EVALUATION OF THE SMALL RESERVOIR PROGRAM FOR RURAL WATER SUPPLY

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December 31, 1974

ABSTRACT

This is the final report of a study concerned with the evaluation of certain reservoir and rural water supply projects in the Province of Ontario assisted under the Agricultural and Rural Development Act. (ARDA).

In Part I of this report a framework and format for the collecting and compiling of operational performance monitoring data on water resource projects are set out. With reference to such a framework and format, performance monitoring is carried out for the Orangeville Dam and Deer Creek Reservoir projects. Problems concerning insufficiency of project or planning data are highlighted.

Where possible, comparisons of pre-project data are made with post project data and inconsistencies examined. Serious inconsistencies are generally found to be lacking although in the case of the Orangeville Dam, the federal share of eligible costs is recorded in the records of the Ontario Conservation Authority as being significantly less than the allowable 37.5%. Suggestions are also made for the adoption of standardized project appraisal and operational performance monitoring frameworks which are compatible for analysis purposes.

Except for minor editing, Part I was presented previously as an interim report.

Part II of this report carries out the impact study which was the subject of a previous feasibility study. Impacts on pertinent social and economic variables are estimated for the Orangeville Dam and Deer Creek Reservoir projects. These two projects, chosen so that they have different objectives, appear to exert differing impacts on the area economy. The Orangeville Dam, the more expensive and earlier of the two, is shown to affect all sectors of the economy, which would appear to be consistent with its objectives. It would appear that the Deer Creek Reservoir primarily affects the agricultural sector in 1971. This is again consistent with its objectives.

Post-project benefit-cost analysis is not attempted as it is infeasible at this time given the data limitations on small area data. Comments are made with regard to the feasibility of performing such an analysis in a post-project sense after the 1976 census becomes available.

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PART I

1. Introduction

This is the final report of a study concerned with the evaluation of certain reservoir and rural water supply projects assisted under the Agricultural and Rural Development Act (ARDA) in the Province of Ontario. The aims of this study as set out in the terms of reference of the contract are as follows:

a) to compile data relating to the Orangeville Dam and Deer Creek Reservoir projects assisted under ARDA;

b) to devise an appropriate framework and format for the presentation of operational performance monitoring data on water resource projects and, with reference to the foregoing, discuss data applicable to the Orangeville Dam and Deer Creek Reservoir;

c) to calculate measures of efficiency of the Orangeville Dam and Deer Creek Reservoir in achieving their objectives;

d) to estimate the impacts of the Orangeville Dam and Deer Creek Reservoir on their respective areas.

Part I of this report will set out and discuss the findings of study components (a) and (b). Specifically, it will present and discuss the operational performance monitoring data applicable to the Orangeville Dam and Deer Creek Reservoir with reference to the framework and format devised for the presentation of such data on water resource projects. As well, general program data and project specific data compiled from the records of the Ontario Conservation Authorities Branch will be presented for the Orangeville Dam and Deer Creek Reservoir.

The Small Reservoir Program for Rural Water Supply was initiated in 1964 by the Ontario provincial government to encourage conservation authorities and rural municipalities to improve their rural water supply. Under this program, the province financed 75% of the cost of acquiring land and constructing dams and reservoirs for purposes of increasing water supply for irrigation, stock watering, fire protection and recreation. In 1966 the program was incorporated into the Second Federal-Provincial Agricultural and Rural Development Agreement and in this context was seen primarily as a means of improving and developing rural water resources in selected areas in both Southern and Northern Ontario in order to stimulate rural economic development. Under this new arrangement, the federal and provincial governments each agreed to contribute 37½ % of the cost of acquiring land and constructing dams and reservoirs. The conservation authority or municipality contributed the remaining 25% and was also responsible for the maintenance and operation of the water supply installations.

The ARDA II agreement dealing with the Small Reservoir Program was signed on October 13, 1966. In this agreement it is stated that "in all cases the benefits are totally for rural people"[1]. However, as this report will indicate, it would seem that, in practice, not all ARDA funded water resource projects benefit only rural people. It should also be remembered that in this respect the objectives of the Conservation Authorities Branch are not identical with those of the Ontario ARDA

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[1] ARDA Agreement: Small Reservoir Program dated October 13, 1966.

administration. The latter is primarily interested in assisting rural people whereas the Ontario Conservation Authority, in this instance, is primarily concerned with increasing the supply of water.

Between 1966 and May, 1972, ARDA expenditures in connection with the Small Reservoir Program amounted to $8,971,942 and involved 144 water supply schemes. Of these projects, 57 were constructed in Southwestern Ontario at a cost of $5,650,291. That is, 39.6% of the total number of projects funded under ARDA during this period were located in Southwestern Ontario and 62.97% of the pertinent ARDA expenditures were in relation to developments in this region. Because of the relatively high degree of urbanization of this area, it is improbable that no urban people benefited from ARDA funded dam and reservoir projects. Thus, it would seem that the objective of confining the benefits to the rural population is not likely to have been met in practice.

2. Project Data: Orangeville Dam

The construction of the Orangeville Dam and Reservoir was first recommended in the Credit Valley Conservation Report, 1956 to prevent flooding and supplement water flows in the dry summer months. In 1957, the authority received a 50% provincial grant under the Conservation Authorities Act to acquire land for the project. This scheme involved the acquisition of 515 acres of land at a cost of $30,000 from 19 different land owners. Engineering studies were undertaken in 1965 and 1966 to determine design criteria for the project. Construction began in 1967 and was completed in 1970. The construction contract was awarded to Capital Paving Limited, Guelph, for $693,924.

The Orangeville Dam is located in the Township of Mono, County

of Dufferin, just north of the town limits of Orangeville. It is the second largest water supply project funded under ARDA II. The reservoir is situated in a basin used mainly for grazing with some cultivation of the higher areas and waste cedar swamplands in the lower sections. The reservoir site itself was mostly swampland with a 15 acre lake in the northeast portion. No existing buildings in the area were flooded in the creation of the reservoir. For more detailed information concerning this project refer to Table 1.

TABLE 1: CHARACTERISTICS OF THE ORANGEVILLE DAM

Location	Township of Mono, County of Dufferin
Objective	Flood Control
Sub-objective	Supplementation of low summer flows
Other Benefits Accruing	Recreation Pollution abatement Improved wildlife habitat
Main Benefiting Municipality	Town of Orangeville
Total Cost	$1,113,910
Construction Commenced	July, 1967
Construction Completed	North Dam: September, 1968 Main Dam: November, 1968 Reservoir: 1969
Project Appraisal Benefit-Cost Ratio	Not indicated by consulting engineers

The Orangeville Dam and Reservoir project involved the construction of the Main Dam, the North Dam, a reservoir and a control structure. The

North Dam is located 5,000 feet north of the Main Dam and is required in order to prevent water in the reservoir from flowing northward into the Nottawasaga River Valley. The reservoir is designed to store winter runoff in excess of approximately three cubic feet per second (c.f.s.) during the months from December to May, thus enabling a steady release of ten c.f.s. during the six months from June to November. As well, the design is such that all floods up to the 1 in 25 year flood should be controlled. The physical specifications for the facilities constructed are given in Table 2.

TABLE 2: PHYSICAL SPECIFICATIONS: ORANGEVILLE DAM

RESERVOIR	Total length: 2 miles Average Width: 1,500 feet Water Storage Volume: 2,300 acre/feet Surface Area: 430 acres
MAIN DAM	Total Length: 1,700 feet Maximum Bottom Width: 1,100 feet Maximum Height: 20 feet
NORTH DAM	Total Length: 1,800 feet Maximum Bottm Width: 1,200 feet Maximum Height: 17 feet
CONTROL STRUCTURE	Crest Length: 90 feet Maximum Probable Flood Discharge: 4,400 c.f.s.

It is understood that the Ontario Conservation Authority Branch has a cost-benefit analysis undertaken by consulting engineers when uncertainty exists as to the benefits of a proposed project. However, in the consulting engineers' report on the Orangeville Dam project no attempt was made to put any dollar value on the three benefits thought to accrue - viz: increased summer flow, dilution of municipal sewage and flood control.

Subsequently, as some rough working papers indicate, the Conservation Authorities Branch attempted to assign dollar values to the benefits accruing from the project. These were assumed to be flood control, recreation, pollution abatement, increased flow and wildlife enhancement. The life of the project was assumed to be 100 years and the interest rate 5%. Other assumptions were not specified. The benefits were computed to be $1,170,000. However, calculations of benefits do not appear to have followed standard present value methods. It was noted that even if the extreme estimated cost of the dam and reservoir ($1,200,000) was used, the cost-benefit ratio would still be close to 1:1. It should be noticed that this extreme estimate was, in fact, very close to the total final cost. The problems involved in the analysis of the benefits accruing to the Orangeville Dam will be considered and discussed in more detail in conjunction with the analysis of the efficiency of the project in achieving its objectives which will be presented in Part II of this report.

While searching the files of the Ontario Conservation Authorities Branch, it was noticed that after the construction of the Orangeville Dam, there was a problem of flooding at the sewage treatment plant located downstream of the dam project. A drainage study of the Credit River basin was commissioned in 1971 to investigate flooding, drainage and erosion problems along the Credit River in the Town of Orangeville. It would appear that the problem of flooding has now been dealt with satisfactorily.

3. Project Data: Deer Creek Reservoir

The Deer Creek Reservoir is located in the Township of North Walshingham, Norfolk County, approximately 2 3/4 miles south of the

Village of Langton and 15 miles west of Simcoe. It is in the middle cost range of water supply projects funded under ARDA II and offers a different range of benefits than the Orangeville Dam. The primary purpose of the Deer Creek Reservoir is the supply of irrigational water requirements to the agricultural crops in the region. Engineering studies were undertaken in 1967 and 1968 to determine the feasibility and design criteria of the project. Construction began in 1968 and was completed in 1969. The construction contract was awarded to O.J. Gaffney Limited, Stratford. For supplementary information regarding the Deer Creek Reservoir, refer to Table 3.

