown. Alternatively a due date, such as ten years time, might be set for when all occupants must have left, the land again being bought by the Crown. The approach taken would depend on the urgency of the demand for the land.

The 1961 Counties Act establishes the Crown's claim on waterside country land. This Act provides for a minimum of a one chain strip along the shores of lakes, rivers, harbours and the sea coast when such land is sub-divided. The Act recognises the importance of shorelines for public recreation.

The minimum one-chain foreshore reserve must be an extra donation in addition to the ordinary reserves contribution levied by a county council, and it must be given in land when waterside land owners sub-divide.

The Counties Amendment Act 1974 removed a stipulation on the size of subdivisions to be approved by a local body. Previously only subdivisions of less than ten acres had to be approved, now all must.

The principle behind the legislation is that all should have access to the coast, the rivers and the back country.

The county councils and the Minister of Lands have discretionary powers to exempt stretches of river.

The "three metres" clause precludes the public use and enjoyment of streams - often a delightful part of a countryside experience. Although the reservation of two chains of land for public use might be excessive in the case of streams, the land adjacent to streams is often unsuitable for agriculture and is a rich source of wildlife. The stream is usually accompanied by a sympathetic change in landform, making it an ideal opportunity for developing a walk. Perhaps with a system in which streams of at least one metre in width are set aside for walkways, the stream could become a recreational facility in addition to the river. (Width, however, takes no account of depth, so a minimum cross sectional quantity of water or year-round average flow would be a better criterion.) The smaller size of the stream, together with the intended use, would not need to involve as much land as the one chain strip. A total of one chain might be reserved. This land could be apportioned equally on both sides of the river, or varied, generally in a ratio of two to one, with the greater portion on the side which includes the track. This criterion of a minimum size of stream would have to be considered in relation to access, possibly being extended to allow access from roads or

associated walkways. Planning of this would involve extensive landscape considerations but would be a valuable recreational asset and serve in the preservation of natural elements within the cultural landscape.

There has never been any requirement for the provision of access through private land to public land or to lakes and rivers except by way of road or railway. Access along the banks of rivers and lakes is insufficient. Provision must also be made for adequate tracts of land providing public right of way to enable public use of the reserved land.

The preservation of the land in this way would meet recreational requirements and could also be used in the preservation of wildlife habitats and plant associations.

Natural vegetation at the side of streams could utilize a lot of agricultural wastes at present entering rivers, function in flood prevention and also in erosion control.

vii. OBJECTIVES FOR PLANNING WITHIN THE RIVER LANDSCAPE:

It is clear that the value of the riverside to large numbers of people comes from its therapeutic qualities as a recreational and visual amenity. This value is sufficient to justify its protection in planning for the future. Development schemes should assign real value to environmental criteria as well as consider financial implications.

The objectives involved and approaches taken in planning for the future must co-operate with natural processes if nature is to coexist in harmony with mankind.

The two basic approaches which provide this harmony are:-

(1) Ecology as a basis for design, and

(2) McHarg's approach - using ecological principles without emphasis on design, or nature, but rather, the proposition "design with nature."(13)

Using either of these approaches, the emerging design is dictated by the natural limitations of the site, giving it a close sympathy with the environment. Preconceptions of zoning and uniformity of development, which ignore ecological criteria, are thus avoided.

The key to McHarg's approach lies in the recognition of identity areas. Plans developing from these considerations owe their origins to the land, the use made of it, and its existing characteristics.(14)

The approach which will give the greatest social benefit for the least social cost should be sought in planning. In this way development is manipulated in the interests of the majority. We should not become the victims of our own technology.

The answer to the problem of enabling people to enjoy their leisure without harm to the rural dweller is the use of a long-term policy which provides a balance between development for public use, the preservation of natural values, and the needs and activities of those who work in the area.(15)

The British have a system of classifying certain landscapes as "Areas of Outstanding National Beauty." Land thus classified remains in private ownership,

and is used as usual, but restrictions are placed on the development of the area so that its character is preserved in perpetuity.

In all cases of development the preservation of public amenity and of high quality environments should have top priority.(16)

The river can act as the centre of focus and be the source of identity to the community. To maximize this effect, the entrance should be pleasing and free from evidence of neglect and decay. Open space should be used to create a green linkage system including and extending beyond the river corridor.

To conserve open space a firm planning and regulatory scheme is a means to control development and protect valuable areas of spatial freedom.(17)

In planning for the river landscape our objectives should be -

1. To minimize the loss of irreplaceable natural resources - e.g. natural riverside, marshes, wildlife habitats, springs.
2. To prevent degradation of water, air and the landscape.
3. To recycle used resources restored to the maximum degree of quality possible.
4. To maximise the compactness of human settlements, work areas, and urban infrastructures and to develop them in close harmony with the natural environment.(18)

Our aim should include the creation of a riverscape both within and beyond the urban fabric which has a distinct and identifiable national character.

Approaches to take:-

Since it is infinitely desirable that planning should be influenced by natural processes and ecological considerations, some guides to development within the river corridor are:-

(1) That flood plains inundated by fifty-year floods should be exempted from all development save agriculture and open space for recreation.

(2) That surface water courses should be retained in an ecologically stable state to a width of not less than two hundred feet on each side of the stream. In general, they should not be cultivated.

(3) That dam sites and their impoundment areas should be prohibited to development as they are potential water resources and recreation areas, and function in artificial recharge of acquifers.

(4) That all forests, woodlands and outstanding trees should be surveyed and subjected to preservation regulations.(19)

Other factors which should be considered in development within the river valley may be independent of, or indirectly related to, ecological aspects.

These include:-

a. Existing and possible public and private open space and recreational facilities, both on the land and on the river.
b. Roads, existing and possible, car parks and view points.
c. Tree planting and the use of mature trees.
d. Advertisements.
e. Improvements to the appearance of existing industrial and residential buildings, standing equipment and premises with reference to repainting schemes.
f. The illumination of the area at night (where appropriate).
g. Places where minimum work and expense would give immediate improvement.
h. The costs of the schemes.
i. A programme of priorities.(20)

Advances in road building technology also promise increased riverside protection. Deep-bore tunnelling makes it possible to excavate subterranean road and transit tunnels without disturbing used land or natural areas at the surface.(21)

In planning for recreational use of the river and riverside, the use-requirements should be considered. These should cover visitor types and their

requirements. Visitor type is related to the life situation and age of the visitor.(22)

Where problems of access limit use of a recreational resource, negotiations should be made for rights of way which might put the land owner in a better position than he is at present. A strict code of rules should be enforced to ensure the privilege is not abused.(23)

CONCLUSION:

The use of ecological principles in planning, combined with both the protection of the riverside from non-essential uses and consideration of aesthetic and environmental criteria, provides the means of ensuring that the riverside continues to function as a viable resource, enriching the quality of life for the inhabitants whose lives are affected by the river.

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I. THE SITE: THE STYX

BRIEF:

A study of the Styx River as a continuous landscape element.

The carrying out of a thorough survey of the river and adjacent area. The survey is to cover environmental factors of geology, soils, relief and climate, visual aspects of land use, emergent features, ecology, zoning, roading, landscape character, access and availability of the river to the public, present uses of the river and present problems associated with the river.

This information is to be appraised to ascertain the value of the river and areas within it as potential recreational areas, and to evaluate the implications of present proposals concerning the river.

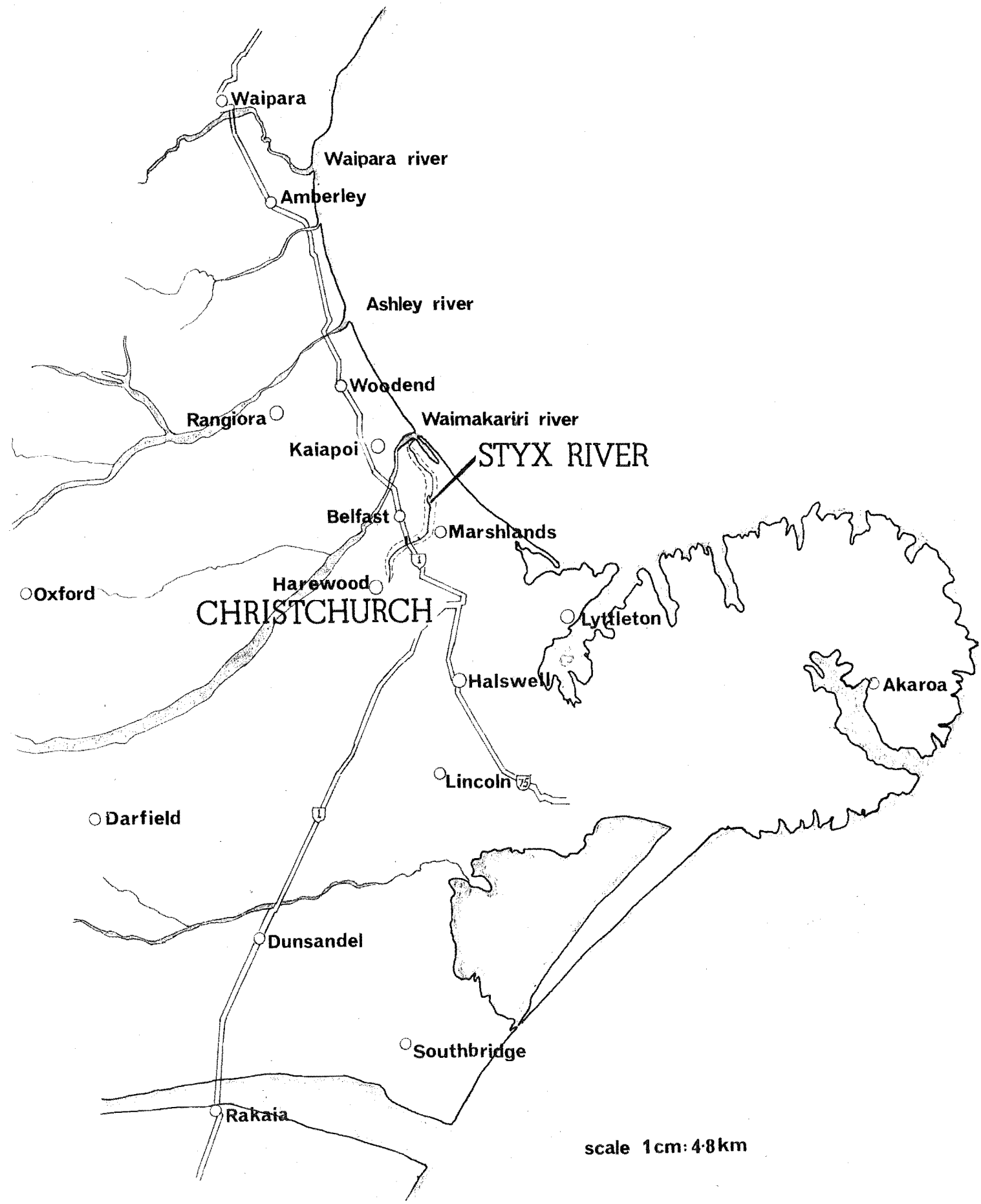
A study of recreational trends in Christchurch together with a brief survey of existing recreational areas and facilities. The equating of this information with that derived from the survey to locate suitable areas for recreation and to propose suitable recreational uses for the land.

