

WATER RESOURCES

INTRODUCTION

This Chapter describes the development of water resources and sewerage and waste disposal in Victoria spanning the period from the early 1930s to the early 1980s. The roles played by the Melbourne and Metropolitan Board of Works and the State Rivers and Water Supply Commission in urban and rural areas are also examined. The Chapter concludes with a section outlining the measures taken to assist in river improvement, drainage, and flood plain management.

HISTORICAL OUTLINE

The availability of natural water supplies substantially influenced the settlement of Victoria. The early European settlers, after they had experienced some poor seasons, came to realise that the rainfall of the State was both uneven and irregular, and that man-made attempts at husbanding available water resources would be needed for agriculture and domestic use. This need applied especially to settlements remote from the coastal areas, which were generally favoured with more regular rainfall.

A Board of Commissioners of Sewers and Water Supply for Melbourne was appointed as early as 1853 and this body was the precursor of the Melbourne and Metropolitan Board of Works (henceforth referred to in this Chapter as the Board), constituted in 1890.

The earliest of the more important country water supplies were generally installed against the background of gold mining in the 1850s — at Bendigo (1858), Ballarat (1860), and Geelong (1865). The construction of subsequent supplies was dictated by the needs of an expanding agriculture after the first flush of gold mining ended in the 1860s. The lessons of the disastrous drought between 1877 and 1881 prompted many to think about the possibilities of irrigation which became a lively issue in the 1880s.

During the following two decades water trusts and irrigation schemes were established, especially after the Irrigation Act of 1886. Practically all such schemes and trusts were finally brought under the legislative umbrella of the *Water Act* 1905, which set up the State Rivers and Water Supply Commission (henceforth referred to in this Chapter as the Commission), a body that was to control all rural water supplies. In 1915, the Water Commission became the authority for building and maintaining works in Victoria under the River Murray Waters Agreement, and in 1917 legislation was passed enabling the Commission to constitute flood protection districts and carry out necessary works.

Agricultural development

Before the First World War, Dr Elwood Mead, the second chairman of the Commission, had advocated the closer settlement of northern Victoria as a means of intensifying and expanding irrigated agriculture. By the 1930s, an area of 200,000 hectares was irrigated and much of it was the result of closer settlement.

As a reaction to the Depression of the early 1930s, governments reduced their expenditure to a minimum, and the lack of funds prevented the construction of major water supply works. The position rapidly deteriorated to the point where the water demands of many cities and towns approached the capacity of water storages and distribution systems.

The previous decade had seen the State's value of production from manufacturing exceed that from agriculture for the first time. Every section of the community had felt the Depression, and unemployment probably affected city people most. When the Country Party gained and held the balance of power in Victoria for the decade after 1935, developments occurred particularly in irrigation, roads, and rural settlement in which the Commission was to play a leading part. L.R. (later Sir Ronald) East became its chairman in 1936 and was to lead it for the next thirty years through a period of major development of the water resources of the State.

In January 1936 a Royal Commission was appointed to inquire into the Commission's charges and costs and other matters. One of the results was that most loan liabilities were assumed by the Victorian Government, but the Government reaffirmed that irrigators had to pay for water rights whether they used the water or not.

Victoria experienced one of its most severe droughts in 1938-39; water in storages was far below requirements and supplies in several irrigation districts were limited. The cost of sand drift removal from Mallee channels was also very high, and in effect officers of the Commission were responsible for promoting soil conservation practices in the Mallee and elsewhere.

There was little construction work undertaken during the Second World War because materials and manpower were directed to the purposes of war. Although water supply was a reserved occupation, many men were released to the fighting forces while others were seconded for wartime construction work.

The years between 1950 and the mid-1960s were years of significant economic development in Victoria, but finance for waterworks, especially in the early 1950s, was greatly disrupted by financial constraints which brought many water conservation works to a standstill. However, although slowed down, the big Eildon Dam was completed, as were Rocklands, Cairn Curran, and Tullaroop Dams. Then in 1963 the Victorian Government asked for and approved a ten year programme of major works to provide for continuity of employment of the experienced engineers, workmen, and plant available after the completion of major projects such as the Eildon Dam.

In the 1950s and 1960s economists began to challenge the soundness of decision making on water development proposals. In 1966 the Commonwealth Treasury issued a paper on investment analysis that detailed the Commonwealth's attitude to the investment of government funds in public works. This paper provided the foundation for the Commission's appraisal of projects. In the 1970s the move to more rigorous economic assessment of developmental proposals was hastened by increasing Commonwealth participation in the field. A reflection of this was evident when the Mitchell River Dam's construction was deferred indefinitely in 1982.

Private financing of water, sewerage, and drainage services on a relatively large scale arose in the 1960s because of the very rapid increase in the subdivision of rural lands for urban use. The *Local Government (Subdivision of Land) Act 1973* required subdividers to enter into agreements with the service authorities for the provision of the services required for their subdivisions. These moves were reinforced by the community's growing concern for the environment, and the Victorian Government's view that the cost of preventing such problems from developing should be met by those receiving the greatest return from the development, i.e., the subdivider or developer. A similar arrangement had been used for many years in meeting the cost of works necessitated by subdivision of irrigated holdings. The urban use of land was more and more being determined in the light of the provision of services, topography, and environmental values.

Melbourne metropolitan development

In 1934, the main storages for the water being supplied by the Board to Melbourne were the original Yan Yean system (completed in 1857), the Maroondah Reservoir (1927) near Healesville, the O'Shannassy Reservoir (1928) near Warburton, and the Silvan Reservoir (1931) in the Dandenong Ranges. In 1934, the number of properties in Melbourne supplied with water was 258,797, and the number of people was estimated at 1,027,000. A programme of major works in the 1920s had placed the Board in a good position to supply water in the early 1930s. However, the Depression curtailed new works but did not significantly slow down the increasing demand for water.

ANNUAL RAINFALL BY DISTRICT : VICTORIA, 1933 TO 1982
(mm)

Year	North Mallee	South Mallee	North Wimmera	South Wimmera	Lower North	Upper North	Lower Northeast	Upper Northeast	East Gippsland	West Gippsland	East Central	West Central	North Central	Western Plains	West Coast
1933	319	399	473	567	477	548	732	988	742	794	802	595	785	615	721
1934	284	351	383	445	481	585	1,044	1,189	1,102	1,094	1,130	723	714	660	806
1935	228	307	374	473	466	526	796	1,199	1,010	1,156	1,073	665	736	645	824
1936	355	360	442	505	458	540	802	1,141	842	991	909	609	722	603	724
1937	298	326	422	440	315	372	549	787	638	742	787	483	507	592	702
1938	143	162	249	309	199	242	410	738	631	661	629	389	387	455	632
1939	338	411	446	545	588	800	1,212	1,612	767	1,079	1,126	793	955	722	876
1940	149	190	251	312	215	276	449	715	596	743	728	432	436	450	597
1941	304	316	465	533	380	492	632	1,049	756	903	961	641	646	691	792
1942	326	387	514	601	429	569	801	1,314	714	865	884	618	811	693	819
1943	190	223	306	375	233	320	580	872	642	841	708	438	514	534	720
1944	151	183	221	301	207	263	432	717	551	799	802	418	438	512	671
1945	214	269	346	421	341	413	644	996	667	769	661	471	553	517	707
1946	323	380	486	633	395	505	877	1,283	848	1,176	1,011	666	760	857	1,108
1947	372	397	511	630	453	578	894	1,330	649	1,086	1,025	640	837	760	913
1948	268	305	453	511	381	455	694	1,043	784	921	801	506	630	632	770
1949	271	328	387	447	470	566	755	1,042	946	918	951	697	795	616	714
1950	421	466	492	523	555	645	787	1,095	998	889	899	668	804	618	601
1951	259	340	438	548	459	568	814	1,219	959	1,125	1,029	732	810	745	894
1952	354	409	495	605	502	607	1,004	1,515	1,061	1,345	1,219	839	904	853	1,077
1953	300	321	437	549	376	475	771	1,176	703	1,014	988	579	728	669	831
1954	296	369	450	449	486	592	798	1,095	789	913	877	703	760	613	683
1955	407	482	519	615	616	701	1,059	1,622	673	986	1,024	722	915	699	888
1956	469	577	579	649	762	834	1,247	1,739	1,040	1,174	1,056	718	1,047	793	900
1957	223	264	340	407	309	377	599	903	711	886	764	520	584	581	737
1958	393	394	413	477	509	568	851	1,213	718	992	893	604	803	634	799
1959	230	271	344	417	392	443	600	931	924	797	783	588	664	603	630
1960	417	490	583	665	530	620	920	1,269	844	1,007	1,074	729	979	851	949
1961	331	354	359	403	356	397	641	845	904	789	690	492	643	544	648
1962	261	305	400	490	443	508	758	1,083	654	897	773	559	704	592	699
1963	399	417	438	495	498	544	812	1,101	857	945	803	642	774	670	648
1964	379	432	554	700	472	585	924	1,259	768	1,109	1,022	783	875	888	1,033
1965	271	319	339	429	340	437	573	850	583	733	748	542	655	536	677
1966	283	336	375	454	452	574	943	1,269	1,039	961	980	670	813	667	785
1967	111	144	188	250	205	274	372	606	527	638	564	317	407	334	460
1968	292	384	439	548	483	578	839	1,348	682	990	862	604	881	675	969
1969	388	423	401	477	443	519	834	964	896	929	789	545	691	594	727
1970	342	385	422	516	468	562	919	1,181	1,047	1,165	1,060	825	842	742	918
1971	324	428	478	633	480	576	782	1,157	798	930	973	730	891	769	991
1972	242	275	315	418	306	384	485	681	517	657	660	493	583	530	651
1973	605	648	712	790	864	933	1,224	1,476	786	993	1,027	820	1,126	779	884
1974	500	546	635	733	708	813	1,147	1,499	1,217	1,024	1,029	767	976	742	844
1975	399	411	421	616	559	680	978	1,330	832	984	935	667	885	683	881
1976	266	268	308	399	273	341	530	740	784	801	752	548	599	542	731
1977	233	277	274	379	280	367	554	802	709	805	862	591	621	552	725
1978	381	441	432	531	524	646	955	1,258	1,171	1,206	1,081	877	839	729	871
1979	385	416	456	580	435	504	678	950	460	759	752	499	717	583	723
1980	274	322	371	505	364	459	705	1,004	692	939	853	545	700	592	767
1981	339	378	449	556	471	618	1,008	1,278	753	874	628	797	607	704	704
1982	112	123	149	230	172	222	379	534	553	628	647	349	403	333	495

Source: Bureau of Meteorology.

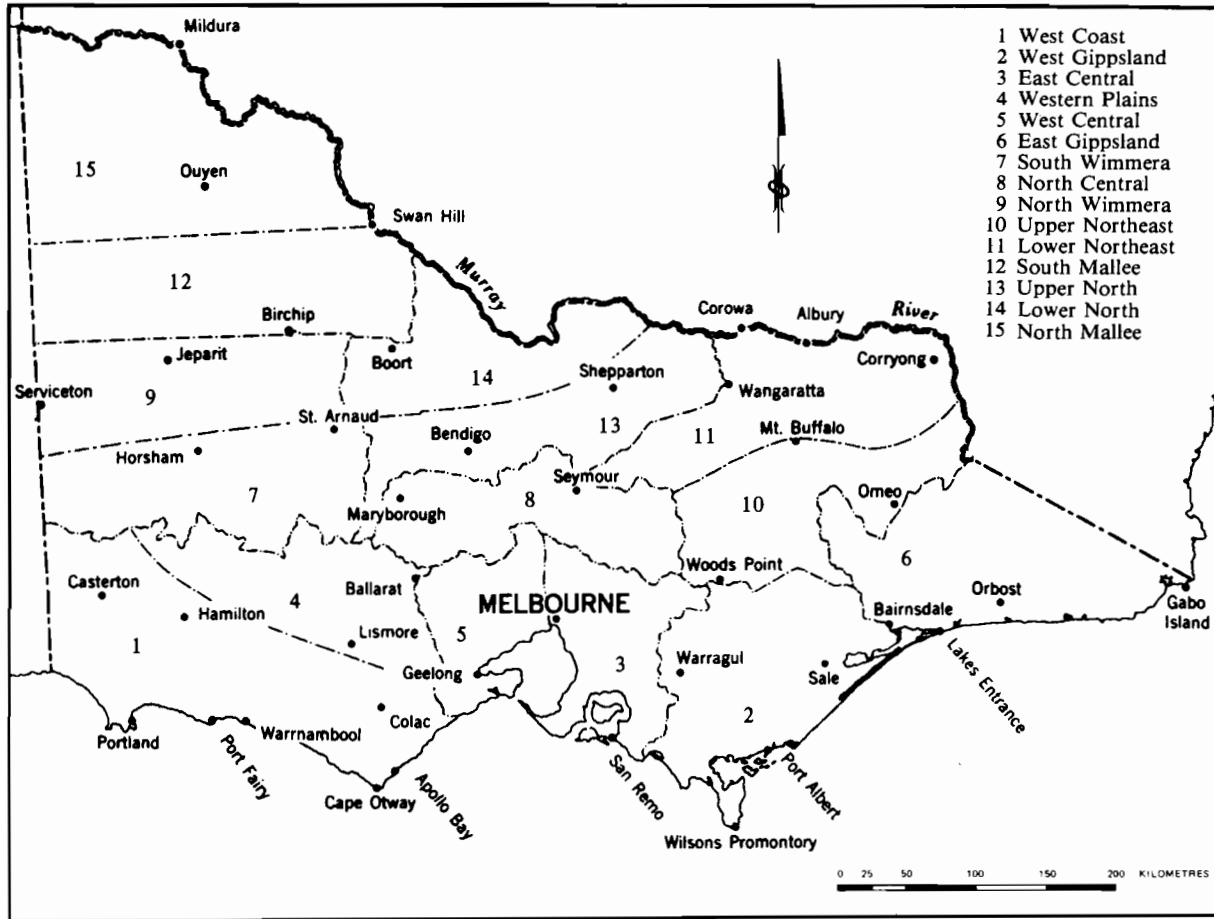


FIGURE 15. Victoria—Rainfall districts.