TABLE 3: CHARACTERISTICS OF THE DEER CREEK RESERVOIR

Location	Township of North Walsingham, County of Norfolk
Objective	Irrigation
Sub-objective	Supplementation of low summer flows
Other Benefits Accruing	Water supply for Langton Stock watering Recreation
Main Benefiting Municipality	Township of North Walshingham
Total Cost	$328,851
Construction Commenced	July, 1968
Construction Completed	July, 1969
Project Appraisal Benefit-Cost Ratio	2.2:1

The Deer Creek Reservoir is located in the middle of an intensive tobacco growing area; the other main crops in the region include grain and corn. The land directly affected by the proposed flooding is all strictly bottomland, wasteland, steep slopes and wooded areas. All these lands are part of tobacco farms except in one instance where a mixed tobacco-pasture operation is involved. No existing buildings in the area were flooded to create the reservoir. For more detailed information concerning land use in the drainage basin refer to Table 4.

TABLE 4: LAND USE IN BASIN: DEER CREEK RESERVOIR

Land Use (1966)	Area	
	Number of Acres	Percentage Distribution
Grain:		
Winter Wheat	781	17.2
Buckwheat	3	0.1
Winter Rye	171	3.8
Oats	26	0.6
Barley	5	0.1
Tobacco	1115	24.6
Corn	399	8.8
Summer Fallow	70	1.6
Hay	52	1.2
Pasture: Improved	128	2.8
Unimproved	25	0.6
Wooded Lands and Forests	1192	26.3
Urban Area: Roads and Buildings	298	6.6
Idle Wasteland	177	3.9
Water (Ponds and Reservoir)	85	1.8
Total	4,527	100.0

The Deer Creek Reservoir project, funded under ARDA, involved the construction of a dam and reservoir. The physical specifications for these facilities are given in Table 5. At the time of construction of the Deer Creek project, a road and bridge were also constructed by

O.J. Gaffney Limited across the lands and structures of the conservation works. This new county development road is part of a main traffic artery going west to Aylmer. The cost of constructing the road and bridge was shared between the Ontario Department of Highways and the County of Norfolk. The total cost of the road and bridge was approximately $366,000.

TABLE 5: PHYSICAL SPECIFICATIONS: DEER CREEK RESERVOIR

Surface Area of Reservoir:	76 acres
Permanent Reservoir Level:	657.5 G.S.C.
Water Storage Volume:	1,485 acre-feet
Greatest Water Depth:	45 feet
Average Water Depth:	30 feet
Flood Storage Level:	667.85 G.S.C.

In the case of the Deer Creek Reservoir, a cost-benefit analysis was done as part of a preliminary engineering study carried out by a firm of consulting engineers. The economic life of the project was assumed to be 50 years and an interest rate of 4% was used for discounting. The benefit-cost ratio was computed with only one benefit quantified-irrigation. Additional benefits such as recreation, stock watering and water conservation were not assigned a dollar value. However, it was pointed out that if one were to consider these additional benefits it could only increase the benefit-cost ratio. Irrigation benefits were computed on the basis of the following crops-tobacco, corn, hay, pasture, vegetables and strawberries. With no irrigation project, only tobacco, corn, hay and pasture were considered in the computations. The reasoning for assuming different land use in the area with the irrigation project was not explained. On this basis, the benefit-cost ratio was computed to be 2.2:1. This benefit-cost analysis will be discussed

further as part of the calculation of measures of efficiency which will be done in conjunction with the impact evaluation phase.

During the search of the Ontario Conservation Authority files, reported complaints were noted. In one instance, a farmer complained of flooding in his cornfield. Since this was mentioned only once in the correspondence, it would appear that the problem was promptly dealt with and a solution was found that was satisfactory to both parties. Also, with the filling of the reservoir, a future road allowance in the area was flooded. The Conservation Authority subsequently purchased this land from the Township of North Walsingham.

4. A Framework for Operational Performance Monitoring

Operational performance monitoring is concerned with program inputs and direct outputs. Thus, for example, capital expenditures (and, where appropriate, other factor inputs) may be related to pertinent physical output measures, while the number of dollars spent may be categorized under various headings. Operational performance monitoring also provides a means whereby regular comparisons may be drawn between estimates of key variables or values made in the project planning stage and the corresponding figures achieved in practice. For physical development projects, such comparisons will normally encompass costs of construction, volume of output and timing of development.

In the case of the Orangeville Dam and Deer Creek Reservoir the operational performance monitoring is being carried out after the completion of the projects rather than throughout the construction of the projects. However, the approach developed for these two projects will serve to define an appropriate framework for the operational performance

monitoring of other water resource projects not yet undertaken. Also, any monitoring data which are found not to have been collected for the Orangeville Dam and Deer Creek Reservoir could, if possible, be recorded for future water resource projects.

The following variables are considered as candidates for inclusion in the operational performance monitoring phase of the evaluation. Under ideal conditions, it would be desirable to collect data on all the following variables.[2]

I PROGRAM LEVEL DATA

1. Annual program expenditures by primary purpose (flood control; irrigation; water supply; recreation; other).
2. Annual program expenditures by type of expenditure (land acquisition; construction; engineering; surveys and miscellaneous; administration).
3. Number of projects by primary purpose.
4. Number of projects approved, underway, completed.
5. Number of man-years employment, technical and professional, by occupational classification.
6. Total Cost; Shareable Cost; Federal Share; Provincial Share; Authority Share.

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[2] Total availability of data for a variable is denoted by *; partial availability by + .

II PROJECT LEVEL DATA

+1. Actual and approved annual expenditures on: land; construction (by type of facility); engineering; surveys and miscellaneous; administration; maintenance.

*2. Total Cost; Shareable Cost; Federal Share; Provincial Share; Authority Share.

*3. Number and amount of payment claims.

+4. Actual and expected facilities complete/incomplete/not started by year.

+5. Number of acres of farmland removed from production.

+6. Number of man-years employment (local; other) in construction/ maintenance.

+7. Number of "benefiting acres"[3]

+8. Cost per "benefiting acre".

*9. Cost per acre-foot of conservation storage.

+10. Total and federal cost per man-year employment.

11. Revenues paid for domestic/agricultural water supply.

12. Revenues generated through recreational facilities of the project.

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[3] "Benefiting acres" is not a well defined concept in the general context of a water resource project. However, in relation to a specific project with specific purposes, various proxy measures can be defined. For example, in the case of a project whose major purpose is flood control, "benefiting acres" could be defined as the number of acres newly protected. "Protected" could then be rigourously defined in order to operationalize the measure.

13. Seasonal peak flow of water.

14. Number of urban water supply connections on the system.

15. Number and amount of farmers' insurance claims.

It would be desirable to collect data on the above set of variables in relation to any water resource project. However, this may not always be possible. Of the measures presented above, those listed under Part I relate to the overall program. It would be desirable to have such measures reported on an annual basis to provide a program summary. However, such summary information is not available from the Conservation Authorities Branch and it is not the purpose of this study to compile these data. The measures listed in Part II above relate to specific projects. The data relating to these measures have been collected, wherever possible, on an annual basis for the Deer Creek Reservoir and the Orangeville Dam and are presented in the following sections of this report.

5. Operational Performance Monitoring: Orangeville Dam

In this section, the operational performance monitoring data are presented and discussed for the Orangeville Dam. These data were computed and tabulated from the files of the Ontario Conservation Authorities Branch.

The actual annual costs by type of expenditures for the Orangeville Dam were computed from the payment claim forms made available by the Accounts Section, Ontario Department of Energy, Mines and Resources. These costs were not available for all the types of expenditure indicated in Section 4. However, on these forms the actual costs were subdivided according to preliminary engineering, land acquisition, development, construction and other. There were no figures or estimates available for the costs of administration or of maintenance. The actual costs by year for the

Orangeville Dam are given in Table 6. There are also no data on the approved annual costs. However, approved total cost figures are available.

As was previously mentioned, the Orangeville Dam was essentially completed by 1970 (1970-71 fiscal year). However, it is not surprising that there were some expenditures after this date. The expenditures for land acquisition may be settlement payments made to parties who initiated protest action when the initial purchase offer was made. The construction costs in 1971-72 could possibly be back payments owed to the contractor. The expenditure for construction in 1973-74 was for fencing at the reservoir site. It would appear that the expenditure for "development" in 1968-69 is an error on the audit form. From the description of the work completed on this form, it seems likely that this cost should have been included in the construction total for 1968-69. Other than the above mentioned, there are no other unusual expenditures for the Orangeville Dam.

For the Orangeville Dam, there appear to be no data available for approved annual costs. However, there are two estimates of approved total costs by type of expenditure - in 1967 and in 1970. In 1970, a revised estimate of the total costs was made. An additional grant of $39,375 was approved at this time for additional costs incurred to complete the dam and reservoir. These additional costs were due to increases in land costs and survey, legal and appraisal fees. For the actual and approved total costs by type of expenditure for the Orangeville Dam and Reservoir, refer to Table 7.