The development of a concept to provide guides for future development of the area associated with the river, to prevent environmental degradation through inappropriate usage, and to maximize the potential of the river corridor while considering the problems associated with development proposals.

Proposals for the development of a selected area associated with the riverside for recreational uses, these recreational uses to be appropriate to the location of the area.

LOCATION:

The Styx River is situated close to the northern city limits of Christchurch. The head of the catchment lies between Christchurch Airport and Harewood Road. The river runs roughly parallel to the Waimakariri River until about $1\frac{1}{2}$ km from the coast, where it turns and runs parallel to the coast. It enters the Waimakariri River via a tidal lagoon kept open to the sea by the Waimakariri River.


Waipara
Waipara river
Amberley
Ashley river
Woodend
Rangiora
Waimakariri river
Kaiapoi
STYX RIVER
Belfast
Marshlands
Oxford
Harewood
CHRISTCHURCH
Lyttleton
Akaroa
Halswell
Lincoln
75
Darfield
Dunsandel
Southbridge
Rakaia
scale 1cm: 4·8km

GENERAL DESCRIPTION:

The Styx River has a total length of well defined channel of 21½ km (13½ miles), 15½ km of which lies below the Main North Road. The river is spring-fed and maintains a relatively constant flow, although its upper limits periodically dries up.

The upper reaches are narrow with steep banks, and run through built-up areas and orchards. About half-way between the Main North Road and Sawyers Arms Road the river enters a wide valley. This distinct and separate valley ceases to exist by the time the river reaches the Radcliff Road bridge. From there on the river flows within the broad lowland landscape, sometimes only 1½ metres below the general landform.

The middle reaches of the river are characterised by fast, turbulent flows and stony substrata. At locations further downstream, its flow is slower and the river is silted.

The land within the catchment is zoned mainly rural, with some residential zoning in the lower reaches. This incorporates the communities of Spencerville and Brooklands.

The predominant tree species along the river is willow. This emphasizes the natural pattern of the river's course and provides spatial definition to the landscape.

SURVEY

1. HISTORY

When the first Maoris came, the Peninsula Hills were clothed in almost impenetrable forest. On the plains, the land was covered with tussock, fern, flax and toetoe, cabbage trees and occasional raupo swamps intersected by winding streams.

Patches of bush, relics of former large forests, grew at Riccarton and Papanui, and further afield at Kaiapoi, Rangiora and Woodend.

The first inhabitants, the Morioris, were almost exterminated with the settlement of Canterbury by Maoris. The remainder fled to the Chatham Islands.

The Maori population became divided into independent commmunities, and tribal wars were frequent.

Towards the end of the 17th century the Ngai-Tahu tribe, coming from Wellington Harbour, took possession of Canterbury and spread over much of the east coast.

A little north of today's Kaiapoi, a Ngai-Tahu chief founded the famous Kaiapohia pa. This was well defended naturally, and with supplementary fortifications was considered impregnable.

At the beginning of the 18th century the Ngai-Tahu had amassed great wealth in greenstone. At about this time the notorious Ngati-Toa chief, Te Rauparaha, fought his way down from Taranaki to the northern shores of Cook Strait and set up his headquarters on Kapiti Island. In 1828 he conquered the northernmost Ngai-Tahu pa at Kaikoura and continued down to Kaiapohia where his uncle and a few of his representatives were mistrusted and slain. Te Rauparaha's desire for "utu" sanctioned retaliation upon the tribe.

In 1830, with the help of an English trading ship manned by an unscrupulous captain, he captured a powerful Ngai-Tahu chief and others, then attacked the Ngai-Tahu. In 1831, with a strong force, he successfully conquered the Kaiapohia pa, taking its great wealth and slaves. The once flourishing Kaiapohia inhabitants were reduced to about a dozen.

At the close of the first quarter of the 19th century there had been at

Kaiapohia, on Banks Peninsula, and in lesser numbers scattered down the coast of Canterbury, thousands of Maoris living in peace and plenty. Ten years later there remained but a handful.

Te Rauparaha's son, Tamihana, was strongly affected by the teachings of the New Testament. He released his Ngai-Tahu slaves and lived for a time amidst those repatriated.

Christianity had brought amity to warring tribes, and the Canterbury Pilgrims met a welcome from the Maori and were able to settle peacefully.[1.]

The European settlement began about 1850 in Canterbury. Its spread was northwards at first because the forested areas at Kaiapoi, Rangiora and Oxford provided timber and fuel.

Many settlers bought land in the expectation that a canal would ultimately be cut through the Estuary to the Avon River. Canals were to be cut from the Avon Estuary to the Styx, and from the Heathcote to the Halswell river. This caused the early settlement of some areas, including Marshlands Road as far as the Styx river, where Polish immigrants later settled.[2]

As part of the canal concept, a 15-ft strip of land was kept aside for a tow path for horses pulling boats. This extended up to Marshlands Road.

Development in agriculture was paralleled by development in industry. The Styx Flour Mill was owned by William Moir and Company (Millers and Grain Merchants) It was situated a little upstream of the Main North Road and its concrete floor, visible from the present road bridge, forms part of the base of cow sheds today. Its water wheel and associated grain store (over the road) are remembered by some people. It was in operation by the 1870's.[3]

Other early industry in the area included the Styx Apple Company, the Styx Meat Preserving, Tallow and Soap Factory,[4] which was sited on the line of the Northern railway, midway between the Station at the Styx and the siding at Chainey's corner, and a manure works near the site of the Styx railway station.

Origin of the Name "Styx"

The Styx river is not so named on any of the old maps. On these, it

Site of former Styx mill, now proposed recreation area of Waimairi County. Identity Area 3.

invariably bears its native name, Purareka-nui.

The river, owing to its undermined banks and deep stream, was always dangerous to cross, even at the ford on the North Road. To make it safer, a tree was put across near the ford, cut from the Papanui bush. A line of flax sticks was thrust into the ground to serve as a guide to the improvised bridge, and hence people crossed the "Pura-kanui" (as the settlers called it) at "the sticks." Even when the well beaten track made the guiding line unnecessary, it was still referred to as "the sticks", the name thus being transferred from the guiding line to the crossing itself, and then to the river. It is hard to say when the change occurred in the spelling of the name, since it occurred in people's minds.

The origin from "the sticks" is however undoubted, although it has been suggested that the dark deep stream reminded crossers of the classical river Styx.[5]

History of River Control

In 1875 the Drainage Board was formed in response to the threat of typhoid. With the formation of a central body it was possible to utilize a scheme from the Heathcote River to the Styx, and from the sea to upper Riccarton.

Little is known about the construction of the stop-banking system, long existent, along the eastern bank of the river between the present flood gates and Earlham Road. This lower Styx area did not come under the Drainage Board's control until 1952. The stop-banking was built when the river was completely tidal, probably by early property owners before the present urban sections along Lower Styx Road were subdivided.

The existing floodgates were constructed about 1930 by the Waimakariri River Trust as part of its stop-banking scheme for the lower Waimakariri River. Its purpose was to exclude the waters of the flooded Waimakariri River, while allowing the Styx River to pass through when the Waimakariri was not in flood. The gates also benefited the Lower Styx district in their action as tidal gates, excluding tidal waters from entering the river on the rising tide, and also enabling drains to function to better effect.

In 1946 proposals were made to construct a channel thirty feet wide and

four feet deep, cleared of willows for fifty feet and designed to take normal flows. Stop banks were envisaged 150 feet apart and four feet high to take flood flows of 1000 cusecs. The scheme was to extend as far as Marshland Road bridge.

In 1950 a less elaborate scheme was envisaged. It consisted of a channel similar in size to the 1946 scheme, but stop-banking was only to be done in a half-mile section near the Pines Plantation, where a three-foot stop bank above normal water level was required to protect a low portion of Lower Styx Road. Other spoil removed from the bed and sides was to be deposited clear of the banks. This work was completed in 1952.

These improvements were envisaged as facilitating outflow of floodwaters, but were not expected to prevent flooding. Provision of an adequate flood channel with stop-banks would be necessary to prevent this.

In 1952, with the complete Styx catchment under the Board's control, an extensive dredging programme of widening and deepening the channel was carried out. This provided extra storage for normal flows, and is responsible for the river's normal flow level below its banks.[6]

The Present Situation: (current events)

Flooding: Flooding in early winter of 1968 on both sides of the lower reaches of the Styx river revealed serious weaknesses in the existing low stop-banks. Residents in affected areas attributed flooding to increased urbanization of the upper catchment. An investigation has recently been made and proposals formulated to enable the river to cope with present and future design flood flows.

The Waimairi County Council, concerned about the flooding, sought guidance in its development of land for urban usage. A report was supplied, including suggestions for continued urban land development, and advice was given to the Council that the Drainage Board make an investigation of possible work in the Lower Styx before giving the technical advice requested.

A flood protection scheme has been planned for the 600 acres of land in the lower reaches of the river. The flood, for which a design has been made, occurs at a frequency of once in fifty years. Widening of the existing cleared section

of the river by the clearance of willows to specified widths above the flood protection region is recommended. This is to lower flood levels and thus benefit drains and tributaries above the main flood protection area. Clearance is proposed to within half a mile of the railway line.

The scheme involves:-

(1) The provision of stop-banks where necessary over a $3\frac{1}{2}$ mile length of river above the flood gates.

(2) The provision of a cleared fairway in the river from the floodgates to within a half mile of the railway line.

(3) The provision of channel enlargement over a $2\frac{3}{4}$ mile length of river above the flood gates.

An assessment of economic value gained from the development of the flood protection scheme shows its inception to be uneconomic at present. Subsidies could possibly become available in the future if there is a change in land usage.[7]

Housing: The Styx riverside has been the location of indiscriminate housing. Whilst some of this is associated with farming, some is purely of a recreational nature. The introduction of housing diminishes the recreation potential of the river as a civic asset, and exposes it to the risk of becoming another Avon - a landscape of lost opportunity.

Housing close to the river is inappropriate in the lower flood-prone areas, is incompatible with some of the other uses of the river, such as duck shooting, and is responsible for the erosion of visual values in the landscape. Some of this housing, as in Hawkins Road and Selkirk Place, has been allowed to develop in areas zoned rural.

The willows along the river system provide major spatial definition and separate identities. Their removal without landscape considerations will be detrimental to the quality of the landscape.

Recreation: As a response to recreational pressures at the nearby Waimakariri "Groynes" Park, two recreation areas are proposed for development on land adjoining the Styx river and near to the Groynes. Their inception will soon take place.

Motorway proposals: Although perhaps twenty years away, proposals have been made for the development of a new Northern motorway which will cross the Styx river about half a mile downstream of the railway viaduct. Development of this will be deferred until the present main road is unable to accommodate the traffic using it.

Existing flood banks. Saline marsh area below floodgates.
View towards Waimakariri river mouth.

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Super
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E N V I R O N M E N T A L F A C T O R S

GEOLOGY

General:

The Canterbury Plain is a complex landform, its surface varying in age from place to place. A large part of the piedmont gravel apron which forms the Canterbury Plain is made up of glacial outwash gravel. The coastal plain is underlain by deposits of peat and fossiliferous marine or estuarine silts, interspersed with sands and gravels. These deposits accumulated during the main post-glacial period of rising sea level.

