Ontario

Royal Commission Inquiry into Grand River Flood 1974

Leach

Ontario

Report of the Royal Commission Inquiry into the Grand River Flood 1974

Commissioner
His Honour Judge W. W. Leach

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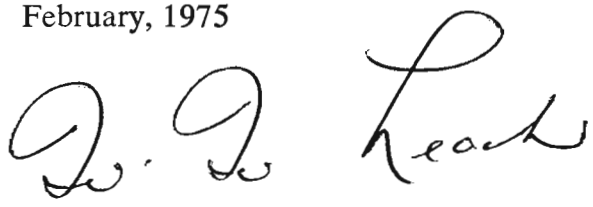
To Her Honour,
The Lieutenant-Governor of the
Province of Ontario

May It Please Your Honour:

Having been appointed by Royal Commission to perform the duties set out in Commission and the Order in Council authorizing it, I respectfully submit to Your Honour my report.

February, 1975



Commissioner

The Order-in-Council O.C. 1600/74

An Order-in-Coucil approved by Her Honour the Lieutenant-Governor, dated the 26th day of June, A.D. 1974.

The Committee of Council have had under consideration the report of the Honourable the Minister of Natural Resources, dated June 18th, 1974, wherein he states that,

WHEREAS the flooding of the Grand River in the Province of Ontario which occurred on the 16th, 17th and 18th days of May, 1974, resulted in considerable property damage, and

WHEREAS such flooding and damage are matters of public concern, and

WHEREAS it is thought fit to refer these matters to an inquiry instituted pursuant to the provisions of the Public Inquiries Act, 1971, S.O. 1971, Chapter 49.

The Honourable the Minister of Natural Resources therefore recommends that pursuant to the provisions of the Public Inquiries Act, 1971, S.O. 1971, Chapter 49, a Commission be issued to appoint His Honour Wilfred Wesley Leach, Judge of the County Court of the Judicial District of Haldimand to inquire into and report upon the nature, extent and causes of the flooding of the Grand River on the 16th, 17th and 18th days of May, 1974, the resulting damage from the said flooding and in particular the action of the Grand River Conservation Authority, participating municipalities and the relevant Ministries of Government of Ontario in the operation of the major dams and reservoirs and the flood warning and communications systems and to make such recommendations as he may deem fit.

The Honourable the Minister of Natural Resources further recommends that all Government Ministries, Boards, Agencies and Commissions shall assist His Honour Wilfred Wesley Leach to the fullest extent in order that he may carry out his duties and functions, and that he shall have authority to engage such counsel, expert technical advisors, investigators, and other staff as he deems it proper at rates of remuneration and reimbursement to be approved by the Management Board of Cabinet.

And the Honourable the Minister of Natural Resources further recommends that Part III of the said Act be declared to the said Inquiry.

The Committee of Council concur in the recommendations of the Honourable the Minister of Natural Resources and advise that the same be acted on.

Certified

J. J. Young
Clerk, Executive Council

Organizational Chart - Grand River Flood Inquiry

Commissioner

His Honour Judge W. W. Leach

Secretary to Commissioner

Mrs. B. MacDonald

General Counsel

R. S. Montgomery, Q.C.

L. Gilbertson, Esq.

– Investigations

– Evidence

– Examination of Witnesses

– Administration of Inquiry

– Transcripts

Consultant

Professor H. D. Ayers, B.A., M.S.,
Director of School of Engineering
University of Guelph

Clerk

J. H. Symington

– Clerk for Inquiry

– Record of Inquiry

– Exhibits

Registrar

F. A. Waters

– Security

– Accommodation

– Finances

– Press Relations

Counsel Representing Interested Parties

Mr. R. J. Miller, Esq. – Counsel for Grand River Conservation Authority

Mr. J. Jenkins, Q.C. – Counsel for Flood Disaster Association

Mr. F. L. Moore, Esq. – Counsel for Regional Municipality of Waterloo

Mr. V. B. Copp, Q.C. – Counsel for City of Cambridge

Mr. J. H. Shivas, Esq. – Counsel for City of Kitchener

Mr. M. Smith, Esq. – Counsel for Minister of Natural Resources

Mr. J. A. Wynn, Q.C. – Counsel for the City of Brantford

Mr. R. Rose, Esq. – Counsel for Insurers

Mr. W. H. P. Madorin, Esq. – Counsel for Insurers

Preface

In view of the widespread interest in this Inquiry, particularly in the Grand River watershed, it is important that all concerned realize its function.

My responsibility as Commissioner is to inquire into and report the facts to answer the terms of reference. In addition, I have been charged to make recommendations.

I have no jurisdiction to pronounce judgment imposing legal liability. This is a matter for the courts of law.

The Inquiry has no responsibility to settle the many claims for damages from the flood to be paid by funds granted by the Province of Ontario. This duty fell upon the Grand River Disaster Relief Fund, chaired by Mr. Robert Kerr.

Procedure followed at Inquiry

General

The Order-in-Council authorizing the Inquiry was approved by Her Honour the Lieutenant-Governor on the 26th day of June, 1974.

The Inquiry opened in the Court House in the City of Kitchener on the 9th day of July, 1974.

Prior to the first day of Sittings, advertisements were placed in all the newspapers in the watershed to the end that all persons who wished to testify would be notified.

Counsel for the Inquiry interviewed more than 100 witnesses to determine the relevancy of their evidence, and carried out investigations to ensure the Inquiry heard all aspects pertaining to the flood.

Sittings

The Sittings of the Inquiry lasted for 43 days over a period of four months, terminating on November the 14th.

The Inquiry sat in various communities throughout the watershed for the convenience of witnesses and the public. Sittings were held in Grand Valley, Kitchener, Cambridge-Galt, Brantford and Cayuga. Cambridge-Galt suffered the most from the flood and for this reason the Inquiry held its Sittings in that City for 36 of the 43 days.

Witnesses were called by the Inquiry counsel, the Grand River Conservation Authority, the Flood Disaster Association, the Department of Natural Resources, and the City of Cambridge-Galt. Witnesses who testified are listed in Appendix "A" to this report. Eighty-four witnesses were heard including flood victims, representatives of the GRCA, Department of Natural Resources personnel, Police, EMO's, and leading experts in the field of hydrology and meteorology.

All counsel were afforded the right to cross-examine the various witnesses. This prolonged the Inquiry but ensured that all aspects of their evidence was explored.

More than 300 exhibits were admitted into evidence. These are listed as Appendix "B" to the report.

With my consent, a group of graduate students from the University of Waterloo recorded the proceedings on 30 miles of tape.

The Inquiry spent a day touring the various dam sites in the watershed and a half a day in the City of Cambridge-Galt. These trips were most helpful in understanding the flood control structures and the extent of the flooding in the City of Cambridge-Galt.

In addition, the Inquiry had two viewings of the film entitled, "A Day in May". This colour film was taken by a professional film producer on the days of the flood, from an airplane which travelled the length of the watershed. It is regrettable that it cannot be included in my report, as it graphically shows, more effectively than words can ever hope to describe, the extent of the devastation caused by the flood. The GRCA will arrange the showing of this film for any persons or groups who are interested.

The evidence, when transcribed, totalled 8057 pages. The reporters and typists provided daily transcripts and the Inquiry is indebted to them for their diligent and accurate reporting.

Acknowledgements

This was an onerous and complex Inquiry but my responsibility was considerably lightened by the thorough, impartial and dedicated presentation of the evidence by Mr. Robert Montgomery, Q.C., as counsel to the Commission.

In this, he was most ably assisted in an exemplary manner by Mr. L. G. Gilbertson.

Mr. Tom Symington performed outstandingly as Clerk, keeping a record of the proceedings and looking after the many exhibits.

Mr. Arthur Waters, who served as Registrar, performed his duties in an efficient, co-operative and sympathetic manner.

Counsel in this Inquiry had a difficult role because of the highly technical nature of the evidence. They met this challenge and conducted themselves with dignity, sincerity and objectivity. They were a credit to their profession. My thanks to Professor Ayers, Consulting Engineer to the Inquiry, for his assistance to my counsel and myself, in unravelling the complex technical data.

At the outset of the Inquiry, I addressed the news media and requested complete and objective reporting so that the public would be completely informed as to the proceedings. This they have done, and I am appreciative of their efforts.

To my Secretary, Mrs. Betty MacDonald, I express my deep gratitude for the time and effort in typing the manuscript.

Finally, I want to thank the Hamilton Spectator for the use of the photo on the cover of the report. This was taken during the flood in the main business section of Cambridge-Galt.

Format of Report

It was apparent throughout the Inquiry that the public misunderstood or had little knowledge of the function of the dams and the water management policy in the watershed. I concluded therefore, that my report could serve a dual purpose of finding facts and informing the public as to the various aspects of water management.

To this end, I have endeavoured to present the report in an attractive readable format, with pictures, maps, etc. I hope I have attained this objective.

I appreciate the support of the Attorney General who concurred in this type of report, and the advice and co-operation of the Queen's Printer, through the Printing Services Branch, Ministry of Government Services.

To further assist the public in understanding the technical terms used, a Glossary of Terms is inserted at the beginning of the report.

Glossary

Abbreviations

Ac. Ft.	The abbreviation for **acre foot** which is equivalent to 43,560 cubic feet and is the quantity of water required to cover one acre to a depth of one foot.
C.S.M.	The abbreviation for **cubic feet per second per square mile** and is the average number of cubic feet of water flowing per second from each square mile of drainage area.
C.F.S.	The abbreviation for **cubic feet per second** and is the unit generally used to express discharge or the rate of flow.
P.P.B.	Parts per billion.
PH	Value measure of acidity or alkalinity.
GRCA	Grand River Conservation Authority.
EMO	Emergency Measures Organization.

Definitions

Bar Graph	Shows hourly precipitation of the total amount of rain.
Channel Capacity	The maximum flow which is contained within the river banks and does not overflow the adjacent low lands.
Climatological Day	Covers twenty-four hour period from 8:00 a.m. to 8:00 a.m. next morning.
Dam	A structure in and across a river valley to impound, control and otherwise regulate the river flow.
Drainage Area	The land surface which contributes run-off.
Dry Dam	A dam used solely to impound water.
Flood	An overflow or inundation coming from a river or other body of water.
Flood Control	The prevention of flooding by controlling the high water stages by means of storage reservoirs, dikes, diversions or channel improvements.
Flood Crest	The maximum height or stage that the flood waters reach during any one flood period.
Flood Hydrograph	A hydrograph which covers only the flood period.
Flood Plain	The land adjacent to the river which will likely be inundated in the event of a flood.
Freeboard	The vertical distance between the maximum permissible level and the top of the dam or dykes.
Hydraulics	As applied to conservation deals with the measurement and control of runoff from river drainage basins.

Glossary (Cont'd)

Definitions	
Hydrograph	A plot of flow against time and is a correct expression of the detailed runoff of a stream resulting from all the varying physical conditions which have occurred on the drainage area above the gauging station previous to the time which it represents.
Hydrology	The science which deals with the occurrence and distribution of water in its various forms over and within the earth's surface.
Hydrometeorology	The science which deals with the inter-relationship of weather and stream flow.
Isohyet	A bar of equal rainfall.
Isohyetal Map	Shows lines of equal amounts of rainfall in inches.
Low Flow Augmentation	This phrase describes the water released from a reservoir to increase the flow of a stream for sewage dilution, riparian rights and other purposes.
Multi Purpose Dam	A dam that is used for many purposes such as flood control, low flow augmentation, recreation, etc.
Precipitation	Includes rain and snow.
Regional Flood Line	An area adjacent to the river which would likely be flooded if Hurricane Hazel in 1954 was transposed over the Grand River watershed.
Reservoir	The body of water created by the construction of a dam.
Spillway	That part of a dam over which the excess water is discharged.
Stream Gauge	A measuring device used to determine the elevation of water at selected points.
Water Levels In Reservoir	Measured in feet from Sea Level.

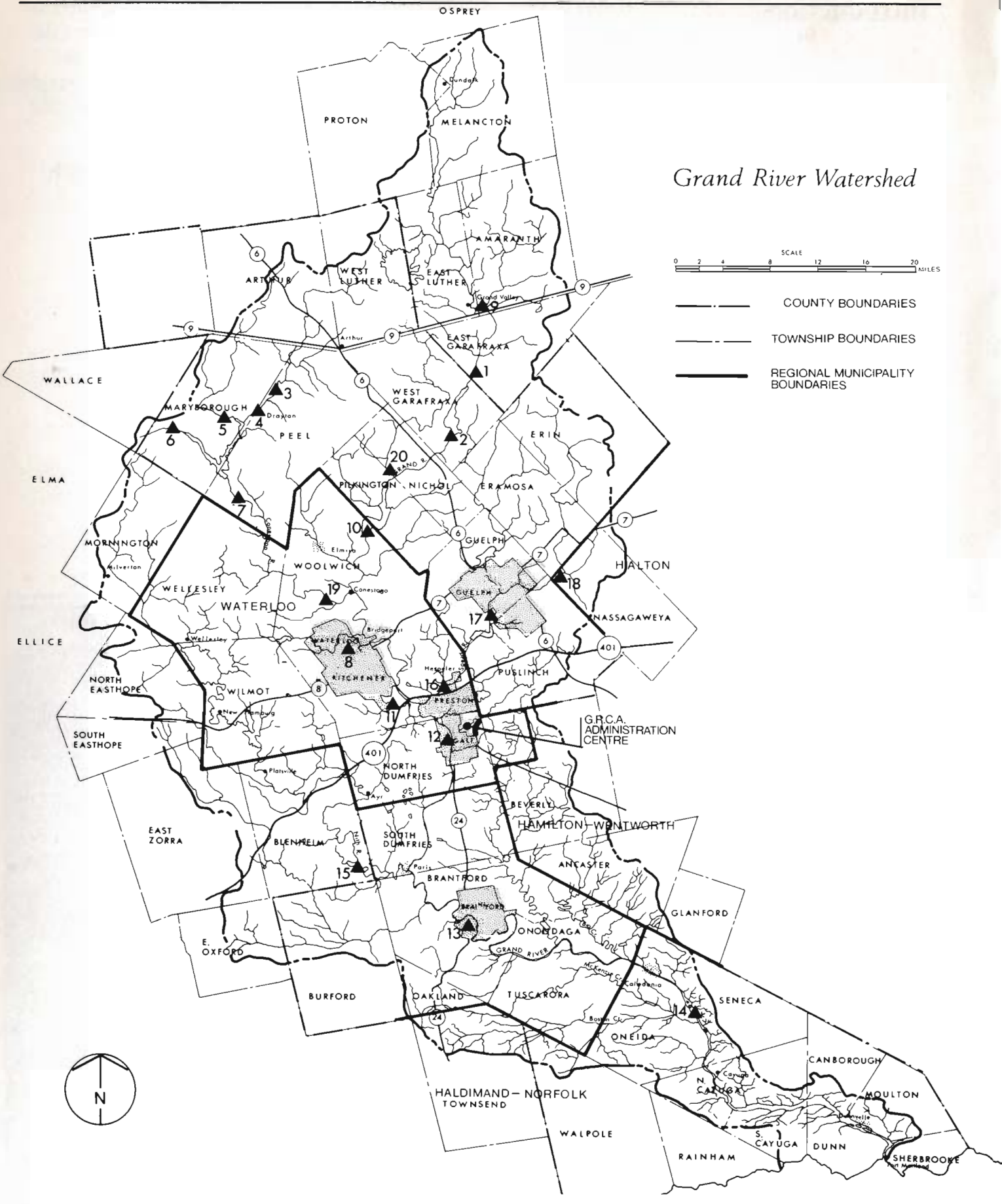
Introduction

Before dealing specifically with the terms of reference, it is essential to know the background of the flood, in all its various aspects. Unless the background is painted clearly and understood, my findings as to the cause of the flood, etc., and my recommendations will not be meaningful. It would be similar to the reading of an historical novel without setting the era of time.

I propose to deal with the background under the following headings:

- **The Grand River watershed;**
- **History of flooding in the Grand River watershed;**
- **Responsibility for water management;**
- **Flood control structures;**
- **The Dilemma of the GRCA;**
- **Official and public apathy.**

Confluence - Speed & Grand River
looking to Preston North
5:30 p.m.
May 17, 1974


Grand River Watershed
SCALE
0 2 4 8 12 16 20 MILES
COUNTY BOUNDARIES
TOWNSHIP BOUNDARIES
REGIONAL MUNICIPALITY BOUNDARIES
OSPREY
PROTON
MELANCTON
AMARANTH
ARTHUR
WEST LUTHER
EAST LUTHER
EAST GARAFRAXA
WEST GARAFRAXA
WALLACE
MARYBOROUGH
PEEL
ERIN
ELMA
PILKINGTON
NICHOL
ERAMOSA
GUELPH
MORNINGTON
WOOLWICH
WELLESLEY
WATERLOO
HALTON
NASSAGAWEYA
ELLICE
NORTH EASTHOPE
WILMOT
PUSLINCH
G.R.C.A. ADMINISTRATION CENTRE
SOUTH EASTHOPE
NORTH DUMFRIES
BEVERLY
HAMILTON-WENTWORTH
EAST ZORRA
BLENHEIM
SOUTH DUMFRIES
ANCASTER
BRANTFORD
GLANFORD
ONONDAGA
E. OXFORD
BURFORD
OAKLAND
TUSCARORA
SENECA
ONEIDA
CANBOROUGH
MOULTON
N. CAYUGA
S. CAYUGA
DUNN
RAINHAM
SHERBROOKE
HALDIMAND-NORFOLK
TOWNSEND
WALPOLE
N

The Grand River Watershed

Geography

The Grand River watershed is situated in the central part of a peninsula in the south-west part of the province. The peninsula is bounded by Lake Erie, Lake Huron, Georgian Bay and the westerly end of Lake Ontario. The watershed has an overall length of 118 miles, an average width of 22 miles and an area of 2614 square miles.
The watershed can be divided into three zones, namely the northern, the central and the southern zones. Each zone has different characteristics.

The **northern zone** is triangular in shape, having a base of 18 miles along a line through the Town of Arthur and a point 3 miles north of the Village of Belwood, and tapering northerly 27 miles to an apex which is within 19 miles of Georgian Bay. This zone is part of a high tableland which is the headwaters of several rivers, namely the Nottawasaga, Beaver, Sydenham, Maitland, the north branch of the Thames River, as well as the Grand and its tributaries. The greater part of this tableland was originally swamp land and has since been drained and is now mainly under cultivation. These drains mainly end up in the Grand owing to its high altitude, one of the highest in the province. It is subject to low temperature and heavy snowfalls. The total annual snowfall for this zone ranges from 120 to 130 inches in depth with a high reported of 154 inches. This zone slopes heavily to the south which magnifies the runoff further. The upper Grand and its tributaries have high gradients and the lateral slopes to the rivers are also quite steep. The soil is clay and there are extensive headwater swamps which are drained.
These physical features produce a high rate of runoff and when combined with adverse climatic conditions are basically the cause of flooding within this zone and downstream.

The **central zone** is the largest of the three zones. Its length from north to south is approximately 64 miles and its width varies from 20 to 40 miles. It contains all of the cities and towns, except Dunnville, and most of the incorporated villages. Most of the flood damage occurs in this zone. The physical features and climatic conditions of this zone are largely similar to those of the northern zone and further aggravate flooding.

The **southerly zone** is roughly triangular in shape, being 12 miles wide on a line running north-easterly through Caledonia and tapering off to one-quarter of a mile where it empties into Lake Erie, about three and a half miles south-east of Dunnville. It has a gradual gradient with an overall length of 27 miles and with an average width of 4 to 5 miles. The flooding in this zone is confined to a narrow strip along the river.

The Grand River and Principal Tributaries

The Grand River and its tributaries are a complex system to manage.
The watershed is drained by the Grand River and its tributaries.
The most important tributaries are the Conestogo, Nith, Speed and Eramosa Rivers, and Whiteman, Fairchild, McKenzie, Boston and Big Creeks. The flow in the creeks is comparatively moderate and consequently have little influence on flood problems.

The Grand River rises about five miles north-east of Dundalk. Its course is southerly as far as Paris where it swings south-easterly and empties into Lake Erie at Port Maitland. Its length is about 180 miles. Its drop from the headwaters to the Lake is about 1165 feet with an average grade of 6.4 feet to a mile. Excluding the above tributaries, the remaining drainage area of the Grand River has a length of 118 miles and an average width of nine miles. The width varies from two miles at Paris, five miles at Cambridge-Galt to 15 miles at Kitchener and Elora. The drainage area is 1049 square miles. Within this drainage area are the cities of Kitchener and Waterloo, and located on the river about midway between the headwaters and Lake Erie is the City of Cambridge-Galt, and 24 miles further downstream is the City of Brantford. Also located on the river are the towns of Paris, Caledonia, Dunnville and Fergus, and the villages of Dundalk, Grand Valley, Elora, Cayuga and Port Maitland.

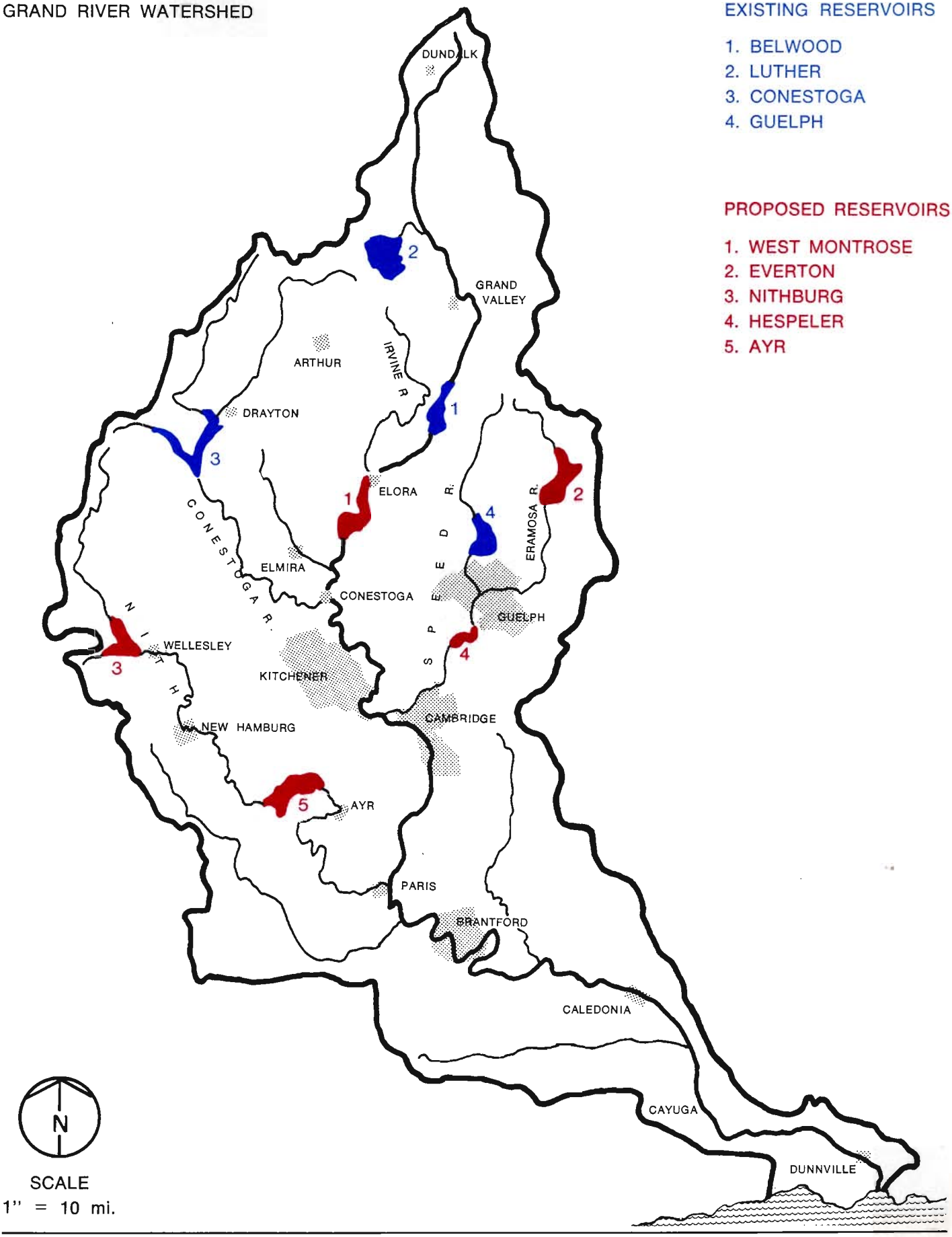
The **Conestogo River** has two branches at its headwaters. One branch rises about ten miles north, and the other branch, ten miles north-west of Arthur. It flows south-westerly for half of its course and thence south-easterly, joining the Grand River near the Village of Conestogo or 25 miles north of Cambridge-Galt. Its length is about 51 miles. Its fall from headwaters, about 550 feet, and it has an average grade of 10.8 feet to a mile. The drainage area is 38 miles long varying from four to 13 miles in width and measuring 317.5 square miles.

The **Nith River** rises about five miles south-east of the Town of Listowel. It has a long meandering course of 98 miles in a general south-easterly direction joining the Grand River at Paris. The total fall from headwaters is about 650 feet with an average grade of 6.6 feet per mile. The drainage area lies in a south-easterly direction and has an area of 432.1 square miles. It measures 45 miles in length and has an average width of about ten miles. The length of the river is more than double the length of its drainage area. The Town of Paris is astride of the Nith's confluence with the Grand.

The **Speed River** rises 18 miles north of Guelph. It flows southerly and joins the Grand River about three and a half miles north of Cambridge-Galt. Its length is 37 miles with a fall of 570 feet and a grade of 15.4 feet to a mile. The drainage area lies almost due north and south with an area of 187.3 square miles. Its length is 30 miles, with a minimum width of four miles at Guelph and a maximum of 11 miles just below Guelph. Guelph is located at the confluence of the Speed and Eramosa Rivers, which is about 15 miles above the confluence of the Speed and Grand Rivers at Cambridge-Preston.

The **Eramosa River** rises 25 miles above Guelph, flows southerly throughout most of its course and then turns westerly as it approaches the confluence at Guelph. It has a total fall of 410 feet and an average grade of 16.4 feet to a mile. The Eramosa drainage area is 115.3 square miles. It lies east of, and parallel to, the Speed and has a length of 23 miles with an average width of five miles.

GRAND RIVER WATERSHED



River Valleys and Beds

The river valleys of the Grand River and its tributaries are, with few exceptions, U-shaped and there is no flaring out into extensive flats which would reduce flood flows by providing natural storage reservoirs. The width between bank crests varies from about 1500 feet to 3000 feet.

