CHAPTER 10

THE COST OF THE DROUGHT: CORRECTION OF INITIAL ESTIMATES FOR VARIOUS ECONOMIC CONSIDERATIONS

It is now necessary to correct for the fact that not all out-of-pocket expenses connected with the drought are necessarily net losses even for the firm whose pocket is involved. In addition, it may be that some losses which are quite real to local economic actors may be cancelled out when the drought is viewed from a larger regional or national stance. Finally, after these considerations have been allowed for, the concern of this study with the municipal system will dictate the elimination from our accounts of losses (and gains) accruing to firms, individuals, and organizations supplying themselves with water.

DROUGHT ADJUSTMENTS AS INVESTMENTS

Certain of the claimed drought costs represented investments in facilities which promise to have some effect on the water costs of their owners over a number of years in the future. In order to assess the economic impact of the drought we must take note of the future streams of annual net benefits (positive or negative) implied by these investments.

Table 26 shows the types of investments reported within each sector and indicates the relative importance of these general types. The industrial sector demonstrates, as we might expect, the greatest variety of adjustments. Recirculation of process and cooling water clearly were the most important of these, though industrial spending on wells was still greater than the total investment of any other sector. The amounts spent by industry on dams and miscellaneous projects were relatively insignificant. In all, investment spending accounted for almost 74 percent of the sector's claimed costs, and for 35 percent of the grand total. For the municipal sector, investments were a very small part of total gross costs, if spending on emergency supply facilities is ruled out. This is almost certainly due to a combination of inflexibility in the planning and execution of "lumpy" projects and the existence of a smaller range of available alternatives than is open to industry, particularly the absence of a common and publicly accepted recirculation technology for municipal sewage.

TABLE 26. SUMMARY OF INVESTMENT PROJECTS

Sector/Description	Reported cost ($)	Percentage of sector total	Percentage of grand total
Industrial			
Cooling-water recirculation	277,000		
Process-water recirculation	175,000		
Wells	162,300		
Dams	2,500		
Miscellaneous	5,700		
Subtotal	622,500	73.7	34.7
Municipal			
Wells	2,600		
Miscellaneous	600		
Subtotal	3,200	0.5	0.2
Commercial			
Air-conditioning recirculation	6,100		
Wells	12,000		
Subtotal	18,100	55.3	1.0
Domestic			
Wells	105,600	70.7	5.9
Miscellaneous			
Golf club sprinkling systems	73,300	32.4	4.1
Total	822,700		45.9

All together, investment in adjustment projects accounted for 45.9 percent of the $1,794,300 total loss. Clearly, it is important to know what part, if any, of this investment represented projects whose future returns will offset the claimed cost.

Appendix F contains a discussion of the conceptual framework for dealing with water-use adjustments. Here, it may be said briefly that these corrections involve comparison of total annual water costs to the firm (or household) before and after the adjustment. Clearly, lower future water bills represent benefits to the firm. Comparison of water costs requires, in turn, knowledge of withdrawals from various sources before and after the investment; the costs to the firm of water from each source and the extent of recirculation introduced (if any); the makeup fraction required by this recirculation system; and the variable cost of recirculation. Given sufficient information about these quantities, our investment corrections would be completely straightforward. The problem, of course, was that our information was far less than complete, and a considerable part of the work involved construction of estimates from available rules of thumb, observed relations, and the incomplete information furnished in the interviews. The major reason for our difficulties in this respect was that the interviewed managers did not, in general, know the impact of the investments on water withdrawals.

The Discount Rate

A major consideration in the evaluation of time streams of costs and benefits is the choice of an appropriate discount rate. We chose to use two rates—8 and 20 percent—intending that the higher one represent the business sector's evaluation of alternative investment opportunities. The lower one, intended as a discount rate appropriate to the public sector, falls within the range of rates recommended for the evaluation of public investments by several economists in testimony before the Joint Economic Committee of the Congress.[1]

Investment in Wells and Recirculation

The challenge in evaluating these investments was in supplying missing information. For wells, this was done by estimating a cost-yield curve for Massachusetts wells based on the experiences of several firms recorded in our interviews. This curve gave us an approximation of yield for projects for which we had only costs, and vice versa. For cooling towers, we relied heavily on the work of Berg et al. and of Cootner and Löf.[2] In the one reported case of installation of process-water recirculation, we used the cost and volume figures supplied us by the firm in question.