TABLE 6: ACTUAL ANNUAL COSTS BY TYPE OF EXPENDITURE: ORANGEVILLE DAM

Type of Expenditure	Fiscal Year								
	1966-67	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75 (to Aug. 74)
	$	$	$	$	$	$	$	$	$
Preliminary Engineering	43,365								
Land Acquisition			43,428				423		1,000
Development			27,451						
Construction		277,199	613,201	85,036	20,882	1,610		315	
Other									
Total	43,365	277,199	684,080	85,036	20,882	1,610	423	315	1,000

TABLE 7: ACTUAL AND ESTIMATED COSTS BY TYPE OF EXPENDITURE: ORANGEVILLE DAM

Type of Expenditure	Original Estimate (1967)	Revised Estimate (1970)	Actual	
			Amount	Percentage Distribution
	$	$	$	
Prelininary Engineering	50,180	50,180	43,365	3.89
Land Acquisition	66,000 (160 acres)	200,000 (179 acres)	44,851	4.03
Development	-	-	27,451	2.46
Construction	950,000	893,000	998,243	89.62
Other	30,500	6,000	-	-
Total	1,096,680	1,149,180	1,113,910	100.0

The land acquistion estimates found in Table 7 include survey, legal and appraisal fees. The construction estimates include engineering and contingency costs. The revised estimate of the total cost of the Orangeville Dam is closer to the actual costs incurred than is the original estimate. However, the component estimates differ substantially from those of the actual. There would seem to be no apparent reason for budgeting $200,000 for land acquisition when the actual expenditures for acquiring land were only approximately $45,000. It may be that the survey, legal and appraisal fees did not increase as much as expected or perhaps the actual construction costs include some of these fees. This could not be determined from the claim forms. In any case, the original estimate is a much better indication of the actual costs of land acquisition.

It also appears that the costs of construction had decreased by 1970. However, after completion of the project, it is evident that this was not the case. The final construction costs are higher than both estimates. The fact that there were no planned expenditures for "development"

would seem to support the hypothesis that those actual expenditures so classified should be considered construction costs. If this hypothesis is true, then 92.08% of the total costs are construction expenditures. The expenditures listed under "other" in both estimates in Table 7 comprise bank interest. The extent to which such a charge entered, if at all, into actual costs could not be determined from the payment claim forms.

For the actual total, shareable, federal, provincial and authority costs by year, refer to Table 8. Table 9 contains these actual and estimated total costs. Shareable cost is defined to be the sum of the federal and provincial shares for those claims in which the federal government contributed.

TABLE 8: ACTUAL COSTS BY YEAR: ORANGEVILLE DAM

Costs	FISCAL YEAR								
	1966-67	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75 (to Aug.1974
	$	$	$	$	$	$	$	$	$
Total	43,365	277,199	684,080	85,036	20,882	1,610	423	315	1,000
Shareable	-	-	512,848	63,777	-	-	98	236	750
Federal	-	-	255,811	31,889	-	-	49	118	375
Provincial	32,524	207,899	257,037	31,888	15,662	1,207	268	118	375
Authority	10,841	69,300	171,232	21,259	5,220	403	106	79	250

TABLE 9: ACTUAL AND ESTIMATED COSTS: ORANGEVILLE DAM

Costs	Original Estimate (1967)	Revised Estimate (1970)	Actual	
			Amount	Percentage Distribution
	$	$	$	
Total	1,096,680	1,149,180	1,113,910	100.0
Shareable	784,876	824,250	577,610	51.9
Federal	392,438	412,125	288,242	25.9
Provincial	392,438	412,125	546,978	49.1
Authority	311,804	324,930	278,690	25.0

As can be seen in Table 8, according to the Ontario Conservation Authorities payment claims, the federal government did not contribute to the cost of the Orangeville Dam in the years 1966-67, 1967-68, 1970-71, or 1971-72. During these years, the provincial government is shown as contributing 75% of the total expenditures and the authority 25%. There are several possible explanations for this. It would appear that not until 1968-69 did the provincial government begin to use, for the Orangeville Dam, the federal funds allocated under ARDA to the Small Reservoir program. Consultations with the Ontario Conservation Authority indicate that a probable explanation for this is that the Orangeville Dam was not an ARDA project until 1968-69. It was also indicated in this consultation that perhaps certain land purchases included in the total cost were not eligible under ARDA. Since funds allocated under ARDA II for the Small Reservoir Program were not project specific, it would appear there was no necessity for the federal share for a given project to be 37.5%. Thus, funds may have been shifted from this project to another project under the program. The above reasoning would also explain the percentage distribution of the actual costs found in Table 9.

The number and amount of payment claims each year for the Orangeville project are given in Table 10. The amount of payment claims is defined to be 75% of the total cost on each claim since the local

authority contributes 25%. As would be expected, the majority of the claims are during the actual construction of the project.

TABLE 10: NUMBER AND AMOUNT OF PAYMENT CLAIMS: ORANGEVILLE DAM

Payment Claims	Fiscal Year								
	1966-67	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75 (To Aug./74
Number	7	15	24	7	2	2	2	2	1
Amount ($)	32,524	207,899	512,848	63,777	15,662	1,207	317	236	750

The number of acres removed from production in order to construct the Orangeville Dam was obtained from the land acquisition files of the Ontario Conservation Authorities. As part of the land acquisition process, an appraiser files a report giving the type of land involved and a fair price for the purchase. From these sources, data on the number of acres removed from production, by type of use, were obtained and are presented in Table 11. However, the acreage does not include 515 acres of land purchased by the Conservation Authority in the late 1950's. There was no information available on the classification of this land. Hence, Table 11 refers to only that land purchased between 1966 and August, 1974. The land was classified as homesite, pastureland, slash or other. Of the total area removed, 52 acres, or 29.1%, was farmland.

TABLE 11: NUMBER OF ACRES REMOVED FROM PRODUCTION BY TYPE OF USE: ORANGEVILLE DAM

Type of land	Area	
	Number of acres	Percentage Distribution
Homesite	20	11.1
Pastureland	52	29.1
Slash	54.1	30.4
Other	52.6	29.4
Total	178.7	100.0

During the construction phase of the Orangeville Dam, progress reports were filed by the supervising engineer which contained information on the number of men working constructing the dam. Using these data, it is possible to compute the number of man-years employment in construction. The progress reports for the Orangeville Dam were filed on a monthly basis. To compute the number of man-years employment created, the total number of man-months was converted to man-weeks. Then, assuming that 48 man-weeks is equal to 1 man-year, the number of man-years was determined. For the number of jobs created in construction for the Orangeville Dam, refer to Table 12.

TABLE 12: EMPLOYMENT IN CONSTRUCTION: ORANGEVILLE DAM

Employment	Fiscal Year	
	1967-68	1968-69
Man-weeks	832	674
Man-years	17.3	14

As previously stated, the construction of the Orangeville Dam was essentially completed by 1968-69. However, there was some work done on the reservoir subsequently, although the Conservation Authority files do not contain progress reports on these latter phases of construction. During 1967-68, the contractor worked from July, 1967 to March 31, 1968, a 39 week period. During this period, 832 man-weeks, or 17.3 man-years, employment were created. Hence, there was an average of 21.3 full-time construction workers per week during the period July 1, 1967 to March 31 1968. In the 1968-69 fiscal year, 674 man-weeks, or 14 man-years, employment were created in the 35 week period between April 1, 1968 and November 30, 1968. Therefore, there was an average of 19.3 full-time workers per week from April 1, 1968 to November 30, 1968. For purposes of estimating employment and income effects, it would be desirable to know how much of this employment and resulting wages went to local persons. This is not known but since the contracting firm was Capital Paving Limited, Guelph, it is likely that most of the man-years employment created benefited employees of this firm from outside the locality.

No annual data are apparently available on the number of man-years employment in maintenance of the project. The Credit Valley Conservation Authority, however, was able to provide some information. There is one full-time dam operator at the dam site at all times and a four or five man work crew working on maintaining and developing the area. If operational performance monitoring were to be undertaken in future years, the required information could be provided. However, no data on past years are currently available.

Three cost effectiveness ratios are calculated relating to water storage and employment. The total cost per acre-foot of conservation storage is calculated to be $484. The total cost per

man-year employment is computed to be $35,588 and the federal cost per man-year employment is $9,209. Note that man-year employment figures refer only to the construction phase as data are not available for the other phases.

The files of the Ontario Conservation Authority contained no information on the number of "benefiting acres" and hence, the cost per "benefiting acre" could not be calculated. Neither were any detailed data available on the actual and expected facilities complete/incomplete/not started by year. In this regard, the only data provided were the completion dates of the facilities involved. There have been no revenues generated through recreational usage of the Orangeville project. There were apparently no data on revenues paid for domestic/agricultural water supply, seasonal peak flow of water, the number of urban water supply connections or the numbers and amount of farmers' insurance claims.

6. Operational Performance Monitoring: Deer Creek Reservoir

In this section, the operational performance monitoring data will be presented and discussed for the Deer Creek Reservoir. These data were also computed and tabulated from the files of the Ontario Conservation Authorities Branch.

For the Deer Creek Reservoir, the payment claim forms provided by the Accounts Section, Ontario Department of Energy, Mines and Resources were used to tabulate the actual annual costs by type of expenditure. These costs were subdivided in the same manner as those of the Orangeville Dam. Again, there were no figures or estimates available for the cost of administration or maintenance. The actual annual costs for the Deer Creek Reservoir are given in Table 13. As in the case of the Orangeville Dam, there are apparently no data on the approved annual expenditures. However, approved total cost figures are available.

TABLE 13: Actual Annual Costs by Type of Expenditure: Deer Creek Reservoir

Type of Expenditure	Fiscal Year					
	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73
	$	$	$	$	$	$
Preliminary Engineering	8,000					
Land Acquisition		3,054	10,221			433
Construction		233,599	63,716	3,965		
Other		5,863				
Total	8,000	242,516	73,937	3,965		433

As previously mentioned, the Deer Creek Reservoir was essentially completed in the 1969-70 fiscal year. The two small expenditures incurred after this date are not unusual. The construction cost in 1970-71 could possibly have been back bills owed to the contractor or payments for miscellaneous work required to complete the project. The land acquisition expenditure in 1972-73 includes the cost of the land purchased from the Township of North Walsingham because of the flooding of the future road allowance. The expenditure classified as "other" in 1968-69 is for the clearing of the reservoir site. Hence, there would seem to be no inconsistencies in the actual annual costs for the Deer Creek Reservoir.

