A WATER CONSERVATION PLAN FOR THE UNIVERSITY OF MANITOBA

BY

(40)

DAVID PARBERY

A Practicum
Submitted to the Faculty of Graduate Studies
in Partial Fulfillment of the Requirements
for the Degree of

MASTER OF NATURAL RESOURCE MANAGEMENT

Natural Resources Institute
University of Manitoba
Winnipeg, Manitoba

ISBN 0-612-13433-4

Name DAVID PARBERY

Dissertation Abstracts International is arranged by broad, general subject categories. Please select the one subject which most nearly describes the content of your dissertation. Enter the corresponding four-digit code in the spaces provided.

Health and Environmental Sciences — SUBJECT TERM

0768 — SUBJECT CODE

U·M·I

Subject Categories

THE HUMANITIES AND SOCIAL SCIENCES

COMMUNICATIONS AND THE ARTS
Architecture 0729
Art History 0377
Cinema 0900
Dance 0378
Fine Arts 0357
Information Science 0723
Journalism 0391
Library Science 0399
Mass Communications 0708
Music 0413
Speech Communication 0459
Theater 0465

EDUCATION
General 0515
Administration 0514
Adult and Continuing 0516
Agricultural 0517
Art 0273
Bilingual and Multicultural 0282
Business 0688
Community College 0275
Curriculum and Instruction 0727
Early Childhood 0518
Elementary 0524
Finance 0277
Guidance and Counseling 0519
Health 0680
Higher 0745
History of 0520
Home Economics 0278
Industrial 0521
Language and Literature 0279
Mathematics 0280
Music 0522
Philosophy of 0998
Physical 0523
Psychology 0525
Reading 0535
Religious 0527
Sciences 0714
Secondary 0533
Social Sciences 0534
Sociology of 0340
Special 0529
Teacher Training 0530
Technology 0710
Tests and Measurements 0288
Vocational 0747

LANGUAGE, LITERATURE AND LINGUISTICS
Language
- General 0679
- Ancient 0289
- Linguistics 0290
- Modern 0291

Literature
- General 0401
- Classical 0294
- Comparative 0295
- Medieval 0297
- Modern 0298
- African 0316
- American 0591
- Asian 0305
- Canadian (English) 0352
- Canadian (French) 0355
- English 0593
- Germanic 0311
- Latin American 0312
- Middle Eastern 0315
- Romance 0313
- Slavic and East European 0314

PHILOSOPHY, RELIGION AND THEOLOGY
Philosophy 0422
Religion
- General 0318
- Biblical Studies 0321
- Clergy 0319
- History of 0320
- Philosophy of 0322

Theology 0469

SOCIAL SCIENCES
American Studies 0323
Anthropology
- Archaeology 0324
- Cultural 0326
- Physical 0327

Business Administration
- General 0310
- Accounting 0272
- Banking 0770
- Management 0454
- Marketing 0338

Canadian Studies 0385
Economics
- General 0501
- Agricultural 0503
- Commerce-Business 0505
- Finance 0508
- History 0509
- Labor 0510
- Theory 0511

Folklore 0358
Geography 0366
Gerontology 0351
History
- General 0578
- Ancient 0579
- Medieval 0581
- Modern 0582
- Black 0328
- African 0331
- Asia, Australia and Oceania 0332
- Canadian 0334
- European 0335
- Latin American 0336
- Middle Eastern 0333
- United States 0337

History of Science 0585
Law 0398
Political Science
- General 0615
- International Law and Relations 0616
- Public Administration 0617

Recreation 0814
Social Work 0452
Sociology
- General 0626
- Criminology and Penology 0627
- Demography 0938
- Ethnic and Racial Studies 0631
- Individual and Family Studies 0628
- Industrial and Labor Relations 0629
- Public and Social Welfare 0630
- Social Structure and Development 0700
- Theory and Methods 0344

Transportation 0709
Urban and Regional Planning 0999
Women's Studies 0453

THE SCIENCES AND ENGINEERING

BIOLOGICAL SCIENCES
Agriculture
- General 0473
- Agronomy 0285
- Animal Culture and Nutrition 0475
- Animal Pathology 0476
- Food Science and Technology 0359
- Forestry and Wildlife 0478
- Plant Culture 0479
- Plant Pathology 0480
- Plant Physiology 0817
- Range Management 0777
- Wood Technology 0746

Biology
- General 0306
- Anatomy 0287
- Biostatistics 0308
- Botany 0309
- Cell 0379
- Ecology 0329
- Entomology 0353
- Genetics 0369
- Limnology 0793
- Microbiology 0410
- Molecular 0307
- Neuroscience 0317
- Oceanography 0416
- Physiology 0433
- Radiation 0821
- Veterinary Science 0778
- Zoology 0472

Biophysics
- General 0786
- Medical 0760

EARTH SCIENCES
Biogeochemistry 0425
Geochemistry 0996
Geodesy 0370
Geology 0372
Geophysics 0373
Hydrology 0388
Mineralogy 0411
Paleobotany 0345
Paleoecology 0426
Paleontology 0418
Paleozoology 0985
Palynology 0427
Physical Geography 0368
Physical Oceanography 0415

HEALTH AND ENVIRONMENTAL SCIENCES
Environmental Sciences 0768
Health Sciences
- General 0566
- Audiology 0300
- Chemotherapy 0992
- Dentistry 0567
- Education 0350
- Hospital Management 0769
- Human Development 0758
- Immunology 0982
- Medicine and Surgery 0564
- Mental Health 0347
- Nursing 0569
- Nutrition 0570
- Obstetrics and Gynecology 0380
- Occupational Health and Therapy 0354
- Ophthalmology 0381
- Pathology 0571
- Pharmacology 0419
- Pharmacy 0572
- Physical Therapy 0382
- Public Health 0573
- Radiology 0574
- Recreation 0575
- Speech Pathology 0460
- Toxicology 0383

Home Economics 0386

PHYSICAL SCIENCES
Pure Sciences

Chemistry
- General 0485
- Agricultural 0749
- Analytical 0486
- Biochemistry 0487
- Inorganic 0488
- Nuclear 0738
- Organic 0490
- Pharmaceutical 0491
- Physical 0494
- Polymer 0495
- Radiation 0754

Mathematics 0405
Physics
- General 0605
- Acoustics 0986
- Astronomy and Astrophysics 0606
- Atmospheric Science 0608
- Atomic 0748
- Electronics and Electricity 0607
- Elementary Particles and High Energy 0798
- Fluid and Plasma 0759
- Molecular 0609
- Nuclear 0610
- Optics 0752
- Radiation 0756
- Solid State 0611

Statistics 0463

Applied Sciences

Applied Mechanics 0346
Computer Science 0984
Engineering
- General 0537
- Aerospace 0538
- Agricultural 0539
- Automotive 0540
- Biomedical 0541
- Chemical 0542
- Civil 0543
- Electronics and Electrical 0544
- Heat and Thermodynamics 0348
- Hydraulic 0545
- Industrial 0546
- Marine 0547
- Materials Science 0794
- Mechanical 0548
- Metallurgy 0743
- Mining 0551
- Nuclear 0552
- Packaging 0549
- Petroleum 0765
- Sanitary and Municipal 0554
- System Science 0790

Geotechnology 0428
Operations Research 0796
Plastics Technology 0795
Textile Technology 0994

PSYCHOLOGY
General 0621
Behavioral 0384
Clinical 0622
Developmental 0620
Experimental 0623
Industrial 0624
Personality 0625
Physiological 0989
Psychobiology 0349
Psychometrics 0632
Social 0451

"A WATER CONSERVATION PLAN FOR THE UNIVERSITY OF MANITOBA"

A practicum submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfilment of the requirements of the degree of Master of Natural Resources Management.

By

Mr. David Parbery

1994

EXECUTIVE SUMMARY

The University of Manitoba (U of M) is the single largest water user in the City of Winnipeg. It used over 1,000,000 m^3 of water in 1993-1994, at a cost of almost $950,000. Although water use has been fairly constant over the last several years, water costs have risen due to City of Winnipeg water rate increases. Water rates for industrial/institutional users, such as the U of M, have increased 13 percent this year (1994/95 fiscal year). This is more than double the average rate increase of the last five years and will amount to an increase of approximately $123,000 in water utility charges to the University of Manitoba's 1994/95 water bill (assuming the amount of water used will be the same as in 1993/94).

Potential City of Winnipeg expenditures of over $400 million for water supply infrastructure upgrading over the next two to three decades could push water rates and service charges to water users even higher. Next year's rate increase will likely be as great as this year's. If City of Winnipeg water rate increases continue at the same rate for the next several years, the University of Manitoba, Fort Garry Campus's (UMFGC) water costs will be over $2,000,000 by the year 2000. If the U of M wants to reduce, or even hold constant its costs for water and sewage treatment it will have to institute water conservation measures.

Based on these findings, a Water Conservation Plan, consisting of defined goals with realistic objectives that are supported by a proactive and practicable policy, is developed. The Water Conservation Plan is based on: 1) water conservation techniques and strategies described in the literature; 2) other institutions' and municipalities' water conservation experiences; and, 3) on-site studies of water uses on the UMFGC.

The plan identifies three top priority water conservation goals; Water Use Reduction, Leak Detection & Repair, and, Education. Several objectives are listed for each goal. Each objective has its own workplan, schedule, budget and monitoring criteria. Workplans describe how the objective is to be carried out; schedules detail the starting time and expected length of time each objective will take; the budget outlines estimated costs and expected savings; monitoring allows for feedback to, and improvement of, goals and objectives. The plan is to be managed by the U of M, Department of Physical Plant.

The plan's objectives have the potential to reduce the UMFGC water use by approximately 16 percent (122,000 m^3). The University of Manitoba could realize cost savings in the order of $131,000 within two years if it adopted and instituted this Water Conservation Plan.

The Practicum also makes three further recommendations that address different aspects of water use and conservation: investigating the use of cheaper sources of water; studying the potential of reusing/recycling water on Campus; and, identifying the uses and users of the 55 percent of Campus water that is unmetered.

The Water Conservation Plan developed for the University of Manitoba, Fort Garry Campus, will aid in reducing future water utility costs, promote sustainability of a vital natural resource, and help to ensure that the University is seen to be an environmentally and economically responsible public institution. The conservation program will create a sustained awareness of the value of water and a commitment to more efficient use in the University of Manitoba's population.

ACKNOWLEDGEMENTS

I would like to thank Dr. John Sinclair for identifying this practicum topic and for his guidance, advice and some great parties over the last year. Thanks also to Dr. Gardner for finding funding for this project. I am very grateful to my Practicum Committee for their invaluable input and for agreeing to move through the Practicum process at such a rapid pace. Thank you Mr. Robert McDowall (Physical Plant), Dr. Daryl McCarntey (Geological Engineering), and Mr. Andrew Weremy (City of Winnipeg, Water Works Department).

I would also like to thank the Physical Plant staff, especially Mr. Don McMullin, for their time, advice and information about Campus operations and copies of UMFGC water records.

Loads of thanks to Jude for help with computer hassles, coffee, last minute photocopying, a friendly ear, scheduling, message taking, and a smile every single day!

Thanks also to the support of my family and friends, it is appreciated. And to the gang, Kate, Sheryl, Cam, Ian, Josh and a cast of dozens. Thanks guys, you made it all fun!

TABLE OF CONTENTS

		PAGE
EXECUTIVE SUMMARY		iii
ACKNOWLEDGEMENTS		vi
LIST OF FIGURES		ix
LIST OF TABLES		x
LIST OF APPENDICES		x
CHAPTER 1 - INTRODUCTION		1
1.1	BACKGROUND	1
1.2	WATER USE CONSIDERATIONS	1
1.2.1	FINANCIAL	1
1.2.2	ENVIRONMENTAL AWARENESS and STEWARDSHIP	2
1.3	PROBLEM STATEMENT	4
1.4	STATEMENT of PURPOSE	9
1.5	OBJECTIVES	10
1.6	METHODS	11
1.6.1	REVIEW of WATER CONSERVATION	11
1.6.2	OTHER INSTITUTION'S WATER CONSERVATION PRACTICES	12
1.6.3	REVIEW of WATER USE - UNIVERSITY of MANITOBA, FORT GARRY CAMPUS	12
1.6.4	ON-SITE STUDIES	13
1.7	PRACTICAL APPLICATION of the STUDY	14
1.8	CONCERNED PARTIES	14
1.9	LIMITATIONS and ASSUMPTIONS	15
1.10	ORGANIZATION	16
1.11	CONCLUSIONS	17
CHAPTER 2 - REVIEW OF WATER CONSERVATION		18
2.1	DEFINITION	18
2.2	WATER DEMAND - HISTORICAL VIEW	18
2.3	JUSTIFICATION and BENEFITS of WATER CONSERVATION	23

2.4 CONSERVATION TOOLS 25
2.4.1 WATER PRICING 26
2.4.2 RATE STRUCTURE CHANGES 26
2.4.3 METERING 29
2.4.4 EDUCATION 29
2.4.5 REUSE/RECYCLING 30
2.4.6 LEGISLATION 31
2.4.7 LEAK DETECTION 32
2.4.8 LANDSCAPE MAINTENANCE 33
2.4.9 TECHNOLOGICAL FIXES - WATER EFFICIENT DEVICES 36
2.5 WATER CONSERVATION PRACTICES and POLICIES in OTHER INSTITUTIONS 38
2.5.1 MUNICIPAL ACTIONS 39
2.5.1.1 City of Winnipeg: 39
2.5.1.2 City of Edmonton: 41
2.5.1.3 City of Regina: 41
2.5.1.4 Regional Municipality of Waterloo: 42
2.5.2 OTHER UNIVERSITIES' ACTIONS 43
2.6 CONCLUSIONS 43

CHAPTER 3 - REVIEW OF WATER USE AT THE UNIVERSITY OF MANITOBA, FORT GARRY CAMPUS 47

3.1 WATER - JURISDICTION 47
3.2 UNIVERSITY of MANITOBA'S WATER SUPPLY 49
3.3 WATER RATE STRUCTURE 50
3.4 WATER USE at the UNIVERSITY of MANITOBA, FORT GARRY CAMPUS 54
3.4.1 Population and Water Use 60
3.4.2 Space and Water Use 60
3.4.3 Seasonal Water Use 63
3.4.4 Other Factors 65
3.5 IDENTIFIED WATER USER GROUPS 65
3.5.1 Water System Losses: 67
3.5.2 Residence Use: 68
3.5.3 Departmental Use: 68
3.5.4 Restaurant Use: 70
3.5.5 Physical Education Use: 70
3.5.6 Groundskeeping: 72
3.5.7 Unknown Uses: 74
3.6 FUTURE COSTS 74
3.7 CONCLUSIONS 77

CHAPTER 4	- A WATER CONSERVATION PLAN FOR THE UNIVERSITY OF MANITOBA, FORT GARRY CAMPUS	79
4.1	INTRODUCTION	79
4.2	CURRENT WATER CONSERVATION EFFORTS at the UNIVERSITY of MANITOBA, FORT GARRY CAMPUS	81
4.3	A WATER CONSERVATION PLAN for the UMFGC	83
4.3.1	PROPOSED WATER CONSERVATION POLICY	84
4.3.2	PROPOSED WATER CONSERVATION PLAN	85
4.3.2.1	PLAN MANAGEMENT	88
4.3.2.2	PLAN GOALS and OBJECTIVES	89
4.3.2.3	DESCRIPTION OF GOALS & OBJECTIVES	92
	Goal 1. Water Use Reduction	92
	Goal 2. Leak Detection & Repair	101
	Goal 3. Education	105
4.4	WATER CONSERVATION PLAN SAVINGS	110
CHAPTER 5	- CONCLUSIONS and RECOMMENDATIONS	114
5.1	CONCLUSIONS	114
5.2	RECOMMENDATIONS	115
BIBLIOGRAPHY		118
PERSONAL COMMUNICATIONS		126

LIST OF FIGURES

Figure 1	Winnipeg Water Rates	3
Figure 2	Water Rates & Water Used	6
Figure 3	Unit Cost of Water	7
Figure 4	Residential Indoor Water Use	21
Figure 5	Conservation Rate Structures	28
Figure 6	City of Winnipeg Water Supply System	51
Figure 7	Location of Metered Water Mains	52
Figure 8	U of M Water Usage & Costs	56

Figure 9	U of M Water Usage Fort Garry & Bannatyne Campuses	57
Figure 10	Population & Water Use	61
Figure 11	Facility Space & Water Use	62
Figure 12	Seasonal Water Use	64
Figure 13	Water User Groups	66
Figure 14	Residence Water Use	69
Figure 15	Departmental Water Use	71
Figure 16	Water Use & Precipitation	73
Figure 17	Future Water Costs	76
Figure 18	Water Conservation Plan Process	87

LIST OF TABLES

Table 1	City of Winnipeg Water Charges	8
Table 2	Benefits of Water Efficiency Methods	40
Table 3	Canadian Universities' Water Conservation Practices	44
Table 4	Water Consumption by User Groups City of Winnipeg & UMGCF	55
Table 5	Daily Water Use UMFGC	59
Table 6	Water Conservation Costs & Savings	111

LIST OF APPENDICES

Appendix 1	Definition of Terms & Abbreviations
Appendix 2	University of Manitoba Water Records
Appendix 3	City of Winnipeg Water Conservation Pamphlet
Appendix 4	Calculation of Water Used for Groundskeeping
Appendix 5	Calculation of Washroom Fixture Leakage
Appendix 6	Water Conservation Ideas

CHAPTER 1 - INTRODUCTION

1.1 BACKGROUND

This research issue was identified by Dr. J.Sinclair (Natural Resources Institute) and Dr. J.Gardner (Vice-President {Academic} and Provost). A water audit or a water conservation project was recommended in their 1992 report, "The University of Manitoba and the Environment: A Framework for Action". This document, and other studies such as Dr. C.Bigelow's "Recommendations on Environmental Education and Research at the University of Manitoba", and the University of Manitoba Physical Plant's "1992 Environmental Services Symposium", call for the University of Manitoba to develop environmental policies and practices that are in keeping with the legal, political, social, environmental and economic realities of today.

1.2 WATER USE CONSIDERATIONS

1.2.1 FINANCIAL

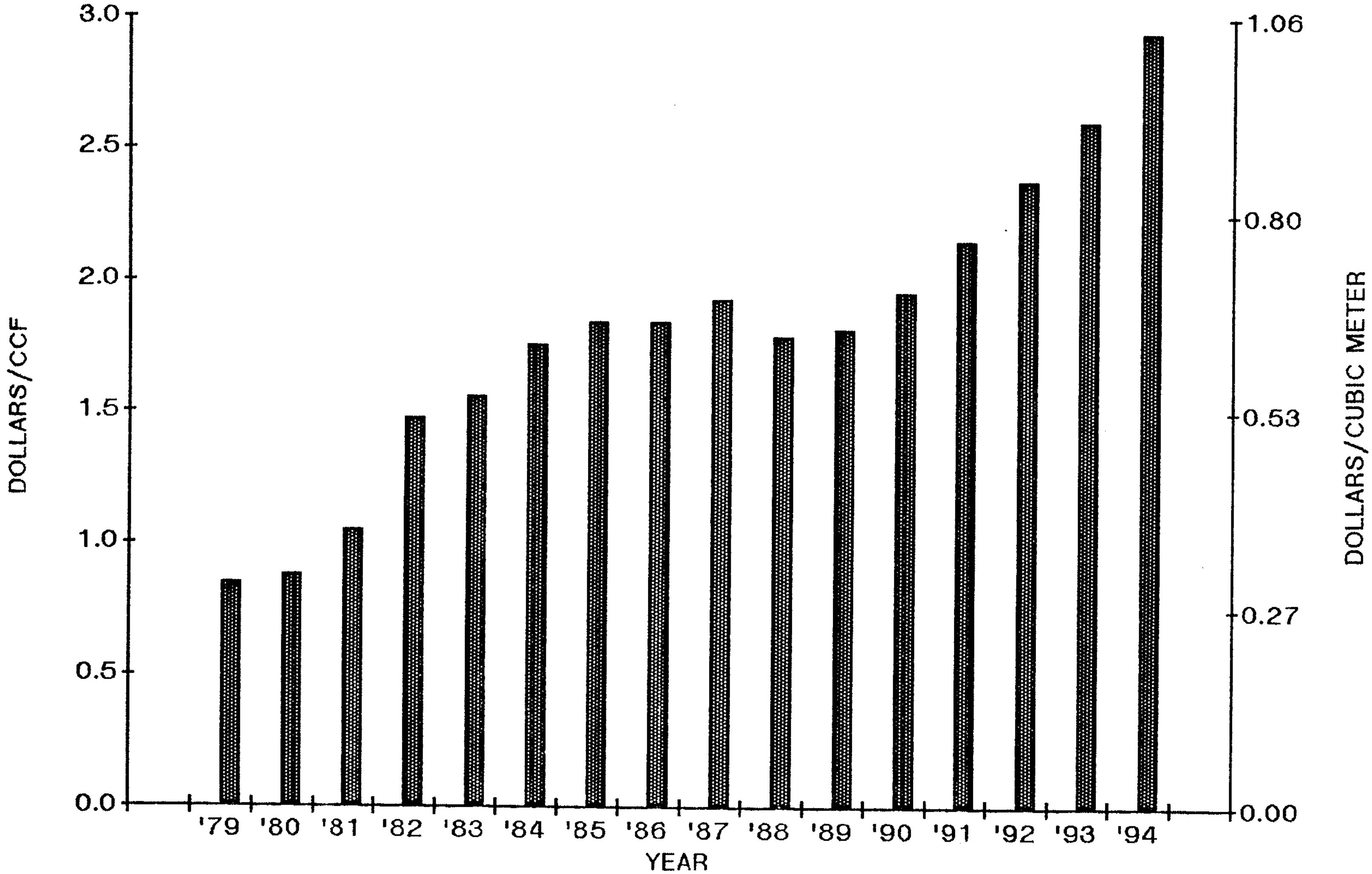
Today within the City of Winnipeg neither water quality nor quantity are concerns for residential, commercial or industrial users such as the University of Manitoba.

However, the cost associated with using water continues to increase even if the amount of water used remains constant. Winnipeg water rates (combined water and sewer charges) have increased 13 percent in the 1994/95 fiscal year (Winnipeg, 1994) (See Figure 1). The city's growing demand for water (demand is approaching the gross capacity of the Shoal Lake aqueduct), as well as the need to rehabilitate the aqueduct, may result in expenditures totalling over $400 million over the next 20 years (Winnipeg, 1992b). The revenue requirements of the water supply plan currently under review by the City of Winnipeg "represents a very significant increase in total required annual revenue. *This increase will have to be reflected in rates.*" (Winnipeg, 1992b. Italics are this author's).

1.2.2 ENVIRONMENTAL AWARENESS and STEWARDSHIP

The evolving environmental movement asks us to consider not only our own needs but the needs of future generations when it comes to resource use. This is the concept of **Sustainable Development** as outlined in the Brundtland Commission's report (WCED, 1987). Businesses and individuals in our consumer driven economy are starting to move towards the more minimalist philosophy of doing more with less, or just doing with less and holding the *status*

Fig. 1 WINNIPEG WATER RATES
(Source: City of Winnipeg)



quo. Consumption taxes such as the GST are created and conservation policies and practices are introduced by governments. These and other changes in our values (society's) have a reciprocal relationship with what is often termed *environmental awareness*. Environmental awareness demands that we ask ourselves what the impacts of our day-to-day business are upon the environment. What improvements can be made? What are the downstream, and upstream, consequences of our use of resources? What are our responsibilities as resource users? Given this, stewardship of the environment and resource use issues need to be addressed by publicly funded institutions such as the University of Manitoba.

1.3 PROBLEM STATEMENT

The University of Manitoba (U of M) is the single largest water user in the City of Winnipeg. If considered as a separate entity, the U of M is the third largest community in Manitoba, after Winnipeg and Brandon, with a population of over 28,000 students, staff and faculty (UM, 1993a). The U of M used over 1,000,000 m^3 of water in 1993-1994, at a cost of about $950,000 (Appendix 2). Water costs have averaged $827,000/year over the last 12 years (not adjusted for inflation) and water use has averaged 1,100,000 m^3/year. Although 1993-1994 water use is slightly lower than the 12 year average, water costs are 14% higher (UM, 1993b). Over time, water rates have continues to rise while the U of M's water use holds steady or even decreases (Figure 2). Figure 3 shows that the unit cost of water is increasing for the University of Manitoba.