[1] For example, Otto Eckstein recommended 7–7.5 percent; Arnold Harberger, 10.8 percent. See U.S. Congress, Joint Economic Committee, *Economic Analysis of Public Investment Decisions: Interest Rate Policy and Discounting Analysis*, Hearings of July 30, 31, and August 1, 1968 (Washington, U.S. Government Printing Office, 1968).

[2] See Brian Berg, Russell W. Lane, and Thurston E. Larson, "Water Use and Related Costs with Cooling Towers," *Journal of the American Water Works Association*, 56 (1964), 311–29; and Paul Cootner and George O. G. Löf, *Water Demand for Steam Electric Generation* (Washington: Resources for the Future, 1965).

Slightly different procedures were employed for domestic-sector wells and commercial-sector recirculation of air-conditioning cooling water. In the former case, discount rates of 4 and 8 percent were used to reflect the lower opportunity cost of investable funds to the average homeowner. In the latter, we had first to estimate hours of air conditioning required per year and to combine this with our cost data to estimate volume of use.[3]

For a small number of investments, our information was insufficient to permit any but the crudest estimates of possible present values. These represent about 7.5 percent of total reported investments in terms of original cost. In all but one of these cases, we simply used the capital cost of the project as its present value to the investor, assuming no net benefits over the life of the project.

Finally, in Table 27, we summarize the results of the various calculations discussed above. The pattern of results shown in this table is not surprising, though the absolute size of the corrections involved may well be. That is, we should not be surprised to find that the industrial-sector investments in wells and recirculation equipment generally result in the largest net present values (the greatest future savings net of capital costs). The scale on which these projects were carried out and the relatively high number of hours of use per year combined to produce this effect. In general, air-conditioning cooling water recirculation projects showed up as less profitable; this was because of the low number of gallons recirculated per year in these seasonal operations. It did, however, appear that the commercial-sector projects involving such recirculation were profitable at both discount rates. These were the only projects outside of the industrial sector which showed up as profitable under *either* rate. Most other cases for which calculations were possible exhibited streams of future savings with present values very close to zero; here, the savings per gallon was often significant, but the number of gallons involved in each future year was so small that total annual savings was not significant.

The observation that the total positive present value calculated under the 8 percent discount rate is almost as large in absolute value as the original total of costs and losses (Table 22) may startle the reader. As we shall see when we combine these results with the other items corrected for various stances, under the 8 percent discount rate for certain accounting stances, the drought is no longer a producer of costs but of benefits in the aggregate. Abstracting from distributional questions, then, under certain sets of assumptions the drought appears as a boon to society. But distributional questions are clearly important here, for the benefits accrue to firms as returns on investments, while the costs are borne by households and municipal governments.

[3] See Berg et al., "Water Use and Related Costs."

TABLE 27. SUMMARY OF CORRECTIONS FOR FUTURE RETURNS TO INVESTMENTS[a]

Sector/description	Reported cost	Present value at 8 percent	Present value at 20 percent
Industrial			
Cooling	−277,000	+999,500	+77,600
Process	−175,000	+438,000	+190,000
Wells	−162,300	+161,200	−46,700
Dams	−2,500	−2,500	−2,500
Miscellaneous	−5,700	−1,700	−1,700
Subtotal	−622,500	+1,594,500	+216,700
Municipal			
Wells	−2,600	−2,600	−2,600
Miscellaneous	−600	−600	−600
Subtotal	−3,200	−3,200	−3,200
Commercial			
Air conditioning	−6,100	+8,700	+400
Wells	−12,000	−10,600	−11,600
Subtotal	−18,100	−1,900	−11,200
Domestic			
Wells (40-year life)	−105,600	−99,900[b]	−102,300[c]
Miscellaneous			
Golf club sprinkling	−73,300	−73,300	−73,300
Totals	−822,700	+1,416,200	+26,700

[a] − figures are costs, gross or net as appropriate; + figures are net benefits.
[b] Evaluated at 4 percent.
[c] Evaluated at 8 percent.