There are no data available on approved annual costs for the Deer Creek Reservoir. However, there are two estimates, made in 1968 and 1969 respectively, of approved total costs by type of expenditure. Also, in 1969, an additional grant of $22,500 was approved for additional costs incurred to complete the project. For the actual and approved total costs by type of expenditure for the Deer Creek Reservoir, refer to Table 14.

Table 14: Actual and Estimated Costs by Type of Expenditure: Deer Creek Reservoir

Type of Expenditure	Original Estimate (1968)	Revised Estimate (1969)	Actual	
			Amount	Percentage Distribution
	$	$	$	
Preliminary Engineering	9,000	9,000	8,000	2.43
Land Acquisition	27,000	29,400	13,708	4.17
Construction	263,000	281,800	301,280	91.62
Other	12,000	12,000	5,863	1.78
Total	311,000	341,000	328,851	100.00

The revised estimate of the total cost of the Deer Creek Reservoir is somewhat closer to the actual total cost incurred than is the original estimate. However, the component estimates, in some cases, differ substantially from the costs actually incurred. In both estimates, the amount budgeted for land acquisition is much greater than the actual cost of acquiring land. The actual construction cost is also greater than either of the estimates. Perhaps some of the charges on the claims forms for construction should actually be listed under land acquisition. The expenditures listed under "other" in both estimates are for the clearing of the reservoir site. It should be noted that the percentage distribution of the actual costs for the Deer Creek Reservoir is very similar to that of the Orangeville Dam.

For the actual total, shareable, federal, provincial and authority costs by year, refer to Table 15. The actual and estimated total costs are given in Table 16.

Table 15: Actual Costs by year: Deer Creek Reservoir

Costs	Fiscal Year					
	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73
Total	$ 8,000	$ 242,516	$ 73,937	$ 3,965	$	$ 433
Shareable		181,886	55,453			
Federal		90,143	27,114			
Provincial	6,000	91,743	28,339	2,974		325
Authority	2,000	60,630	18,484	991		108

As can be seen in Table 15, the federal government apparently did not contribute to the cost of the Deer Creek Reservoir in the years 1967-68, 1970-71 or 1973-74. This is the same pattern noticed for the Orangeville Dam. Similar reasons as those hypothesized for the Orangeville project

might explain the apparent deficiencies in federal funding. It should be noted that, in this case, the percentage of federal funding is much closer to the maximum allowable, 37.5%, than in that of the Orangeville Dam.

Table 16: Actual and Estimated Costs: Deer Creek Reservoir

Costs	Original Estimate (1968)	Revised Estimate (1969)	Actual	
			Amount	Percentage Distribution
	$	$	$	
Total	311,000	341,000	328,851	100.00
Shareable	226,500	249,000	237,339	72.17
Federal	113,250	124,500	117,257	35.66
Provincial	113,250	124,500	129,381	39.34
Authority	84,500	92,000	82,213	25.00

The number and amount of payment claims each year for the Deer Creek Reservoir are given in Table 17. As would be expected, the majority of the claims are during the construction phase of the Deer Creek Reservoir.

Table 17: Number and Amount of Payment Claims: Deer Creek Reservoir

Payment Claims	Fiscal Year					
	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73
Number	1	9	5	2	0	1
Amount ($)	6,000	181,886	55,453	2,974	-	325

The land acquisition files of the Ontario Conservation Authorities and the appraisal report for the Deer Creek Reservoir were used to determine the number of acres removed from production, by type of use, in order that this project could be undertaken. For the Deer Creek Reservoir, the land acquired is classified as bottomland, woodland, tobacco land or pastureland. The number of acres removed from production for the Deer Creek Reservoir is given in Table 18.

Table 18: Number of Acres Removed from Production by Type of Use: Deer Creek Reservoir

Type of Land	Area	
	Number of Acres	Percentage Distribution
Bottomland	59.2	20.0
Woodland	123.6	41.7
Pastureland	8.0	2.7
Tobacco Land	3.9	1.3
Type Unknown	101.4	34.3
Total	296.1	100.0

However, for 101.4 acres, or 34.3%, of the land acquired, the land use was not available. From Table 18, it is evident that at least 11.9 acres, or 4%, of the total acreage was farmland. From the land acquisition files, it was clear that none of the 101.4 acres was tobacco land. If the assumption is made that the acreage whose type is unknown has the same proportion of bottomland, woodland and pastureland as that of the 194.7 acres for which the land use is known, then 16.8 acres of the total would be pastureland, and 20.7 acres, or 6.9%, of the total acreage removed would be farmland.

During the construction of the Deer Creek Reservoir, progress reports were filed on a weekly basis by the supervising engineer. These reported the number of construction workers and were used to compute the number of man-years employment in the construction of the Deer Creek Reservoir. The number of man-weeks employment was computed from these reports and converted to man-years employment using the assumption that 48 man-weeks is equal to 1 man-year. The number of jobs created in the construction of the Deer Creek Reservoir is given in Table 19.

Table 19: Employment in Construction: Deer Creek Reservoir

Employment	Fiscal Year	
	1968-69	1969-70
Man-weeks	199	297.5
Man-years	4.1	6.2

Construction of the Deer Creek Reservoir began on July 21, 1968 and continued until October 5, 1968. The following year construction commenced again on April 6 and was completed by July 26. There were no progress reports for any construction after this date. During 1968-69, from July 21 to October 5, an 11 week period, 199 man-weeks, or 4.1 man-years, employment were created. Hence, there was an average of 18.1 full time construction workers per week during this time period. In the 1969-70 fiscal year, 297.5 man-weeks, or 6.2 man-years, were created in the 15 week period from April 6 to July 26. Therefore, during this time period, an average of 19.8 full time workers per week were employed in the construction of the Deer Creek Reservoir. The contracting firm for the Deer Creek project was O.J.Gaffney Limited, Stratford. Hence, it is likely that a majority of the men employed during the construction were imported from the Stratford area and therefore benefited from the project in the form of wages received.

There are no annual data available on the number of man-years employment in maintenance. However, the Long Point Conservation Authority provided the following information. There is one full time dam operator at the dam site at all times and a two or three man work crew working on the maintenance of the project. Again, if the operational performance monitoring were being done on a yearly basis, more data could be provided.

For the Deer Creek Reservoir project, the number of "benefiting acres" is available from the Ontario Conservation Authority files. In an Ontario Conservation Authority report, it is stated that the Deer Creek Reservoir would directly benefit 1,900 acres in the basin through the supply of irrigational water requirements. These acres are those above the dam site and immediately adjacent to the reservoir. However, the term "benefiting acres" was not defined in this report and should not be confused with the concept of "benefiting acres" introduced earlier.[4] For this reason, the number of "benefiting acres" in the current context should be considered only as an estimate of the true number of "benefiting acres".

Four cost-effectiveness ratios are calculated relating to water storage, employment and benefiting acres. The total cost per benefiting acre for the Deer Creek Reservoir is $173. This ratio is computed using the estimate of "benefiting acres" given previously. The total cost per acre-foot of conservation storage is calculated to be $222. The total cost per man-year employment is computed to be $31,927 and the federal cost per man-year employment is $11,384. Again, the man-year employment figures refer only to the construction phase as data are not available for the other phases.

For the Deer Creek project, there appears to be no detailed data on the actual and expected facilities complete/ incomplete/ not started by year. Only the completion dates are given. The amount of revenue generated through recreational facilities is not applicable to the Deer Creek Reservoir since no admission fee is charged for the use of such facilities. Data are also not available on revenues paid for domestic/ agricultural water supply, seasonal peak flow of water, the number of urban water supply connections or the number

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[4] See Page 12

and amount of farmers' insurance claims. We have already noted that these data are not available for the Orangeville Dam and this could also be the case for any other ARDA assisted water resource project in Ontario.

7. Comments

As is apparent throughout this Part, several desirable data are not available for the Orangeville Dam and Deer Creek Reservoir. Because of this, certain facets of an ideal performance monitoring evaluation could not be pursued. It would appear that the reason these items are unavailable is the lack of a standard project proposal and data reporting format. One of the purposes of this study has been to define such a reporting format. However, on the basis of the experiences gained in compiling the data for Section 4, there would appear to be a need to develop a format for project planning and updating which is compatible with the performance monitoring framework. Part of performance monitoring involves the comparison of actual with planned achievements. However, if information from the planning or pre-project phase is not available on a compatible basis with the actual or current project data, such comparisons cannot be made. This point is particularly relevant if current project performance monitoring is to be adopted.

As was mentioned previously, it may be doubted whether the benefits from the Orangeville Dam and Deer Creek Reservoir projects have accrued solely to rural people. In fact, as has been pointed out, a significant proportion of the jobs created in the construction phases of both projects were likely filled by individuals from urban areas in Southwestern Ontario. Although it is possible that long term benefits will accrue to persons from

rural areas, it would seem especially likely, in the case of the Orangeville Dam, that such benefits will also accrue to the urban population of Orangeville itself. As was also pointed out previously, the objective of confining benefits to persons in rural areas would appear to be impractical in the context of the Small Reservoir Program.

PART II

1. INTRODUCTION

This part of the report will deal with study elements (c) and (d) as set out in Part I, Section I - to calculate measures of efficiency of the Orangeville Dam and Deer Creek Reservoir in achieving their objectives; and, to estimate the impacts of the aforementioned projects on their respective areas. Within the context of the terms of reference of this study, these elements are to be discussed in a "post-project" sense as opposed to "pre-project".