On several stretches of the Grand, Speed and Eramosa Rivers, solid rock outcroppings appear. On the Grand, the river bed is of solid rock in the following localities: for a distance of two miles above Paris; three miles at Glen Morris; from about one and a half miles below Cambridge-Galt to Cambridge-Preston; from three miles below Elora to the Shand Dam; and about seven miles above and below Grand Valley. On the Speed the bed of the river from Cambridge-Preston to Guelph is nearly all solid rock, and this continues up the Eramosa for eight miles, except one mile at Guelph. In the case of the other tributaries – the Nith in particular – ledge rock is some distance below the bed of the rivers. The bed of the Conestogo River, for example, consists of embedded boulders for much of its length, with the known depth of overburden varying from nine feet in the river bed near Glen Allan to 125 feet at St. Jacobs.

Demands on the System

The Grand, and its major tributaries, flow through one of the most important socio-economic regions in Canada.

The population of the watershed is approximately 450,000 with 350,000 living in urban areas. It contains the major population centres of Waterloo (42,000), Kitchener (120,000), Guelph (61,000), Cambridge (65,000), Brantford (61,000). It is one of the most densely populated watersheds in Canada. The population has increased annually at the rate of 2% to 3% over the past ten years. Treasury Board of Ontario predictions forecast a doubling of the population in the next twenty-five years.

The major urban centres have a large, varied and growing industrial productivity. The rural areas contain some of the finest agricultural land in the province.

The river system is vital to the people of the watershed. It provides water for municipal, industrial and agricultural uses. It is the vehicle for the conveyance of sewage and waste. All major communities and most of the smaller ones empty their treated sewage into the river system. It also meets the growing recreational demands upon it.

Despite these conflicting demands, it is aesthetically a fine river, particularly as it widens from Brantford on its way to Lake Erie.

On the other side of the coin, the river system, at times when it floods, poses a serious threat to the safety of citizens who live or engage in business on or near its banks.

As the population of the watershed increases, so will the demands on the system. Likewise, more lives will be endangered unles remedial measures are taken.

History of Flooding in the Grand River Watershed

Man's settlement of the watershed is a perfect example of how man can upset nature's balance.

When the Grand River was settled in the early part of the last century, the pioneers cleared away the forests and turned them into farm lands. They drained the land to make it productive. Later, they built cities and towns with complex drainage systems that channelled excess water and rainfall into the river.

The vast forests that retained and held water on the land as natural water reservoirs, are gone. Improved drainage from farm fields, added to the storm drains and acres of asphalt and concrete from built up areas, rush water into the river instead of allowing it to soak into the ground. The increased urbanization in the past decade, particularly in the central part of the watershed, has magnified the danger of serious flooding.

The Grand River Conservation Report provides a comprehensive history of the flooding of the Grand.[1] Flooding on the Grand River and its tributaries has always been a serious problem. Floods have been recorded as far back as 1790. Since 1900 there have been at least ten times when serious flooding has occurred.

Major flood damages have occurred at the City of Brantford, Galt and Guelph, the Town of Caledonia, Dunnville, Fergus, Hespeler, Paris and Preston and in various villages and agricultural lands throughout the watershed.

Over the years dikes have been built at some of the major flood-vulnerable points along the river. Brantford constructed dikes in 1894 and has raised and extended them since that time. They have served that City well over the years and did so in the 1974 flood.

In the 1920's and 1930's the residents of the watershed realized the seriousness of the problem. They appreciated the danger of flooding. They also realized that unless steps were taken to reduce flooding that the economic development of the watershed would be retarded.

They organized a Grand River Commission and after years of effort, coupled with assistance from the Ontario and Federal Governments, showed some results. The Shand Dam at Belwood was built in 1942. The Luther Dam followed in 1954 and the Conestogo Dam was completed in 1958. A new dam at Guelph is now being constructed.

The three dams that have been constructed only control 20% of the runoff in the watershed. These dams, by holding back the spring flood waters, give the area some measure of safety from flooding, but are insufficient in number to give reasonable protection.

This is particularly so now, as all the factors that made these first dams necessary have multiplied with the rapid growth of the watershed.

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[1] See Exhibit 6 (6)

The potential for flood damage is now very high and very serious and the risk will magnify unless major action is taken.

There have been many studies of the problem and inquiries into floods on the Grand. Based on past performance, I can only conclude that this will not be the last.

Responsibility for Water Management of the Grand

Statutory Authority

The GRCA is responsible for the water management of the Grand River and its tributaries and derives its authority from the Conservation Authorities Act, R.S.O. 1970, Chapter 78, as amended.[1]

Section 19 of the Act provides:
"The objects of an authority are to establish and undertake in the area over which it has jurisdiction, a program designed to further the conservation, restoration, development and management of natural resources other than gas, oil, coal and minerals."

Section 20 of the Act also grants additional powers to the Authority to accomplish its objects.

The relevant subsections are:
"S. 20
(a) to study and investigate the watershed and to determine a program whereby the natural resources of the watershed may be conserved, restored, developed and managed;

(i) to determine the proportion of total benefit afforded to all participating municipalities that is afforded to each of them;

(j) to erect works and structures and create reservoirs by the construction of dams or otherwise;

(k) to control the flow of surface waters in order to prevent floods or pollution or to reduce the adverse effects thereof;"

Under section 23 of the Act, the GRCA must obtain the approval of the Minister of Natural Resources before proceeding with a project.

Organization

All municipalities whose waters flow into the Grand River system are members of the GRCA. The Authority is made up of parts of all of the 56 municipalities.

The province appoints eight members to the Authority and the participating municipalities, 32, for a total of 40 members. All of the members participate on some advisory board of the Authority. The Authority members delegate certain responsibilities to an Executive Committee of ten members and a chairman. The Authority employs a substantial permanent staff headed up by a General Manager, to implement all aspects of the conservation programme. The headquarters of the Authority is located at Shade's Mills in Cambridge-Galt.

Partnership

Although the GRCA is virtually autonomous by Statute, it operates, in practice, as a partnership with the Department of Natural Resources and the member municipalities. To implement capital projects it relies on provincial grants and by assessing member municipalities on a cost-benefit basis.

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[1] See Exhibit 6 (14)

Wide Responsibility of GRCA

Although this Inquiry is mainly concerned with flooding, it must be realized that the GRCA is concerned with many aspects that affect the lives of persons in the watershed.

These are embraced in the word, "conservation". This includes low flow augmentation and water quality, wild life management, reforestation, flood plain regulations, recreation areas and environmental impact studies.

The GRCA has complex responsibilities in a complex and changing society.

Financial

The GRCA to carry out its myriad responsibilities has to rely mainly on funds from the municipalities and the Provincial Government.

The diagram opposite indicates the GRCA sources of funds from 1964-1974.[1]

This chart indicates that during that period the GRCA received 8.92% of its income in the amount of $3,559,195.00 from its own operating revenues; 61.28% or $24,441,896.00 from the Province and 29.80% or $11,885,019.00 from municipal levies.

Since 1966 the GRCA has had plans ready for the construction of five more dams urgently needed to control flooding and dilute pollution. One of the five is under construction at Guelph.

Construction of the others has been held up over a disagreement on who will pay for them. In the past, the cost of building of the three dams, the Shand, the Conestogo, and the Luther was shared three ways. The Federal Government and the Provincial Government each paid 37½ per cent; and the municipalities making up the Conservation Authority paid the remaining 25 per cent.

Since 1966, the plans for the dams have been approved by the Provincial Government which has pledged its 37½ per cent. To date, the Federal Government has not approved paying its 37½ per cent.

In 1969, the Provincial Government agreed to finance a greater share of the project, but the municipalities feel they cannot afford to pay more than 25 per cent of the cost.

This delay has increased the costs of the construction of the dams and the cost of land acquisition.

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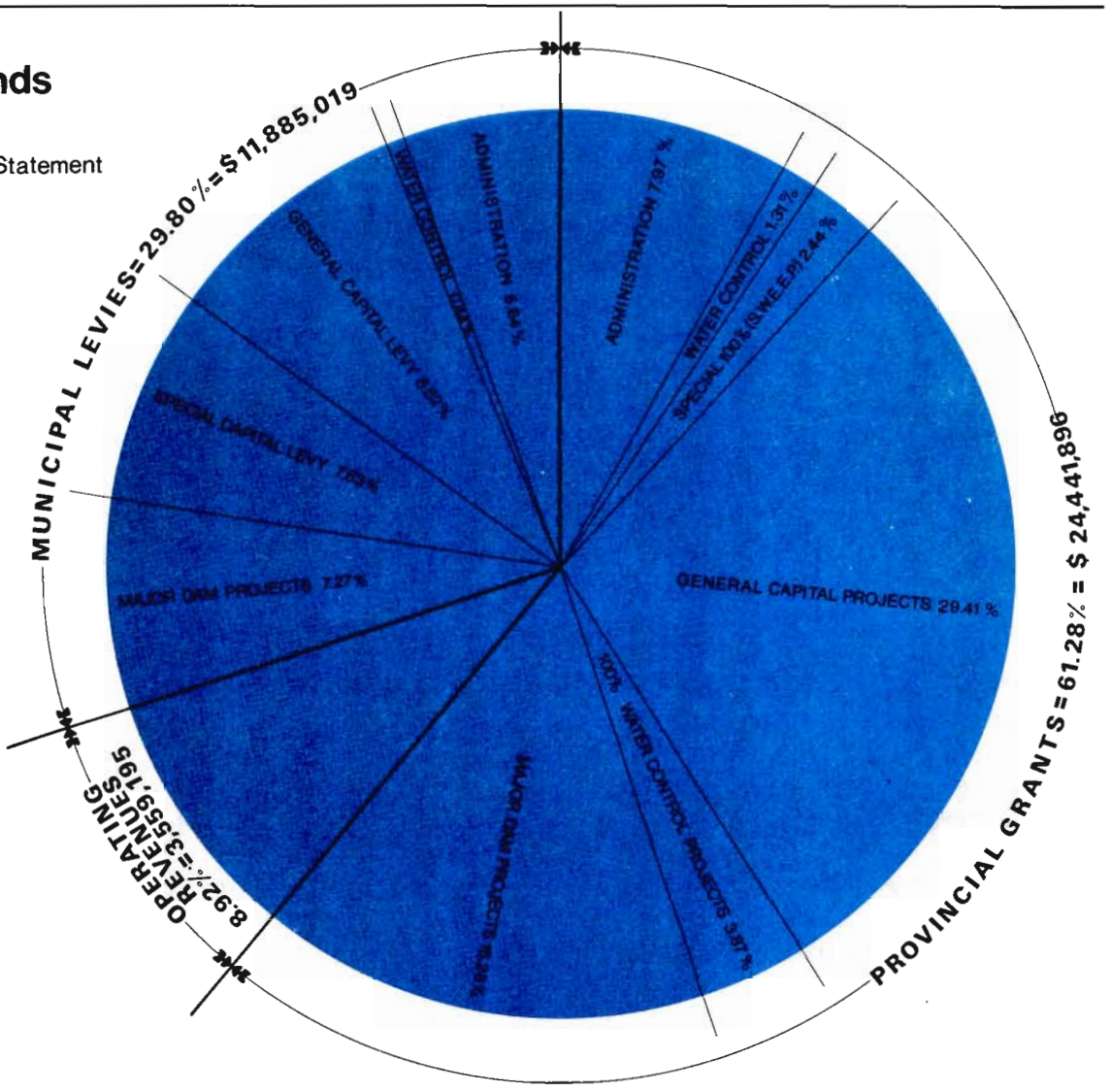
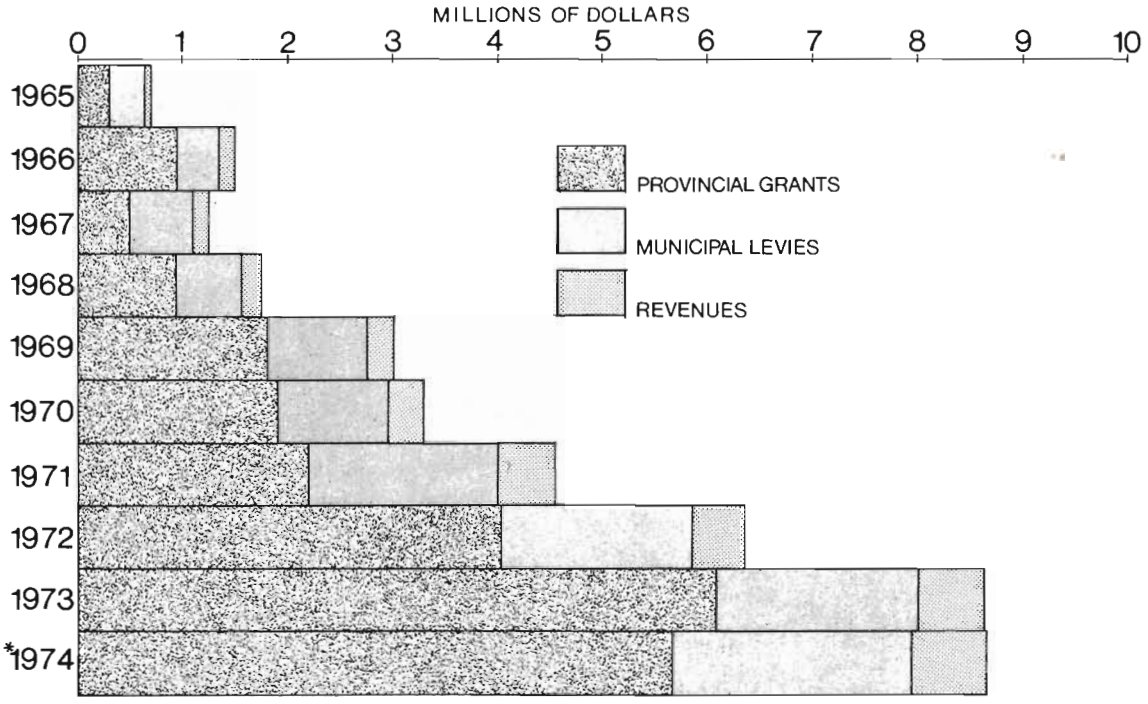
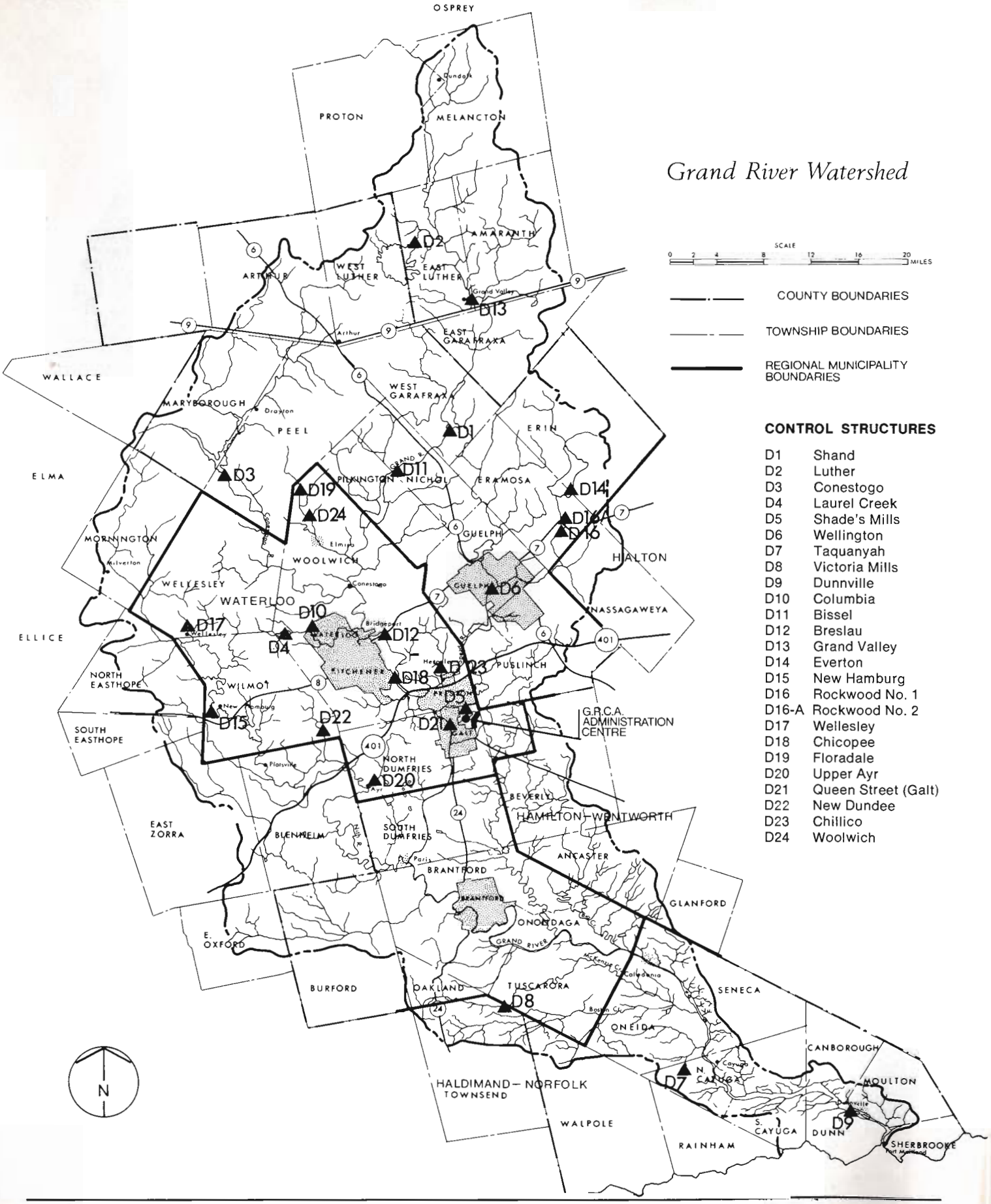
[1] See Exhibit 6 (19)

G.R.C.A.
Sources of funds

From 1965–1974
as reflected in Auditors' Statement
*1974 estimated






Grand River Watershed
SCALE
0 2 4 8 12 16 20 MILES
COUNTY BOUNDARIES
TOWNSHIP BOUNDARIES
REGIONAL MUNICIPALITY BOUNDARIES
CONTROL STRUCTURES
D1 Shand
D2 Luther
D3 Conestogo
D4 Laurel Creek
D5 Shade's Mills
D6 Wellington
D7 Taquanyah
D8 Victoria Mills
D9 Dunnville
D10 Columbia
D11 Bissel
D12 Breslau
D13 Grand Valley
D14 Everton
D15 New Hamburg
D16 Rockwood No. 1
D16-A Rockwood No. 2
D17 Wellesley
D18 Chicopee
D19 Floradale
D20 Upper Ayr
D21 Queen Street (Galt)
D22 New Dundee
D23 Chillico
D24 Woolwich
OSPREY
PROTON
MELANCTON
AMARANTH
ARTHUR
WEST LUTHER
EAST LUTHER
EAST GARAFRAXA
WEST GARAFRAXA
WALLACE
MARYBOROUGH
PEEL
ERIN
ELMA
PILKINGTON
NICHOL
ERAMOSA
MORNINGTON
WOOLWICH
GUELPH
HALTON
WELLESLEY
WATERLOO
NASSAGAWEYA
ELLICE
NORTH EASTHOPE
WILMOT
PUSLINCH
SOUTH EASTHOPE
G.R.C.A. ADMINISTRATION CENTRE
NORTH DUMFRIES
BEVERLY
HAMILTON-WENTWORTH
EAST ZORRA
BLENHEIM
SOUTH DUMFRIES
ANCASTER
BRANTFORD
GLANFORD
ONONDAGA
E. OXFORD
BURFORD
OAKLAND
TUSCARORA
SENECA
ONEIDA
CANBOROUGH
MOULTON
N. CAYUGA
S. CAYUGA
DUNN
SHERBROOKE
RAINHAM
WALPOLE
HALDIMAND-NORFOLK
TOWNSEND
N

Control Structures and Monitoring Systems

Existing Dams and Reservoirs

General

As indicated on the map, there are a total of 24 dams having some degree of control on the various rivers in the watershed. They vary in size from the small dam at New Dundee to the large Shand Dam. The functions of the dam also vary, in that their purposes may be flood control, low flow augmentation, recreational and aesthetic, or a combination of purposes. Only two, the Shand and the Conestogo, with their reservoirs, have a major flood control function. The Luther Dam is located on a tributary of the Grand River in the north end of the watershed with a drainage area of 21.1 square miles, and consequently, does not have a major flood control function. Only 20% of the watershed is above these reservoirs.

Shand Dam and Reservoir

It was constructed in 1942 on the Grand River near Fergus, for flood control and water regulation.

The dam is 78 feet high and 2100 feet long. It is the earthfill type with a thick central clay core and a concrete gravity spillway section. The spillway section has a discharge capacity of 60,000 c.f.s. and is equipped with four crest gates, each 30.5 feet high by 30 feet wide. The maximum water level is 1394.6 feet and the top of the dam 1400 feet.

The reservoir – Lake Belwood – is 7.4 miles long with an average width of 2000 feet. The surface area is 1829 acres and has a storage capacity of 48,000 acre feet or 13,031 million imperial gallons.

The drainage area is 308.5 square miles.

Conestogo Dam and Reservoir

The Conestogo Dam and its reservoir was constructed in 1957 on the Conestogo River near Glen Allan. The dam is multi-purpose for flood control and flushing of the Grand. There was contradictory evidence introduced at the Inquiry as to which had priority, and I will deal with this later in my report.

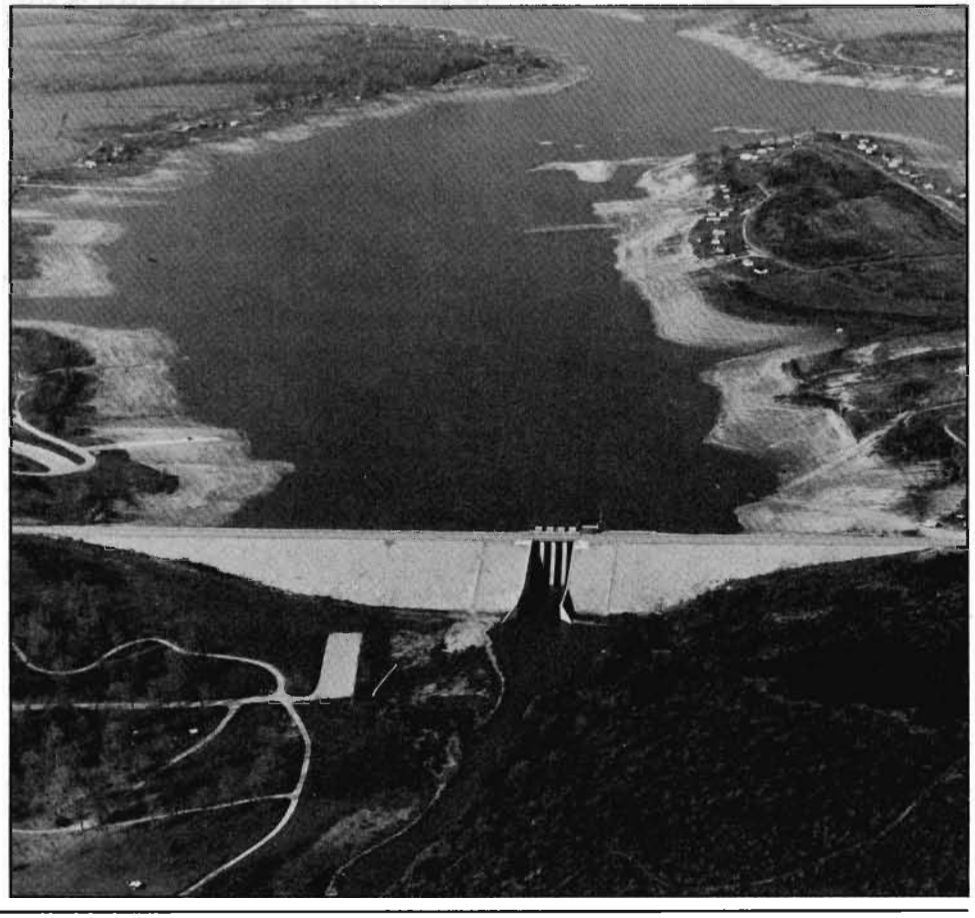
The dam is 96 feet high and 1790 feet long with a thick central clay core with a concrete gravity spillway. The spillway has a capacity of 55,000 c.f.s. and is equipped with four fixed roller gates each 20 feet by 15 feet and one discharge pipe, five feet in diameter. The dam has a maximum water level of 1290 feet and the top of the dam, 1296 feet.

The reservoir is divided into an east and west fork, each six miles long. The average width of the reservoir is 2000 feet with a surface area of 1816 acres. It has a storage capacity of 47,000 acre feet or 12,800 million imperial gallons.

The dam and reservoir serve a drainage area of 219.5 square miles.

Shand Dam

Conestogo Dam



Luther Dam and Reservoir

The dam was constructed in 1954, near Grand Valley. The earth dam is 930 feet long and approximately 19 feet high, with provisions for controlled discharge of the stored water. The maximum water level is 1580 feet and the top of the dam is 1584 feet.

The flooded area of the reservoir covers some 4500 acres of former peat bog. The reservoir is four miles long with an average width of 13,000 feet. The storage capacity is 10,000 acre feet or 2715 million imperial gallons. This is sufficient for a flow of 50 c.f.s. during the summer months.

The dam and reservoir serve a drainage area of 21.1 square miles.

Existing Monitoring Systems

General

The GRCA has three monitoring systems in the watershed:

(1) Stream gauges

(2) Snow stations

(3) Rain gauges

Stream Gauges

The GRCA maintains a hydrometric network on various stations in the watershed as shown overleaf.

These gauges, 20 in number, record the stream flow and it is transmitted to GRCA headquarters where it is recorded. The information is transmitted orally by radio (broken line) or telemetrically (solid line). These gauges aid the GRCA in predicting downstream flows for purposes of alerting municipalities; determining required discharges from the reservoirs; and locating ice or debris jams at critical points on the rivers in the basin.

The telemetric data from the gauge is recorded automatically at GRCA headquarters as to flow, date and time. Several of these charts were introduced as exhibits for the crucial dates of the flood.

Snow Stations

This monitoring system is not really relevant to the Inquiry, as the snow had melted sometime prior to the flood. However, it does provide us with further background information.

The GRCA maintains throughout the watershed a snow survey system with approximately 13 stations.[1] The station consists of a 1000 foot long stretch of land and snow samples are taken every 100 feet in a tube. Samples are taken twice a month at each station. The snow is weighed to determine the water content. From this, probable spring runoffs can be forecast.