Even at the 20 percent (private opportunity cost) discount rate a small, positive present value results for the aggregate of all investments, and a larger one results for the industrial sector alone. This is particularly striking, since informal contact with businessmen *outside* our study area suggests that they feel that most water-use adjustments are at best breakeven propositions when evaluated in relation to alternative investment opportunities.[4]

Now, it is certainly not true that the results of these investments were always positive. As mentioned earlier, smaller and less intensively used installations tended to produce negative present values, and the aggregates for each important subclass are very much the reflections of the large returns accruing to one or a few firms. This accentuates the distributional

[4] This dim view of water-use investments was *not* common among those interviewed who had made such investments. See the discussion on this point below.

questions raised by aggregation of these results with those from other sources and sectors.

There remain two interesting questions to be discussed in connection with the investment corrections. First, to what extent do the perceptions of the firm managers involved agree with our results where project profitability is concerned? There were 16 firms in the industrial and commercial sectors for which we had both a reasonable basis for the estimation of returns and an answer to our question concerning the perceived profitability of water-use investments.[5] The results of a comparison of our present value calculations and the managers' responses to the question on perceived profitability are shown in Table 28.

TABLE 28. COMPARISON OF CALCULATED AND PERCEIVED PROJECT PROFITABILITY, 16 PROJECTS

	Projects firm managers perceived as profitable	Projects firm managers perceived as unprofitable
Positive present value at both discount rates	6	1
Negative present value at both discount rates	3	2
Positive present value at 8 percent; negative present value at 20 percent	1	3

Note that in only one case did a manager find unprofitable a project which our calculations found profitable at both discount rates. In three cases, projects profitable at 8 percent but not at 20 percent by our estimates were perceived as unprofitable by the managers involved. In general, Table 28 indicates that our results accord with the perceptions of managers when we use the 20 percent discount rate reflecting the assumed opportunity cost of private capital.

We have thus found two striking results in our study of water-use investments undertaken because of the drought. First, some of these investments have been extremely profitable for those who undertook them. But, second, managers do not seem to have been aware of these opportunities until the crisis atmosphere of the drought drew their attention to them. This second

[5] These 16 firms represented 17 separate projects; but the 1 firm with 2 projects made only one overall answer to the profitability question, and we were forced to treat these two investments as a single project.

conclusion seems implicit in managers' statements that all these adjustments were forced on them by the drought.

To what extent are the results above likely to be applicable to future droughts or to droughts in other climatic regions? Can we expect it always to be the case that the industrial sector will be able to avoid loss by investment in recirculation, etc., and not realize it beforehand? Our answer to these questions also amounts to an explanation of the existence of such enormously profitable opportunities within so mundane an area as the firm's water-use pattern.

We feel that there exists, at least in the humid Northeast, a large degree of slack in the adoption of existing industrial water-use technology by firms.[6] This slack is explained not by a lack of profit incentive—our results tend to show that many such adjustments are highly profitable—but by a lack of interest in and knowledge of water use on the part of management. This, in turn, may be attributed to the relatively small part of total costs accounted for by water inputs; to the general lack of training in water-use technology in industrial engineering curricula; and, most importantly, to the existence of an inherited attitude which emphasizes the availability of water without reference to its price and encourages vague notions of water as somehow "special" and not subject to the same market calculations as other inputs. It seems to be true that in this situation a relatively severe drought, with attendant public pressures and real or imagined dangers of low flows and falling water tables, serves to bring the firm's water-use pattern under the scrutiny of management.

One implication of this view is that it is difficult to predict the impact of future droughts, for this will depend on the rate at which existing technology is adopted relative to the rate at which new technology is developed, and on the comparative rates of change of water withdrawals and safe yield. However, if the slack in adoption of technology is gradually taken out of the system and the aggregate water withdrawals do not fall relative to safe yield, one could expect that droughts, as defined in our model, will have an increasingly severe impact on the industrial sector. On the other hand, large-scale adoption of withdrawal-reducing adjustments on the part of industry, particularly that segment served by public systems, would tend to lower the projected-demand safe-yield ratios of the affected towns and decrease their vulnerability to long periods of rainfall shortage and consequent low runoffs and streamflows.

[6] For some evidence on the relatively greater use of water per unit of value added in humid regions as opposed to drier regions, see L. M. Falkson, "Regional Variations in Industrial Water Use Technology," in *Proceedings of the Second Annual Water Resources Conference* (Urbana, Ill.: American Water Resources Association, 1967).