Source: Bureau of Meteorology

The winter and spring of 1938 were exceptionally dry, and the high temperatures of December brought about a crisis in the water supply. Only the imposition of severe restrictions on the domestic use of water prevented complete failure of supply to several areas. Valuable rains fell towards the end of February 1939, and the restrictions were lifted in June when storages had reached a satisfactory level. Abundant rainfall and favourable conditions prevailed until 1944-45 when another, but less severe, drought occurred. Those years of good rains proved most fortunate because the Second World War prevented any but the most urgent water works from being carried out.

In the 1930s investigations had continued into additional storages to supply Melbourne's needs. Attention was concentrated on the upper reaches of the Yarra River, which had long been regarded as the logical source of additional water. In 1940, the Board decided to proceed with the construction of a new storage in the vicinity of McVeighs but the Second World War delayed the scheme until 1946. This storage, the Upper Yarra Dam, was completed in 1957, just one hundred years after the inauguration of the Yan Yean system, and its capacity of 200,000 megalitres doubled the Board's total storage at the time.

The post-war immigration policies of the Commonwealth Government were to have a marked effect on Victoria's population growth, particularly Melbourne's. There was also internal migration from rural areas and country towns to the metropolitan area: Melbourne grew by 1.26 million persons between 1947 and 1976, while the population of the rest of Victoria increased by only 0.36 million; in 1933 the metropolitan area had accounted for 54 per cent of Victoria's population, in 1981 the proportion was 67 per cent.

Until 1975, the planning for future water and sewerage services had been based on estimates of the number of people requiring such services. It became evident, however, that the need for urban land and services was largely determined by the number of households being formed rather than by population growth. Therefore the declining birth rates and immigration of the 1970s would lower estimates of population growth but not affect to the same extent the estimates of households to be formed over the next two decades; these were mainly determined by the children already born and living in Melbourne. In 1975, policies were introduced to improve the rate of production of serviced residential land in Melbourne and to contain the cost of the services by providing them in "preferred development areas".

General developments

Since the Second World War, the Commission has initiated the establishment of three new regionally based authorities. The first was the Latrobe Valley Water and Sewerage Board, which was created under the provisions of special legislation passed in 1951 (for drainage) and 1954 (for water supply). The Board was made responsible for the supply of water to the Morwell and Traralgon areas, and for the treatment and disposal of industrial and domestic wastes from the La Trobe Valley, including the highly toxic wastes from the gasification of brown coal.

The second regional authority was the Dandenong Valley Authority. The legislation setting up the Authority in 1963 established the principle of financing drainage services on a catchment basis, and gave the Authority wide powers in drainage and flood plain management throughout the catchment of the Dandenong Creek (the Cardinia Creek catchment was added to the Authority's area in 1976). The third of the special authorities was the West Moorabool Water Board which was constituted in 1968 to augment the supply of water to both Ballarat and Geelong.

Two drought periods in four years (1967-68 and 1972-73) resulted in Melbourne facing a serious water shortage in the summer of 1973. The Victorian Government appointed a Standing Committee to advise it on overcoming the emergency and to plan for future water conservation. The Committee, consisting of representatives of the Commission, the Board, and the Treasury, confirmed the need for a single body to co-ordinate the administration of Victoria's water resources.

In 1975, the Water Resources Act established a Ministry of Water Resources and Water Supply for the purpose of ensuring the most efficient utilisation of water resources. The Act vested in the Minister the responsibility for the administration, throughout the State, of water resources, water supply, drainage, and sewerage. It did not change the functions

of either the Commission or the Board. Instead, it brought both bodies under a single Ministry to enable the co-ordination of their activities, and created the position of Director of Water Resources as chairman of a Water Resources Council that was formed to provide information and advice to the Minister.

In 1979 and 1980, there were two developments with substantial implications for the future management of water services in Victoria. First, in November 1979, the Board of Review of the Role, Structure and Administration of Local Government in Victoria presented its report (the Bains Report) which noted that, outside the metropolitan area, water supply and sewerage could be the responsibility of local government. Then, legislation in early 1980 established the Public Bodies Review Committee with wide powers to review the efficiency, structure, and role of Victoria's public bodies. In 1980, the Commission and each constituted water, sewerage, drainage, and river improvement trust or authority, except the Board, was referred to the Committee for review. The Committee produced a series of reports, the sixth of which contained recommendations for the re-structuring of local water and sewerage authorities by substantially reducing the number of bodies providing water services.

With a worsening economy and scarce public funds, new directions became essential for the water industry. Increasingly, major projects were being subjected to more rigorous examination, and the beneficiaries of services were being more carefully defined and expected to bear their share of costs.

Changes to the Melbourne and Metropolitan Board of Works

When the Board was constituted in 1890, it consisted of a chairman and 39 commissioners who were elected by the councils of the 22 municipalities in the metropolitan area. The numerical representation was determined by the size of the population and total valuation of properties in each municipality. In the ensuing years, the Board was reconstituted several times so that new municipalities that had become part of the metropolitan area could be represented on the Board. This principle of municipalities being directly represented on the Board was maintained until 1978. In that year, the Victorian Government initiated an inquiry into the functions and constitution of the Board. Acting on the recommendations of the inquiry, the Government replaced the Board of 54 commissioners with one consisting of a full-time chairman and six part-time members, four of whom were elected by representatives of metropolitan municipalities.

Changes to the State Rivers and Water Supply Commission

In 1961, the Commission consolidated its scattered offices in a new head office in Armadale. When the Commission began work in 1906, it had a total staff of 71 officers, but the growth in its responsibilities since then has been reflected in the growth in staff members to 1,800 in 1980; more than two-thirds of the staff are in country offices.

Until 1939 the Commission had authority for all staff appointments subject to obtaining Ministerial approval for appointments and promotions at salaries above \$500 per annum. Although the 1936 Royal Commission had recommended that the Commission should be free to make its own appointments and promotions and to set salaries, the Victorian Government made these matters the responsibility of the Public Service Board by the Public Service (Transfer of Officers) Act of 1937, which came into effect in 1939.

The *State Rivers and Water Supply Commission (Special Projects) Act 1969*, empowered the Commission to provide consulting services outside Victoria. Since then, it has assisted developing nations in the evaluation and implementation of water resource projects, particularly for irrigation and drainage works in Ethiopia, Indonesia, Fiji, Thailand, Ghana, Afghanistan, Kampuchea, and the Philippines.

Commonwealth-State relations

As in most areas of governmental activity, the Commonwealth Government co-operates with Victoria in matters relating to water. The prime instance of this is the Bureau of Meteorology's provision of data that are essential to the planning and management of water resources. The Australian Water Resources Council is another source of assistance particularly through its programme of funding water resource assessment and research.

Federal co-operation had its beginning in the River Murray Waters Agreement of 1915 between the Commonwealth and the States of Victoria, New South Wales, and South Australia. The four governments are represented on the River Murray Commission which is responsible for the construction and operation of works under the agreement. The Commonwealth Government also entered into agreements with the States of Victoria and New South Wales to authorise the Snowy Mountains Hydro-electric Scheme. A National Sewerage Programme was designed to overcome the backlog of unsewered urban development and began in 1973. Although the programme was ended in 1976-77, this effort reduced the number of unsewered properties in Melbourne from 162,000 in 1972-73 to 139,000 in 1975-76 and to 93,000 in 1978-79. The National Water Resources Programme began in 1976 whereby the Commonwealth undertook to provide grants to the States over five years for water conservation. It aimed at reducing the effects of flooding and at providing drainage and works to control salinity in the Murray Valley.

Environmental concerns

The constitution of the Environment Protection Authority (EPA) in 1970 was a most significant event in the management of water resources. It grew out of the inquiry of the Joint Select Committee on Drainage which, in its first report of 1967, recognised the problems caused by a lack of unified control of and responsibility for the wastes discharged to the environment, and recommended that a single pollution control authority should be created; in 1970, the necessary legislation was enacted.

The EPA delegated its powers for licensing of discharges into water to the Commission, the Board, the Dandenong Valley Authority, and the Latrobe Valley Water and Sewerage Board. The primary objectives have been the protection of the quality of surface water and control of waste discharges. The increasing requirement for the protection of the water environment has also led to the development of more sophisticated treatment plants and to a fundamental re-examination of the requirements for the collection and disposal of wastewaters with increasing recognition of the advantages of disposal on land.

Salinity of soil and water, particularly in the Murray River, has become a matter of national concern. Saline zones were already in existence prior to European settlement—these are an intrinsic part of the northern Victorian landscape—but changes in land-use since settlement (clearing of native forest and vegetation, introduction of irrigation) have substantially changed the hydrological balance. Major problems with salinity are now evident in many of the irrigated areas, and in parts of the unirrigated farming and grazing lands of northern Victoria, the Western District, and the Mallee. The wet seasons of 1973 to 1975 particularly caused sharp rises in water tables and pressures in the aquifers of the Goulburn and Campaspe Valleys. In 1975, the Commission produced a ten year plan for mitigating the effects of salinity and this became the subject of inquiry by the Parliamentary Public Works Committee.

URBAN WATER SUPPLY

Melbourne metropolitan area

Although the period from 1950 onward was one of considerable construction work by the Board, the capacity of the system for transferring water to Melbourne and distributing it was insufficient to meet peak demands. Restrictions were applied to the use of water each summer from 1950-51 to 1960-61 (with the exception of 1952-53), pending the completion of major distribution mains and service reservoirs. Smaller distribution mains and service reservoirs were also constructed throughout the metropolitan area to provide water to new residential and industrial development. In the thirty years after the Second World War, the number of properties supplied with water increased almost threefold, from 308,731 in 1945-46 to 885,485 in 1978-79.

In 1962, the Board recommended to the Victorian Government that future increases in metropolitan demand should be met in three ways: by diversion of water from the Big River, a tributary of the Goulburn River; by more water from the upper reaches of the Yarra River; and by diversion of water from the Thomson River, which flows toward the Gippsland coast from a point some 120 kilometres east of Melbourne. The proposals were

based on predictions that Melbourne's population would reach five million by the year 2000 (a prediction that was substantially modified in 1975).

The proposal for the further use of stream flows in the Yarra catchment, in which Melbourne is mainly located, was received by the public without controversy. So too was the proposed diversion of the Thomson River, given that adequate provision would be made for both existing and possible future irrigation in the Thomson Valley. But the proposal to divert water from the Big River drew sharp criticism from rural interests in northern Victoria and from the Commission on the grounds that the Big River and all other streams serving the Goulburn-Murray irrigation system were already fully committed and that, apart from the need to expand irrigation, there was an urgent need to consolidate existing development.

In its case against the diversion of the Big River, the Commission drew attention to the unused water resources in the Lower Yarra catchment and in the coastal streams east of Melbourne, which were sufficient, in its view, to meet the domestic and industrial needs of a much greater metropolitan population. The Board opposed the use of the Lower Yarra because of the poor quality of water and the lack of sufficient control over land-use in the catchment. During this controversy, in 1964, the Premier, the Hon. H.E. (later Sir Henry) Bolte emphatically stated that his Government would not agree to the diversion "of one drop" of Big River water to the metropolitan area.

The proposals were referred to the Parliamentary Public Works Committee, which, after a five year inquiry, recommended to the Victorian Government in 1967 that the Board should proceed with the development of the water resources of the Upper Yarra tributaries and the Thomson, Aberfeldy, and lower Yarra Rivers. It was also recommended that a reservoir should be constructed on Cardinia Creek by about 1977. Development of the Big River for metropolitan supply was not recommended. The Board proceeded to implement the recommendations.

It was at this stage that one of the most severe droughts in Melbourne's history occurred. Unusually low rainfall throughout 1967 and the first four months of 1968 caused storages to be seriously depleted. Moderate restrictions on use were first introduced in September 1967, and progressively extended. By April 1968, the volume of water stored in the reservoirs had fallen to the equivalent of only about four months' supply. The drought broke at the end of April, storage levels gradually rose, and restrictions were removed by September. This drought emphasised Melbourne's vulnerability to severe droughts and highlighted the need for additional storage. As a result, construction of the Cardinia Reservoir and the first stage of the Thomson River diversion were advanced.

In 1972, below average rainfall from March onward resulted in Melbourne's storages failing to fill in the winter and spring. By early summer, another drought was in progress, which approached that of 1967-68 in severity. Unfortunately, neither the Thomson River diversion nor the Cardinia Reservoir was completed. Increasingly severe restrictions on water use were enforced and again drew attention to the lack of sufficient storage.

The new Standing Committee on Water Supply, formed by the Commission, the Board, and the Treasury, advised the Victorian Government in the emergency. On its recommendation of January 1973, the Government asked the Board to begin the Yarra Brae storage immediately, to begin the second stage of the Thomson River diversion as soon as possible, and to investigate immediately the siting of a major new reservoir on either the Thomson or Yarra Rivers.

