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IS PUBLIC INTERVENTION IN WATER RESOURCES DEVELOPMENT CONDUCIVE TO ECONOMIC EFFICIENCY?*

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The objective of this paper is to raise questions about matters which many of us working in the water resources field have felt to be settled. Some propositions in welfare economics which have become firmly established in concept and practice are reviewed in their historical context, and questions are raised regarding their relevance and applicability at this stage in the development of water resources in the United States, and whether or not their uncritical application has created some mischief for the efficiency water resource programs achieve. Finally, attention is directed toward the institutional mechanism through which public intervention seeks to influence the decision regarding the extent and character of governmental resource development programs, and whether or not these institutions are compatible at present with the efficiency objectives that justify public intervention.

I

RECENT HISTORICAL BACKGROUND

The effort devoted to developing decision rules for governmental participation in the water resources field has a fairly long history. The initial major contribution to this field has been the work of personnel in the water resource agencies, the Bureau of the Budget and the former Bureau of Agricultural Economics. In the academic area notable contributions were made by Professor Ciriacy-Wantrup at the University of California, and by agricultural economists at other land grant colleges. The framework of decision rules evolved to some extent pragmatically and existed in fairly complete form

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in the *Green Book*.[1] However, in the middle 1950's, the field was discovered by other economists as well, and the flow of literature was notably increased.

There were two events, one policy and the other political, which probably accounted for the increased interest in the field. The first was the Treasury-Federal Reserve Accord in 1951, which liberated the latter from its obligation, assumed during World War II, to support the price of government securities, thus returning to the Federal Reserve System its traditional function of seeing that interest rates performed more nearly their economic role in the economy. The second was a change in national administrations which resulted in there being exhibited in Washington a marked preference for having more of the nation's economic functions carried out by the private sector.

The change in administrations accompanied by a tendency to withdraw government participation in the economic sector induced economists to some extent to address more specifically than before the justification for public intervention in the water resources field. The tenents of applicable welfare economics, which first appeared in developed form in the work of Pigou,[2] had become submerged in the details of controversy over the "New Welfare Economics," and a modern restatement and rehabilitation appeared to be necessary. To a certain extent this was done, albeit inadvertently, by Professor Baumol[3] in his incisive monograph, *Welfare Economics and the Theory of the State*. Nevertheless, despite the excellence of the work and the stimulus it provided for some who contributed to the subject in the water field, Baumol's effort was dominated by a rather narrow consideration of exposing the fruitlessness of welfare economics as it was characterized by discussion during the decades of the thirties and forties. While he presented the most comprehensive statement for governmental intervention, he did not appear to regard it essentially as a restatement of the venerable Pigouvian thesis. Essentially Baumol's effort was a critique of the application of the classical model in analysis of real world problems in significant areas. It was a constructive piece of demolition work, but so far as the rehabilitation of Pigou was concerned, it

1. Sub-Comm. on Benefits and Costs, Report to the Federal Inter-Agency River Basin Comm., Proposed Practices for Economic Analysis of River Basin Projects (1950) [hereinafter cited as Green Book].

2. A. C. Pigou, The Economics of Welfare (4th ed., MacMillan 1952).

3. W. J. Baumol, Welfare Economics and the Theory of the State (Harvard Univ. Press 1952).

left the matter at approximately the point where Pigou had begun forty years previously.

Several related, though independent, efforts were undertaken during the mid-fifties directed toward an attempt to develop the economic rationale for public intervention. At the most general level was the work of Paul Samuelson,[4] which was an extension of some of the earlier work of Howard Bowen,[5] and which was pursued further by Musgrave.[6] Julius Margolis,[7] among others, cultivated the area in the water resources field, and I believe somewhat innocent of the excellent statement by Earl Heady.[8]

The argument, irrespective of its particular formulation, goes somewhat as follows. In an economy characterized by competitive conditions, and in the absence of certain technical conditions in some restricted areas, *i.e.*, complete divisibility of inputs and outputs, and allied independence of production (and consumption) functions, free market results will fail accurately to reflect the social worth of inputs and outputs through the intermediary of prices. Where indivisibilities in production occur, resulting in the least cost scale of output being large in relation to the market, decreasing cost industries occur. In these instances pricing of output at marginal costs will not recover full costs and thus poses problems for efficiency under private management. On the consumption side, indivisibilities associated with outputs (*e.g.*, flood damage by means of regulated discharge from storage reservoirs) means that the product or service cannot be discreetly packaged and offered separately to each individual subject to payment of a price. Accordingly, a conventional market cannot be organized. Where production functions are physically interdependent, external economies and diseconomies arise causing divergences between private and social marginal product and cost. In the resources field, the prevalence of such conditions makes it clear that were resource development restricted exclusively to the private sector, there would result fairly widespread inefficiencies. Accordingly, public intervention could be

4. P. Samuelson, *The Pure Theory of Public Expenditure,* 36 Rev. Econ. & Statistics 387 (1954).

5. H. R. Bowen, Toward Social Economy (Rinehardt 1948).

6. R. A. Musgrave, The Theory of Public Finance: A Study in Public Economy (McGraw-Hill 1959).

7. J. Margolis, *Secondary Benefits, External Economies and the Justification of Public Investment,* 39 Rev. Econ. & Statistics 347 (1957).