The Christchurch artesian area covers an area fifty miles long by ten miles wide. The water is drawn from permeable gravel beds, interstratified with impermeable silts. The artesian effect is due to the rise in level of these strata inland.[1]

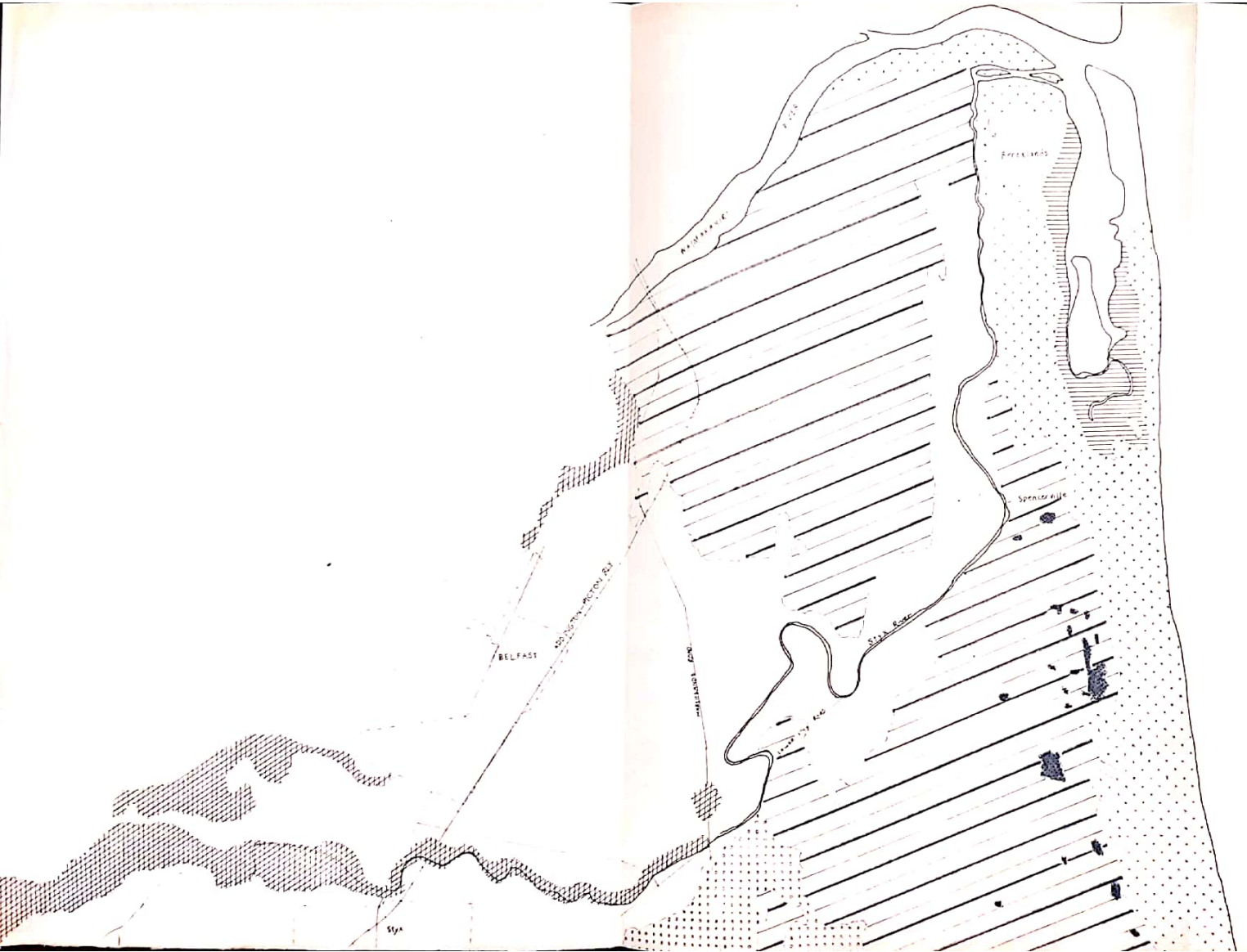
Greywacke and metamorphic rocks predominate in the mountain area, and erosion debris forms the parent material of the soils of the plains.(2)

History

In the Early Cretaceous period of geological history, the mountain ranges developed as a result of compression and uplift of sediments. This relief was slowly eroded, becoming reduced to an undulating "peneplain" which extended throughout Canterbury and far beyond. This was subsequently covered by sea.

In the Early Pleistocene period, crustal movements and elevation accelerated withdrawal of the sea. This period was followed by one of great oscillations in the climate. During cold phases glacial erosion and frosts accelerated movement of soil and rock debris. During warm interglacial periods, streams carved terraces, and the rise in sea level formed raised beaches and cliffs. Wind blown loess silts accumulated during glacial episodes.[3]

Fig (1) shows the geology of the area. This is largely uniform, consisting of river gravel, sand and silt, and swamp deposits, some overlain by dune sand.



GEOLOGICAL RESOURCES

Scale 1 31,680 (1" to 40 ch) **Fig. 1**

Lagoon mud
mud and sand flats of tidal lagoon at mouth of Waimakariri River

Sand beach, dune sand and sand
sand beach and active sand dunes, fixed dunes and sand.

Peat and fine silt
interdune swamp small swamps formed in poorly drained hollows between fixed dunes In some ares sand covers these swamps.

Sand dunes and sand
older dunes and sand deposits inland from the coast and generally fixed by vegetation.

Peat swamps
low lying swamp areas most of which have been drained.

Alluvium
flood plain alluvium. Alluvium deposited by flooding of rivers.

Gravel
recent gravel channels. Gravel and sandy gravel in river channels and former river channels.

General - Soils

The Plains consist of a series of broad fans, terraces and flood plains with flat to gently undulating surfaces which have been built up by the major rivers. Smaller rivers and streams occupy the interfan depressions. The lower parts of the fan surfaces consist of thin sediments, gravels, stones and fine alluvium. Their accumulation was accompanied by accumulation of loess.

Near the rivers the loess mantle is thick and the sediments are fairly coarse. Further away the loess is thinner and the textures are finer.

The soils formed in this way show little mineralogical diversity. This is because the primary source of most of the loess and alluvium is the schist/greywacke complex of the Southern Alps and their eastern extensions.

Minerals derived from the greywacke/schist complex are resistant to weathering, and the rocks are indurated, causing the detritus supplied to the drainage systems to be coarse, and the alluvium to be predominantly stony and gravelly. The soils of the plains are predominantly coarse with low clay content.[4]

Silt loams and sandy loams are fine-textured soils of alluvial origin. Clay loams are only found in the subsoils of soils formed on loess.

Alluvial influences in association with loess accumulation have been dominant factors in the development of the soils of the plains. In the lower reaches of rivers and streams, swamp hollows and lagoons have been filled in by alluvial deposition.

Soils within the Styx region have been affected by a further factor resulting from the coastal location.

The coastal influences involve:

(1) The encroachment by sand,

(2) Saline effects on areas influenced by tides.

(1) Sand dunes form a continuous coastal belt, two to three miles wide, extending northwards from Banks Peninsula to the Kowhai River. They are associated with sand plains and swampy hollows.[5]

The sand dunes have encroached on to peat swamps in the Marshland district, and on to saline mud flats near Kaiapoi. The sand belt is increasing in width.

(2) Saline flats border the tidal reaches of the estuaries and river valleys. Seepage and seasonally high brackish water tables on tidal flats and flats on tidal reaches of river have maintained the salinity of these soils and made them problem areas for land development.

The presence of the floodgates precludes tidal influences to much of the lower Styx area and over the time of their operation will have enabled the dispersion of salts from soils previously exposed to saline influences.

The area below the floodgates shows marked coastal characteristics.

Strongly saline areas are unsuitable for agriculture, allowing grazing only when the water table permits. These soils can be improved under a comprehensive drainage scheme. They are deficient in phosphate and, to a lesser extent, lime.

Comments on Soils of the Styx River Catchment

Soils are recent in origin and consist of mainly sand and silt loams and some peaty loams. They are derived from greywacke alluvium and varying amounts of fine sandy loess and dune sand. This includes the Taitapu, Motukarara, Waimakariri and Kaiapoi soils. The Waimairi peaty loam is derived from peat.

The soils fall into sub groups related to their origin and distribution. These are -

1. Soils of the Waimakariri Fan
2. Soils of the lowland and drained swampland
3. Soils of the coastal sand dunes.

Soils of the upper area on the airport side of Gardners Road, are predominantly those of the Waimakariri fan. The lowland and drained swampland soils occur slightly nearer the coast with intrusions stretching inland up the river valleys. Their occurrence is integrated with soils of the Waimakariri fans in the area between the Main North Road and Gardners Road, but they become the dominant soils from about half a mile above the Main North Road until the coastal sand dunes soils become dominant. These soils occur on the coastal side of the river in its lower reaches, from Hawkins Road to the river mouth.

Description of Soils within River Corridor

Waimakariri series:

9C Waimakariri sandy loam - commonly occurs between former and existing river courses. Very free draining, friable and easily worked. Coarser textured soils have formed on the sand dunes which flank the overflow channels of the Waimakariri river, and where the dunes have been breached by cultivation, wind erosion has occurred.

9c 2 Waimakariri shallow sandy loam - rests on loose gravel at 18" down. Through drainage is rapid and soils dry out badly in summer. These soils are associated in many places with Waimakariri sandy loam. Variable texture, mainly stony.

9e Waimakariri silt loam - occurs most extensively in the lower reaches of rivers where stream velocity decreases. Medium draining, highly fertile and well suited for agricultural use.

Profile description

Waimakariri sandy loam

Horizon		
A	10 in	dark greyish brown fine sandy loam; friable; weakly developed coarse nutty structure with many medium and fine cast granules; many roots; diffuse boundary.
BC	18 in	olive brown fine sandy loam; very friable; weakly developed coarse blocky structure with fine cast granular structure in places; few roots; sharp boundary.
C_2		on loose greywacke stony alluvium.

Kaiapoi series:

13e Kaiapoi silt loam - A slower draining soil than Waimakariri silt loam, but of similar nutrient status.

13d Kaiapoi fine sandy loam - Widely distributed, occurs on narrow levees running through the coastal swamps adjacent to Taitapu soils. Free draining. With drainage of adjacent swamps and lowering of the water table, can be used for winter grazing and cultivation can be earlier. Favourable mineral nutrient status.

Profile description

13e Kaiapoi silt loam

A 8 in very dark greyish brown silt loam; friable; moderately developed medium and fine granular structure; many roots; distinct boundary.

BC 16 in pale yellowish brown fine sandy loam; very many distinct medium and fine strong brown mottles. Firm; massive; many worm casts; indistinct boundary.

C on pale olive grey loamy fine sand; few diffuse yellow stains; friable; massive; very few roots.

Taitapu series:

Gley recent soils.

14e Taitapu silt loam - coarse textured subsoils where occur in borders of streams. Good moisture retention. Higher CEC percentage base saturation and organic C than Kaiapoi soils. Located in former swamps, today water table lowered by drainage. Thin topsoils, massive subsoils are slow draining and poorly aerated.

Profile description

A1 7 in Very dark brown silt loam with reddish brown flecking and staining along root channels; firm to friable; mod. developed fine granular and some medium nutty structures; distinct boundary.

Cg 13 in grey silt loam with faint diffuse reddish yellow mottling; distinct root channels grey in colour. Moderately developed coarse blocky breaking to fine blocks; indistinct boundary.