ACCOUNTING ASSUMPTIONS AND THE CHANGING PICTURE OF DROUGHT LOSSES

A final question in the correction of raw losses is that of the effect on our estimates of costs and losses of various choices of accounting stance. By "accounting stance" we mean the geographical or political area from whose point of view we choose to measure the level of economic activity and hence the size of the economic impact of the drought. For example, if we choose a local stance—defining "local" in terms of the geographic area served by the public water supply system—we shall wish to count as losses the full gross business losses suffered by all firms located in this area (assuming away for the moment the question of deferral of lost production to future days). If, on the other hand, we adopt a regional stance—say the state or all of New England—we shall have to take into account the possibility that production lost by one firm because of the water shortage may be made up during the same period by increased production at another firm in another part of the region. (For a multiplant firm, this transfer may be from one plant to another.) This would be the case, for example, if orders which could not be filled were shifted by buyers to other firms. Clearly, however, the deferral of production cannot, in fact, be assumed away, and it is likely that production lost during short shutdowns will be made up by the same firm at a later date.[7] Thus, for any accounting stance we must consider the possible transfers in time or space of "lost" production. When, however, production is deferred or transferred—and we take account of this under the particular stance we are using—it is still true that, in general, costs will have been incurred by the accounting unit.

The transfer of production presumably means that the real cost of obtaining the given amount of goods goes up by at least the increase in transport costs required to get the goods to their point of use.[8] Similarly, deferral of production has a real cost. This will include at least the cost of waiting (the social rate of time discount) and possibly that of the more intensive

[7] The possibility of deferral of production exists where the goods are, in a sense, storable; for example, an electric utility cannot make up lost production of energy at a later date (except to the extent that the activities depending on the energy are themselves postponable). On the other hand, the production of energy would probably be easily transferred to some other utility.

[8] We do not assume that transport costs decrease or remain the same, since this contradicts the normal economic assumptions about the behavior of firms. For consistency, this position is maintained even though in an imperfect world it may very well be incorrect in many cases. This assumption is conservative in the light of our conclusions above regarding firms' nonefficient behavior with respect to their water inputs, and in the sense that it tends to increase the recorded level of losses where our findings generally (and most controversially) point to the conclusion that drought losses are small relative to those resulting from other "disasters."

use of factors of production in making up the production later. For example, overtime use of facilities will involve costs of accelerated depreciation of equipment and of sacrificed leisure on the part of labor. Similar extra costs may attach to transferred production if the facilities to which it is transferred are otherwise fully employed. As these last two statements imply, it is necessary to make explicit assumptions about the degree of unemployment in the area or at the time to which production is shifted.

Now, of course, business losses need not be the only item in our cost/loss totals which will be affected by choice of an accounting stance. It may be that certain claimed costs are, from a regional accounting view, really only income transfers, though from the town's point of view they may be legitimate costs. And perhaps some of the gains we have just calculated as accruing to certain investing firms should not appear in the local and regional accounts because certain national firms will remit profits to headquarters to be distributed to other investment projects (retained earnings) and to stockholders, only a small fraction of whom will live in the locality or region of interest.

Appendix G describes in somewhat more detail our approach to corrections for accounting stance and deferral or transferral of production and sales. It also describes how we dealt with the problem of net earnings remittals from divisions of national firms. Originally, we considered 12 different combinations of discount rate, accounting stance, defer/transfer percentages, and degree of factor unemployment. As expected, the extremes of the resulting range of total losses were marked by the following accounts:

1. highest loss—local stance, 20 percent discount rate, no deferral or transferral;
2. smallest loss (highest net gain)—national stance, 8 percent discount rate, 100 percent deferral or transferral, high unemployment.

It also seems reasonable to contend that these accounts represent the proper information sources for two important levels of decision-makers. The local/20 percent figures are probably the best source of loss information for the local government officials who wish to take account of private sector investment opportunities. The national/8 percent account, on the other hand, represents the overview required of the economist and policy-maker working for federal agencies.

It may be that local officials prefer to work with something approximating the public's conception of drought loss, i.e., with figures uncorrected for investment returns or anything else. It is, of course, the burden of this section that such an approach would be conceptually incorrect and dangerously misleading in that it seriously overstates the economic impact of drought.

In addition to the two basic accounts mentioned above, we have included their discount-rate twins for contrast. That is, we show the local/8 percent/zero deferral and the national/20 percent/100 percent deferral account results as well as our decision-maker accounts. This serves to emphasize the dramatic effects produced by varying the discount rate used in evaluating investment projects. (See Tables 29 through 32.)