Public opposition to the Yarra Brae storage was so great that, after the drought broke, the Victorian Government decided construction would not begin until the effects of the storage on the natural and social environment had been investigated and considered. A study by the Board to which other government bodies and the public contributed, indicated that another scheme in the Lower Yarra area was better and in 1974 the Victorian Government authorised the Board to proceed with building the Winneke Reservoir and associated works. These procedures were the forerunner to the development of formal environmental impact assessments.

Finally, in 1977, the Board was given approval to proceed with the third stage of the Thomson River diversion. The study ordered in 1973 of the siting of a major new reservoir had concluded that the Thomson was a better prospect than Watsons Creek in the Lower Yarra catchment. The third stage was designed to increase Melbourne's total storage of

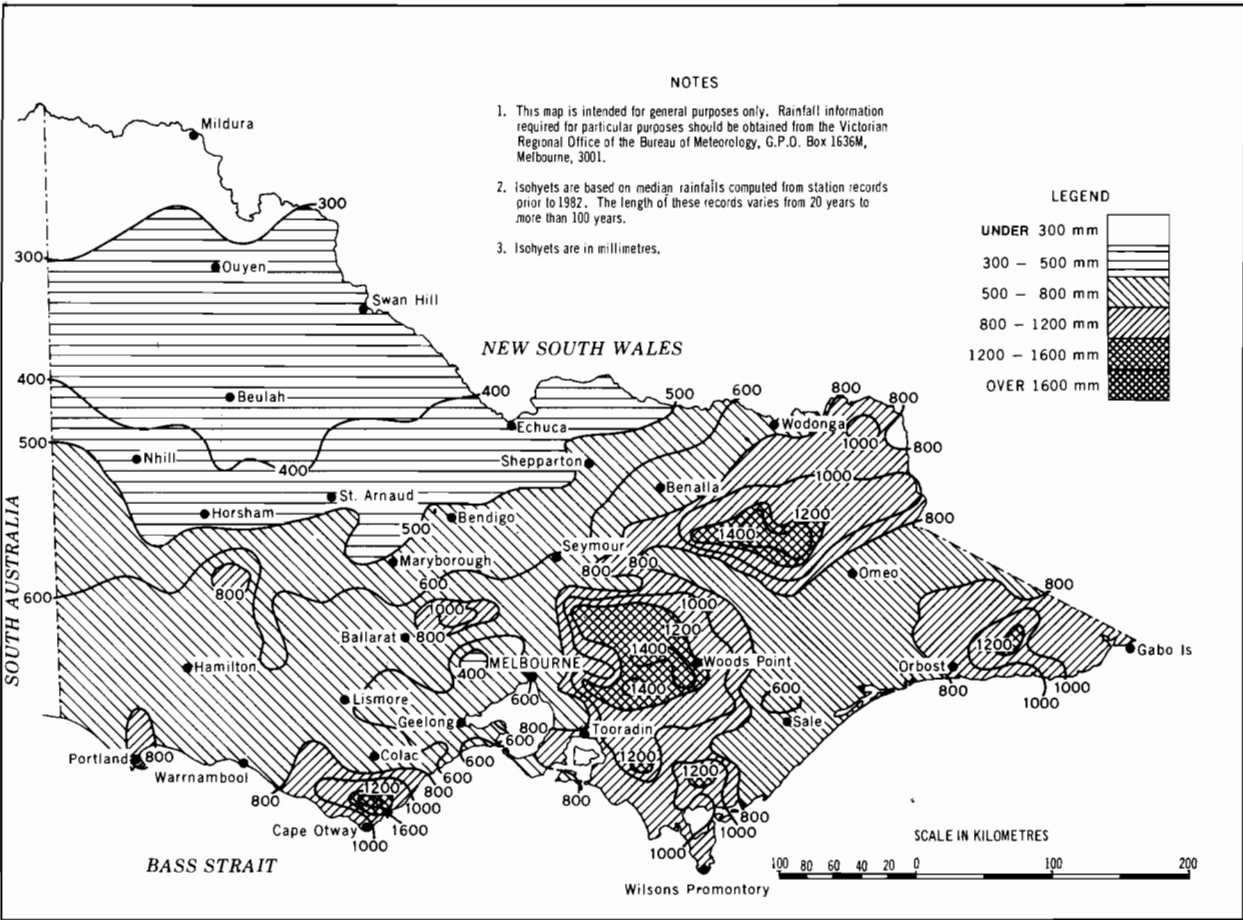


FIGURE 16. Victoria—Median annual rainfall. (The median annual rainfall is that value which has been exceeded during half the years on record and not exceeded during the other half.)

Source: Bureau of Meteorology.

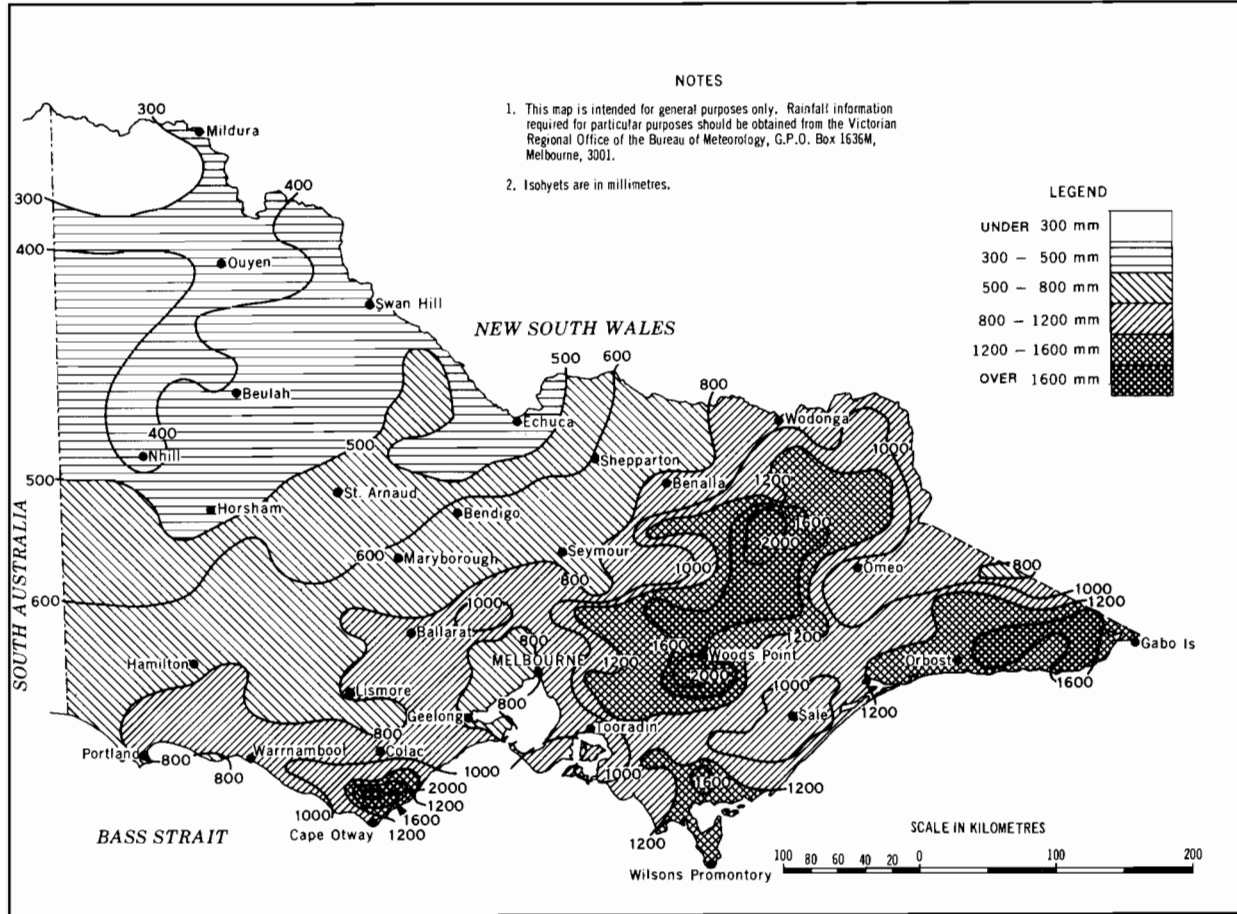


FIGURE 17. Victoria—Rainfall for the year 1978, representing a “wet year”.

Source: Bureau of Meteorology.

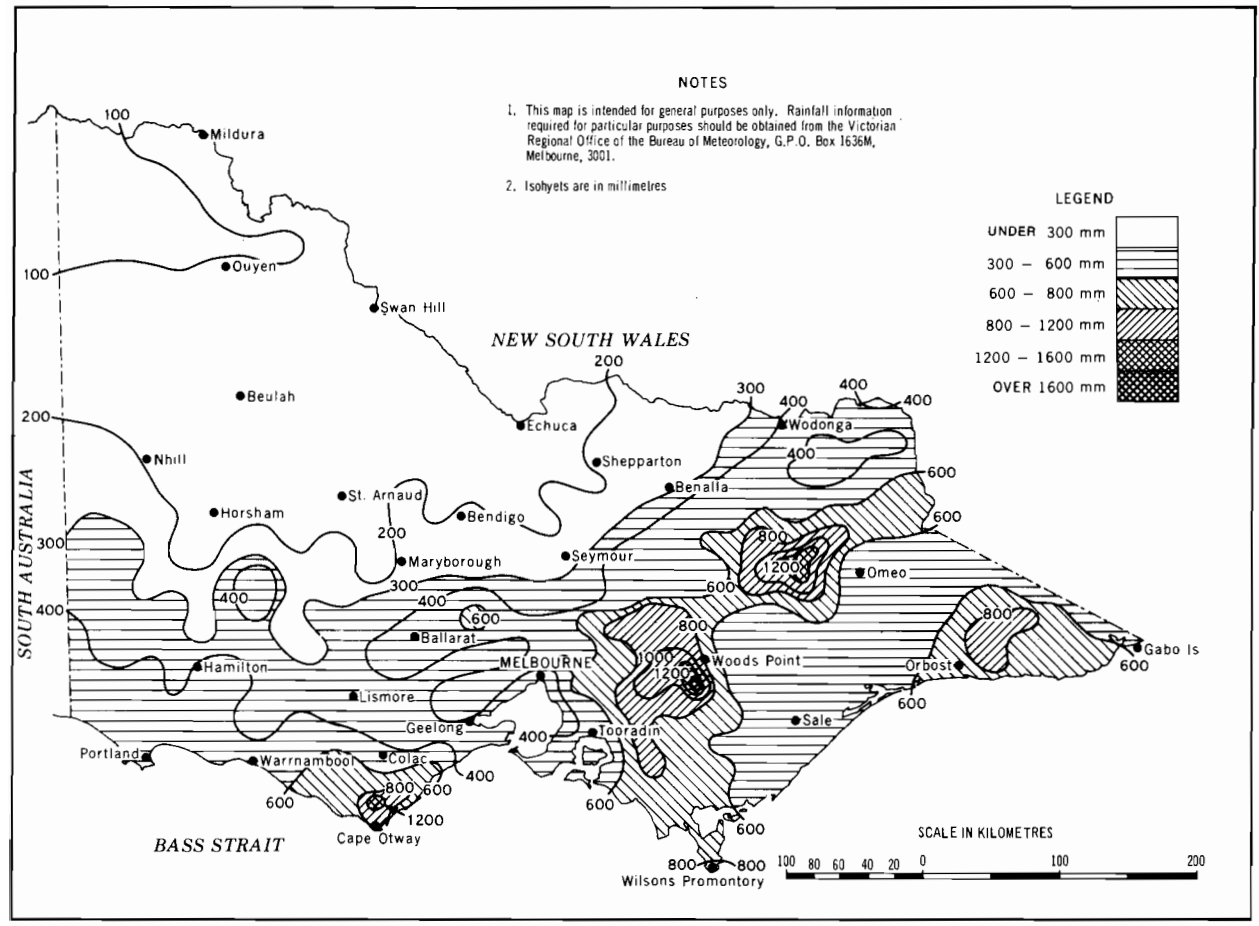


FIGURE 18. Victoria—Rainfall for the year 1982, representing a “dry year”.

Source: Bureau of Meteorology.

water to three times its annual consumption. This would afford such security of supplies that restrictions would be necessary only very infrequently, and would be no more severe than restrictions on garden watering.

Other major works constructed after the 1967 and 1972 droughts were the Greenvale Reservoir, the Yarra Valley Conduit between Upper Yarra Reservoir and Silvan Reservoir, the Silvan-Cardinia Conduit, and the Cardinia-Dandenong Conduit. The first two stages of the Thomson River diversion were completed by 1977, and the Cardinia Reservoir was filled in 1977. Diversion of waters from the Thomson River had been planned for both metropolitan use and to supplement the Mornington Peninsula system; the connection between the metropolitan and peninsula systems was made in 1981.