8. E. O. Heady, Economics of Agricultural Production and Use, ch. 26 (Prentice-Hall 1952).

demonstrated to be a necessary condition for the improvement of efficiency.

In this connection, perhaps not enough explicit attention was paid the fact that while public intervention was *necessary*, it need not be *sufficient* for improvement in efficiency. For intervention to be also a sufficient condition for improvement in efficiency, appropriate criteria must be developed and, assuming in the final analysis that there is a feasible way to do so, applied with sufficient fidelity to ensure that the objectives of public intervention in the interests of efficiency are reasonably approximated. This, of course, has been the ostensible purpose of benefit-cost analysis and the standards for its application.

II

THE SUBSIDY IN PUBLIC CAPITAL

It is perhaps well at this point to consider the circumstances given rise by the Treasury-Federal Reserve Accord. As a backdrop, it is interesting that benefit-cost analysis had its inception in the field of water resource development in the United States during the 1930's when widespread unemployment was being experienced. Yet the basic model from which decision rules were derived was the classical full employment model reflecting conditions wherein prices have a unique significance. The fact that it had any utility, and it did, was because only a nominal interest rate was imputed and because fairly extensive claims to secondary and/or indirect benefits were incorporated. This is not meant to imply that the reasoning underlying secondary benefit estimation was conceptually sound, but this was before the theories of Keynes and related developments had percolated to the general practitioner.

Following World War II, however, the existence of inflationary pressures made it abundantly clear that the Federal Reserve System should be liberated from its obligation to support the price of Treasury bonds, which in turn resulted in a substantial rise in the interest rate with time. To the extent that these rates reflect the marginal return to capital in the sectors from which it is withdrawn in funding public works, the rise in the rate of interest needs to be reflected fully in the benefit-cost calculations dealing with public investment. That is to say, if economic efficiency is to be achieved by governmental intervention, the marginal efficiency of investment

must be equated between the private sector supplying funds and the public sector utilizing them. If it is not, then while intervention may remain a necessary condition, it need not be sufficient. In that event the justification for public intervention must be judged by the relative degree of inefficiency under private as compared with public development.

What may be the quantitative significance of the preceding observations? Although interest rates rose considerably following the Treasury-Federal Reserve Accord, the rates used in federal water resource project evaluation were slow to respond. Initially, in 1952, the Bureau of the Budget requested of agencies that projects submitted for authorization employ a standard rate computed on the basis of the average rate of interest payable by the Treasury on outstanding long-term government bonds.[9] Budget Bureau Circular A-47, containing the standard, had a rather ambiguous existence, and not until 1962 and Senate Document 97[10] was the standard made mandatory on all agencies participating in water resources development.

It should be observed that the interest rate referred to above was the coupon rate on bonds of long maturities rather than current yields. Accordingly, the rate continued to be determined in part by the level of rates prevailing before the Treasury-Federal Reserve Accord, and thus reflects in part the persistent influence of the artificially depressed rates. Table 1 gives the trend on actual yields of long-term government securities and the computed rates for project evaluation purposes based upon the average of the coupon rates.

Such differences are sufficient to alter the benefit-cost ratio to less than unity of projects in the 1.0:1 to 1.2:1 range, of which there have been quite a number. If, on the other hand, one takes as more pertinent the rates which a government corporation engaged in self-financing projects, such as the TVA, has had to meet in its bond issues (averaging around 4.5 per cent), the divergence between the computed and the actual rates results in larger discrepancies in project evaluation studies. In the extreme the benefit-cost calculation may overstate benefits by thirty to forty per cent.

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9. *Hearings Before the House Committee on the Interior and Insular Affairs: Discussion of Budget Bureau Circular A-47 and the Related Power Partnership Principle*, 84th Cong., 1st Sess. 54 (1955).

10. Policies, Standards and Procedures in the Formulation, Evaluation and Review of Plans for Use and Development of Water and Related Land Resources, S. Doc. No. 97, 87th Cong., 2d Sess. (1962).