These results, then, represent the corrected versions of the original aggregate annual community losses as estimated from our survey data (Table 22). They include, however, the losses (gains) incurred by self-supplied water-users as well as those related directly to the performance of the municipal system. Because we are interested in the impact of drought on the municipal system, it is necessary for us to remove this influence of self-supply.

LOSSES INCURRED BY SYSTEM CUSTOMERS

In our survey, virtually the only self-supplied users were industrial firms. Outside of this sector, only the farms included in the Pittsfield miscellaneous sector were not system customers.

The methods adopted to remove losses related to self-supply problems were straightforward. In the industrial sector, all the recorded business losses due to shutdowns resulted from low flows in the streams serving self-suppliers. Investment projects were allocated between municipal and self-supply categories, depending on the pre-adjustment withdrawal source. For example, a well dug by a system customer to escape municipal use restrictions was charged to the municipal system since it reflects system inadequacy.

Farm losses were attributed entirely to problems with self-supply.

The results of this separation of costs by supply source are presented in Table 33. Here, the results are not broken down more finely than the sectoral totals by town and are presented only for the two key accounts: local/20 percent/zero deferral; and national/8 percent/100 percent deferral.

COMMENTS AND CONCLUSIONS: LOSSES TO ALL WATER USERS

While our principal interest will be in the per capita losses discussed in Chapter 11, certain features of the estimates presented so far require comment.

First, as might be expected, total losses for each town decrease in passing from the raw data of Table 22 to the corrected figures in Tables 29 through 32. Of the several corrections made to the initial loss estimates, the most significant are clearly those for the investment aspects of various adjustments made by water-users. These corrections are most important for the industrial sector where some very large and very profitable adjustments were undertaken. Unfortunately, our data do not allow us to separate the effects of demand composition and size of shortage, but evidence we present in the next chapter suggests strongly that the two factors are interdependent. As shortages increase above some threshold level, apparently about 10 percent, the industrial sector begins to suffer from restrictions. Up to that threshold, it appears that every effort is made to place the burden on the domestic sector through restrictions on outside use or to bear it at the municipal level by obtaining emergency supplies. The involvement of the industrial sector seems to trigger the plant managers' awareness of water problems and available technology discussed in connection with the investment corrections themselves.

COMMENTS AND CONCLUSIONS: LOSSES TO SYSTEM CUSTOMERS

The most striking result of eliminating from consideration losses and gains not related to the performance of the municipal system is that some of the widest swings in town losses disappear. Under no combination of accounting stance and interest rate do the gains accruing to those *system customers* investing in profitable water-use adjustments fully offset the losses suffered by other customers. Thus, the Fitchburg total, which showed a net gain of about $1,130,000 under the national/8 percent combination, is changed by the elimination of returns to self-suppliers, to a net *loss* of about $64,000. As could be expected from the great importance of industrial-sector investments in the Fitchburg totals, this change comes about because a large part of the total investment gain recorded in Table 32 (national/8 percent combination) accrued to self-suppliers.

It is not surprising to discover that the greatest positive impact of water-use adjustments spurred by the drought was on self-supplied users, for these tend to be the heaviest users, and the most profitable investments were those involving the largest quantities of water. Municipal users, on the other hand, were often in the position of having to install air-conditioning recirculation equipment by virtue of town ordinance, and such installations generally involved a small amount of water and relatively few hours of operation, making for small annual water-cost savings or, indeed, in several cases, for higher annual costs.

The other 2 cities display considerably less sensitivity to our inclusion or exclusion of drought impact on self-suppliers. This is partly because Braintree and Pittsfield have fewer large self-supplied industrial users.

TABLE 29. THE EFFECT OF CHANGING ASSUMPTIONS ON ESTIMATED DROUGHT LOSSES: LOCAL STANCE/20 PERCENT DISCOUNT RATE/ZERO DEFERRAL OR TRANSFER (LOCAL DECISION-MAKER)