**MELBOURNE WATER SUPPLY:
CONNECTIONS AND CONSUMPTION,
1935-36 TO 1981-82**

Year	Number of improved properties supplied with water as at 30 June	Annual consumption	Maximum daily consumption
		megalitres	megalitres
1935-36	266,909	121,980	653
1940-41	297,392	142,134	772
1945-46	308,731	130,009	736
1950-51	354,415	169,229	970
1955-56	424,500	187,922	971
1960-61	510,078	253,772	1,550
1965-66	612,844	269,487	1,818
1970-71	696,018	332,506	1,863
1975-76	829,941	384,058	2,290
1980-81	913,652	453,306	2,933
1981-82	930,573	451,416	2,838

Source: Melbourne and Metropolitan Board of Works

**MELBOURNE WATER SUPPLY:
ANNUAL WORKING EXPENSES
(INCLUDING INTEREST),
1935-36 TO 1981-82**

Year	Total	Average per improved property
		\$
1935-36	1.35	5.04
1940-41	1.47	4.96
1945-46	1.81	5.87
1950-51	2.83	7.98
1955-56	4.67	11.08
1960-61	8.08	15.83
1965-66	12.15	19.83
1970-71	19.18	27.56
1975-76	45.90	55.31
1980-81	95.96	105.02
1981-82	121.41	130.47

Source: Melbourne and Metropolitan Board of Works.

It has always been the Board's policy to use its catchments exclusively for water supply and to preclude all habitation and industry from them with the objective of obtaining an economic, virtually untreated supply of water for the city. The Board has undertaken detailed studies into the effects of different land treatments on the quality and quantity of water, setting up experimental catchments at Coranderrk, near Healesville, in 1955, and in the North Maroondah area in 1969. Valuable information was gathered, and a report published in 1981 that was intended to provide a basis for management strategies.

After the passage of the *Health (Fluoridation) Act 1973*, and the subsequent direction by the Commission of Public Health that fluoride should be added to Victoria's water supplies, the Board commissioned and constructed fluoridation plants at seven strategic points in the metropolitan supply system during 1976-77.

Outer Melbourne metropolitan areas and country towns

By 1934, 401,700 persons in 223 towns were provided with a reticulated water supply; 98 of these town supplies were administered by the Commission and the balance was managed by local authorities. From 1933 to 1939, unemployment relief funds of some \$6m were an important source of finance for work on many town water supplies. Major projects were completed including extensions and improvements to the main urban systems of the Mornington Peninsula, the Otways, and the Coliban. Unemployment relief funds were also used for the removal of drift sand from the channels of the Wimmera-Mallee system.

During the Second World War, the only water works constructed by the Commission were for camps for servicemen or prisoners of war; work on the Rocklands Dam to store water for the Wimmera-Mallee system had to be suspended in 1942 and the site camp was used by the RAAF.

In the La Trobe Valley, water supply works constructed by the State Electricity Commission (SEC) on the Tyers River were extended by the Commission before being handed over to the Latrobe Valley Water and Sewerage Board in 1954. Later developments included construction of the Moondarra Reservoir and connection to the existing system by the Tyers River pipeline. These works provided bulk water supplies to Morwell and Traralgon and large quantities of water to the SEC for power generation and to Australian Paper Manufacturers Ltd (APM) at Maryvale for its paper mill.

From 1943, finance for town water supplies (and sewerage) was provided directly by the Victorian Government at the interest rate of 3 per cent per annum. Local authorities also had access to these funds as well as to capital borrowed on the private market on which the Victorian Government provides annual subsidies to limit the interest and redemption to 3.25 per cent in the case of water trusts and 3.5 per cent for sewerage authorities. During the 1970s, government funding of these services was generally restricted and the trend was for privately borrowed capital to form an increasing part of local authorities' total capital funds. Similarly, developers of land were required to provide the services as part of the land development process. In 1965, 80 per cent of the capital for country town supplies (about \$4m in that year) was met from government funds and the balance by private loans. By 1980, the annual capital expenditure had risen to \$18.2m of which \$13.4m or 74 per cent was financed from private loans. The provision of works for urban supplies directly controlled by the Commission has become a major part of its activities. In 1965 capital expenditure was about \$1m per annum; by 1979-80, this had risen to about \$9.6m. In 1981, the Victorian Government changed the basis of assistance for the urban water and sewerage services by adopting, in principle, the phasing out of interest subsidies and introducing revenue subsidies for the towns that were providing services at a cost well above the State average.

Since the Second World War, and particularly during the late 1960s and early 1970s, development on the Mornington Peninsula has been substantial (population increased by about 5 per cent per annum in the 1970s). In 1981, more than 270,000 persons lived in an area extending from Neerim South in the north-east to Portsea in the south-west. To keep pace with demand, the supply system has been developed from its small beginnings to a large integrated network of storages, pipelines, pumping stations, and associated works. The distribution network has grown from 40 kilometres of pipelines in 1930 to 1,900 kilometres in 1980.

The headworks of the present system are situated on the Bunyip and Tarago Rivers, with Tarago Reservoir, constructed in 1964, being the major storage. A high rate of growth on the Peninsula is expected well into the 1990s as the area continues to absorb part of greater Melbourne's growth. To provide security of supply until the turn of the century, additional water was obtained from the Board's Cardinia Reservoir from 1981.

In 1968 the Eppalock pipeline and pump station were installed to supplement the Coliban system, which supplies Bendigo, from Eppalock Reservoir. By 1980 a total of 70,000 persons received reticulated water, and a further 1,900 rural properties received water for domestic, stock, or irrigation purposes.

The Otway Waterworks District, extending from the Otway Ranges to Warrnambool, and including towns along the Princes Highway west of Camperdown, provided water to a total population of 120,000 in 1980. Since 1958, the resources of the system have been

supplemented by pumping from the Gellibrand River. Until 1976, the Otway Main pipeline was the only conveyor of water from the headworks. However, growing demand necessitated the construction of the South Otway pipeline and additional pumping facilities on the Gellibrand River. This pipeline delivers water some 80 kilometres to Warrnambool and provision has been made for boosting supply as demand increases.

Works were commenced in 1927 to augment the supply to Geelong and the Bellarine Peninsula by tapping the Barwon River. With the rapid growth of the city, the Commission handed over responsibility for the headworks to the Geelong Water and Sewerage Trust in 1955. The influx of holiday makers to the Bellarine Peninsula greatly increased the effective population to be supplied, and compounded the necessity to provide for a basic growth rate of 4 to 5 per cent per annum during the 1970s. In 1976, by arrangement with the Geelong Waterworks Trust, the Commission commenced the installation of a pipeline to augment the water resources of the Bellarine Peninsula system; the first stage was completed in 1978.

To indicate the trend in expansion of water supplies to country towns the statistics for Ballarat show that, between 1959 and 1979, the population increased from 55,000 to 71,500 (30 per cent) and water consumption from 7,986 megalitres to 13,516 megalitres (69 per cent). During the record dry year of 1967, in which water consumption by Ballarat reached 118 megalitres per day, the Ballarat Water Commissioners entered into negotiations with the Water Commission and the Geelong Waterworks and Sewerage Trust with a view to constructing a storage on the West Moorabool River at Bungal, near Lal Lal. The Bungal Dam was completed in 1973 by the West Moorabool Water Board set up for that purpose in 1968 with the pumping station, pipeline, and other works to convey water from the dam to Ballarat being completed in 1976. The storage has subsequently been managed by the Ballarat Water Commissioners.

By 1980, reticulated water supplies were provided to a total of 461 towns in Victoria outside the metropolitan area, serving a total population of approximately 1,080,000. Of these town supplies, 335 were managed and maintained by local authorities while the Commission directly controlled supplies to 126 towns. The position had been reached in Victoria where practically every community with more than 200 residents has a reticulated water supply, and each year new systems are constructed for even smaller communities. Artificially fluoridated water was used in 54 provincial cities and towns in 1981; the first to have fluoride added to its water supply was Bacchus Marsh, in 1962.

Since the first water treatment plant in Victoria was installed at Shepparton in 1930, several local water supply authorities have sought to improve the quality of the water supplied from their systems through the construction of treatment plants. The number of towns that receive a fully treated and chlorinated supply has increased from five in 1954 to 32 in 1980.

RURAL WATER SUPPLY

Closer settlement

One of the most important factors in water supply in rural Victoria has been the closer settlement of country districts. This already had a long history in Victoria and was seen as necessary if the Commission was to make irrigation in northern Victoria efficient. Government support extended to the acquisition and subdivision of land and the promotion of schemes overseas to attract settlers. After the First World War, closer settlement was also seen as a means of placing returned soldiers on the land. Legislation in 1918 transferred responsibility for the purchase and settlement of lands in irrigation areas to the Water Commission from the Lands Purchase and Management Board. Settlements were developed at Werribee, Nyah, Shepparton, Swan Hill, Red Cliffs, Kerang, Tongala, Woorinen, Maffra, and Sale. By 1934-35, the total area irrigated had reached 200,000 hectares.

After the Second World War, closer settlement in irrigation areas was conducted jointly by the Commission and the Soldier Settlement Commission (later the Rural Finance and Settlement Commission, then the Rural Finance Commission). This phase of development included the Murray Valley Irrigation Area, Robinvale, and the Nambrok-Denison Scheme in the Macalister Irrigation District. Dunbulbalane and the Campaspe Irrigation District were also settled at this time but as closer settlements, not soldier settlements.

Royal Commission on Water Supply, 1936

Like most members of the community, irrigation farmers were badly affected by the economic Depression of the early 1930s. Many of them fell substantially in arrears with payment of their water rates and a number of the Commission's districts accumulated growing financial losses.

In 1936, the Victorian Government appointed the Royal Commission on Water Supply to inquire into, among other things, the financing of capital works in irrigation districts and whether irrigation farmers should be excused their arrears of rates. The Royal Commission recommended financial relief for irrigators, and the *Water Act* 1937 and an amendment in 1940 provided remission of substantial arrears and the payment of the rest in instalments. The Victorian Government also adopted the Royal Commission's recommendation that the liability for capital works should be transferred from the irrigators to the State.

Soil conservation

Of all the difficulties faced by the Commission in the 1930s and 1940s, the most trying and expensive was sand drift in the Mallee. Closer settlement in the area meant clearing of the land and long fallows for wheat farming, and thus the Mallee sands began to drift. The drifts were worse in dry years when there was only poor germination of grasses and crops, and the period from 1938 until 1945 was the worst. It was during these years that dust storms frequently carried the Mallee soil to Melbourne and sometimes as far as New Zealand.

The significance of the sand drifts for the Commission lay in the Wimmera-Mallee Supply System, a network of 16,000 kilometres of open earthen channels that supplied in 1982 some 22,000 farm dams and 51 townships in the Wimmera and the Mallee with water for their livestock and domestic use; the source of water for the system lies in the reservoirs in the Grampians. Long stretches of these channels would fill with sand, and every year the Commission had to put men and horses on the job of shifting it so that the annual "channel run" of water could begin. The Wimmera-Mallee Division monopolised so much of the Commission's resources in those years that it was frequently referred to as "the second Commission", the "first" one being the rest of the Commission put together.

Because of the sand drifts, the Minister of Water Supply and the Commission became the sponsors of soil conservation in Victoria. After the severe drought of 1938, in which sand drift "reached colossal proportions", some lengths of channel were replaced by pipes, others moved to more stable land, and others provided with three chain (60 metres) reserves, fenced and sown with cereal rye to maintain cover. The Commission also acquired power under a by-law "to prohibit the clearing, cultivating or fallowing of land, likely to drift, within one chain of any channel under the control of the Commission". This power was incorporated in the *Water Act* 1942, which extended the distance from a channel over which that power could be exercised to three chains (60 metres).

In 1940 Harold Hanslow, one of the Water Commissioners, donated the Hanslow Cup to be awarded in a competition for the "Best Effort to Control Soil Drift on a Mallee Farm". In the same year, aided by Hanslow's recommendations, the Minister of Water Supply sponsored the *Soil Conservation Act* 1940, which established the Soil Conservation Board; the Board's functions were principally research, advice, and co-ordination of the activities of government departments insofar as they affected soil conservation.

The drought of 1944 and early 1945 saw more sand than ever drift into the channels, and in the financial year of 1945-46 the Commission had to spend \$645,654 on the removal of 9,400,000 cubic metres of sand from the channels—the same volume of material as was later required to build the embankment of Lake Eildon.

Soon after, the Victorian Parliament passed the Soil Conservation and Land Utilisation Act, which came into effect in July 1947. This established the Land Conservation Authority, which in 1949 became the Soil Conservation Authority; the Authority later took over the Hanslow Cup competition. The major difference between the Authority and the old Soil Conservation Board lay in the Authority's power to direct land owners to remedy erosion, to impose conditions on the use of land to prevent erosion, and to regulate the use of land in catchments.



Aerial view of the Werribee Farm showing lagoon treatment of wastewater on the edge of Port Phillip Bay.

Melbourne and Metropolitan Board of Works

The South-Eastern Purification Plant, near Carrum, treats approximately 30 per cent of Melbourne's wastewater. The final effluent is conveyed from Carrum to Bass Strait via a 50 kilometre outfall conduit, discharging at Cape Schanck.