The approach taken in the following sections is intended to isolate unexpected changes in variables of the impact areas for one or more years during which the project was in operation. This will be done on the basis of historical trends. Further, through the examination of trends in similar but unaffected areas, it will be attempted to determine as far as possible, the effects of the projects on their respective impact areas.

The remaining sections of this report will discuss the methodology employed, data limitations encountered in relation to the study elements and to the methodology, and will present the estimated impacts of the Orangeville Dam and Deer Creek Reservoir on the economies of their surrounding areas.

2. DATA LIMITATIONS

As was anticipated in the original feasibility study[1],

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[1] Feasibility Study of Econometric Simulation Techniques for Evaluating Certain Water Resource Projects Assisted Under ARDA in the Province of Ontario: Report submitted to the Department of Regional Economic Expansion by Susan M. Murray; March 31, 1974.

the major sources of small area data are the decennial and mid-decennial censuses. Since the projects under study were initiated after 1966, this use of census data allows estimation of post-project impacts (and benefits) only for 1971. Selected non-census data are available more frequently but cannot cover the full range of variables under study.

Due to multiplier effects in the local economy, one would expect cumulating effects of the project impacts from year to year through the operation of the multiplier process - in fact, this is borne out empirically in later sections of this study. Impact analysis estimates impacts in a specific year. These impacts will, thus, include the cumulated multiplier effects to that year. However, due to the cumulating effect of the multiplier, projection of actual impacts over a long period of time, would require estimated actual impacts for at least two, and preferably more years, for the full range of variables to be considered.

Thus, within the context of limitations of the use of census data, impact analysis will be possible wherever data are available for that year. Post-project benefit-cost analysis, on the other hand, cannot be attempted reliably on the basis of only one year's actual impact for the full range of variables. For this reason, the availability of small area data at five or ten year intervals to 1971 for most variables has made the calculation of a post-project actual benefit-actual cost ratio impossible. Even if such a ratio could be calculated after 1976 census data become available, the statistical reliability of this calculation would be questionable since, even then, there would be insufficient data on which to base a sound projection. Accordingly, the remainder of this report will deal solely with study element (d) - impact analysis.

In conducting this study, two types of general data limitations were encountered. The first, timing of the data, has been discussed above. The second limitation relates to lack of data on variables in key years. For example, retail sales statistics for 1971 were not yet attainable from Statistics Canada. These will not be available until the fourth quarter of 1975. Similarly, data on manufacturing and income were not available due to staff constraints at Statistics Canada. In both cases, alternative sources were utilized to estimate project impacts.

Missing observations were encountered for some variables, which did not prevent an estimated impact from being derived. Such problems will be noted when the estimated impacts are presented.

3. THE METHODOLOGY FOR IMPACT ANALYSIS

The general approach taken in the impact analysis was to examine the data relating to a pertinent variable for unexpected changes on the basis of historical trends. The areas presumed to have been affected by the projects were matched with unaffected areas on the basis of several economic indicators in 1966[1]. This matching was intended to provide a control area which had a social and economic structure similar to the impact area prior to the implementation of the project. Then, on the assumption that the control area will illustrate how the regional economy of the impact area would have evolved if the project had not been undertaken, one can attempt to isolate changes in the impact area which occur after the project was implemented. These changes represent "impacts" although this should not imply a direct cause and effect relationship. Causal relationships might be established for certain variables on the basis of the objectives of the projects. For example,

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[1] Ibid

in the case of the Deer Creek Reservoir, it would appear likely that such changes in the agricultural sector are directly related to the project. On the other hand, the Orangeville Dam has the potential to affect many sectors of the economy since it is a basic contribution to the economic infrastructure of the area. However, all the changes observed may not be due solely to the project.

The Orangeville Dam is located just north of the town limits of Orangeville, the main benefiting municipality. However, Orangeville is located near four township borders. Therefore, because of the nature of the project itself, and the geographic proximity of Orangeville to these townships, these townships may benefit from the project directly or through leakage effects. Hence, these four townships were used as the impact area for the Orangeville Dam project. The impact area consists of the Townships of Mono, Amaranth and East Garafraxa in Dufferin County and the Township of Caledon in Peel County. As determined in the feasibility study, the control area consists of the Townships of Bentinck, Normanby and Egremont in Grey County.

In the case of the Deer Creek Reservoir, the primary purpose is the supply of irrigational water requirements to the surrounding region-i.e. to the Township of North Walsingham, which is the main benefiting municipality. The other benefits accruing from the project are not as extensive as those of the Orangeville Dam. For these reasons, it was decided that any leakage effects the project might have would be negligible. Therefore, the Township of North Walsingham in Norfolk County was chosen as the impact area for the Deer Creek Reservoir analysis. The control area was chosen to be the Township of Middleton in Norfolk County.

Each control area possessed the same underlying social-economic structure as its impact area immediately

prior to project implementation. The control area then represents the historical trends over time in the impact area excluding the effects of the project. This is a necessary assumption since the implementation of the project may have altered the socio-economic structure of the impact area and, hence, the time trends.

The statistical methodology employed is a basic time series model with a time dummy variable inserted to represent project effects. Specifically, the model employed is

$$Yt = \alpha i + \beta t + \gamma PT + \varepsilon t \qquad (1)$$

where Yt = value of variable in year t

αi = constant effect in area i

t = time

PT = project time (= 0 if control area or prior to project implementation)

εt = random error

This linear model can be modified to accommodate non-linear trends where necessary. With short time series, the linear model is usually the most reliable so that this form was used unless an alternative form was significantly better. In fact, the only alternative which improved the fit was the exponential.

One special case of the model employed was used when more than one year's impact was estimable. In such cases, one might expect a shift in the constant effect and a cumulative multiplier effect. The model employed in these cases was

$$Yt = \alpha i + \beta t + \eta + \gamma PT + \varepsilon t \qquad (2)$$

where Yt, αi, t, PT, εt are as in (1) and

η = constant applied only in project period

In order to estimate the impact of the project on the variable Y,

an estimated value of Y must be calculated. This is the expected value of Y if the project was not undertaken. This can be easily seen to be $\hat{Y}t=\hat{\alpha}i+\hat{\beta}t$ where $\hat{\alpha}i$ and $\hat{\beta}$ are the estimates of the parameters of equations (1) and (2). Thus, the estimated value of the impact of the project on Y is $Yt - \hat{Y}t$ where Yt is the actual value in year t and $\hat{Y}t$ is the simulated value of variable in year t without the implementation of the project.

The accuracy of estimated impacts, of course, depends on the ability of the time series model to explain variations in Y. The statistic generally used to test this ability is the coefficient of determination, R^2. This statistic varies between zero and one, with proximity to one indicating an accurate fit. In fact, R^2 is the proportion of the variance of Y explained by the model. Thus, the accuracy of the estimated impact is directly related to the value of R^2. Appendix I presents the estimated models and their respective R^2 for all impact estimations.

4. ESTIMATED IMPACTS: ORANGEVILLE DAM

The Orangeville Dam would appear to be oriented towards rural development as well as agricultural development. It is a large project, in terms of size of expenditure, and thus, would appear to have the potential to affect many sectors of the regional economy. One might expect this because of the contributions this dam may have made to the economic infrastructure of the Town of Orangeville. As will be seen in the following tables, the estimated impacts of the Orangeville Dam are spread widely across the economy.

The following tables present the estimated impact of the Orangeville Dam on its aforementioned impact area. Table 20 relates to the agricultural sector in 1971; Tables 21-26 presents the income and business sectors in 1967-1972; Table 27, the quality of life and labour statistics in 1971; Table 28, the manufacturing statistics for 1967-1971.

TABLE 20: ESTIMATED IMPACTS: AGRICULTURE:

ORANGEVILLE DAM: 1971

VARIABLE	ACTUAL	ESTIMATE	IMPACT	% OF ACTUAL	% OF ESTIMATE
Total Value of Agricultural Products Sold ($) b-1	12,739,800	10,490,822.38	2,248,977.62	17.65	
Total Number of Farms b-3	963	1,009.53	-46.53		4.61
Total Area of Farms (ac) b-3	160,180	176,828.01	-16,648.01		9.41
% of Owner Operators b-3	0.7260	0.7645	-0.0385		5.03
Total Farm Capital ($) b-1	88,943,400	60,129,304.69	28,814,095.31	32.39	
Total Value of Farm Land and Buildings ($) b-1	70,042,300	43,436,908.03	26,605,391.97	37.98	
Total Value of Machinery and Equipment ($) b-1	7,942,200	7,568,227.59	373,972.41	4.70	
% of Improved Acreage b-3	0.7531	0.7708	-0.0177		2.29
Total Number of Livestock b-3	257,689	310,654.03	-52,965.03		17.05
Number of Small Scale Farms b-3	314	364.4	-50.41		13.83
Average Size of Farm (ac) b-3	166.41	170.9	-4.49		2.62

NOTE: (1) b-1: 5 year census data: Special Request: Statistics Canada
(2) b-3: 5 year census data: Census of Agriculture Stat. Can. Publications 96-707, 607, 536, Bulletin 2-6, 1951:Vol.VI-II.

A small scale farm is defined to be a farm with the value of agricultural products sold less than $2500. This variable and the value of agricultural products sold were not available in 1956. However, this does not affect the estimation of the impacts on these two variables. When the estimated impact is less than zero, this impact is calculated as a percentage of the estimated value for 1971 in order to represent the magnitude of the negative change. When the impact is positive, the percentage is calculated on the basis of the actual value in order to represent that proportion of the actual value which may be due to the Orangeville Dam Project.