GC 18 in grey silt loam with contrasting greenish grey in vertical veins and diffuse instant reddish-yellow mottling in matrix; weakly developed coarse blocky structure; horizon saturated below 29 in; distinct boundary.

A on dark brown peaty silt loam.

Waimairi series:

16g Waimairi peaty loam; rests on silt loam or clay loam at depth of 6 to 9 inches. Slow draining. Where horizon of peaty loam is less than 6 inches deep, soils are classed as peaty phases of Taitapu or Temuka soils.

Where water table has been lowered, the peat has shrunken and consolidated. Where cultivated, it has oxidized. Topsoils are very friable, mellow, and of good nutrient status. Good for market gardening and intensive cropping when drained.

Motukarara series

Saline gley recent soils

Motukarara soils can be reclaimed where drainage is possible, but salt must be leached out before good plant growth is possible. Drainage must prevent upward movement of saline ground water through porous subsoils liable to flooding from streams and high tides. Stop banks are needed.

Widely distributed on low lying, poorly-drained sites near estuaries and saltwater lagoons. During droughts salinity increases as result of capillary action. Salts are leached in heavy rain. Can take limited grazing in summer.

19e Motukarara silt loam - no data published (September 1974).

Waikuku Complex

These occur in well defined, discontinuous strips north of Christchurch. Soils are comparatively stable, support fair pastures. About 10% of the complex consists of narrow tongues of Tatiapu, Waimakariri and Kaiapoi soils formed on alluvium deposited by streams winding through sand dunes. These soils drain rapidly but do not dry out as rapidly as related soils. If cultivated, they erode quickly and may require stabilization with marram grass.

21b Waikuku loamy sand.
21bE Waikuku loamy sand, eroded phase

No available data (September 1974)

The soil map is a very recent one and distinguishes certain soils previously included with other groups. Data on these is not published at present, but these soils are limited in their occurrence. The general classification given on the soils map gives an indication of their properties and of similar soils.

Should the site chosen for more detailed study involve these soils, I shall seek further information.

They are:-

Soils of the Waimakariri fan	(9d Waimakariri fine sandy loam (10bs Selwyn loamy sand, stony phase.
Soils of the lowland and drained swamp land	17cz Te Kakahi sandy loam, very shallow phase.
Soils of the coastal sand dunes	- 20a Kawaki sand

6

SOILS CLASSIFICATION

Soils of the Waimakariri Fan

Fig. 2

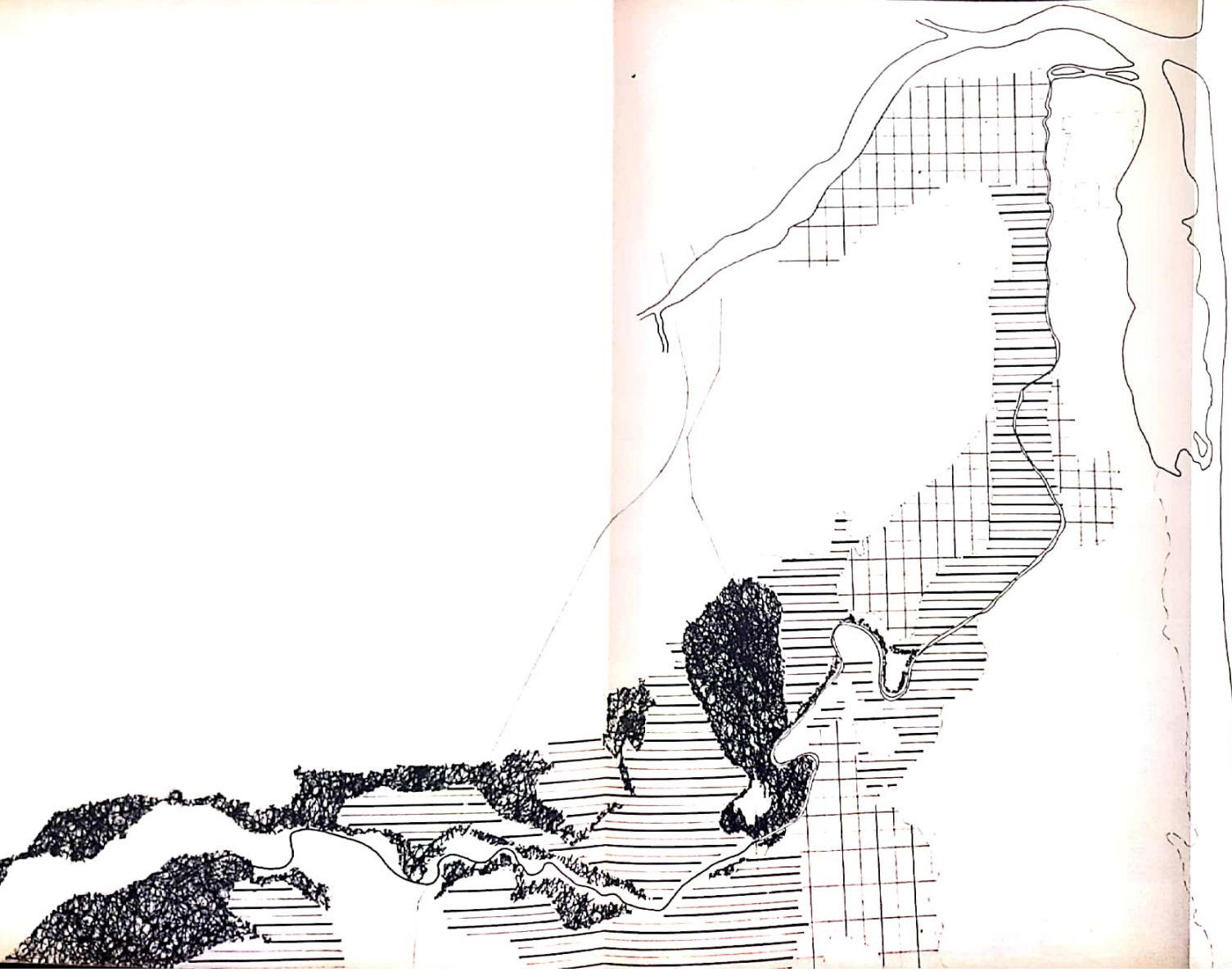
- Waimakariri silt loam — 9e
- Waimakariri fine sandy loam — 9d
- Waimakariri sandy loam — 9c
- Waimakariri sandy loam very shallow phase — 9c2
- Selwyn sandy loam very shallow phase — 5
- Selwyn loamy sand, stony phase — 10bs

Soils of the Lowland & drained Swamp land

- Kaiapoi silt loam — 13e
- Kaiapoi fine sandy loam — 13d
- Kaiapoi fine sandy loam, shallow phase — 13c
- Taitapu silt loam — 16e
- Taitapu fine sandy loam — 16d
- Waimairi peaty loam — 16g
- Te Kakahi sandy loam very shallow phase — 15e
- Aranui loamy sand — 19
- Motukarara silt loam — 19e

Soils of the Coastal Sand Dunes

- Kairaki sand — 20a
- Waikuku loamy sand — 21b
- Waikuku loamy sand, eroded phase — 21bE



SOIL LIMITATIONS TO USE

Fig. 3

Class 1 Soil of flat land with minimal limitations to pastoral use

1A Limitations of nutrients

- 9e Waimakariri silt loam
- 9d Waimakariri fine sandy loam
- 9c Waimakariri sandy loam

1B Limitations of drainage and nutrients

- 13e Kaiapoi silt loam
- 13d Kaiapoi fine sandy loam
- 2b Kaiapoi fine sandy loam, shallow phase
- 14e Taitapu silt loam
- 3a Taitapu fine sandy loam
- 16g Waimairi peaty loam

Class 2 Soils of flat land with moderate soil limitations to pastoral use

2A Limitations of insufficient moisture and to a lesser extent, nutrients

- 19e Motukarara silt loam (weakly to moderately saline)
- 21b Waikuku loamy sand
- 6 Aranui loamy sand

Class 3 Soils of flat land with severe soil limitations to pastoral use

3E Limitations of frequent dryness

- 9cz Waimakariri sand loam, very shallow phase
- 5 Selwyn sandy loam, very shallow phase
- 10os Selwyn loamy sand, stony phase
- 17cz Te Kakahi sandy loam very shallow phase
- 21bE Waikuku loamy sand, eroded phase
- 20a Kairaki sand

Relief

The land through which the Styx river flows is part of the ancient peneplain of Canterbury. Because this has a very gentle gradient, the river begins at a low altitude, its source being only about eight miles from the coast.

The topographical map for Kaiapoi gives the hundred-foot contour and spot elevations below it. Interpolating from the available contour heights, the river begins at an elevation of about eighty-eight feet a.s.l. The elevation of the land near to the Main North Road is thirty-five feet, the river about eight feet below this. This means that the greater fall in altitude occurs in the upper section of the river, and hence its flow is faster there.[7]

The river flows through a distinct basin from below Sawyers Arms Road until it reaches the housing cluster at Selkirk Place. Thereafter, there is no longer a distinctly separate valley containing the river which now becomes part of the general landscape.

The upper limits flow through a consistently flat area. The middle section, associated with the basin is planal, gently sloping, with some minor topographical undulations in the fringe areas, the topography within the basin being varied and interesting. In the lower area the topography varies according to the dominant influence - sand dune or floodplain. Sand dunes become quite conspicuous from Marshlands Road towards the sea, their presence being mainly on the coastal side of the river.

CLIMATE Regional

G
110-125 The area falls into the geographical region classified as Eastern South Island. Climatic characteristics of this region are:-

1. A generally homogeneous climatic unit.
2. Antartic influences are particularly marked in the area from time to time.
3. Easterly influences are the dominating ones, being expressed particularly in a high variability of rainfall, and relatively large mean annual ranges of temperature.[8]

The mean annual rainfall is about 75cm. This low value is due to the prevalence of weaterly winds, which deluge Westland and the mountains but are dry over the eastern lowlands. The Southern Alps also cause the Canterbury "North-wester". This wind is hot and dry. It generally reaches to within 20 miles of the east coast, where there is likely to be a cooler north-east wind curving in towards the region. The north-wester passes over it, towards the sea.

The north-wester brings occasionally very high temperatures and is responsible for low humidities. It is commonly followed by cold air of a front causing large diurnal ranges of temperature.

Cold fronts pass over quickly, and are the source of the greater part of the region's precipitation, especially if they are followed by southerly or easterly winds. Flooding from these is almost an annual event.

This results in a high mean annual variability of rainfall, and a low average number of wet days. The mean annual variability of rainfall is higher near the coast - 16% c.f. 12% at foot of hills.

Rainfall is not intensified orographically.

Winter is cold with a rainfall minimum.

Coldness is partly due to latitude, to the occasional invasion of subantarctic air, and to draining of the frigid air from the mountains to the lowlands. The winter snowline is about 4000'.

The lack of local relief has two consequences on the region's climate.

(1) It makes the area cloudy for an eastern location, with a characteristic coastal cloud belt of about 20 miles width - the factors promoting cloudiness occur frequently and without much seasonal variation. The percentage possible sunshine is below the country's average.

(2) There is a corresponding lack of climatic diversity within the region.

The climate is distinctive in its variations from year to year. These are largely due to rainfall variations. Moisture deficiencies are common in many years.