Melbourne and Metropolitan Board of Works





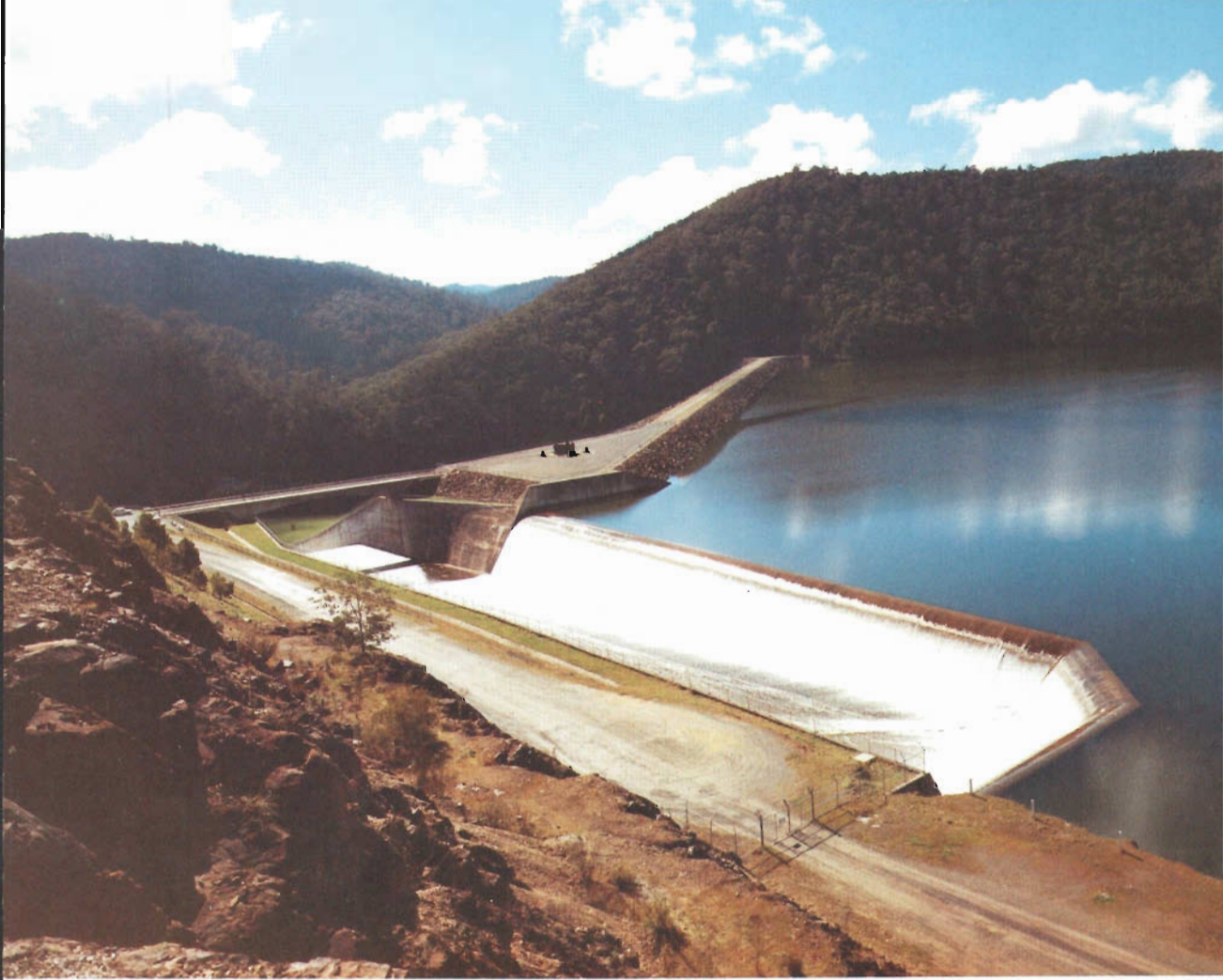
Cardinia Reservoir, near Emerald, an outer Melbourne suburb, is the largest operational reservoir in Melbourne's water supply system with a capacity of 287,000 megalitres.

Melbourne and Metropolitan Board of Works

The effects of dry-land salting in northern Victoria. The clearing of native forest and vegetation, and the introduction of irrigation agriculture has contributed to the salination and waterlogging of land.

State Rivers and Water Supply Commission





The Upper Yarra Reservoir near Warburton is a key storage in Melbourne's water supply system with a capacity of 200,000 megalitres.

Melbourne and Metropolitan Board of Works



The State Rivers and Water Supply Commission since its inception has managed rivers for the control and regulation of water supply. This includes river bank improvement and drainage works.

State Rivers and Water Supply Commission

Inspection of the old Eildon Reservoir in 1946 by Mr L. R. East (Chairman of the State Rivers and Water Supply Commission) (foreground), Mr M. G. Speedie, Dr J. L. Savage, and Mr E. D. Shaw (background, left to right). The new dam was being considered for construction at this time.

State Rivers and Water Supply Commission



Eildon Reservoir with the hydro-electric generator power station at the base of the dam wall.

State Electricity Commission of Victoria





Early private dam construction utilised teams of draught horses and scoops. This enabled layers of soil to be placed in and around dam sites which were later trodden down and compacted by the horses.

State Rivers and Water Supply Commission

The Thomson Dam near Erica in Gippsland under construction in 1982. When completed this dam will impound about 1.1 million megalitres of water and the reservoir will extend for some 23 kilometres from the wall.

Melbourne and Metropolitan Board of Works



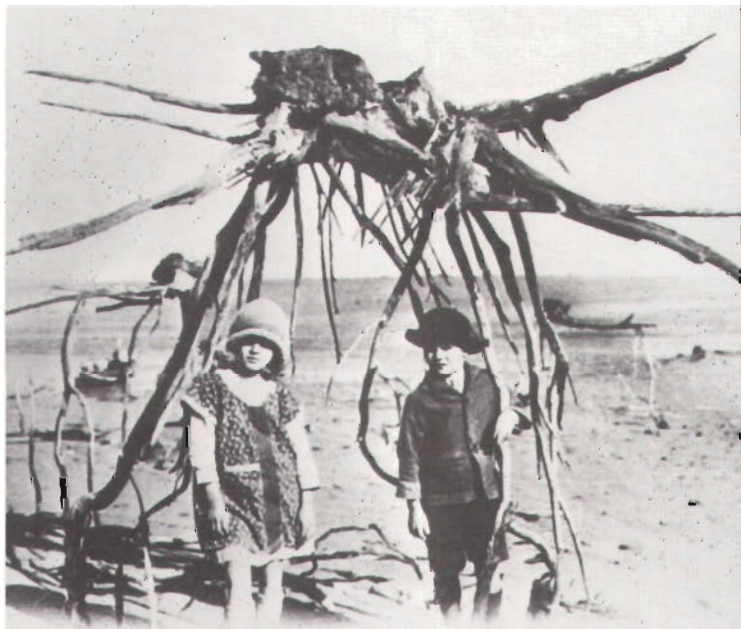


Flooding of the Yarra River in 1934 covered the Burke Road Bridge at Kew.

The Age

During the 1930s, high winds caused millions of tonnes of soil to blow away in the Mallee region. In some areas two metres of soil shifted, exposing tree roots.

Soil Conservation Authority



A dust storm heads towards Mildura, January 1968.

Sunraysia Daily



Millewa pipeline

The Depression and the dry years of the 1930s had also caused some Mallee settlers to abandon their farms, especially in the north-west, the Millewa, where the farms were too small to support the settlers through a series of dry years. In 1950, under the North-west Mallee Areas Act, the area was re-subdivided, the holdings being increased in size and reduced in number, and this afforded the Commission the opportunity to re-organise the channel system on more economical lines.

The Millewa Waterworks District is supplied with water from the Murray River, originally through open earthen channels. However, the porous soils of the area meant that the channel system delivered to the farms and towns only about 12 per cent of the total water diverted from the river, and the State Development Committee in 1966 recommended the replacement of the channels with pipelines. The Committee and the Commission had as their model the piped water supply to Rainbow West which was completed in 1958. The piping of the Millewa District was completed in 1975; 621 kilometres of Commission channels and 370 kilometres of farm channels were replaced with pipelines and the volume of water saved annually was estimated to be 9,140 megalitres.

Water storage construction

Closer settlement, the intensification of agriculture, and increased use of water had effected a large increase in the productive capacity of the northern areas of the State. This in turn generated an assured demand for water, but by the late 1930s development was limited by the volume of water available from storages and the capacity of the distribution systems. By 1941 the Commission was already studying the practicability of enlarging Eildon Reservoir, and the severe water shortages in the drought years of 1938, 1944, and 1945 further emphasised the need to conserve more water.

The Commission had built Yarrawonga Weir and the Hume Dam on behalf of the River Murray Commission before the Second World War, but it was only after the war that the Commission could begin the programme of enormous expansion in storage capacity that made possible the great post-war expansion of irrigation in Victoria.

The enlargement of the Eildon Reservoir in central Victoria was one of the biggest water conservation projects to be undertaken to that date in the southern hemisphere. The contract was let in 1950 to the Utah Construction Company. It proved to be a time of what was then regarded as rapid inflation, and during 1952 practically all the Commission's other construction work had to be shut down in an effort to keep up payments to the contractor. Even the Eildon project had to be slowed down because of the shortage of funds. The slowing down caused hundreds of workers to be dismissed, but the contractors completed the project in approximately the tendered time and at a cost of \$52m.

Eildon introduced large-scale American contractors and their methods to Australia, and Australians rapidly learned to emulate their achievements, as was later demonstrated on works carried out by Australian contractors and constructing authorities.

The completion of the new Eildon Reservoir in 1955 proved that its 3.4 million megalitres of stored water would be not only valuable in droughts. Exceptional weather conditions over the Murray and Goulburn catchments caused particularly severe and prolonged flooding along the Murray River. The new reservoir practically filled in a few months in 1956 instead of the forecast two and a half years under average conditions, and substantially reduced the volume of flood waters reaching the Murray from the Goulburn. It is believed that this saved the towns of Wentworth and Renmark from complete inundation.

Rocklands Reservoir on the Glenelg River was completed in 1954, and added 340,000 megalitres to the storages of the Wimmera-Mallee Domestic and Stock Water Supply System. The Rocklands scheme was the first in Australia to divert the waters of a coastal river on a large scale to supply the needs of the less well watered inland.

Work on the Cairn Curran Dam had been stopped by the financial conditions of the early 1950s, but was completed in 1956 and conserved the waters of the Loddon River for the northern irrigation districts.

Eppalock Dam near Bendigo was completed in 1963. Its waters are used both for supplementing the Campaspe Irrigation District and providing water to Bendigo. Power for its pumps is obtained from hydraulic turbines operated by part of the water released

for irrigation downstream; it was the first installation of this type in Australia. Water is also available to supplement the Goulburn-Murray system.

In 1963 the Bolte Government asked the Commission to submit a ten year programme for the construction of country water storages so that the Commission could proceed from one project to the next without having to disband its construction team every time a project was completed. The Victorian Government approved of the Commission's programme, estimated to cost \$74m, and promised that funds would be provided each financial year to meet the cost. This was the first time that any Victorian Government had promised funds for more than one financial year except in the case of the Eildon contract.

Apart from the Chowilla Dam, proposed for the Murray River downstream of Mildura, the Commission had completed the ten year programme of constructing country water storages by 1972, thus substantially fulfilling the target originally set by the Victorian Government in 1964. The individual projects were the Devilbend Reservoir on the Mornington Peninsula (14,500 megalitres) completed in 1964; Lake Buffalo near Myrtleford (capacity 24,000 megalitres) completed in 1965; Lake Bellfield near Halls Gap (78,500 megalitres) completed in 1967; the Greens Lake Scheme near Corop (capacity 32,500 megalitres) completed in 1968; Lake Nillahcootie on the Broken River near Benalla (capacity 40,000 megalitres) completed in 1968; Tarago Reservoir near Neerim South (capacity 37,500 megalitres) completed in 1968; the first stage of Lake Merrimu on Coimadai Creek near Bacchus Marsh (capacity 19,000 megalitres) completed in 1969; Lake Mokoan on Winton Swamp near Benalla (capacity 365,000 megalitres) completed in 1971; and Lake William Hovell on the King River south of Wangaratta (capacity 13,500 megalitres) completed in 1971.