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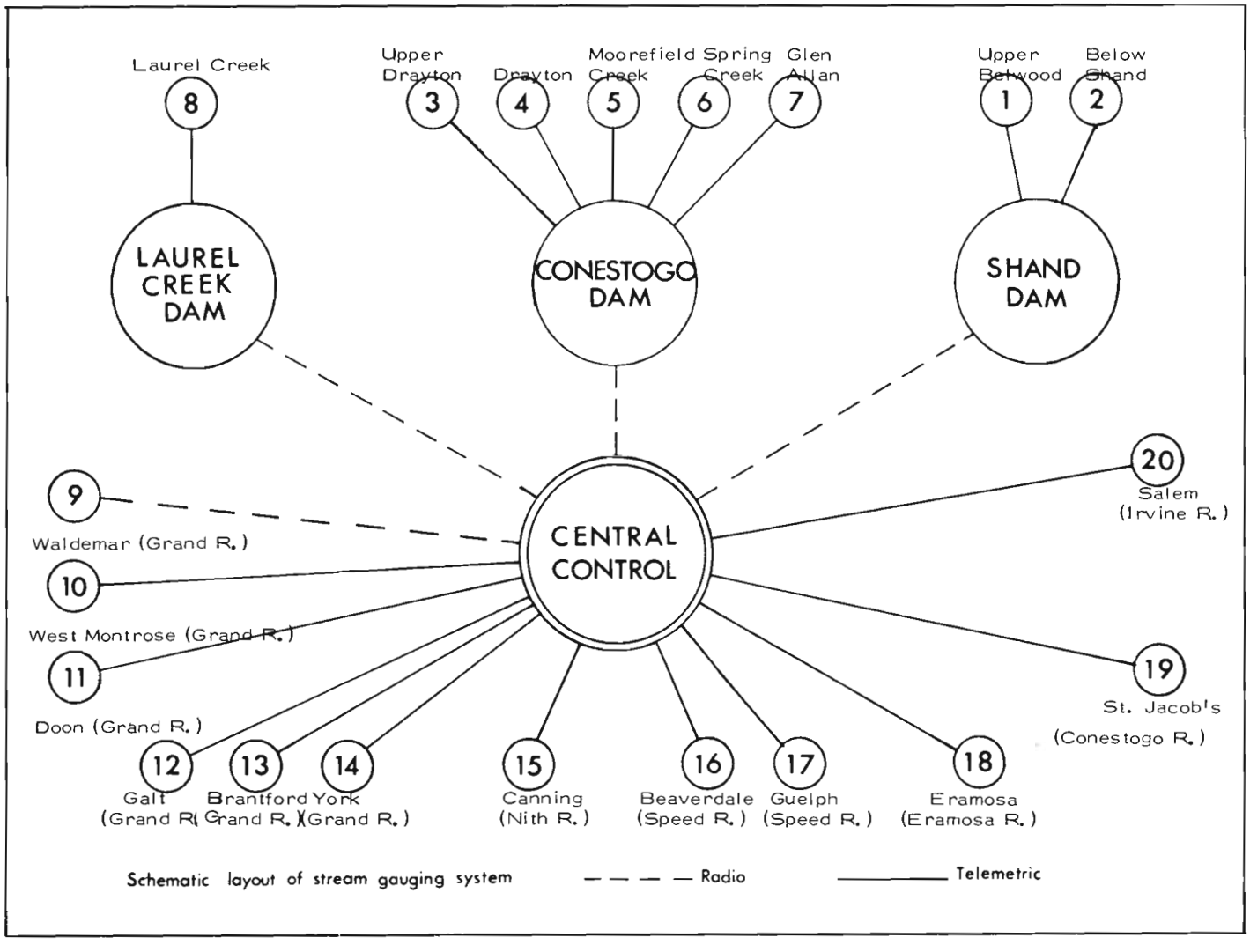
(1) See Exhibit 39 (5)

Rain Gauges

The GRCA relies mainly on the Conservation Branch of the Department of Natural Resources for its weather forecast. This forecast system will be dealt with later on in the report.

The GRCA maintains ten rain gauging stations and six weather stations. These units do not forecast weather, but record it. The weather stations measure rain, temperature, and, in some cases, record wind velocity. Rain gauges are spotted throughout the watershed at dams, in parks, and at homes of GRCA staff. These are wedge-shaped plastic devices. Persons who look after these gauges are asked to report to GRCA headquarters if they measure one inch or more of rain. The GRCA uses this information to estimate run-off.

Grand River Conservation Authority - Hydrometric Network July 1974



Dilemma of the GRCA

General

There was widespread criticism of the GRCA throughout the watershed following the flood. This was mainly directed at the policy of the GRCA in the operation of the Shand and Conestogo Dams. It is therefore necessary to review the history of the water management policy.

Studies

It is doubtful if there is a watershed in Canada that has been more thoroughly studied by more qualified persons.
The first study was commissioned in 1932 by the Minister of Lands and Forests of Ontario and was named the Finlayson Report.[1] During the Inquiry, it was called the "old testament" of GRCA policy. That Commission was asked to report on 'the problems of municipal water supply, sewage disposal, flood control, power development and afforestation in the Grand River Valley'.

The report concluded that remedial action has to be taken for flood control, water dilution and water supply for the various municipalities in the watershed. To carry this out, it recommended the construction of five storage reservoirs, as well as other measures. The report concluded that the problems would increase with the increase of population.
In 1939 the H. G. Acres Report to the Grand River Commission was a more detailed study of the Finlayson Report and was the basis for the Shand Dam. The report stated that the fundamental purposes of the dam and reservoir are:

(a) restoring minimum flow for dilution of sewage and industrial wastes;

(b) preventing flood damage by temporarily impounding flood peaks;

(c) restoring the river as a source of wealth, convenience and comfort to the community.

These two reports established a policy that the dams and reservoirs would have a multi-purpose function, namely flood control and low flow augmentation.

These reports were followed by:

(a) 1939 Cost Apportionment Report [2]

(b) 1954 Hydraulic Report [3]

(c) 1961 Flood Control and Water Conservation Brief [4]

(d) 1964 Report re West Montrose [5]

(e) 1965 Speed River Report [6]

(f) 1966 Grand River Conservation Authority Brief [7]

(g) 1967 Cost Allocation Report [8]

(h) 1967 Montrose Functional Report [9]

(i) 1971 Treasury Board Report [10]

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(1) See Exhibit 6 (1)
(2) See Exhibit 6 (4)
(3) See Exhibit 6 (6)
(4) See Exhibit 6 (7)
(5) See Exhibit 6 (8)
(6) See Exhibit 6 (9)
(7) See Exhibit 6 (10)
(8) See Exhibit 6 (11)
(9) See Exhibit 6 (12)
(10) See Exhibit 6 (13)

All of these reports agreed upon the needs for more dams and reservoirs. All agreed they were to be multi-purpose dams for flood control and low flow augmentation. There were differences of opinion as to which dams should be constructed first. It is also significant that the various municipalities were to be assessed on a cost-benefit basis. That is, they were assessed a certain percentage for flood control and a certain percentage for low flow augmentation. In most cases, the municipalities were only charged, subsequently, twelve percent for flood control. Municipal councillors of the various municipalities assessed must have known of the low priority for flood control and the high priority placed on low flow augmentation.

These reports and studies cover a period of approximately forty years. Only three dams, the Shand (1942), the Luther (1954) and the Conestogo (1959) have been completed in that period. The population of the watershed has more than doubled. Urbanization, deforestation and other factors have increased the run-off and magnified both the flood control and low flow augmentation problems.

The "New Testament"

In 1966 the GRCA submitted a brief of Flood Control and Water Conservation to the governments of Ontario and Canada.[1] This was described as the "new testament" of policy of the GRCA, during the Inquiry. The purpose of this brief was to outline the urgent need for additional flood control, pollution abatement, and water conservation measures on the Grand River and its tributaries. The brief requested financial assistance from both governments to carry out the recommendations.

The brief recommended the adoption of the Grand River Conservation Report 1954, which proposed the following storage reservoirs on the Grand River and its tributaries:

West Montrose	Guelph	Ayr
Everton	Hespeler	Nithburg [2]

To date, not one of these reservoirs has been completed. Only one has been started at Guelph, which is expected to be finished in 1976.

The proposal to construct these additional dams ran into serious opposition from the outset and it is still continuing.

Several member municipalities opposed the plan mainly because they could not afford to pay their share of the cost. The City of Kitchener and the City of Galt, municipalities who would stand to benefit most from the dams, passed resolutions opposing the dam and forwarded these to the Ontario Government. It is ironic that these two suffered the most from the 1974 flood. Certain other municipalities, where dams are to be constructed, continue to oppose their construction. Their opposition is understandable as they will lose attractive, arable land and the downstream municipalities will benefit. The Ontario Government

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(1) See Exhibit 6 (10) (2) See Exhibit 6 (6)

and the Federal Government each paid 37½ per cent of the costs of the Shand and Conestogo Dams, and the member municipalities, 25 per cent. For several years after receiving the 1966 brief, the Ontario authorities negotiated with Ottawa to the end that the Federal authorities would make the same percentage contribution for the proposed five new dams. As yet, this has not been forthcoming. The dispute appears to be due to the position of the Federal authorities that these dams are a provincial responsibility.

Conclusion

The GRCA is caught in a complex dilemma.

In the first place, the primary purposes of the Shand and Conestogo, namely, to provide flood control protection and low flow augmentation, are conflicting.

In the spring, these two dams control and trap the runoff from the melting snow. The reservoirs have to be filled at this time in order to provide dilution downstream the rest of the year. If they do not store sufficient water at that time, the residents downstream would have no sewage dilution, Brantford would have no drinking water, and the river could run dry. It would be a catastrophic situation. (See photos overleaf of Galt, Paris and Brantford with low flow conditions.)

On the other hand, by filling the reservoirs in the spring to meet the low flow augmentation requirements, almost all the flood protection is removed for a three month period and a flood could ensue should there be unusual precipitation.

Although a flood is tragic, relatively few people are affected, whereas if the river should run dry, it would affect the lives of a large percentage of the people in the watershed.

The GRCA have followed this policy since the Shand and Conestogo have been constructed. It is a difficult policy to live with.

Since 1954 the GRCA have advocated more dams to solve this dilemma, but without success for the reasons stated in the previous section. These dams would provide the GRCA with flexibility to meet its obligations. In effect, the GRCA has been trying to operate a seven cylinder vehicle on two cylinders, and without the funds to correct the problem.

Added to this frustration has been the encroachment on the flood plains permitted by certain municipalities, which compounds the danger of flooding. Enforcing of the flood plain regulations by the GRCA is necessary, but not a popular task.

The Intangibles

Humanity has an ability to wipe tragedy from its mind and pretend it won't happen again. An outstanding example was the lack of preparedness by the Allied Nations prior to the last Great War in the face of Germany's remilitarization.

Grand River Low Flow Conditions

Galt:
Downstream view from Queen Street Bridge, (Aug. 24, 1936) Flow C.50 C.F.S.
Photo By The Department of Planning and Development.

Paris:
Penman's Dam and algae in main stream. Summer 1949, flow C. 200 C.F.S.
Photo By The Department of Planning and Development.

Brantford:
Wilkes Dam, Oct. 12, 1963, flow 500 C.F.S. (Dec. 13, 1963 not shown, flow 285 C.F.S.)
By Courtesy Of The Brantford Expositor.

So with floods. The last serious flood in the watershed was in 1954. In 1974, there was apathy throughout the watershed not only among the endangered, but in municipal governments, and to some extent, in the GRCA. There was no sense of urgency to do something about the growing risk of flooding. Perhaps, this is a human failing, and to some degree can explain the inaction and improper action of certain public employees, particularly in warning the public of the flood.

Another intangible that affected the action of persons of responsibility was the fact that the Region of Waterloo was in its first year of operation. Public employees, in some instances, were not familiar with their new areas of responsibility, or whose duty it was to carry out certain functions in the event of a flood. Throughout the Inquiry, several witnesses used the phrase, "I presumed he would look after that."

The construction of the Shand and Conestogo Dams had implanted in the minds of many residents, who live in the flood plain, a feeling of security from flooding. This is the only plausible explanation as to why residents on the river banks would sit and watch the river rise without much concern. The GRCA, to some degree, is responsible for this attitude as in its literature and on its signs at the dams, it invariably used the words, "Flood Control" conspicuously to describe their water management policy. My conclusion from the evidence was that the emphasis was placed on "flood control" in order to facilitate grants for the erection of more multiple purpose dams to protect and serve the public. The motivation was laudable but the method was misleading.

Another intangible aspect of this Inquiry is the fact that a very small percentage of the population of the watershed are endangered by a flood. The large percentage of the population, therefore, have little serious concern for flood protection which will be reflected in their taxes. However, all residents, whether in the flood plains or not, benefit from the low flow augmentation provided by the existing dams and reservoirs.

There exists a large body of opinion in the watershed which takes the view that those who take the risks and live in the flood plain should not expect the rest of the residents to pay for their gamble. They feel this is inequitable, as in most cases, flood plain property was purchased at a reduced price.

Another intangible factor is the desire of certain persons to live dangerously in the flood plain. An example was shown during the Inquiry where a person who had his home destroyed in the flood is already building in the same location. He has received compensation for 100 per cent of his damages from the taxpayers of Ontario.

Friday, May 17th was a sunny day in Cambridge-Galt. It was deceiving. The citizens did not realize the approaching catastrophe. They did not visualize the flood that was descending upon them from the north.

The Terms of Reference

General

My report, to this point, has dealt with the background matter which is essential to understand, before dealing with the actual terms of reference of the Inquiry.

Terms of Reference

The terms of reference may be summarized as follows:

I am to inquire and report upon:

(a) causes of the flood;

(b) nature and extent of flooding;

(c) resulting damage;

(d) action of the GRCA;

(e) action of participating municipalities;

(f) action of ministries of the Ontario Government;

(g) flood warning system;

(h) communications system;

(i) to make such recommendations as I deem fit.

Galt - Queen Street - Bridge West
5:30 p.m.
May 17, 1974

Causes of Flood

General

In a previous chapter, I dealt with the history of the flooding in the Grand.

The history goes back to 1790, but the 1974 flood was the severest in the recorded history of the watershed. The conditions which cause all floods may be grouped into two general classifications:

(a) geophysical, which are permanent;

(b) climatic, which are variable.

I have described in the earlier part of the report, in a summary manner, the geophysical aspects of the watershed. The drainage basins produce a high rate of runoff into the Grand and its tributaries. These rivers, due to the steep gradient in the northern and central zones of the watershed, channel the water southerly at a high rate of speed. Speed of flow is a critical factor in all flooding.

The four main causes of the 1974 flood were:

(a) unusual rainfall;

(b) saturated soil;

(c) lack of storage capacity in the Shand and Conestogo reservoirs;

(d) reduction of channel capacity.

Unusual Rainfall – Saturated Soil

General

The basic cause of the flood was the unusually heavy rainfall in the watershed on the night of May 16-17. This was superimposed on a dangerous set of antecedent conditions.

Antecedent Conditions

In the first 15 days of May, the precipitation in the watershed was equal to or in excess of the normal amount for the entire month. Most of this fell in the week May 9 - 15, the period immediately preceeding the flood producing storm.

By way of illustration, 2.85 inches of rain fell at the Shand Dam in the period May 1 - 15. The May mean average rainfall for the *entire* month of May at the same location for the period 1960 - 73 was 2.90 inches.

At the Conestogo Dam, 3.43 inches of rain fell from May 1 - 15, whereas the mean average from 1960 - 73 at the same location for the *entire* month of May was 2.63 inches.[1]

The first 15 days of May was an extremely wet period in the watershed. Therefore, on the morning of May 16, prior to the heavy rainfall, three dangerous conditions conducive to flooding existed:

(a) saturated soil with little absorptive capacity;

(b) high reservoir levels at the Shand and Conestogo Dams;

(c) high river flows, above and below the dams.

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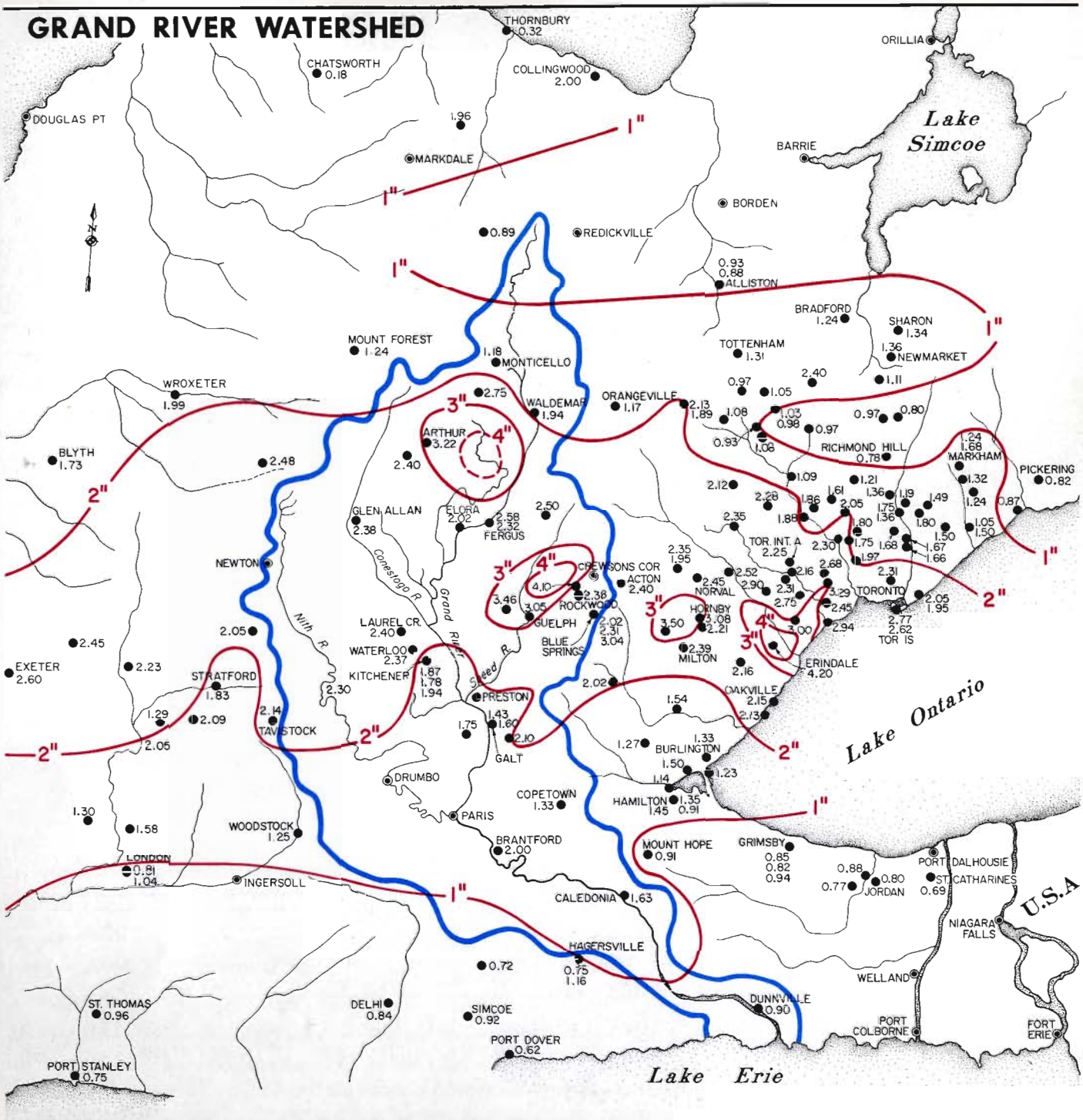
[1] See Exhibit 10



PRECIPITATION STATIONS

TOTAL PRECIPITATION (Inches) FOR 24 - HOUR PERIOD
8 a.m. EDT May 16 to 8 a.m. May 17, 1974

Isohyets..... —2"—

Note: Plotted data includes information from all available sources, both standard rain gauges of Atmospheric Environment Service Canada, and non-standard gauges.

Map prepared June 14, 1974

SCALE 10 5 0 10 20 30 40 MILES

CONSERVATION AUTHORITIES BRANCH • ONTARIO MINISTRY OF NATURAL RESOURCES • K M

Rainfall: May 16-17

It commenced raining intermittently in the watershed on the afternoon of May 16. That evening, an intense storm system moved across the watershed from the north-west. The following rainfall amounts were recorded on the GRCA precipitation gauges for the night May 16/17:

Shand	2.66 inches
Conestogo	2.38 inches
Luther	1.18 inches
Laurel Creek	2.40 inches
Rockwood	2.38 inches

Mr. McMullen, a hydrometeorologist, with an international reputation, prepared on June 14, 1974, an isohyetal map which is reproduced from data obtained from the Canadian Weather Service and other sources.[1] This map shows lines of equal rainfall amounts for various parts of the watershed during the 24 hour period from 8:00 a.m. May 16 to 8:00 a.m. May 17.

This map, which I find to be as accurate as possible, within scientific limitations, indicates the various amounts of rainfall during that climatological day. It indicates the southern part of the watershed had one inch of rain. In the Cambridge-Galt area, Kitchener-Waterloo area, two inches of rain. The heaviest rainfall occurred in the north middle section of the watershed with readings of up to four inches.

Mr. McMullen testified that there was an average rainfall over the entire watershed of 2.05 inches on that climatological day. This was unusually heavy for a day in May as the probability of two and a half inches is less than 1/10 of 1%. Such a high intensity rainfall is uncommon in May and is primarily confined to the summer months. A fortiori, it is even more unusual to have up to three to four inches in a day in May.

Other experts testified at the Inquiry to the effect that this was a most unusual storm and the probability of such recurring in May would be in the range of 50 to 150 years.

The results of such heavy rainfall in such a short time span on saturated soil resulted in high runoffs into already swollen rivers.

Lack of Storage Capacity of the Reservoirs

In one sense, it is incorrect to state that the fact there was little storage capacity in the reservoirs was a cause of the flood. On the other hand, had there been ample storage capacity, it would have reduced the effects of the flood.

The Shand and Conestogo reservoirs were of limited benefit during the flood as little storage was available. The evidence indicated the reservoirs delayed the peaks for about three hours with respect to their arrival time at Cambridge-Galt.

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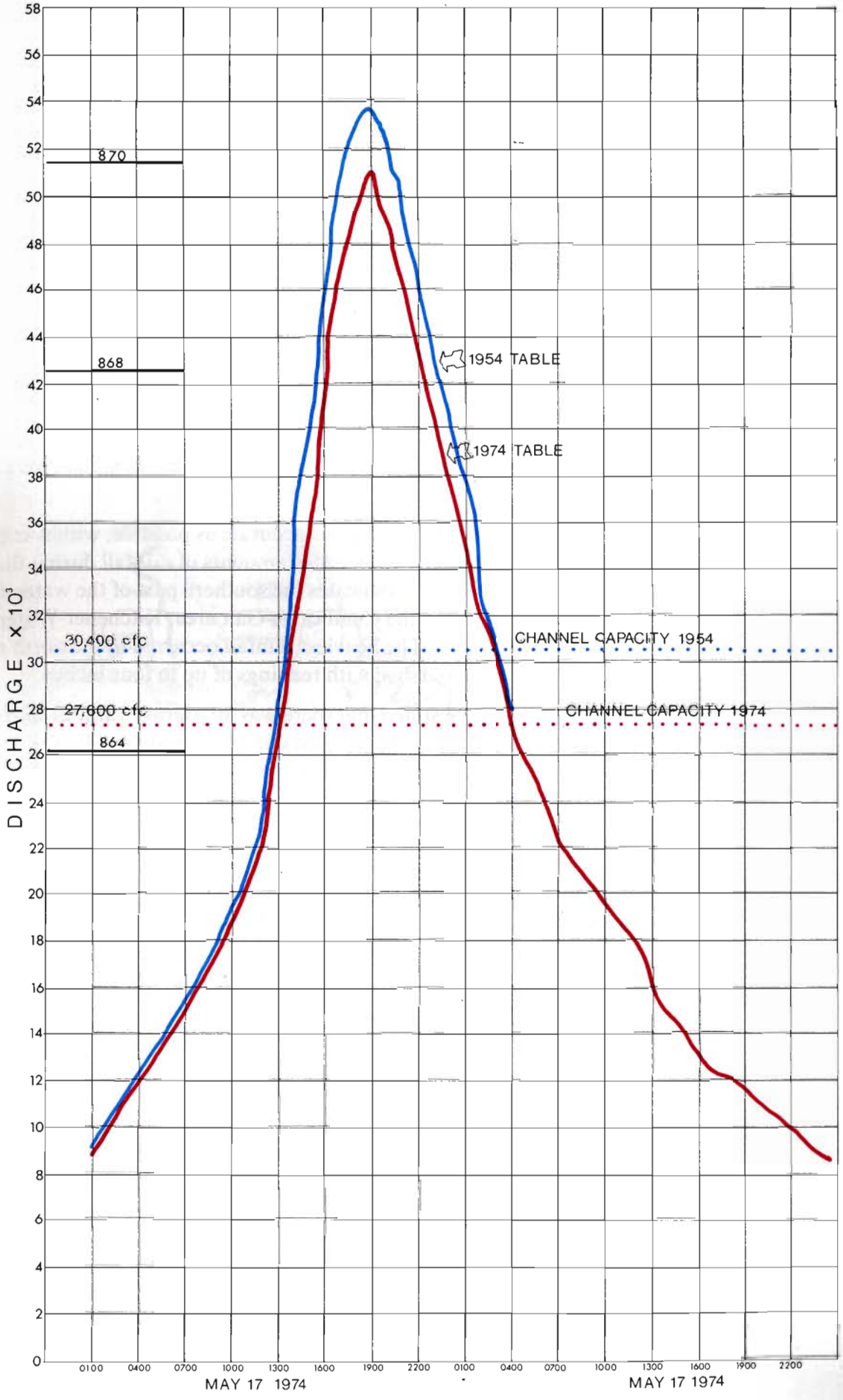
[1] See Exhibit 21

GALT–HYDROGRAPH



Both the Shand and Conestogo reservoirs were above their normal holding levels at around 2100 hours on May 16th, which was a critical period.

The Shand Lake level at 2100 hours on May 16th was 1394.82 feet. The normal holding level is 1394.6 and the maximum level is 1395.6. It had only .8 foot storage capacity.

The Conestogo Dam at 2045 hours on May 16th had a level of 1290.21 feet. The normal holding level is 1290 feet and the maximum level, 1291 feet. It had only .8 foot storage capacity.

The often repeated criticism that the "dams were no damn good" during the flood is basically true.

However, as previously stated, under the chapter entitled, "Dilemma of the GRCA", the GRCA must fill the reservoirs in the spring or they will not be able to meet the dilution requirements downstream for the rest of the season.

I can't resist the temptation of using the phrase, "They are damned if they do, and damned if they don't" in describing the position of the GRCA at this time of the year.

Reduction of Channel Capacity

If the capacity of the river to channel the water is reduced by infilling or by construction of buildings, this can contribute to flooding.

In this flood, most of the serious flooding was in three municipalities, Kitchener-Bridgeport, Cambridge-Galt and Brantford.

No serious reduction in the channel capacity has occurred in Kitchener-Bridgeport.

However, since 1949, in Cambridge-Galt, there has been a significant encroachment in the river channel by filling and reduction of the flood plain with structures.[1] The infilling was mainly by the municipality itself. Structures have been built by commercial firms and the municipality.