City of Winnipeg water rates for industrial/institutional users have increased 13 percent this year (1994/95 fiscal year). This is more than double the average rate increase of the last five years. The water charge increase for 1994 is 3 percent with an additional 10 cent/100 Cu.Ft. water system upgrade charge for aqueduct rehabilitation and a future water treatment plant, and a 22 cent increase in sewer charges (Table 1). This amounts to an increase in utility rate charges of approximately 13 percent, or about $123,000 to the University of Manitoba's 1994 water bill (assuming the amount of water used will be the same as in 1993). Potential expenditures of over $400 million for infrastructure upgrading to meet demand over the next two to three decades could push water rates and service charges to water users even higher (Winnipeg, 1992b). To help put off some of the $400 million of expenditures the City of Winnipeg is implementing a water conservation program with a short term goal of reducing demand for water by 5 percent. This would defer the need for new water supplies until the year 2002, five years beyond the time when additional

Fig. 2 WINNIPEG WATER RATES &
AMOUNT OF WATER USED (UMFGC)

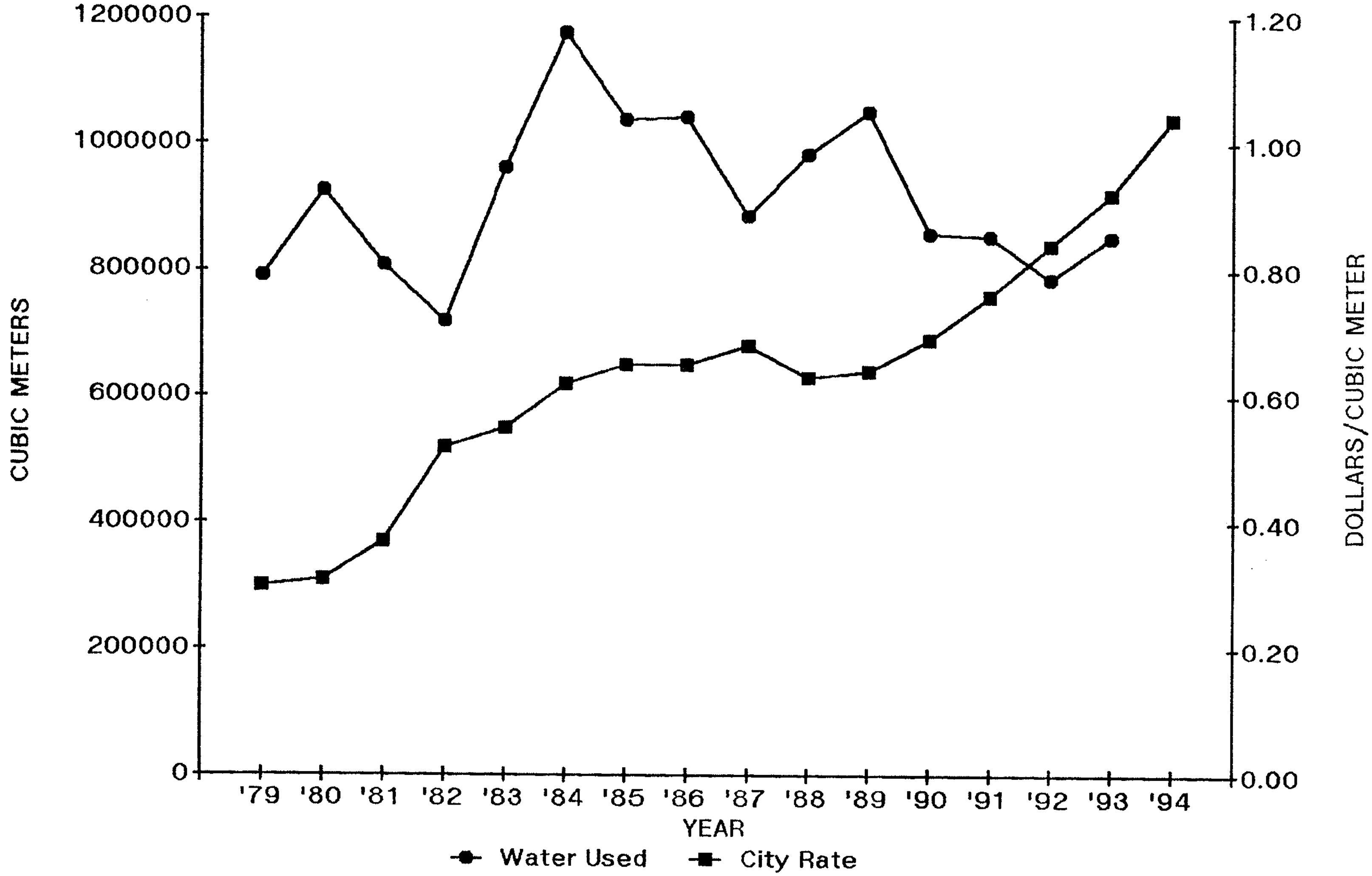


Fig. 3 UNIT COST of WATER (UMFGC)
(Source: Physical Plant & City Records

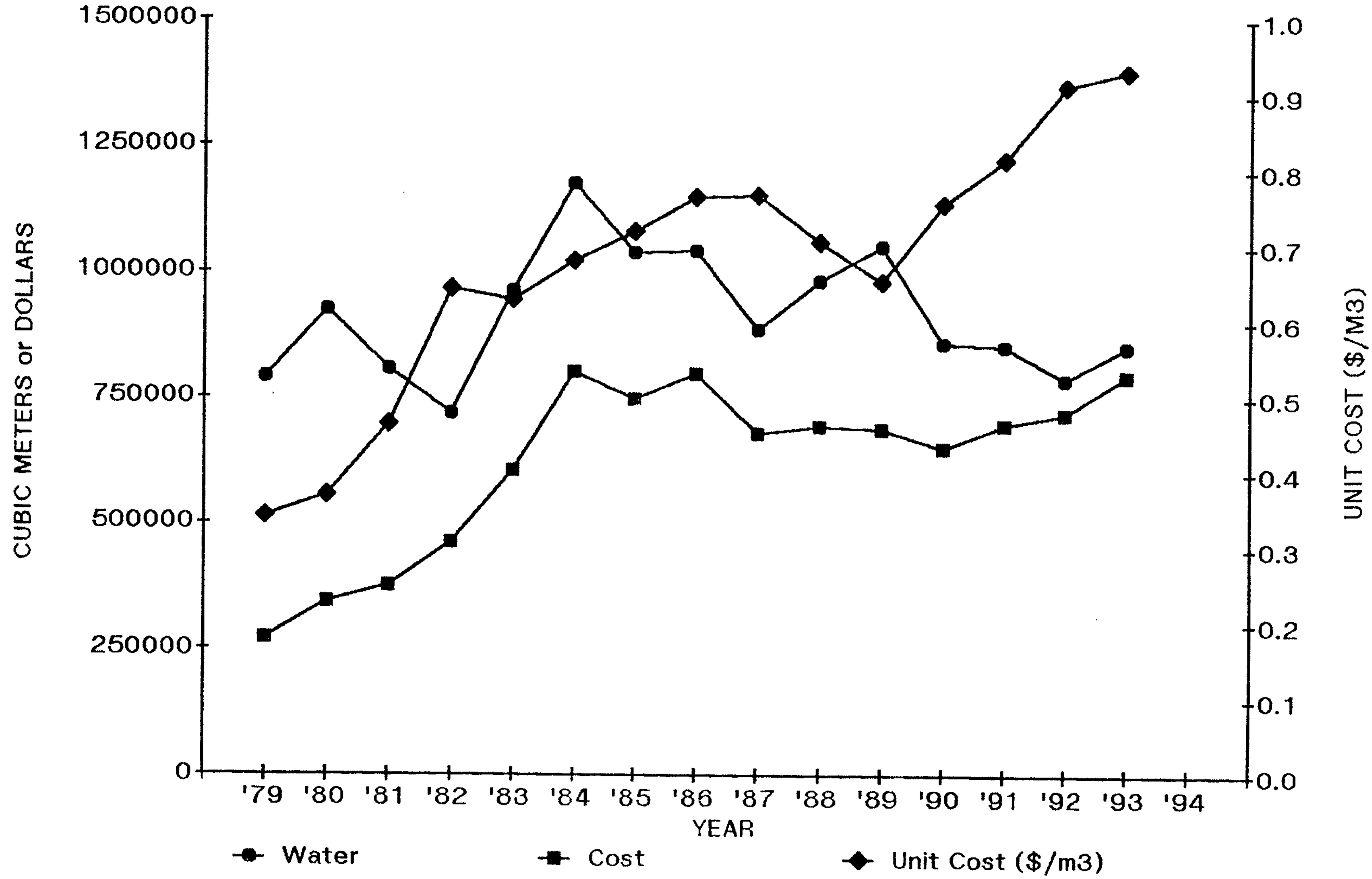


Table 1 City of Winnipeg Water Charges

NOTICE OF NEW WATER AND SEWER RATES

The Council of The City of Winnipeg approved an increase to the water and sewer rates as well as to the Quarterly Charge, to take effect January 1st, 1994. The new rates and new Quarterly Charge will be charged only for the consumption on or after the effective date of January 1st, 1994. The portion of your bill covering the period prior to January 1st, 1994 will be at the old rates.

Included in the water charge is a provision which includes both a 3.0% increase on each block rate plus 3.5¢ per 100 cubic feet for the aqueduct rehabilitation program and 6.5¢ per 100 cubic feet for a future water treatment plant.

A comparison of the old and new water rates is shown below. The old and new Quarterly Charge schedule is shown on the reverse hereof.

Consumption Per Quarter	OLD RATE		NEW RATE	
	Water Charge Per 100 Cu. Ft.	Sewer Charge Per 100 Cu. Ft.	Water Charge Per 100 Cu. Ft.	Sewer Charge Per 100 Cu. Ft.
First 9,600 Cu. Ft.	$1.41	$1.83	$1.55	$2.05
9,601 to 96,000 Cu. Ft.	$1.10	$1.83	$1.23	$2.05
Over 96,000 Cu. Ft.	$0.78	$1.83	$0.90	$2.05

(1 gallon = 0.16 Cu. Ft. or 1 Cu. Ft. = 6.25 Gallons)
(1 litre = .0353 Cu. Ft. or 1 Cu. Ft. = 28.316 litres)

(see over)

QUARTERLY CHARGE

A Daily Equivalent of the "Quarterly Charge" is assessed based on meter size as follows:

	QUARTERLY CHARGE (90 Days)		DAILY EQUIVALENT	
METER SIZE	OLD RATE	NEW RATE	OLD RATE	NEW RATE
5/8"	$ 11.51	$ 11.70	$0.1279	$0.1300
3/4"	$ 12.39	$ 12.60	$0.1377	$0.1400
1"	$ 15.03	$ 15.30	$0.1670	$0.1700
1 1/2"	$ 18.54	$ 18.89	$0.2060	$0.2099
2"	$ 28.21	$ 28.78	$0.3134	$0.3198
3"	$ 99.41	$101.60	$1.1046	$1.1289
4"	$125.78	$128.57	$1.3976	$1.4286
6"	$187.31	$191.50	$2.0812	$2.1278
8"	$257.63	$263.42	$2.8626	$2.9269
10"	$327.95	$335.34	$3.6439	$3.7260

FORM WW84: 93 12

capacity would be needed if conservation were not implemented (Winnipeg, 1992b).

In these days of decreased funding and increased environmental awareness it is vital that large, publicly funded institutions, such as the University of Manitoba, address their costs and be seen as good environmental citizens, following the lead of the community (the City of Winnipeg) and also helping to set standards for others in the community to follow.

1.4 STATEMENT of PURPOSE

Given this discussion and in keeping with the City of Winnipeg conservation initiative, as well as reducing current and future environmental and economic costs associated with water use, the purpose of this research is to deliver a comprehensive and practical Water Conservation Plan for the University of Manitoba. The conservation plan should create a sustained awareness of the value of water and a commitment to more efficient use in the University of Manitoba's population.

Beyond the immediate potential benefits of reducing utility costs by reducing water use, are the long term environmental and economic considerations. The concept of environmental sustainability and stewardship of our resources must be taken into account. A water conservation strategy for the University of Manitoba will aid in reducing future water utility costs, promote sustainability of a vital natural resource, and help to ensure that the University is seen to be an environmentally and economically responsible public institution.

1.5 OBJECTIVES

The objectives of this study are:

1 To define water conservation, and identify current water conservation tools and practices;

2 To identify current water uses and costs at the University of Manitoba, Fort Garry Campus, and to extrapolate future water requirements and costs from historical data;

3 To develop a Water Conservation Plan for the University of Manitoba that outlines water conservation goals and involves faculty, staff and students.

1.6 METHODS

A variety of research methods were used to meet the three objectives. The literature dealing with current water conservation practices was examined, as was the conservation practices of other institutions and municipalities. A review of water use at the UMFGC was made. Baseline data on current water use at the U of M was established from water utility records. On-site observation of campus operations and interviews with staff and faculty aided in identifying high water users. Measurements of water used in some operations on campus were made. These observations will be used to point out high water consumption habits that might be changed if water conservation methods were to be employed.

1.6.1 REVIEW of WATER CONSERVATION

The literature dealing with water conservation was reviewed. Sources of information include texts and journals available through the U of M libraries and the City of Winnipeg libraries, as well as literature from the City of Winnipeg and other municipalities. CD-ROM indices and an internet database, both available through the U of M libraries were searched.

1.6.2 OTHER INSTITUTIONS' WATER CONSERVATION PRACTICES

Other institutions' and municipalities' water conservation programs were examined to determine existing and effective water conservation techniques. Water records, including cost of water and amount of water used, as well as environmental policy information, was requested of universities across Canada. Information on water conservation strategies used in the water deficient municipalities of Edmonton, Regina and Waterloo was examined. Where applicable to the U of M situation, proven water conservation practices of other institutions and municipalities are incorporated into the water conservation plan.

1.6.3 REVIEW of WATER USE - UMFGC

Water costs and current water uses were identified for specific user groups on the UMFGC. This was a necessary step before any practical water conservation strategy could either be created or implemented.

Baseline data on the UMFGC's water use, and its associated costs, was established from University and City of Winnipeg utility records. Future costs were predicted by extrapolating current trends and taking into account anticipated water rate increases and proposed changes to the city's water rate structure.

Current high water users and high water use operations have been identified. This was achieved in a variety of ways; interviews with staff at physical plant to identify heavy water users, on-site inspections, investigation of water using operations, and consultation of other institutional water investigations that identify heavy water use activities.

1.6.4 ON-SITE STUDIES

Several water using operations on campus were reviewed to see what their water conservation potential is. The three water using operations studied were: 1) groundskeeping (Appendix 4); 2) washroom fixture leakage ((their water use was either measured directly or was calculated from available data, see Appendix 5); and, 3) readings were also taken from the three metered water mains on campus to check daily variability of water use and to try to establish a base load figure of water use. Two of the meters are located in pits, one of which is prone to flooding. In keeping with Workplace Safety and Health regulations, two people and the use of a winch, rope, safety harness, and a gas "sniffer" were required to access the pits. This study was only carried out for 4 days because of the inconvenience in obtaining daily readings.

1.7 PRACTICAL APPLICATION of the STUDY

This study will result in a Practicum that will be submitted in partial fulfilment of the requirements for the degree, Masters of Natural Resource Management (University of Manitoba). It will outline practicable and cost-effective water conservation strategies that should result in improved water cost control, and will recommend action plans that can be implemented in progressive stages to reduce water use on the UMFGC.

1.8 CONCERNED PARTIES

As it is the aim of this study to produce a practical water conservation strategy for the University of Manitoba it will be necessary to take into consideration the views of concerned parties, their mandates and operational milieus. These include University of Manitoba Physical Plant, University of Manitoba water users (departments, staff and students), and the City of Winnipeg, as the water supplier.

1.9 LIMITATIONS and ASSUMPTIONS

This study is limited to the University of Manitoba's Fort Garry Campus (UMFGC). Objectives and recommendations for a water conservation strategy are particular to that campus but will likely be transferable to other institutions as well as the Bannatyne Campus.

It is assumed that all meters are accurate and the readings from them reflect actual water use on the UMFGC. It is also assumed that all records supplied by the City of Winnipeg and Physical Plant are accurate. Physical Plant records do not divide water costs between the two campuses. To arrive at water costs for the separate campuses the water bill was apportioned between the two campuses based on the percentage of water used by each campus.

Please be aware that some graphs that show similar information may be portayed with different scales so as to allow comparisons of a particular nature. Also note that some graphs deal with University of Manitoba (U of M) data and some with University of Manitoba, Fort Garry Campus, (UMFGC) data. As noted in section 1.3 the water costs for the years 1979-1981 are not included in the Physical Plant records. Water costs shown for these years are based on the amount of water used and the water rate levied by the City of Winnipeg at that time. Over 99 percent of the water used at the University of Manitoba is charged at the third block rate (see section 3.3). This rate is used as a base figure throughout the study in a variety of calculations to arrive at past, present and future water costs. Water use and costs for the fourth quarter of the 1993/94 fiscal year are estimated for the Bannatyne Campus. This means that total water use and costs for the U of M for 1993/94 are also estimates.

All costs given in sections 4.3 and 4.4 are estimates. These costs are taken from "Means Building Construction Cost Data" (1992).

1.10 ORGANIZATION

This Practicum will be organized into 4 chapters. Following the discussion of Purpose in the Introduction, the Methods used in researching the problem will be outlined (chapter 1). Chapter 2 is a review of water conservation and a look at other municipalities' and institutions' water conservation policies and practices. Current water use at the UMFGC, will be looked at in chapter 3. In Chapter 4 current campus water conservation initiatives are reviewed and a Water Conservation Plan is developed for the UMFGC. Chapter 5 will make recommendations concerning water conservation practices for the UMFGC.

1.11 CONCLUSIONS

The methods (section 1.6) help form guidelines for a review of water use and water conservation at the UMFGC. Water conservation techniques, practices and problems taken from the literature are referred to as water uses on campus are reviewed. Other institutions' and municipalities' water conservation experiences have helped to determine effective practices for the U of M, and the on-site studies have aided in showing what practical water savings can be made on campus.

CHAPTER 2 - REVIEW OF WATER CONSERVATION

This chapter gives a definition of water conservation, and identifies water conservation tools and practices as required by Objective 1.

2.1 DEFINITION

> **Conservation** - "*protection, preservation, and careful management of natural resources*".
>
> (Collins English Dictionary, 1986)

Water conservation is a collection of efforts by water users, and often water suppliers, to reduce the amounts of water used or lost. This often has the added benefit of reducing the costs associated with water use, such as water treatment (Armory, 1993). In the context of this study, water conservation means the careful management of the U of M's water uses with the view to reducing the amount of water utility charges paid to the City of Winnipeg.

2.2 WATER DEMAND - HISTORICAL VIEW

According to a United Nations' ministerial conference on water, world-wide water use is continuing to increase.

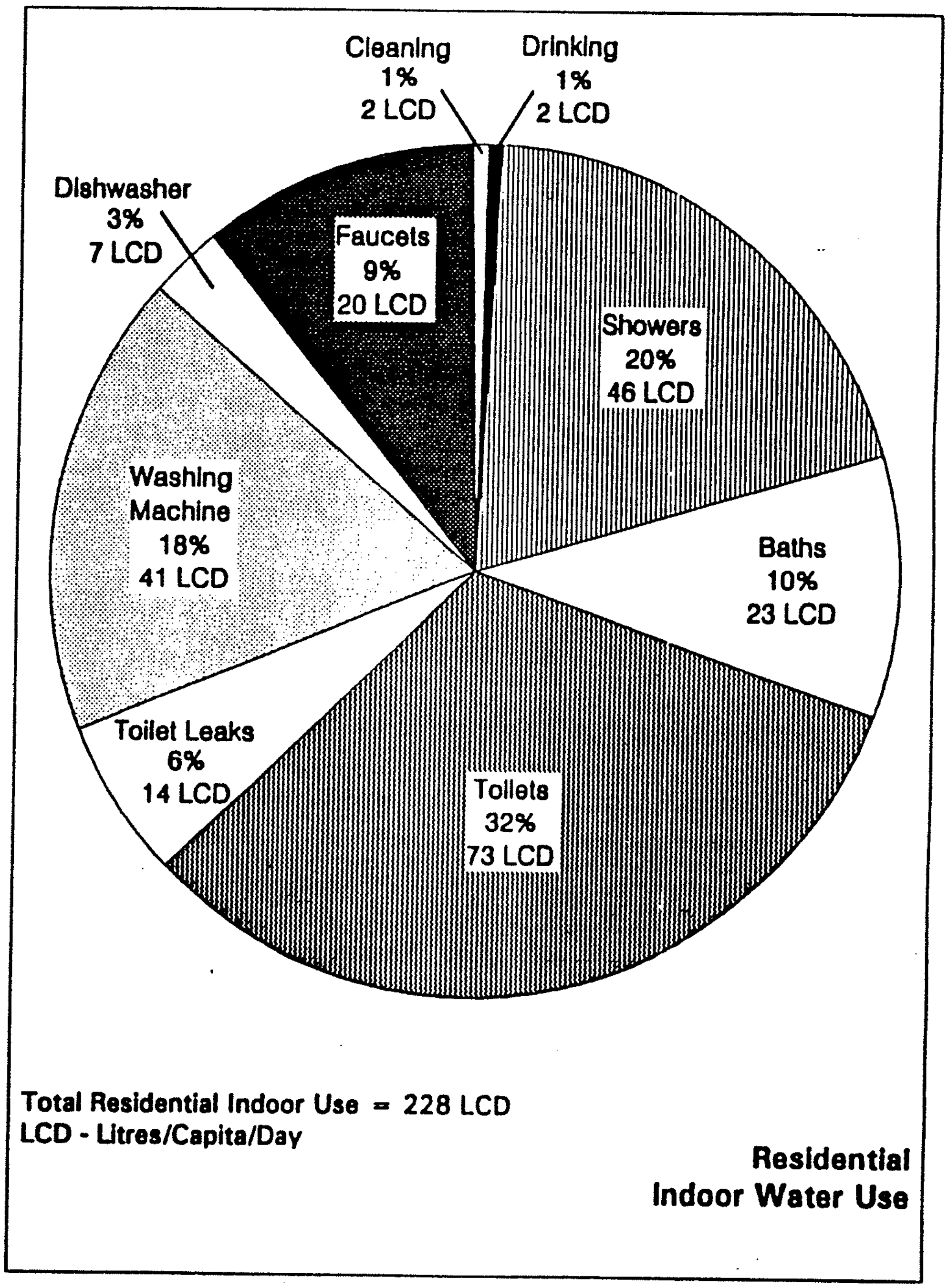
"Water demand has tripled from what it was in the 1950's, and set to double again by 2050 (world-wide)" (WInnipeg Free Press, 1994).

It is difficult to determine a consensus on what constitutes "average" water consumption in North America. Although experts disagree on exactly how much water Canadians use, they do agree that we are among the world's largest water users. Water use in Canada is divided into three sectors, agricultural (7 percent of total water used), industrial (84 percent of total water used) and residential (9 percent of total water used) Postel (1984). The U of M is considered an industrial water user, although it has elements of all three sectors. While residential water use accounts for only a small part of the total water used in Canada, it is the largest user group of municipal water. In Winnipeg residential water use accounts for 60 percent of water use (Winnipeg, 1991). Water for domestic use needs to be of high quality, must be delivered to many customers, and has to be treated afterwards. This makes for expensive municipal water supply systems (Postel, 1985).

Studies concerned only with residential water use often do not take water used in commercial or industrial endeavours into account when computing per capita water use. Residential water use figures may or may not refer to indoor uses only; they could include garden and lawn watering as well. According to Kulshreshtha (1993), Canada has the highest domestic and industrial water uses in the world (on a per capita basis) and we are the 4th highest total (domestic + industry + agriculture.) per capita water user in the world after USA, Chile, and Madagascar. Meakin (1993), puts us second after the USA with the average Canadian household using 360 litres/day, 2-3 times that of some European countries. Kreutzwiser (1991), says that Canadians may be the world's largest water users, using more than 2,000 LCD (litres of water/person /day) for all uses. Keating (1986) places Canadians as the world's second largest water users at 4,100 LCD (including industry use). He states that we average 285 LCD in home use. Thomsen (1994) gives a figure of 390 LCD (litres per capita per day) for North American water consumption. Jenkins (1993) gives a range of water consumption rates from across Canada. The lowest figure in his study is from Waterloo (409 LCD) and the highest from Toronto (786 LCD).

The average consumption in Winnipeg is 480 LCD with about 60 percent of this accounted for by residential use (288 LCD) (Winnipeg, 1991). This is very close to Kreutzwiser's (1991) figure for Canadian domestic use of water being 63 percent of total municipal water used. In Winnipeg, outdoor water use ranges from 3 to 13 percent, depending on the weather (Winnipeg, 1992a). Figure 4 shows typical residential indoor water use in the City of Winnipeg.

Figure 4 Residential Indoor Water Use



Historical water consumption patterns in Winnipeg suggest a continuing trend towards higher consumption by individuals with a long-term increase of about 1 percent/year, consistent with trends for most North American cities (Winnipeg, 1991). This increase is possibly due to increased water using appliances and larger lots requiring more summer watering. If this increase in water use continues it means that Winnipegers could be using 50 percent more water (750 LCD) by the year 2040 with no increase in population (Winnipeg, 1991). Over the last ten years residential demand has increased significantly, commercial demand has increased slightly, and industrial demand has dropped (Winnipeg, 1991). While considered an industrial/institutional water user the UMFGC is really a community composed of residential, commercial, and industrial water users.

In the past water has been considered a physical substance required by a community and not as an economic good, subject to the laws of supply and demand (Holtz and Sebastian, 1978) and water management has focused on water development to supply water wherever and in whatever amounts desired (Postel, 1985). "Water is free" with a low economic "cost incurred in its treatment, pumping, delivery and pressure, and in treatment of waste... "Higher living standards ...has resulted in ever-increasing demands for water" and water suppliers have treated claims on water as "requirements" to be met and not as "demands" to be managed (Meakin, 1993).

2.3 JUSTIFICATION and BENEFITS of WATER CONSERVATION

Both ecological and economic reasons can be made for conserving water. Ecological reasons include preservation of natural waters and their associated wildlife habitats, concerns about future supply (Foster & Sewell, 1981), and water quality degradation (El-Ashry and Gibbons, 1986). However, most arguments for water conservation are economic and include increasing scarcity of resources, inflation, high cost of new supplies, and efficient new technologies (CEA, 1992).

The two recent recessions of the early 1980's and 1990's subjected Canada to high interest rates, inflation and deteriorated economic activity that forced municipal governments to cut back and restrain spending on (among other things) waterworks infrastructure (MacLaren, 1985). As the traditional approach of large "structural measures" (El-Ashry and Gibbons, 1986) becomes increasingly challenged by fiscal realities and environmental constraints, conservation measures are seen as the alternative to more expensive open-ended enlargement of water supply facilities in meeting increasing water demand (Holtz and Sebastian, 1978); McPherson, 1978). It has been found that investments in water recycling, efficiency and conservation can increasingly yield more usable water per dollar than can conventional water supply projects (Postel, 1985).

Postel (1985), states that the supply-side management philosophy is no longer appropriate for solving today's water problems. Meakin (1993), says "water management must effect changes in demand, not supply. The environmental concerns about increased use of water have intensified during the last two decades to the point where development of new supplies is politically unfeasible, and the prospects for financing major construction are discouraging. The use of demand management alternatives represents an important aspect of water supply planning. Demand reduction programs can balance future supply and demand at a cost that is below the economic, social, and environmental costs of new supply development."

According to Hanke (1985), "Traditionally, in water supply planning, you meet demand (water requirements) by adjusting supply. This way of doing things is changing as supply limits are reached (either literally or realistically), environmental considerations are re-evaluated, inflation increases, and system expansion costs rise. An economic approach requires that benefits and costs of alternative policies be examined, including conservation."

Meakin (1993), states that "in purely economic terms, the case for municipal water conservation is strong". He points out that when we use less water not only do we not pay for what we did not use we also do not pay for treatment of the water as wastewater. For example, wastewater treatment accounts for almost 70 percent of the cost of water in Winnipeg (Winnipeg, 1994).

Other benefits of conservation include reduction of peak and base demands, resulting in reduced cost of operation and maintenance, postponement of system expansion, increased ability to conform to economic growth situations, and, conservation and improved utilization of other resources such as materials and energy (Flack, 1978). Sanders and Thurow (1982) see conservation addressing such problems such as seasonal and peak demands, as well as aiding environmental protection, energy conservation, and fiscal constraint.

2.4 CONSERVATION TOOLS

Conservation is a Demand Side Management (DSM) technique. DSM is widely used in the energy field and involves managing the demand for a resource instead of trying to increase its supply.

There are a number of water conservation "tools" that can be used to decrease demand for water. They include: water pricing, rate structure changes, metering, education, reuse/recycling, legislation, leak detection, and water saving technologies.

2.4.1 WATER PRICING

As mentioned in section 2.2 water is a free good. There is no charge for its use, only for its treatment and delivery systems. Several authors think that water should be priced as any other good in the market place (El-Ashry and Gibbons, 1986; Hanke, 1985; Mather, 1984; Sanders and Thurow, 1982). McNeill and Tate (1991), note that the "Federal Water Policy called for realistic water pricing as a central measure to encourage both water conservation and the user-pay philosophy of valuing water resources."