Climatic types

Christchurch 1939-1953 (Garnier)	humid	moist subhumid	dry subhumid	mean annual pptn	mean annual % variability of r.f
	5 years	7 years	3 years	28.80"	17.3

So there is a high likelihood of varying types of climate in different years.

Weather records are shown for the period 1968 to 1972. Recording Stations at Christchurch airport and Rangiora are the closest to the site. Both sets of figures are relevant, since the river begins at about a mile from the Airport, and its mouth is about seven miles from Rangiora.

Winds:- Daytime sea breezes usually extend from the coast inland for twenty miles or more during settled summer weather. On the Canterbury coast there is a persistent sea breeze, so the most frequent winds come from this direction.

TABLE 1

CHRISTCHURCH AIRPORT

% frequency of surface wind directions

N	N.E	E	S.E	S	S.W	W	N.W	Calm	
8.3	17.6	11.6	0.4	9.7	19.7	11.1	6.0	15.6	1968
5.2	22.9	12.1	1.1	7.5	17.3	7.5	5.6	20.8	1969
5.3	20.8	13.4	1.4	7.7	19.2	7.5	5.2	19.5	1970
4.4	17.1	17.0	0.3	6.8	16.6	11.1	4.8	21.9	1971
7.4	15.6	10.4	0.8	8.5	15.9	13.7	5.7	22.0	1972
6.12	18.8	12.9	.8	8.04	17.74	10.18	5.46	19.96	means

RANGIORA

% frequency of surface wind directions

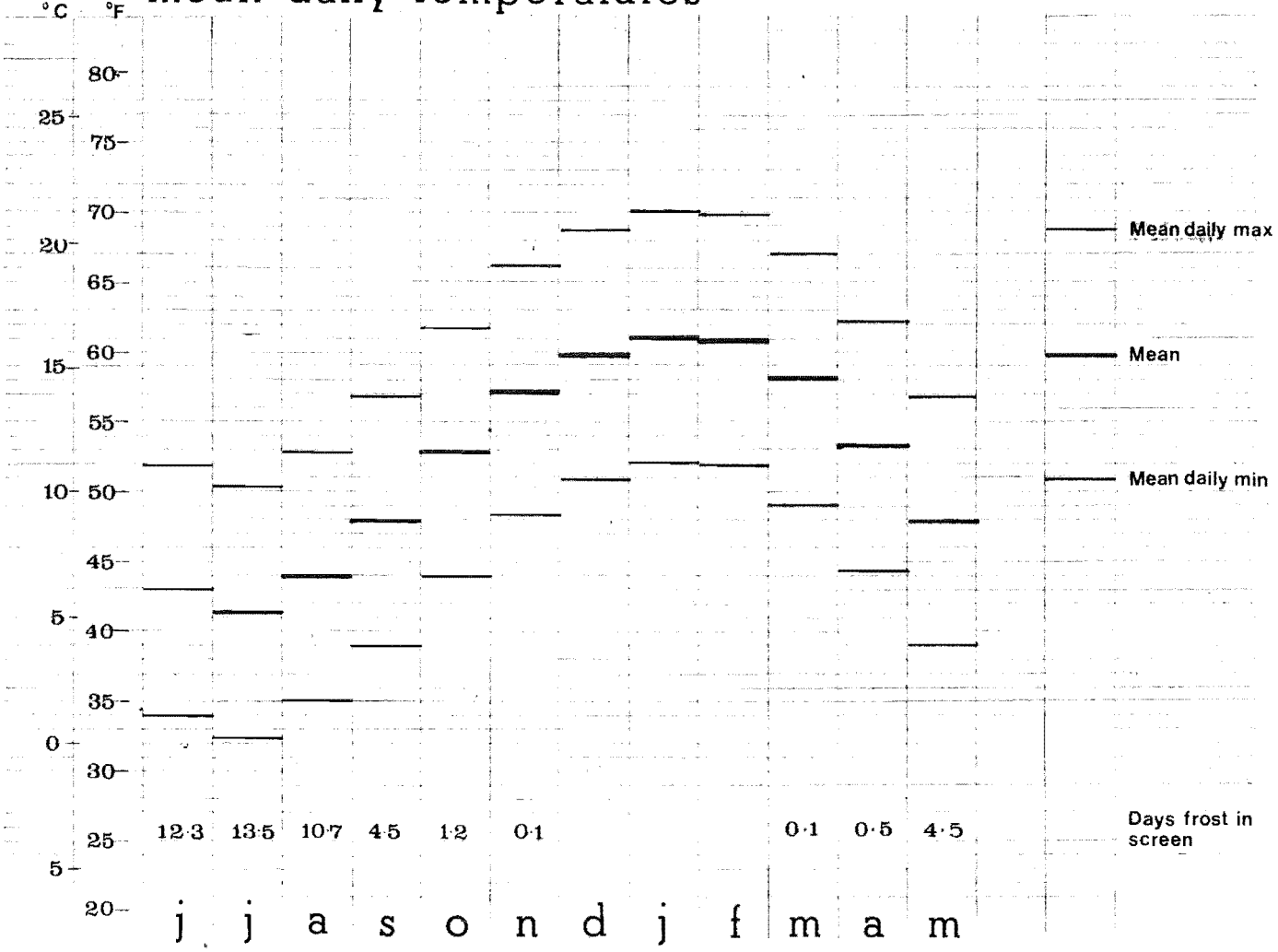
N	N.E	E	S.E	S	S.W	W	N.W	Calm	
3.4	6.8	25.2	1.9	0.5	21.9	13.4	20.6	6.3	1968
4.4	9.9	18.6	3.0	1.4	26.7	5.8	24.4	5.8	1969
3.4	12.2	16.7	4.7	0.8	22.3	9.2	28.2	2.5	1970
9.4	10.5	17.5	3.3	11.9	13.7	12.2	18.7	2.8	1971
4.9	6.3	18.9	0.8	11.8	17.8	26.6	10.7	2.2	1972
5.1	9.14	19.38	2.74	5.28	20.48	13.44	20.52	3.92	means

	Latitude	Longitude	Height above mean sea level
CHRISTCHURCH AIRPORT	43° 29' S.	172° 32' E.	30 metres
RANGIORA	43° 19' S.	172° 34' E.	46 metres [10]

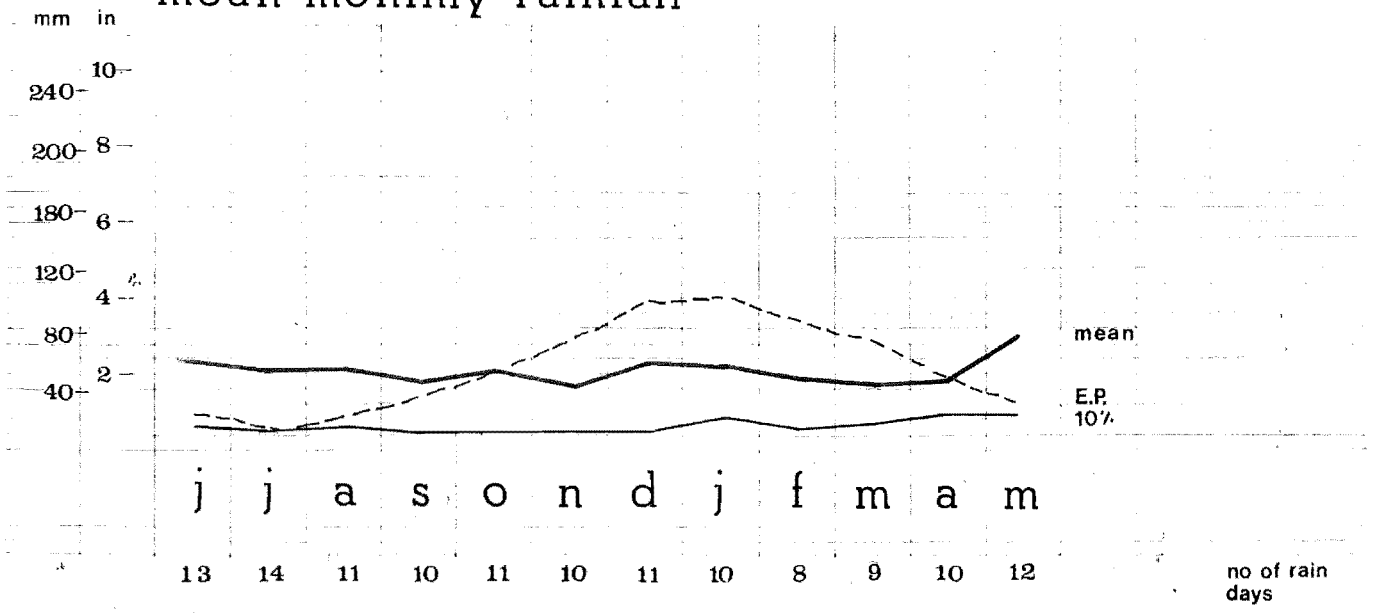
CHRISTCHURCH AIRPORT

Fig. 4

mean daily temperatures



mean monthly rainfall



The figures show that while there is some correlation between the two stations, the dominant winds differ for the two locations.

At Rangiora, the north-westerly, south-westerly and easterly winds occur at about equal frequency. The frequency of the other winds is significantly less. The westerly and north-easterly winds are quite important. Calm conditions are uncommon.

At Christchurch airport, the most frequent winds are the north-easterly and south-westerlies, while the frequency of calm days is higher than either of these. The easterly and westerly winds are quite common.

CHRISTCHURCH — Average number of days with gusts reaching -

Years of data	40 m.p.h. or more Nov-April	May-Oct	Total	60 m.p.h. or more Nov-April	May-Oct	Total
24	32	24	56	1.8	1.5	3.3

Thus there is a tendency for stronger winds in the summer period - a time when their occurrence is more harmful to plants.

The climatograph uses data collected from observations collected in New Zealand up to 1960. The mean temperatures for the warmest and coldest months are 16.3° and 5.3°C.

Annual averages	Mean daily max. Jan	July	Mean daily min. Jan	July	
	22.5	10.3	12	.8	(from Gerlach's climatogram)

The rainfall and potential evapotranspiration graph E.P.) indicates a moisture deficit between September and April. (However, the effect of this on plants is affected by soil moisture status.) (Fig.2)

The risk of drought is indicated by the graph of mean minimum rainfall occurring in 10% of the recorded observations (i.e. the average minimum reading derived from the minimum for 10-year periods - and therefore likely to occur once in ten years.) Comparing this graph with E.P. gives a more realistic picture of the likelihood of drought. (Again, this factor is a function of soil.)

TABLE 2

CHRISTCHURCH AIRPORT

	Bright sunshine hours	total annual r.f. mm	No of rain days	No of days snow or hail	Screen frosts
1968	2,120	726	111	7	38
1969	1,973	382	109	12	42
1970	1,847	589	120	3	31
1971	1,875	446	127	1	30
1972	2,166	551	124	5	39
Average	1,996.2	538.8	118.2	5.6	36

RANGIORA

1968	745	114	3	50
1969	372	101	5	60
1970	601	117	3	43
1971	524	120	2	16
1972	533	121	3	48
Average	555	114.6	3.2	43.4

10

Frosts:

The incidence of screen frosts is higher at Rangiora than at Christchurch airport. Although the Rangiora site is nearer the coast and windier, both factors reducing frost likelihood, the airport may be tempered by the proximity of large amounts of asphalt and the passage of air from over the city.