This has resulted in a channel capacity reduction in Cambridge-Galt from 30,400 c.f.s. in 1954 to 27,600 c.f.s. in 1974.[2]

In contrast to the reduction in Cambridge-Galt, the City of Brantford increased the channel capacity in 1954 of 33,000 c.f.s. to 39,000 c.f.s. in 1974. This was the result of channel improvements such as cleaning out islands and building dikes.

From this evidence I can only conclude that the reduction of the river capacity and the encroachment on the flood plain at Cambridge-Galt contributed to its own flooding.

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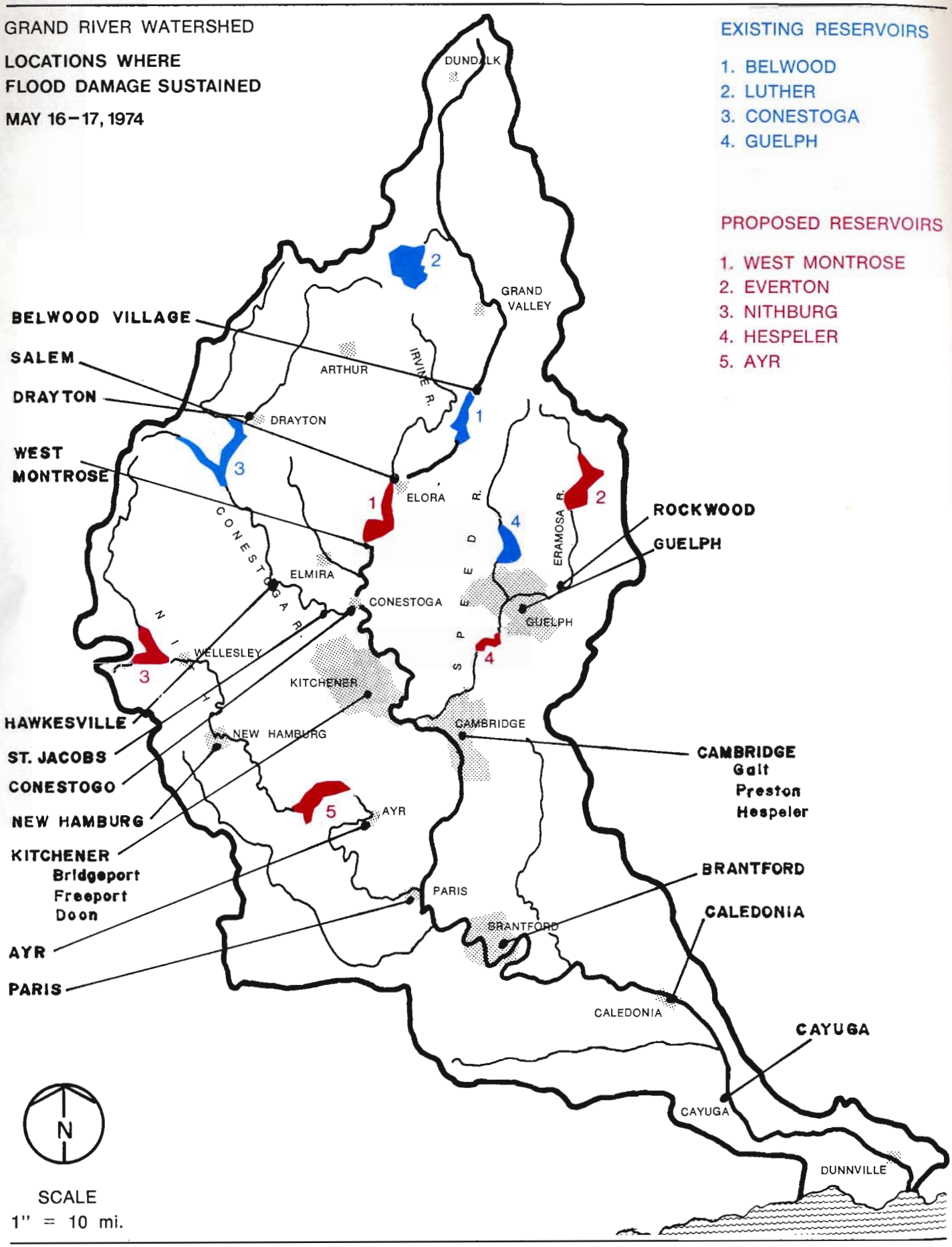
(1) See Exhibit 53 (2) See Exhibit 54


GRAND RIVER WATERSHED
LOCATIONS WHERE
FLOOD DAMAGE SUSTAINED
MAY 16–17, 1974
EXISTING RESERVOIRS
1. BELWOOD
2. LUTHER
3. CONESTOGA
4. GUELPH
PROPOSED RESERVOIRS
1. WEST MONTROSE
2. EVERTON
3. NITHBURG
4. HESPELER
5. AYR
DUNDALK
GRAND VALLEY
ARTHUR
IRVINE R.
DRAYTON
ELORA
SPEED R.
ERAMOSA R.
CONESTOGA R.
ELMIRA
CONESTOGA
GUELPH
NITH R.
WELLESLEY
KITCHENER
NEW HAMBURG
CAMBRIDGE
AYR
PARIS
BRANTFORD
CALEDONIA
CAYUGA
DUNNVILLE
BELWOOD VILLAGE
SALEM
DRAYTON
WEST MONTROSE
ROCKWOOD
GUELPH
HAWKESVILLE
ST. JACOBS
CONESTOGO
NEW HAMBURG
KITCHENER
Bridgeport
Freeport
Doon
AYR
PARIS
CAMBRIDGE
Galt
Preston
Hespeler
BRANTFORD
CALEDONIA
CAYUGA
N
SCALE
1" = 10 mi.

Nature and Extent of Flooding

Nature of Flood

Flooding has occurred in the Grand in past years at the time of the spring break-up. The cause of these floods was mainly due to excessive run-off after heavy winter snowfalls. Usually ice jams would occur at points in the river causing a back-up of water. This type of flooding has rarely occurred since the construction of the Shand and Conestogo Dams as they have trapped the excess flow in the reservoirs.

The 1974 flood occurred after the early spring break-up and the reservoirs were filled with the run-off from melted snow.

The high precipitation from May 1 - May 17th resulting in high run-off, swollen rivers, and full reservoirs produced what could be called a high late spring flood.

Extent of Flooding

General

The map opposite indicates locations throughout the watershed where flooding occurred on May 16 - 17th. Many of these municipalities suffered only minor flooding. The major flooding occurred in Kitchener-Bridgeport, Cambridge-Galt, Paris and Brantford. In addition, there was serious flooding of farm lands in various parts of the watershed. I will only deal with the areas of severe flooding.

Cambridge-Galt

Cambridge-Galt was the most severely flooded municipality in the watershed. The flooding exceeded anything previously recorded, since 1790. (See map.)

The channel capacity in the city is 27,600 c.f.s. At 7:00 p.m. on May 17th the flow was 53,000 c.f.s., the highest in recorded history.

The Grand overflowed its banks at approximately 1:00 p.m. on May 17th in the main business section and crested at approximately 7:00 p.m. that night.

The water reached a depth of up to six feet in the downtown commercial area.

The problem was compounded by the high velocity of the flow which was estimated to be 15 - 20 knots.

The Grand flows in a northerly to southerly direction through the city and the central part of the city is in a valley.
Grand Avenue runs along the west bank and is mainly a residential area. Water Street is along the east bank and the northerly part is commercial and the southerly residential. Ainsley Street, a main commercial street, runs parallel to Water Street but is located east of Water Street. It has a higher elevation at its intersection with Main Street.

Each side of the river, from Parkhill Road on the north to the southerly built-up area of the city, was flooded in an easterly and westerly direction for a distance of one to one and a half blocks.

On the west bank, Grand Avenue and Middleton Avenue were flooded. On the east bank, Water Street and parts of Ainsley were flooded.

The material which was used on the tour of Cambridge-Galt details precisely the flooding that occurred.[1] Three road traffic bridges and one railway bridge cross the Grand in the downtown section. At the peak of the flood the river overflowed these bridges and traffic was unable to cross. The effect of the blockage was to cut the downtown section in half. The bridges with their abutments act as minor dams to a degree and back up water.

Provincial Highway No. 24, which is a main traffic artery from the south into the city, was flooded early on May 17th.

Flooding also occurred in the north-westerly section of the city, mainly affecting agricultural land. In this area, a section of the MacDonald-Cartier Expressway was washed out and traffic was backed up for 15 miles. The intersection of Fountain Street with the Blair Road was closed to traffic by mid afternoon.

The flooding of main streets, bridges and highways resulted in a great deal of traffic congestion. Residents who were endeavouring to reach their homes or places of business had to take circuitous routes. The problem was further magnified by the many sightseers from out of town who came to see the flood. Added to this was the fact that children were let out of school on May 17th and they flocked downtown to join the excitement. The sun shone brightly in the afternoon and created almost a carnival atmosphere in the face of a great tragedy.

Kitchener-Bridgeport-Freeport-Doon

The Village of Bridgeport, now a part of Kitchener, had serious flooding. It is located south of the confluence of the Conestogo and Grand Rivers. It, together with the Village of Conestogo, was the first to receive the impact of the heavy flows of both rivers.

The heavy rains during the night of May 16 - 17, caused flooding in the village early in the morning of May 17. By 5:30 a.m., the river was over its banks and the basement of the municipal offices, and other basements, were flooded. The earth berm, which protects the village, had not been completed. The river continued to rise, and by 8:30 a.m. the flooding was so severe that Bridge Street and the Grand River Bridge were closed to traffic. At this time, the residents were being evacuated by truck. Later in the morning, boats and a front end loader were required to carry out rescues. Sections of an existing dike were washed out and the current became so swift, it was impossible to rescue persons with boats. Volunteer hovercraft were pressed into service and they completed the rescue missions.

The river flooded the banks at Bridgeport to a height of approximately four feet. (See map.)

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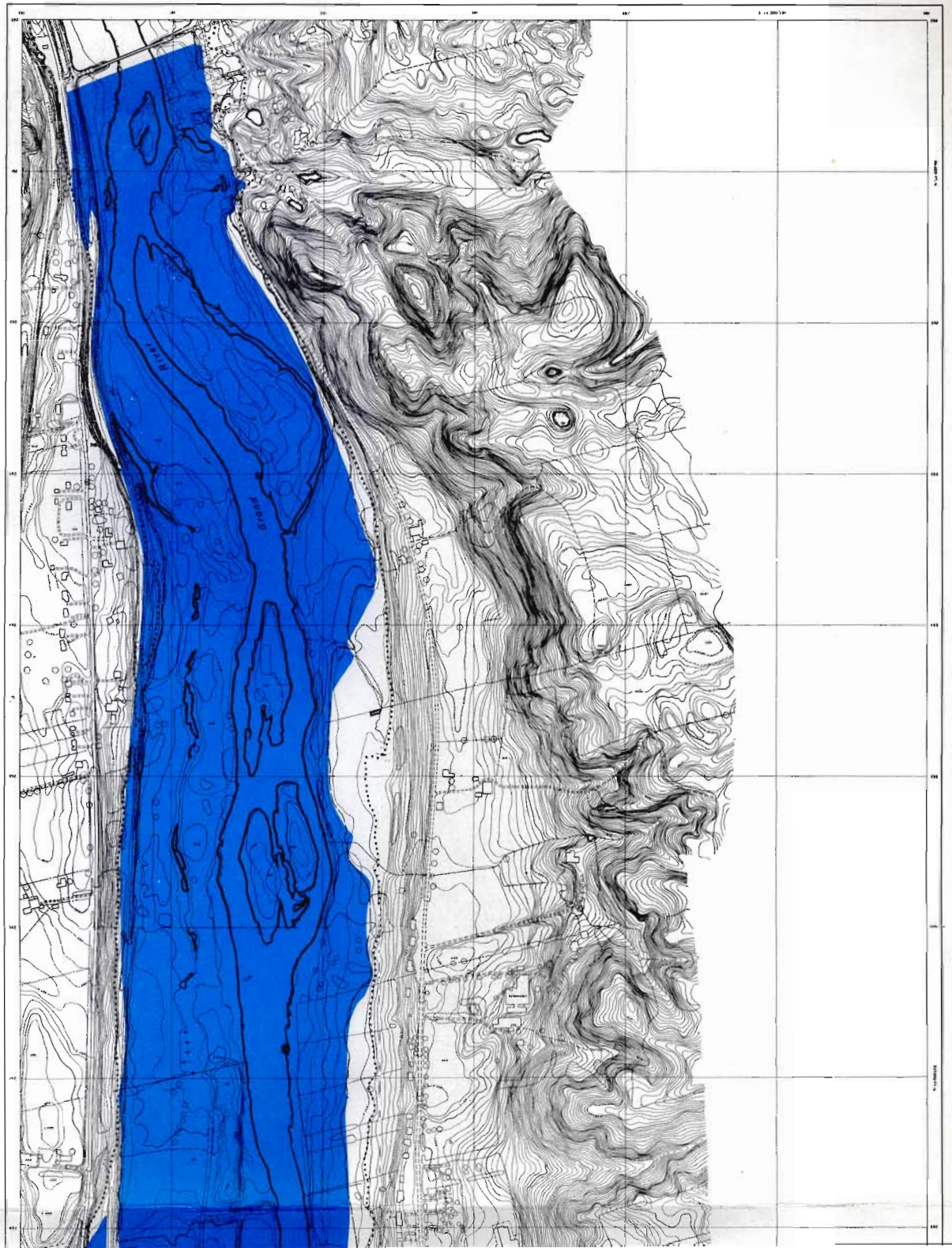
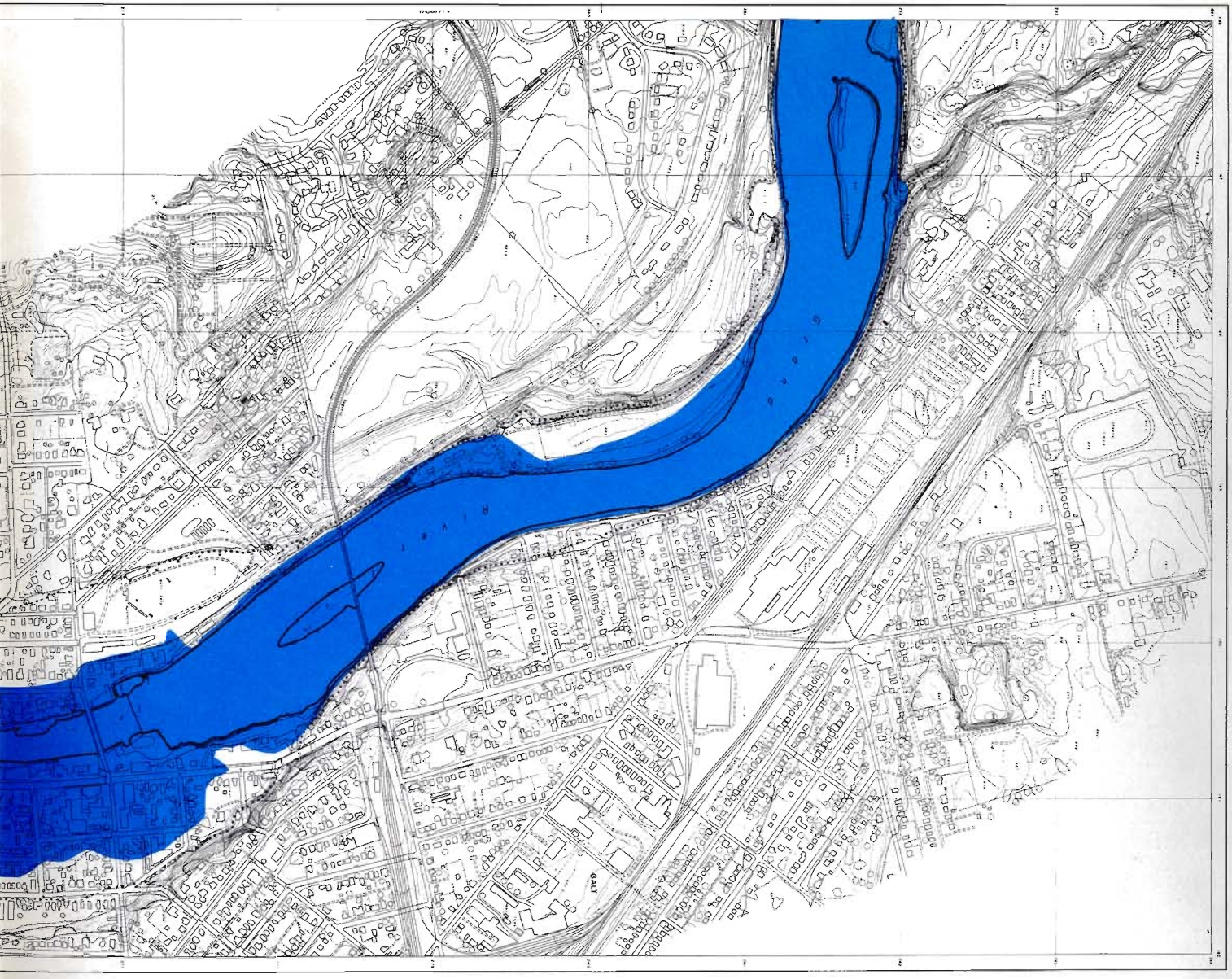
[1] See Exhibit 34 (b)

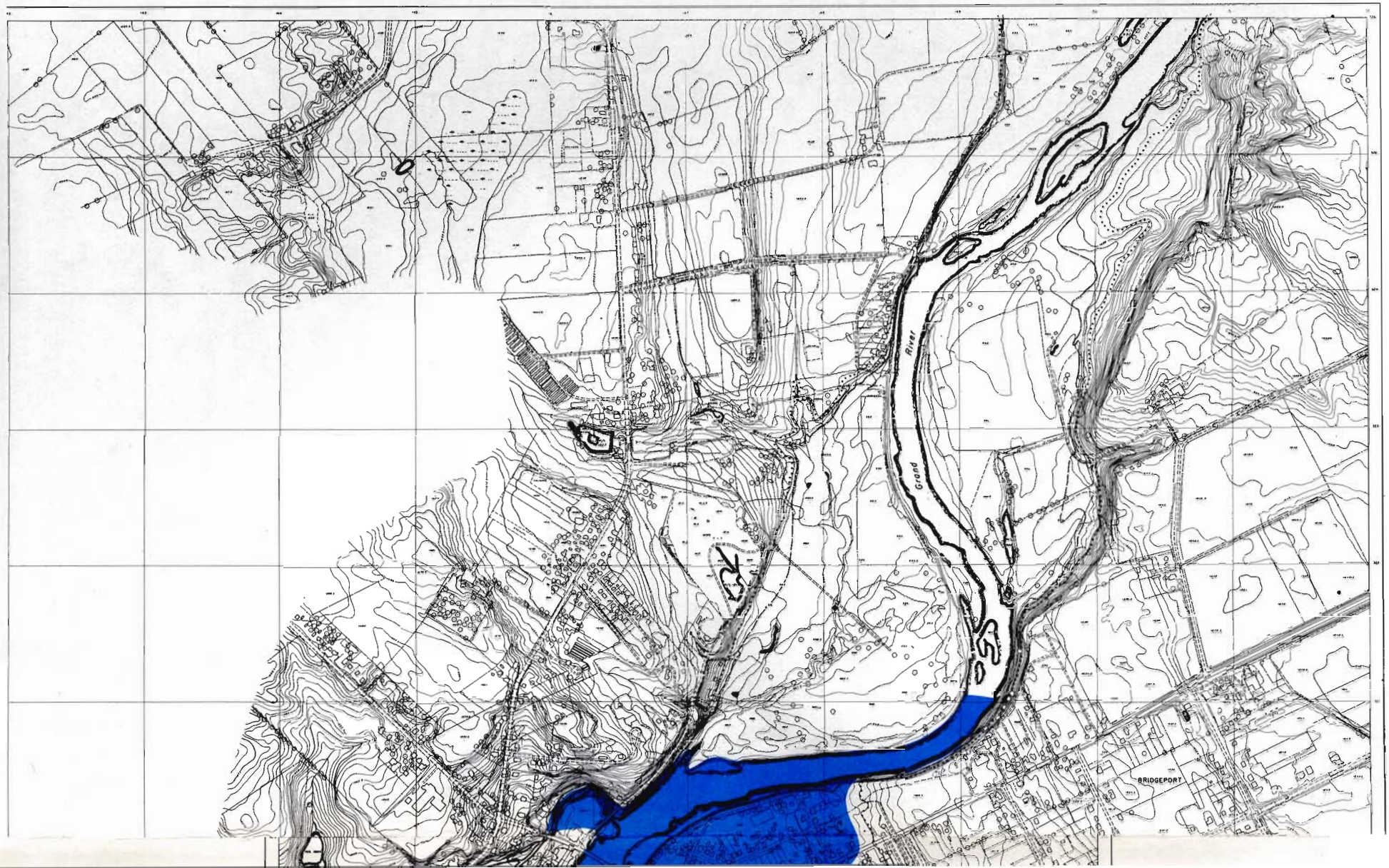
Flood Levels for Galt and part of Preston for May Flood 1974

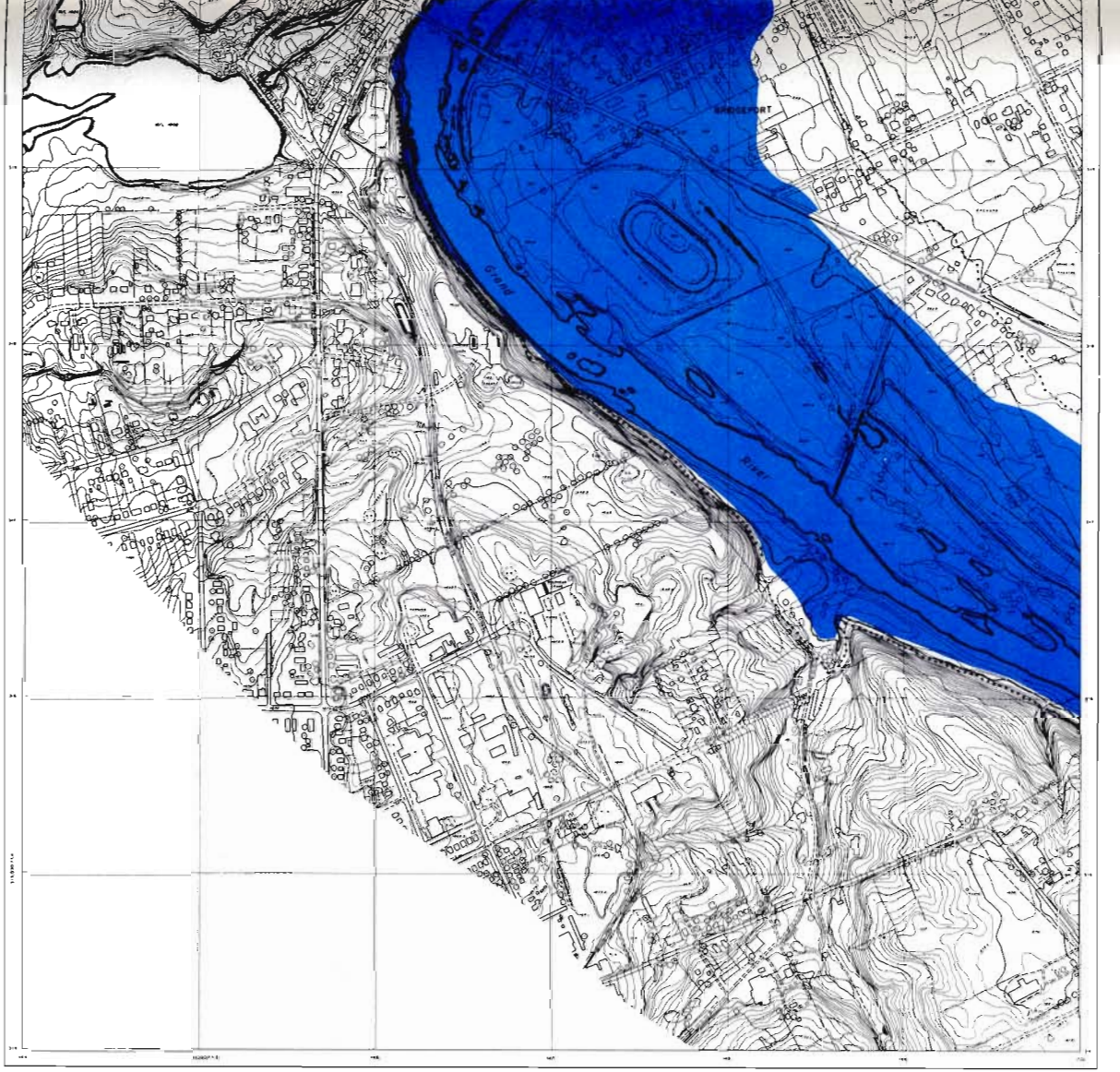



GRAND RIVER
GALT


GALT

Bridgeport
Flood Levels for
May 1974



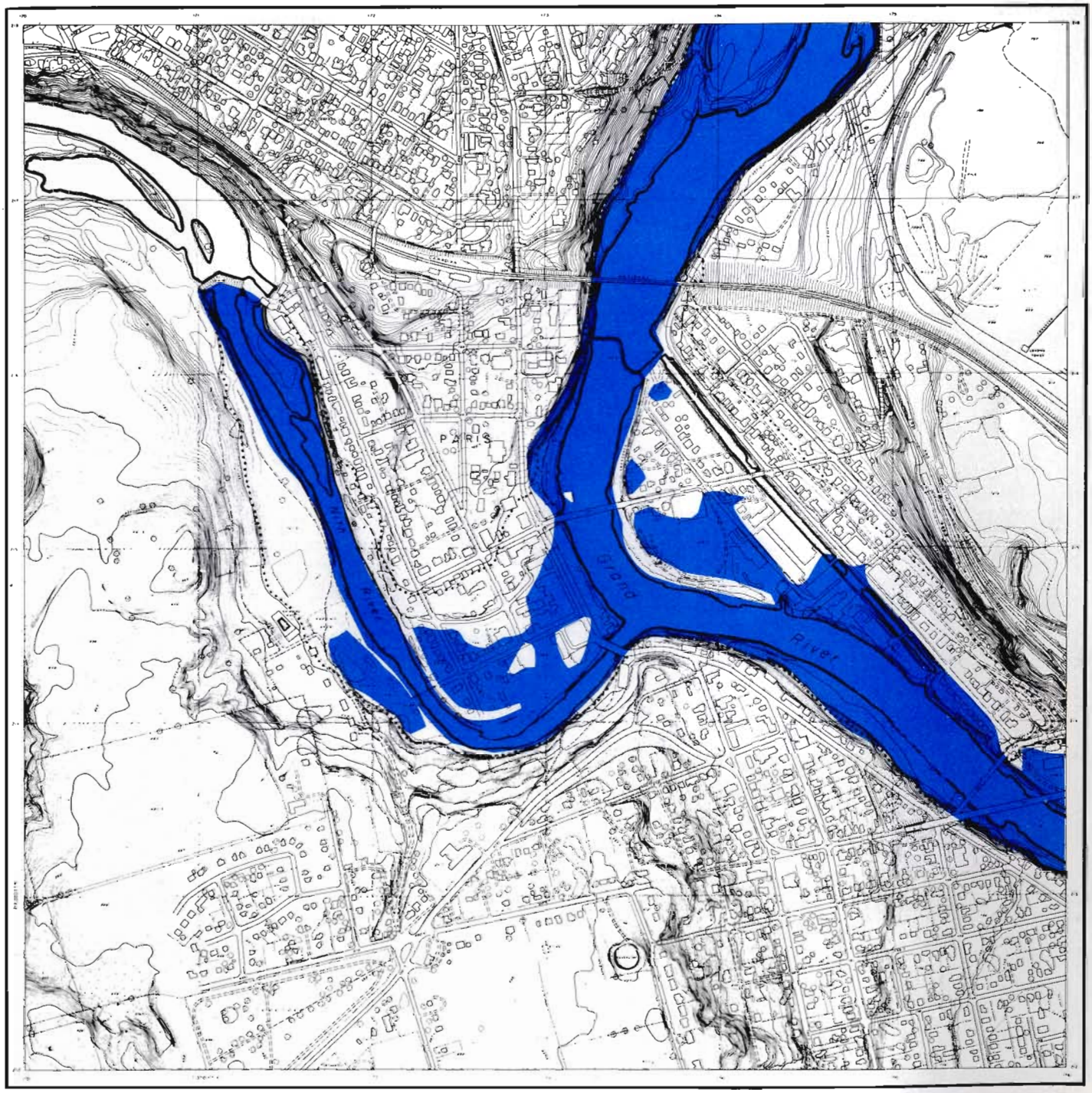

BRIDGEPORT
GRAND
RIVER

Bingeman Park, located downstream from Bridgeport, had as much as ten inches of water over the floors of some buildings.