Kreutzwiser (1991) states that the "full economic value of water resources must be acknowledged and reflected in user charges. Efficient use and sound decisions are not achieved when water is considered a free good or supplied at a subsidized cost." With higher costs for water, reflecting its true value, consumers will use less. McNeil and Tate (1991) state that higher prices could lead to a 30-50 percent drop in demand by municipalities.

2.4.2 RATE STRUCTURE CHANGES

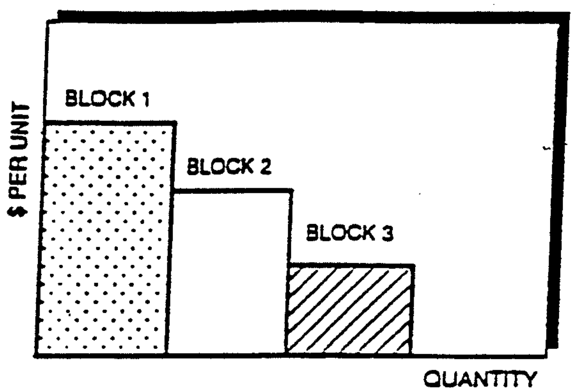
Rate structures can be a very effective water conservation tool (Winnipeg, 1992c). "Volume based rates provide signals to consumers about the amount of water they are demanding.

The linkage between resource usage, on the one hand, and economic and environmental impacts, on the other, thereby becomes visible at the individual consumer level" (Tate, 1989).

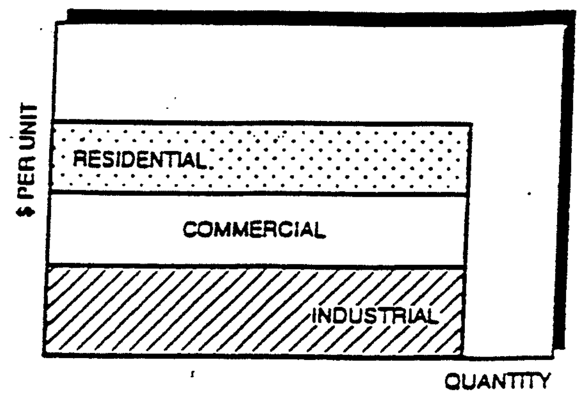
Flat rate, or constant unit charge (CUC), is a constant rate per unit of water rate structure and is the simplest of the volume based rates. U of M uses this form of rate structure for its internal water charges to departments. The current structure used by the City of Winnipeg is a declining block rate which charges a lower rate for large amounts of water used and a higher rate for smaller amounts of water used (Table 1). Flat rates and declining block rates discourage conservation of water, increase capacity requirements and result in economically inefficient use of water (McNeill and Tate, 1991). Water rate structures are shown in figure 5.

Increasing block rates can significantly lower water demands and system costs when applied to users of large amounts of water or users with highest peak flows. It is these users who have the greatest impact on a water system, since systems are built to meet the largest demands (McNeill and Tate, 1991).

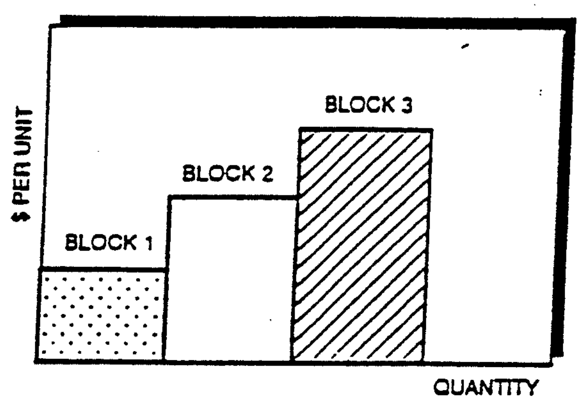
Fig. 5 Conservation Rate Structures



CURRENT RATES



UNIFORM VOLUME RATES BY CLASS



INVERTED BLOCK RATES

2.4.3 METERING

Many studies have shown that metered customers have a greater incentive to control water use than unmetered (flat rate) customers (Hanke, 1985; McNeill and Tate,1991). Metering as a conservation tool is most effective with pricing reform. Research has found that water use declines following the installation of water meters and the implementation of volume based pricing. This reflects consumer psychology as users realize they can control their water bills through their actions (McNeill and Tate, 1991). "Universal metering is required to collect reliable water-use data for any system and provides a firm basis for water-use accounting" (McPherson, 1978) and is recommended for any water conservation program (Armory, 1993; Jenkins, 1993; Mather, 1984; Pearse, *et al.* 1985).

2.4.4 EDUCATION

The effectiveness of a water conservation program depends on the level of public awareness and support of that program. Public education has been identified as the single most important technique for making water conservation successful (Postel, 1985; Sanders and Thurow, 1982). Education is essential for making other water saving techniques effective (El-Ashry and Gibbons, 1986).

A survey found that over 60 percent of Winnipegers would use less water if their bill doubled (Winnipeg, 1992c). With a total rate increase of 13 percent this year it may not be too long before Winnipegers see that doubling. It is vital that the people and institutions supplied by the City of Winnipeg be aware of how to conserve water. The Water Conservation Program carried out by the City of Winnipeg includes an aggressive public education component.

2.4.5 REUSE/RECYCLING

An economic way of making limited water supplies go further is to run the water through the water supply and treatment system several times and not use it just once. El-Ashry and Gibbons (1986) site examples from Tuscon, Arizona, and Postel (1985) from several countries, where the same water is used several times in commercial, industrial and even residential operations. Postel (1985) makes a distinction between reuse and recycling. She defines reuse as "water that once used, is collected, treated, and redistributed to a new site", whereas recycling involves "using the same water over again at the same site". Recycling can also recover valuable materials in the used water, depending on what the water was used for. Most recycled/reused water is used for cooling, irrigation or landscaping purposes.

Asano (1981) suggests using recycled wastewater for applications that are least sensitive to public health and public acceptance, i.e. agricultural irrigation and industrial cooling. McPherson (1978) states that household water use can be reduced by 25 percent if recycled greywater is used for flushing toilets and that community use can be reduced by about 10 percent.

2.4.6 LEGISLATION

Regulating water use is a powerful conservation tool usually used only when crisis conditions emerge, e.g. a drought. Restrictions on municipal water often include decreasing or banning use of water on landscapes, (Mather, 1984), or limiting the hours during which lawns can be watered. Fines and penalties for "illegal" water use may be levied and differential water rates might be imposed.

An engineering rule of thumb mentioned by Hanke (1985) is that water use will be about 85% of normal when water use restrictions are imposed. Water reduction can be significant when legislated. The community of Greenwich, Conn. cut water use by 25% during a drought in 1980 (Pringle, 1982).

Regulating water conservation by imposing by-laws is unpopular when there is no water crisis and would be politically dangerous for any civic government to do, but it might be easier for an institution to apply rigourous water conservation practices to its own internal users. However, the implementation of aggressive conservation measures is a short-term, crisis oriented, approach and is not congruent with a long-term sustainable water conservation program.

2.4.7 LEAK DETECTION

Most municipalities incur system losses on the order of 15-20 percent, much of this due to leakage (Jenkins, 1993; Winnipeg, 1992c). Investing in leak detection and repair is one of the most universally cost-effective conservation measures that can be undertaken (Postel, 1985). Waste and leakage can be better detected and reduced in metered communities (McPherson, 1978). Keating (1986) estimates that water leaks account for 5-10 percent of water use in North American homes. The City of Winnipeg's unaccounted for water typically varies between 15 and 18 percent (A.Weremy, Pers. Comm.)

McMaster University reduced water use by 20 percent after instituting a leak detection and repair program in the late 1980's. Leak detection survey and repair costs paid for themselves in one year (A.Paskevicius, Pers. Comm.).

2.4.8 LANDSCAPE MAINTENANCE

An important use of water in our dry climate is for lawn maintenance. A typical 279 m^2 lawn (3,000 sq.ft.) on a 15 X 30 m lot (50 X 100 ft.) costs approximately $200/year to water (Frank, 1994). Kentucky bluegrass is one of the most common turfs and one of the thirstiest (Loly, 1994). It requires 732 litres per m^2 per growing season (18 gal./sq.ft./growing season, or 0.18" of water/day in the summer) (Frank, 1994; Thomsen, 1994). Other common grasses for lawns in Winnipeg are varieties of fescue. Bluegrass and fescues require more water than nature provides in this environment. Kentucky bluegrass and fescues require about 890 mm (35 inches of water) per year (Ellefson, Stephens, and Welsh, 1992; Frank, 1994). Average summer precipitation is 378 mm in Winnipeg (Environment Canada, 1993) and 380 mm (10-20 inches, or 0.10"/day) in southern Manitoba (Ellefson *et al*, 1992).

The shortfall is made up from city water. The City of Winnipeg (Winnipeg, 1991) estimates that 8-27 percent of water used in Winnipeg from July to August is used outdoors, most of it for lawn watering. Thomsen (1994) maintains that the typical single family American residence uses about 341,000 litres of water/year on landscape areas. The City of Winnipeg estimates that outdoor water use ranges from 3 to 13 percent of total annual consumption (Winnipeg, 1991). This component of Winnipeg residential water use is weather dependant. As southern Manitoba is vulnerable to both short and long term droughts a lot of water may be needed to keep lawns green.

In the arid American Southwest a type of landscaping called "xeriscaping" is being used to construct drought resistant green spaces that use only the natural amount of precipitation that falls in the area. "Xeriscaping (derived from the greek word xeros meaning "dry") a term applied to techniques that reduce the water required to maintain gardens...(it) stresses the establishment of landscapes adapted to the arid environments around them, rather than trying to transplant and maintain water-consumptive landscapes..." (O'Keefe, 1992).
O'Keefe (1992) states that "quality, water-efficient landscaping" can result in an estimated 20-80 percent savings in landscape water usage and that "in most parts of the country (USA) it's quite possible to reduce or completely eliminate the need for added water above natural precipitation." Quoting from a study carried out in Tuscon, Arizona in 1990, Thomsen (1994) says that consumption of water was 54-75 percent less in a xeriscape than in a traditionally designed landscape. Loly (1994) states that water-efficient landscape management, i.e. xeriscaping, can result in an estimated 20 percent saving in landscape water use.

Xeriscaping practices (from O'Keefe, 1992) include:

- -reducing the areas devoted to lawns
- -planting water-conserving plants
- -using the water holding capacity of soils
- -using micro-irrigation/drip irrigation systems that most efficiently meet the plants needs
- -using mulches to cover soil
- -extensive use of hardscapes (decks and walkways)

One of the tenets of xeriscaping is the use appropriate irrigation techniques. As mentioned above, micro-irrigation/drip irrigation systems are used to efficiently meet the plants water needs. Irrigation uses less water than overhead (sprinkler) watering. The disadvantages of overhead watering are that it:

- -can result in a loss of 30-50 percent water to runoff and evaporation
- -usually uses about 45% more water in order to deeply water landscape plants
- -may wash topsoil away (on hilly areas)
- -is time consuming
- -may promote fungal diseases by creating too moist an environment.

(O'Keefe, 1992; Thomsen, 1994).

Other advantages to xeriscaping, besides lower water costs, include easier and less expensive maintenance as the lawn/grounds require less water, mowing and fertilizer (Loly, 1994). With xeriscaped grounds the peculiar cycle of watering grass to make it grow so that it can be cut, and then watered to make it grow again, is broken. Lawn maintenance at the U of M could also be simplified, or at least made less expensive, by returning to the former method of lawn maintenance used on the Fort Garry Campus between 1927-1952. Sheep, from the agricultural college, were allowed to graze on the grounds. This practice was discontinued after complaints about flowers being eaten were received from the Botany department (Thomsen, 1994).

2.4.9 TECHNOLOGICAL FIXES - WATER EFFICIENT DEVICES

There are many water conserving devices available on the market. Older homes or buildings may be retrofitted with aerators, flow restrictors, and toilet dams. Newer structures can be built with the latest in water saving, low-flush toilets and shower heads. Newer water using appliances are energy and water efficient. Water saving devices could save 1/3 of in-house water use (not including outside uses such as lawn watering and car washing) (McPherson, 1978).

The installation of water conserving devices helps make water conservation as automatic as possible and is simpler than changing behaviour and maintaining new habits (Buzelli *et al*, 1991; Sanders and Thurow, 1982). The payback period of installing residential water conserving equipment can be anywhere from a few months to 4 years (Postel, 1984).

According to Flack (1978) water conservation techniques can save from 32 to 70 percent of water used in a residential setting. Buzelli *et al*, (1991) state that up to 42 percent of residential water used can be saved by using water-efficient toilets and another 10 percent saved by using a low-flow shower head

Seventy-five percent of water used in the home is used in the bathroom (Buzelli *et al*, 1991) with the largest single water user being the toilet. It uses between 32 and 41 percent of indoor water used according to Sanders and Thurow (1982), and Winnipeg (1992a), while MacPherson (1978) and Keating (1986) assert that toilet use is 50% of residential water use. The toilet uses approximately 34,000 litres of water to remove 625 litres of waste in one year (Pringle, 1982).

Jenkins (1993) notes that retrofit programs that rely on the homeowner to install devices have only a small reduction in total water demand (5.3 percent for Waterloo and 4.6 percent for Edmonton). Variablilty in water use reduction could be due to several factors: improper installation, incomplete installation, or, the homeowner may opt not to install the retrofit kit at all. If carried out properly, high water savings like those mentioned by Flack (1978), and Buzelli *et al* (1991), may be realized through retrofitting. The Regional Municipality of Waterloo has decided to replace inefficient fixtures with water saving ones, rather than continue to retrofit. Waterloo authorities believe that the one-time, proper installation of water-efficient fixtures will save more water than the retrofitting of old fixtures (Jenkins, 1993). As with the retrofit program, homeowners have the option of joining the program. Costs are shared 50/50 between the homeowner and the Municipality.

2.5 WATER CONSERVATION PRACTICES and POLICIES in OTHER INSTITUTIONS

There are many water conservation practices and policies in use today that could be adopted by the U of M for its own water conservation plan. Conservation information from the U of M's supplier, the City of Winnipeg, is readily available. Information about water conservation programs in three water deficient municipalities (Edmonton, Regina and Waterloo) was requested. The Edmonton and Regina water conservation authorities sent information by mail. The Waterloo authority referred the researcher to a report already received from Edmonton.

2.5.1 MUNICIPAL ACTIONS

2.5.1.1 City of Winnipeg:

The City of Winnipeg's water conservation program is aimed at all water users; residential, commercial and industrial. A goal of 5 percent reduction in projected demand has been set. This would defer the need for new water supplies until 2002 (Winnipeg, 1992b). The Department of Waterworks, Waste and Disposal has instituted a water education program using billboards, newspaper ads, brochures and TV and radio commercials. The campaign uses the slogan *"Conserve Water. The Meter's Running!"* and encourages water users to consider the fact that they pay the water bills and that saving water is saving money. A pamphlet listing water saving tips is available (Appendix 3).

The City's Water Conservation Report (Winnipeg. 1992a) suggests several methods for encouraging water conservation. Among them are: increasing water rates, public education, and introducing new plumbing codes. Table 2 outlines the methods considered in the conservation report. The Winnipeg water rate structure is under review and a recommendation to adopt uniform rates by customer class is under review (S.Martinson, Pers. Comm.). A 13 percent increase in water rates took effect in 1994.

A pilot project to review the cost effectiveness of a leak repair program is underway, and a review of "green space"

USER GROUP		WATER EFFICIENCY METHODS								Outdoor Use		
		Public Educ.	Leak Repair	Toilet Dams/ Low flow toilets	Low-flow Shower Head	Faucet Aerator	Water Audits	Plumbing Codes	Efficient Washers (Dish/ clothes)	Odd/even Watering	Low Water use Landscape	Summer Surcharge
RESIDENTIAL	Single-Family Residential	●	●	●	●	●	◒	○	◒	●	●	●
	Multi-Family Residential	●	●	●	●	●	●	○	●	◒	◒	◒
COMMERCIAL	Office Bldgs. -City Offices	◒	●	●	○	◒	●	○	○	◒	◒	○
	-others	●	●	●	○	◒	●	○	○	◒	◒	○
	Retail/Wholesale sales											
	- Small users	●	●	◒	○	◒	◒	○	○	○	○	○
	- Large Users*	◒	◒	◒	○	◒	●	○	○	○	○	○
	Hotel	◒	●	●	●	●	●	○	●	○	○	○
	Restaurant	◒	◒	◒	○	◒	◒	○	●	○	○	○
	Institutional											
	Hospitals	◒	◒	◒	◒	◒	●	○	●	◒	◒	○
	Schools/Day cares	●	●	●	◒	◒	●	○	○	◒	◒	○
	Universities	●	●	◒	◒	◒	●	○	◒	◒	◒	◒
	Personal Care Facilities	◒	◒	◒	◒	◒	●	○	●	◒	◒	○
	Curling Clubs/Arenas	◒	◒	○	◒	○	◒	○	○	○	○	○
	Misc. (Churches,others)	◒	◒	◒	○	○	◒	○	○	◒	◒	○
INDUSTRIAL	Small Users	◒	◒	◒	○	◒	●	○	○	○	○	◒
	Large Users**	○	◒	○	○	○	●	○	○	○	○	◒
GREENSPACE	Boulevards	○	○	○	○	○	◒	○	○	●	●	●
	Parks	○	○	○	○	○	◒	○	○	●	●	●
NEW SERVICES	Residences	○	○	●	●	●	○	●	◒	○	●	●
	Comm./Indust.	○	○	◒	○	◒	○	●	●	○	◒	○

* Auto dealers, Laundromats, Dry cleaners, Dept. stores, Supermarkets. (Consumption > 2million Litres/Year)

** (Consumption > 2million Litres/Year)

● Very beneficial
◒ Beneficial
○ Little of no benefit

Benefits of Water Efficiency Methods by User Groups

irrigation practices has been proposed (Jenkins, 1993). A pilot retrofit project involving 4,000 single family homes, an apartment building, and several offices and commercial buildings was undertaken in 1992 and 1993 (Jenkins, 1993). In 1994 the City of Winnipeg will implement the first stages of a Multi-family Retrofit Program (A.Weremy, Pers. Comm.).

2.5.1.2 City of Edmonton:

Edmonton is undertaking aggressive water conservation activities to defer a $150 million water supply system expansion. It has started a Water Conservation Advisory Committee to review conservation options and has instituted a public information program. The campaign logo and theme is *"Saving Water Makes Cents"*. The city is reviewing water conservation programs from across Canada and is also reviewing its rate structure and charges.

The City is also carrying out shared-cost audits of large commercial and industrial users and has carried out a retrofit pilot project of 4,000 homes. The City of Edmonton is a 100 percent metered municipality.

2.5.1.3 City of Regina:

Regina's early water conservation program focussed mainly on customer awareness of water conservation options (Jenkins, 1993). It is now attempting to educate commercial customers, outlining potential conservation benefits. Water efficient devices are identified with a logo.

Water conservation information is mailed to every residential customer with every utility bill, and information workshops are presented at community meetings. Guidelines for lawn watering are given, and 20 low water use landscaping seminars (xeriscaping) were scheduled for 1993.

2.5.1.4 Regional Municipality of Waterloo:

The Waterloo region started a water conservation program in 1987 to ensure that adequate supplies were available for future area growth (Jenkins, 1993). A rebate program was started to promote the installation of water efficient fixtures in new dwellings.

A water efficient fixture installation pilot project in the Kitchener area appears to reduce water use by 20-30 percent. A water conservation curriculum was developed for the public and separate school systems. Replacement of automatic with manual flush urinals in schools resulted in a savings of $185,000. Community education is carried out by means of radio and TV ads, booth displays in malls and through a semi-annual regional newsletter. An industrial newsletter carries articles on conservation. In 1990 the region adopted a by-law outlawing the use of water for once-through cooling of process equipment.

A number of outside water use restrictions, governing lawn watering, car washing, etc., are in effect throughout the region.

2.5.2 OTHER UNIVERSITIES' ACTIONS

Twenty-five universities across Canada were contacted by mail and were requested to send the researcher copies of their environmental policies, water conservation programs/practices, and to note the amount of water used on their campuses and its cost. Eleven universities replied to the request (Table 3). Replies ranged in detail from that of Memorial University whose reply consisted of one line: *"At the present time, water consumption is neither metered nor do we pay for same."*, to that of the University of Waterloo, which supplied detailed monthly water use accounts accompanied by graphs. Five of the universities contacted asked to be informed of the results arising from this study.

2.6 CONCLUSIONS

According to Hanke (1985) "water conservation is the major policy that is currently being debated by water utilities throughout the world." It is seen as a solution to today's municipal utilities financial problems. The City of Winnipeg states that conservation is the lowest cost component in demand modification and that residential water use presents the greatest opportunity for moderation of water demand (Winnipeg, 1991a).

Table 3

Canadian Universities' Water Conservation Practices

UNIVERSITY	ENVIRONMENTAL POLICY	ENVIRONMENTAL GUIDELINES	WATER CONSERVATION POLICY	WATER CONSERVATION GUIDELINES	WATER (m3)	COST	UNIT COST $/m3	CONCERN?	OTHER/COMMENTS
MEMORIAL	NS	NS	NONE	NONE	NA	NA	0	NO	Consumption is not metered No cost for university water
ACADIA	NS	NS	Re:Energy	NA	192546.14	$129,366.83	0.672	YES	Low-flow shower heads installed to reduce energy costs. Interested in reducing water costs. Each building is metered as part of a leak detection program, and to ID high users.
NEW BRUNSWICK	NS	NS	NONE	NONE	417385	$343,915	0.824	YES	Rely on University population to be aware of related environmental concerns.
MCMASTER	NS	NS	Re:Energy	NA	834955	$534,046.56	0.674	YES	Water use addressed as part of the global energy management plan. Low-flow shower heads installed. Washbasin aerators installed. Ultrasound leak detector purchased. Campus community awareness program. Energy mgt. has helped reduce water use. Low-flow flushing devices for urinals and toilets not implemented due to cost. Univ. monitors all chemical compounds discharged to sewers.
WATERLOO	NS	NS	YES		757910	$1,038,016.20	1.38	YES	Water conservation conforms to regional policies and by-laws.
WESTERN	NS	NS	YES		1033834	$417,941	0.404	YES	Cost avoidance is measured Low-flow shower heads installed in residences. Automatic urinal flush devices replaced with manual ones. River water used for lawn irrigation. Elimination of a large number of water-cooled air conditioning units. New buildings/systems take water conservation into account. Five water conserving projects on Deferred Maintenance list, awaiting funding.
MANITOBA UMFGC	DRAFT		NONE	NONE	1024181.2 859149.9	$1,067,350 $895,363	1.042 1.042	YES	(see p.51, Chapter 4, section 4.2)
WINNIPEG	NONE	NONE	NONE	NONE	57994	$68,073	1.174	YES	Common sense use. Don't waste it.
BRANDON	NONE	NONE	NONE	NONE	80000	$60,000	0.75	YES	
REGINA	NS	NS	YES		249454	$322,433.19	1.292	YES	Rebate received for evaporation from cooling towers. % reduction to sewer charge in summer months for irrigation water. Retrofitting of existing toilets. New toilets specified as water saver type. Existing urinals converted to flush valves. Existing flush valves (toilets & urinals) adjusted to min. volume. All shower heads retrofitted with restrictors, now low-flow. All faucets fitted with aerators.
ALBERTA	NONE	NONE	YES		2494593	$2,596,625	1.041	YES	All buildings metered. Work with City of Edmonton Water Conservation Committee. Use low-flush equipment and water conserving devices where possible. Use of once-through cooling water curtailed. Use of timers to control flushing of urinals. Review lawn watering. Periodical procedures review.
CALGARY	DRAFT		NONE	Re:Energy	948623	$569,878.66	0.601	YES	Policy being formulated with Physical Plant. Priority for conservation projects with a payback in < 2 years. Analyzing infra-red sensors to control flushing of urinals. River water used for lawn irrigation. River water used for central cooling equipment chillers.

NS = NOT STATED NA = NOT APPLICABLE

"Successful efforts to curb per capita demand invariably include some combination of water saving technologies, economic incentives and consumer education. These measures are mutually enforcing and they are most effective when implemented together" (Postel, 1985). While technological or structural responses have traditionally been favoured to answer water needs, Kreutzwiser (1991) believes that behavioural and other nonstructural (e.g. regulations, managing demand) adjustments warrant much greater attention. Lee (1972) cautions that water requirement forecasting must take into account political and social changes as well as technological changes and economic growth. He thinks the former are the most significantly dynamic variables.
Postel (1985) notes that "conservation requires creativity; there is no ready-made package that will prove effective and economical for every community." Each water user must decide for themselves how best to reduce their water demands and costs.

Based on the information presented above and in the preceding chapters, water conservation strategies to be implemented at the U of M must be adaptable to the university's particular circumstances. They should be based on the U of M's current and future water requirements, be within budget constraints, be equitable and efficient, make use of as many conservation tools as possible, be easily implemented, have a reasonable payback time, and be sustainable.

To determine the best water conserving strategies that can be carried out at the U of M, a Water Conservation Plan is needed. The Plan will outline water conservation goals, be a reference source for a future campus water audit, and discuss methods of involving faculty, staff and students in its implementation. In the following chapter water use at the U of M will be looked at with the view to understanding how much water is used, and how, where and by whom it is used.

CHAPTER 3 - REVIEW OF WATER USE AT THE UNIVERSITY OF MANITOBA - FORT GARRY CAMPUS

In keeping with Objective 2, this chapter reviews the U of M's water supply system and analyzes current water uses at the U of M, Fort Garry Campus. Water user groups are identified, and current water requirements and rates are used as a basis for predicting a future water use scenario.

3.1 WATER - JURISDICTION

According to Pearse *et al* (1985) the provinces of Canada have the greatest amount of control over water resources as stated in The Constitution Act, 1867 {s.92, 92A}. Manitoba assigns various departments or crown corporations the responsibility of managing different aspects of water resources (Bellinger, 1975). For example, fish and wildlife habitat protection, as well as the issuing of licences for municipal use, and some aspects of recreational use are all overseen by different branches of the Department of Natural Resources. Hydro-electric power generation comes under the authority of the Department of Energy and Mines and the Manitoba Hydro Corporation. It is the province that grants the City of Winnipeg the licence to draw water for municipal uses. Municipal governments are primarily concerned with maintaining adequate supplies at reasonable rates to their customers.

The federal government, under the authority of the Canada Water Act (1970, (s.26)) initiated a water policy study in 1984. The final report, submitted a year later, concluded that present federal water policies were inadequate to deal with the changing economic, environmental, and social demands on Canada's water resources and that new policies involving provincial governments (who are largely responsible for water use within their provincial boundaries) be created to help deal with the problems of water resource allocation (Pearse *et al*, 1985). Pearse *et al* (1985) note that, traditionally, water management in Canada has meant managing supplies. However, the policy of simply increasing supply to meet demand is being questioned on both economical and environmental grounds. First, the cost of providing additional supplies for a variety of users (agricultural, industrial and residential) rises when the infrastructure is expanded and delivery systems are extended. This may be seen in future if the the City of Winnipeg's demand for water requires expansion and of the water supply system at a cost of $400 million (Winnipeg, 1992b). Second, increasing supplies disrupts, and may even deplete, natural water systems.