	Braintree			Fitchburg			Pittsfield			Sector totals	
Sector	Corrected costs ($)	Percentage of town total	Percentage of sector total	Corrected costs ($)	Percentage of town total	Percentage of sector total	Corrected costs ($)	Percentage of town total	Percentage of sector total	Corrected costs ($)	Percentage of grand total
Industrial											
Business losses	—			171,400			—			171,400	
Investments	2,500			(53,800)			27,300			(24,000)	
Other	2,500			30,000			17,700			50,200	
Subtotal	5,000	2.6	2.5	147,600	26.0	74.7	45,000	15.0	22.8	197,600	18.7
Municipal											
Lost revenue	—			173,100			54,900			228,000	
Emergency supply	125,000			144,200			12,000			281,200	
Other	12,900			5,200			15,000			33,100	
Subtotal	137,900	72.6	25.4	322,500	57.0	59.5	81,900	27.2	15.1	542,300	51.4
Commercial											
Business losses nurseries	8,600			—			—			8,600	
Business losses—other	—			3,000			3,000			6,000	
Investments	—			(400)			11,600			11,200	
Subtotal	8,600	4.5	33.3	2,600	0.5	10.1	14,600	4.8	56.6	25,800	2.4
Domestic											
Wells reported	23,000			30,200			49,100			102,300	
Sprinkling losses	14,200			29,400			—			43,600	
Subtotal	37,200	19.6	25.5	59,600	10.6	40.8	49,100	16.3	33.6	145,900	13.8
Miscellaneous											
Farm losses	—			—			45,000			45,000	

Golf club costs	—			25,000			48,700			73,700	
Tree losses	1,200			6,000			16,500			23,700	
Subtotal	1,200	0.6	0.8	31,000	5.5	21.8	110,200	36.6	77.4	142,400	13.5
		Percentage of GT			Percentage of GT			Percentage of GT		Grand total	
Town totals	189,900	18.0		563,300	53.4		300,800	28.5		1,054,000	—

Notes:

1. Business-loss corrections were calculated using the following two general formulae.

(a) Full Employment

Corrected Loss = $(1 - d)$ (original net value-added lost) + d(wages lost + transfer/defer charge),

where "wages lost" are the estimated portion of original value-added lost, and the transfer/defer charge is 2 percent of lost gross production as discussed in the text; d is the percent deferral assumed.

(b) Unemployment

Corrected Loss = $(1 - d)$ (original net value-added lost) + d(transfer/defer charge)

The same procedure is used for both the industrial and commercial sectors. In the former, information was drawn from the *1963 Census of Manufactures* and the Federal Power Commission, *Annual Statistical Series*. For the latter, the primary source of information was the *1958 Census of Business*, Vol. I, *Retail Trade Statistics*.

2. Corrections for remitted net returns are made as discussed in the text. The assumption is 95 percent drain from local area; no drain on national level.

3. One small item on the Pittsfield industrial/other total was eliminated. It involved an increase of about $100 in a firm's water costs due to its shift to city water under low-flow conditions in the brook it normally tapped. It was assumed that this was a cost only to the firm because there was sufficient slack in the municipal system to take on this load without any net social cost. It would, in any case, be eliminated later as purely the result of self-supply deficiencies.

4. Tree losses in Pittsfield were given a "credibility" correction. This consisted of calculating the per capita "tree expenditures" for Braintree and Fitchburg (tree losses and expenses of measures to save trees and shrubs). These followed the expected pattern being high for heavily residential Braintree (about $.40) and low for Fitchburg (about $.18). As Pittsfield's demand composition was midway between the other two, a simple average of these figures (about $.295) was used as a per capita tree loss estimate. (Pittsfield did not report any spray-truck or similar measures to save trees.)

5. Farm losses in Pittsfield were reduced to a 3.5 percent transfer charge in the national accounts to reflect the large degree of slack existing in the nation's farm sector.

6. Lost-revenue estimates have not been corrected to reflect the impact of deferral (or of transferral in the wider stances).This problem seemed too complex to tackle with the information available—particularly as our original lost-revenue estimates were derived independently of business losses.

TABLE 30. THE EFFECT OF CHANGING ASSUMPTIONS ON ESTIMATED DROUGHT LOSSES: LOCAL STANCE/8 PERCENT DISCOUNT RATE/ZERO DEFERRAL OR TRANSFER