The old City of Kitchener did not suffer seriously from the flood mainly due to the fact that the Grand circumvents the city in a south-easterly direction.

Freeport, located at the south end of Kitchener, had three or four homes flooded, and some vacant land.

Paris showing area flooded during May 1974



Paris

Paris is located at the confluence of the Nith and Grand Rivers. The community had serious flooding but not to the degree of Cambridge-Galt. (See map page 37.)

Paris, over the years, has constructed dikes but these were not sufficient to hold back the eight to ten feet rise in the river.

The Nith River did not actually flood but it was backed up by the Grand resulting in the flooding of the Lion's Park and a residential area, known as Coney Island.

The Grand reached its peak in the late afternoon of May 18.

Shortly after noon hour, water began to seep into the basements along the Grand River.

Hundreds of volunteers took part in sandbagging vulnerable points, particularly the Grand Dam, and this reduced the severity of the flooding substantially.

William and Grand River Streets were flooded and merchants sandbagged the entrance to their stores. At one point, boats were running up and down Grand River Street.

On Willow Street, residents of the public housing complex evacuated their homes with the help of friends.

The water pollution control plant on Race Street was out of operation for a short time.

The flooding also affected many merchants on the east side of Grand River North. Many of these buildings have their foundations right into the bed of the river. They have had experience with flooding and move their stocks from the basement to a higher level. However, they were not prepared for the height of flooding that occurred.

Brantford

Brantford experienced one of the worst floods in its history, but not to the same degree as Cambridge-Galt.

(See fold-out map in pocket at end of report.)

The Grand River reached a peak flow of 61,900 c.f.s. at 2359 hours on May 18th, an all time record. The river rose to a height of 18.2 feet.

The worst of the flooding was in the Birkett Lane and River Road section of the city.

At approximately 10:30 p.m., the dike gave way in Holmesdale, flooding several streets, especially Sunset Street and Grand River Avenue.

The former canal along Greenwich Street overflowed flooding the street.

A section of the Newport Road, south-east of the city, and a section of River Road, east of Newport Road, were washed out.

The Brant County Board of Education, who built a new building in the flood plain against the order of the GRCA, was forced to move equipment and furniture.

It was estimated that approximately one hundred families evacuated their homes on Saturday night.

The city was declared to be in a state of emergency for six hours on Saturday. The emergency arose when the water treatment plant ceased to function. Brantford takes its drinking water from the Grand River. Water came through a breach in a canal dike, flooding pump generators and contaminated water entered the reservoirs. Water tank trucks were pressed into service and they hauled water to central points for pick-up by residents.

Water service was partially restored by 9:00 a.m. and residents were advised to boil their water. The state of emergency was lifted at noon. However, residents boiled their water until Monday.

The sewage treatment plant was isolated by the flood waters but continued to operate throughout the crisis.

Hundreds of basements were flooded leaving behind mucky grime to clean up.

Caledonia Fairgrounds - North East 7:30 a.m.
May 18, 1974

Caledonia-Cayuga

Neither community suffered serious flooding.

In Caledonia, parklands on the west side of the town and the agricultural grounds were inundated, with no serious damage. These areas are often flooded but the effects have been reduced by the construction of dikes.

Cayuga suffered flooding in the trailer park, which was mainly occupied by trailers. Most owners removed the trailers. Only one claim was made on the Disaster Relief Fund from Cayuga.

Dunnville

A machine shop and a residence was the only property affected by flooding in Dunnville.

However, a potentially dangerous situation existed which could have caused severe flooding, if it were not for the action of Mr. F. Scholfield, the Clerk of the Municipality.

The Dunnville Dam was constructed in 1829 for the purpose of feeding water into the Welland Canal. The dam is in a serious state of deterioration. In addition, three waste weirs were constructed to control the height of the reservoir. These have not been operational for years, but their maintenance is the responsibility of the GRCA.

Cayuga - Flooded Houses on Inside Bend North
8:00 a.m.
May 18, 1974

On Saturday, May 18th, debris flowing down the Grand was piling up in front of the first waste weir, which was preventing the escape of this water. If this condition had continued, there could have been serious flooding.

Mr. Scholfield and an employee of the GRCA arranged for a backhoe and a bulldozer and had the debris removed, which solved the problem.

Mr. F. Scholfield, a longtime resident of Dunnville, testified this was the first time he realized the weirs were not operational.

Agricultural Lands

A considerable amount of agricultural land was flooded throughout the watershed, but from the evidence heard, it is impossible to fix the quantum.

The flooding had two detrimental effects. Firstly, it eroded valuable topsoil and deposited gravel waste on the land. Secondly, as a result of the saturated state of the soil, crop planting was delayed reducing the financial return. There was no evidence tendered of losses to farm buildings or equipment.

Grand River - 1st. Oxbow South of Conestogo - looking North
1:00 p.m.
May 17, 1974

Damages caused by the Flood

General

Words and figures are rather weak weapons to describe the damages caused by the flood. One can estimate the physical damages to buildings and property but how does one evaluate the fears, discomfort and anxiety of the flood victims. What is the "price tag" to be fixed for the suffering of an elderly couple in Cambridge-Galt who were trapped all night in the second floor of their home, the first floor flooded, with no light or heat or no communication with the outside world. Meanwhile, the water is rising in the house. Outside, their son, who has driven from near Toronto, is scouring the city for news of his parents, and no one can answer him. This is an example of some of the evidence heard from a flood victim.

What is the value for cleaning up the debris, muck and grime that this flood left in Cambridge-Galt, Bridgeport, Paris and Brantford.

What quantum of damages should be fixed for business dislocation, loss of profits and stock in Cambridge-Galt.

These items cannot be valuated.

No Loss of Life

The miracle of this tragic flood, and I use the word, "miracle' advisedly, was that there was no loss of life.

Just south of Cambridge-Galt, one man spent the night of May 17th lodged in a tree. He was rescued by a helicopter in the early morning of May 18th.

Main Street, Bridge - Galt
Approx. 5:30 p.m.
May 17, 1974

Galt, South - Highway 24 closed- Sewage Plant West 5:30 p.m. May 17, 1974

Galt - Main to Queen - West 5:30 p.m. May 17, 1974

Cambridge-Galt

This city suffered most from the flood. Water rose to a height of six feet in the downtown section.

It rose so rapidly that people were trapped in upper storeys of buildings and had to be rescued.

The high velocity of the flood carried everything before it. Cars were transported in the flood for blocks. Store windows broke under the pressure, and merchandise of all sorts floated along with the current.

Added to this was the debris from up river such as trees and logs which floated along the main street breaking windows in stores.

During the flood, the fire department was called upon to extinguish a fire which occurred in a building surrounded by flood waters.

As described in the previous chapter, the serious flooding occurred in the residential area on the west side of the river and the business and residential area on the east side of the river.

Fortunately, structural damage to buildings was minimal but there was extensive damage to contents and stock of many commercial and residential buildings.

Mr. Robert Kerr, the Chairman of the Grand River Disaster Relief Fund, filed an estimate of damages for the entire watershed.[1] The figures were based on the amount being claimed by the various victims of the flood. For Cambridge, the estimated figures were:

Industry	$1,943,900
Residential	
Small Business, Clubs, etc.	2,899,205
Municipal	240,000
Total	$5,083,105

These figures contain no provision for clean up costs for industry, residences, etc., or for loss of business. The clean up was a tremendous problem for all persons affected by the flood.

I would be remiss if I did not mention how the citizens of the city united together to solve their problems. The pictures and testimony presented to the Inquiry evidenced the dedication of the rescue workers.

Hundreds of persons and organizations volunteered to assist during the flood and massive clean up. Symbolic of this, was the work of the Mennonite Disaster Workers with volunteers from the watershed and as far away as the United States. They came with their own cleaning equipment, and food, did a tremendous and unpleasant job, and left unobtrusively.

[1] See Exhibit 102

Water Street, Galt - 10:30 a.m. May 18, 1974

Water Street, Galt - 10:30 a.m. May 18, 1974

Kitchener-Bridgeport-Freeport-Doon

Bridgeport experienced very severe flooding.

Rescues of trapped flood victims had to be carried out.

Many residences along the river were flooded and contents damaged.

The municipal building with the post office in the basement suffered severe damage.

The estimate of damage is under the heading Kitchener, which includes Bridgeport, Freeport and Doon.[1] Most of this damage occurred in Bridgeport. The estimate was:

Industry	$ 4,965
Residential, Small Business, etc.	503,043
Municipal	184,039
Total	$692,047

Included in the municipal damages were the major items, the Kiwanis Park, Bridgeport $130,000, and the damages to the Doon Golf Course estimated at $22,000.00. No provision is included in the estimate of the total damage for cleaning up the residential properties.

(1) See Exhibit 102

Freeport Bridges
Grand River - looking East
1:00 p.m.
May 17, 1974

Bridgeport looking North - 1:00 p.m. May 17, 1974

Bridgeport - 11:30 a.m. May 17, 1974

Paris

Paris was not as severely flooded as Cambridge-Galt and Bridgeport.

It was not necessary to rescue victims from their homes.

The many volunteers who assisted in sandbagging played an important part in reducing the damages.

The estimate of damages for Paris was as follows:

(1) Industry	Nil
Residential, Small Business, etc.	$237,000
Municipal	6,700
Total	$243,718

These figures contain no allowance for the large clean-up job performed by merchants and residents.

(1) See Exhibit 102

Paris - Confluence Nith
Grand River
7:00 a.m.
May 18, 1974

Brantford

Brantford, in certain areas of the city, suffered severe flooding. However, it was not necessary to rescue any flood victims. Many of the homes in the flood areas had flooded basements causing damage to furnaces and contents therein.

These persons all had a nasty mess to clean up over the week-end.

Damages for Brantford were estimated to be:

(1) Industry	Nil
Residential	$425,988
Municipal (Repair dikes)	24,000
Total	$449,988

(1) See Exhibit 102

Brantford - Cockshutt Road
Board of Education - North West
7:00 a.m.
May 18, 1974

Other Areas

The damages for the rest of the watershed, not described above, were estimated to be:

[1] Municipal Damages – Region of Waterloo	$ 52,020
Residential, Small Business, Agricultural	210,852
Industry	5,000
Total	$267,872

Total Damages for Watershed

The total damages from the flood, not including business losses and clean up costs, was estimated to be $6,736,730.00.[1]

This total was broken down as follows:

Industry	$1,953,865
Residential, Small Business, Churches, Clubs, and Farms	4,276,106
Municipal	506,759
Total	$6,736,730

[1] See Exhibit 102

Flood Forecasting

General

In the chapter dealing with the causes of the flood, I concluded it was mainly due to the abnormally high precipitation in a short period.

In this chapter, I propose to consider the weather forecasts received and the manner they were acted upon by the GRCA.

Action of Conservation Authorities Branch

The Conservation Authorities Branch of the Ontario Ministry of Natural Resources is responsible for weather watching for the 38 conservation authorities in the province, including the GRCA.

It depends substantially upon weather forecasting information supplied by the Federal Department of the Environment weather office at the Toronto International Airport. The weather office automatically contacts the Conservation Branch if more than one inch of precipitation is forecast.

The Conservation Branch then applies the weather forecast to the data it has on hand such as soil conditions, river flow, snow density, etc. From this, the run-off of the river can be predicted, and the flood potential. The Branch then notifies the authority concerned.

Mr. McMullen is the Senior Hydrometeorologist with the Branch and is assisted by Mr. Gryniewski. At the time of the flood, Mr. McMullen was ill and Mr. Gryniewski was left in charge.

The daily weather map and forecast was delivered to the Branch at 11:00 a.m. May 16 by a courier from the Federal Atmospheric Environmental Service. This report indicated possible precipitation in the Grand watershed. Mr. Gryniewski called the Public Forecaster at 12:30 p.m. to obtain more information re forecast precipitation. He was advised that **one-half to one inch** was expected in a general area from Windsor to Toronto. He felt this forecast presented no problem to the Grand.

At 12:20 p.m., Mr. Gryniewski was advised that the Quantitive Precipitation Forecast was not available as the computer in Montreal was inoperative temporarily.

At 3:30 p.m. Mr. Gryniewski again contacted the weather office and was advised that **one inch to one and one-quarter inches** was forecast for the Windsor to Toronto area. This indicated to him high flows in the Grand but no flooding problems. Mr. Gryniewski made several phone calls to different authorities. Before he called the GRCA, Mr. Stevens of the GRCA phoned him.

Forecast to GRCA

Mr. Gryniewski, at 4:00 p.m. May 16, advised Mr. Stevens that there would be above normal flows in the Grand but not in the flood range. A forecast of **up to one inch of rain** in thunderstorms was estimated. At no time did the GRCA receive an official weather advisory from the Conservation Branch.

It rained in the watershed that afternoon but the weather report at 1800 hours on a local television station indicated the rain was over.

At 2030 hours the operator at the Laurel Creek Dam reported 1.55 inches of rain and localized flooding in Waterloo. In their reports at 2100 hours Shand and Conestogo reported 1.0 and 0.68 inches of rain respectively. This was the first indication to the GRCA that the rain was exceeding the forecasts. At that time, the GRCA moved into flood control operations. Mr. Gryniewski did not contact the GRCA again until 11:00 a.m. on May 17th.

Conclusions

The evidence clearly indicates the inexactness of the science of weather forecasting.

The GRCA was advised to expect around **an inch of rain** and the watershed received from **two inches to four inches.** I am not being critical of anyone in this regard. These figures show the unreliability of weather forecasts.

The evidence indicated that weather forecasting can be reasonably accurate on a grid of 200 miles square, but very inaccurate when applied to a watershed of the size of the Grand. Another difficulty is that the science cannot forecast if the rain will fall above or below the dams. This is significant in the operation of the dams. A basic principle in their operation is not to release water in the face of a storm, as the heavy rainfall could be below the dam which would compound an already serious problem.

I am satisfied that the GRCA acted in the only responsible manner they could in the light of the inaccurate forecasting.

Mr. McMullen, in testifying as to the inexact science of weather forecasting, illustrated the problem by saying it always helps to look out the window before predicting.

The Flood Warning System

General

Many of the witnesses criticized the flood warning system. This criticism was directed at the GRCA and at certain municipalities.

The GRCA has a duty to inform municipalities and other agencies of impending floods. This is particularly so, when they are operating with full dams in the spring.

The municipalities too, when they receive the flood warnings should have a plan that will warn and protect all their residents. It does not matter that certain persons will not heed the warnings. They are entitled to have the warning.

A proper flood warning system can save lives and property.

Very little expenditure is required to set up adequate warning systems. The watershed has telephone systems, wireless systems with police and fire departments, radio stations, etc. It is just a matter of preparing a practical plan, using all the means of communication available and a determination to see that the warnings reach all the affected persons.

There is no excuse for the GRCA or municipalities not to have a proper flood warning system.

Flood Warnings by GRCA

GRCA Communications and Monitoring Systems

The GRCA has a fairly complex internal radio system to keep itself informed of developments in the watershed. The diagram on page 54 illustrates this network.[1] There are six base stations, one repeater station, 36 mobile units in cars and trucks, and six portable units. This system worked quite well during the flood for internal communications and for emergency communications with other agencies.

At the headquarters of the GRCA there is a central telephone switchboard having five lines. If one line is busy, the call automatically comes in on another line. During the flood, these lines were inundated with calls.

With regard to the internal warning system of the GRCA there exists a procedure of routine reporting. Telemetered information is automatically received from the stream gauges indicating river flow.

The telemetered information fed into the operator's control office at the Shand and Conestogo Dams are checked twice daily. Any special conditions are reported to Control by dam operators.

On an average day, the dam operators report water levels, inflows, discharges and the storage in acre feet. In addition, the gate openings, gauge readings, temperature, precipitation, and general weather remarks are reported to Control.

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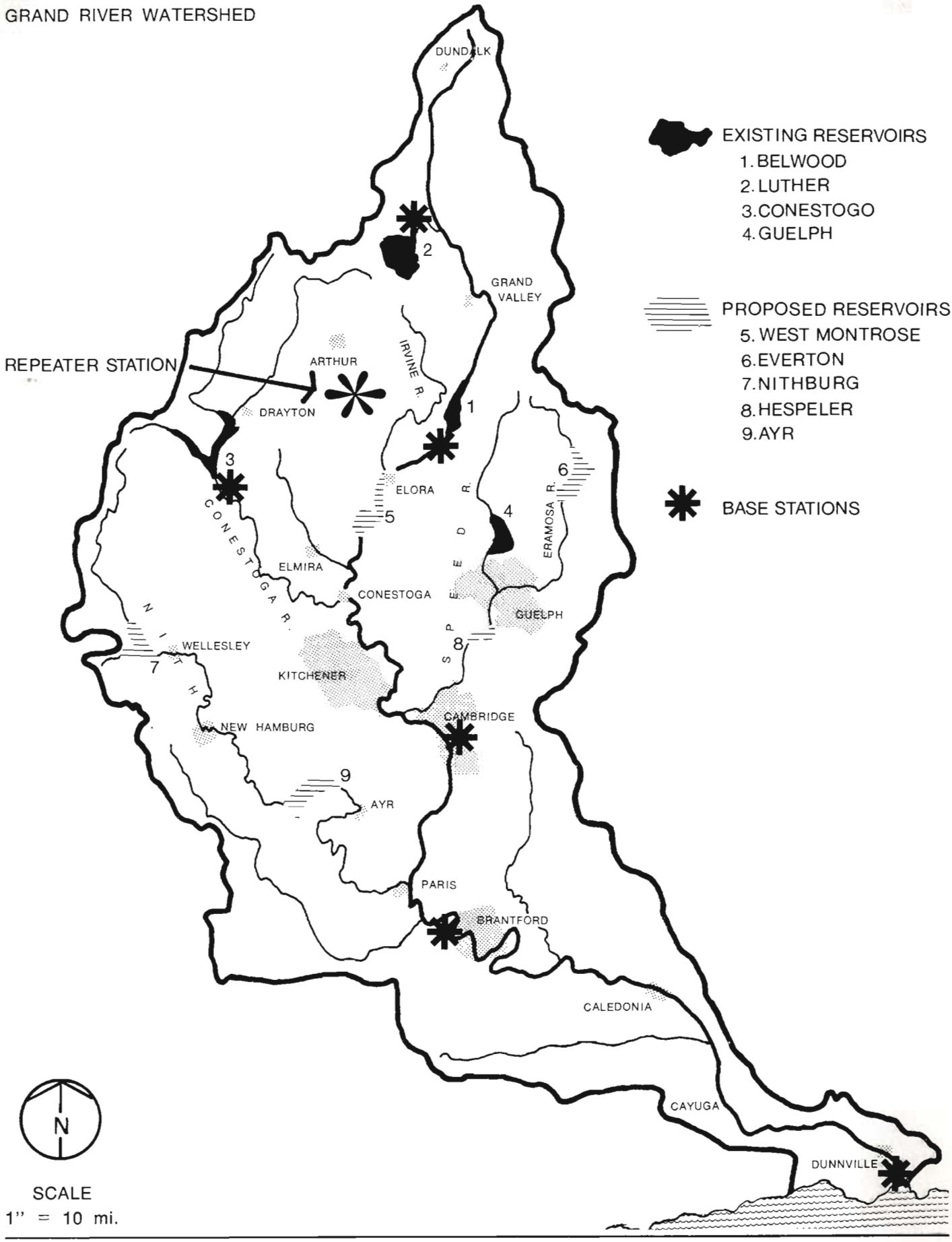
[1] See Exhibit 39 (8)


GRAND RIVER WATERSHED
DUNDALK
GRAND VALLEY
IRVINE R.
ARTHUR
REPEATER STATION
DRAYTON
ELORA
SPEED R.
ERAMOSA R.
CONESTOGA R.
ELMIRA
CONESTOGA
GUELPH
NITH
WELLESLEY
KITCHENER
NEW HAMBURG
CAMBRIDGE
AYR
PARIS
BRANTFORD
CALEDONIA
CAYUGA
DUNNVILLE
1
2
3
4
5
6
7
8
9
EXISTING RESERVOIRS
1. BELWOOD
2. LUTHER
3. CONESTOGO
4. GUELPH
PROPOSED RESERVOIRS
5. WEST MONTROSE
6. EVERTON
7. NITHBURG
8. HESPELER
9. AYR
BASE STATIONS
N
SCALE
1" = 10 mi.

During a flood alert, all operational reports and calls have top priority on radio systems and emergency telephone.
The GRCA also operates:

(1) 20 recording stream gauges;

(2) 12 snow measuring courses;

(3) 9 precipitation and temperature measuring stations.

The snow measuring courses and weather stations give detailed information on the flood potential in the watershed.
The data recorded by the stream gauges allows staff to follow the development of a flood as it moves through the watershed. By means of this information, predictions can be made as to the height and time of arrival of the flood at downstream locations.

Short Notice

The size of the Grand River watershed does not allow a great deal of advance warning of floods.

The steep gradient from the dams to Cambridge-Galt results in high velocity in the river flow.

The travel time of the flood waters from the Shand and Conestogo Dams to Cambridge-Galt is 20 hours, and to Brantford, 27 hours.

Caledonia, Cayuga and Dunnville have substantially more time to prepare.

In view of the limited warning time, it is essential for the GRCA to get its warnings out early and for local officials to be ready to act.

The Flood Warnings Given by the GRCA in May

The GRCA, over the years, has had a flood warning system. Simply described, it is a list of persons in municipalities along the river who were contacted by the GRCA in the event of potential floods. These included municipal clerks, county engineers, chiefs of police and members of the GRCA.

In January, 1974, the GRCA, for various reasons, decided to revise its flood warning system. One of the reasons was the advent of regional government to Waterloo. On January 11, 1974, the following letter was sent out by the GRCA.[1]

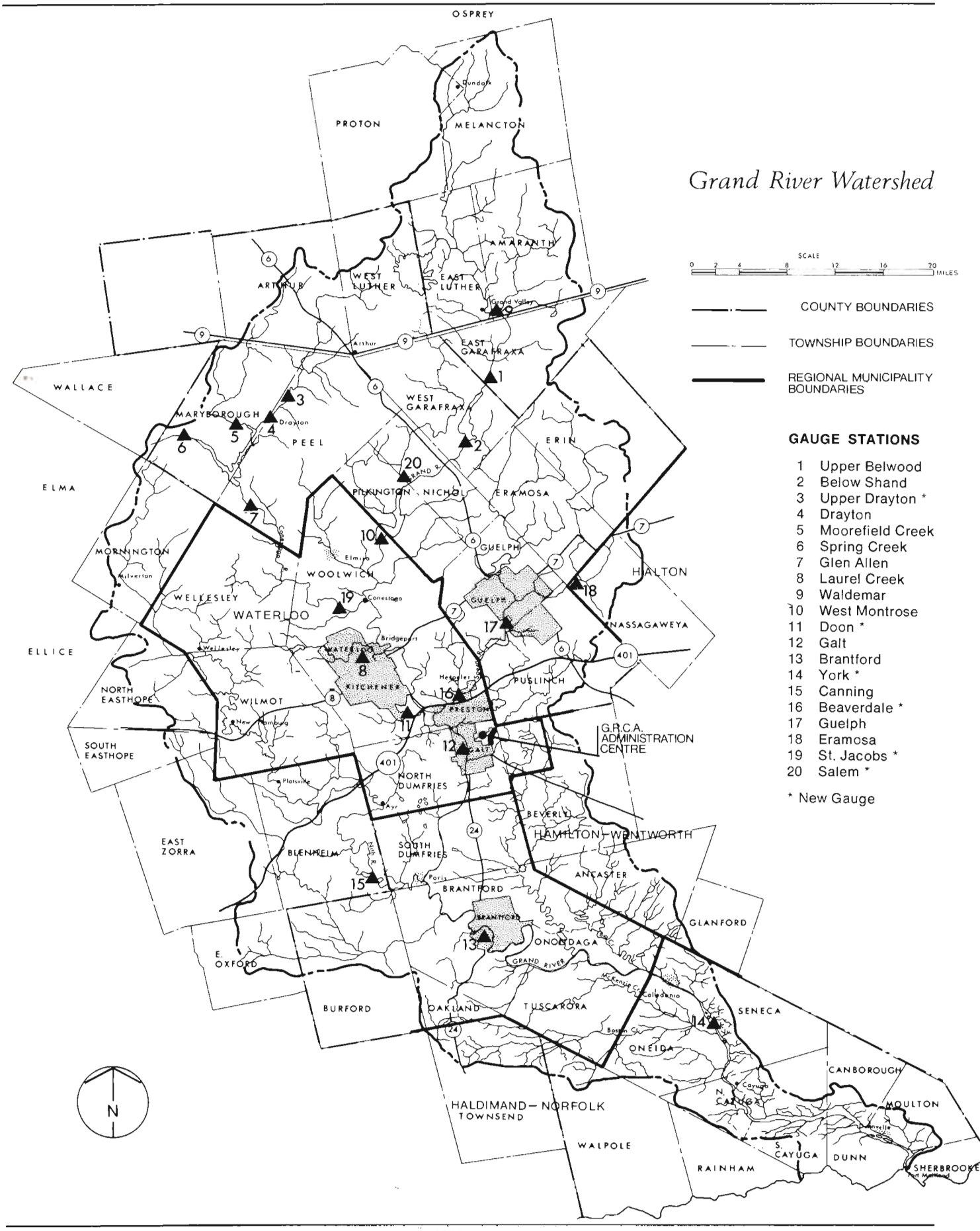
January 11, 1974

TO: Clerks of Municipalities – Grand River Watershed
County Engineers – Grand River Watershed
Chiefs of Police – Brantford, Paris, Waterloo Region, Guelph, Fergus, Dunnville
Members of the Grand River Conservation Authority

Re: Flood Warning System—Grand River Water shed

The Grand River Conservation Authority is currently revising its Flood

(1) See Exhibit 11


Grand River Watershed
SCALE
0 2 4 8 12 16 20 MILES
COUNTY BOUNDARIES
TOWNSHIP BOUNDARIES
REGIONAL MUNICIPALITY BOUNDARIES
GAUGE STATIONS
1 Upper Belwood
2 Below Shand
3 Upper Drayton *
4 Drayton
5 Moorefield Creek
6 Spring Creek
7 Glen Allen
8 Laurel Creek
9 Waldemar
10 West Montrose
11 Doon *
12 Galt
13 Brantford
14 York *
15 Canning
16 Beaverdale *
17 Guelph
18 Eramosa
19 St. Jacobs *
20 Salem *
* New Gauge
OSPREY
PROTON
MELANCTON
AMARANTH
ARTHUR
WEST LUTHER
EAST LUTHER
EAST GARAFRAXA
WEST GARAFRAXA
WALLACE
MARYBOROUGH
PEEL
ERIN
ELMA
PILKINGTON
NICHOL
ERAMOSA
MORNINGTON
WOOLWICH
GUELPH
HALTON
WELLESLEY
WATERLOO
NASSAGAWEYA
ELLICE
KITCHENER
PUSLINCH
NORTH EASTHOPE
WILMOT
SOUTH EASTHOPE
G.R.C.A. ADMINISTRATION CENTRE
NORTH DUMFRIES
BEVERLY
HAMILTON-WENTWORTH
EAST ZORRA
BLENHEIM
SOUTH DUMFRIES
ANCASTER
BRANTFORD
GLANFORD
ONONDAGA
E. OXFORD
BURFORD
OAKLAND
TUSCARORA
SENECA
ONEIDA
CANBOROUGH
MOULTON
HALDIMAND-NORFOLK TOWNSEND
WALPOLE
S. CAYUGA
DUNN
RAINHAM
SHERBROOKE
N

Warning System. This "system" is a list of people in all municipalities along the river. These individuals receive routine flood bulletins, and, in cases of flood danger, they are advised of the estimated extent of flooding, and the approximate time that the flood crest will reach their municipality. It is assumed that these individuals will take the responsibilty of advising residents of the municipality so that they can take appropriate action. A copy of the proposed warning system, as approved by the Executive of the Authority, is attached.