3.2 UNIVERSITY of MANITOBA'S WATER SUPPLY

The U of M is located within Winnipeg's city limits and consists of two campuses, the Fort Garry Campus, located in the south end of the city off Pembina Highway, and the Bannatyne Campus, located downtown adjacent to the Health Sciences Centre, Winnipeg's second largest water user, Winnipeg (1992b). The University occupies 407,200 m^2 of assignable and non-assignable space (U of M, 1992a). The Fort Garry Campus takes up an area of 2.74 km^2 (U of M, 1992a). Green space, not including agricultural fields but including walkways, covers 303,514 m^2 (D.Kohut, Pers. Comm.). The U of M is the 11^{th} largest employer in the province of Manitoba with 3,292.6 full-time equivalent (FTE) academic and support staff (UM, 1993a). As mentioned in Chapter 1, the UMFGC is the third largest community in Manitoba with a year-round total population of about 28,000.

The University of Manitoba's supply of water and treatment of wastewater are handled by the City of Winnipeg's Waterworks, Waste and Disposal Department. The University of Manitoba (like all other city water users) is charged for water and sewer services on a quarterly basis. The University of Manitoba water bills cover the cost of services, i.e., supply and treatment of water before and after use. Water is a free good and there is no cost for the water itself.

City of Winnipeg water is withdrawn from Shoal Lake, located 190 km SE of Winnipeg, and is carried by an aqueduct to the city reservoirs (Figure 6). Water is then pumped from the reservoirs through the distribution system. The University of Manitoba

receives city water from three metered water mains (Figure 7). Meters can be accessed at: 1) the West Gate by Pembina Highway, 2) west of St. Andrews College, off Dysart Road and, 3) on the boulevard of Freedman Cres., south of the obelisk. It is from these three meters that the city determines how much water has been used by the U of M. The City then charges the University a set rate for every 100 cubic feet (100 Cu.Ft., or CCF) it uses (Table 1), plus a quarterly charge based on meter size.

3.3 WATER RATE STRUCTURE

The City of Winnipeg currently uses a Declining Block Rate structure. This rate structure is widely used by water utilities and recognizes economies of scale inherent in providing a large volume of water to a given user class but does not support water conservation (Winnipeg, 1992c). The first block covers the first 9,600 Cu.Ft. of water used. The user is charged $1.55/100 Cu.Ft. The second block is from 9,601 to 96,000 Cu.Ft. and the user is charged $1.23/100

Fig. 6 City of Winnipeg Water Supply System

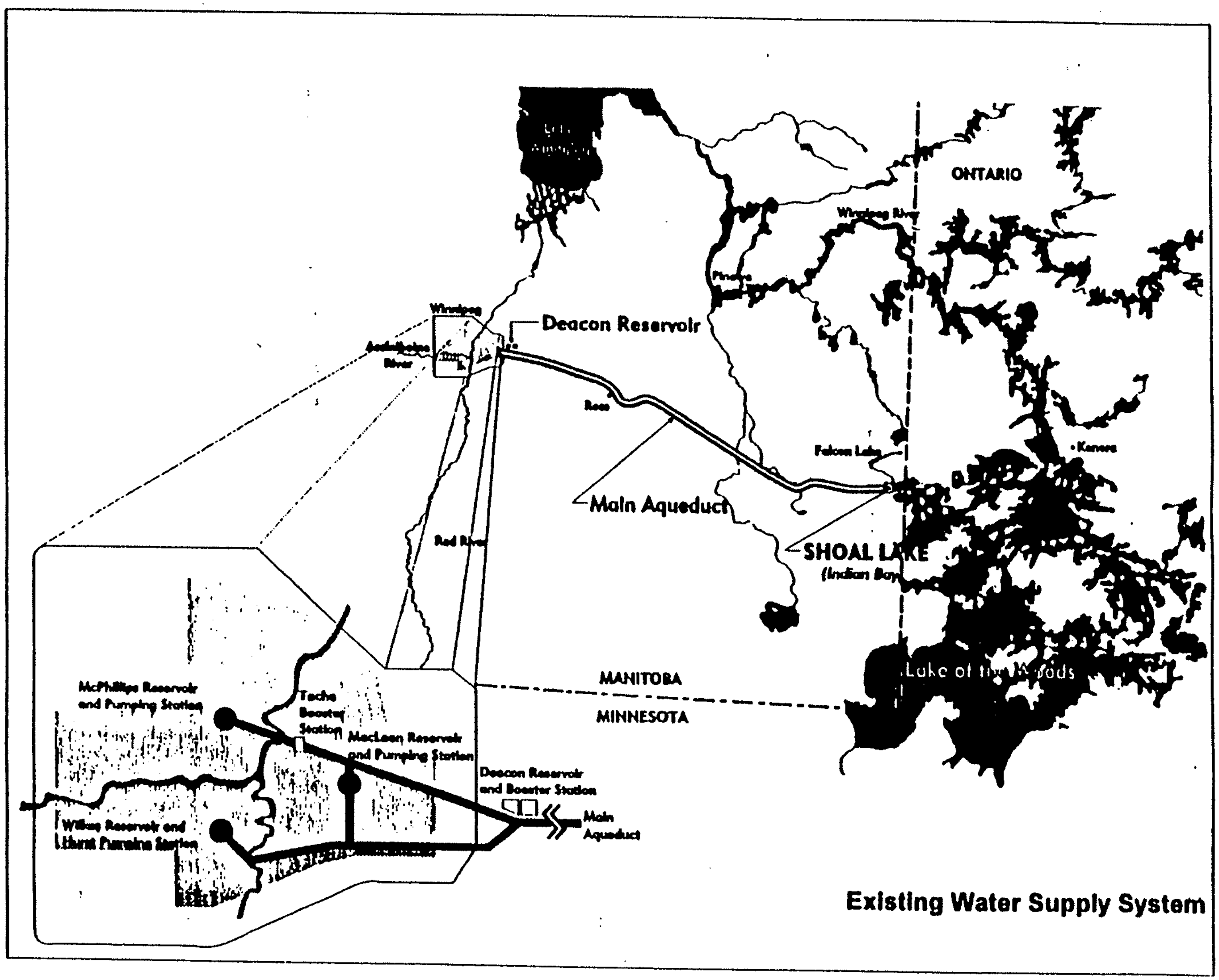
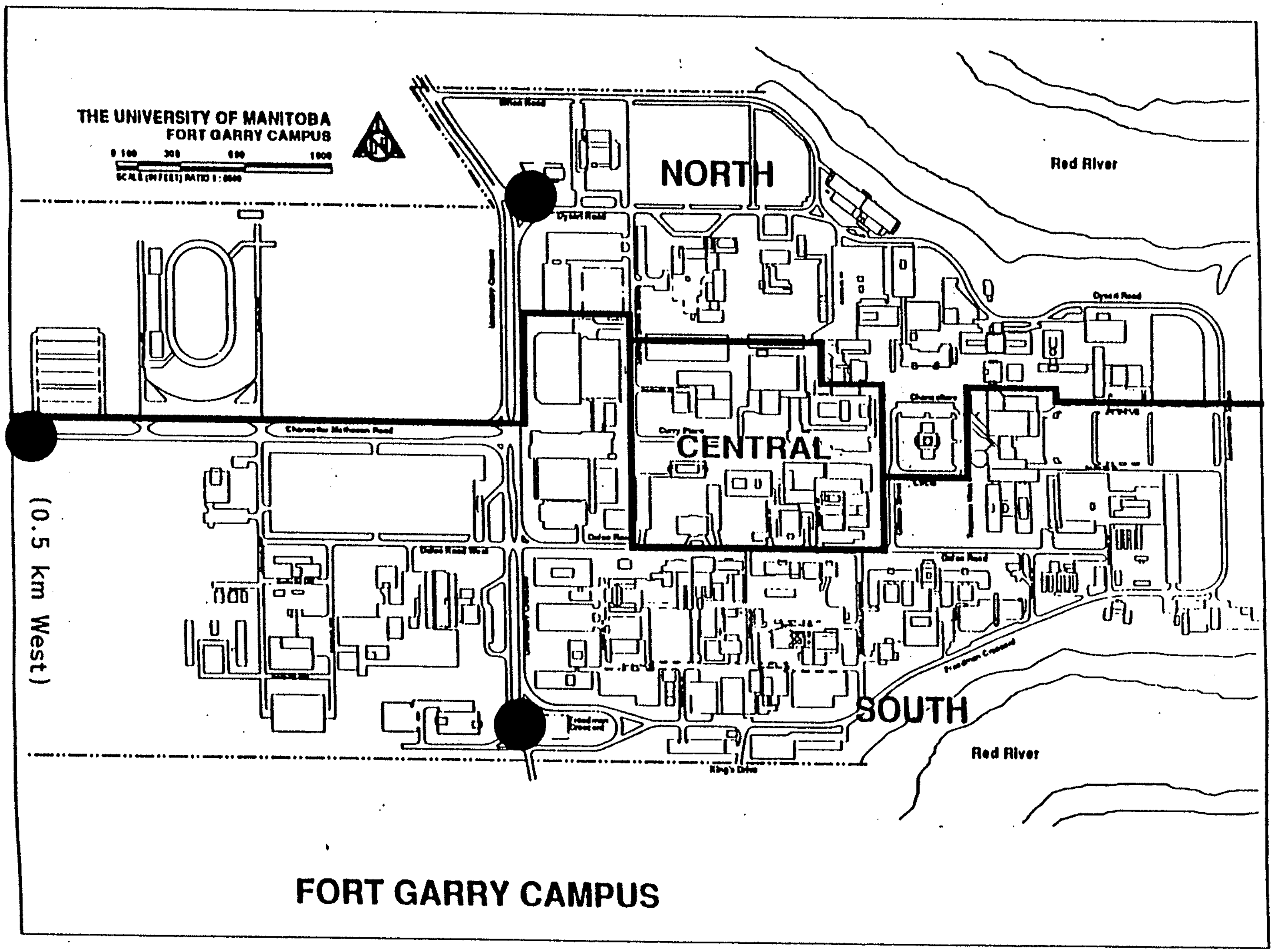


Fig. 7 Location of Metered Water Mains



Cu.Ft. of water used. The third and last block covers any water use over 96,000 Cu.Ft. and the user is charged $0.90/100 Cu.Ft. (1994 City of Winnipeg water rates). The City also imposes a sewer charge of $2.05/100 Cu.Ft. on all users (Table 1). This charge covers wastewater treatment costs. The City of Winnipeg is currently reviewing its rate structure (Winnipeg, 1992c) and may adopt a Uniform Volume Rate (by class) structure (S.Martinsen, City of Winnipeg, Pers. Comm.) (see Figure 1). "A uniform volume rate structure is one in which the same price is charged for every unit consumed, regardless of total consumption levels" (Winnipeg, 1992c). There is no volume discount. Each customer class is charged a different rate. "The difference between uniform volume rates by customer class and declining block rates is that a uniform rate structure charges the same price for every unit of water consumed, without regard for the total amount. The unit price charged is determined by membership in a customer class, rather than by volume of use" (Winnipeg, 1992c).

Due to the lack of volume discount the uniform rate structure is considered to provide some incentive for year-round conservation because customers can minimize their total bill by avoiding excessive use (Winnipeg, 1992c). Municipal water rates are revenue neutral, that is they are set to recover costs incurred in providing the service and are not meant to generate profit (Fortin, 1985).

For internal accounting purposes the University of Manitoba, through the Physical Plant, charges departments for their water use. University departments are billed at a rate slightly higher than the City of Winnipeg rates. This is done to recover costs incurred by the University of Manitoba Physical Plant in providing services. Only approximately 22 percent of the water used on the Fort Garry campus can be accounted for by internal billing as the majority of structures on campus (77 percent) are not metered.

3.4 WATER USE at the UMFGC

In 1993 the UMFGC used slightly over 850,000 m^3 of city water at a cost of about $795,000. Water use at the University of Manitoba in 1992 was 97.6 LCD, close to the commercial water use figure for Winnipeg of 91 LCD (Table 4). Water use at the UMFGC in 1992 was 85 LCD (Table 4). Figure 8 shows the amount of water used by the U of M for the last several years and its cost. Figure 3 shows the amount of water used by the UMFGC and its cost. There is great variation in water use from year-to-year. It can also be seen from Figure 3 that the unit cost of water for the UMFGC is increasing over time. Figure 9 shows the amounts of water used on the university's two campuses (Fort Garry Campus (FGC) and the Bannatyne (Medical) Campus (BTN)).

Table 4

WATER CONSUMPTION BY USER GROUPS
City of Winnipeg & University of Manitoba

USER GROUP	1989 DEMAND		1992 DEMAND	
	LCD	%	LCD	%
Industrial	49	13	??	?
Commercial	91	24	??	?
Residential	242	63	288	60
TOTAL	382	100	480	100
UMFGC			85.0	83
UMBTN			328.2	17
UM TOTAL			97.6	100

LCD = litres/capita/day

UMFGC = University of Manitoba - Fort Garry Campus

UMBTN = University of Manitoba - Bannatyne (Medical) Campus

Fig. 8 UNIVERSITY WATER USAGE & COSTS
(Data Source: Physical Plant Records)

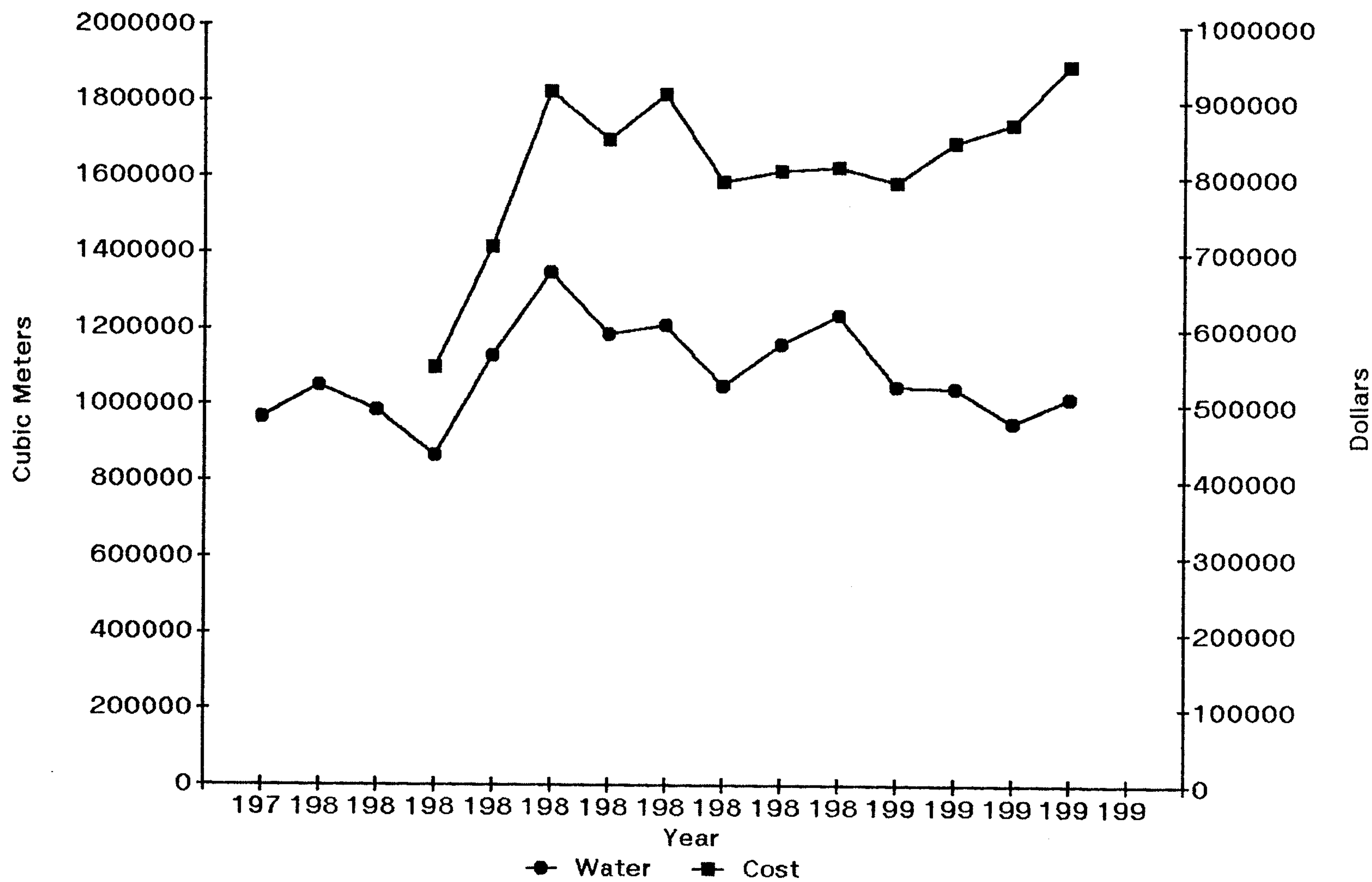
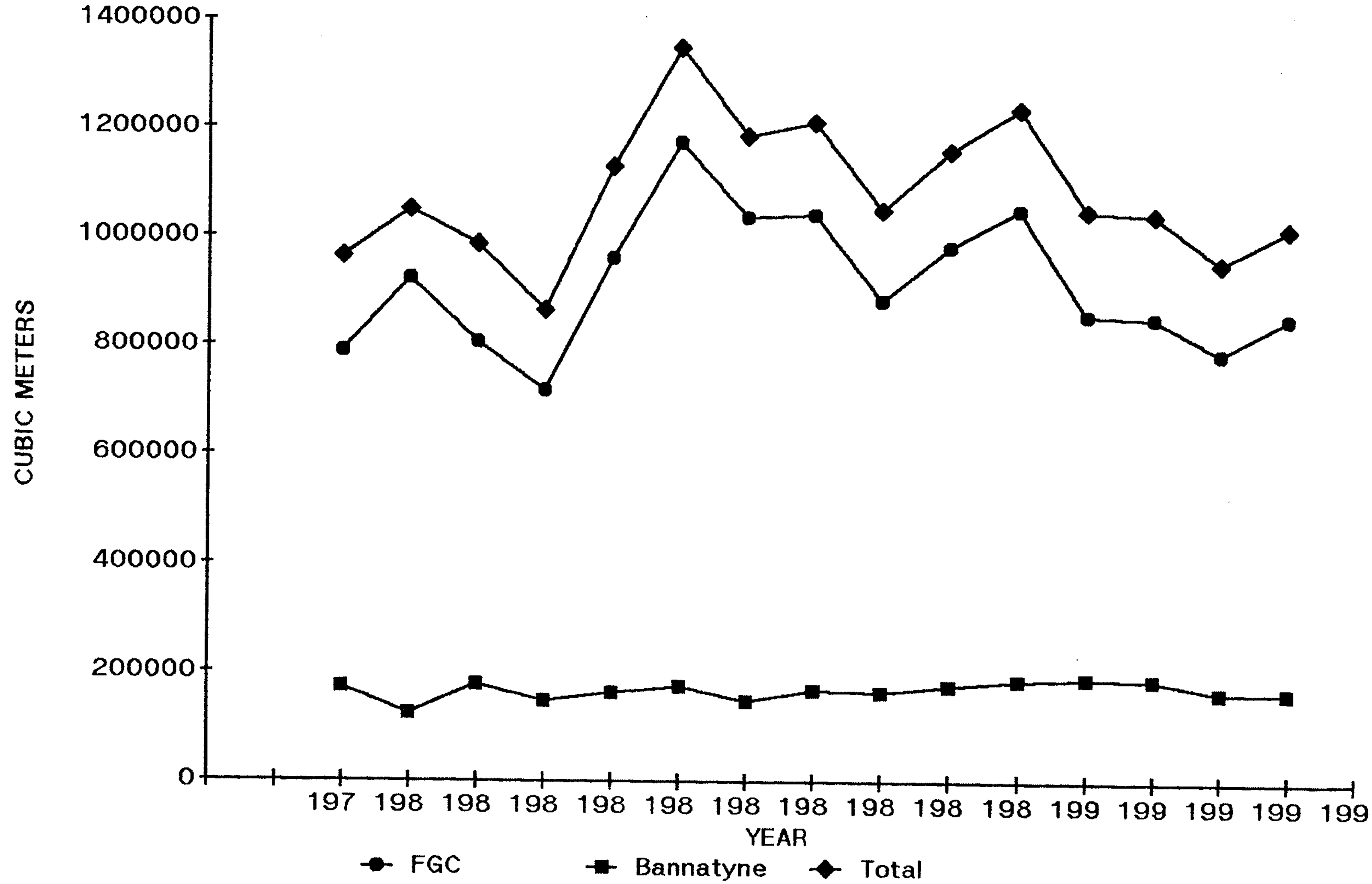


Figure 9 UM WATER USAGE

Fort Garry and Bannatyne Campuses



From this graph it can be seen that the variation in year-to-year water use is reflective of Fort Garry campus water use habits.

There are several possible explanations for the great variability in water use over the years. It may: reflect changes in the university population (see Population and Water Use, below); be a result of increasing/decreasing facility space. (Increases in work area mean larger volumes to heat and cool, as well as more water lines and water using fixtures (water fountains, washrooms, etc...) (see Space and Water Use, below); be seasonal/weather dependant, e.g. hotter, dry summers would mean more water is used for groundskeeping (see Seasonal Water Use, below); or might be due to Other Factors (see below).

As mentioned in the Methods section. an attempt was made to monitor daily water use. The meters (Figure 7) were read during the September long-weekend when there were few students or staff at the UMFGC. Readings taken during a low use period give an approximate "base load" figure for campus water use of 227,000 m^3 or 26 percent of yearly water use (Table 5).

Table 5 Daily Water Use UMFGC - Approximate Base Load

DATE	WEST METER *	SOUTH METER **	NORTH METER **
Sept.2	--	--	--
Sept.3	182	403	260
Sept.4	136	428	290
Sept.5	177	306	200
Sept.6	173	305	200
Meter Totals	668	1442	950

Total of all meters = 2760 Cubic Meters

Daily average = 2760/4 = 690 Cubic Meters

690 X 395 = 251,850 Cubic Meters/Year
or, 29% of UMFGC use.
(Total UMFGC use = 859150 Cubic Meters in 1993/94)

Measured between 12:50 and 1:14 pm each day

* Meter read in gallons X 1000 - converted to Cubic Meters.
** Meter read in kilolitres - converted to Cubic Meters.

3.4.1 POPULATION and WATER USE

Almost 1,300 students make their home in the universities' five residences and over 20,000 people "work" on campus for up to 8 hours a day. All the residential uses of water, - showers, toilets, drinking fountains, etc... - occur at the U of M. In 1992 water use at the UMFGC was 85 LCD, notably less than the 15 year (1979-1993) average of 107 LCD.
Figure 10 shows UMFGC student and staff populations (FTE), and water use plotted over 14 years, from 1979 to 1992. There is no observable positive correlation between student numbers and water use from 1979-1982, or from 1989-1992. However, there is a slight but noticeable positive correlation during the 1982-1989 period. A proportional relationship between student population and water use would logically be expected. Why it is not observed across the entire time span is not known, but it suggests that it is not just the size of the university population, or its changes in size over time, that affects water use.