Snow and Hail:

These have been classed together. Neither occurs very frequently. Hail can be damaging to crops and its incidence may include the warmer months. Snow is rare and seldom lies.

There is no marked difference in the occurrence of snow or hail at either location. Records covering many years may establish some pattern in their incidence.

Table 2 shows a close correlation in volume of rainfall and occurrence at both Rangiora and Christchurch airport for the period 1968-1972.

Mean monthly and annual rainfall for the period 1921-1950 shows a fairly evenly distributed rainfall with a winter maximum. This is a departure from the winter rainfall minimum characteristic of the Eastern South Island region.

Mean monthly and annual rainfall (mm) 1921 - 1950

	Jan	Feb	Mar	Ap	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Christchurch Botanic Gardens	56	46	43	46	76	69	61	58	51	51	51	61	669

Relative Humidity - Commonly between 70% and 80% in coastal areas and about 10% lower inland. It varies inversely with temperature, so is high on fine nights. The diurnal variation in relative humidity is greater than the difference between summer and winter.

CHRISTCHURCH:

Humidity

January		July	
3 am	3pm	3am	3pm
87%	61%	89%	73%

Very low humidity may occur from the Föhn effect produced by north-westerly conditions.

Sunshine hours: A high proportion of the annual sunshine occurs in the winter months.

Percentage of possible sun

	Summer	Winter
CHRISTCHURCH	46	45

Table 2 shows the sunshine hours for Christchurch airport between 1968 and 1972. The average, 1,996, is very close to a figure for the period 1935-1960 of 1,990 hours.

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E C O L O G Y

VEGETATION:

At the time of European settlement the river and its catchment were clothed in short tussock grassland with flax, toetoe, nigger-heads, and some cabbage trees. This landscape had come into existence after the Polynesian settlement.

The vegetation of the landscape in pre-Polynesian times consisted of forest. Constituent species were podocarp, kanuka, broadleaf hardwoods and other trees.

During the Polynesian era the short tussock grasslands, flax, toetoe and native sward grasses became dominant with scattered patches of kanuka and kowhai.

The present vegetation shows limited evidence of its pre-European state. The predominance of introduced coniferous and broad-leaved trees, together with introduced grasses and herbs, has transformed the landscape to its present state.

The river corridor shows limited species diversity. Many of the species, although well adapted and prospering, have not colonized other areas. Free-seeding or self propagating species include silver poplar, willow, elderberry, blackberry, gorse, flax, toetoe, cabbage trees and nigger-heads. Some species of limited occurrence which are spreading naturally are European alder, silver birch, Coprosma. Common species which are apparently not proliferating are eucalyptus, black and Italian poplars, wattle (acacia dealbata), macrocarpa and radiata pine.

The three major divisions of the soils in the catchment are related to the distance from the coast. These divisions are reflected in the vegetation species successfully reproducing in the area. The vegetation of the soils of the Waimakariri fan and of the lowland and drained swampland are relatively similar, while those of the coastal sand dune soils have fewer species in common with the other soil groups.

The table shows the distribution of common species.

Table 3

	Soils		
	1 Waimakariri fan	2 lowland and drained swampland	3 Coastal sand dunes
Successfully reproducing species			
Trees			
Alnus glutinosa	—	—	—
Betula pendula	—	—	
Cordyline australis	—	—	
Hoheria populnea	—		
Populus alba		—	—
Salix discolor	—	—	—
Salix viminalis	—	—	
Salix fragilis	—	—	—
Shrubs, ferns and Herbs			
Blechnum capense		—	
Carex secta	—	—	
Convolvulus arvensis	—		
Cytisus scoparius	—	—	
Hedera helix	—		
Juncus pallidus		—	
Juncus maritimus			—
Lupinus arboreus			—
Lycium chinense		—	
Muehlenbeckia axillaris	—		
Phormium tenax	—	—	—
Plagianthus divaricatus			—
Rubus fruticosa	—	—	
Typha muelleri			—
Sambucus nigra	—	—	
Ulex europaeus	—	—	—
Vinca major	—		
Species not multiplying			
Cedrus deodara		—	
Cupressus macrocarpa	—	—	—
Eucalyptus	—	—	
Fraxinus excelsior	—		
Juglans regia	—		—
Pinus radiata	—	—	—
Platanus orientalis		—	
Populus nigra and nigra italica	—	—	
Salix alba var. vitellina	—	—	
Salix babylonica	—		

WILDLIFE:

The survey plan shows wildlife observed during the study of the river. Notable species were ducks, fantails, pukekos and quail.

No survey has been prepared on the wildlife or fish of the river by the Wildlife Division or Acclimatization Society, but fish expected to be present are fresh-water eel, whitebait, brown trout, with yellow eyed mullet and kawhai in the lower reaches.

The ecological habitats present are woodlands, swamps associated with former river courses, flood plains, the river valley itself, sand dunes and the saline salt marsh of the tidal area.

BIOLOGY:

The Styx and its tributary, Kaputone Creek, are probably the least polluted of the Waimakariri river system. The river was studied in 1972. This was carried out through a survey of the benthic invertebrates and a limited programme of chemical and physical sampling.

There are few effluent outfalls into the Styx River. Effluent enters from two milking sheds. Kaputone Creek receives household wastes and some percolation from a rubbish tip in the upper area. The middle and lower reaches receive domestic wastes from an industrial complex.

pH measurements showed the Styx River to be slightly alkaline.

Conductivity, a measure of dissolved ions, was generally low - lower in the Styx River than in Kaputone Creek.

Turbidity, indicating the amount of suspended and dissolved sediment, was low, with higher values in the lower reaches of the river. Although this is a measure of organic pollution, it is also affected by the flow rates.

Dissolved oxygen levels were high and relatively constant. The higher levels in the Styx River reflect the greater amount of weed growth than in Kaputone Creek.

Biochemical oxygen demand (B.O.D.) a measure of oxygen required for aerobic bacteria to decay organic matter (and hence an indication of organic pollution) was low. This classifies the river as very clean.

Salinity is negligible because of the effectiveness of the flood gates.

Species diversity of the benthic invertebrates was high, indicating a low measure of organic pollution.

Species diversity, together with relatively high oxygen demand and low B.O.D., shows the river to be generally unpolluted. The confluence of Kaputone Creek and the Styx River has a slight effect on the Styx River, but the water quality recovers quickly.(1)

Notes and References

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O T H E R F A C T O R S

ZONING:

The land is predominantly zoned rural. This is associated with farming and other uses which do not conflict with rural purpose. (Zoning is shown on Survey 2.)

The communities of Spencerville and Brooklands are zoned Residential A. This involves single family dwellings and up to two units per site. Brooklands falls within the area to be protected by the proposed floodbanks, and Spencerville is just beyond the floodable zone. This suggests their unwise siting. They are located on the unproductive coastal sand dune soils, so do not impinge on to agriculturally productive land.

Spencerville provides an interesting contrast with the rural area above it. This contrast is heightened by the compactness of Spencerville. In contrast, Brooklands extends in an undisciplined sprawl and shuts off the motorist from much of the rural area.

If the land above Spencerville, zoned "deferred urban", is developed, the experience of arrival at Spencerville will be reduced and the sense of a continual urban sprawl towards Christchurch will be created. This area owes its distinctive character to its rural setting. The character of the tow path and river, here accessible from the road, may be lost. This area is quiet and isolated and the most rural part of the river catchment.

Although the land has been zoned rural, areas in Hawkins Road and Selkirk Place have permitted recent housing development which creates a distinctively urban character and seems to violate the intended purpose of the zonation.

A large area of land above the Main North Road has been zoned for recreation. This use is favourable to protecting the riverside from urban decay.

The area at present under grass, adjacent to Styx Mill road and zoned Industrial C, is perhaps a conflict. Land adjacent to this is zoned Residential A, Rural and Recreational. Industrial C involves heavy industry other than

noxious industries. A graduation from Industrial to Commercial to Residential to Recreational and Rural would create a transition towards the countryside, minimise land use conflicts and have a logical land-use pattern.

LAND USE INVENTORY

Fig. 5

Primary Production

Intensive livestock	poultry, pigs, horse training	
Cropping	garden's fresh vegetables, small fruits, nurseries	
	orchards: pip fruits	
	cash cropping (grains pulses roots)	
Dairying	town milk supply	TM
Other farms	small grazing areas, minor farms, other categories	
Forestry	exotic	

Non Primary Production

Urban land	residential and industrial	
	recreational (golf courses, playing fields, domains)	
	functional (cemeteries, quarries, yards)	
Idle	scrubs, swamps, sand, unfarmed	

LAND USES:-

The map shows current land uses within the area. Land use is largely dependent on soil type. In the lower and middle area dairying is associated with the Taitapu silt loam. The sand dune soils on both sides of the more fertile land close to the river are used for winter dairying and forestry, while the land close to the sea and the Waimakariri is unfarmed.

Forestry provides stability to dunal soils and utilizes the soils of less value to agriculture.

In the Marshlands area market gardening and orchards utilize the Kaiapoi and Waimakariri silt loams and the Waimairi peaty loam. These soils are associated with minimal limitations to use. The upper limits are also associated with orchards and market gardening on the Selwyn loamy sand and Waimakariri fine sandy loam.

The existing recreation areas tend to be on the less productive soils. These are relatively passive recreation types in which use pressures are not excessive, e.g. Spencer Park includes a wildlife refuge in the Brooklands lagoon, and the coastal sand dune soils are popular for golf.

The present land uses are in keeping with their zoning and responsible for much of the character of the area.

ROADING:-

Survey 2 shows the extent to which the river is dissected by roading. This division is marked in such areas as the Main North Road. Here the absence of continuity in the vegetation, the marked change in topography and land use, emphasized by the bulkiness of the concrete bridge and roadside fencing, divorce the areas above and below the road.

Radcliff Road follows the river, but is well away from it until the river bends. The continuation of willows on either side of this bridge, together with similar land use and topography, prevent this road from dividing the landscape. Hawkins Road, however, serves as a boundary beyond which there is no naturally unifying element serving to break up the landscape. This road limits the area which can be associated with the river.

Marshlands Road serves as a major division to the river. Here, division is largely a function of the traffic volume, emphasized by the cross-roads and bridge. The absence of willows upstream of the bridge, combined with their re-establishment downstream, acknowledges the interruption caused by the road. Here there is a contrast between the slow pace of the river and accompanying road, and the opposing high-speed road which shows no sympathy with the natural landscape pattern it dissects.

Below Marshlands Road, Lower Styx Road roughly follows the river. The few roads crossing the river in this area are not divisive, are associated with the local use of the area and, except for the bridge at the floodgates, do not coincide with natural boundaries. The bridge and road associated with the floodgates, although sited at the juxtaposition of obviously different land uses and habitats, tend to emphasize the contrasts in these rather than create a division in their own right.

In the upper area, Sawyers Arms Road serves as a division between a backyard creek and a countryside stream.

Identity areas: Associated with the soils, land use, ecology, spatial relationships, relief, environmental aspects, roading, river characteristics and other factors, a series of areas emerge which have certain common qualities creating a distinct unity and identity.

Roading is a dominant feature in dividing the landscape and defines the limits to some of the identity areas.