	Braintree			Fitchburg			Pittsfield			Sector totals	
Sector	Corrected costs ($)	Percentage of town total	Percentage of sector total	Corrected costs ($)	Percentage of town total	Percentage of sector total	Corrected costs ($)	Percentage of town total	Percentage of sector total	Corrected costs ($)	Percentage of grand total
Industrial											
Business losses	—			171,400			—			171,400	
Investments	2,500			(1,113,800)			(1,200)			(1,112,000)	
Other	2,500			30,000			17,700			50,200	
Subtotal	5,000	2.6	—	(912,400)	—	—	16,500	6.1	—	(89,000)	—
Municipal											
Lost revenue	—			173,100			54,900			228,000	
Emergency supply	125,000			144,200			12,000			281,200	
Other	12,900			5,200			15,000			33,100	
Subtotal	137,900	73.0	25.4	322,500	—	59.5	81,900	30.3	15.1	542,300	—
Commercial											
Business losses nurseries	8,600			—			—			8,600	

Business losses—other	—			3,000			3,000			6,000	
Investments	—			(8,700)			10,600			1,900	
Subtotal	8,600	4.6	—	(5,700)	—	—	13,600	5.0	—	16,500	—
Domestic											
Wells reported	22,000			29,600			48,300			99,900	
Sprinkling loss	14,200			29,400			—			43,600	
Subtotal	36,200	19.2	25.2	59,000	—	41.1	48,300	17.8	33.6	143,500	—
Miscellaneous											
Farm losses	—			—			45,000			45,000	
Golf club costs	—			25,000			48,700			73,700	
Tree losses	1,200			6,000			16,500			23,700	
Subtotal	1,200	0.6	0.8	31,000	—	21.8	110,200	40.7	77.4	142,400	—
		Percentage of GT			Percentage of GT			Percentage of GT		Grand total	
Town totals	188,900	—		(505,600)	—		270,500	—		(46,200)	—

Note: See notes to Table 29.

TABLE 31. THE EFFECT OF CHANGING ASSUMPTIONS ON ESTIMATED DROUGHT LOSSES: NATIONAL STANCE/20 PERCENT RATE/100 PERCENT DEFERRAL OR TRANSFER WITH UNEMPLOYMENT (NATIONAL DECISION-MAKER)

	Braintree			Fitchburg			Pittsfield			Sector totals	
Sector	Corrected costs ($)	Percentage of town total	Percentage of sector total	Corrected costs ($)	Percentage of town total	Percentage of sector total	Corrected costs ($)	Percentage of town total	Percentage of sector total	Corrected costs ($)	Percentage of grand total
Industrial											
Business losses	—			6,200			—			6,200	
Investments	2,500			(246,500)			27,300			(216,700)	
Other	2,500			30,000			17,700			50,200	
Subtotal	5,000	2.8	—	(210,300)	—	—	45,000	17.7	—	(160,300)	—
Municipal											
Lost revenue	—			173,100			54,900			228,000	
Emergency supply	125,000			144,200			12,000			281,200	
Other	12,900			5,200			15,000			33,100	
Subtotal	137,900	75.9	25.4	322,500	—	59.5	81,900	32.2	15.1	542,300	—

Commercial											
Business losses nurseries	300			—			—			300	
Business losses—other	—			100			100			200	
Investments	—			(400)			11,600			11,200	
Subtotal	300	0.2	—	(300)	—	—	11,700	4.6	—	11,700	—
Domestic											
Wells reported	23,000			30,200			49,100			102,300	
Sprinkling loss	14,200			29,400			—			43,600	
Subtotal	37,200	20.5	25.5	59,600	—	40.8	49,100	17.3	33.6	145,900	—
Miscellaneous											
Farm losses	—			—			1,800			1,800	
Golf club costs	—			25,000			48,700			73,700	
Tree losses	1,200			6,000			16,500			23,700	
Subtotal	1,200	0.7	1.2	31,000	—	31.2	67,500	26.3	67.5	99,200	—
		Percentage of GT			Percentage of GT			Percentage of GT		Grand total	
Town totals	181,600	28.4		202,500	31.7		254,700	39.9		638,800	—

Note: See notes to Table 29.