3.4.2 SPACE and WATER USE

There does not appear to be any positive correlation between changes in facility space and water use at the UMFGC (Figure 11). Over the 13 year time span shown, facility space has increased by 9 percent and water use, while varying widely

Fig. 10 UMFGC POPULATION & WATER USE

(Source: University Records)

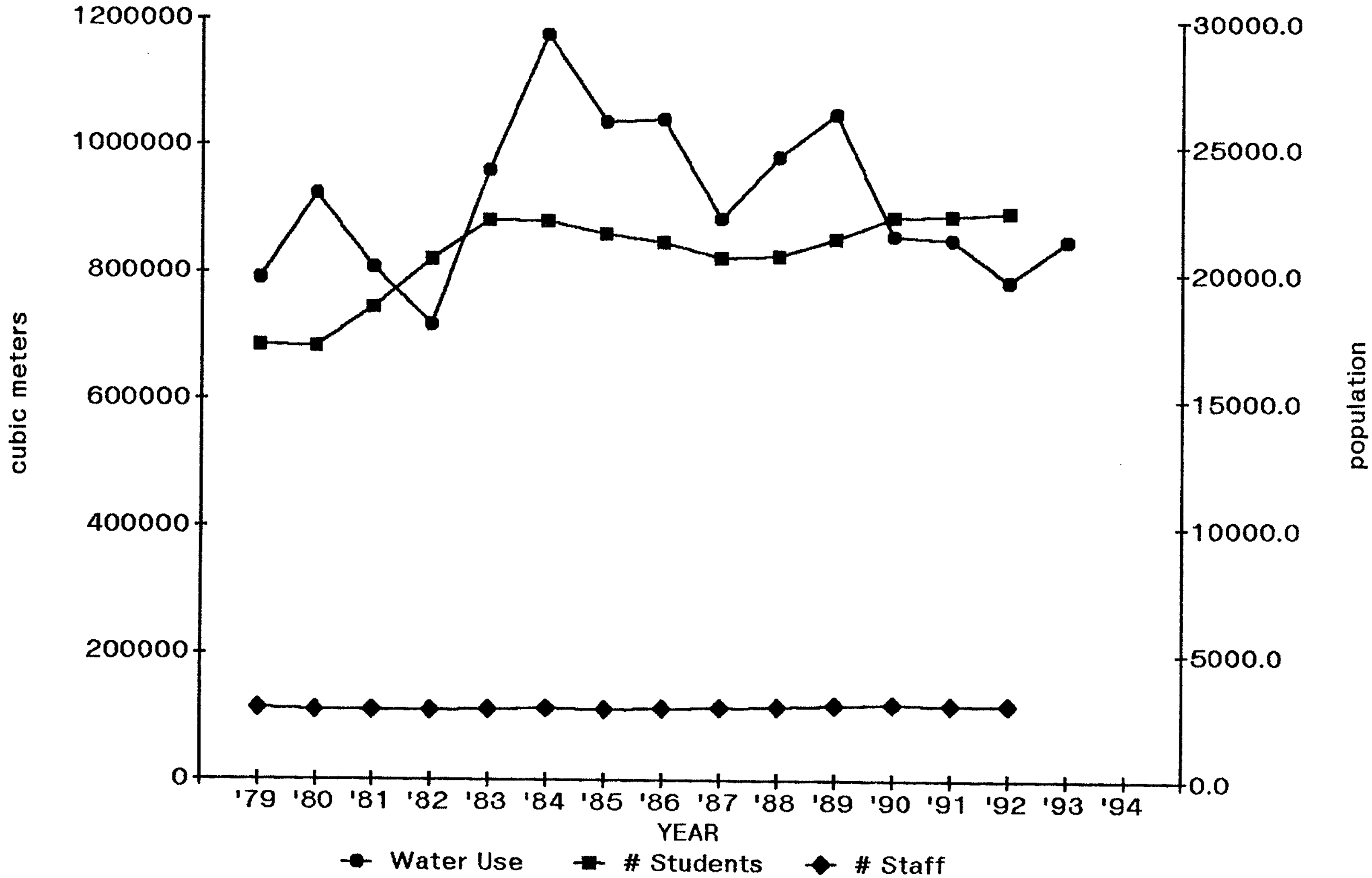
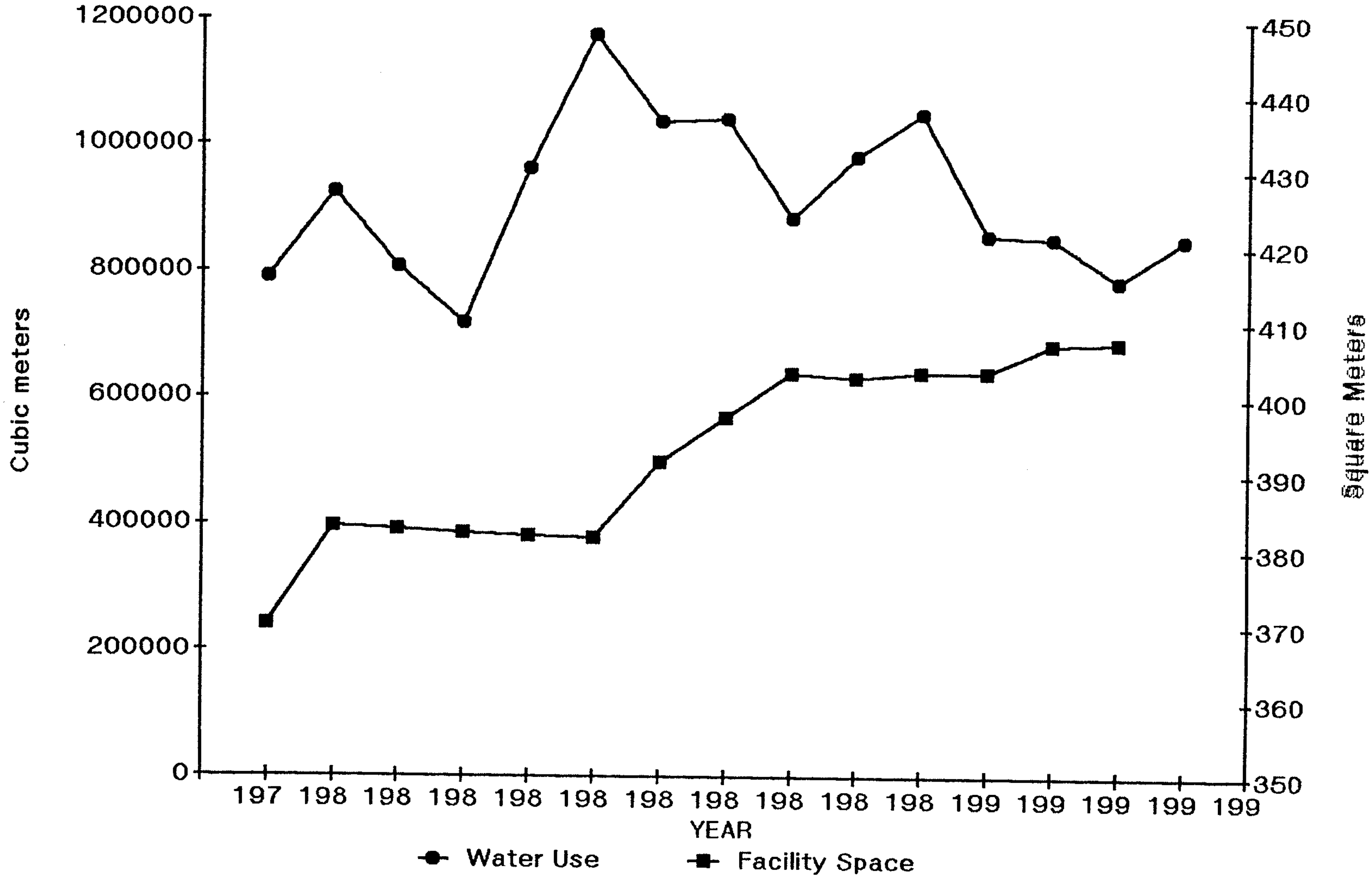


Fig. 11 FACILITY SPACE & WATER USE
(Source: University Records)



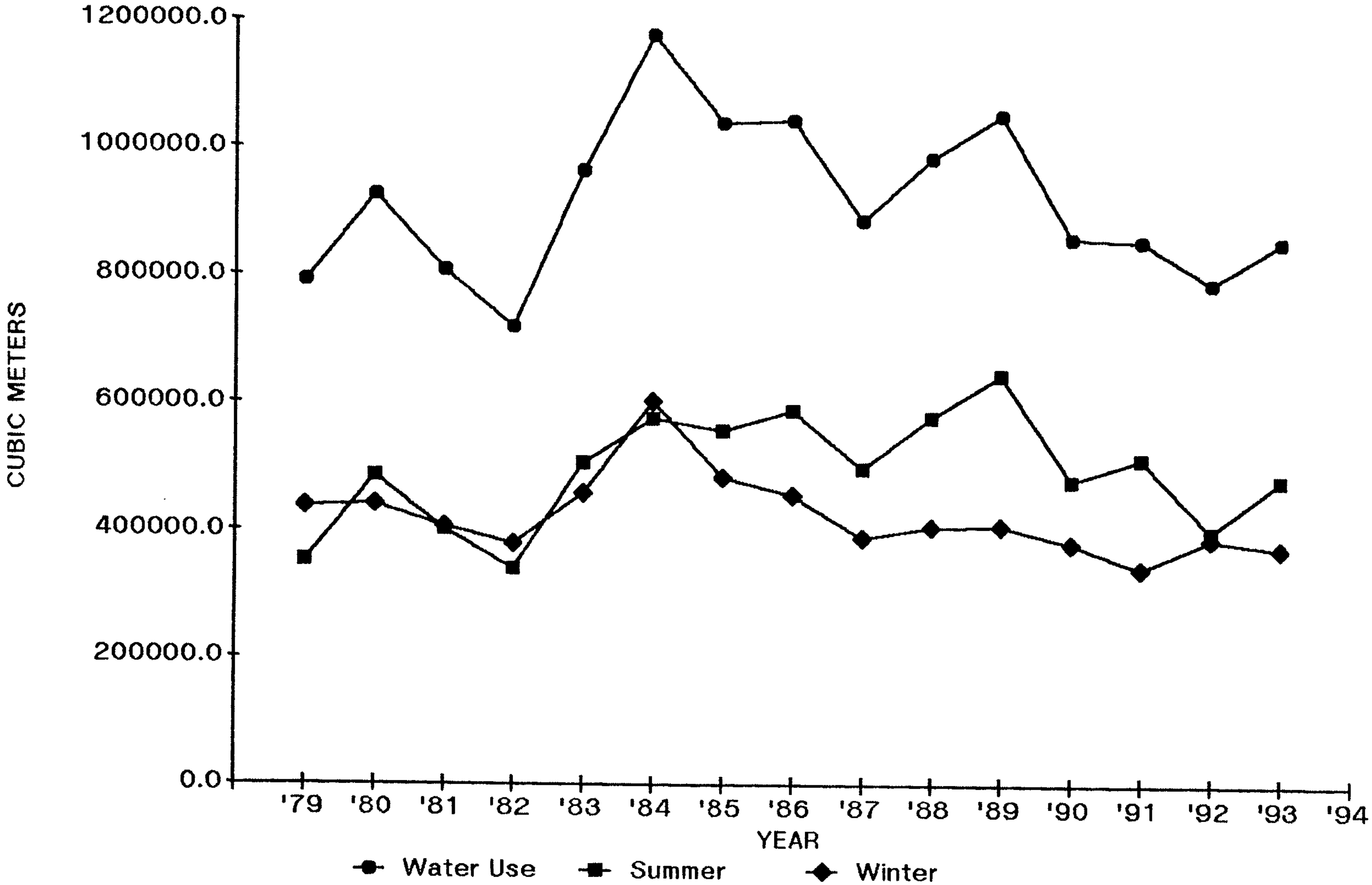
on a year-to-year basis, has remained fairly constant over time.

3.4.3 SEASONAL WATER USE

Figure 12 is a seasonal breakdown of water use on the UMFGC. The first and second fiscal quarters (April-September) cover the summer months and the third and fourth quarters cover the winter months. During the summer months the student population is about 30 percent of its winter levels. Despite this, summer water use is slightly higher than winter use (490,000 m^3 and 420,000 m^3, respectively, {averaged over 15 years}). It can also be seen from Figure 12 that winter water use (with the exception of 1984) is fairly constant over time, while summer use appears quite variable. This variation in summer water use over the years mimics the variation of total campus water use, with the exception of the peak in 1984 which is apparently due to heavier than average water use in the winter of that year. With a much reduced student population in the summer months it is not clear why water use is at almost the same level as in the winter months. It may be due to including the months of April and September as summer months (done so as to take lawn watering into account). These months are really part of the winter session. Groundskeeping water uses also only occur in the summer months, and vary from year-to-year

Fig.12 SEASONAL WATER USE (UMFG

(Source: Physical Plant Records)



depending on the amount of precipitation, but this accounts for only 7.3 percent of UMFGC water use (see section 3.5.6). Increased water use from other departments (not yet metered) may be another possible reason for the variability of summer water use over the study period, although there is no way to support this supposition.

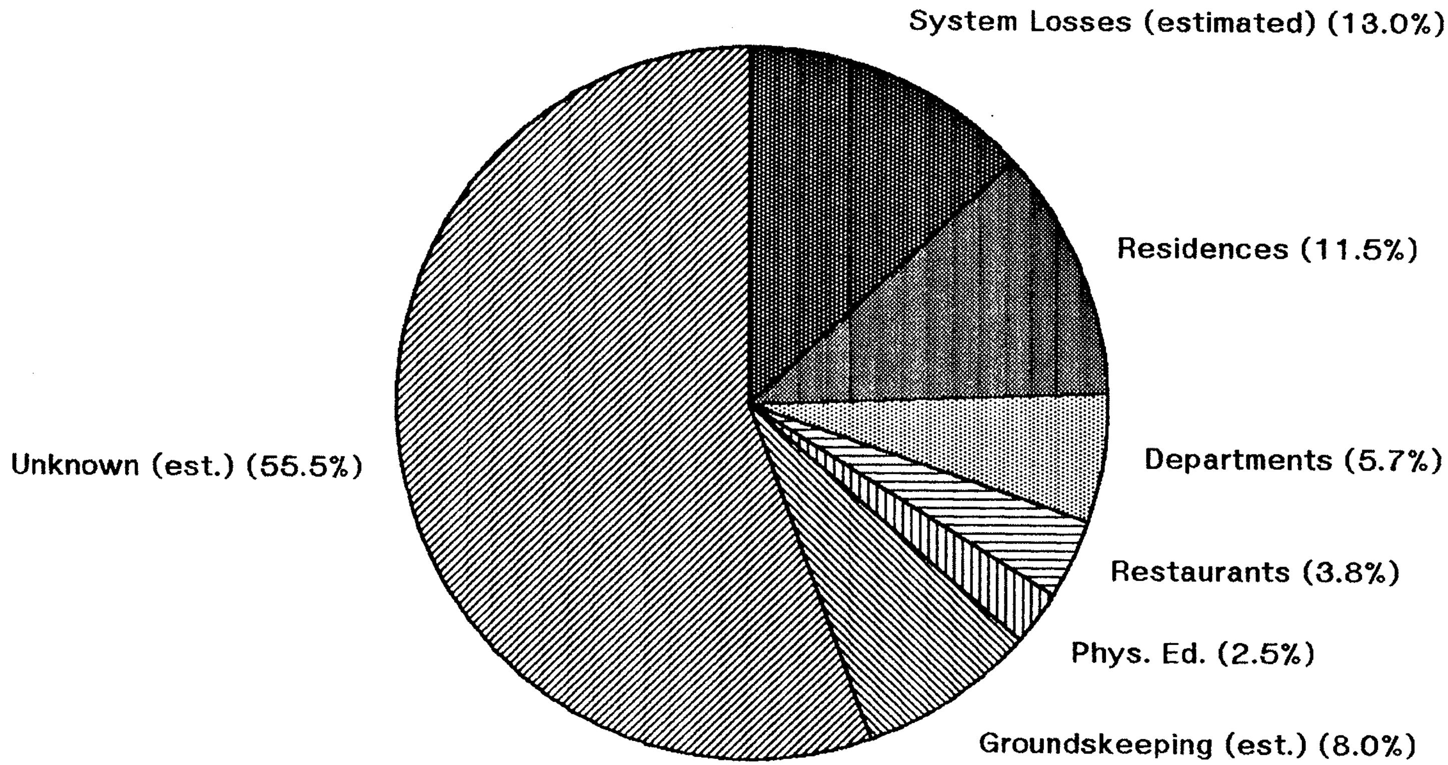
3.4.4 OTHER FACTORS

Other factors affecting water use at the U of M, not directly related to population size could include: start or cessation of heavy water use experiments in the Science departments; increased/decreased water use attributable to annual changes in Agricultural or Dairy Science programs; irregular or shoddy leak maintenance; improper metering or record keeping.

3.5 IDENTIFIED WATER USER GROUPS

U of M water user groups are shown in Figure 13. Identified water uses are those departments, buildings, and operations that are either metered, or, whose water use can be estimated. System loss, residence use, departmental use, restaurant use, physical education use, and groundskeeping

Figure 13 WATER USER GROUPS
(Source: after Physical Plant Records)



comprise the identified groups. What uses the remaing water are put to are unknown. The various water use groups are described below. All figures are for the 1992-1993 fiscal year with the exception of groundskeeping. The latter is an estimated figure representing the amount of water needed for lawn watering. Lawn watering was not needed over the summer of 1992 because of high precipitation rates. Figure 13 is, therefore, an idealized representation of water user groups on the UMFGC.

3.5.1 WATER SYSTEM LOSSES:

The average water system loss (unaccounted for water) in a Canadian municipality is 15 percent (Jenkins, 1993). The amount of unaccounted for water in Winnipeg is estimated at between 15 and 18 percent (A.Weremy, Pers. Comm.). System losses are due to leakage, firefighting and sewer flushing (Winnipeg, 1992a). The system losses for the UMFGC may be higher as the system is smaller and older on average than the City of Winnipeg system (A.Weremy, Pers. Comm.). On the other hand system losses could be lower than the Winnipeg average as the UMFGC is an end point in the City's water delivery system (R.McDowall, Pers. Comm.). A study carried out at the UMFGC by Reid Crowther Consultants in 1979/80 estimated water loss due to leakage at 13 percent. This equates to a loss of approximately 111,000 m^3 (or $103,000) for the UMFGC in the 1993/94 fiscal year.

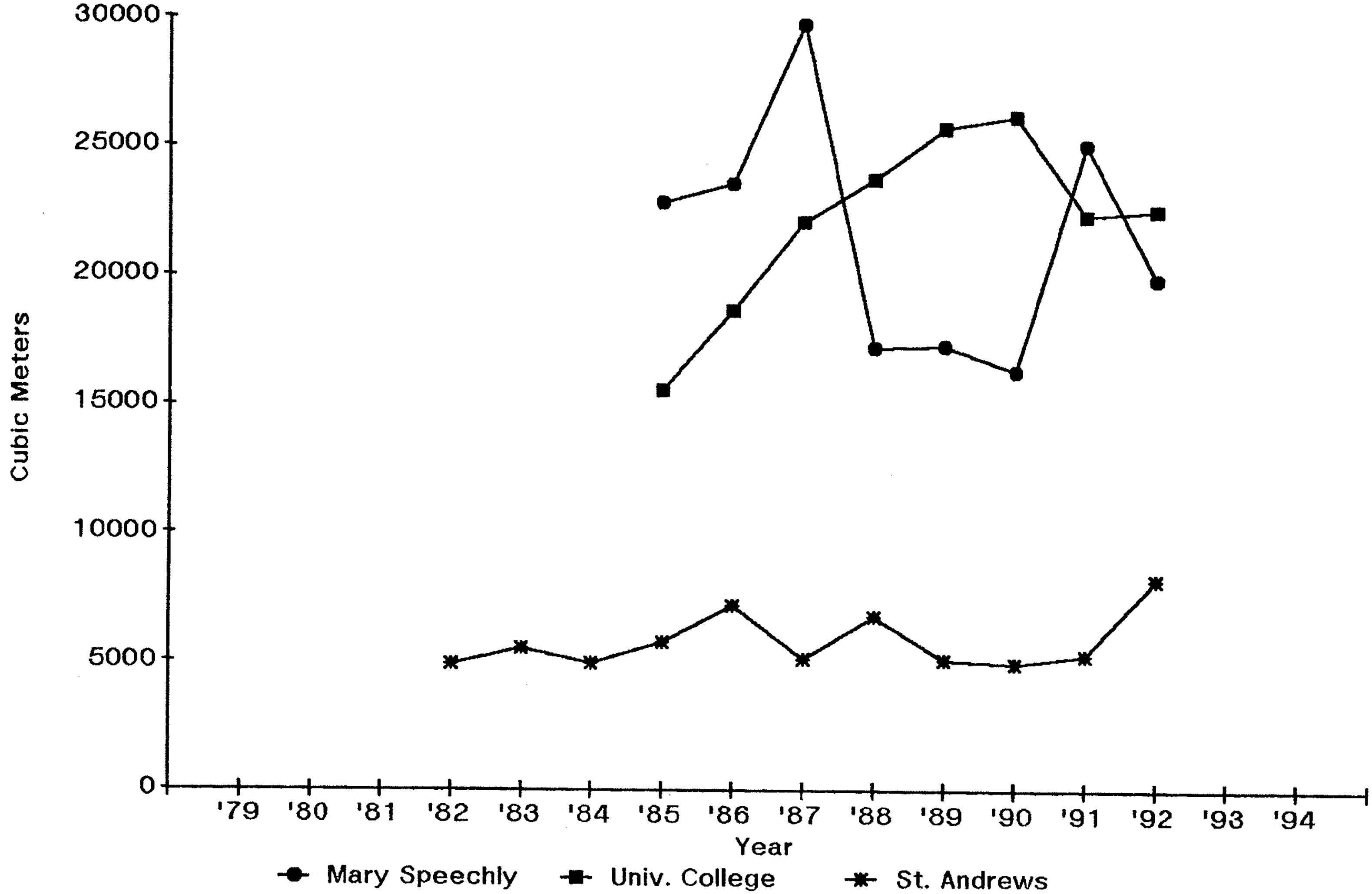
3.5.2 RESIDENCE USE:

Water uses in University residences are similar to, but not identical to, residential water uses. Both use water for cooking, bathing/showers and laundry. Daily per capita use in the five U of M residences is about 193 LCD, which is lower than City of Winnipeg indoor residential use (Figure 4). Differences are possibly attributable to: i.) bath versus shower use in residences and in houses. Generally more water is used in bathing than in showering, and bath tub use is minimal on campus while it is common in houses; ii.) lower amounts of water used for laundry in residences over home use. Residence use accounts for approximately 90,500 m^3 or 11.5 percent of Campus water use. Water use patterns are particular to their residence (Figure 14). Some residences show large increases in water use over the years while others show a decrease, or remain constant.

3.5.3 DEPARTMENTAL USE

This group is comprised of the departments of Agriculture, Geology (Wallace Building), Engineering (Structures Lab only), Dairy Science, St. Paul's College and the R.H.

Figure 14 RESIDENCE WATER USE
(Data Source: Physical Plant Records)



Institute. Departmental use accounts for slightly over 44,500 m^3, or 5.7 percent of total UMFGC water use. Water use patterns are particular to their departments/structures some of which are shown in Figure 15. Some departments show an large increases in water use over the years while others show a decrease, or remain constant.

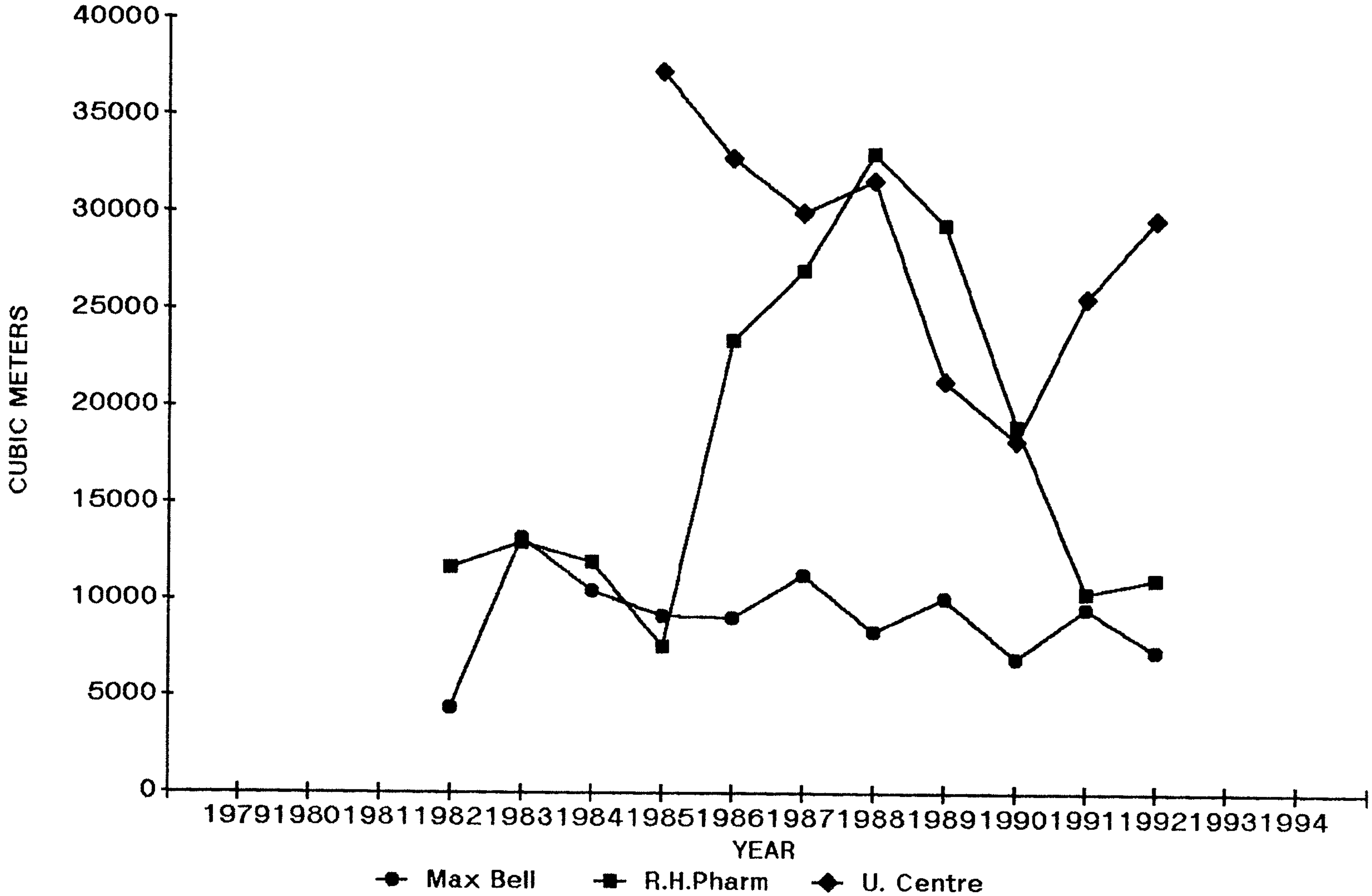
3.5.4 RESTAURANT USE:

Scholar's restaurant and the University Centre food services kitchen make up this group. They used about 29,700 m^3 of water in 1992.

3.5.5 PHYSICAL EDUCATION USE:

This group includes the Max Bell Centre and the Frank Kennedy Physical Education Centre/Continuing Education building. Showers, campus swimming pool and hockey rink are housed in these structures. Water use amounts to just under 20,000 m^3.

Figure 15 DEPARTMENTAL WATER USE
(Data Source: Physical Plant Records)



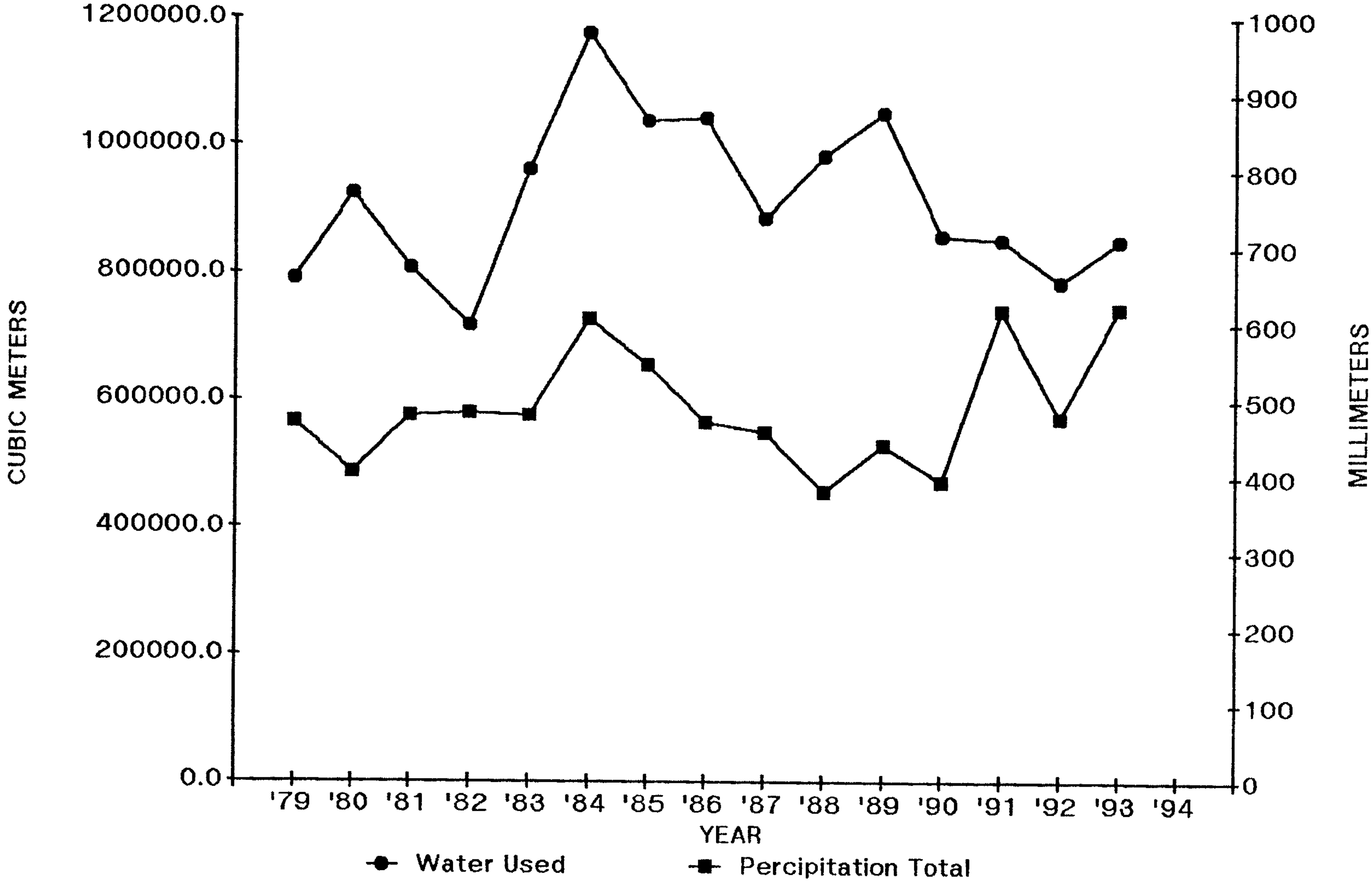
3.5.6 GROUNDSKEEPING:

The amount of water used for groundskeeping is difficult to estimate as no account is kept of the water used and lawn watering cannot be scheduled as it is weather dependant. Watering of lawns, trees, shrubs and flower beds is only done as needed, and the amount of water used supplements the amounts delivered by precipitation. No lawn watering was carried out during the last two summers because of higher than normal precipitation (E.Rzezudik, Pers. Comm.).