Please advise the Authority, as soon as possible, of the names, addresses and telephone numbers of the persons in your municipality who will take on this responsibility. They may be municipal officials or employees, or private citizens.

Thank you for your co-operation.

Yours very truly,

Ilmar Kao,

Assistant General Manager,
Grand River Conservation Authority
Encl.

The letter was mailed to 86 persons in municipalities along the Grand and 42 members of the GRCA.

Only 33 replies were received up to August 15, 1974.

It is significant that Cambridge-Galt, which has such a precarious location for flooding, was one which did not reply.

Attached to the letter was a flood warning system, telephone numbers of GRCA staff, and dams, and a list of all persons to whom the letter was addressed.

Despite the poor response to the letter, the GRCA, to my surprise, did not follow it up by urging replies, as requested.

Granted, the municipalities should have all replied, but it is my view that the GRCA should have contacted the municipalities for the missing names. It was too serious a matter to be left hanging in the air.

The flood warning system, enclosed with the letter, contained the following significant paragraph:

"During the flood periods, Authority staff will be on 24 hour duty at Authority headquarters. Periodic bulletins will be issued through the radio and television stations at Waterloo Region, Brantford, and Hamilton."

It will be seen later that the GRCA complied with very few parts of the new warning system on May 16 and 17.

Warnings on May 16 by GRCA

Mr. Stevens arrived at the GRCA headquarters around 10:00 p.m. He was alone. Upon checking the stream gauges, and considering the

rainfall, he realized the possibility of flooding existed. He called:

(a) R. Middleton, City Engineer, Brantford;

(b) J. Gandier, City Engineer, Cambridge-Galt;

(c) Mr. Camp, EMO, Region of Waterloo.

He advised them that there would be flooding on May 17, but he did not predict levels. He also advised that the watershed was experiencing heavy rains with full reservoirs and the discharges would have to be increased.

Mr. Stevens also gave Mr. Camp more specific information about West Montrose and Bridgeport. He was concerned as they are farther upstream.

Around midnight, Mr. Stevens suggested to Mr. Camp that the Waterloo Regional Police should be contacted and he agreed to do so. It was felt they could contact the outlying municipalities upstream. Mr. Stevens did not contact anyone else in the Region of Waterloo, as he felt notice to Mr. Camp was notice to the Region.

No other municipalities were contacted on May 16.

Warnings on May 17 by GRCA

Mr. Stevens worked all night May 16/17. By 6:30 a.m. on May 17th, he had completed his first estimates of the flooding. He decided to hold these until 8:00 a.m., for examination by Mr. Kao when he arrived. He felt there was no danger as the major municipalities had been notified the night before. In addition, his preliminary calculations indicated the flood peak at Cambridge-Galt was not expected until 6:00 p.m. on May 17th, and the first problems there, about 3:00 p.m. Consequently, if he held his estimates until 9:00 a.m., Cambridge-Galt would still have six hours' notice, and Brantford, twelve hours.

Another factor in favour of delay was that raining did not stop until after 6:00 a.m.

Mr. Stevens, after 6:00 a.m., received telephone calls from the press, citizens, radio, and municipal officials, but kept no log of these.

Mr. Stevens stayed on duty until 2:00 a.m. May 18th after being on duty continuously since 7:30 a.m. May 16th.

Mr. Kao, after he arrived at the office at 7:30 a.m., took over issuing the flood warnings.

Mr. Kao issued the following warnings:

(a) 0915 hours – phoned Mr. Gandier, Engineer, Cambridge-Galt. He was out. Mr. Kao asked to speak to Mr. Bandoni, and he was out. He spoke to Mr. Thompson, another engineer, and told him:

(i) to expect major flooding in Cambridge-Galt;

(ii) Highway 24 to be flooded by noon;

(iii) Another five feet in the afternoon.

(b) 0925 hours – spoke to Mr. Middleton's secretary re Brantford flooding;

(c) 0925 hours – spoke to Mr. Ough, Clerk of Paris, and advised him to expect eight or nine feet rise to be reached between 7:00 p.m. and 8:00 p.m.

(d) 0930 hours – spoke to Mr. Roberts, EMO, Haldimand-Norfolk and advised as to flood situation;

(e) 1440 hours – spoke to Mr. Middleton advising him river would peak in Brantford at 18 feet.

The actual peak reached in Cambridge-Galt was 19.7 feet compared to a prediction of 17.5 feet, and the time of arrival was out by approximately one hour. The peak flow in Cambridge reached 53,000 c.f.s.

Mr. Kao testified that he issued no bulletin through the media, as provided for in the flood warning system. He stated that he and Mr. Stevens were too busy answering phone calls from the press, citizens, etc., to do so.

Warnings by Municipalities, Agencies
Emergency Measures Organization—EMO

Mr. H. C. W. Camp, Emergency Planning Officer for the Regional Municipality of Waterloo, performed outstanding services during and after the flood.

Prior to the flood, he had prepared a disaster plan for the Region as well as one for each of the seven area municipalities. The regional plan has been adopted and others are in abeyance pending the adoption of the regional plan. Mr. Camp's name was not included in the original mailing list but was added later.

Mr. Camp's report outlined the work he carried out from 2245 hours May 16 to 1340 hours on May 20th.[1]

Mr. C. Stevens of the GRCA contacted Mr. Camp at 2245 hours May 16th and predicted flooding in West Montrose and Bridgeport.

Mr. Camp contacted the Regional Police who notified the residents of Bridgeport and West Montrose. He also arranged with the police to notify residents in St. Jacobs, Hawkesville, Conestogo and New Hamburg. Although he is only a one-man office, he performed countless other services during the flood such as procuring boats, aiding in rescue and in the clean-up.

I commend Mr. Camp for his services and for the fact that he logged in writing the various actions he took.

Mr. Roberts, the Emergency Planning Officer for the Region of Haldimand-Norfolk, also performed valuable services, by notifying the Regional Administrator, the Regional Police, the Regional Engineer, and the municipalities in the Region affected by the flood. Unfortu-

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[1] See Exhibit 62

nately, Mr. Roberts received brusque and uncalled-for treatment from the Cayuga Detachment of the O.P.P. when he advised them of the flood.

Police

The Waterloo Regional Police performed outstanding service in notifying persons in Bridgeport, Conestogo, St. Jacobs, West Montrose and Hawkesville.

They carried out efficiently any duties they were asked to perform.

Throughout the watershed, the O.P.P., Regional and Municipal Police notified and assisted persons who were flooded or in danger of being flooded.

I will deal specifically later with the police role in Cambridge-Galt, as it was an unusual situation.

Many policemen, in the severely flooded areas, risked their lives for flood victims, and I commend them for their courage and devotion to duty.

Flood Warnings by Cambridge-Galt

General

Cambridge-Galt is one of the most flood prone municipalities in the watershed. It has suffered several major floods this century and has minor annual flooding. The flooding has been gradually increasing and there is no assurance that it will not become even greater in the future.

Flooding is mainly due to the fact that the river has been confined to its low water channel by buildings and retaining walls built along its banks.

The channel has been further restricted by infilling and by several large shoals which have been built up in the river from debris carried down by flood waters, factory refuse and rubbish being dumped along the river banks.[1]

The city, being located south of the confluence of the Speed and Conestogo Rivers with the Grand, consequently receives the impact of the runoff from these three rivers and their tributaries.

In the light of these past experiences and conditions, I would have thought the municipality, for the protection of its citizens, would have had a comprehensive warning system. It did not.

In past floods, the GRCA notified the City Engineer. He, in turn, notified the police department. The police department had a list of merchants who were notified when there was danger of flooding. Significantly, no residential owners on Water Street and George Street were on the list. The GRCA left it to the City Engineer to determine who should be notified.

The GRCA, during past floods, would issue bulletins to the Engineer, and these, over the years, were found to be be quite accurate.

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[1] See Exhibit 6 (6), p. 133

Mr. Wilson was appointed Chief Administrator of the city in October, 1973. He previously resided near Toronto, and consequently, had no background experience with flooding in Cambridge-Galt. He admitted receiving the letter from the GRCA, dated January 4, 1974, requesting names of persons to be advised in case of flooding.[1] He turned this letter over to the Clerk, who did not answer it.

Mr. Camp, EMO, prior to the flood, contacted Mr. Wilson to set up a flood warning system but nothing materialized.

As a result, when the May flood occurred in Cambridge-Galt, they had no warning system and the GRCA did not even have a name to contact.

This was a poor performance by the city officials. The citizens deserved better.

Warning by GRCA on May 16

Mr. Gandier is the Chief Municipal Engineer of the city. He has been employed in the area since 1960 and has had experience with floods in the city in the past.

He admitted receiving the call from the GRCA around 11:00 p.m. on May 16th advising that there would be flooding in the city the next day. No levels were given.

Mr. Gandier did not notify anyone and returned to bed. He testified he did not feel the flood would be any worse than the annual flooding that had occurred in the last 14 years.

This attitude was not good enough. He deserves criticism as he was remiss in his obligation, not only to the council of the city, but also to the citizens who were endangered by a possible flood.

Mr. Middleton, the Chief Engineer of Brantford, received approximately the same information from the GRCA as did Mr. Gandier. He testified he takes all flood warnings seriously. He immediately contacted his Works Superintendent to have the night duty man check for the river levels periodically and to close the storm valves, if necessary.

He took these positive steps, even though Brantford does not have the potential flood danger of Cambridge-Galt, and has seven hours more warning time. Mr. Middleton arranged a meeting with the Mayor, Chief of Police and other officials the first thing next morning.

His actions were in distinct contrast with the inaction of Mr. Gandier.

Warning by RCA on May 17

Mr. Kao of the GRCA phoned Mr. Gandier around 9:30 a.m. on May 17, but he was out. He spoke to Mr. Thompson of the engineering department.

His evidence was that he told Mr. Thompson:

(a) To expect major flooding in Cambridge-Galt;

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[1] See Exhibit 11

(b) Highway 24 to be flooded by noon;

(c) Another five feet in the afternoon.

Mr. Thompson contradicted this testimony by testifying that Mr. Kao warned:

(a) The river would rise an additional three feet;

(b) Would peak by 1:00 p.m.

I accept Mr. Kao's evidence. Mr. Thompson passed his version of the conversation to Mr. Bandoni, who later relayed it to Mr. Gandier, third hand. Mr. Gandier, to this point, had still not notified the city officials or police. His only concern appeared to be the contents of the engineering warehouse. After lunch, he ascertained the river was over thirteen feet. For the first, and only time, he tried to contact the GRCA but the lines were busy.

Thus, we have the almost incredible situation around noon on Friday. A city is about to be inundated. The Chief Engineer, who has received warnings, tells no one. The Mayor and the Chief Administrator do not realize it. The headquarters of the GRCA is in the city, possessed of all the information, and is not contacted. The police do not learn of the possible flood until it has started.

No emergency council meeting was called on the morning of the 17th as was done in Brantford.

Mr. Wilson, the city's Chief Administrator, received no word from anyone about the impending flood. He was absent from his office on other business until 1:45 p.m. when the flood was well in progress. At noon, he crossed the bridge to go for lunch but the high water made no impression on him.

Fire Chief Pollington of Cambridge-Galt received a request in the morning of the 17th for boats for Conestogo. He called Mr. Wilson, who consented. Amazingly, neither person discussed or even considered that Cambridge-Galt would be hit by the flood next.

Police-Cambridge-Galt

The breakdown in communications also extended to the Waterloo Regional Police detachment in Cambridge-Galt. This detachment received no notice from Regional Police Headquarters, the GRCA, or from the city.

Staff Sergeant Herman was in charge of the detachment. At approximately twelve noon on May 17th the Chamber of Commerce phoned about a possible flood. The Staff Sergeant dispatched a constable to check the river levels. Upon receiving advice that the river was rising quickly, the office started calling merchants that were on the flood list.

The Chamber of Commerce phoned again and asked if the police had a loud hailer, but one was not available in the force.

The Staff Sergeant then dispatched Constable Wise and Constable Shuttleworth to go to the downtown area covering Water Street from the C.P.R. bridge to Concession Street, also Main Street and everything bordering Ainslie Street, and to notify all persons to prepare for a flood.

Two Sergeants, three cruisers and two Beatmen were in the downtown core assisting with traffic and merchants in difficulty.

The evidence indicated that very few residents were warned by the police as they did not consider it to be their responsibility.

Regional Police Headquarters

There was a considerable amount of contradiction in the testimony of the senior police officers.

Chief Henrich testified that he received the letter dated January 11, 1974, enclosing the flood warning system from the GRCA and that it was studied by his department at staff meetings.(1)

Deputy Chief Kunkle and Staff Sergeant Herman denied seeing or studying the warning system.

Chief Henrich testified he phoned Staff Sergeant Herman in the morning of May 17th, but the Staff Sergeant said he did not learn of the flood in Cambridge-Galt until noon.

Staff Sergeant Clare testified that he instructed the dispatcher at Regional Police Headquarters in the morning of May 17th to advise the Cambridge-Galt Detachment of the high condition of the river. Staff Sergeant Herman testified the message was not received. No explanation was forthcoming as to why this important message was not received.

Chief Henrich did not attend in Cambridge-Galt until May 20th – three days after the flood. His explanation was he had delegated responsibility to his Deputy and he was satisfied the force was carrying out their duties.

I find this explanation difficult to accept. When a tragedy of the magnitude that struck Cambridge-Galt occurs, it was his duty to be on the scene to ensure that everything possible was being done to assist and that the Detachment was properly staffed.

Cambridge Chamber of Commerce

Mr. Faichney, the General Manager of the Chamber of Commerce, first learned of the flood around 11:00 a.m. on May 17th.

He phoned the GRCA and was advised that a minimum of two feet of water could be expected over the Grand River retaining walls downtown during the afternoon.

Mr. Faichney commenced calling retailers and urged the police to do so.

Following the flood, the Chamber of Commerce sent out a questionnaire to all citizens who sustained flood damage in the city.(2)

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(1) See Exhibit 11 (2) See Exhibit 110

Five hundred and forty-six questionnaires were mailed out and 320 returned, a 59% return.

Hereunder is a recap of the returns, which is quite significant:

"Cambridge Chamber of Commerce

Recap of Flood Warning Questionnaire

Questionnaires mailed	546
Replies received	320
Percentage of return	59%

Replies to Questions

1. Did you receive any notification of impending flooding on May 17, 1974?

92 Yes **227** No **29%** received some sort of warning.

2. If so, at what time?

Earliest time of warning was 9:30 a.m. Most were warned between 11:30 a.m. and 2:00 p.m.

3. If so, from whom did you receive notification?

40 from the police **(44%)** 29 from representatives of the Chamber of Commerce **(32%)** 39 from miscellaneous other sources.

4. What information were you given? i.e. Were you advised how much flooding was expected?

Many general answers were given but no specific footage of flooding was disseminated by the authorities.

5. Were you advised to take any precautions?

45 Yes **237** No

6. If so, what precautions were you advised to take? Those who received any advice at all were told to clear their basements.

7. In your opinion, was the warning given in sufficient time for you to take the necessary precautions?

10 Yes **251** No

8. Were you given enough information so that you knew what precautions you should take?

6 Yes **272** No

The above figures are fully documented and readily available at the Chamber of Commerce office, 2 George St. North, Cambridge.

Don Faichney
General Manager"

This evidence indicates dramatically the lack of notice to citizens of Cambridge-Galt.

Conclusions as to Warnings to Citizens of Cambridge-Galt

My conclusions, from the foregoing, are that the citizens of Cambridge-Galt received very little warning of the impending flood.

With a proper warning system, a great deal of the suffering and damages could have been ameliorated.

The GRCA provided adequate warning to the municipality prior to the flood but it was not acted upon during the course of the flood. Bulletins could have been issued via radio by the GRCA which would have been helpful to the citizens.

The major cause of the lack of warning was the failure of the engineering department to act and convey the information it possessed to city officials. In the morning, it appeared that no city officials seemed concerned as to whether or not there was to be a flood.

The Regional Police, the Fire Department and the City Administrator were really in the dark until they were in the midst of the flood.

One can understand the bitterness of the large number of victims who had no notice or had inadequate notice.

A flood warning system must be devised to give citizens reasonable notice of a threatening flood.

I have been critical of many persons in this chapter, and I do so in the hope that city officials will not be so remiss in their duties again. In this chapter, I have been critical of the City Engineering Department, the City Administrator, the Police and the Fire Department, for the role they played in the flood warning system.

However, in all fairness to them, once the city was in flood, they performed outstanding services to the citizens. This extended right through to the clean-up.

The police deserve special commendation. They worked long hours under difficult conditions and in real danger, to assist flood victims. I have purposely chosen the picture of the policeman on duty, with water up to his waist, for the cover of this report to indicate the importance of their contribution.

The fire department are equally worthy of compliments.

Warnings by GRCA to Brantford

Mr. Middleton, the City Engineer of Brantford, testified he received the letter from the GRCA, dated January 11, 1974, re the new flood warning system.[1] He replied to this letter on January 22nd, enclosing the names of persons who should be contacted in the event of a flood.

Mr. Middleton received the first call from Mr. Stevens of the GRCA at approximately 10:00 p.m. on May 16th. Mr. Stevens advised that in Brantford there would be no serious risk in the river during the night but

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[1] See Exhibit 11

there would be flooding the next day. Mr. Stevens advised he would call back in the morning with further information.

Action by City of Brantford

Following the call from Mr. Stevens, Mr. Middleton took action. He testified he took all flood warnings as a serious matter.

He immediately called his Works Superintendent to arrange for the night duty man to check the river levels periodically and to close the storm water valves, if necessary.

At 9:00 a.m., Mr. Middleton met with Mayor Bowen and the Chief of Police and advised them that flooding was to be expected.

At 9:30 a.m., the GRCA called again and advised Mr. Middleton that the river was expected to rise seven to eight feet later in the evening. The gauge at the police station was checked and showed a reading of eight feet, which meant the level might rise to 16 feet, which was considered serious.

Mr. Middleton, at 10:00 a.m., called the GRCA and was advised by Mr. Kao that the flooding would be severe and the river would rise 17 feet, more or less.

During the same period, the Brantford Police received a message from Mr. Roberts, EMO for Haldimand-Norfolk, stating, "Probable flood expected, Brantford of 1954 proportion."

During the morning the engineering department arranged for sandbags to bolster the dikes, organized barricades, lights, etc.

A further check was made with the GRCA and the police chief was given the latest forecast. The Superintendent of the water pollution plant was consulted re its operation in the event of a flood.

The police looked after the warning of residents by knocking on doors or by using a loud hailer system.

There were no complaints by residents of lack of notification of the flood.

Mr. Middleton testified that the flood warning received at Brantford by the GRCA with regards to river levels and arrival times was entirely adequate and earlier warning would not have enabled Brantford to eliminate any of the problems which were encountered.

He was further of the opinion that all municipalities should have a flood plain study, like Brantford. This was of real benefit in the flood as it enabled the municipality to make fairly accurate predictions as to how high the water would rise in various parts of the city.

Conclusions

The GRCA provided adequate and accurate information to the city prior to the flood.

The city engineering department provided sound leadership and worked

in co-operation with the city police and the public utilities to perform outstanding service to the community.
Despite the fact that certain of the dikes were breached, the damage was kept to a minimum.

The city staff and police deserve commendation for their efforts.

GRCA Warnings to Bridgeport, St. Jacobs, West Montrose

Mr. Stevens of the GRCA at 2245 hours on May 16th phoned Mr. Camp, EMO, predicting 15 hours probability of flooding for West Montrose and Bridgeport.

Mr. Stevens called Mr. Camp again at 2345 and advised flooding was to be expected in West Montrose at 4:00 a.m. and Bridgeport at 8:00 a.m. He advised he was particularly worried about low lying homes.

Mr. Camp immediately called the Elmira Detachment of the Waterloo Regional Police and asked if they would warn residents on the south bank of the Grand at West Montrose of the possibility of flooding. The police carried this out immediately and also notified the residents of the trailer park on the north bank in West Montrose.

Following this, Mr. Camp called the Waterloo Detachment and asked them to warn residents in the low lying parts of Bridgeport that flooding was expected and that they may have to leave their homes and move to higher ground. This was carried out immediately by the police.

At 0030 hours on May 17th, Mr. Stevens advised Mr. Camp to arrange the warning of people living in low lying areas of Hawkesville and St. Jacobs. The Regional Police were contacted. They pointed out that it was a difficult assignment but that they would do their best.

At 0255 hours, 17 May, Mr. Stevens again called Mr. Camp re Bridgeport advising flooding there would be from 8:00 a.m. to 9:00 a.m. and that it would be worse than last time. Mr. Camp again called the Regional Police who advised they had already notified Bridgeport.

Mr. Camp then notified the Supervisor of the Regional Pollution Control whose laboratory and offices are located at Bridgeport.

At 0440 Mr. Stevens asked Mr. Camp to request the Regional Police to warn home owners on the south side of Regional Road #17, near the old bridge in Conestogo. This was done.

At 0745 Mr. Camp, at Mr. Steven's request, asked the police in New Hamburg to warn residents in low lying areas. This was done.

Conclusions

No complaints were heard at the Inquiry from Bridgeport, Conestogo, St. Jacob's, New Hamburg, West Montrose or Hawkesville, that there was a lack of warning.

The evidence indicated that Mr. Stevens of the GRCA, working through Mr. Camp, and in conjunction with the Regional Police, gave residents of these areas adequate notice of the impending flood.

Mr. Stevens, Mr. Camp and the Regional Police deserve commendation for their efforts.

GRCA Warning to Paris

Mr. Ough, the Clerk of Paris, testified he received the GRCA letter of January 11, enclosing the flood warning system and asking for names to notify in the event of a flood.[1]

He replied to the GRCA letter and supplied a list of officials to be notified. This list included the Mayor, Fire Chief, Police Chief, Works Superintendent and himself.

Mr. Ough received the first flood warning from the GRCA at about 9:45 a.m. on May 17th. Mr. Kao advised him that the Grand would rise another six to eight feet, and would peak around 8:00 p.m. The river at that time was six feet high.

Mr. Ough immediately notified the Reeve, who, in turn, notified the Paris co-ordinator for the EMO, the Police Chief, the Public Utilities Manager, and others.

Mr. Ough testified he received no complaints from people stating they were not notified of the flood. The only complaint heard by the Inquiry was from Mr. Piovotty, the president of the Old Country Furniture Ltd. The company operates a warehouse, an old theatre, on the edge of the river. No one was in charge of the warehouse on the day of the flood. Mr. Piovotty complained no one contacted him in Brantford concerning the flood until 5:30 p.m. The building started to flood at 6:00 p.m. and considerable furniture was damaged before it could be removed.

Conclusions

I am satisfied that the GRCA adequately warned Paris. In addition, due to Mr. Ough's sense of duty, the citizens of Paris were given proper warning.

Warning to Caledonia, Cayuga, Dunnville

These three communities, located in the lower Grand, have a considerable period of time from when the river peaks at Cambridge-Galt to prepare for a flood.

Mr. Roberts, the EMO for Haldimand-Norfolk Region, first received warning of the flood at 9:00 a.m. May 17th. He notified the Chief Administrator for the Region, the Clerks of the Towns of Haldimand and Dunnville. Cayuga and Caledonia are part of the Town of Haldimand. Mr. Roberts also notified the Regional Police, Regional Engineer, Simcoe and Cayuga O.P.P. and the Health Unit.

Mr. Roberts testified that the peak arrival times received from the GRCA were "remarkably accurate". He was advised the peak would

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[1] See Exhibit 11

arrive at Caledonia about noon May 18th; at Cayuga, 6:00 p.m. May 18th; and at Dunnville, 2:00 a.m. Sunday, May 19th.

Mr. Roberts testified he received fine co-operation from the O.P.P. and the Regional Police.

Mr. K. Berscht, Clerk-Treasurer of the Town of Haldimand, (Caledonia and Cayuga), testified he received several flood warning calls from EMO Roberts. He had no criticism of the flood warning system.