These discrepancies relate only to the differences between the computed rate and the yields on long term government bonds. Students of the problem, on the other hand, have uniformly recommended rates which exceed the yield on government bonds, ranging from five per cent up to nine per cent.[11] Fox and Herfindahl[12] have

TABLE 1

COMPARISON OF YIELDS OF GOVERNMENT LONG-TERM SECURITIES AND COMPUTED COUPON RATES

Year	*Current Yields (Per Cent)*	*Computed Rates (Per Cent)*
1952	2.68	2.50
1953	2.93	2.50
1954	2.70	2.50
1955	2.94	2.50
1956	3.08	2.50
1957	3.47	2.50
1958	3.43	2.50
1959	4.08	2.50
1960	4.02	2.50
1961	3.90	2.625
1962	3.95	2.625
1963	4.00	2.875
1964	4.15	3.00

recently reviewed the projects authorized by the Congress in 1962 for construction by the Corps of Engineers, applying alternatively interest rates of 4, 6 and 8 per cent, and discovered that the percentage of these with benefit-cost ratios below unity under the assumed rates of interest were respectively 9, 64 and 80 per cent. From these observations one can infer that artificially depressed rates have been used to justify projects which may be either inherently uneconomic or at least undertaken prematurely. And, of course, even with respect to projects which would show benefits in excess of costs at the higher interest rates, the use of depressed rates results in inefficiencies in the design of works, *i.e.*, excessive capital intensity and/or scale of facility.

11. O. Eckstein, Water Resources Development (Harvard Univ. Press 1958); J. Hirshleifer, J. C. DeHaven & J. W. Milliman, Water Supply: Economics, Technology and Policy (Univ. of Chicago Press 1960).

12. I. K. Fox & O. C. Herfindahl, *Attainment of Efficiency in Satisfying Demands for Water Resources*, 54 Am. Econ. Rev. 198 (1964).

III

THE FALLACY OF THE "EVALUATION-REIMBURSEMENT" DICHOTOMY

A second area in which the sufficiency of public intervention for improvement of economic efficiency may be questioned relates to some issues which result as a rather special case, a fact which may not be generally appreciated in water resource development planning. The problem in question involves the distinction which is drawn between economic evaluation and reimbursement. The matter was first raised by the French engineer Dupuit[13] in the early nineteenth century and resurrected by Harold Hotelling[14] in his classic work on marginal cost pricing. The burden of the marginal cost pricing thesis is that the context of the general economy, the investment decision is independent of the reimbursement policy for individual chunks of productive capacity. In a somewhat different form, yet cut from the same cloth, is the Hicks-Kaldor thesis[15] in modern welfare economics that decision with respect to economic efficiency can be regarded as independent of the attendant income distribution. That is to say, if beneficiaries from a change in the state of affairs can compensate out of their gains those who are affected adversely (*e.g.*, project beneficiaries versus unbenefited taxpayers), whether they do or not is not critical to the change being sufficient for improvement in productive efficiency. The income distribution which attends the change in circumstances is asserted to be an ethical question without implications for efficiency. Again, these postulates from welfare and related economic theory are reflected in the distinction which is made in water resource development practice between project justification and the reimbursement policy.

For these postulates to be applicable in practice, one of two special circumstances is required. The first relates to the technical conditions of production, and the second to the stage in the pro-

13. Reprinted with comments by Mario di Bernardi and Luigi Einaudi, *De l'Utilite et da sa Mesure*, La Riforma Sociale, Turin, 1932.

14. H. Hotelling, *The General Welfare in Relation to Problems of Taxation and of Railway and Utility Rates*, 6 Econometrica 242 (1938).

15. J. R. Hicks, *Foundations of Welfare Economics*, 49 Economic Journal 696 (1939), and *The Rehabilitation of Consumer Surplus*, 12 Rev. Econ. Studies 549 (1940); N. Kaldor, *Welfare Propositions of Economics and Interpersonal Comparisons of Utility*, 49 Economic Journal 480 (1939).

duction process in which the resource development project is intended to function.

With respect to the technical conditions of production, the minimum scale of development to achieve low costs per unit output must be quite large in relation to the market so that the project will operate with decreasing costs. This is the typical situation in which marginal cost pricing presents a problem. Marginal cost pricing is a general rule for efficient production and exchange, but typically marginal costs exceed average costs so that pricing at marginal costs will return full costs. In the case of decreasing cost industries, marginal costs fall below average costs and thus full costs cannot be recovered with such a pricing policy. Perhaps in this latter case it should be said that when viewed realistically, not only should the scale be large in relation to the market, but also that conditions in the economy would need to be comparatively static so that excess capacity would be anticipated as a relatively permanent feature of the facility in question if a pricing policy consistent with full cost recovery were adopted.