Two methods of estimating groundskeeping water requirements of the UMFGC green spaces are described in Appendix 4. It is estimated that about 63,000 m^3 of water (8 percent of UMFGC water) are used for this purpose. The notable variations in yearly total campus water use (Figures 8 and 9) cannot be explained by the yearly differences in groundskeeping watering practices (which are weather dependant) as might have been expected. If groundskeeping water use were the single most significant variable in total water use then years with high precipitation should see a decrease in water use, and years with low precipitation should see and increase in water use, i.e. the water use graph should be a mirror image of the seasonal precipitation graph. As can be seen in Figure 16, with a few exceptions, this is not the case.

Fig. 16 WATER USE & PRECIPITATION

University of Manitoba (FGC)



3.5.7 UNKNOWN USES:

This classification covers all other uses on the UMFGC that are not metered or estimated. It accounts for 55.5 percent of water used, or about 437,000 m^3. For the 1992/93 fiscal year the cost for this unmetered water was approximately $400,000.

Where, and how, is this water used? It is probably used throughout the 77 percent of structures on campus that are not metered. In addition to the uses mentioned above, other commercial and industrial uses of water take place such as, photography labs., scientific research, refrigeration and air conditioning, a fine arts studio, and several greenhouses. Only newer buildings and services that charge fees, such as residence or food services, are metered.

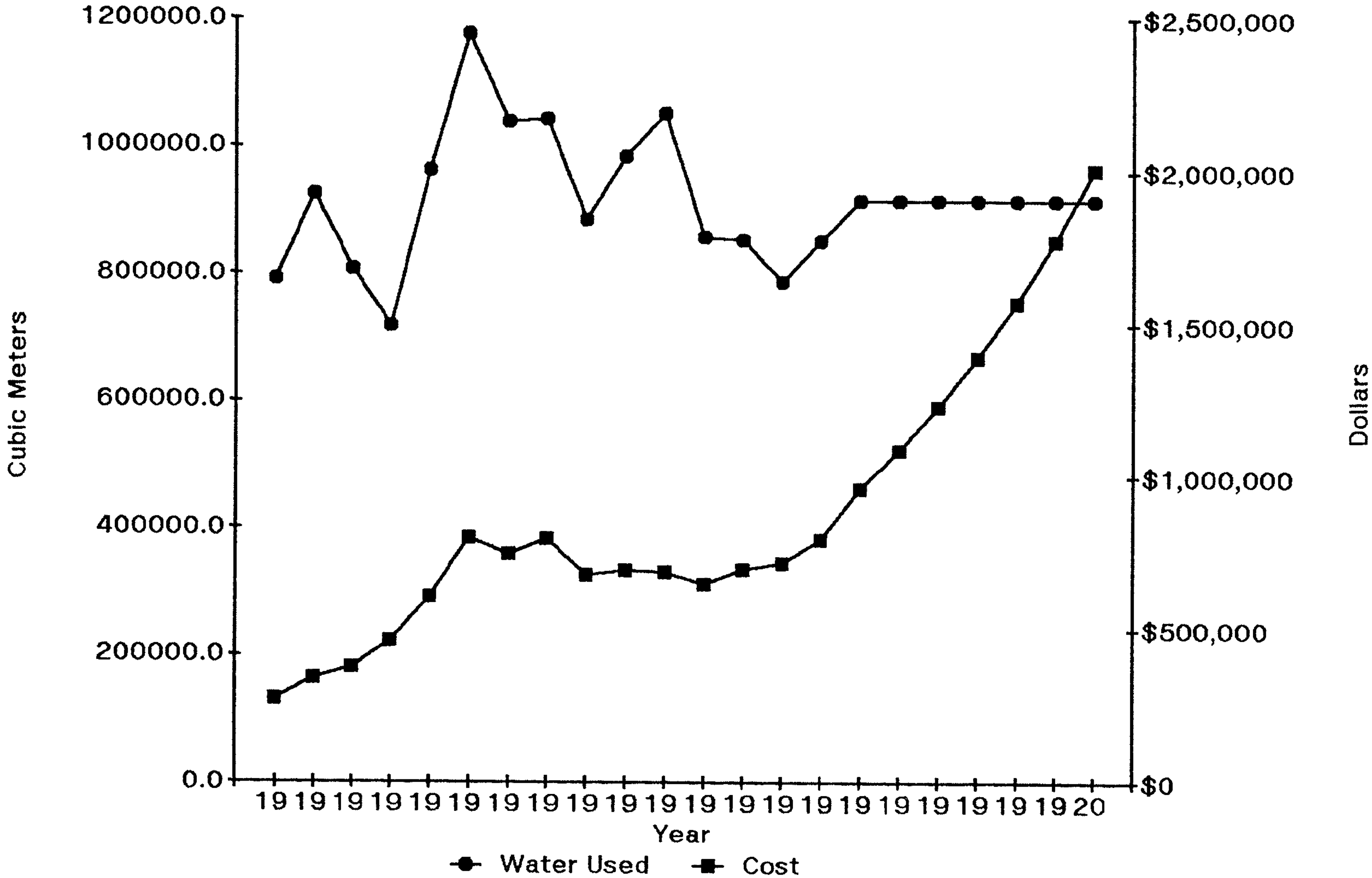
3.6 FUTURE COSTS

In the preceding sections some of the UMFGC water uses and their costs have been described. Water use has varied over the years making it difficult to extrapolate the most likely future water use/cost case. A future cost scenario using the average amount of water used at the UMFGC over the last 15 years (915,445 m^3) is presented here. Succeeding water rate increases are based on capital expenditures considered over a 5 year planning window (A.Weremy, Pers. Comm.). While rates are set annually, and no rate is determined after the next year, it can be assumed that next year's rate increase and the following years' will be close to this year's rate increase of 13 percent (A.Weremy, Pers. Comm.). Future costs are extrapolated to the year 2000 (Figure 17). Large potential rate increases as described here are not unlikely should the City of Winnipeg follows through with its plans of water system repair and upgrade as outlined in the City's Conceptual Planning Studies (Winnipeg, 1991, 1992b, and see section 1.2.1). It can be seen from Figure 17 that by the year 2000 the U of M could be faced with water utility costs of approximately $2,000,000.

An alternative to using high quality but relatively costly City of Winnipeg water is to find and use a cheaper source of water. Water can be drawn from the Red River at a rate of 25,000 litres/day (25 m^3) for domestic and municipal uses. This is equivalent to 9,125 m^3/year, or 1 percent of the U of M's current demand. River water is not a high quality water source such as City of Winnipeg water, but might be adequate for non-potable uses. For $150/year, 100,000 m^3 could be drawn from the Red River (274 m^3/day). This would meet 11 percent of the UMFGC water demand at a cost of $0.0015/$m^3$. Currently, the U of M pays the City of Winnipeg $0.932/$m^3$ of water.

Fig. 17 Fututre Water Costs

(Source: after Physical Plant Records)



3.7 CONCLUSIONS

Jurisdiction for water, its supply to the U of M, and City of Winnipeg water rate structures have been reviewed. and water uses and user groups have been identified (Figure 13). Since the campus is not universally metered it is not possible to determine how it's unknown-use portion of water (55 percent of total) is used. Potential water conserving practices exist for the identified water uses (system leakage, residence use, groundskeeping, departmental uses, restaurants, and physical education).

Although water use has varied from year to year figure 3 shows that over the last 10 years there is a trend towards lower water use. This is in spite of a relatively unchanged university population (Figure 10), and an increase in facility space (Figure 11). During that same period water costs remained constant or increased only slightly. Decreasing water use and stable water costs are hopeful signs that the U of M is managing its water use in an effective manner. Nevertheless, the unit cost of water (Figure 3) due to City of Winnipeg water rate increases has risen sharply over the last five years and UMFGC water costs are starting to climb. Also at this time, University of Manitoba expenditures are rising and net revenues are falling (UM, 1993a). Only by reducing water use can water costs be brought down. Estimated future water costs are shown in Figure 17. It is possible that by the year 2000 the U of M will be paying over $2,000,000 for its water (assuming water use remains constant). A water conservation plan for the UMFGC is outlined in the next chapter.

CHAPTER 4 - A WATER CONSERVATION PLAN FOR THE UNIVERSITY OF MANITOBA, FORT GARRY CAMPUS

4.1 INTRODUCTION

In this chapter current campus water conservation initiatives are reviewed and a Water Conservation Plan is developed for the UMFGC. As required by Objective 3, the plan outlines water conservation goals and involves faculty, staff and students in its implementation.

As outlined, conservation of water resources calls for the active cooperation of federal and provincial governments, as policy and law makers (Pearse *et al*, 1985), municipal authorities, as supplier (in the case of the City of Winnipeg), and users (in this instance the University of Manitoba - Winnipeg's largest water user).

All three levels of government (federal, provincial, and civic) are concerned about water conservation, but on vastly different scales. Federal and provincial governments' main concerns are on a basin or waterway scale, involving a number of different water users over a wide geographic area (Foster and Sewell, 1981; Pearse *et al*, 1985). Maintaining water quality as well as sufficient quantity are major concerns.

To reduce demand for increased water supplies, and put off costly capital expenditures, **demand management** can be used (Pearse *et al*, 1985). Pearse *et al* (1985) and Keating (1986) believe that substantial opportunities exist for improving the efficiency of water use (See Chapter 2). Pearse *et al* (1985) conclude that water management should shift from its traditional reliance on supply management to a policy involving more attention to demand management. A major component of demand management is **conservation.**

To help defer the costs of its water system upgrade the City of Winnipeg has started a water conservation program, as recommended in its Regional Water Supply Conceptual Planning Study (Winnipeg, 1992b). The City recommends that residential, commercial, and industrial/institutional users (like the University of Manitoba) follow its water conservation guidelines (see Appendix 3, and Table 2) to help:

1) lower the users' costs, and;

2) reduce demand so that the City might defer large future costs involving upgrading of its water delivery system.

4.2 CURRENT WATER CONSERVATION EFFORTS at the UNIVERSITY of MANITOBA, FORT GARRY CAMPUS

At the present time there is no written policy concerning water use or water conservation at the University of Manitoba. Efforts undertaken to conserve water are done so on a faculty, departmental or individual basis.

Examples of water conservation efforts are:

1.) The Geology Department uses recirculated water in their small rock saws. Plastic tubs under the saws act as settling ponds trapping grit and sludge carried from the sawn rocks by water used to cool the saw and rocks during cutting. The water is then pumped back to the saw where it is used again. This process can be repeated many times before the tubs need to be emptied of their collected rock fragments and sludge. Beside saving on the amount of water used another advantage to this process is that the rock fragments and sludge are not carried down the drains as they used to be. They can be disposed of with other garbage.

2.) Showers in the Frank Kennedy change rooms were changed from the standard type where water flow and temperature could be controlled by the user, to a semi-automatic type that ran for a pre-determined amount of time at a set temperature. This energy and water saving shower was controlled by pushing a large button in the wall and obviated the need of fiddling with taps. (Max Bell change rooms have a similar type of shower in them.) Unfortunately, because of non-specified reasons the showers were changed back to the older type at a cost estimated to be $12,000.

3.) Urinals in older structures, such as the Tier Building, used to flush automatically. They were controlled by a timer and every few minutes, whether they had been used or not, the urinals flushed. These old style urinals have now been replaced by urinals with a manual flushing system; however, automatic flushing urinals, with a 2 minute flush cycle of several litres, are still in use in some buildings on campus (e.g. UMSU's pub.)

4.) Irrigation of the Quadrangle is now controlled by a sprinkler system. Sprinkler systems can be more efficient at delivering water than randomly placed and operated sprinklers. The Quadrangle irrigation system was metered allowing for documentation of water use, but the meter was removed in October of 1991.

Appendix 6 lists a wide range of water conservation techniques taken from the literature. Some of them are incorporated into the Water Conservation Plan given below.

The University of Manitoba Recycling and Environment Group, Physical Plant and some administrative personnel, as well as the departments of Environmental Science, Landscape Architecture, Civil and Geological Engineering, and the Natural Resources Institute, and numerous individuals (students and staff) have concerns about the campus environment. Many students and staff, concerned about resource use and environmental degradation, lack the organization, time and resources to implement changes in their scholastic and work environment. It falls to Administration and Operations personnel to construct an action plan to deal with the water use and water conservation issues at the U of M. In the following sections a Water Conservation Plan is proposed for the UMFGC.

4.3 A WATER CONSERVATION PLAN for the UMFGC

The reasons for instituting water conservation on the UMFGC are both economic and environmental (see sections 1.2 and 1.3). Reduced water use results in lower water and sewer charges. For every cubic meter of water saved through conservation the U of M "saves" $1.04 (Winnipeg, 1994). Reduced use of water supply pipes and water-using fixtures also results in reduced maintenance and servicing costs and helps conserve a vital natural resource. The U of M will also be seen as a good environmental citizen by its funding agencies and the public.

If the UMFGC wants to reduce, or even hold constant, it costs for water and sewage treatment it will have to institute water conservation measures. A water conservation plan consisting of defined goals with realistic objectives that are supported by a proactive and practical policy is needed.

4.3.1 PROPOSED WATER CONSERVATION POLICY

There is no guiding principle or existing water conservation policy adhered to by the U of M. Since the University Administration has funded this study, it can be inferred that the governing bodies of this institution have some interest in developing (if not adopting) policies to deal with one of the myriad environmental problems facing the U of M - water conservation.

Policies are formulated to bring about a desired change (Brown, 1990) and should have realistic, attainable goals (Tisdell, 1990). They can help promote the responsible management of resources (Trauth, Claborn and Urban, 1987) but must ensure that resulting actions are economically and ecologically sustainable (WCED, 1987).

A water conservation plan should have a governing policy, giving it direction and justification. This policy would also show Administrations' support of water conservation efforts. A water conservation policy for the University of Manitoba could read as follows:

The University of Manitoba recognizes the conservation of water as an integral part of water management; and as a principal factor in the preservation of one of our most important natural resources. The University of Manitoba actively supports the efficient use of water supplies and is committed to the ongoing reduction of its own water use by adopting all reasonable and practicable water conservation techniques. The goal is to reduce water use and its associated economic and environmental costs, in a sustainable manner, and to be a leader in conservation efforts in the community.

4.3.2 PROPOSED WATER CONSERVATION PLAN

The water conservation plan described here is based, in part, on:

i) advice from the Practicum Committee (Dr. D.McCartney, Mr. R.McDowall, Dr. J.Sinclair, and Mr. A.Weremy.);

ii) environmental auditing information taken from the literature (Dean, 1990; Nerbas, 1992; Thompson and Therivel, 1990; and, Tomlinson, 1990), and D.McCartney (Pers. Comm.); and,

iii) the City of Edmonton Water Conservation Program (Jenkins and Parsons, 1991).

The proposed water conservation plan:

1.) is particular to the institution it is created for;

2.) attempts to at least maintain water costs at their current levels, or preferably, reduce them;

3.) increases awareness of the environment and its problems.

The water conservation plan is derived from the campus water conservation policy. As the schematic of the Water Conservation Plan shows (Figure 18) the plan identifies three specific goals that the literature and other institutions have identified as being most effective in reducing water use, including: water use reduction; leak detection and repair; and, education. Several objectives are listed for each goal. Each objective has its own workplan, schedule and budget. Workplans describe how the objective is to be carried out; schedules detail the starting time and expected length of time each objective will take; the budget

Figure 18 WATER CONSERVATION PLANNING PROCESS
University of Manitoba

1) GENERAL ENVIRONMENTAL POLICIES

↓

2) WATER CONSERVATION POLICY
(Direction and Justification for Plan)

↓

3) WATER CONSERVATION PLAN REVIEW
(for critique, new ideas, monitoring)
(= under authority of, i) Administration/Operations,
ii) Sustainable Development Co-ordination Group,
iii) Campus Environmental Committee ?)

↓

4) WATER CONSERVATION PLAN MANAGEMENT
(= Physical Plant)

↓

5) WATER CONSERVATION PLAN

GOALS

WATER USE REDUCTION
LEAK DETECTION & REPAIR
EDUCATION

OBJECTIVES (for each Goal)

WORKPLAN
SCHEDULE
BUDGET

MONITORING
(feedback to Goals and Plan Review)

outlines (estimated) costs and expected savings. Each objective is to be monitored to check that plan goals are met effectively. Plan oversight, goal setting, creation and critique of new ideas, and monitoring, should be carried out by the campus Sustainable Development Co-ordination group. The plan is to be managed by the U of M Physical Plant.

The advantages of following a focussed plan with set goals and objectives are:

1.) it saves time, money and duplication of effort if all concerned parties are operating under the same principles and towards the same goals;

2.) it gives guidelines to follow with respect to specific water conservation tools and techniques; and,

3.) acts as a reference against which changing goals, procedures and policies can be measured.

4.3.2.1 PLAN MANAGEMENT

Physical Plant should manage the water conservation plan as that department is responsible for the operation and maintenance of the Campus water supply system. They are also the authority that would be called upon to institute any technological changes called for in the plan's objectives.

4.3.2.2 PLAN GOALS and OBJECTIVES

Priorities should be set for water conservation goals for the University of Manitoba, and their objectives identified and defined. Three goals for the UMFGC are:

1. Water Use Reduction;
2. Leak Detection and Repair; and,
3. Education.

It can be seen that most of the water conservation tools described in Chapter 2 (section 2.4) fall under one of the above goals. Some of the goals' possible objectives, are listed below. Each objective would have its own workplan, schedule and budget, as well as specific monitoring considerations. Some projects such as leak detection and repair will realize savings in a short time, while others, such as landscape alteration (xeriscaping), may take some time realize significant savings. Costs and savings are only calculated for a period of two years. All costs and savings are estimates.

GOAL 1: WATER USE REDUCTION

OBJECTIVE 1:

Improve the U of M water use database by establishing a base load figure for the UMFGC and identify the amount of water used by all water user groups through metering.

OBJECTIVE 2:

Change groundskeeping practices so as to use less water. Highly water consumptive plants and grasses should be replaced with drought resistant varieties able to live on the amount of precipitation received in southern Manitoba.

OBJECTIVE 3:

Retrofit water fixtures in washrooms, Physical Education shower rooms, and residences throughout campus. Where possible replace existing fixtures with low water use fixtures.

OBJECTIVE 4:

Carry out site-specific studies of water using operations on campus. Water uses to be identified by the departments/faculties concerned. Information to be passed to Physical Plant for water conservation action, if appropriate.

OBJECTIVE 5:

Departments/Faculties be advised on how to reuse water in their water using operations, (if water reuse is appropriate).

GOAL 2: LEAK DETECTION amd REPAIR

OBJECTIVE 1:

Identify leakage sites and rates. Repair significant leaks.

OBJECTIVE 2:

Implement an anode installation/maintenance program to help extend water main life. Can be carried out in conjunction with water main repairs.

OBJECTIVE 3:

Implement universal metering on the UMFGC to aid in detecting leaks and to act as check against City of Winnipeg meters.

GOAL 3: EDUCATION

OBJECTIVE 1:

The university population should be informed of the need for water conservation. Develop a water conservation ethic among UMFGC water users by increasing student, staff and faculty knowledge of the benefits of conservation.

OBJECTIVE 2:

Create a water conservation database for use as background material for Physical Plant conservation efforts and for departmental/faculty research.

4.3.2.3 DESCRIPTION OF GOALS AND OBJECTIVES:

Examples of how some of the above listed objectives would be carried out are described below:

GOAL 1: Water Use Reduction

To reduce water use at the UMFGC water user groups must be identified. The amount of water they use and the way they use water need to be known before water conservation techniques can be recommended.

OBJECTIVE 1:

Improve the U of M water use database by establishing a base load figure for the UMFGC and identify the amount of water used by all water user groups through metering.

Workplan:

The university's base load is the minimum continuous load over a given period of time. Base load can be determined by measuring campus water use from the three metered water mains. A cool spring weekend would be a good time to measure the base load as the majority of the campus population would be absent, and other water use activities such as air conditioning and lawn watering would be at a minimum or not in operation. From this figure the daily base load can be derived. Readings should be taken in the early morning and in the evening to measure differences, if any, between night and day water use.

To identify how much water is being used and where and by whom it is being used, Physical Plant can use the monthly water meter readings taken from all metered structures on campus. Those structures/operations not metered can be either:

1. metered as part of an universal metering project for the university, or;

2. metered for water use over a period of time using a portable clamp-on water meter (Portaflow Mk II) supplied by Physical Plant. Periodic metering of the structure will establish the amount of water used over that period and the building/structure/department's water use pattern.

(To assist in monthly water meter readings taken at the two mains that are underground, one of which is frequently under water, remote readable meters could be installed.)

Schedule:

1. Base load can be measured by Physical Plant personnel over the May long-weekend. Readings to be taken from the three metered mains at 7:00 a.m. and 7:00 p.m., Saturday, Sunday and Monday.

2.a. A universal metering program can be started in June the after base load figure is established. The 77 percent of buildings on campus not metered (66 structures) can be metered over the summer at a rate of 6 buildings/week. Priority should be given to known or possible high water users such as the Departments of Chemistry, Physics, and Botany.

or,

2.b. The Portaflow Mk II can be used on non-metered buildings to measure the amount of water used. This program can be started immediately. Each building to be metered for one day (24 hours). The amount of water used over this time period would represent a low water use figure as the summer student population is about a third of the winter population. This periodic metering exercise could be repeated during the winter session to see what difference greater student numbers makes on water use for a specific department/structure.

Budget:

1. Base load measurements on May long-weekend. Three measurements, twice per day, for three days. Each set of three measurements take 1 hour to complete by two persons.

Total = 6 hours work X 2 persons = 12 person-hours.
12 person-hours X hourly rate of pay (Means Common Labourer rate for 1992 multiplied by 2%/year inflation and City Cost Index for Winnipeg of 1.018) of $ 29.00 = $ 348 = **$ 350**

2.a. Universal metering. Each meter takes 1.333 hours to install (Means, 1992). With a daily output of 6 meters (Means, 1992) it will take 3 weeks to install the 66 meters.

1.333 X 66 = 87.98 man-hours.

At 6 meters/day, 66/ 6 = 11 days + 4 days extra, because the work area is not confined to one building but is spread out across campus = 15 days, or 3 work weeks.

Cost of meter = $ 800 for a meter for a 2" water line.

Labour per meter = $ 39.90 X 1.018 (Winnipeg City Cost Index)

Subtotal = $ 840.62

Total = 66 meters X $ 840.62 = $ 55,481 = **$ 55,500**

or,

2.b. Installation of portable clamp-on meter for 66 buildings at 1 hour per installation/removal = 66 X 2 hours.

Labour rate per hour = (Means Skilled Worker rate for 1992 multiplied by 2%/year inflation and City Cost Index for Winnipeg of 1.018) = $ 38.66

Equipment Cost: Already owned by Physical Plant

Total = 132 hours X $ 38.66 = $ 5,103.12 = **$ 5,100**

Although universal metering is the prefered conservation tool, budgetary considerations would support option 2.b., use of the portable flow meter.

Total costs = $ 5,450

MONITORING:

Measurement of the UMFGC base load should be carried out twice each year to keep track of changes. It is suggested that base load measurements be taken on the October and May long-weekends for the reasons given above.

Notably higher or lower than average monthly water use should be investigated. Readings from the metered structures on campus will help to identify the water user and the reasons for the change in water use can then be ascertained by interview. If the campus is not universally metered and the change in water use is not attributable to one or more of the metered campus users then water use changes will have to be ascertained through inquiry and use of the Portaflow Mk II meter.

Identification of water users and knowledge of the amount of water they use will help to establish baseline data for the UMFGC. High water uses can then be targeted for reduction by Physical Plant.

GOAL 1: Water Use Reduction

OBJECTIVE 2:

Change groundskeeping practices so as to use less water. Highly water consumptive plants and grasses should be replaced with drought resistant varieties able to live on the amount of precipitation received by southern Manitoba.

Potential Reduction in Water Use: **3.6%***

* {This figure represents 45% of U of M's groundskeeping water use (Appendix 4). Forty-five percent is the average amount of landscape water saved by using xeriscape practices. The figure was arrived at by averaging those given by Loly, 1994; O'Keefe, 1992; and, Thomsen, 1994.}

Workplan:

Campus grounds to be changed to a low water use landscape or xeriscape (see Appendix 4, and section 2.4.8). New bedding plants, turf areas, trees and shrubs to consist of species which are able to survive without additional water beyond that received by precipitation. This plan calls for the purchase and planting of plants indigenous to the area, or ornamentals that are drought resistant. Costs for local species should be lower than those for imported or exotic species and will require less watering. Campus grounds should be transformed to a xeriscape in stages keeping within groundskeeping budgets. A xeriscape plan should be worked out with the assistance of a Landscape Architecture graduate student (as part of a thesis). Groundskeeping efforts are to be devoted to the implementation of a xeriscape and not the sustaining of highly water consumptive grounds cover.

Schedule:

1. The xeriscape work plan should be prepared over the winter session, 1994/95.

2. Implementation of the xeriscape plan is to be carried out during the spring and summer of 1995. Alteration of campus grounds to a xeriscape will continue over the next decade.