MAJOR WATER STORAGES : VICTORIA, 1857 to 1981

Name of dam	Year of completion (or enlargement)	Height of embankment	Type (a)	Capacity of reservoir (megalitres)	Owner (b)
Yan Yean	1857	(metres) 12	TE	206	MMBW
Upper Stony Creek					Geelong Water and Sewerage Trust
No. 1	1868	29	TE	3,420	
Spring Gully	1869 (1929)	24	TE	2,500	SRWSC
Barkers Creek	1869	13	TE	2,700	SRWSC
Malmsbury	1870 (1887 and 1940)	24	TE	18,000	SRWSC
Newlyn	1871 (1960)	12	TE	3,300	SRWSC
Crusoe	1873	12	TE	1,500	SRWSC
Lower Stony Creek	1875	21	PG	640	Geelong Water and Sewerage Trust
Gong Gong	1877	30	TE	1,830	Ballarat Water Commission
Evansford	1887 (1940)	17	PG	1,620	Maryborough Waterworks Trust
Wartook	1887	11	TE	29,500	SRWSC
Mt Cole	1889 (1926)	24	VA	400	Ararat City Water Supply Commission
Goulburn Weir (Nagambie Reser- voir)	1890	15	PG	25,000	SRWSC
Laanecoorie	1891 (1909)	22	TE	8,000	SRWSC
Korumburra No. 1	1895 (1924)	15	TE	130	Korumburra Waterworks Trust
Upper Coliban	1903 (1917 and 1925)	28	TE	31,500	SRWSC
Waranga Basin	1905 (1917 and 1925)	12	TE	411,000	SRWSC
Korwein- guboorra	1910	12	TE	2,091	Geelong Water and Sewerage Trust
Pykes Creek	1911 (1930)	39	TE	24,000	SRWSC
Lance Creek	1911	17	TE	1,900	SRWSC
Moorabool	1915	18	TE	6,640	Ballarat Water Commission
Melton	1916 (1937 and 1967)	35	ER	17,000	SRWSC
Beaconsfield	1918	24	TE	900	SRWSC

MAJOR WATER STORAGES : VICTORIA, 1857 to 1981—*continued*

Name of dam	Year of completion (or enlargement)	Height of embankment	Type (a)	Capacity of reservoir	Owner (b)
		(metres)		(megalitres)	
Frankston	1920	19	TE	680	SRWSC
Taylor's Lake	1923	12	TE	36,000	SRWSC
Eildon	1927 (1955)	79	TE, ER	3,390,000	SRWSC
Maroondah	1927	41	PG	28,370	MMBW
Glennaggie	1928 (1958)	37	VA, PG	190,000	SRWSC
Pine Lake	1928	16	TE	64,000	SRWSC
O'Shannassy	1928	34	TE	4,220	MMBW
Silvan	1931	43	TE	40,210	MMBW
Lysterfield	1934	14	TE	4,200	SRWSC
Yallourn Weir	1935	12	PG	490	SEC
Tank Hill	1938	19	TE	760	SRWSC
Yarrowonga Weir	1939	22	TE, VA	117,500	River Murray Com- mission
Ryan's Creek	1940	21	TE	678	Benalla Waterworks Trust
Lauriston	1941 (1949)	33	CB, ER	20,000	SRWSC
Junction	1945	26	CB	1,480	SEC
White Swan	1951	41	TE	14,060	Ballarat Water Com- mission
Rocklands	1954	28	PG, ER	348,000	SRWSC
Bostock	1955	27	TE, ER	7,430	Geelong Water and Sewerage Trust
Cairn Curran	1956	44	TE	148,000	SRWSC
Clover	1956	24	CB	290	SEC
Korumburra No. 3	1956	17	TE	410	Korumburra Water- works Trust
Upper Yarra	1957	89	TE, ER	207,200	MMBW
Rocky Valley	1959	32	ER	28,370	SEC
Tullaroop	1959	41	TE, ER	74,000	SRWSC
McCay	1960	30	TE, ER	1,400	SRWSC
Moondarra	1961	41	ER	30,840	Latrobe Valley Water and Sewerage Board
Yallourn Storage	1961	21	CB	8,020	SEC
Eel Hole Creek	1962	21	TE	30,840	SEC
Eppalock	1963	45	TE, ER	312,000	SRWSC
Candowie	1964 (1977)	17	TE, ER	1,900	Westernport Water- works Trust
Djerriwarrah	1964	18	TE	750	Melton Waterworks Trust
Herne's Oak	1964	23	TE	350	SEC
Devilbend	1964	27	TE, ER	14,500	SRWSC
Buffalo	1965	30	TE, ER	24,000	SRWSC
Hyland	1965	22	TE	680	Leongatha Water- works Trust
West Barwon	1965	43	TE, ER	21,820	Geelong Water and Sewerage Trust
Running Creek	1966	20	ER	345	Hurstbridge Water- works Trust
Bellfield	1967	55	TE, ER	78,500	SRWSC
Nillahcootie	1968	35	TE, ER	40,000	SRWSC
Tarago	1968 (1973)	34	TE, ER	37,500	SRWSC
Merrimu	1969	37	TE, ER	19,000	SRWSC
Mokoan	1971	10	TE	365,000	SRWSC
William Hovell	1971	35	TE, ER	13,500	SRWSC
Greenvale	1971	52	TE, ER	26,540	MMBW
Bungal	1972	49	ER	59,600	West Moorabool Water Board
West Gellibrand	1972	23	TE	2,000	Colac Waterworks Trust
Cardinia	1973	86	TE, ER	279,000	MMBW
McCall Say	1973	21	TE	1,130	Benalla Waterworks Trust
Roslynne	1974	37	TE, ER	24,500	SRWSC
Battery Creek	1976	17	TE	136	Fish Creek Water- works Trust
Nicholson River	1976	16	PG	636	Lakes Entrance Water- works Trust

MAJOR WATER STORAGES : VICTORIA, 1857 to 1981—*continued*

Name of dam	Year of completion (or enlargement)	Height of embankment (metres)	Type (a)	Capacity of reservoir (megalitres)	Owner (b)
Swingler	1977	16	PG	400	MMBW
Lerderberg Weir	1977	14	PG	60	SRWSC
Mountain Hut	1978	17	ER	230	Euroa Waterworks Trust
Dartmouth	1979	180	TE, ER	4,000,000	River Murray Com- mission
Winneke	1981	85	ER	100,000	MMBW

Source: State Rivers and Water Supply Commission.

(a) CB: Buttress; ER: rock fill; PG: gravity; TE: earth; VA: arch.

(b) MMBW: Melbourne and Metropolitan Board of Works; SEC: State Electricity Commission; SRWSC: State Rivers and Water Supply Commission.

Improvements in water distribution

Besides the construction of water storages, the Commission undertook many other major works after the Second World War in the renovation and enlargement of distribution systems. The two main projects of the 1950s were the electrification of the Red Cliffs irrigation pumps (1954) and the duplication of the Goulburn-Waranga channel.

The original, or main, channel connecting the Goulburn Weir to the Waranga Reservoir, now known as the Stuart Murray Canal, was completed in 1904 to deliver water from the Goulburn River to the Waranga Basin and to northern irrigation districts. It had a capacity of 3,600 megalitres per day, was 40 kilometres long, and was the major factor in the great development of irrigation in northern Victoria through its vast network of main and distributary channels. The question of increasing its capacity was investigated by a Parliamentary Public Works Committee in 1946 which decided that a channel capacity of at least 7,200 megalitres per day was necessary to utilise fully the water available from Eildon Reservoir. The Committee recommended duplication of the Goulburn-Waranga channel to increase capacity rather than enlargement of the existing channel, which was retained. The remodelling and enlargement of distributary channels in the Goulburn irrigation system was also begun in the 1950s so that they could carry the extra water available from the enlarged Eildon Reservoir.

Pipelines were used to improve the distribution of water in the Mallee irrigation districts that were supplied by pumps on the Murray, i.e., Tresco, Nyah, Red Cliffs, and Merbein. Earthen channels were replaced by pipes, most of which had thin concrete linings, and this reduced losses of water through evaporation and seepage. The Tresco district was completed in 1975, and at the end of 1980 Nyah was also completed, Merbein was nearly completed, and Red Cliffs over half completed. Robinvale had originally been constructed as a pipeline system in 1947 and served as a model for these later improvements.

Chowilla and Dartmouth Dams

The construction of a dam at Chowilla on the Murray River, just downstream of the border of South Australia with Victoria, was deferred in 1967 by the River Murray Commission because of greatly increased cost and other factors. Subsequently, it was found in the exceptionally severe drought of 1967-68 that a flow of 2,200 megalitres per day was required below Mildura to keep salinity in the Murray below reasonable limits, which would be impossible if the dam were built. It had also been found that evaporation losses from the dam each year could be 50 per cent higher than originally envisaged. The River Murray Commission engaged consultants in 1967 to examine the question of salinity in the Murray River basin, and requested the Snowy Mountains Authority to report on the practicability of a dam site on the Mitta Mitta River at Dartmouth.

It was concluded from these investigations that a storage at Dartmouth would provide greater benefit in terms of cost and yield. The Dartmouth Dam (capacity 4,000,000 megalitres) was subsequently constructed by the Commission for the River Murray commission and was completed in 1979 at a cost of \$139m, borne equally by the Commonwealth Government and the States of New South Wales, Victoria, and South Australia under the River Murray Waters Agreement. The embankment of the dam, the highest in the southern hemisphere, is 180 metres high and contains 14.1 million cubic

metres of earth and rock fill. Dartmouth Dam has increased the safe yield of the Murray system by approximately 900,000 megalitres per annum, subject to its being operated to give reasonable drought security.

Irrigation expansion after the Second World War

The expansion and intensification of irrigated agriculture in Victoria after the Second World War began with the settlement of returned soldiers. Soldier settlements at Robinvale and in the Murray Valley Irrigation Area began in 1947, and in the Nambrok-Denison district in Gippsland in 1950. In the Murray Valley the Commission not only constructed the channels to serve 24,000 hectares, but undertook the grading and preparation of a substantial part of each farm. Lucerne or mixed pastures were sown in readiness for the settlers so that they could be productive from the day they went into occupation; 450 mixed farms and 140 orchard blocks were prepared.

The additional water available for irrigation from Eildon and the other water conservation projects was used for the intensification of irrigation within the irrigation districts — for instance, water rights in the Goulburn-Murray Irrigation District have more than doubled since 1955 to about 1.8 million megalitres in 1980. Moreover, the efficiency of water distribution, i.e., the ratio of water delivered to that received from the headworks, increased steadily from around 50 per cent in the 1950s to around 70 per cent in the 1970s.

The area of irrigated agriculture in Victoria estimated by the Commission increased steadily from about 42,000 hectares in 1906-07 to about 350,000 hectares in 1954-55. With the increase in available water after the enlargement of Eildon, irrigation development accelerated and reached a peak of 600,000 hectares in 1972-73. The most recent statistics show that, in 1981-82, 576,000 hectares were irrigated. The predominant culture is flood irrigated pastures (native, annual, or perennial) which amounted to 80 per cent of the total area irrigated and are used for livestock production such as dairying, beef, wool, lamb, and mutton. Irrigated vineyards, orchards, and market gardens amounted to 58,000 hectares in 1981-82.

The total of 576,000 hectares irrigated includes 76,000 hectares irrigated by private diverters from surface and ground waters outside the irrigation districts. The private diverters' production is mostly horticultural and this accounts for the estimated value of their production in 1981-82 being \$152m out of a total for all irrigation of \$565m.

Developments in administration and finance

So far, the expansion and intensification of irrigated agriculture in Victoria can be seen to have depended on closer settlement, the expansion of storage capacity, and improvements in the distribution system. To these should be added several key developments in administration and finance. The first was the compulsory charge for water rights allocated to "commanded and suitable lands" in the irrigation districts. This was first imposed by the Water Act of 1905 but it was revised by the Water Act of 1909 which based the charge on the volume of water right; the previous Act had based it on the net annual value of farms. Surveys were necessary to define areas of commanded and suitable land and until they were completed the Water Commission charged a rate per acre per watering. Thereafter, the compulsory charge ensured an income for the Commission and stimulated use of the water right or the sale of the land to someone who would use it, developments that accorded with Dr Mead's views on how irrigation in Victoria could be made to pay. For some time, land owners resented this measure, but when the droughts of subsequent years proved the value of irrigation, the attitude changed.

The basis of water entitlements in the irrigation districts is a volume of water, the water right, that is allocated to each farm in proportion to its area of irrigable land. The water right is the basis for compulsory water charges. In most years, water in excess of water right can be made available and the total seasonal entitlement is expressed in terms of a percentage of water right. The volume of water made available in most years varies between 130 and 165 per cent of water right, while the water actually delivered varies between 120 and 140 per cent. The allocation of water and the operation of the supply system are aimed at maximum availability of water in each year and a guarantee that, should dry conditions prevail, at least the water right will be delivered.

The Depression of the 1930s drew attention to the irrigators' difficulty in financing both the capital liabilities and the maintenance of irrigation districts. This was resolved by the 1936 Royal Commission, and since then most capital expenditure on the storage, distribution, and drainage of water has been borne by the taxpayer. The ground for this is that, while irrigation certainly benefits the individual farmer, it also benefits the community generally through assured food supplies, the decentralisation of population, and the development of other related support industries in country areas. Nevertheless, the irrigators still found it difficult to pay for the operation and maintenance of irrigation districts, especially in periods of economic recession even though government held water charges down to such a level that the supply works deteriorated through lack of maintenance. There was an improvement in the finances of districts in the years following the Second World War but heavy operating losses occurred in many of the older ones.

Under the Water Acts, the Commission normally revised its valuations of lands within irrigation districts every five years. When the valuations were revised on the basis of the greatly increased prices being paid for irrigation lands in the 1950s, there were widespread protests and appeals against the valuations. A test case in 1959 upheld one of the appeals and reduced the Commission's valuation by 40 per cent. The court case showed that, in areas that had been settled and developed for many years, it was practically impossible to assess the unimproved capital value, i.e., the value of the land before clearing and improvement. On a technical point, the court also quashed Commission rates in all irrigation districts, and so, to validate those rates, Parliament passed the *Water Irrigation Districts Act 1959*; the Act also reduced all valuations from 1 July 1954 by 40 per cent, in line with the court's decision.

The Commission had long been urging that all valuations should be reviewed and reassessed, and in 1960 the Victorian Government passed legislation for the appointment of a Valuer-General to undertake this task. Further legislation followed in 1968 to clarify the definition of unimproved capital value under the name "site value".

The amalgamation in 1959 of all the irrigation districts served by the Goulburn, Loddon, and Murray systems to form the Goulburn-Murray Irrigation District (GMID) greatly assisted the financial management of the districts. The irrigation districts that had previously operated independently became irrigation areas within the GMID, with a common basis of water rights. They were then managed as a single financial enterprise with the same local administration and staffing as before. A similar advantage was gained by the formation of the Macalister Irrigation District, comprising the Maffra-Sale and Central Gippsland Irrigation Areas.

As water rights and sales in the GMID increased in the 1950s and 1960s, water deliveries and charges also increased. Since the increases were achieved with much the same staff as before, unit costs were lower and the district revenue began to match costs.