TABLE 21: ESTIMATED IMPACTS: INCOME AND BUSINESS SECTORS: ORANGEVILLE DAM: 1967

VARIABLE	ACTUAL	ESTIMATE	IMPACT	% OF ACTUAL	% OF ESTIMATE
Population c-5	16,619	15,784.24	834.76	5.02	
Business Assessment ($) c-5	N.A.				
Land & Building Assessment ($) c-5	N.A.				
Number of Taxable Returns c-2	6,159	5,961.88	197.12	3.2	
Total Income ($) c-2	32,985,000	32,503,857.15	481,142.85	1.46	
Average Income ($) c-2	3,727.25	4,015.11	-287.86		7.16
Total Tax Payable ($) c-2	3,797,000	3,639,095.25	157,904.75	4.15	

NOTE: (1) c-5: Annual data: Ontario: Dept. of Municipal Affairs Summary of Financial Reports of Municipalities. (2) c-2: Annual Data:Dept. of National Revenue, Fine Locality Income/Taxation Statistics; Prepared by Stat. Services Div. DREE. (3) These sources apply as well to Tables 22-26.

TABLE 22: ESTIMATED IMPACTS: INCOME AND BUSINESS SECTORS: ORANGEVILLE DAM: 1968

VARIABLE	ACTUAL	ESTIMATE	IMPACT	% OF ACTUAL	% OF ESTIMATE
Population	18,005	15,925.95	2,079.05	11.55	
Business Assessment ($)	1,108,070	1,571,123.31	-462,953.31		29.46
Land & Buildings Assessment ($)	19,325,127	22,860,697.54	-3,535,570.54		15.47
Number of Taxable Returns	6,988	6,102.72	885.28	11.24	
Total Income ($)	40,278,000	35,361,714.27	4,916,285.73	12.21	
Average Income ($)	4,156.5	4,252.71	-96.21		2.26
Total Tax Payable ($)	5,294,000	4,238,190.49	1,055.809.51	19.94	

TABLE 23: ESTIMATED IMPACTS: INCOME AND BUSINESS SECTORS: ORANGEVILLE DAM: 1969

VARIABLE	ACTUAL	ESTIMATE	IMPACT	% OF ACTUAL	% OF ESTIMATE
Population	19,069	16,067.66	3,001.34	15.74	
Business Assessment ($)	2,039,900	1,703,393.57	336,506.43	16.49	
Land & Building Assessment ($)	60,509,730	24,036,426.47	36,473,303.53	61.93	
Number of Taxable Returns	N.A.				
Total Income ($)	46,537,000	38,219,517.43	8,317,428.57	17.87	
Average Income ($)	4,477	4,490.32	-13.32		0.29
Total Tax Payable ($)	N.A.				

TABLE 24: ESTIMATED IMPACTS: INCOME AND BUSINESS SECTORS: ORANGEVILLE DAM 1970

VARIABLE	ACTUAL	ESTIMATE	IMPACT	% OF ACTUAL	% OF ESTIMATE
Population	19,741	16,209.37	3,531.63	17.98	
Business Assessment ($)	2,431,790	1,835,663.82	596,126.18	24.51	
Land & Building Assessment ($)	93,691,555	25,212,155.5	68,479,399.5	73.09	
Number of Taxable Returns	9,260	6,384.44	2,875.56	31.06	
Total Income ($)	60,792,000	41,077,419.58	19,714,571.42	32.43	
Average Income ($)	4,970.5	4,727.93	242.57	4.88	
Total Tax Payable ($)	9,882,000	5,436,380.97	4,445,619.03	44.98	

TABLE 25: ESTIMATED IMPACTS: INCOME AND BUSINESS SECTORS: ORANGEVILLE DAM: 1971

VARIABLE	ACTUAL	ESTIMATE	IMPACT	% OF ACTUAL	% OF ESTIMATE
Population	N.A.				
Business Assessment ($)	N.A.				
Land & Building Assessment ($)	N.A.				
Number of Taxable Returns	9,440	6,525.29	2,914.71	30.87	
Total Income ($)	70,457,000	43,935,285.71	26,521,714.29	37.64	
Average Income ($)	5,251.25	4,965.54	285.71	5.44	
Total Tax Payable	11,814,000	6,035,476.17	5,778,523.83	48.91	

TABLE 26: ESTIMATED IMPACTS: INCOME AND BUSINESS SECTORS: ORANGEVILLE DAM: 1972

VARIABLE	ACTUAL	ESTIMATE	IMPACT	% OF ACTUAL	% OF ESTIMATE
Population	N.A.				
Business Assessment ($)	N.A.				
Land & Building Assessment ($)	N.A.				
Number of Taxable Returns	10,707	6,666.13	4,040.87	37.74	
Total Income ($)	88,758,000	46,788,642.86	41,969,357.14	47.29	
Average Income ($)	5,806	5,203.14	602.86	10.38	
Total Tax Payable ($)	15,045,000	6,634,571.42	8,410,428.58	55.9	

The source document defines business assessment as an assessed value based on business or corporation income. Taxable income and average income are based on Taxation Statistics. These statistics are available on the basis of post office service districts which may not coincide exactly with the census subdivisions used in the other sections of this impact analysis. However, on the basis of the entire impact area, they provide a good approximation of total and average income and are the best statistics available at the present time. In Tables 21-26, N.A. indicates that the actual value was not available and hence, no impact could be estimated. For Table 21, business or corporation and land and building assessment values were missing for one of the townships in the

impact area so that no actual value was available. In 1969, there was no breakdown for taxable returns. As well, municipal statistics were not available beyond 1970.

TABLE 27: ESTIMATED IMPACTS: QUALITY OF LIFE AND LABOUR STATISTICS: ORANGEVILLE DAM: 1971

VARIABLE	ACTUAL	ESTIMATE	IMPACT	% OF ACTUAL	% OF ESTIMATE
Total Number of Owned Dwellings a-1	4,450	3,411.82	1,038.18	23.32	
Total Number of Residences with Running Water a-1	5,615	5,320.09	294.91	5.25	
Total Number of Residences with Flush Toilets a-1	5,580	5,019.59	560.41	10.04	
Total Labour Force a-1	8,800	5,635.46	3,164.54	35.96	
Total Number Presently Employed a-1	8,395	5,508.06	2,886.94	34.39	

NOTE: (1) a-1: Ten year census data: Special Request: Statistics Canada

Census data for total employment and total number presently employed are randomly rounded so that the last digit is always zero or five for confidentiality reasons. Hence, the estimated impacts of these variables given in Table 27 are subject to this source of error. However, the effects of this are likely to be negligible. For the variables presented in Table 27, an exponential fit provides a more accurate fit than that of the linear.

TABLE 28: ESTIMATED IMPACTS: MANUFACTURING: ORANGEVILLE DAM: 1967-1971

VARIABLE	YEAR	ACTUAL	ESTIMATE	IMPACT	% OF ACTUAL	% OF ESTIMATE
Number Employed in Manufacturing c-4	1967	458	366.75	91.25	19.92	
	1968	411	370.42	40.58	9.87	
	1969	497	374.08	122.92	24.73	
	1970	513	377.75	135.25	26.36	
	1971	536	381.39	154.61	28.84	
Number of Manufacturing Establishments c-4	1967	13	16.16	-3.6		19.55
	1968	14	16.13	-2.13		13.20
	1969	12	16.10	-4.1		25.45
	1970	12	16.07	-4.07		25.32
	1971	14	16.04	-2.07		12.71
Wages and Salaries Paid ($) c-4	1967	1,754,000	1,730,657.96	23,342.04	1.33	
	1968	1,759,000	1,909,043.94	-150,043.94		7.85
	1969	2,216,000	2,087,429.93	87,429.93	3.94	
	1970	2,552,000	2,265,815.92	286,184.08	11.21	
	1971	2,956,000	2,444,201.90	511,798.10	17.31	
Selling Value of Factory Shipments ($) c-4	1967	13,439,000	13,598,981.21	-159,981.21		1.17
	1968	13,410,000	15,134,891.62	-1,724,891.62		11.38
	1969	15,241,000	16,670,802.02	-1,429,802.02		8.57
	1970	20,394,000	18,206,712.42	2,187,287.58	10.72	
	1971	23,056,000	19,742,622.83	3,133,377.17	14.37	

NOTE: (1) c-4: Annual data: Census of Manufacturing; Statistics Canada Publications 31-209

Because Statistics Canada could not fulfill a special request for manufacturing statistics at a census subdivision or municipality level, the data in Table 28 were taken from the annual Census of Manufacturing publications. Statistics in this publication are available only for Orangeville itself. However, since it is likely that the majority of manufacturing activity in the impact area would be carried out within the Town of Orangeville, this would not appear to be a serious problem. Similarly, statistics in the control area applied only to the Town of Hanover.

In summarizing these tables, it would appear that the Orangeville Dam has exerted influences in all sectors of the area economy. As mentioned previously, there is no clear cause and effect relationship between the project and the indicated impacts. The purposes of the dam are not to make direct inputs into any sectors of the economy but rather to provide an improved climate for activity in all sectors.

In the agricultural sector, impacts on total value of agricultural products sold and farm capital are positive and large enough to suggest a relationship with the dam. Similarly, large negative impacts were observed for the number of livestock and the number of small scale farms. The value of agricultural products sold (17.65% impact) may reflect improved crop protection or greater utilization of the existing area by farmers. Implied positive effects on total farm capital (32.39%) and value of farm land and buildings (37.98%) could represent either increased value of the land due to the protection factor or simple inflationary pressure exerted by the presence of the dam. The number of small scale farms was apparently decreased (by 13.83%). This might represent consolidation of small marginal farms into larger economic units. The connection of the dam with the total number of livestock is not particularly clear.