Budget:

1. Partial funding of a Landscape Architecture graduate thesis for one year to cover costs of materials, photocopying, etc... = **$ 1,000.**

2. One day xeriscaping workshop for groundskeeping personnel = **$ 500.**

Savings on water costs may not be realized until the later years of the project when the majority of the campus grounds consist of low-water use ground cover (assume 10 years for conversion of campus grounds to a xeriscape).

Assuming water use remains the same as in 1993 and costs increase only at the assumed inflation rate of 2% until the end of the project (10 years, = 2004 A.D.), the Present Value of a one year savings of 3.6% from the UMFGC water bill 10 years in the future is $PV = V_n/(1 + i)^n$,

where: PV = Present Value

$V_n = W_s(V_t) - OC_s$

V_t = Future Value of UMFGC water bill = $V_0(1 + i)^{10}$

V_0 = Initial water bill (1993/94) = $ 794,336

OC_s = Opportunuity Cost of student funding and workshop with a combined interest rate + inflation rate of 5% = $ $1500(1.05)^{10}$ = $ 2443.34

i = discount rate (interest rate), 3% assumed

n = 10 years

W_s = Water savings due to xeriscaping = 3.6%

PV = $ 26,778.02 (= $ 26,800 in Water Savings after 10 years, divide by 5 for the 2 year figure) = **$ 5,360**

Xeriscape Costs = **$ 1,500**

Total Savings = $ 3,860

MONITORING:

Water use for the campus grounds should be quantified for the summer of 1994. Groundskeeping water use should be kept track of over the life of the project to document water savings.

GOAL 2: Leak Detection and Repair

Leakage can be a large part of water system losses. It is estimated that such losses account for 13 percent of water use on the UMFGC (R.McDowall, Pers. Comm.). Prevention, and the detection and repair of leaks could result in significant water savings for the U of M.

OBJECTIVE 1:

Identify leakage sites and rates. Repair significant leaks.

Potential Reduction in Water Use: **9%** (Jenkins and Parsons, 1991).

Workplan:

Losses due to leakage can be assumed if there is a difference between water used according to total of all campus meters (assumes a universally metered campus) and the total of the meters on the three city mains. Leaks can also be determined by the use of the portable flow meter or by the use of ultrasonic and/or sonar leak detectors. Leak detectors can be employed by an outside consultant or can be purchased and used by U of M Physical Plant personnel. The leak detection survey will identify leakage sites and rate of water loss. Since the amount of water lost from a leak can be estimated from the leak survey the cost of the water lost can also be estimated. Only those leaks that can be cost effectively repaired should be included in the repair program. Locations of leaks not repaired should be recorded for future monitoring as leaks can grow over time. Eventually repair may become cost effective.

Schedule:

1. A leak detection and repair program should be carried out over the summer of 1994. The leak detection survey would take 1 week and would be completed during the month of June.

2. Repair program to commence in July.

Budget:

1.a. *Option 1 is to purchase a basic leak detector that identifies leaks but not the rate of leakage. Cost = **$ 5,000.**

1.b. #Option 2 is to purchase a more elaborate leak detector that identifies leaks and rate of leakage. Cost = $ 27,000.

1.c. #Option 3 is to commission a leak detection survey that includes a water audit of the campus and testing of all meters. Cost = $8,000

(* Al Paskevicius, Pers. Comm.)

(# Scott Marais, Pers. Comm.)

The purchase of a leak detector (Option 1 or 2) is prefered over a one-time audit (Option 3) because the detector can be used as needed, year after year, to detect new or recurring leaks, were as the audit measures the leakage state of the campus only once. The information and recommendations that arise from a one-time audit become less dependable over time. Future changes in the water supply system and new leaks cannot be accounted for with a typical audit. Option 1 is prefered over Option 2 because of its lower cost and ease of use.

Leak detection survey is estimated to take the month of June at a cost of $ 4,610 (Means Common Labourer wage rate of $ 224/day X Winnipeg City Cost Index 1.029, for 20 days) and is carried out yearly. $4,610 X 2 = **$ 9,220.**

2. Cost of the leak repair program depends on the number and severity of the leaks found. One major leak is assumed to be found and repaired in the first two years.

Cost of Leak repair of a 20' section of pipe is estimated to be = **$ 1,260** (from Means, 1992).

Potential Water Savings: **9%** (Jenkins and Parsons, 1991), which is equivalent to 76,680 m^3 (UMFGC 1993/94 water use). This accounts for $ 71,490 of the U of M's 1993/94 water costs.

Water savings	= $ 70,490 X 2 = **$ 142,980**
Leak detection costs	= $ 4,610 X 2 = **$ 9,220**
Leak detection equipment cost	= **$ 5,000**
Leak repair costs	= **$ 1,260**
Total savings	= $ 127,500

MONITORING:

Leak detection and repair should be an on-going part of water management at the UMFGC. It should be noted that any water loss reduced by leak repair is a saving realized each and every year following that repairand that repair costs will pay for themselves over time. When savings realized from leak detection and repair become equal to costs incurred for the detection and repair program, the program should then be suspended until water meter records again indicate losses due to leakage.

GOAL 3: Education

Many studies recognize education as a very important component of water conservation (El-Ashry and Gibbons, 1986; Postel, 1985; Sanders and Thurow, 1982). To successfully implement water conservation strategies, faculty, staff and students must be made aware of water use issues and concerns at the UMFGC.

OBJECTIVE 1:

The university population should be informed of the need for water conservation. Develop a water conservation ethic among UMFGC water users by increasing student, staff and faculty knowledge of the benefits of conservation.

Potential Reduction in Water Use: **4%** (Jenkins and Parsons, 1991).

Workplan:

To help make the UMFGC population aware of water use and the water conservation issue, as well as to generate water conservation strategies, the Physical Plant should hold a one day Water Conservation Workshop. This workshop will inform participants of water use issues at the U of M and discuss water possible conservation strategies.

Participants should include: Physical Plant and Administration representatives; representatives from identified campus water user groups (Physical Education, Residences, Food Services); representatives from known or suspected high water using departments or faculties (Chemistry, Physics, Botany, Engineering, Agriculture); representatives of concerned student groups such as the Student Council and UMREG, and other interested departments or faculties (Landscape Architecture, Economics, Psychology); and interested off-campus parties such as the City of Winnipeg - Waterworks Department, the Health Sciences Centre (Winnipeg's second largest water user) and the University of Winnipeg.

To better inform the residential portion of the campus population about water conservation techniques the City of Winnipeg's water conservation information sheet should be handed out to all residence students. This information can be included with the standard University campus/residence information given to each student at the start of the academic year. To see if this component of water conservation education is effective, the water use of the campus residences should be measured monthly over at least one but preferably two years and compared to historical water use data for the same residences. This education/behaviour study could be carried out by a Psychology student as part of an honours thesis.

To reach the wider campus population monthly water conservation "reminders" should be published in the U of M newspapers, the Manitoban, and the Bulletin (combined circulation of 20,000 including off campus circulation). A water conservation "reminder" should be placed in the student day-timer to be published by the U of M. Water conservation "reminders" would be similar to the City of Winnipeg's Water conservation information sheet that accompanies residential water bills.

Schedule:

1. One day Water Conservation Workshop to be held on campus. Time to be set after determining participant availability, but should be held before regular session begins in September, 1994.

2. City of Winnipeg Water Conservation Information Sheet to be included with residence students' information packages.

3. Monthly newspaper ads to start in September issues of the Manitoban and the Bulletin. Water conservation "reminder" to be placed in the student day-timer for September distribution.

4. Psychology (?) honours student to monitor monthly water use in residences over the year.

Budget:

1. One day Water Conservation Workshop held at U of M.

   = $ 327.70 for lunch and coffee for 25 persons.
   To be held yearly with concerned departments and faculties. Therefore, $ 328 X 2 = **$ 656**

2. Water Conservation information sheet from the City of Winnipeg = $ 300 for 1300 copies. Given each year to residence students = $ 300 X 2 = **$ 600**

3. Monthly newspaper adds = $ 4,500/year X 2 = **$ 9,000**

4. Psychology student funding; cost of material, photocopying, etc... = $ 500/year X 2 = **$ 1,000**

Total Costs = **$ 11,260**

Potential Reduction in Water Use: **4%** (Jenkins and Parsons, 1991)

= 34,079 m^3 of water (1993/94 UMFGC use), or = approximately, **$ 31,800** of U of M water costs for 1993/94.

Net Savings = $ 20,540

MONITORING:

The monitoring of reduction in water use of the campus population due solely to water conservation education efforts, would be difficult to carry out because of the many factors influencing water use at the UMFGC. Monitoring of residence water use before and after a campus wide education program were carried out, could supply Physical Plant with an estimate of savings due to "education" efforts only. If water conservation education were found to be effective then the education program could be intensified in order to realize even greater savings. If the education effort did not affect water use at the UMFGC then all water conservation education "resources" could be directed elsewhere.

4.4 WATER CONSERVATION PLAN SAVINGS

The Net Savings, or Net Benefits, of carrying out the detailed objectives of the Water Conservation Plan are approximately $131,000, or about 16 percent of the UMFGC's 1993/94 water costs. Table 6 shows the computed costs and savings of the objectives described.

Leak detection (and repair), followed by education, show the greatest potential for water and dollar savings over the two year time line. It will take a longer period of time for the water conserving potential of the other objectives to be realized. It is possible that the several objectives listed in section 4.3.2.2 but not described in detail, will also contribute towards longer term water savings at the University of Manitoba, Fort Garry Campus.

Table 6

WATER CONSERVATION COSTS and SAVINGS

WATER CONSERVATION OBJECTIVES - COSTS

GOAL 1: WATER USE REDUCTION

OBJECTIVE 1:

1. Base load measurements on May long-weekend.	$ 350
2.b. Use of portable clamp-on meter	$ 5,100
COSTS	**$ 5,450**

OBJECTIVE 2:

1. Partial funding of a Landscape Architecture student.	$ 1,000
2. One day xeriscaping workshop for groundskeeping personnel	$ 500
COSTS	**$ 1,500**

GOAL 2: Leak Detection and Repair

OBJECTIVE 1:

1.a. Purchase a leak detector.	$ 5,000
1.b. Leak detection survey.	$ 9,220
2. Leak repair	$ 1,260
COSTS	**$ 15,480**

Table 6 Cont'd.

GOAL 3: Education

OBJECTIVE 1:

1.	One day Water Conservation Workshop.	$ 660
2.	Water Conservation info. sheet 1300 copies	$ 600
3.	Monthly newspaper advertising.	$ 9,000
4.	Psychology student funding	$ 1,000
COSTS		**$11,260**

TOTAL COST **$33,690**

WATER CONSERVATION OBJECTIVES - SAVINGS

GOAL 1: WATER USE REDUCTION

OBJECTIVE 1:

1. Metering and base load measurements.

SAVINGS = No direct savings. This is a monitoring objective.

OBJECTIVE 2:

1. & 2. Change landscaping practices.

Potential Reduction in Water Use: **3.6%**

SAVINGS **$ 5,360**

Table 6 Cont'd.

GOAL 2: Leak Detection and Repair

OBJECTIVE 1:

1. Purchase and use of a leak detector.

Potential Reduction in Water Use: **9%** of System Losses

SAVINGS **$ 127,500**

GOAL 3: Education

OBJECTIVE 1:

1.-4. Campus education re: Water Conservation.

Potential Reduction in Water Use: **4%**

SAVINGS **$ 31,800**

TOTAL BENEFITS **$ 164,660**

TOTAL COST = $ 33,690

TOTAL BENEFITS = $ 164,660

NET BENEFIT = $ 130,970 (or, approximately, **$ 131,000**)

BENEFIT TO COST RATIO = 164,660/33,690 = 4.9

CHAPTER 5 - CONCLUSIONS and RECOMMENDATIONS

5.1 CONCLUSIONS

The University of Manitoba faces increasing costs for the supply and treatment of its water. Even with water use holding steady, City of Winnipeg rate increases will add to the University's future yearly water costs.

This Practicum was undertaken to review the UMFGC water use and to help reduce that water use and its asscociated costs, both economic and environmental. Section 1.5 set out three Objectives for this study. In keeping with Objective 1 water conservation has been defined, and water conservation tools and practices have been identified in Chapter 2. With respect to Objective 2, the UMFGC's water supply system has been reviewed and current water uses at the UMFGC have been analyzed in Chapter 3. Also in Chapter 3, water user groups have been identified, and a future water use scenario, based on historical water use and likely future water rate increases has been presented. As required by Objective 3 a Water Conservation Plan for the University of Manitoba, Fort Garry Campus, that outlines water conservation goals has been developed and is described in Chapter 4.

The Water Conservation Plan identifies three specific goals that the literature and other institutions have identified as being most effective in reducing water use, including: water use reduction; leak detection and repair; and, education. Several objectives are listed for each goal. Each objective has its own workplan, schedule and budget, and each objective is to be monitored to check that plan goals are met effectively.

The plan's three goals have the potential to reduce the UMFGC's water costs by about 16 percent of current costs. The University of Manitoba could realize cost savings in the order of $131,000 within two years if it adopted and instituted the Water Conservation Plan goals for the Fort Garry Campus. At a unit cost of $\$0.932/m^3$ (Figure 3), this is equivalent to a water use savings of about 122,000 m^3.

5.2 RECOMMENDATIONS

This study makes seven recommendations. The first four form the basis of the Water Conservation Plan while the last three recommendations are concerned with alternative water supplies and water user identification.

It is recommended that:

1. The University of Manitoba formulate a Water Conservation Policy to act as a guide to water conservation efforts at the University;

2. All University of Manitoba, Fort Garry Campus, water conservation efforts follow the plan established in this study, and that the plan be managed by Physical Plant;

3. Reasonable goals be established for the plan including, but not limited to, Water Use Reduction, Leak Detection/Repair, and Education;

4. Objectives be set for each goal;

5. As part of the Water Use Reduction goal, the University attempt to account for its 55 percent unmetered water.

6. The feasibilty of using cheaper river water (from the Red River) for groundskeeping and other secondary (non-potable) uses be investigated; and,

7. The potential for greywater reuse/recycling on the University of Manitoba, Fort Garry Campus, be investigated.

It is incumbent upon the University of Manitoba, as a publicly funded institution, to enact and follow environmental and economic policies, plans and strategies that take the concerns of its funding agencies, the public, and its student body, staff and faculty into account. These policies, plans and strategies must be environmentally and economically effective, efficient, and equitable.

This study has outlined a practicable and cost-effective water conservation plan that can be implemented to reduce water use and costs on the University of Manitoba, Fort Garry Campus. Future research in this area could include a more rigorous Cost-Benefit analysis of water conservation objectives, studies of specific water conservation techniques applied to particular water user groups (e.g. campus residences), and the creation of economically and environmentally sound and consistent policies for the University of Manitoba.

BIBLIOGRAPHY

Armory, W.,
1993: Water master plan: A useful management tool. Journal of New England Water Works Association. Vol. 107, NO. 2, June 1993. P.127-131.

Asano, T.,
1981: Municipal waste water reuse: A perspective. **In**, Water Resources Management in Industrial Areas. Selected papers from the international symposium held by the International Water Resources Association (IWRA), 7-11 September 1981, Lisbon, Portugal. L.R.Beard and W.H.C.Maxwell, editors. Tycooly International Publishing Limited, Dublin. P. 397-407.

Bellinger, D.,
1975: Canadian water management policy instruments- A national overview. **In**, Institutional Arrangements for Water Management: Canadian Experiences. B.Mitchell, editor. Published by the Department of Geography, University of Waterloo. P. 1-42.

Bigelow, C.,
1991: Recommendations on environmental education and research at the University of Manitoba.

Brown, L.R.,
1990: State of the world, 1990. A Worldwatch Institute Report on Progress Toward a Sustainable Society. W.W.Norton & Company, publishers. 253 p.

Buzelli, B., Good, M., McCormick, J.S., and McCormick, J.R.,
1991: How to get water smart. Product and practices for saving water in the nineties. Terra Firma Publishing. Santa Barbara, California. 128 p.

CEA (Canadian Electrical Association),
1992: Demand side management in Canada - 1992. Published with the cooperation of the Minister of Energy, Mines and Resources Canada. 178 p.

CICA (Canadian Institute of Chartered Accountants),
1992: Environmental auditing and the role of the accounting profession. Research Report, Studies and Standards Department. 156 p.

Collins English Dictionary,
1986: The Collins Paperback English Dictionary. W.T.MacLeod, managing editor.

Dean, G.,
1990: Environmental auditing in local authorities. **In**, Environmental Auditing. Working Paper no. 130. S.Thompson and R.Therivel, editors. Published by Oxford Polytechnic. Schools of Biological and Molecular Sciences and Planning. P. 7-26.

El-Ashry, M.T. and Gibbons, D.C.,
1986: Troubled waters. New policies for managing water in the American West. World Resources Institute. A Center for Policy Research. Study 6. 89 p.

Ellefson, C.L., Stephens, T.L. and Welsh, D.,
1992: Xeriscape gardening. Water conservation for the American landscape. Maxwell MacMillan Canada, Inc. Don Mills, Ontario. 323 p.

Environment Canada,
1993: Annual meteorological summary. Atmospheric Environment Service. 23 p.

Flack, J.E.,
1978: Management alternatives for reducing demand. **In** Municipal Water Systems. The challenge for urban resource management. D. Holtz and S.Sebastian, editors. Holcomb Research Institute. Indiana University Press. P. 200-210.

Fortin, M.,
1985: The user-pay principle and the Canadian municipal water industry. **In**, The Economics of Municipal Water Supply: Applying the User-Pay Principle. S.H.Hanke and M.Fortin. Inquiry on Federal Water Policy. Environment Canada. Research Paper No. 21. P. A-1 to A-59.

Foster, H.D. and Sewell, W.R.D.,
1981: Water - the emerging crisis in Canada. Canadian Institute for Economic Policy. 117 p.

Frank, J.,
1994: Efficient watering practices. Water Efficient Gardening Seminar. Fort Whyte Centre, Winnipeg, Manitoba. April 6, 1994.

Gaboury, J.A.M.,
1968: Conversion factors, weights and measures and atomic constants. Falconbridge Nickel Mines Ltd. 71 p.

Gardner, J.S., Sinclair, J., and Ladd, B.,
1992: The University of Manitoba and the environment: A framework for action. A Preliminary Report. 26 p.

Greeno, J.L., Hedstrom, G.S., and DiBerto, M.,
1985: Environmental auditng. Fundamentals and techniques. Center for Environmental Assurance. Arthur D. Little, Inc. John Wiley and Sons, publisher. 303 p.

Hanke, S.H.,
1985: The user-pay principle and market socialism. **In**, The Economics of Municipal Water Supply: Applying the User-Pay Principle. S.H.Hanke and M.Fortin. Inquiry on Federal Water Policy. Environment Canada. Research Paper No. 21. p. B-1 to B-83.

Holtz, D., and Sebastian, S.,
1978: Municipal water systems. The challenge for urban resource management. D. Holtz and S.Sebastian, editors. Holcomb Research Institute. Indiana University Press. 307 p.

Jenkins, L.,
1993: Canadian water conservation survey. Water Plants Engineering,Public Works, Water Branch, City of Edmonton. 25 p.

Jenkins, L., and Parsons, F.,
1991: Water conservation program. City of Edmonton. Department of Environmental Services. Five chapters, four appendices.

Keating, M.,
1986: To the last drop. Canada and the world's water crisis. MacMillan of Canada, publisher. 265 p.

Kreutzwiser, R.D.,
1991: Water resource management: Canadian perspectives and the Great Lakes water levels issue. **In**, Resource Management and Development. Addressing Conflict and Uncertainty. B.Mitchell, editor. Oxford University Press. xxx p.

Kulshreshtha, S.N.,
1993: World water resources and regional vulnerability: Impact of future changes. International Institute for Applied Systems Analysis. 124 p.

Lee,T.R.,
1972: Approaches to water requirement forecasting; A Canadian perspective. Social Science Series No.9. Canada Centre for Inland Waters, Environment Canada. 9 p.

Loly, W.,
1994: A water - efficient green thumb. Winnipeg Real Estate News, Friday, March , 1994. P. 7.

Mather, J.R.,
1984: Water resources. Distribution, use, and management. John Wiley and Sons, publishers. 418 p.

MacLaren, J.W.,
1985: Municipal waterworks and wastewater systems. Inquiry on Federal Water Policy. Environment Canada. Research Paper No. 3. 50 p.

McNeill, R. and Tate, D.,
1991: Guidelines for municipal water pricing. Social Science Series No. 25. Inland Waters Directorate, Water Planning and Management Branch, Environment Canada, Ottawa Canada. 66 p.

McPherson, M.B.,
1978: Conservation in household water use. **In**, Municipal Water Systems. The Challenge for Urban Resource Management. D. Holtz and S.Sebastian, editors. Holcomb Research Institute. Indiana University Press. P. 183-199.

Meakin, S.,
1993: Municipal water issues in Canada. Background Paper. Sciences and Technology Division, Research Branch, Library of Parliament, Canada. April, 1993. 26 p.

Means, R.S. (Company, Inc.),
1992: Means building construction cost data. 50th Annual Edition. Published by the R.S.Means Company Inc. 553 p.

Nerbas, M.,
1992: An environmental audit of the eastern irrigation district, Brooks, Alberta, 1991. Canadian Water Resources Journal, Vol. 17, NO. 4, 1992. P. 391-404.

O'Keefe, J.M.,
1992: Water conserving gardens and landscapes. Storey Communications, Inc. Pownal, Vermont 05261. 156 p.

Pearse, P.H., Bertrand, F. and MacLaren, J.W.,
1985: Currents of change. Final report on federal water policy. September 1985. Government of Canada. 222 p.

Postel, S.,
1984: Water: Rethinking management in an age of scarcity. Worldwatch Paper 62. Worldwatch Institute, 1984. 65 p.

Postel, S.,
1985: Conserving water: The untapped alternative. Worldwatch Paper 67. Worldwatch Institute, 1985. 66 p.

Pringle, L.,
1982: Water. The next great resource battle. MacMillan Publishing Company. 144 p.

Sanders, W. and Thurow, C.,
1982: Water conservation in residential development: Land-use techniques. American Planning Association. 34 p.

Statistics Canada,
1989: Canada yearbook 1990. Minister of regional Industrial Expansion. Government of Canada.

Statistics Canada,
1991: The consumer price index. March 1991, Catalogue 62-001. Statistics Canada, Prices Division. 44 p.

Tate, D.M.,
1989: Municipal water rates in Canada: Current practices and prices. Social Science Series No.21. Water Planning and Management Branch Inland Waters Directorate, Environment Canada.

TBS (Treasury Board Secretariat),
1976: Benefit-cost analysis guide. Planning Branch. 80 p.

Thompson, S. and Therivel, R.,
1990: Environmental Auditing. Working Paper No. 130. S.Thompson and R.Therivel, editors. Published by Oxford Polytechnic. Schools of Biological and Molecular Sciences and Planning. 70 P.

Thomsen, C.,
1994: Design and maintenance of the water efficient landscape. Water Efficient Gardening Seminar. Fort Whyte Centre, Winnipeg, Manitoba. April 6, 1994.

Tisdell, C.A.,
1990: Natural resources, growth and development: Economics, ecology, and resource-scarcity. Praeger Publishers. 186 p.

Tomlinson, P.,
1990: Environmental auditing in the private sector. **In**, Environmental Auditing. Working Paper no. 130. S.Thompson and R.Therivel, editors. Published by Oxford Polytechnic. Schools of Biological and Molecular Sciences and Planning. P.27-36.

Trauth, K.M., Claborn, B.J. and Urban, L.V.,
1987: A water resources audit for small communities. Journal of the American Water Works Association, Vol. 79, No. 5, May 1987. P.48-51.

UM (University of Manitoba),
Physical plant environmental services symposium.

UM (University of Manitoba),
1981: IS book.September 1981. Institutional statistics. Office of Institutional Analysis. Seventh edition, September, 1981. 76 p.

UM (University of Manitoba),
1986: IS book.Institutional statistics. Office of Institutional Analysis. Twelfth edition, 1985-1986. 90 p.

UM (University of Manitoba),
1992: IS book.Institutional statistics. Office of Institutional Analysis. Eighteenth edition, 1991-1992. 85 p.

UM (University of Manitoba),
1993a: IS book.Institutional statistics. Office of Institutional Analysis. Nineteenth edition, 1992-1993. 91 p.

UM (University of Manitoba),
1993b: Physical plant water utility records.

WCED (World Commission on Environment and Development),
1987: Our common future. World Commission on Environment and Development. Gro Harlem Brundtland, Chairman. Oxford University Press. 400 p.

Winnipeg, (City of),
1991: Maintaining a quality water supply for Winnipeg. Phase 1 Report - Assessing Needs and Opportunities. July 1991.

Winnipeg, (City of),
1992a: Water conservation report. Regional Water Supply Conceptual Planning Study. City of Winnipeg Waterworks, Waste, and Disposal Department. Prepared by Wardrop Engineering Incorporated.

Winnipeg, (City of),
1992b: Phase 2 progress report. Regional Water Supply Conceptual Planning Study. City of Winnipeg Waterworks, Waste, and Disposal Department. Prepared by Wardrop Engineering Incorporated.

Winnipeg, (City of),
1992c: Conservation water rate structure review. City of Winnipeg Waterworks, Waste, and Disposal Department. Prepared by CH2M HILL, Calgary Alberta. December 1992.

Winnipeg, (City of),
1994: Notice of new water and sewer rates. Waterworks, Waste and Disposal Department. 1 p.

Winnipeg Free Press,
1994: "World heads for crisis as supply of clean water runs dry, UN conference told". Newspaper article, March 23, 1994.

PERSONAL COMMUNICATIONS

D.Kohut	Physical Plant, University of Manitoba.
S.Marais	Heath Consulting, Saskatoon, Saskatchewan.
S.Martinsen	City of Winnipeg Water Works, Waste and Disposal Department.
D.McCartney	Professor of Geological Engineering, University of Manitoba.
R.McDowall	Assistant Director, Energy, Physical Plant, University of Manitoba.
A.Paskevicius	Superintendent, Utilities Service, Department of Physical Plant, McMaster University.
E.Rzezudik	Physical Plant, University of Manitoba.
A.Weremy	City of Winnipeg Water Works, Waste and Disposal Department.

Acadia University, Department of Physical Plant, T.G.Taylor

Brandon University, Department of Physical Plant, T. Dankersloot

McMaster University, Department of Physical Plant, A.Paskevicius

Memorial University of Newfoundland, Department of University Works, A.E.Kiernan

University of Alberta, Department of Physical Plant, G.Balut

University of Calgary, Department of Physical Plant, M.Sloan

University of Manitoba, Department of Physical Plant, R.McDowall

University of New Brunswick, Department of Physical Plant, S.Ball

University of Regina, Physical Plant, V.Moneo

University of Western Ontario, Physical Plant Department, D.K.Boyce

University of Waterloo, Plant Operations, D.J.Churchill

University of Winnipeg, Physical Plant, L.Zebenski

Appendix 1

DEFINITION OF TERMS & ABBREVIATIONS

DEFINITION OF TERMS:

Audit - (Environmental Audit) - An independent, systematic assessment of an organizations' policies, programs, and practices using external performance criteria to verify whether they comply with legal requirements, internal policies and accepted practices (CICA, 1992; Greeno, Hedstrom and DiBerto, 1985; Nerbas, 1992). An audit is a management tool that provides a database of information for future use (Trauth *et al*, 1987).