The drought of 1967-68 resulted in some 10,000 private bores being sunk throughout Victoria. This increase in the use of ground water caused a number of problems particularly around Koo-Wee-Rup and on the flats of the King and Mitchell Rivers where ground water levels declined dramatically. The *Ground Water Act 1969*, was the first legislation to control the use of ground water in Victoria, and the Commission and the Department of Minerals and Energy became responsible for its administration.

Salinity and drainage

By the time the area of land under irrigation in Victoria was reaching its peak in the 1970s, more and more questions were being raised about whether irrigation should be promoted further. The questions were concerned with the economics of irrigation and its effects on the environment—such as the salinisation and waterlogging of land in the irrigation areas, the increasing amounts of salt finding their way into rivers, particularly the Murray, and the modification of riverine environments, their flora and fauna, by reservoirs and regulation of flows for irrigation. At the same time, the Commission saw the need to concentrate on improving what had already been developed rather than expanding irrigation any further. The most pressing need was to solve waterlogging and salinity problems because, unless that were done, the future of considerable areas of irrigated land would be bleak.

In the early period of irrigation development, the provision of water was paramount and channel construction had preceded any provision for drainage. Within a relatively short time, water tables began to rise, particularly in the Cohuna and Kerang Irrigation Districts, and because of the salinity of the ground water, problems of soil salinity and alkalinity developed. Since 1920, the Water Commission has progressively provided surface drainage in the districts irrigated by gravity. In most cases, irrigators have been well served by these provisions although, in 1977, an irrigator near Sale claimed damages for flooding. The case was decided in 1979 in the Commission's favour, with the Supreme Court upholding the criteria the Commission uses for designing such drainage works—namely, that the system is to provide for a nominated level of service and there is no responsibility on the Commission for the consequences of floods beyond the capacity of the drain.

Surface drainage proved inadequate in coping with rising water tables and increasing salinisation of land. In the 1930s, sub-surface drainage had been installed to protect horticulture in the Sunraysia district, and in the late 1960s a combination of sub-surface drainage and piped water supply permitted much of the Tresco Irrigation Area to be reclaimed from salinisation. Then, in 1966-67, sub-surface drainage in the form of ground water pumping was used to reclaim land in the Macalister Irrigation District. The success of this work encouraged the Commission to investigate the suitability of ground water pumping for protecting irrigated land elsewhere.

The severe drought of 1967-68 caused a deterioration of water quality in the Murray River and led to the identification of the Sunraysia district and the Barr Creek catchment as the largest Victorian contributors to Murray River salinity. After the drought, the River Murray Commission engaged Gutteridge, Haskins and Davey as consultants to investigate and report on salinity in the Murray River. The consultants' report was published in 1970 and formed the basis of the Commission's own strategy for dealing with salinity and waterlogging along the Murray. That plan was published in 1975, and the Victorian Government referred it to the Parliamentary Public Works Committee for recommendations on its adoption.

Meanwhile, the very wet years of 1973 to 1975 resulted in serious waterlogging, with horticulture in the Shepparton region suffering the worst losses. The Commission began the extension of surface drainage in the region and the installation of a comprehensive grid of ground water pumps; the Victorian Government provided funds for the Rural Finance Commission to finance private ground water pumps that would complement the Commission's. The ground water is discharged to channels and drains and more than half is used for irrigation. Operating rules limit salinity in channels receiving ground water and the contribution of salt to the Murray.

The Parliamentary Public Works Committee recommended a number of the Commission's 1975 proposals. Two important schemes have recently been completed—works at Mildura and Merbein to intercept saline ground water flowing into the Murray and divert it to the Wargan evaporation basins (1980), and the remodelling of the Woorinen evaporation basins to increase their capacity (1979). The Victorian Government also accepted the Parliamentary Committee's recommendation of loans for works by irrigation farmers that would mitigate salinity and waterlogging on their own farms.

Other recommended works were a scheme to increase the evaporation capacity of the Barr Creek works, the extension of surface and sub-surface drainage in the Shepparton region, disposal works for the drainage proposed for Nangiloc and Colignan, and a wide ranging programme of investigations into ground water and salinity.

Perhaps the most unfortunate aspect of the spread of waterlogging and salinity in the 1970s was that their worst effects, during the wet years between 1973 and 1975, coincided with considerable economic difficulty in irrigated agriculture—over-production of wine grapes, the reduction in public subsidisation of dairying and canning fruits, and the collapse of the export market for beef. The loss of the British market consequent upon Britain joining the European Economic Community also contributed to these difficulties.

However, conditions improved, largely because of the coincidence of good seasons in the late 1970s with excellent markets for wheat and mutton. The rationalisation of the dairying, beef, and canning fruits industries also greatly improved returns to the remaining

farmers. The economic improvement has been reflected in a widespread resolution by irrigators to solve their waterlogging and salinity problems themselves, particularly by the remodelling of irrigation layouts in the GMID.

SEWAGE AND WASTEWATER DISPOSAL

Melbourne metropolitan area

The original sewerage system for Melbourne, commissioned in 1897, was based on a network of sewers collecting and conveying wastewater from the urban areas to a point at Spotswood on the west bank of the Yarra River. From there it was pumped to the Main Outfall Sewer, which then conveyed the sewage 25 kilometres to the Metropolitan Sewage Farm at Werribee. The scheme was designed for an eventual population of 1,000,000 persons and it provided a sound framework for extending the network of sewers as urban development occurred.

By 1935, the population served by the system just equalled the population for which it had been originally designed, and the enlargement of various parts was becoming necessary. In 1937, the sides of the uncovered portions of the Main Outfall Sewer were raised to increase its capacity from 409 megalitres to 545 megalitres per day. A separate system was completed in 1941 to serve the south-eastern suburbs of Mentone, Parkdale, Mordialloc, and Cheltenham; it included a new treatment plant at Braeside. By the early 1940s sewers had been provided for 96 per cent of the population of the metropolitan area and of the remaining 4 per cent a large proportion was either scattered in predominantly rural areas or in locations where sewerage was not justified.

When Melbourne's system was first commissioned in 1897, the sewage was treated by filtration through the soil of the Metropolitan Sewage Farm at Werribee, the sewage being applied to the land by flood irrigation. This method is still used, although grass filtration in the winter and lagoon treatment were introduced in 1930 and 1937, respectively, to augment the treatment capacity of the farm.

The lagoon system has been used extensively since the Second World War and now treats about 50 per cent of the wastewater received at the farm. It is the most extensive of such systems in Australia and was the first in the world to make use of anaerobic lagoons in modern sewage treatment.

Systematic grazing of the pastures has been essential to maintain the land and grass filtration areas in a suitable condition for sewage purification. For this purpose, large numbers of livestock (some 20,000 sheep and 15,000 cattle) have been grazed over the area. The revenue derived from the sale of fat stock has materially reduced the cost of sewage treatment.

Sewerage construction was suspended from March 1942 to conserve materials and manpower for war purposes. After the war the Board was unable to keep pace with the demand and by 1956, there were some 52,000 houses in areas more than half developed for which sewers were not provided. The unsewered houses used septic tanks and pan services, but other household wastes still flowed into drains and watercourses, thus giving rise to water pollution throughout the metropolitan area.

In the early 1950s, the extension of the sewers and the enlargement of the whole system were regarded as having equal urgency and it was proposed to carry them on concurrently at a rate permitted by the availability of designs, labour, materials, and capital funds. In 1952, several proposals were considered including one for the disposal of untreated sewage from part of the metropolitan area into the ocean near Cape Schanck. The estimated cost of the scheme and the time required for construction were, however, too great and would have delayed the provision of sewerage for the other suburbs. A modified scheme was, therefore, adopted by the Board in 1955 with the aim of providing sewers to the largest number of properties in the shortest possible time, having regard to the funds available.

This new scheme was to be constructed in two stages, the first being a new trunk sewer from Spotswood to Brooklyn, a new pumping station at Brooklyn to replace the Spotswood Pumping Station, enlargement of the Main Outfall Sewer, additional treatment capacity at the Werribee farm, and several large relieving and intercepting sewers. Enlargement of the Main Outfall Sewer began in 1958 and the Brooklyn Trunk Sewer and Pumping Station were completed in 1964. The Hobsons Bay Main Sewer, which crosses under the lower

reaches of the Yarra River, also had to be lowered to permit the river to be widened and deepened for shipping. The difficult task of tunnelling under the river was successfully completed in 1971.

The second stage of the enlargement programme was approved in principle by the Board in 1964 and consisted of the construction of a new sewerage system, the south-eastern system. The metropolitan area was divided into two zones, eastern and western; the western zone would continue to be served by the Werribee system while the eastern zone would change over to the south-eastern system. This required the construction of some 33 kilometres of trunk sewer extending from Kew to Carrum, and the first stage (290 megalitres per day) of a modern purification plant at Carrum. Considerable public discussion ensued about whether the effluent from the treatment plant should be discharged into Port Phillip Bay or Bass Strait. The matter was settled in 1969 when the Victorian Government directed that an ocean outfall 57 kilometres in length should be constructed to discharge the effluent into the ocean near Cape Schanck. In June 1975, the South-eastern Purification Plant commenced treating flows; by 1978, it was treating approximately 180 megalitres per day and the discharge to the farm at Werribee had been reduced from 570 to 410 megalitres per day.

In the 1960s, at the same time as the whole system was being enlarged, the rate of providing sewers for improved properties approximately doubled. The extension of the sewers received further help in 1974 when the Commonwealth Government initiated the National Sewerage Programme to overcome the backlog of sewerage works in Australian cities.

**MELBOURNE AND METROPOLITAN BOARD OF WORKS:
SEWERAGE CONNECTIONS, EXPENDITURE
AND WORKING EXPENSES, 1935-36 TO 1981-82**

Year	Number of improved properties for which sewers were provided	Average annual expenditure between years shown	Total annual working expenses plus interest
		\$m	\$m
1935-36	251,507	0.52	1,650
1940-41	281,288	0.22	1,821
1945-46	291,536	1.16	1,891
1950-51	321,548	2.46	2,792
1955-56	358,805	6.93	4,235
1960-61	395,109	15.11	6,823
1965-66	467,705	24.89	11,971
1970-71	559,000	68.74	22,458
1975-76	662,912	71.38	65,274
1980-81	793,118	87.48	122,042
1981-82	820,075		146,903

Source: Melbourne and Metropolitan Board of Works.

In 1971, the Victorian Government transferred to the Board the responsibility for sewerage a substantial number of properties in the eastern fringe of Melbourne, in the northern part of the Dandenong Creek catchment, and the Brushy Creek catchment. To serve the area, the Board commenced the Eastern Region Sewerage Scheme, a feature of which is the use of temporary treatment plants until the Dandenong Valley Trunk Sewer is completed. Sewage from the area will then be conveyed to Carrum for treatment.

In the 1970s, a number of the major sewers were constructed as tunnels. This greatly

reduced the disturbance to the community, the interruption of other services, the cost of reinstating them, and the claims from property owners, all of which are associated with sewers constructed in trenches.

In the development of Melbourne's sewerage system, particular consideration has been given to the preservation and enhancement of the environment, particularly as it relates to the protection of the waters of Port Phillip Bay and the streams and water courses draining into the Bay. In view of the recreational and commercial value of the Bay, the Board, in conjunction with the Fisheries and Wildlife Division and the Port Phillip Authority, began a study in 1967 of the physical, chemical, and biological characteristics of the Bay waters. The first phase of this study was completed in 1973 and indicated that the Bay as a whole was relatively unpolluted. Wastewater discharges have risen progressively over the years as a result of population growth and industrial expansion. The per capita discharge of domestic wastewater also increased steadily during the fifteen years up to about 1960 because of extensive installation of hot water services, washing machines, and other water using appliances. Subsequently, the discharge per person levelled off and remained virtually unchanged.

The provision of sewers to new residential and industrial development has generally been hindered by a lack of capital funds, particularly since the Second World War. For several years, the Board, when requested by the subdivider, constructed sewers in new subdivisions at the subdivider's expense, and then refunded 80 per cent of the outlay to the subdivider when 80 per cent of the properties were connected. In 1968, the Board decided to reduce the refund and end it entirely for agreements made after April 1970. Then, in February 1970, the Board invoked its powers under the Melbourne and Metropolitan Planning Scheme to require subdividers to meet the cost of sewerage works in certain areas. In addition, they were required to contribute a minimum of \$1,730 per hectare of subdivided land towards the cost of main sewers and treatment facilities. These measures were strengthened in 1973 by the Local Government (Subdivision of Land) Act which ensured that sewerage would be provided in new subdivisions as they were developed.

Outer Melbourne metropolitan areas and country towns

By 1934, sewerage had been provided for 122,750 persons in eight country towns (Ballarat, Bendigo, Colac, Echuca, Geelong, Mildura, Swan Hill, and Warrnambool). The systems were installed and operated by local authorities under the general supervision of the Commission. From then until 1939, when resources were directed to military needs, another seven towns had been seweraged — Bairnsdale, Benalla, Castlemaine, Dandenong, Hamilton, Kerang, and Shepparton.

Sewerage construction was slow to resume after the war because of shortages of labour and materials. By the early 1950s, sewerage services were provided to some 260,000 persons in 60 centres — an increase of only 40,000 in a decade. In 1959, however, the Victorian Government provided substantially more funds and thirteen schemes were begun. Thereafter, construction was fairly vigorous and, by 1980, 137 sewerage authorities served 1,024,000 persons outside the metropolitan area in addition to those served by the Geelong and La Trobe Valley authorities.