Identity areas are shown on Analysis 3.

Area 1 extends throughout the upper area bounded by Sawyers Arms Road. Here, elevation, soils, land use, the proximity to the airport and the many views to the mountains create a common relationship. The area is delimited by the change in landform and soil type below Gardners Road.

Area 2 is the up-river area associated with the shallow phase of Te Kakahi sandy loam. This area is within a river valley.

Area 3 is a continuation of Area 2, but distinguished from it by its separation from the western area and the influence of the Main North Road upon it.

Area 4 is dominated by the linearity and movement of road and railway and the housing between these. The housing is excessively close to the river. The topography of this area is also a distinctive feature.

Area 5 is dominated by the separation between the river and general landform. The general landscape is expansive and used for dairying, cropping and other purposes. Houses are a conspicuous feature of this landscape. An area fairly dominated by human activity.

Area 6 is dominated by the urban development of Hawkins Road and the presence of Marshlands Road. This is a busy area associated with conveyance through the area.

Area 7 is used for cropping. This area is delimited by Marshlands Road and the river and is very influenced by human activity.

Area 8. This reflects its coastal proximity. Dune areas and associated topography and vegetation are combined with good open space relationships. The

Identity Area 1: Waimakariri fan - upper catchment area.

Identity Area 4: Urban encroachment:
Domination of area by housing and roading.

Identity Area 5: Open landscape, showing importance of trees in defining space.

Identity Area 5: Basin area associated with river.

Identity Area 13: Flood-prone, with linear alignment and open ends towards Port Hills and mountains.

character is distinctly rural without excessive housing. The area is defined by the vegetation of the river and the forest plantations.

Area 9 is associated with the definition by willows, the roading pattern and the land use.

Area 10. This area is isolated and very rural. The land use combined with the seclusion effected by the river's willows and the nearby forestry separate off this area. It is a very linear area of forestry, river, river vegetation and road. All these elements align themselves towards Spencerville.

Area 11. This area is a macro landscape. The predominant use is dairying. The area is defined by the forest belt and the river system. It is an open-ended area extending towards the Waimakariri. Views to the mountains are a conspicuous feature.

Area 12. Spencerville - makes a good contrast with Area 8. The settlement, sandy soils, pines, river and willows, together with the change in direction of the road and river, create the distinctive character of this area.

Area 13. The lower area, below Area 11. This is distinguished from Area 11 by its greater linearity, its separation by roading, its proneness to flooding, and its proximity to the Waimakariri. The open-ended area towards the Waimakariri allows for large views of the mountains.

Area 14 - Coastal sand dune area. Kairaki sand soils. Some enclosed areas due to topography, macrocarpa and pines. Largely unfarmed.

Area 15 - Brooklands - informal settlement similar to Spencerville but more spread-out. Coastal environs very evident. Sandy soils.

Area 16. Saline marsh - distinctive vegetation. This area is exposed to winds. Distinctively coastal, with the sea sometimes visible. Floodbanks are a conspicuous feature. Very open landscape.

Access: The river runs through privately owned, freehold land. The plan of the Waimairi County's District Scheme shows the existence of paper roads on either side of the river from below Marshlands Road. This land, however, is at present inaccessible to the public except for the tow path near Spencerville and the area below the floodgates.

The 1974 Amendment to the Counties Act provides for the setting aside of a chain of land on either side of rivers over five metres in width when subdividing. The survey of the river by the drainage board shows that this includes land to as far up-river as the Main North Road.

R E C R E A T I O N I N C H R I S T C H U R C H

The Styx River corridor and fringe areas at present offer the opportunity for a planned recreational facility for Christchurch city. This might be part of a system of recreational areas incorporating those already in existence. Consideration of the existing and planned recreational areas and their types, beyond and within the city limits, together with consideration of population densities and likely population spread, would help to locate the area or areas where land development for recreation would be of most benefit.

Choice of site depends on consideration of:-

- access
- intended use
- proximity to population using site
- suitability of the area for the use (carrying capacity and other factors)
- zoning and town planning schemes
- availability and value of the land
- possible conflicts.

This, however, is inadequate without also a consideration of the type of recreation for which there is the greatest demand and consideration of future preferences. Recreation areas provide the opportunity to create an open-space linkage system which can incorporate nature within the city confines, and control and subdue urban sprawl at the city edges.

Work by Neighbour on outdoor recreation in Christchurch provides information on the recreation types engaged in by Christchurch people, the relative popularity of these recreational activities, the types of people for whom various activities have the greatest appeal, and a guide to future recreational characteristics.

The table ( ) shows the demands in both Auckland and Christchurch for various activities. The activities fall within three general groupings for recreation[1].

Recreation Types:

1. Rural passive - take place outside the urban area, where the "natural environment" is an important attraction. Facilities are not essential to the pursuit. Passive pursuits require little expenditure of money, time or energy and involve few skills.

2. Rural active - Active pursuits involving the expenditure of money for equipment require energy and, usually, skills.

3. Urban based - take place within the periphery of the urban area. Facilities, equipment, or buildings and fields are specifically prepared to enable physical participation.
   These activities are usually organized by clubs.(2)

Table (4)

Participation in Outdoor Recreation

Christchurch : Auckland

Activity	Percentage of Sample Population participating	
	CHCH	AK
Picnics	88	72
Driving for pleasure	83	77
Visiting the beach	77	84
Organised sport - spectator	59	50
Walking for pleasure	57	50
Sea/river swimming	52	66
Staying at bach	50	54
Pool swimming	35	44
Organised sport - participant	33	30
Horse and dog racing - spectator	31	26
Pleasure boating	27	23
Motor racing - spectator	24	11
Fishing - (sea)	20	37
Golf	20	14
Fishing - (fresh water)	17	6
Car rallies	13	7
Power boating	12	16
Tramping	9	9
Camping - caravan	9	11
camping - tents	9	15
Hunting	8	7
Skiing	7	6
Tobogganing	6	2
Nature studies	6	10
Camping - hostels	6	13
Water skiing	5	6
Ice skating	5	1
Sailing	5	16
Surfing	5	5
Canoeing	3	4
Horse riding	3	9
Scrambling	3	2 (3)

The table shows that, with the exception of fishing, swimming, power boating and car rallies, the rural active pursuits attract no more than one-tenth of either population sample. Rural passive activity, however, is engaged in by at least forty per cent of the two populations. The urban-based activities are also characterized by relatively high participation rates for each activity in both centres.

Although the participation rate may vary, swimming is the most popular "active" outdoor recreational activity. Despite its broad appeal, participation in swimming declines rapidly with age, with less than a quarter of the people over 44 years of age taking part, compared with three quarters of the 16 - 24 years age group. The presence of young children in the family encourages swimming trips. Sunday is the most popular day for it.

Fresh water fishing is popular in Christchurch due to the many suitable rivers. This activity has more appeal to males and single persons, but in 67 per cent of cases the fishermen were accompanied by their families, few of whom participated. The majority of the fishing trips are of a day's duration and all travelled by car.

The Waimakariri. being the closest, is the most used, followed by the Rakaia, then Lake Coleridge.

SUMMARY: The majority of activities take place both at weekends and in the holiday period, with Sunday the most popular day. The car is of overwhelming importance to participation in rural active pursuits. Participants in some activities travel further than others - camping, tramping, skiing and hunting occur over two hours journey away.

Most recreational pursuits are family based.

Neighbour's study found the rural passive sports to have universal appeal. The activities of driving for pleasure, picnics, walking for pleasure and sea or river swimming were all participated in by over fifty per cent of the population sampled.

Study of the future preferences was limited in its coverage of activities, and showed a preference for organized sport, golf and skiing. Neighbour's results here do not favour rural passive recreation.

Future Preferences: The Most Desired Activities — Table 5

Activity	Percentage of mentions
Organised Sport	21.5
Golf	14.1
Skiing	5.8
Swimming	5.3
Tramping	4.8
Freshwater fishing	4.5
Hunting and shooting	4.2
Driving for pleasure	2.9
Camping	2.8
Water skiing	2.6
Horse riding	2.6
Walking	2.4
Power boating	2.3
Sailing	2.2
Sea water fishing	1.5

There are limitations in the value of predictions of future preferences.

(1) These results come from the next generation's middle aged and old people - Tomorrow's younger generation could not be represented.

(2) Values change and opinions now may reflect an intellectual rather than a practical bias.(4)

(3) The population growth rate will favour the increase in the ratio of young to middle aged, and of middle aged to old people. People are living longer.

(4) Increased skills in active recreational pursuits of the future generation.

Points (3) and (4) would support the prediction of a future increase in demand for active recreation. Certain active activities, such as swimming and skiing, will also have more appeal to the middle aged of the future because many

attained these skills when young.

Neighbour's work establishes the present demand for rural passive activities and suggests a future increase in the demand for active recreation, notably organized sport, skiing and golf.

The popularity of driving for pleasure is known to decrease as traffic volumes increase, and there is a subsequent increase in the demand for other passive recreation which is not so far away. This involves a definite end point. Neighbour found that 62% of trips had a definite end point.

Length of trip - the bulk of recreational pressure in the area extends to a radius of 50 miles from the city centre. Fifty-seven per cent of the destinations of the trips were water-based.(5)

The Styx river area is well suited for such recreational types as picnicking, fishing and walking. The area is also of value in pleasure driving, and forms part of the experience in travelling to Spencer Park, the beach, or to Brooklands. Some areas could also be used for golf. The importance of water-based recreation renders golf of secondary importance at the river side, but could be associated with other recreational types to ensure access. Although swimming is usually a much preferred water recreational use, much of the river is inaccessible and those areas easily accessible are generally shaded, with vegetation on the sun-ward side of the river. There is an absence of pools, and the river is very linear. The steep banks suggest danger rather than invitation to the water.

The river could be of limited use to row-boating and canoeing. Camping is already provided at Brooklands and the demand so close to Christchurch should not render this a priority. Duck shooting should be confined to certain areas of the river such as the area below the flood gates.

To establish suitable areas for recreation, a look at the overall pattern of recreational areas in and around Christchurch is required. This thesis does not set out to do a penetrative assessment, but attempts a skeletal survey.