In the income and business sectors, the cumulating effect of the multiplier is evident on most variables. Reference to the manufacturing sector indicates similar trend. However, it is not as evident with regard to the number of manufacturing establishments. The dam's contribution to the infrastructure of the area is illustrated by the estimated impacts on employment in general and employment in manufacturing in particular. Thus, it would appear that this project has contributed to rural development in the impact area.

5. ESTIMATED IMPACTS: DEER CREEK RESERVOIR

The effects of the Deer Creek Dam are primarily intended to benefit the agricultural sector of the surrounding region. This will be borne out by the estimated impacts which are presented in the following tables. Table 29 presents the estimated impacts for the agricultural sector in 1971; Tables 30-34, the income and business sectors in 1968-1972; Table 35, the quality of life and labour statistics in 1971.

The variables presented in Table 29 are defined in the same manner as in the case of Orangeville. However, for the Deer Creek Reservoir, the Township of Middleton did not form a suitable control with respect to the total number of livestock. This was evident from the series of data. In this isolated instance, the control and impact area did not have the same relationship with time. For this reason, the impact was estimated without the use of a control group for the total number of livestock only.

TABLE 29: ESTIMATED IMPACTS: AGRICULTURE: DEER CREEK RESERVOIR: 1971

VARIABLE	ACTUAL	ESTIMATE	IMPACT	% OF ACTUAL	% OF ESTIMATE
Total Value of Agricultural Products Sold ($)	11,409,650	11,068,978.37	340,671.63	2.98	
Total Number of Farms	292	289.89	2.11	0.72	
Total Area of Farms (ac)	38,620	38,910.00	-290		0.75
% of Owner Operators	0.6473	0.6335	0.0138	2.13	
Total Farm Capital ($)	46,061,100	37,657,804.13	8,403,295.87	18.24	
Total Value of Farm Land and Buildings ($)	40,378,800	32,142,518.38	8,232,281.62	20.38	
Total Value of Machinery and Equipment ($)	5,277,300	5,356,176.88	-78,876.88		1.47
% of Improved Acreage	0.7424	0.7617	-0.0193		2.53
Total Number of Livestock	46,427	58,452.50	-12,025.5		20.57
Number of Small Scale Farms	18	5.63	12.37	68.72	
Average Size of Farm (ac)	132.26	130.78	1.48	1.12	

NOTE: The sources of data on these variables are the same as those for Orangeville.

TABLE 30: ESTIMATED IMPACTS: INCOME AND BUSINESS SECTORS: DEER CREEK RESERVOIR: 1968

VARIABLE	ACTUAL	ESTIMATE	IMPACT	% OF ACTUAL	% OF ESTIMATE
Population	2,907	2,822.80	84.20	2.90	
Business Assessment ($)	52,725	48,551.67	4,173.33	7.92	
Land & Building Assessment ($)	5,812,525	5,624,463.99	188,061.01	3.24	
Number of Taxable Returns	624	588.39	35.61	5.70	
Total Income ($)	4,166,000	4,252,736.84	-86,736.84		2.03
Average Income ($)	5,532	5,771.11	-239.11		4.14
Total Tax Payable ($)	670,000	654,421.05	15,578.95	2.32	

NOTE: The sources of data on these variables are the same as those for Orangeville. This is also true for Tables 31-34.

TABLE 31: ESTIMATED IMPACTS: INCOME AND BUSINESS SECTORS: DEER CREEK RESERVOIR: 1969

VARIABLE	ACTUAL	ESTIMATE	IMPACT	% OF ACTUAL	% OF ESTIMATE
Population	2,892	2,832.62	59.38	2.05	
Business Assessment ($)	52,850	48,586.06	4,263.94	8.07	
Land & Building Assessment ($)	5,755,325	5,703,450.73	51,874.27	0.90	
Number of Taxable Returns	N.A.				
Total Income ($)	3,489,000	4,447,561.40	958,561.40		21.55
Average Income ($)	4,525	5,904.18	-1,379.18		23.35
Total Tax Payable ($)	N.A.				

TABLE 32: ESTIMATED IMPACTS: INCOME AND BUSINESS SECTORS: DEER CREEK RESERVOIR: 1970

VARIABLE	ACTUAL	ESTIMATE	IMPACT	% OF ACTUAL	% OF ESTIMATE
Population	2,883	2,842.44	40.56	1.41	
Business Assessment ($)	51,925	48,620.46	3,304.54	6.36	
Land & Building Assessment ($)	5,806,550	5,782,437.46	24,112.54	0.41	
Number of Taxable Returns	662	613.65	48.35	7.3	
Total Income ($)	4,158,000	4,642,385,97	-484,385.97		10.43
Average Income ($)	5,501	6,037.25	-986.25		16.33
Total Tax Payable ($)	689,000	740,982.46	-51,982.46		7.01

TABLE 32: ESTIMATED IMPACTS: INCOME AND BUSINESS SECTORS: DEER CREEK RESERVOIR: 1970

VARIABLE	ACTUAL	ESTIMATE	IMPACT	% OF ACTUAL	% OF ESTIMATE
Population	2,883	2,842.44	40.56	1.41	
Business Assessment ($)	51,925	48,620.46	3,304.54	6.36	
Land & Building Assessment ($)	5,806,550	5,782,437.46	24,112.54	0.41	
Number of Taxable Returns	662	613.65	48.35	7.3	
Total Income ($)	4,158,000	4,642,385.97	-484,385.97		10.43
Average Income ($)	5,501	6,037.25	-986.25		16.33
Total Tax Payable ($)	689,000	740,982.46	-51,982.46		7.01

TABLE 34: ESTIMATED IMPACTS: INCOME AND BUSINESS SECTOR: DEER CREEK RESERVOIR: 1972

VARIABLE	ACTUAL	ESTIMATE	IMPACT	% OF ACTUAL	% OF ESTIMATE
Population	N.A.				
Business Assessment ($)	N.A.				
Land & Building Assessment ($)	N.A.				
Number of Taxable Returns	711	638.88	72.72	10.14	
Total Income ($)	5,067,000	5,032,035.09	34,964.91	0.69	
Average Income ($)	5,361	6,303.39	-942.39		14.95
Total Tax Payable ($)	789,000	827,543.86	-38,543.86		4.65

In Tables 30-34, N.A. indicates that no impact could be estimated. As in the case of the Orangeville Dam, there was no breakdown for taxable returns in 1969 and the municipal statistics were not available beyond 1970. As was the case for the total number of livestock, the Township of Middleton did not provide a suitable control with respect to land and building assessment and business assessment. For this reason, these impacts were estimated without the use of a control group.

TABLE 35: ESTIMATED IMPACTS: QUALITY OF LIFE AND LABOUR STATISTICS: DEER CREEK RESERVOIR: 1971

VARIABLE	ACTUAL	ESTIMATE	IMPACT	% OF ACTUAL	% OF ESTIMATE
Total Number of Owned Dwellings	510	601.85	-91.85		15.26
Total Number of Residences with Running Water	735	897.85	-162.85		18.14
Total Number of Residences with Flush Toilets	624	897.85	-273.85		30.50
Total Labour Force	1,320	1,339.4	-19.4		1.45
Total Number Presently Employed	1,280	1,339.4	-59.4		4.43

For the variables presented in the above table, an exponential model provides a more accurate fit than that provided

NOTE: Sources of data on these variables are the same as those for Orangeville.

by the linear. The Census of Manufacturing does not report for areas small enough to be used in relation to the Deer Creek Reservoir. For this reason, no impacts can be estimated for the manufacturing sector. However, this sector would seem unlikely to be influenced by an irrigation reservoir.

The overview presented by the preceding tables should be interpreted in the context of the objectives and the completion date of the dam. The Deer Creek Reservoir was intended originally to provide irrigation in a relatively rich tobacco growing area of the province. Further, the project was completed in July, 1969 indicating that there would have been only one full growing season for which the irrigation facilities were available prior to the census date in June, 1971. Thus, the impacts presented in the foregoing tables are measured very early in the post-project period and are not subject to large multiplier effects.

The lack of significantly large impacts on employment or labour force in the overall economy tend to indicate that the Deer Creek Reservoir has had little impact in the industrial sectors. In the agricultural sector, however, impacts are evident. The small magnitude of the impact on total value of agricultural products sold (impact 2.98%) may be the result of diminishing marginal returns to scale in a highly intensified agricultural sector or solely due to the early measurement of the impact. In general, the impacts on the agricultural sector are positive in nature and may reflect a stimulus to this sector of the economy. Related to the early estimation of impacts, it is possible that irrigation connections or expertise in the use of the facilities may not have been developed to their full potential by the 1971 census date.

6. COMMENTS

In comparing the results of the impact studies of the Orangeville Dam and the Deer Creek Reservoir, several factors should be kept in mind. First, the capital expenditures involved in the two projects are grossly different - Orangeville involved roughly three times the amount spent for the Deer Creek Reservoir. Second, the location and objectives of the two projects were different. The Orangeville project was primarily intended to promote rural development and is located close to the town of Orangeville with a developed economic structure. Deer Creek Reservoir, on the other hand, would be intended solely for agricultural development. This project is located in the Township of North Walshingham, which contains no sizeable economic centres. Third, at 1971 the Orangeville project had been at least partially completed for four years, while the Deer Creek Reservoir had been completed for only one full growing season.

For these reasons, it may be advisable to pay close attention to the sign and trend of the impacts rather than to the absolute size. Supporting this contention is the fact that these impacts are statistical estimates and thus subject to random error.

Susan M. Murray,
December 31, 1974.

APPENDIX I

The following is a list of mnemonics which will be used throughout the presentation of the estimated models for both the Deer Creek Reservoir and the Orangeville Dam.