Mr. Dell, area council member for Cayuga, testified that EMO Roberts provided accurate flood warnings. He had no complaint about the warning system.

Mr. F. Scholfield, Clerk-Treasurer of Dunnville, received notification of the flood from EMO Roberts at 9:30 a.m. on May 17th. At about 3:00 p.m., the O.P.P. notified Mr. Scholfield that the crest would hit Dunnville at 2:00 a.m. on Sunday, May 19th. This information turned out to be accurate.

Conclusions as to Flood Warnings in the Watershed

It is clear that the GRCA did not follow the flood warning system detailed in Exhibit 11, but this had little detrimental effect.

Mr. Stevens and Mr. Kao, on the night of May 16 and in the morning of May 17, did notify every municipality in the watershed of the impending flood. All the municipalities in the watershed, other than Cambridge-Galt, were satisfied with the timing and accuracy of the warnings they received and have no criticism of the GRCA in this regard.

In Cambridge-Galt, the major problem was caused by the fact the City Engineer, Mr. Gandier, did not take the warnings seriously and kept the information to himself. However, I do not find the GRCA blameless in its warning to this city. They knew, or should have known, of the seriousness of the situation and issued periodic bulletins on radio to the public. The GRCA assumed that the Regional Police Detachment in the city knew of the impending flood, whereas, in fact, they did not know it until it was upon them. The onus, in my view, is on the GRCA to follow up its warning with additional information in a critical situation of this sort.

Mr. Stevens did an admirable job, with the aid of Mr. Camp, in notifying persons in municipalities that first felt the flood. The GRCA was understaffed the night of May 16th. Mr. Stevens was estimating river flows, instructing dam operators, answering telephone calls, and issuing flood warnings. It was too heavy a responsibility for one man. He was unable to keep records of the calls he received and made because of the pressure of events.

It is clear that the GRCA have to devise a better system.

The Operation of the Dams by the GRCA

General

There was widespread criticism throughout the watershed of the GRCA in the operation of the dams prior to and during the flood.

The following were typical questions and statements made by the press and the public:

(a) Why were the reservoirs full on May 16?

(b) They were kept full so that the cottage owners on the reservoir could use their boats.

(c) Why didn't the GRCA start lowering the reservoirs in the face of heavy precipitation?

(d) Why was there no flood storage on May 16?

The Inquiry had the benefit of a great deal of expert evidence relating to the operation of the dams during the flood. Professor Ayers, Professor Solomon, Professor Dickinson, Mr. McMullen, Mr. Murray, Mr. MacKrell, and other persons, testified and I am appreciative of their assistance. Surprisingly, they did not disagree to any large extent. Numerous documents, charts, graphs and maps were introduced into evidence to support their contentions.

Multipurpose Dams

I am convinced that one of the difficulties in the public's mind is the use of the word, "dam". To most laymen a "dam" is only used to impede the flow of water, or for flood control. This definition is incorrect when applied to the Shand and Conestogo Dams, as with most of the dams in the province. These two dams, which exercise some measure of control of the rivers, were built as multi purpose dams.

Their uses, which include flood control, also serve urban water supply, irrigation, pollution abatement, and maintenance of flow and recreation. These functions are sometimes conflicting and incompatible, and consequently, create many operational problems. In a previous chapter entitled, "Dilemma of the GRCA", I have dealt in some detail with the conflicting purposes of the system.

In the spring of 1974, the GRCA followed the policy of filling up the reservoirs in the spring so that they could be drawn down the rest of the summer to provide low flow augmentation downstream. This policy was inherited from the GRCA's predecessor, the former Grand River Commission.

This policy has long been recommended and approved by the Ontario Government via the Conservation Authorities Branch of the Ministry of Natural Resources. It has been approved over the years by the various departments and ministries which had previously been responsible for the supervision of the various conservation authorities, including the Department of Lands and Forests, the Department of Energy and Resources Management and the Ontario Water Resources Commission.

The paramount purpose of the dams is to provide low flow augmentation to facilitate a continuous flow of water downstream in the dry season in order to satisfy riparian rights, sewage dilution, supply of water to Brantford, recreational and aesthetic benefits. These benefits are enjoyed by the large percentage of the people in the watershed. The flood control aspects of the dams enure to the benefit of a small percentage of the residents of the watershed.

The result of this policy is that when the reservoirs are full to meet the low flow requirements, there is no flood storage capacity. This is the situation that existed in May prior to the flood.

Low Flow Augmentation Requirements

The GRCA is of the view that the following flows are required:

Doon – 200 c.f.s. for sewage dilution;

Brantford – 600 c.f.s. for water supply;

Galt – 450 c.f.s. for water dilution.

The minimum operational discharge from the dams is 250 c.f.s.

Professor Solomon was of the opinion that these amounts were higher than required, but the weight of the evidence was against him.

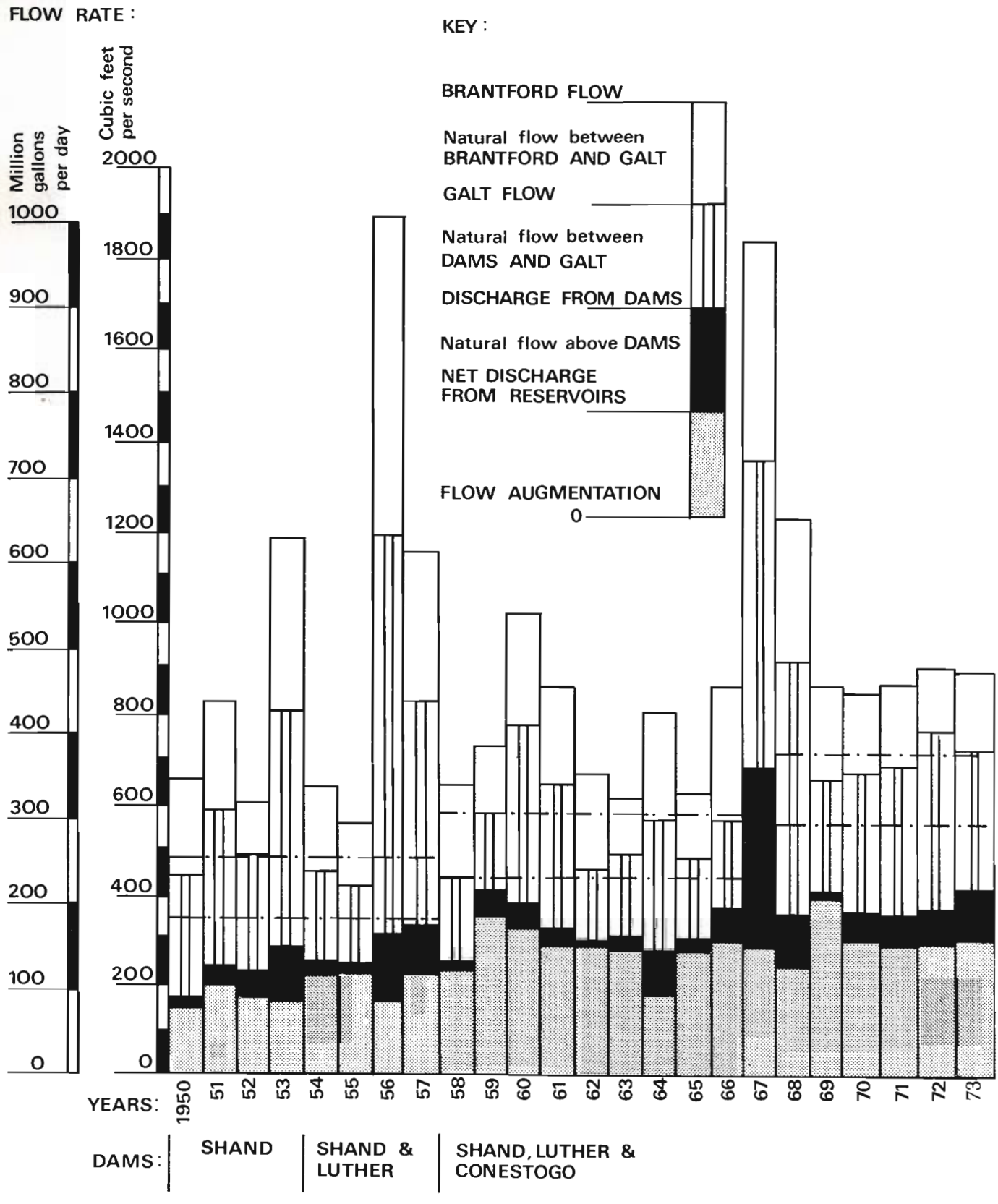
It was suggested by certain witnesses that the GRCA should have left one-third of the reservoirs empty for flood control in May. Mr. Kao testified, and I accept his evidence, that if the Shand Dam was held down to two-thirds capacity on May 1st, it would have only been filled five years out of 26 by the end of May, and in eight of those years, there would have been a deficiency for low flow augmentation. In addition, only one out of 25 years would it have been filled if there had been storage for one inch of runoff on June 1st. Repeating the same exercise for the Conestogo, it would have been filled in only two years out of 14, and there would have been a deficiency in five out of 14 years.

These figures indicate that if one "trades off" water to be used for low flow augmentation so as to obtain flood storage, it can be expected that low flow augmentation shortages will occur in a substantial number of years.

From this and other evidence, I am therefore satisfied that the GRCA was justified in having its reservoirs full on May 16.

I am satisfied that the dams were kept full for low flow augmentation purposes. The bar graph on page 72 shows the amount of low flow augmentation during the four month period – June, July, August and September from 1950 - 73. This graph indicates the significant amounts of augmentation required annually to meet the various downstream needs.

I am also satisfied there is no substance to the allegation they were kept full for boaters.



Summer flow regulations bargraph showing daily mean flows for the four month period — June, July, August and September 1950-1973

Releasing Dams in Face of a Storm

Criticism has been made of the GRCA for not releasing more water when it was learned of a heavy rainstorm about to strike the watershed.

Several experts testified it is very dangerous to discharge a dam in the face of a storm, unless one is sure where the rain is falling. There was a definite risk if the water had been dumped earlier on May 16th, the discharge would have converged with heavy precipitation below the dams to aggravate an already dangerous situation. There was no way to know where the precipitation would fall. I conclude the GRCA made a reasonable decision in not releasing water earlier on the 16th.

Dams in Danger

Professor Solomon suggested in his evidence that the manner in which the dams were operated created a danger of dam failure.

All other expert witnesses disagreed with this proposition.

I am satisfied that the GRCA operated the dams properly and at no time was there a risk of failure.

Conclusions

I am satisfied that the GRCA, prior to and during the flood, operated the dams properly and in accordance with established policy.

With only two major dams, they are trying to carry out a seven dam responsibility.

I concur with the appraisal of the GRCA by Mr. Murray, Supervisor of the Professional Services of the Conservation Branch, "They did the best they could with the system they had, under the circumstances."

Recommendations

General

During the course of the Inquiry, it became obvious that certain remedial measures should be implemented immediately instead of waiting for the publication of this report. I was concerned that a flood situation might develop in the fall of 1974, which is traditionally a dangerous period of the year.

I therefore urged the GRCA, the City of Cambridge-Galt, the Regional Police, and the EMO to take immediate steps to improve the flood warning system.

I am pleased to report that the parties concerned proceeded to implement my suggestions by holding several meetings and deciding upon a workable plan.

The GRCA and the officials of Cambridge-Galt have also taken other steps, which it is hoped will alleviate flooding in that community. It was most satisfying to me that these two parties, which were at loggerheads following the flood, are now approaching the problem in a constructive and reasonable manner, with a desire to try and avoid the mistakes of the past.

If this Inquiry served no other purpose, the change of attitude in itself, was a significant achievement.

Danger of Future Flooding

I do not want to appear as an alarmist, but from the evidence heard, it is clear that the potential exists for very serious flooding in the watershed in the future, with real danger of loss of lives and extensive property damage.

The rapid urbanization in the watershed is daily increasing the runoff into the Grand and its tributaries.

Flood control has been given a very low priority, as opposed to low flow augmentation, in the water management policy.

Low flow augmentation, recreational benefits and aesthetic values are important but should not be placed ahead of the protection of human lives.

Recommendations

I have listed several recommendations, which, if implemented, would provide reasonable flood protection for the residents of the watershed. The recommendations attack the problem of flood control in various ways. Most are inter-related.

Floods are a natural phenomena and cannot be totally abolished no matter what remedial action is taken in the watershed. As long as people continue to live in the flood plains, there will be flood victims.

However, it is my view, that it is incumbent on our society, with all its affluence, to give reasonable protection to endangered citizens.

For these reasons, I respectfully submit the following recommendations:

Dam Construction

1 That the GRCA embark immediately upon the construction of the Montrose Reservoir. This will control the Irvine River and provide flash flood storage in the system of 20,000 acre feet. This reservoir has been recommended by experts for the past twenty years, and had it been in existence in May, would have substantially decreased the flood damage in Cambridge-Galt.

2 That the GRCA carry out an exhaustive analysis of alternatives before proceeding with the construction of the other reservoirs recommended in the 1966 Grand River Conservation Authority Brief.[1]

3 Recommendations 1 and 2 should be carried out with a view to terminating, as soon as possible, the interim policy of having full reservoirs by the end of May.

4 That some flood storage be maintained at all times in the new dams constructed.

Basin Planning

5 That the Provincial Government take the initiative to establish a multi-disciplinary planning team to be responsible for the development of a comprehensive water management plan for the Grand River Basin.

The team should include representatives from the Provincial, Regional and Municipal Governments, and the GRCA. The terms of reference for studies should reflect the needs and concerns of the local areas, as well as that of the province. In particular, the team should carry out, or co-ordinate the carrying out of the various studies recommended.

Staff assigned to the planning team should be relieved of sufficient other duties to make their contribution reflect the importance of the assignment.

The team should have sufficient resources to enable it to engage the full time services of a technical director and support staff for a contractually limited period.

Water Quality

6 That special technical studies be undertaken in order to establish water quality standards appropriate to various reaches of the Grand River and its tributaries.

These studies should provide the necessary input to planning evaluation of alternatives for effluent loading and reservoir releases.

A computer simulation should be carried out to take into account the probabilistic nature of stream biochemical processes and their effect upon significant water quality characteristics. Complementary field work will be essential to calibrate the computer model.

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[1] See Exhibit 6 (10)

Flood Routing Model

7 That the Conservation Authorities Branch develop a hydrologic simulation model to allow the prediction of the consequences of real or assumed flood events under different flood routing policies.

It is further recommended that a mathematical optimizing model be developed to select flood routing policies so as to ensure maximum benefits from existing and future reservoirs considering their multi purpose nature.

The model should be continuously evaluated and modified as the hydraulics of the valley change through dam construction, channel modifications, and other manmade effects.

Flood Warnings

8 That the GRCA organize in its headquarters a flood warning team that can be assembled on short notice. The members of the team to be allotted specific duties under direction of a superior officer.

That flood prone municipalities institute a fail safe flood warning system of communications, based upon information collected and interpreted by GRCA personnel.

Information should be transmitted directely by the GRCA, and logged, to a senior responsible officer(s) in each municipality, including police headquarters, in a form which enables anticipatory actions to be taken.

Annual flood warning rehearsals should be carried out with a critical evaluation afterwards.

Flood Disaster Operations

9 That the Province take the initiative to ensure that a co-ordinated plan for coping with flood disaster situations is developed.

The GRCA, the Provincial Government, and municipalities, should have a clear understanding of the roles and responsibilities of individuals and agencies.

A detailed inventory of equipment and resources such as boats, loud-hailers, two-way radio systems, rescue capabilities should be accessible to all in responsible positions.

Flood Plain Studies

10 That the GRCA expedite its program of flood plain mapping for flood prone communities, so that all affected municipalities have current information on properties and owners likely to be affected by the river at various stages of flooding.

Channel and Structural Improvements

11 That the GRCA regularly monitor the performance and characteristics of channels and river structures, and that improvements be carried out when and where there are demonstrable net benefits to be realized.

In particular, the channel reach through Cambridge-Galt should receive immediate attention with a view to carrying out those changes which will provide some relief from flooding hazards.

Hydrometeorological Instruments

12 That funds be made available to the GRCA to secure equipment and personnel to improve its flood forecasting system. For example, access to radar weather systems, telex weather information and telemetered rain gauges.

The GRCA should also consider raising the river gauges that were "topped" in the May flood.

Building in the Flood Plain

13 That no further building or development be allowed within the regional flood lines. No channel infilling should be allowed without express permission.

The GRCA should be supplemented to enforce the prohibition against flood plain building.

If any building, development or renovation, is allowed in the flood plain, the property owners should be required to sign a hold-harmless agreement. This should run with the land and be registered on title. It should covenant that neither the municipality, the GRCA, or the Ontario Government will be responsible for or be expected to provide compensation toward any flood damage to the new work.

Flood Insurance

14 That the Provincial Government explore the feasibility of the establishment of a government subsidized flood insurance program.

Such insurance to be available at reasonable cost to persons who already have property located in the watershed.

Conservation Authorities Branch

15 This Branch has a serious responsibility in forecasting flood warnings to the 38 conservation authorities in the province.

The evidence indicated that the Branch is understaffed and underequipped to carry out its functions.

It is recommended that the Ministry of Natural Resources consider upgrading the Branch and providing it with the proper staff and equipment, so that it can perform its role in a more efficient manner.

Cambridge-Galt

16 This community is most vulnerable to flooding.

The GRCA and the municipality should work together and reduce flooding by:

(a) The purchase of properties along the river banks in the downtown section as they become available. The buildings to be demolished and turned into park lands.

This would substantially increase the river flow area during flood time and improve the appearance of the city. An example of what can be done can be seen in the City of Guelph.

(b) Strictly enforce the prohibition against infilling and flood plain building.

Kitchener-Bridgeport

17 Bridgeport suffered severe damage. The city and the GRCA could reduce effects by improving the earth berm and by purchasing and demolishing properties on the river banks as they become available.

This would enlarge the river flow area during flood, and if turned into a park, would improve the downtown section.

Grand Valley

18 This village is flooded almost every spring due to ice jams. I recommend that the GRCA be prepared each spring with available personnel, equipment and explosives to deal with ice jams in this village or anywhere else in the watershed, so as to prevent flooding.

Dunnville

19 That the GRCA examine the weirs in Dunnville. If they are to remain inoperable, the GRCA should develop a procedure to have them

Mouth of Grand River - Silt
8:00 a.m.
May 18, 1974

cleared of debris so they will not contribute to flooding in the community.

Flood Control Officer

20 It is recommended that the GRCA consider the appointment of a flood control officer.

This officer should devote full time to the many aspects of flood control.

Flood control is too serious a problem in the watershed to be dealt with on an ad hoc basis.

Public Relations

21 It is recommended that the GRCA step up its public relations program. From the evidence, it was clear that most of the residents of the watershed did not understand the dams had multi purposes. They do not understand the water management policy of the GRCA. To obtain the many improvements required, such as dams, will require the input and understanding of the residents of the watershed.

Appendix A

List of Witnesses

1 Mr. James Bauer
2 Mr. Robert Kerr
3 Mr. Ola Martin Berg
4 Mr. John William Murray
5 Mr. Donald Norman McMullen
6 Mr. Peter Nick Gryniewski
7 Staff Inspector Charles Clare
8 Mr. Ilmar Kao
9 Mr. Charles Stevens
10 Mr. Herbert Charles Walter
11 Staff Sergeant Donald Herman
12 Sergeant Nyles Soehner
13 Dr. Gerrard Patrick Aloysius Evans
14 Deputy Chief Clarence Martin Kunkle
15 Constable John William Shuttleworth
16 Sargeant Kenneth Alan Muir
17 Mr. Clare Bowman Bauman
18 Mr. John Pawley
19 Chief Wilfred Henrich
20 Mr. Neil Andrew Stanners
21 Mr. Joseph Russell Faulkner
22 Staff Inspector Harold Ulmer
23 Mr. John Etherton
24 Mr. Gordon MacLeod Coutts
25 Mr. George Leslie Wilson
26 Mr. J. Everest Goudier
27 Mr. Frank Scholfield
28 Mr. Frederick Russell Smith
29 Mr. Robert William Dell
30 Mr. Orville Lealand Roberts
31 Mr. William McKenzie Berscht
32 Mr. Gordon Russell Bartlett
33 Mr. Kenneth William Best
34 Mr. John Peterson
35 Staff Sergeant Potter, O.P.P.
36 Inspector Wood, O.P.P.
37 Mr. Leslie M. Canivet

38 Mr. John David Thompson
39 Mr. Lyle Hurd
40 Mr. Frank James
41 Mr. Johann Van Der Woert
42 Chief Edward A. Johnston
43 Mr. Steven Joseph Gyorffy
44 Mr. Peter Piovotty
45 Mr. Ronald Middleton
46 Mr. Robert Wilson
47 Mr. Jack Arthur Ough
48 Mr. Mac Makarchuk
49 Mr. Edwin Gerald Axworthy
50 Mr. Roland William Davies
51 Major Donald William Foster
52 Captain Parnham
53 Captain Thompson
54 Major Campbell
55 Mr. Ralph Lloyd Thompson
56 Mr. Fabian Bandoni
57 Mr. David Arthur Sanderson
58 Mr. William R. Atkinson
59 Mr. Donald Faichney
60 Mr. Garry Richard Peters
61 Mr. Daniel James Bailey
62 Mr. Albert Turnbull Brown
63 Fire Chief Pollington
64 Mayor Claudette Marie Millar
65 Mr. Ray Good
66 Mr. Mervin Henry Quast
67 Mr. George Alexander Collins
68 Mr. Lawrence Bingeman
69 Mr. David Michael Pollock
70 Mr. Richard Saunders
71 Mr. Leon Maurice Therian
72 Ruth Mills
73 Mr. Frank Goldspink
74 Mr. Edwin Galbraith
75 Mr. William James Wilson
76 Mr. John Kersh
77 Mr. Robert W. Hewitt
78 Professor William Trevor Dickinson
79 Mr. John P. O'Reilly
80 Mr. Maurice MacKrell
81 Mr. Ian William McCaig
82 Dr. Shully I. Solomon
83 Professor Hugh Duncan Ayers

Appendix B

Exhibits

No.	Property of	Entered by	Description
1			Terms of Reference
2			Globe & Mail Advertisements Affidavit of Publications
3	GRCA	Mr. Miller	Annual Report, 1973
4	GRCA	Mr. Miller	Map – Grand River Valley
5	GRCA	Mr. Miller	Grand Valley Map
6(1)	GRCA	Mr. Miller	1932 Finlayson Report
6(2)	GRCA	Mr. Miller	1938 Grand River Conservation Act
6(3)	GRCA	Mr. Miller	1939 Acres Report
6(4)	GRCA	Mr. Miller	1939 Cost Apportionment Report
6(5)	GRCA	Mr. Miller	1958 O.M.B. Decision
6(6)	GRCA	Mr. Miller	Conservation Report (Sec. Ed. 1962) 1954 Hydraulic Report
6(7)	GRCA	Mr. Miller	1961 Grand River Conservation Brief
6(8)	GRCA	Mr. Miller	(A&B) 1964 General Report West Montrose & Ayr Reservoirs
6(9)	GRCA	Mr. Miller	1965 Speed River Report
6(10)	GRCA	Mr. Miller	GRCA 1966 Brief (Official Plan)
6(11)	GRCA	Mr. Miller	1967 Cost Allocation Report
6(12)	GRCA	Mr. Miller	1967 Montrose Functional Report
6(13)	GRCA	Mr. Miller	1971 Treasury Report
6(14)	GRCA	Mr. Miller	1973 Conservation Authorities Act
6(13-B)	GRCA	Mr. Miller	Letters dated December 21, 1971
6(15)	GRCA	Mr. Miller	1970 Fill Regulations
6(16)	GRCA	Mr. Miller	1966 Flood Line Report
6(17)	GRCA	Mr. Miller	1973 Brantford Flood Plain Studies
6(18)	GRCA	Mr. Miller	1974 Shand Operation Manual
6(19)	GRCA	Mr. Miller	GRCA Source of Funds (Graph)
6(20)	GRCA	Mr. Miller	Financial Statements, Dec. 31, 1973
6(20-B)	GRCA	Mr. Miller	Budget Information 1974
7	GRCA	Mr. Miller	Audio portion of film viewed
8	Mr. Jenkins	Mr. Jenkins	Photograph (Sign)
9	Mr. Jenkins	Mr. Jenkins	Flood Report – May 16/19, 1974

No.	Property of	Entered by	Description
10	Mr. Jenkins	Mr. Jenkins	Report on Flood Grand River Watershed, May 16 - 19, 1974
11	Mr. Jenkins	Mr. Jenkins	Letter – Revised Flood Warning System
12	Mr. Jenkins	Mr. Jenkins	Report – Mr. Atkinson Can. General Tower Ltd.
13	Mr. Jenkins	Mr. Jenkins	Excerpt – Kitchener Record (Xerox copy) dated May 20, 1969
14(1)			Copy of Order in Council
14(2)	Mr. Smith	Mr. Smith	Letter dated Dec. 15, 1966
14(3)	Mr. Smith	Mr. Smith	Copy of Letter dated June 27, 1967
14(4)	Mr. Smith	Mr. Smith	Copy of Letter dated June 10, 1967
14(5)	Mr. Smith	Mr. Smith	Copy of Letter dated July 11, 1967
14(6)	Mr. Smith	Mr. Smith	Copy of Letter dated August 2, 1967
14(7)	Mr. Smith	Mr. Smith	Copy of Letter dated August 14, 1967
14(8)	Mr. Smith	Mr. Smith	Copy of Letter dated August 28, 1967
14(9)	Mr. Smith	Mr. Smith	Copy of Letter dated Sept. 6, 1967
14(10)	Mr. Smith	Mr. Smith	Copy of Letter dated Sept. 18, 1967
14(11)	Mr. Smith	Mr. Smith	Order in Council dated Nov. 2, 1967
14(12)	Mr. Smith	Mr. Smith	Copy of Letter dated February 22, 1968
14(13)	Mr. Smith	Mr. Smith	Copy of Letter dated March 6, 1968
14(14)	Mr. Smith	Mr. Smith	Copy of Letter dated March 12, 1969
14(15)	Mr. Smith	Mr. Smith	Copy of Letter dated July 18, 1969
15(1)	Mr. Smith	Mr. Smith	Copy of Letter dated March 28, 1969
15(2)	Mr. Smith	Mr. Smith	Copy of Resolution dated April 2, 1969
15(3)	Mr. Smith	Mr. Smith	Copy of Letter dated April 8, 1969
15(4)	Mr. Smith	Mr. Smith	Resolution (Wellesly) dated April 8, 1969
15(5)	Mr. Smith	Mr. Smith	Resolution (Fergus) dated April 9, 1969
15(6)	Mr. Smith	Mr. Smith	Resolution (Moulton) dated April 9, 1969
15(7)	City of Galt	Mr. Smith	Copy of Resolution dated April 9, 1969
15(8)	City of Galt	Mr. Smith	Copy of Resolution dated December 3, 1969
16	Mr. Miller	Mr. Miller	Letter (H. G. Acres) dated December 15, 1943
17	GRCA	Mr. Miller	Map
18	GRCA	Mr. Miller	Letter re Warning
19	Mr. Jenkins	Mr. Jenkins	Weather Forecast
20	Mr. Jenkins	Mr. Jenkins	Table of Readings
21	Mr. Smith	Mr. Smith	Map (Isohyetal)
22	Mr. Smith	Mr. Smith	Chart – Bar Graph (Hourly Rainfall)