The Sewerage Districts Act was amended in 1973 to allow authorities to require all new subdivisions to be seweraged. Provision was also made to allow authorities to sewer land that was already subdivided and recover the cost from the owners. In 1976, the Act was amended again to allow a sewerage authority to administer more than one district.

Treatment processes

Because of the cost of engineering works and equipment, biological oxidation and stabilisation in lagoons gradually became more usual in the 1920s and 1930s. The early lagoon systems used anaerobic basins for primary treatment, followed by aerobic ponds and a maturation lagoon. Although this treatment is most efficient, the anaerobic sections cause offensive odours. In more recent times, oxidation lagoons have been designed to operate so that they do not give rise to odours.

Fine-bubble activated sludge plants have recently been installed at Mornington, Melton, and Sunbury, where larger capacities can be provided in stages for future population increases. A recent variation of the activated sludge process has been the oxidation ditch.

In the mid-1950s, the Latrobe Valley Water and Sewerage Board constructed a pipeline to dispose of wastewaters from APM's paper manufacture and the Gas and Fuel Corporation's production of gas from coal. The pipeline went from Morwell to Rosedale from where an open channel took the waste to the coast, near the Ninety Mile Beach. Originally, it was intended that the effluents would be discharged into the sea but, when they were found to be suitable for irrigation, a large area of land was developed near Dutson for irrigation and disposal. After twenty-five years, the capacity of this land to absorb the wastes was exceeded and it was necessary to design an alternative disposal system. Just prior to this, the disposal of increasing quantities of saline water arising from power generation in the La Trobe Valley was provided for by a pipeline constructed from the Loy Yang power station to McLoughlin's Beach and completed in 1981.

In 1975, the Victorian Water Resources Council set up the Reclaimed Water Committee which continued earlier work by the Commission and the Board on the use of treated wastewater. Trials are being carried out on vegetables, cereal crops, trees, and other plants to determine safe standards for future uses; some golf courses and recreation areas are already being watered with treated effluent. The increasing interest in the use of reclaimed water also led the Health Commission to issue revised regulations for its use in 1978.

RIVER IMPROVEMENT, REGIONAL DRAINAGE, AND FLOOD PLAIN MANAGEMENT

The flood of most significance in Victoria was that which occurred in December 1934. Exceptionally heavy rain was recorded in Melbourne, the catchments to its east, and Gippsland. In just 36 hours, Silvan recorded 330 mm of rain, landslides threatened the conduits supplying water to Melbourne, and the Koo-Wee-Rup area was well under water, as were the suburbs adjacent to the Yarra River (the Yarra flood levels are now used as a guide for the issue of building permits). Large floods occurred in various areas of the State in other years, such as 1952, 1956, 1973, 1975, and 1978, and have significantly influenced changes to legislation and responsibilities.

As a contrast, the severe drought of 1938-39 climaxed in the disastrous bush fires of January 1939 when very large areas of Victoria—in particular, the forest areas of the Great Dividing Range—were devastated. The catchments for Melbourne's water supply suffered severely and, although extensive regrowth has now restored the heavy forest cover, the records of stream flows over this period illustrate the effects that loss of the forest cover and the subsequent re-growth of young trees can have on the water harvest.

River improvement

Since its inception, the Commission has had general powers to manage rivers for the control and regulation of water supply. Very little attention was given to the problems of stream management until the passage of specific legislation in 1948.

An inquiry in 1945 by the Parliamentary Public Works Committee made three major recommendations for river management. The first was that a land utilisation council should be established to advise on land-use in catchments; the council would comprise representatives of the Commission, the Departments of Lands, Agriculture, and Mines, the Forests Commission, and the Soil Conservation Board. This recommendation was given effect to by the *Soil Conservation and Land Utilisation Act 1947*.

The second recommendation was that the Commission should control river improvement and drainage works. Works could be undertaken either by locally constituted trusts or the Commission, but the Commission has not been able to do so because it has not been funded for that purpose. Considerable work has been carried out by the trusts, acting under the general supervision of the Commission. The third recommendation, that funds for these works should be increased and put on a regular basis, was accepted.

The first trust, the King River Improvement Trust, was constituted in 1950; by 1980, 32 trusts were operating. Each trust established since 1963 has been constituted to cover the whole of a municipality (or municipalities), to provide a wider base for consideration of benefit and associated revenue raisings; this approach is more consistent with consideration of stream management on a catchment basis.

In 1975, the Commission established a Standing Consultative Committee on River

Improvement representing a wide range of resource management agencies. The Committee has prepared guidelines for river management to ensure that consideration is given to the environmental consequences of proposed works.

Regional drainage and flood plain management

Problems arise from the encroachment of residential, industrial, and sporting developments on land liable to flooding. There have been a number of measures over the years to assist in the control of such development, including approval of plans of sub-divisions by municipal councils (1914), provisions under the Health Act (1919), and the Uniform Building Regulations (1945).

Drainage works in the 19th century and early parts of the 20th century were essentially concerned with the development of land for rural purposes or to deal with specific problems of urban development. The 1934 flood can be seen as a significant event not only in its own right, but also in its influence on subsequent events. The Commission, for instance, established a Rivers and Reclamation Section with specific responsibilities for drainage works in the Koo-Wee-Rup and Carrum areas. The 1936 Royal Commission on Water Supply suggested that drainage rates should be levied over an entire catchment, not just the areas benefiting from drainage, and particularly referred to the Koo-Wee-Rup, Cardinia, and Carrum districts. This proposal was not adopted by the Victorian Government. As early as 1943, there were also moves to form a drainage authority encompassing the Dandenong Creek catchment.

During the 1930s and immediately after the Second World War, funds and materials for main drains were very limited and the Board had to construct drains to only "half capacity" in some metropolitan areas, particularly Brighton, Caulfield, Moorabbin, Mordialloc, Clayton, and Glenroy. Subsequent development in these areas led to frequent and severe occurrences of flooding and required the construction of relief drainage in the 1960s and 1970s.

In some areas of Melbourne such as along Gardiners Creek, Moonee Ponds Creek, and Merlynston Creek, the topography was suitable for the construction of retarding basins to reduce the run-off to amounts more suited to the downstream capacity of the drainage. The first of these basins was completed in Hawthorn East in 1927, but most of them were constructed between 1958 and 1968 when seventeen basins were completed, the largest being at Jacana on Moonee Ponds Creek. However, because of the extensive encroachment of residential, industrial, and sporting developments on lands liable to flooding, the Board also had to provide increased capacity by engineering works such as concrete linings, piling, and piping.

A means of controlling development on metropolitan flood plains came with the Melbourne and Metropolitan Planning Scheme in 1955 which enabled land to be reserved for public open space along many reaches of major water courses. In many areas, however, municipal councils proceeded to level or fill this land, which interfered with the passage of flood waters and plans for future drainage works. This led to the introduction in 1963 of a planning requirement that the natural condition and topography of the land could not be altered without the permission of the planning authority, the Board.

Outside Melbourne, the wet years of the early 1950s caused Lake Corangamite to rise to unusually high levels and flood surrounding farm land. The Commission constructed a channel to divert sufficient of its water to the Barwon River for the surrounding land to be protected from flooding in the future.

The *Drainage Areas Act* 1958 was the successor to previous legislation for the drainage of agricultural land. Eighty-four drainage areas were proclaimed under this Act and works carried out to improve agricultural productivity, but the legislation was deficient in that no adequate provision was made for subsequent maintenance of works.

After investigations overseas by the then chairman of the Commission, Sir Ronald East, a proposal was made in 1957 to provide for river boards that would manage regional drainage and rivers throughout almost the whole of the State. However, the State Government's proposal to give effect to this was not accepted in the Upper House in the Parliament and it was not until 1963 that the concept was to receive partial statutory recognition through the establishment of the Dandenong Valley Authority.

Rapid increases in run-off were being caused by extensive domestic and industrial

development in the catchment of the Dandenong Creek. Local councils recognised that flooding was becoming a problem in the upper part of the catchment and made urgent requests for action. The Dandenong Valley Authority Act established the principle of financing drainage services on a catchment basis by requiring all land owners, from the limits of the catchment to the outfall, to contribute to the cost of handling the run-off from the catchment. The Act also empowered the Dandenong Valley Authority to control all development, building, and works within areas it declared to be liable to flooding so that the capacity to pass flood flows could be preserved.

The Authority has been responsible for the development of two important concepts: namely, the organisation of contributory drainage schemes to cover the whole of subsidiary catchments by essentially voluntary agreement between land owners, and the use of a combination of small drains and grassed channels, instead of large main drains, to carry flood flows. The Authority also extended the use of retarding basins to include their use in controlling peak flows within quite small sub-catchments of comprehensive drainage schemes.

By the mid-1960s, virtually all municipal councils were using their power under a 1962 amendment to the Local Government Act to require construction of roads and drainage within sub-divisions at the time of sub-division. While the new sub-divisions were adequately drained and no regular flooding was likely to result within the sub-divisions, the provisions of the Act did not apply to the improvement of drainage along water courses. Consequently, the widespread construction of road pavements in sub-divisions led to an increased risk of flooding along many of the major metropolitan water courses.

Another consequence of the attempts by municipal councils and other authorities to control the use of riverine lands and the drainage of land, particularly in new sub-divisions, was that several drainage disputes went to court in the 1950s and 1960s. In 1965, the Victorian Parliament established a Joint Select Committee on Drainage that reported in 1967 and 1970, recommending many changes in the law associated with drainage and the use of riverine lands. These reports gave rise to the *Environment Protection Act 1970*, which regulated, among other things, the discharge of wastes into water courses.

In 1972, the State Development Committee reported on the provision of water and sewerage to new sub-divisions, which was followed in December 1973 by the passage of the Local Government (Sub-division of Land) Act. This Act provided, *inter alia*, amendments to the Local Government Act, the Melbourne and Metropolitan Board of Works Act, the Dandenong Valley Authority Act, the Sewerage Districts Act, and the Water Act.

In short, the amendments to the Local Government Act gave drainage authorities the power to object to plans of sub-division on grounds of drainage, and the right to require proper measures to be taken to dispose of and control drainage from the proposed development. The Act also amended the Board's Act so that municipalities were no longer entitled to connect drainage to a system under the Board's control until "a drain or water course [was certified as] adequate or suitable for the acceptance of the additional water which is likely to enter it".

By this time, the increasing concern in the community for conservation and improvement of the environment was an important factor in the development of Melbourne's drainage. This was evident in the protests against the location of freeways along water courses and the channelling of creeks into constructed drains. Increased efforts were made by the Board to reduce the need for new drainage works by the use of retarding basins, and to landscape the creeks so that they not only provide the required flow capacity but are also visually attractive. This led to increasing interaction between responsible authorities and community groups.

The Joint Select Committee on Drainage had also recommended the establishment of regional drainage authorities, and flooding in 1971 and 1973 kept this issue under notice. However, the concept was omitted from the Drainage of Land Act, which was passed in 1975, basically because of opposition to the principle that people living in the highlands should contribute financially to the resolution of drainage problems occurring downstream.

The *Drainage of Land Act 1975*, empowered the Board and the Commission to seek declaration of areas along major water courses as being liable to flooding. New approaches to flood control under the Act were set out in the report of the Victorian Water Resources Council, *Flood Plain Management in Victoria*. The report gave principles for defining

flood plains, together with guidelines for permissible works and structures in flood prone areas, and led to the adoption in 1978 of the one per cent probability flood as the level for defining land that was liable to flooding and a guide for planning purposes.

The Drainage of Land Act attempted to set out the rights and obligations of individuals and authorities in relation to the passage of drainage waters. It aimed at the preservation of natural drainage characteristics, established a Drainage Tribunal for the settlement of disputes, and provided for the declaration of drainage courses by public authorities. These intentions proved difficult to translate into legislation, and amendments were necessary in 1978 and 1981. The functions of the Drainage Tribunal were incorporated in the functions of the Planning Appeals Board in 1981.

Urban development to the west of Werribee was identified in the early 1970s as being in the probable path of waters that might break away from the Werribee River in the event of a flood. A subsequent dispute reached the Town Planning Appeals Tribunal and resulted in a voluntary scheme between land owners, the Shire of Werribee, and the Victorian Government to identify the flood problem and propose solutions on a regional basis. This example led to the passage of the *Water (Drainage) Act 1978*, which empowered the Commission to develop regional drainage proposals. Provision was made for consultative committees to enable the widest possible participation by affected people in the drawing up of proposals.

In November 1978, the Uniform Building Regulations were strengthened so that municipal councils could impose appropriate conditions on development in areas liable to flooding; provision was made for consultation by councils with the drainage authority about the likely flood levels.

Some inadequacies in these provisions were immediately recognised particularly concerning the nomination of flood levels and the consequent risk of a council's being liable for damages. Specific problems occurred at Echuca and Horsham relating to buildings proposed for vacant allotments within otherwise well developed areas. The *Local Government (Land Liable to Flooding) Act 1979*, was introduced and specifically acknowledged that a risk of flooding could exist.

The *Building Control Act 1981* repealed previous legislation controlling buildings on land liable to flooding and a new building regulation defining the respective responsibilities of the municipalities and the drainage authorities was gazetted in 1982. Further legislation statutorily defining the "one per cent probability flood event" as the flood of reference and empowering the definition of flood fringe areas was introduced in 1982.