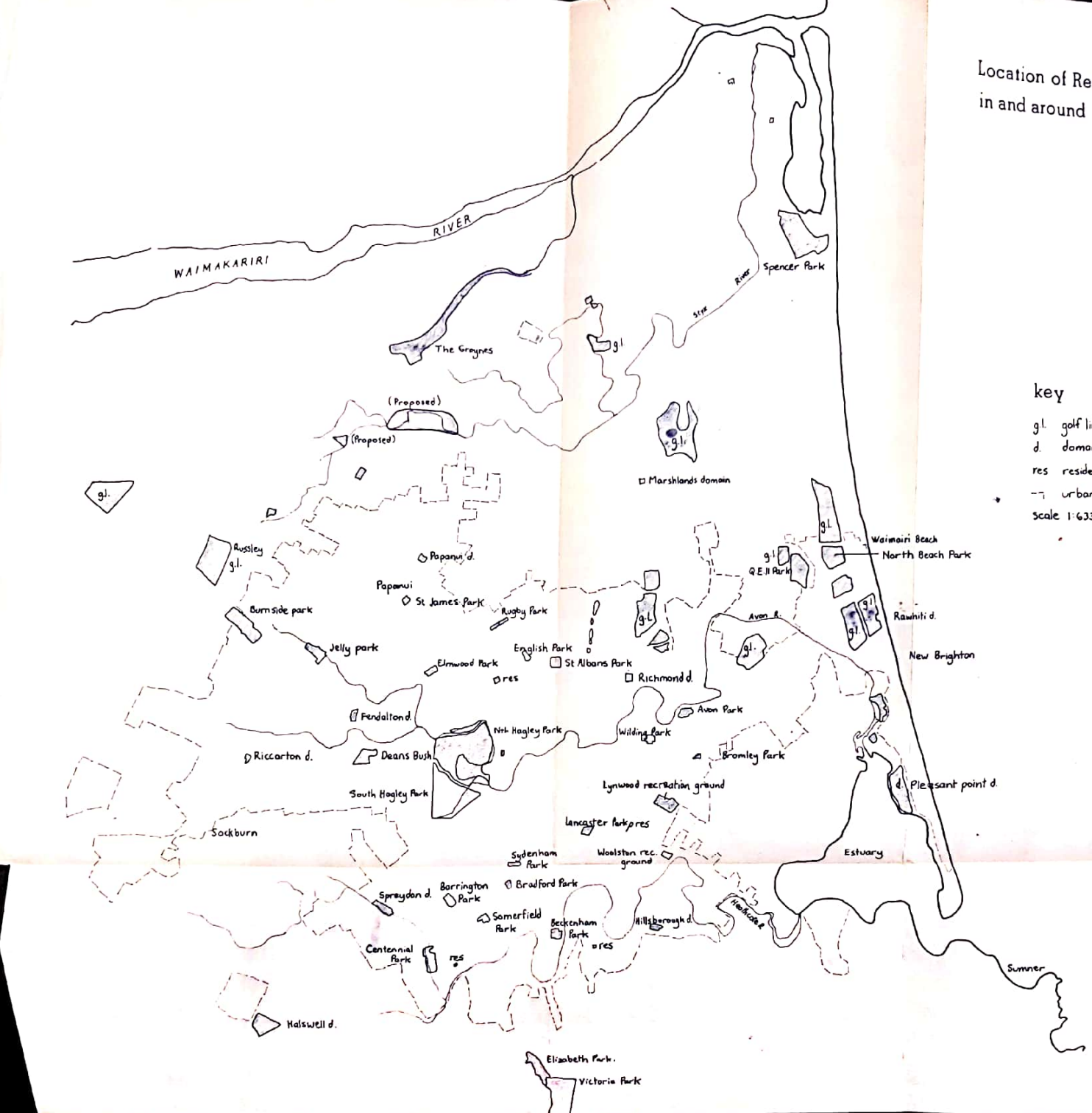
Within Christchurch most of the parks and domains offer both active recreation and opportunity for passive use. Those areas beyond the urban limits are poorly located for sports grounds, and such use would be inappropriate with the rural atmosphere. There is a tendency for golf courses to be sited at or beyond the city limits. This use is a response to land values, but is also appropriate to the rural land use atmosphere. The proposed recreational area in the upper Styx is well suited to passive recreation and is intended to remove pressure on the nearby Groynes. (See figure 6)

The Styx River might be used for recreation utilizing a linkage concept which would relate the recreational areas of the Groynes and upper Styx River with the Styx-Waimakariri river mouth. Under such a concept, the area of most value involves most of the area below the Main North Road.

The area could be divided into three sectors, each incorporating a recreational facility. These sectors would correspond with Identity area 5 (below Main North Road), Identity areas 8 and 11 (below Marshlands Road and above Spencerville) and Identity areas 11 and 13 (below Spencerville.)

Soil type definitions and boundaries alone are insufficient data for determining suitable areas for recreational use. Recreational uses should be sympathetic to soil properties but occupy a wide range of soil types. The appraisal evaluates areas suitable for recreation.

If the concept of providing open-space recreational linkage was used, the area between the Main North Road and Radcliff Road would utilize its unique landform through the development of a walkway. This corridor area is a unique section of the river and of greater recreational value than the higher land adjacent to it. The walkway could extend to Marshlands Road and be connected with the large area at Identity area 8, which is well suited to passive recreational development.



Location of Recreation Areas in and around Christchurch

Figure 6

key

g.l. golf links
d. domain
res residential park
-- urban limits
scale 1:63360 (1 inch = 1 mile)

Notes and References

(1) p39 Ann M. Neighbour 1973 Outdoor Recreation in Christchurch; a survey of activity patterns. Dept. of Geography, Christchurch, University of Canterbury. 92pp.

(2) pp10-12 Ibid

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(4) pp40-61 Ibid

(5) pp69-71 Ibid.

COMMENTS ON SURVEY AND ANALYSIS

Analysis 3 shows the importance of the river corridor in defining the identity areas. These areas enrich the landscape through their variety. The proposed fairway clearance from the floodgates to the area below the railway line would, in removing the willows, reduce this variety by reducing the numbers of identity areas, amalgamating some into poorly defined, large scale areas. The willows, in following the river course, provide a natural pattern within the landscape and imply the existence of a river from some distance away. Analysis 3 shows the vegetation important in defining the identity areas. Although this vegetation is important, its present use tends to be excessively linear, and is often very close to the river for excessively long stretches. Fairway clearance requirements for flooding could be met without reduction of landscape diversity, through siting of vegetation at greater distances from the river but modulating distance of set-back to provide variety. Fairway clearance should also consider the value of vegetation in stabilizing river banks and habitats along the river.

The proposed stop-banking in Lower Styx Road would further separate views to the river from the road. The siting of stop-banks beyond the road, or of a gradual mounding with the road along the top, would ensure the river is of value as a visual resource to the motorist. (Siting within the flood zone would involve some loss of use of the road, however, but an alternative route could be provided for times of flooding.)

The survey shows that the area affected by flooding is largely on the north-west side of the river in Identity Areas 11 and 13.

The use of the coniferous element is more acceptable in the upper and coastal sections of the river than in the middle area. (Identity Area 5.) This acceptability is a function of the habitats for which such vegetation is adapted. Silver poplar is useful both visually and functionally in the lower dunal areas.

Housing should be restricted in amount and distribution, and materials and colours should be appropriate to those of the landscape. Vegetation

should be used more often in relating the houses to the landscape, and in controlling focus.

Bridges should also respond to the landscape colours and materials, though colour choice should also be influenced by safety requirements. Structure of bridges should respond to the nature of the river and of the road crossing it. The Radcliffe Road bridge is well suited to its road, river and vegetation. Marshlands Road bridge does not reflect the high speed of its traffic. The use of vertical concrete restricts views and cautions the driver.

CONCEPT:

1. The creation of a continuous green open-space area associated with the river and delimited by vegetation belts.
2. The prevention of urban development within the green open-space area, and limitations to the ultimate size of Spencerville and Brooklands, to maintain a rural character to the area associated with the river. Future removal of those housing groups which destroy the rural atmosphere desired.
3. The provision of a linked system of recreational areas associated with the river and with existing recreational areas nearby.
4. A transition with distance from Christchurch, in recreational usage. (The use of the upper area for sports fields has already been planned by the Waimairi County. Although this use will impose order upon an area whose value lies in its naturalness, it will retain open space and provide public recreational facilities in an area close to a large population. The area seen as having most value for sports fields is that already flat, belonging to the upper flood plane area and including the proposed Harewood Park sports field.)
5. The provision of walkways to link the larger recreational areas together and to thus provide a continuous recreational area to the public.
6. The creation of a major recreational drive in the lower section, incorporating an alternative route of return.
7. The continued rural use of land within the vegetation belts which is not required for recreation or for planting in vegetation belts.

Identity Area 8: Part of area selected for detailed design, as seen from Lower Styx road.

Identity Area 8: Coastal influence - sand dune - part of detailed design area.

Design Philosophy for detailed area.

The retention and emphasis of rural and riverside character appropriate to the location: the continued integration of this area with the broad landscape beyond the site.

Suitable vegetation to be predominantly of rounded form, especially where close to the river. Some use of coniferous trees, reflecting the coastal element of the area on sand-dune areas sufficiently far from the river.

The integrated use of deciduous and evergreen trees of rounded form using vegetation from native and related floras to develop a distinctive New Zealand character to the area.

Vegetation predominantly of textures sympathetic to willow, chosen and used to exploit an atmosphere of peace and relaxation. Choice also being influenced by seasonal changes, existing vegetation of the site and the growth rate. Vegetation to reduce scale of area but to retain important views and openness of the landscape.

Use of topography, especially dunes, for emphasis of a natural pattern in the vegetation.

Design of structural elements to exploit curvilinear line emphasizing character of flow and relaxation in the landscape.

Structures associated with water to emphasize horizontal plane, utilizing some contrast of vertical elements.

Structural materials to be harmonious with total environment. Choice of colours to exploit some brightness and gaiety, with dominant colour dark brown, compatible with colour of vegetation.

Purpose:- A passive recreational facility for daily outings, with similar uses to "The Groynes", serving the population of Christchurch city. Provision of parking facilities, picknicking areas, barbecuing areas, walking tracks, playing areas, fishing areas and a swimming area.

In Summary:

The positive effects of vegetation:

(a)Willows act in subdividing the region into areas of good size and scale, and provide unity to the landscape.

(b)The willows create a natural element in the landscape and are very significant as emergent features.

(c)The willow is a very pleasing species visually,so long as healthy,in riparian locations.

(d)They function in reducing incoming water volumes and rates,thus serving in the interests of flood prevention.

(e)They provide stability to the banks,preventing erosion and containing the river.

The drainage boards clearance programme:

Removal of willows,without replacement by any other form of vegetation,would seriously reduce the quality of the environment,open much of the landscape into areas too vast in scale to still be associated with the river,and reduce the diversity of the landscape types,through reducing the number of identity areas.The willows,however are in many cases too near the river for good scale relationships,and there tends to be excessive linearity of the willows.These repeat the rivers course without any variation and sometimes monotonously.Many of the willows are excessively crowded and often in poor condition.Sometimes good views are screened by vegetation,and in one area below Spencerville,the river is close to the road,yet completely screened from it.

Accepting the necessity for some form of vegetation to be associated with the river;Possible solutions to the flood problem are:

(1)Removal of willows to varying distances of set back from the river-exploiting the vegetation in creating interesting views,in screening and uniting areas within the landscape.Use of other tree species,appropriate to a riparian location,but not as invasive as willows.

(Suggested species are used in the detailed area)

(2)Planting of non-invasive species,appropriate to the riparian location,by a phased programme,in which willows are removed only when the new vegetation planted further back,is of sufficient stature. Planting is to exploit natural patterns,and to act as a sub-theme upon the dominant;-the river.The use of native and related plants to be integrated with willow-like species.

(3)In many cases the willows are only on one side of the river. Widening of the willow-free side could retain many of the willows in tact,and yet increase the water holding capacity of the river.

(4)The use of large tree belts of vegetation in the catchment area to utilize water and thus reduce volumes and rates of the water reaching the river,thereby reducing flood levels.(As shown on Concept 5 of the drawings).

(5)A possible low weir system in the river-valley part of Identity area 8,while still allowing for the existence of a walkway in this area.(see page 15)Suggested weir sites being from level with the top of Selkirk Place to somewhere downstream of the railway viaduct.