No.	Property of	Entered by	Description
23	Mr. Smith	Mr. Smith	Chart (Amount of rainfall over the watershed)
24	Mr. Smith	Mr. Smith	Chart – Cube Root Normal Probability Rainfall
25	Mr. Smith	Mr. Smith	Chart – Expected rainfall (one day)
26(1)	Mr. Smith	Mr. Smith	Chart – Hydrograph of Flood Runoff (West Montrose)
26(2)	Mr. Smith	Mr. Smith	Chart – Hydrograph of Flood Runoff (Brantford)
26(3)	Mr. Smith	Mr. Smith	Chart – Hydrograph of Flood Runoff (Galt)
26(4)	Mr. Smith	Mr. Smith	Chart – Hydrograph at below Shand Dam
26(5)	Mr. Smith	Mr. Smith	Chart – Hydrograp at Marsville
26(6)	Mr. Smith	Mr. Smith	Chart – Hydrograph at Conestogo River at Glen Allan
26(7)	Mr. Smith	Mr. Smith	Chart – Hydrograph at Conestogo River above Drayton
26(8)	Mr. Smith	Mr. Smith	Chart – Hydrograph at Speed River below Guelph
26(9)	Mr. Smith	Mr. Smith	Chart – Hydrograph at Eramosa River above Guelph
26(10)	Mr. Smith	Mr. Smith	Chart – Hydrograph at Nith River near Canning
26(11)	Mr. Smith	Mr. Smith	Chart – Hydrograph at Nith River at New Hamburg
26(12)	Mr. Smith	Mr. Smith	Chart – Hydrograph at Nith River at Nithburg
26(13)	Mr. Smith	Mr. Smith	Chart – Hydrograph at Alder Creek near New Dundee
26(14)	Mr. Smith	Mr. Smith	Chart – Hydrograph at Schneider Creek at Kitchener
26(15)	Mr. Smith	Mr. Smith	Chart – Hydrograph at O.A.C. Farm Gauge (No. 5) at Guelph
26(16)	Mr. Smith	Mr. Smith	Chart – Hydrograph at Laurel Creek at Waterloo
26(17)	Mr. Smith	Mr. Smith	Chart – Hydrograph at West Canagagigue near Floradale
26(18)	Mr. Smith	Mr. Smith	Chart – Hydrograph at Canagagigue Creek near Elmira
26(19)	Mr. Smith	Mr. Smith	Chart – Hydrograph at Blue Springs Creek near Eden Mills
26(20)	Mr. Smith	Mr. Smith	Chart – Hydrograph at Lutteral Creek near Oustic

No.	Property of	Entered by	Description
27	Mr. Smith	Mr. Smith	Probability of Monthly Runoff – May and June
28(1)	Mr. Smith	Mr. Smith	Monthly Runoff – Grand River above Shand (Apr. & May)
28(2)	Mr. Smith	Mr. Smith	Monthly Runoff – Grand River above Shand Dam (Mar. Apr. May & June)
29(1)	Mr. Smith	Mr. Smith	Table of Grand River Peak Flows
29(2)	Mr. Smith	Mr. Smith	Graph of Grand River Peak Flows
30	Mr. Smith	Mr. Smith	Surface Wind Shand Dam, May 16 & 17, 1974
18(1)	Mr. Smith	Mr. Smith	March, 1974, Letters to Wardens & Mayors, etc.
18(2)	Mr. Smith	Mr. Smith	March 6, 1974, Letters to Wardens & Mayors, etc.
18(3)	Mr. Smith	Mr. Smith	Mailing List updated to 1974
31	Mr. Smith	Mr. Smith	Table – Rainfall Runoff
32	Mr. Smith	Mr. Smith	Log (Copy)
33(1)	Mr. Copp	Mr. Copp	Large Map of Grand River – (Hespeler Area) – Regional Flood Line, etc.
33(2)	Mr. Copp	Mr. Copp	Large Map of Grand River (Preston Area)
33(3)	Mr. Copp	Mr. Copp	Large Map of Grand River (Galt Area)
34(a)	Mr. Copp	Mr. Copp	Large Tour Map
34(b)	Mr. Copp	Mr. Copp	Tour Guide
35	Mr. Copp	Mr. Copp	Photograph – Farm Lands
36	Mr. Copp	Mr. Copp	Photograph – Corner of Church and Ainslie Streets
37	Mr. Miller	Mr. Miller	Chain of Command of Grand River Authority
38	Mr. Miller	Mr. Miller	Personnel Regulation #24
39(1)	Mr. Miller	Mr. Miller	Map of Political Divisions of Watershed
39(2)	Mr. Miller	Mr. Miller	Large Map – Physical of Watershed
39(3)	Mr. Miller	Mr. Miller	Large Map – Drainage Basins – colour lines
39(4)	Mr. Miller	Mr. Miller	Large Map – Grand River Watershed
40(a)	Mr. Miller	Mr. Miller	Proposed Water Management System
40(b)	Mr. Miller	Mr. Miller	Water Control Reservoir System
40(c)	Mr. Miller	Mr. Miller	Diagram by Mr. Kao
41	Mr. Miller	Mr. Miller	Preliminary Survey of Conestogo River Acres – Letter Apr. 3/43
42	Mr. Miller	Mr. Miller	GRCA's Division of Operations
43	Mr. Miller	Mr. Miller	Letter from McLeod to Penrock May 12/67 – Reply May 17/67

No.	Property of	Entered by	Description
44	Mr. Miller	Mr. Miller	University of Waterloo Institute Report
45	Mr. Miller	Mr. Miller	Grand River Conservation Note re Oper. Records Summary, Shand & Conestogo Dams
46	Mr. Miller	Mr. Miller	GRCA Hydrometric Network July, 1972
39(5)	Mr. Miller	Mr. Miller	Map – Hydrometric Network
39(6)	Mr. Miller	Mr. Miller	Map – Snow Station Chart
39(7)	Mr. Miller	Mr. Miller	Rain gauge weather stations
47	Mr. Miller	Mr. Miller	Note re Galt Hydromatic Gauging Station
48	Mr. Miller	Mr. Miller	CNC/IHD Report of main results achieved during IHD
39(8)	Mr. Miller	Mr. Miller	Map – Grand River Watershed Base Stations, Radio Stations
49	Mr. Miller	Mr. Miller	Daily Report of Water Control Operation – Aug. 10
50	Mr. Miller	Mr. Miller	Letter Apr. 22/74 from Corporation of Cambridge, Office of Administration Officer, M. Coutts
51(1)	Mr. Miller	Mr. Miller	Telemetric Chart (Montrose)
51(2)	Mr. Miller	Mr. Miller	Telemetric Chart
51(3)	Mr. Miller	Mr. Miller	Telemetric Chart (City of Cambridge)
51(4)	Mr. Miller	Mr. Miller	Telemetric Chart (City of Brantford)
51(5)	Mr. Miller	Mr. Miller	Telemetric Chart (York)
51(6)	Mr. Miller	Mr. Miller	Telemetric Chart
51(7)	Mr. Miller	Mr. Miller	Telemetric Chart
51(8)	Mr. Miller	Mr. Miller	Telemetric Chart
51(9)	Mr. Miller	Mr. Miller	Telemetric Chart
51(10)	Mr. Miller	Mr. Miller	Telemetric Chart (Gates Irvine River)
51(11)	Mr. Miller	Mr. Miller	Telemetric Chart (Conestogo River)
52	Mr. Miller	Mr. Miller	Map of Grand River Watershed
53	Mr. Miller	Mr. Miller	Chart (Map) Grand River Watershed
54	Mr. Miller	Mr. Miller	Hydrograph – Comparison of 1954 and 1974
55	Mr. Miller	Mr. Miller	Hydrograph – City of Brantford
56	Mr. Jenkins	Mr. Jenkins	Photograph – Plaque
57	Mr. Miller	Mr. Miller	Daily Report – Water Control Operations dated May 15, 1974
58	Mr. Miller	Mr. Miller	Daily Report – Water Control Operations dated May 16, 1974

No.	Property of	Entered by	Description
59	Mr. Miller	Mr. Miller	Map of Grand River Watershed dated May 16, 1974
60	Mr. Miller	Mr. Miller	Map of Grand River – Downtown Cambridge-Galt area
61	Mr. Miller	Mr. Miller	Map of Grand River – Downtown Cambridge-Galt area
62	Mr. Moore	Mr. Moore	Report by Mr. Camp dated May 18, 1974
63	Mr. Camp	Mr. Copp	City of Cambridge – Peacetime Disaster Plan
64	Mr. Camp	Mr. Copp	Regional Disaster Plan (copy) Mun. of Waterloo
65	Mr. Moore	Mr. Moore	Letter dated July 12, 1972
66	Mr. Moore	Mr. Moore	Copy of Emergency Measures Act
67	Mr. Moore	Mr. Moore	Report – Staff Sgt. Herman, dated July 1, 1974 (copy)
68	Mr. Moore	Mr. Moore	Flood list 1974 (Galt-Cambridge)
69	Mr. Moore	Mr. Moore	Report by Sgt. Soehner
70	Mr. Moore	Mr. Moore	Medical Officer of Health Report dated July 9, 1974
71	Mr. Moore	Mr. Moore	Occurrence Reports related to flood
72	Mr. Moore	Mr. Moore	Report – Const. Shuttleworth
73	Mr. Moore	Mr. Moore	Report – Sgt. Muir
74	Mr. Moore	Mr. Moore	Report – Mr. D'Arcy Dutton
75	Mr. Miller	Mr. Miller	Log – Conestogo Dam
76	Mr. Miller	Mr. Miller	Log – Shand Dam
77	Mr. Moore	Mr. Moore	Report – Staff Inspector Ulman dated June 24, 1974
78	Mr. Copp	Mr. Copp	Newscast C.F.T.J. – 12:30 p.m. May 17, 1974
79	Mr. Copp	Mr. Copp	Newscast C.F.T.J. – 2:30 p.m. May 17, 1974
80	Mr. Copp	Mr. Copp	Collections of Bulletins C.F.T.J.
81	Mr. Copp	Mr. Copp	Newscast (Special Report) C.F.T.J. after 3:00 p.m.
82	Mr. Copp	Mr. Copp	Map showing flood lines
83	Mr. Copp	Mr. Copp	Letter dated September 11, 1974
84	Mr. Copp	Mr. Copp	Map – Buildings or parts of buildings removed since 1949 – City of Cambridge
85	Mr. Copp	Mr. Copp	Map – New buildings or additions constructed since 1949 – City of Cambridge
86	Mr. Miller	Mr. Miller	Vol. 1 The Lower Grand Study – May 1969

No.	Property of	Entered by	Description
87	Mr. Wickett	Mr. Wickett	Report by Mr. Roberts
88	Mr. Wickett	Mr. Wickett	Flood Reports – O.P.P. & Telex communications
89	Mr. Wickett	Mr. Wickett	Report – Inspector Roberts
90	Mr. Miller	Mr. Miller	Map – Dunnville Weirs
91	Mr. Gilbertson	Mr. Gilbertson	Letter – Mr. Kanivet, dated March 19, 1974
92	Mr. Gilbertson	Mr. Jenkins	Group of five photographs – Kruger Creek
93(1)	Mr. Shivas	Mr. Shivas	Map – City of Kitchener
93(2)	Mr. Shivas	Mr. Shivas	Map – Kiwanis Park
93(3)	Mr. Shivas	Mr. Shivas	Map – Bridgeport
93(4)	Mr. Shivas	Mr. Shivas	Map – Freeport area
93(5)	Mr. Shivas	Mr. Shivas	Map – Doon Valley Golf Course
94	Mr. Shivas	Mr. Shivas	Report – Chief Johnston dated July 16, 1974
95	Mr. Shivas	Mr. Shivas	Report – Bridgeport Flooding, dated Sept. 24, 1974
96	Mr. Shivas	Mr. Shivas	Letter to Mr. Kao, Feb. 20, 1974
97	Mr. Shivas	Mr. Shivas	Report by Mr. S. Gyorffy, June 27, 1974
98	Mr. Shivas	Mr. Shivas	Report (Damages) City of Kitchener, Sept. 20, 1974
99	Mr. Shivas	Mr. Shivas	Report – F. S. Graham, August 2, 1974 re Flood Damage costs to Kitchener
100	Mr. Shivas	Mr. Shivas	Report – H. R. Selman – Damage costs – Kitchener
101	Mr. Shivas	Mr. Shivas	Map – Flood Area – City of Brantford
102	Mr. Kerr	Mr. Gilbertson	Grand River Relief Fund estimates
103	Mr. Gilbertson	Mr. Gilbertson	Report – Mr. Makarachuk
104	Mr. Gilbertson	Mr. Gilbertson	Report – Mr. Gerald Axworthy
105	Mr. Gilbertson	Mr. Gilbertson	Report – Mr. Davies
106	Mr. Gilbertson	Mr. Gilbertson	Flight Log – Helicopter
107	Mr. Gilbertson	Mr. Gilbertson	National Defence Operations Log
108	Mr. Gilbertson	Mr. Gilbertson	Tour Guide Copy
109	Mr. Montgomery	Mr. Montgomery	Bandoni Report, dated May 27, 1974
110	Mr. Copp	Mr. Copp	Chamber of Commerce Letter, dated May 27, 1974 Letter to Dr. Booth and questionnaire
111	Mr. Copp	Mr. Copp	Questionnaires returned and summary
112	Mr. Jenkins	Mr. Jenkins	Letter – D. R. Pollington, dated May 22, 1974

No.	Property of	Entered by	Description
113	Mr. Gilbertson	Mr. Gilbertson	Statement of Mayor Millar to Council, dated June 17, 1974
114	Mr. Good	Mr. Jenkins	Photographs (6) of Mr. Good's farm
115	Mr. Collins	Mr. Montgomery	7 maps – weather pattern – surface analysis
116	Mr. Collins	Mr. Montgomery	3 charts of temperature
117	Mr. Collins	Mr. Montgomery	Charts of average rainfall
118	Mr. Collins	Mr. Montgomery	Report – Dr. Pollock – Isohetal maps, radar, photographs and text
119	Mr. Collins	Mr. Montgomery	Geological Map
120	Mr. Jenkins	Mr. Jenkins	North American Labour Party Report
121	Mr. Jenkins	Mr. Jenkins	List of Persons – Flood Disaster Association
122	Mr. Gilbertson	Mr. Gilbertson	Disaster Plan for Dunnville & Haldimand
123	Mr. Copp	Mr. Copp	Memo re new construction below Flood Lines
124	Mr. Miller	Mr. Miller	Memo re discussion notes on Flood Warning System meeting
125	Mr. Jenkins	Mr. Jenkins	Front page of Cambridge Daily Reporter, May 18, 1974
126	Mr. Jenkins	Mr. Jenkins	Weather forecaster's map
127	Mr. Jenkins	Mr. Jenkins	Weather forecaster's map
128	Mr. Gilbertson	Mr. Gilbertson	Figures and Table regarding Grand River Flood
129	Mr. Gilbertson	Mr. Gilbertson	Water Survey of Canada – Report of 9 stations
130	Mr. Rose	Mr. Rose	Report re Historical Supreme Flows (P. 63 only)
131	Mr. Gilbertson	Mr. Gilbertson	Waterloo Regional Police Report dated Sept. 27, 1974
132	Mr. Gilbertson	Mr. Gilbertson	Preliminary outline plan for the study and investigation of the May 17th, 1974 flood in Galt, etc.
133(1)	Mr. Miller	Mr. Miller	Hydrograph
133(2)	Mr. Miller	Mr. Miller	Hydrograph
133(3)	Mr. Miller	Mr. Miller	Hydrograph
134(1)	Mr. Miller	Mr. Miller	Population Projection
134(2)	Mr. Miller	Mr. Miller	Population and Water Demand Projection
134(3)	Mr. Miller	Mr. Miller	Water Consumption Projection
134(4)	Mr. Miller	Mr. Miller	1986 Water Consumption Projection
134(5)	Mr. Miller	Mr. Miller	Ratio of stream flow to waste flow

No.	Property of	Entered by	Description
134(6)	Mr. Miller	Mr. Miller	Fig. 6 – Graphs showing average B.O.D. Kitchener Sewage Treatment Plant, etc.
134(7)	Mr. Miller	Mr. Miller	Return period of drought in years
134(8)	Mr. Miller	Mr. Miller	Fig. 8 – Flow Regulation at Kitchener
134(9)	Mr. Miller	Mr. Miller	Fig. 9 – Sustained flow at Doon outfall
134(10)	Mr. Miller	Mr. Miller	Examples of flow regulation
135	Mr. Jenkins	Mr. Jenkins	In the Wake of Hurricane Hazel
136	Mr. Miller	Mr. Miller	Table 1 – Reservoir Storages
137	Mr. Miller	Mr. Miller	Agreement between Govt. of Province of Ontario and GRCA for construction of Conestogo Dam
138	Mr. Miller	Mr. Miller	Return period in years – Mean flow at Kitchener
139	Mr. Gilbertson	Mr. Gilbertson	Affidavit re publications for hearings at Cayuga and Brantford
140	Mr. Gilbertson	Mr. Gilbertson	Copy of speech delivered by Mr. McQueen at Brantford
141	Mr. Gilbertson	Mr. Gilbertson	Copy of specifications re Conestogo
142	Mr. Gilbertson	Mr. Gilbertson	Copy of instructions for tenderers re Shand Dam
143	Mr. Jenkins	Mr. Jenkins	Qualifications – Dr. Solomon
144	Dr. Solomon	Mr. Jenkins	Book – Water Survey of Canada
145	Dr. Solomon	Mr. Jenkins	#49 Effects of Natural Storage
146	Dr. Solomon	Mr. Jenkins	119(a) Effect of Reservoir at time of Concentration
147	Dr. Solomon	Mr. Jenkins	#3 – 6 Hour Hydrograph – Grand River
148	Dr. Solomon	Mr. Jenkins	#6 Hour Unit Hydrograph Belwood
149	Dr. Solomon	Mr. Jenkins	Decreased time of concentration runoff – 6 hour unit
150	Mr. Jenkins	Mr. Jenkins	Estimated 6 hour and 1 hour unit hydrograph at Belwood
151	Mr. Jenkins	Mr. Jenkins	#7 Reconstruction of Inflow Hydrograph at Belwood
152	Mr. Jenkins	Mr. Jenkins	Peak Flow Recurrence (Credit River) 1916 - 1941
153	Mr. Jenkins	Mr. Jenkins	Peak Flow Recurrence (Credit River) 1942 - 1957
154	Mr. Jenkins	Mr. Jenkins	Peak Flow Recurrence (Thames River) 1916 - 1941

No.	Property of	Entered by	Description
155	Mr. Jenkins	Mr. Jenkins	Peak Flow Recurrence (Thomas River) 1942 - 1957
156	Mr. Jenkins	Mr. Jenkins	Peak Flow at Galt (Recurrence Probability) 1914 - 1941
157	Mr. Jenkins	Mr. Jenkins	Peak Flow at Galt (Recurrence Probability) 1942 - 1957
158	Mr. Jenkins	Mr. Jenkins	Peak Flow at Galt (Recurrence Probability) 1958 - 1974
159	Mr. Jenkins	Mr. Jenkins	Peak Flow at Galt (Recurrence Probability) 1958 - 1973
160	Mr. Jenkins	Mr. Jenkins	Relationship – Mean Daily Maximum Flow at Galt – 1930 - 1947
161	Mr. Jenkins	Mr. Jenkins	Relationship between Daily and maximum flow at Galt (1942 - 1957)
162	Mr. Jenkins	Mr. Jenkins	Letter dated October 17, 1974 – Environment Canada to Dr. Solomon
163	Mr. Jenkins	Mr. Jenkins	Book – Annex 9, P. 103 Lessons from Dam Incidents
164	Mr. Jenkins	Mr. Jenkins	Excerpt – Book, Water Resources Engineering, (2nd Edition)
165	Mr. Jenkins	Mr. Jenkins	Re current interval 24 hour precipitation at Guelph in May
166	Mr. Jenkins	Mr. Jenkins	Comparison of maximum precipitation – 24 hour period
167	Mr. Jenkins	Mr. Jenkins	Comparison between average runoffs during May 16th and 17th flood
168	Mr. Jenkins	Mr. Jenkins	Relationship between rainfall, runoff, estimated by Ex. 31
169	Mr. Jenkins	Mr. Jenkins	Variation in flow levels – 1967
170	Mr. Jenkins	Mr. Jenkins	Variation in flow and lake levels in spring, 1967
171	Mr. Jenkins	Mr. Jenkins	Book – Surface Water Data, Ontario, 1972
172	Mr. Jenkins	Mr. Jenkins	Document dated Nov. 4, 1974 – Water Survey Canada below Shand Dam
173	Mr. Jenkins	Mr. Jenkins	Quantitative precipitation Chart – Forecast Map
174	Mr. Jenkins	Mr. Jenkins	Map – Radar Imagery, May 17, 1974
175	Mr. Jenkins	Mr. Jenkins	Map – Radar Imagery, May 17, 1974
176	Dr. Solomon	Mr. Jenkins	Book – (1972 - Oct.) Environmental Remote Sensing, etc.

No.	Property of	Entered by	Description
177	Mr. Jenkins	Mr. Jenkins	Runoff generation model at Galt
178	Mr. Jenkins	Mr. Jenkins	Estimated flows at Galt
179	Mr. Jenkins	Mr. Jenkins	Superimposed levels variations at Galt and Doon
180	Mr. Jenkins	Mr. Jenkins	Correlation levels at Doon and Galt
181	Mr. Jenkins	Mr. Jenkins	Proceedings at Seminar – Environmental Canada at Burlington
182	Mr. Jenkins	Mr. Jenkins	Letter from Brantford P.U.C. dated Sept. 12, 1974
183	Mr. Jenkins	Mr. Jenkins	Interim Report – Wasto River Loading Guidelines
184	Mr. Jenkins	Mr. Jenkins	Grand River at Glen Morris Bridge Flow Variation, etc.
185	Mr. Jenkins	Mr. Jenkins	Grand River at Glen Morris Variation Flow, Total and Fecal Coli
186	Mr. Jenkins	Mr. Jenkins	Grand River at Glen Morris Variations of flow. Total and dissolved phosphorus
187	Mr. Jenkins	Mr. Jenkins	Variations of Flow – Grand River at Glen Morris Bridge
188	Mr. Jenkins	Mr. Jenkins	Water Quality Data for Grand River Basin
189(a)	Mr. Jenkins	Mr. Jenkins	Correlation between flow at Galt and BOD at Glen Morris bridge
189(b)	Mr. Jenkins	Mr. Jenkins	Correlation between flow at Galt & DO at Glen Morris bridge
189(c)	Mr. Jenkins	Mr. Jenkins	Correlation between flow at Brantford and DO at Canfield Junction
189(d)	Mr. Jenkins	Mr. Jenkins	Correlation between flow at Brantford and BOD at Canfield Junction
189(e)	Mr. Jenkins	Mr. Jenkins	Flow of Grand River at Galt versus soluble P. at Glen Morris bridge
189(f)	Mr. Jenkins	Mr. Jenkins	Flow of Grand River at Brantford versus Canfield Junction per soluble P.
190(a)	Mr. Jenkins	Mr. Jenkins	Deficits from 450 c.f.s. at Galt
190(b)	Mr. Jenkins	Mr. Jenkins	Deficits from 400 c.f.s. at Galt
190(c)	Mr. Jenkins	Mr. Jenkins	Deficits from 350 c.f.s. at Galt
191	Mr. Jenkins	Mr. Jenkins	Monthly runoff in Grand River above Shand Dam
192(a)	Mr. Jenkins	Mr. Jenkins	Weather Maps, Toronto (1800 hours) May 15, 1974

No.	Property of	Entered by	Description
192(b)	Mr. Jenkins	Mr. Jenkins	Weather Maps, Toronto (0000 hours) May 16, 1974
192(c)	Mr. Jenkins	Mr. Jenkins	Weather Maps, Toronto (0600 hours) May 16, 1974
192(d)	Mr. Jenkins	Mr. Jenkins	Weather Maps, Toronto (1200 hours) May 16, 1974
192(e)	Mr. Jenkins	Mr. Jenkins	Weather Maps, Toronto (1800 hours) May 16, 1974
192(f)	Mr. Jenkins	Mr. Jenkins	Weather Maps, Toronto (0000 hours) May 17, 1974
192(g)	Mr. Jenkins	Mr. Jenkins	Weather Maps, Toronto (0600 hours) May 17, 1974
193	Mr. Jenkins	Mr. Jenkins	Storm Advisory issued by D.O.E. – AES Toronto, May 16, 1974 – 1:30 P.M. E.S.T.
194(a)	Mr. Copp	Mr. Copp	Characteristic Levels – Storage Volume, Variation of levels in May 15, 16, 1974 at Shand
194(b)	Mr. Copp	Mr. Copp	As above at Conestogo
195	Mr. Smith	Mr. Smith	Conservation Authorities – Ont. Hydrolic Regions
196	Mr. Smith	Mr. Smith	Water Resources Research – The 3 Parameter Regional Distribution
197	Mr. Smith	Mr. Smith	Peak flow recurrence probability curve of Grand River
198	Mr. Smith	Mr. Smith	Peak flow recurrence probability curve of Grand River at Galt, 1914 - 1941 period
199	Mr. Smith	Mr. Smith	Dam failure and dam accidents
200	Mr. Miller	Mr. Miller	Copy Agreement dated March 27, 1953
201	Mr. Miller	Mr. Miller	Photograph – Sign at Conestogo
202	Mr. Montgomery	Mr. Montgomery	Book – Statistical Methods in Hydrology
203	Mr. Jenkins	Mr. Jenkins	Extension Plan for Flood Control, May, 1970
204	Mr. Montgomery	Mr. Montgomery	Letter – Mr. Hornibrook (See Ex. 13)
205	Mr. Smith	Mr. Smith	Series of Pictures – Weirs - Dunnville
206	Mr. Miller	Mr. Miller	Amended reconstruction of Inflow Hydrograph (See Exhibit 151)
207	Mr. Miller	Mr. Miller	Peak discharges calculated for regional storm
208	Mr. Miller	Mr. Miller	Typical Hydrograph for Galt
209	Mr. Montgomery	Mr. Montgomery	List of Publications by Professor H. D. Ayers

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