TABLE 32. THE EFFECT OF CHANGING ASSUMPTIONS ON ESTIMATED DROUGHT LOSSES: NATIONAL STANCE/8 PERCENT DISCOUNT RATE/100 PERCENT DEFERRAL OR TRANSFER WITH UNEMPLOYMENT (NATIONAL DECISION-MAKER)

	Braintree			Fitchburg			Pittsfield			Sector totals	
Sector	Corrected costs ($)	Percentage of town total	Percentage of sector total	Corrected costs ($)	Percentage of town total	Percentage of sector total	Corrected costs ($)	Percentage of town total	Percentage of sector total	Corrected costs ($)	Percentage of grand total
Industrial											
Business losses	—			6,200			—			6,200	
Investments	2,500			(1,567,900)			(29,100)			(1,594,500)	
Other	2,500			30,000			17,700			50,200	
Subtotal	5,000	2.8	—	(1,531,700)	—	—	(11,400)	—	—	(1,538,100)	—
Municipal											
Lost revenue	—			173,100			54,900			228,000	
Emergency supply	125,000			144,200			12,000			281,200	
Other	12,900			5,200			15,000			33,100	
Subtotal	137,900	76.4	25.4	322,500	—	59.5	81,900	—	15.1	542,300	—

Commercial											
Business losses nurseries	300			—			—			300	
Business losses—other	—			100			100			200	
Investments	—			(8,700)			10,600			1,900	
Subtotal	300	0.2	—	(8,600)	—	—	10,700	—	—	2,400	—
Domestic											
Wells reported	22,000			29,600			48,300			99,900	
Sprinkling loss	14,200			29,400			—			43,600	
Subtotal	36,200	20.0	25.2	59,000	—	41.1	48,300	—	33.6	143,500	—
Miscellaneous											
Farm losses	—			—			1,800			1,800	
Golf club costs	—			25,000			48,700			73,700	
Tree losses	1,200			6,000			16,500			23,700	
Subtotal	1,200	0.7	1.2	31,000	—	31.2	67,000	—	67.5	99,200	—
		Percentage of GT			Percentage of GT			Percentage of GT		Grand total	
Town totals	180,600	—		(1,127,800)	—		196,500	—		(750,700)	—

Note: See notes to Table 29.

TABLE 33. SEPARATION OF LOSSES BY USERS' WATER SUPPLY SOURCE

Raw data (Table 22)

(*dollars*)

	Braintree		Fitchburg		Pittsfield	
Sector	Municipal customer	Self-supplier	Municipal customer	Self-supplier	Municipal customer	Self-supplier
Industrial	2,500	2,500	241,300	509,900	87,700	300
Municipal	137,900		322,500		81,900	
Commercial	8,600		9,100		15,000	
Domestic	38,200		60,600		50,400	
Miscellaneous	1,200		31,000		148,700	45,000
Total	188,400	2,500	664,500	509,900	383,700	45,300
Combined total	190,900		1,174,400		429,000	

Local/20 percent data (Table 29)

(*dollars*)

	Braintree		Fitchburg		Pittsfield	
Sector	Municipal customer	Self-supplier	Municipal customer	Self-supplier	Municipal customer	Self-supplier
Industrial	2,500	2,500	61,400	86,200	45,000	
Municipal	137,900		322,500		81,900	
Commercial	8,600		2,600		14,600	
Domestic	37,200		59,600		49,100	
Miscellaneous	1,200		31,000		65,200	45,000
Total	187,400	2,500	477,100	86,200	255,800	45,000
Combined total	189,900		563,300		300,800	

National/8 percent data (Table 32)

(*dollars*)

	Braintree		Fitchburg		Pittsfield	
Sector	Municipal customer	Self-supplier	Municipal customer	Self-supplier	Municipal customer	Self-supplier
Industrial	2,500	2,500	(339,600)	(1,192,100)	(11,400)	
Municipal	137,900		322,500		81,900	
Commercial	300		(8,600)		10,700	
Domestic	36,200		59,000		48,300	
Miscellaneous	1,200		31,000		65,200	1,800
Total	180,600	2,500	64,300	(1,192,100)	194,700	1,800
Combined total	180,600		(1,127,800)		196,500	

Note: Figures in parentheses are net benefits or gains reflecting investment returns.

Thus the scope for the kinds of investments found profitable in Fitchburg was considerably smaller. In addition, as noted above, it appears that the industrial sector is not generally involved in drought problems until the level of potential shortage climbs to something above 10 percent. Thus, in Braintree with a shortage somewhat less than 10 percent, the largest part of the loss was borne (at least initially) by the municipal system itself through the provision of emergency supplies. Pittsfield had a somewhat larger shortage, but the town's one really large industrial concern is a system customer which accounts for almost one-quarter of total system demand.

In the next chapter we take these losses related to the performance of the municipal system as our basic data in calculating per capita annual losses for the 3 towns and the several sectors. We also discuss the relation of these per capita losses to the level of system shortage faced by each town.