VARIABLE	MNEMONIC
Total Value of Agricultural Products Sold	TVPS
Total Number of Farms	TF
Total Area of Farms	LF
% of Owner Operators	POO
Total Farm Capital	TFK
Total Value of Farm Land and Buildings	TVFLB
Total Value of Machinery and Equipment	TVME
% of Improved Acreage	PIA
Total Number of Livestock	TL
Total Number of Small Scale Farms	TSF
Average Size of Farm	ASF
Population	POP
Business Assessment	BA
Land and Building Assessment	LBA
Number of Taxable Returns	NTR
Total Income	TY
Average Income	AY
Tptal Tax Payable	TTP
Total Number of Owned Dwellings	TOD
Total Number of Residences with Running Water	TRRW
Total Number of Residences with Flush Toilets	TRFT
Total Labour Force	TLF
Total Number Presently Employed	TPE
Number Employed in Manufacturing	NEM
Number of Manufacturing Establishments	NME
Wages and Salaries Paid	WS
Selling Value of Factory Shipments	VFS
Time	t
Project Time	PT

ORANGEVILLE DAM

The following is the set of estimated models and their respective R^2 used in estimating the impacts of the Orangeville Dam. In these equations, the first constant given is the constant effect in the Township of Mono, the second applies to the Township of Amaranth, the third to East Garafraxa, the fourth to Caledon, the fifth to Bentinck, the sixth to Normanby and the seventh to Egremont. In those models for the variables for which yearly data were available, the first seven constants are as above and the eighth is the constant effect applied only in the project period.

TVPS = 439,126.633 + 1,171,948.633 + 1,167,007.383 + 870,426.38
+ 805,503.495 + 1,801,243.75 + 1,497,383.75 + 91,936.919t -
+ 342,147.448PT R^2=0.8775

TF = 373.285 + 408.785 + 296.035 + 366.285 + 433.409 + 509.409
+ 463.909 - 5.421t - 6.503 PT R^2=0.9442

LF = 57,311.584 + 60,980.084 + 43,919.834 + 53,695.084 + 68,138.11
+ 69,095.864 + 72,375.113 - 501.846t - 3,397.88PT R^2=0.9084

POO = 0.8355 + 0.8802 + 0.8691 + 0.7954 + 0.8713 + 0.9141
+ 0.9081 - 0.0038t - 0.0388PT R^2=0.8292

TFK = 5,454,861.21 + 5,473,462.96 + 3,607,346.71 + 7,889,299.21
+ 4,278,502.51 + 7,504,565,51 + 6,434,640.51 + 474,038.92t
+ 6,574,784.21PT R^2=0.9483

TVFLB = 2,882,046.88 + 2,232,546.134 + 487,923.13 + 5,061,435.13
+ 1,355,416.5 + 3,053,366.5 + 2,314,484.0 + 395,232.94t
+ 6,544.693.46PT R^2=0.9579

TVME = 783,891.34 + 1,096,478.84 + 815,951.84 + 887,131.09
+ 863,887.85 + 1,507, 647.6 + 1,352,190.35 + 51,559.03t
+ 6947.04PT R^2=0.9024

PIA = 0.6577 + 0.8122 + 0.7727 + 0.6525 + o.5949 + 0.7076
+ 0.6715 + 0.0021t - 0.0144PT R^2=0.8986

TL = 62,189.38 + 111,201.38 + 86,735.38 + 73,178.13 + 95,319.06
+ 131,139.06 + 126,964.81 + 137.26t - 21,786.29PT R^2=0.6723

TSF = 80.36 + 80.86 + 30.36 + 93.11 + 108.02 + 95.52 + 67.27
+ 0.5084t - 3.35PT R^2=0.6431

ASF = 155.54 + 148.51 + 151.75 + 146.39 + 157.76 + 131.53
+ 156.23 + 0.9426t - 3.93PT R^2=0.8317

POP = 7,143.70 + 2,712.66 + 801.04 + 3,709.70 + 7,190.23
+ 2,186.15 + 1,704.44 - 311.52 + 35.43t + 271.42PT R^2=0.9825

BA = 384,585.47 - 30,496.36 - 224,618.90 - 13,319.64
+ 583,625.06 - 186,797.71 - 207,973.21 - 284,950.51
+ 33,067.56t + 112,676.61PT R^2=0.7612

LBA = 3,953,398.52 + 1,252,563.37 - 1,939,276.27 +6,660,993.19
+ 5,839,090.52 + 784,714.75 + 229,926.93 - 9,030,771.69
+ 293,932.24t + 6,530,423.13PT R^2=0.6637

NTR = 3,239.74 + 555.41 - 37.76 + 1,922.74 + 2,354.81 + 485.98
+ 23.14 - 134.55 + 35.21t + 188.95PT R^2=0.9617

TY = 18,727,536.71 - 206,629.95 - 3,509,129.95 + 11,776,366.05
+ 11,934,476.19 + 603,309.52 -1,989,190.48 - 2,468,522.70
+ 714,464.29 + 1,985,680.58PT R^2=0.9090

AY = 4,104.06 + 2,703.56 + 2,630.89 + 4,721.06 +3,642.07 + 2,698.57
+ 1,991.24 - 446.32 + 237.61t + 165.48PT R^2=0.9798

TTP = 2,438,392.86 - 599,107.14 - 1,042,273.8i + 1,643,892.86
+ 1,369,904.76 - 237,261.91 - 518,928.57 - 470,261.63 + 149,773.81t
+ 406,298.87PT R^2=0.8657

TOD $=e^{7.216 + 6.49 + 5.46 + 6.546 + 7.37 + 6.26 + 6.12 + 0.007t + 0.1868PT}$
R^2=0.9753

TRRW $=e^{6.68 + 5.77 + 4.52 + 5.84 + 6.72 + 5.01 + 0.059t - 0.0084PT}$
R^2=0.9827

TRFT $=e^{6.73 + 5.84 + 4.64 + 5.90 + 6.73 + 5.12 + 5.18 + 0.0529t + 0.0317PT}$
R^2=0.9870

TLF $=e^{7.7 + 6.88 + 5.9 + 7.01 + 7.85 + 6.85 + 6.6 + 0.0082t + 0.3911PT}$
R^2=0.9735

TPE $=e^{7.63 + 6.77 + 5.81 + 6.82 + 7.74 + 6.76 + 6.48 + 0.0137t + 0.3503PT}$
R^2=0.9667

NEM = 341.09 + 953.15 + 42.52 + 3.67t + 22.13PT R^2=0.9057

NME = 16.37 + 21.31 - 3.19 - 0.0297t + 0.0297PT R^2=0.8903

WS = 481,956.06 + 2,601,939.43 - 263,971.97 + 178,385.99t + 141,314.01PT

R^2=0.9611

VFS = 2,847,608.39 + 8,028,936.15 - 2,820,470.81 + 1,535,910.40t

+ 1,085,889.6PT R^2=0.9446

NOTE: In the last four equations only three constants appear since in the manufacturing sector, data were available for only Orangeville and Hanover.

DEER CREEK RESERVOIR

The following is the set of estimated models and their respective R^2 used in estimating the impacts of the Deer Creek Reservoir. In these equations, the first constant given is the constant effect in the Township of North Walshingham and the second applies to the Township of Middleton. For those variables for which no control was utilized, this second constant does not appear. As well, when yearly data were available, the final constant is the constant effect applied only in the project period.

TVPS = 5,263,252.75 + 4,470,631.36 + 280,113.99t + 264,003.44PT R^2=0.9352

TF = 367.64 + 408.90 - 3.89t + 6.04PT R^2=0.9227

LF = 39,111.96 + 41,142.13 - 56.60t + 696.70PT R^2=0.5524

POO = 0.6163 + 0.6908 + 0.0034t - 0.0398PT R^2=0.6483

TFK = 14,458,594.77 + 14,706,588.08 + 1,183,556.24t + 6,747,812.22PT R^2=0.9540

TVFLB = 12,536,895.51 + 12,875,639.86 + 999,389.62t + 6,850,722.39PT R^2=0.9484

TVME = 1,472,583.45 + 1,225,934.84 + 193,137.81t - 251,177.44PT R^2=0.9879

PIA = 0.7238 + 0.7240 + 0.0016t - 0.0159PT R^2=0.4779

TL = 35,416.34 + 1,096.96t - 12,025.5PT R^2=0.4837

TSF = 36.78 + 67.65 - 1.58t + 14.48PT R^2=0.7658

ASF = 106.95 + 99.93 + 1.05t + 3.34PT R^2=0.9842

POP = 2,714.80 + 3,812.81 + 105.02 + 9.82t - 21.82PT R^2=0.9836

BA = 48,173.33 + 4,782.73 + 34.39t - 434.39PT R^2=0.4525

LBA = 4,755,610.0 + 251,964.39 + 78,986t - 81,974.23PT R^2=0.9622

NTR = 550.58 + 483.54 + 26.54 + 12.61t + 3.36PT R^2=0.8782

TY = 3,668,263.16 + 2,298,868.42 - 251,969.42 + 194,824.56t
- 23,653.13PT R^2=0.8295

AY = 5,371.90 + 3,966.05 - 180.72 + 133.07t - 219.01PT R^2=0.6332

TTP = 524,578.98 + 231,377.19 + 20,288.22 + 43,280.70t - 27,566.42PT
R^2=0.7396

TRRW $= e^{5.77 + 6.04 + 0.0518t - 0.2094PT}$ R^2=0.9767

TRFT $= e^{5.75 + 5.98 + 0.0512t - 0.2708PT}$ R^2=0.9911

TOD $= e^{5.98 + 6.37 + 0.021t - 0.1867PT}$ R^2=0.9903

TLF $= e^{6.9 + 7.2 + 0.0152t - 0.026PT}$ R^2=0.9974

TPE $= e^{6.86 + 7.17 + 0.0154t - 0.0373PT}$ R^2=0.9994