Audit Plan - a focussed plan for carrying out an audit, with specific goals and tasks outlined. The plan documents the institutions water uses and outlines water conservation tools that can be used (see, Protocol).

Conservation - "protection, preservation, and careful management of natural resources" (Collins English Dictionary, 1986).

Demand Side Management - techniques to manage the demand for a resource instead of trying to increase its supply.

Protocol - a list or set of examination procedures described and arranged so as to provide a guide to an auditor in carrying out the audit. They may be generic or specific (CICA,1992). Protocols organize audit procedures into sequential steps and can be quite lengthy (Greeno *et al*, 1985).

Sustainable Development - the development (of resources) that meet the needs of the present without compromising the ability of future generations to meet their own needs (WCED, "Our Common Future").

System Loss - the amount of unaccounted for water in a water supply system. System losses are due to leakage, firefighting and sewer flushing (Winnipeg, 1992a).

Task - The objective(s) or goals to be achieved by using a particular water conservation tool.

Tool - A water conservation issue or technique, that when implemented, will reduce water use.

Water Conservation - a collection of efforts by water users, and water suppliers, to reduce the amounts of water used or lost. This often has the added benefit of reducing the costs associated with water use, such as water treatment. In the context of this study, water conservation means the careful management of the U of M's water uses with the view to reducing the amount of water utility charges paid to the City of Winnipeg.

Xeriscaping - (derived from the greek word xeros meaning "dry") is a term applied to techniques that reduce the water required to maintain gardens. It stresses the establishment of landscapes adapted to the arid environments around them, rather than trying to transplant and maintain water-consumptive landscapes (O'Keefe, 1992).

ABBREVIATIONS:

DSM	Demand Side Management
FTE	Full Time Equivalent (full-time - part-time/2)
GST	Goods and Services Tax
LCD	litres/capita/day
UM	University of Manitoba
UMBTN	University of Manitoba, Bannatyne Campus
UMFGC	University of Manitoba, Fort Garry Campus
UMREG	University of Manitoba Recycling and Environment Group

Appendix 2

UNIVERSITY OF MANITOBA WATER RECORDS

WATER CUBIC FOOT TOTAL BY ACCOUNT AND YEAR:

FORT GARRY	LOCATION	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93
		CCF	CCF	CCF	CCF	CCF	CCF	CCF	CCF	CCF	CCF	CCF	CCF	CCF	CCF
05750-2		127	82	54	20	20	REMOVED								
06340-1	U. CRESCENT	288,083	350,527	307,316	300,816	378,132	405,597	346,134	348,830	295,645	298,449	285,226	249,254	234,389	227,506
06322-1	ZOOLOGY DISCHARGE	-155	-98	-2,634	-6,927	-35	-306	-281	-4	-4	-4	-130	-68	-249	-753
06330-1	SOUTH PIT	42,592	39,408	41,183	52,859	47,264	71,006	75,890	82,450	95,855	133,918	79,403	59,853	59,243	55,033
06320-1	NORTH PIT	18,187	19,290	7,629	16,835	6,533	23,904	21,237	16,418	13,674	16,278	103,588	51,824	49,482	42,859
06321-1	ZOOLOGY DISCHARGE	-69,484	-82,657	-69,349	-110,016	-91,318	-85,202	-76,678	-77,710	-92,685	-101,648	-77,198	-58,021	-41,560	-48,796
00960-2	37 KINGS DRIVE	108	153	94	111	278	179	221	169	183	285	248	271	76	125
BANNATYNE															
09-09-09450-2-4	OLD BASIC SCIENCE	5,484	6,048	6,070	0	0	8,989	9,014	6,962	3,845	4,722	4,223	3,582	3,188	2,858
09-09-09440-1-9	MEDICAL SERVICES	63	1,328	1,923	221	38	86	28	32	32	44	48	55	58	105
09-09-11290-1-6	731 MCDERMOT	31	84	84	88	131	125	179	217	98	103	93	92	97	191
09-09-11320-1-0	CHOWN BLDG.	14,489	6,752	8,013	7,948	13,928	11,118	13,128	21,883	20,385	18,307	17,314	20,382	19,391	19,491
09-09-05540-1-6	BASIC SCIENCE	28,296	17,826	34,706	37,083	34,977	29,349	19,906	25,505	26,049	28,929	33,077	31,946	29,876	23,164
09-09-11420-1-9	DENTAL (Back)	3,520	3,769	4,860	5,038	5,540	5,553	3,901	2,690	3,015	4,006	3,529	3,755	3,250	1,247
09-09-09470-1-2	DENTAL (Front)	9,824	8,711	7,759	2,049	3,521	6,732	6,613	2,530	4,973	6,496	7,716	7,477	10,791	9,197
09-09-11330-7-5	754 MCDERMOT													128	800
09-09-11340-3-2	758 MCDERMOT												16	0	0
09-09-11350-4	766 MCDERMOT												21	0	0
09-09-11370-3-5	772 MCDERMOT													42	287
09-09-11380-2-5	776 MCDERMOT													86	758
09-09-11390-7-2	778 MCDERMOT													80	608
TOTAL CU. FT. - CAMPUS AND BANNATYN		34,112,500	37,126,800	34,886,700	30,612,300	39,900,900	47,695,000	41,921,200	42,795,200	37,108,500	40,988,200	43,711,600	37,041,900	36,837,700	33,665,700
TOTAL CU. FT. - FORT GARRY CAMPUS		27,945,800	32,677,200	28,527,200	25,369,800	34,087,400	41,517,700	36,654,300	36,815,300	31,268,800	34,727,600	37,111,600	30,311,300	30,139,100	27,797,500
TOTAL CU. FT. - MEDICAL COLLEGE		6,166,700	4,449,600	6,339,500	5,242,500	5,813,500	6,177,300	5,266,900	5,979,900	5,839,700	6,260,600	6,600,000	6,730,600	6,698,600	5,868,200

CFYR.XLS

	79-80	80-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93
	APR 1979 CCF WATER	MAY 1980 CCF WATER	APR 1981 CCF WATER	APR 1982 CCF WATER	APR 1983 CCF WATER	JAN 1984 CCF WATER	JAN 1985 CCF WATER	JAN 1986 CCF WATER	JAN 1987 CCF WATER	JAN 1988 CCF WATER	JAN 1989 CCF WATER	FEB 1990 CCF WATER	JAN 1991 CCF WATER	JAN 1992 CCF WATER
FIRST 96,000 CU. FT.	$0.75	$0.83	$1.08	$1.17	$1.24	$1.24	$1.30	$1.30	$1.30	$1.30	$1.13	$1.18	$1.24	$1.33
9,601 TO 96,000 CU. FT	$0.50	$0.55	$0.70	$0.91	$0.96	$0.98	$1.01	$1.01	$1.01	$1.01	$0.88	$0.92	$0.98	$1.03
OVER 96,000 CU. FT.	$0.38	$0.42	$0.54	$0.82	$0.87	$0.87	$0.91	$0.91	$0.91	$0.91	$0.80	$0.63	$0.68	$0.72
SEWER	$0.47	$0.47	$0.52	$0.65	$0.70	$0.88	$0.94	$0.94	$1.02	$1.14	$1.22	$1.34	$1.49	$1.65
COST ADDED TO OFFSET METER CHARGI											$0.01	$0.01	$0.01	$0.02
OUR BILLING RATE	$0.86 /CCF	$0.88 /CCF	$1.08 /CCF	$1.47 /CCF	$1.57 /CCF	$1.75 /CCF	$1.85 /CCF	$1.85 /CCF	$1.93 /CCF	$2.05 /CCF	$1.83 /CCF	$1.98 /CCF	$2.18 /CCF	$2.38 /CCF
TOTAL COST AS RECORDED				$548,871	$709,969	$912,588	$849,627	$909,553	$794,938	$808,485	$813,505	$793,765	$845,937	$869,738
BUDGET SHEET FINAL							$954,045	$877,282	$807,703	$788,197	$813,505	$797,921	$813,549	$875,238

University of Manitoba Quarterly Water Consumption
1993-1994 (from Physical Plant Records)

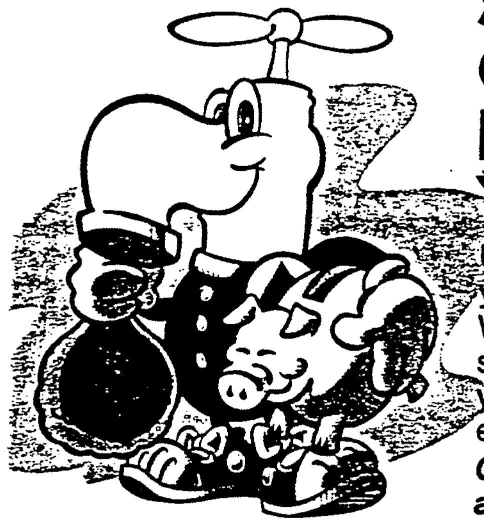
CAMPUS	CCF 1993-94	
1	88,187	
2	80,893	
3	56,313	
4	75,492	
CAMPUS TOTAL	**300,885**	
MEDICAL		
1	14,631	
2	18,318	
3	12,154	
4	13,179	(Estimated)
MEDICAL TOTAL	**58,282**	(Estimated)
GRAND TOTAL	**359,167**	(Estimated)

CAMPUS	300,885	
MEDICAL	58,282	(Estimated)
TOTAL	359,167	(Estimated)

FORT GARRY CAMPUS COST	$ 794,136		
BANNATYNE CAMPUS COST	$ 154,065		(Estimated)
TOTAL		**$ 948,201**	(Estimated)\

Appendix 3

CITY OF WINNIPEG WATER CONSERVATION PAMPHLET

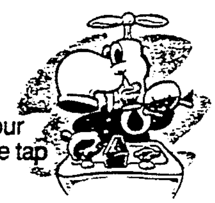


SAVING MONEY ON YOUR WATER BILL IS EASIER THAN YOU THINK!

Use these water saving suggestions to lower your water bills and benefit the environment. We've included **8** simple, tried and true water saving tips you can put to good use around your home. But water conservation doesn't end there.

Conserve water, because the meter's running... and you pay the bills.

MONEY SAVING TIPS:

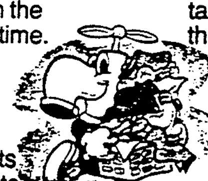


1. ***Brush Off!***
Turn off the water while brushing your teeth or while shaving – never let the tap run continuously.

2. ***Food Colour For Thought!***
Check your toilet for leaks. Put a little food colouring in your tank. If colour appears in your bowl, you have a leak that should be repaired immediately.

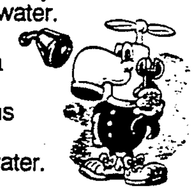
3. ***Chill Out!***
Running the tap continuously, waiting for the water to run cold is very wasteful. Instead, fill a bottle with drinking water and keep it in the refrigerator to save yourself water and time.

4. ***Fill'er Up!***
Wash only full loads of laundry or full loads of dishes.



5. ***Nighttime Is The Right Time!***
Water your lawn during the coolest parts of the day – early morning or at night – to reduce water lost to evaporation. Position the sprinkler so the water lands on the lawn, not on paved driveways or sidewalks.

6. ***Clean Sweep!***
Sweep leaves and gravel off driveways rather than hosing them off with water.



7. ***Light Showers Forecast!***
Take shorter showers, or install a water-saving shower head. Long showers can waste 5 to 10 gallons of water per minute, and waste the energy required to heat the water.

8. ***Space Saver!***
Put an accepted water displacing device in your toilet tank (eg. a gravel filled bottle). By taking up space in the tank, it will help reduce the amount of water wasted with every flush.

CONSERVE WATER.

The Meter's Running!

WATERWORKS, WASTE AND DISPOSAL DEPARTMENT

A Checklist of Water Conservation Ideas

For Schools and Colleges

This checklist provides water conservation tips successfully implemented by industrial and commercial users.

General Suggestions

Increase employee, faculty, and student awareness of water conservation.

Conduct contests for employees and students (e.g., posters, slogans, or conservation ideas).

Seek employee and student suggestions on water conservation; locate suggestion boxes in prominent areas.

Install signs in all restrooms encouraging water conservation.

When cleaning with water is necessary, use budgeted amounts.

Read water meter weekly to monitor success of water conservation efforts.

Assign an employee to monitor water use and waste.

Determine the quantity and purpose of water being used.

Determine other methods of water conservation.

Building Maintenance

Check water supply system for leaks.

Turn off any unnecessary flows.

Repair dripping faucets and showers and continuously-running or leaking toilets.

Install flow reducers and faucet aerators in all plumbing fixtures where possible.

Reduce the water used in toilet flushing by either adjusting the vacuum flush mechanism or installing toilet tank displacement devices (dams, bottles, or bags).

As appliances or fixtures wear out, replace them with water-saving models.

Shut off water supply to equipment rooms not in use.

Minimize the water used in cooling equipment, such as air compressors, in accordance with manufacturer recommendations.

Reduce the load on air conditioning units by shutting air conditioning off when and where it is not needed.

Keep hot water pipes insulated.

Avoid excessive boiler and air conditioner blow down. (Monitor total dissolved solids levels, and blow down only when needed.)

Instruct clean-up crews to use less water for mopping.

Change window cleaning schedule from periodic to an on-call/as-required basis.

Kitchen and Laundry Areas

Turn off the continuous flow used to clean the drain trays of the coffee/milk/soda beverage island; clean the trays only as needed.

Turn dishwasher off when not in use. Wash full loads only.

Replace spray heads to reduce water flow.

Recycle rinse water from the dishwater or recirculate it to the garbage disposer.

Do not use running water to melt ice or frozen foods.

Use water conserving ice makers.

Presoak utensils and dishes in ponded water instead of using a running water rinse.

Use water from steam tables in place of fresh water to wash down cooking area.
floors in

Reprogram washing machines to eliminate a rinse or suds cycle when possible and if not restricted by health regulations.

Reduce water levels, where possible, to minimize water required per load of washing.

Wash only full loads of clothes.

Evaluate wash formula and machine cycles for water use efficiency.

Pool

Lower pool water to reduce amount of water splashed out.

Use a pool cover to reduce evaporation when pool is not being used.

Reduce amount of water used to clean pool filters.

Exterior Areas

Convert from high water-using lawns, trees, and shrubs to landscape design incorporating plants providing beautiful colour and requiring less water. In the future, design landscapes that require less water.

Inventory outdoor water use for landscaped areas.

Water landscape only when needed; two to three times a week is usually sufficient.

Wash autos, buses, and trucks less often.

Discontinue using water to clean sidewalks, driveways, loading docks, and parking lots. Consider using brooms or motorized sweepers.

Avoid landscape fertilizing and pruning that would stimulate excessive growth.

Remove weeds and unhealthy plants so remaining plants can benefit from the water saved.

In many cases, older, established plants require only infrequent irrigation. Look for indications of water need such as wilt, change of colour, or dry soils.

Install soil moisture overrides or timers on sprinkler systems.

Time watering, when possible, to occur in the morning or evening when evaporation is lowest.

Make sure irrigation equipment applies water uniformly.

Investigate the advantages of installing drip irrigation systems.

Mulch around plants reducing evaporation and discouraging weeds.

Remove thatch and aerate turf encouraging movement of water to the root zone.

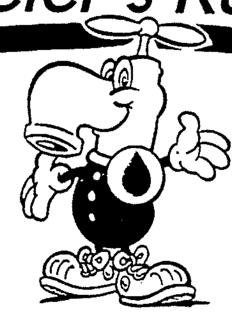
Avoid runoff and make sure sprinklers cover just the lawn or garden, not sidewalks, driveways, or gutters.

Do not water on windy days.

During spring and fall, most plants need approximately half the amount of water needed during the summer.

The ideas presented are not intended as an endorsement by the City of Winnipeg Waterworks, Waste and Disposal Department of any method, process or specific product but are merely suggestions.

CONSERVE WATER.
The Meter's Running!



WATERWORKS, WASTE
AND DISPOSAL DEPARTMENT

Appendix 4

CALCULATION OF WATER USED FOR GROUNDSKEEPING

Groundskeeping:

The amount of water used for groundskeepimg is not known as no account is kept of the water used. Lawn watering is not scheduled as it is weather dependant and the amount of water used varies from year to year. No lawn watering was carried out during the last two summers because of higher than normal precipitation (E.Rzezudik, Pers. Comm.).
Watering of lawns, trees, shrubs and flower beds is only done as needed, and the amount of water used supplements the amounts delivered by precipitation.

Two methods of estimating UMFGC groundskeeping water requirements are used. The average of the figures derived from the two methods is used as the estimated figure of water used for groundskeeping purposes.

METHOD 1:

To estimate water delivered to the green spaces of the UMFGC the water requirements of the plants are subtracted from the amount of natural precipitation they receive. The difference is what the UM would need to apply to keep plants healthy and green. As turf, or lawns, are the largest "green" component of the UMFGC green spaces, water requirements are calculated only for grasses. It should be noted that grasses require more water than trees or shrubs (Thomsen, 1994).

DATA.

Ground cover at the UMFGC occupies 40-41 acres (D.Kohut, Pers. Comm.), not including walkways. The average, **40.5 acres**, is used in the following calculations.

The grounds consist mostly of lawns, made up of Kentucky Bluegrass and Fescues, which require **732 litres/m2/growing season** (Frank, 1994; Thomsen, 1994).

Over the growing season, grasses require 0.18" of water/day.
Seasonal precipitation is 0.10"/day.
There is a **shortfall** of **0.08"/day, or 45%**, of the required demand.
This shortfall must be supplied by lawn watering.

ESTIMATE CALCULATION.

UMFGC grounds = 40.5 acres = 163,897.7 m2

Water demand is = 163,897.7 m2 X 732 l/m2/season
= 1.1997×10^8 l/season (year)
= 119970 m3/season

45% of the required demand = 119,970 m3 X 0.45
= **53,986.5 m3**

Almost 54,000 m3 must be applied to the grounds.

METHOD 2:

To estimate water delivered to the green spaces of the UMFGC the yearly landscape water requirements of a typical family residence is used as a standard. As typical residential landscapes consist of more than just grass this measurement includes not only lawn watering requirements but the water requirements of trees and shrubs as well.

DATA.

Ground cover at the UMFGC occupies 40-41 acres (D.Kohut, Pers. Comm.), not including walkways. The average, **40.5 acres**, is used in the following calculations.

Typical family residence uses 340,686 litres/year for landscape purposes (Thomsen, Pers. Com.).

Typical family "lawn", (or area of lot size minus area of house) = 279 m2 (Frank, 1994).

ESTIMATE CALCULATION.

340,686 litres/279 m2 = 1221.1 litres/m2/year
= 1.2 m3/m2/year

UMFGC grounds = 40.5 acres = 163,897.7 m2

1.2 m3/m2 X 163,897.7 m2 = **196,622.2 m**3 of water used/year

Over 196,000 m3 of water must be applied to the grounds.

GROUNDSKEEPING WATER USE:

Method 1 = 53,986.5 m3

Method 2 = 196,622.2 m3 *

Average = 125,304.3 m3 **

This average represents 14.6 % of UMFGC water use in 1990, a dry year where seasonal precipitation was below the norm (Environment Canada, 1994). The 1990 year's figure was used instead of 1993's as there was no grounds watering carried out in 1993. It is interesting to note that water use in 1990 (858,297.6 m3), a dry year requiring lawn watering, is almost equal to the water use total for 1993 (859,149.9 m3) a year in which there was no lawn watering. This points out the great variability in water use on the UMFGC from year to year.

To more fairly represent the varying climatic conditions that occur over time and affect groundskeeping water use at the UMFGC, the average of the amounts of water applied for groundskeeping in a dry year (1990) and a wet year (1993) will be used to represent the UMFGC annual groundskeeping water use component of this study.

1990 groundskeeping water use = 125,304.3 m3
1993 groundskeeping water use = 0 m3

mean = **62,652.1 m3** or, 8 % of UMFGC 1992 water use.

---

* This figure is almost 3.5 times that calculated for Method 1. Assuming Method 1 is reliable it would seem that most people over-water their lawns. Another reason for the discrepancy may be that car washing and pool use is included in Thomsen's figure used in Method 2.

** Taking the information given above into account, this figure should be considered an upper limit for groundskeeping water use.

Appendix 5

CALCULATION OF WASHROOM FIXTURE LEAKAGE

Washroom Fixture Leakage:

One of the on-site studies of water use on the campus was an investigation into leakage of washroom fixtures. Leaking bathroom fixtures can cause losses of up to 120 litres/day for residential users. {This figure is derived from Keatings' (1986) figure of North American home water leakage of (up to) 10%, and the average water use figure for Winnipeg of 300 LCD from Thomsen (1993), adjusted to account for a family of 4 (= 1200 litres/day). The adjusted figure is close to Sanders and Thurow's (1992) figure of 1310 litres/day of water used by the average American family of 4}.
Washrooms in 21 buildings on campus were examined for leaking toilets, urinals, and faucets. Showers, if present, and nearby hallway water fountains were also examined. Information was recorded on a "Leak Detection Form" (see below). Water flow rates from leaking faucets, showers and water fountains were measured with a graduated cylinder and stopwatch. Leaking toilets were identified by the sound of running water and/or the disturbance of the water in the bowl. Leakage rates for the toilets were taken from the literature and applied to the UM fixtures. Flows from running urinals were estimated. The leakage rates for the various fixtures were multiplied by the number of those fixtures on campus (from Physical Plant zone managers' records) to arrive at an estimate of the total fixture leakage for the campus. Total leakage has been estimated 0.57 percent of UMFGC 1992 water use (equivalent to 4,528.5 m3/year, or, $ 4,092).

LEAK DETECTION FORM

BUILDING: ____

FLOOR: ____

AREA: ____

ROOM NUMBER: __________

HALLWAY: _____
WASHROOM: _____
OTHER: _____

TIME OF DAY: __________

DEVICE:
WATER FOUNTAIN _____
TOILET _____
FAUCET _____
URINAL _____
SHOWER _____
OTHER _____

PROBLEM:
NONE _____
LEAK _____
FLOW _____
OTHER ____________________________________

RATE: __________ ml/minute

COMMENTS/OBSERVATIONS:

LEAKAGE IN UMFGC WASHROOMS

DEVICE:	# OF UNITS	# WITH LEAKS	PERCENTAGE	ml/min. TOTAL LEAKAGE	# UNITS UMFGC	UMFGC LEAKAGE
WATER FOUNTAIN	35	1	2.86	360	500	5148.0
TOILET	93	5	5.37	* 52.5	537	302.8
FAUCET	139	4	2.88	23.1	702	116.7
URINAL	95	4	4.21	779.2	189	1550.0
SHOWER	45	6	13.33	1349	50	1498.5
OTHER	2	0	0	0	5	0.0

* AT 4 GALS/DAY LEAKAGE (Buzzelli et al, 1991).

TOTAL = 8616 ml/min.

4528.5 m3/year

159924.9 Cu. Ft./year

TOTAL = 0.53% of UMFGC 1993 (estimated) water use.

or, $ 4,131 of UM 1993 water bill.

Leakage of fixtures is a very small component of the total amount of water used. Normal maintenance procedures are adequate to address normal leakage. No intensive leak maintenance program appears to be needed at the U of M.

Appendix 6

WATER CONSERVATION IDEAS

A variety of conservation practices can be implemented at the University of Manitoba, Fort Garry Campus. The following list of water conservation ideas is taken from the literature and are divided into water use categories.

General Suggestions:

-Increase staff, faculty, and student awareness of water conservation.

-Seek University of Manitoba staff, faculty, student suggestions for water conservation, especially from those in high water demand areas.

-Carry out water audits for all water users to determine quantity and purpose of water being used.

-Meter the rest of the campus to better understand where/how water is being used.

-Increase internal (University of Manitoba) water charge to campus water users.

-Install signs in all water use areas encouraging conservation.

-Read water meters weekly to better monitor success of water conservation efforts.

-Conduct contests between similar water users (e.g. the student residences, or the various food services on campus) to see who can reduce water use the most.

-Educate students and staff w.r.t. what substances can safely be washed down drains and/or eliminate or reduce need for flushing chemicals down drains in science labs.

-Consider reclaiming "grey water" for irrigation and other NON-POTABLE uses (heating, cooling, construction)

Building Maintenance

-Check water supply system for leaks and repair promptly.

-Turn off unnecessary flows.

-Repair leaky faucets/showers and running toilets. Discontinue use of automatic flow urinals

-Install flow reducers and aerators in all plumbing fixtures where possible (as fixtures wear out) and replace them with water-saving models.

-Reduce water used in toilet flushing by adjusting vacuum flush mechanisms or installing toilet tank displacement devices.

-Minimize water used in cooling equipment.

-Reduce load on air conditioning units by shutting off units when not in use.

-Keep hot water pipes insulated.

-Avoid excessive boiler and air conditioner blow down.

-Instruct clean-up crews to use less water for mopping.

-Change window cleaning and other cleaning schedules from periodic to an on-call/as needed basis.

Kitchen and Laundry Areas

-Wash only full loads of dishes/clothes.

-Replace spray heads to reduce water flow.

-Recycle rinse water from the dishwasher or recirculate it to the garbage disposal.

-Do not use running water to melt ice or frozen foods.

-Use water conserving ice makers.

-Pre-soak utensils and dishes in ponded water instead of using a running water rinse.

-Use water from steam tables in place of fresh water to wash down floors in cooking areas.

-Evaluate washing machine cycles for water use efficiency.

Pool

-Lower pool water to reduce amount of water splashed out.

-Use a pool cover to reduce evaporation when pool is not in use.

-Reduce amount of water used to clean pool filters.

Exterior Areas

-Inventory outdoor water use for landscaped areas.

-Water landscape only when needed.

-Water vehicles less often.

-Do not use water to clean sidewalks, parking lots etc...

-Future parking lots and sidewalks should be built with permeable asphalt or interlocking bricks to allow water to flow into the ground and help recharge groundwater supplies.

-Convert from high water-using lawns, trees and shrubs to landscape incorporating plants requiring less water (xeriscape). Design future landscapes that require less water.

-Avoid landscape fertilizing and pruning that stimulates excessive growth.

-Remove weeds and unhealthy plants so remaining plants can benefit from the saved water.

-Time watering to occur in the early morning or late evening when evaporation is lowest. Be aware of changing seasonal water needs of plants.

-Make sure irrigation equipment is well maintained.

-Mulch around plants reduces evaporation and discourages weeds.

-Aerate turf to encourage movement of water to roots.

-Do not water on windy days.