Of course, at the time of the Hotelling article there was excess capacity throughout the economy. With depressed conditions, a marked decline in the birthrate, and general economic stagnation, there was widespread merit to pricing policies which were indifferent to the recovery of full costs. On the other hand, while this is doubtless true under relatively static conditions, under conditions of vigorous economic expansion it no longer remains true that cost recovery is irrelevant for efficient resource use. For example, while initially there may be unused capacity which warrants a marginal cost pricing policy indifferent to the recovery of full costs, when use begins to approach capacity an unemphasized extension of the marginal cost pricing rule requires that prices be raised to ration the scarce capacity until a point is reached at which the revenue demonstrates a beneficiary willingness to pay for the service sufficient to justify an expansion of facilities. In the case of an inland waterway, for example, marginal cost pricing suggests that user fees be applied immediately sufficient to cover annual operating and maintenance costs while excess capacity exists on the waterway. However, as use of the waterway expands to the point where congestion begins to appear, each additional unit of use inflicts costs associated with the congestion on all other users of the waterway. In this sense a social cost occurs. This cost will rise progressively until the congestion costs approach the cost of enlarging the capac-

ity. If user fees are raised correspondingly, the user fee at this point (corresponding to the marginal social cost) will be just equal to the average cost of an increment of capacity. In short, the marginal cost pricing under these conditions will result in exactly recovering costs of facilities of optimal scale and schedule of expansion.[16]

The only other circumstance in which a case can be advanced for divorcing reimbursement policy from project evaluation involves productive facilities which provide consumer goods under a special set of circumstances. In the case of consumer goods, welfare propositions would suggest that such can be provided without regard to reimbursement, provided the undertaking is regarded primarily as a desirable income redistributive measure.[17] While there may be some implications for efficiency even here, efficiency in this case is a subordinate consideration.

On the other hand, while in principle a similar argument may be advanced in the case of projects producing intermediate goods and services destined for further use in the production process, there seem to be enough problems associated with this case in practice to raise doubts regarding their efficacy as income redistributive measures as well as their consequences for efficiency. Income redistribution can be looked upon technically as relaxing the budget constraint of specific disadvantaged individuals or groups. Or, in some cases, as making provision for some items, catering to what are referred to as "merit wants," to enter into the consumption patterns of individuals whose incomes are inadequate for this purpose. Subsidization of producer goods and services via reimbursement policies, on the other hand, has the effect of redistributing several stages removed from the point of intended impact with the consequent diffusion of redistributive effects among many individuals and groups

16. As a practical matter, of course, it is neither realistic nor desirable to have a continuously varying price of unpredictable magnitude (although peak load pricing of definite and known characteristics is another matter). The degree of uncertainty attending unstable prices for project output would affect adversely the investment environment for related industries. A practical alternative developed by Electricité de France is a stable price or rate equal to the average cost of the incremental capacity (incorporating where appropriate peak load pricing provisions) which results in recovering fully the cost of facilities at an optimal scale of capacity and/or expansion schedule. See M. Boiteux, *Marginal Cost Pricing*, in Marginal Cost Pricing in Practice 51 (Nelson ed., Prentice-Hall 1964). This point has also been established by Herbert Mohring, The Benefits of Urban Highway Investments, Paper Presented at the Brookings Institution Conference on Government Investment Expenditures, Washington, D.C., Nov. 1963.

17. That income redistribution is an implicit requirement is apparent since even here there would otherwise be a distortion of the marginal conditions required for efficiency in consumption.

not qualified on welfare grounds. It resembles too much a scatter-gun approach in which only a small proportion of the shot-charge ultimately hits the intended target.

On efficiency grounds the practice with respect to facilities providing producer goods and services has serious economic consequences. In the first instance, when services of water resource development projects are provided without cost, users of these factor services consider them as zero priced and combine their productive factors in proportions which reflect the "free" input. A greater use of the services of the facility is made than real costs warrant. That is, not only those who *could* compensate the development agency (even if not required to do so) take advantage of the subsidized service, *but also other firms which would not find it profitable to do so if they were required to meet the cost of the services they employ*. This will lead to premature excess demand, or congestion, whatever the case in question may be, and political pressure for expansion of facilities to alleviate the ostensible capacity shortage. There thus develops a systematic bias in favor of facilities to be of greater capacity than economically justified and/or redeveloped or expanded prematurely when built at public expense.

In addition to the inefficiency a systematic bias in favor of over-expansion introduces into the system, there appear inefficiencies throughout the system in productive enterprise which utilizes the publicly provided factor services.[18] That is, if materials and service in process are obtained by related production units at below their opportunity cost, there will be distortion in the marginal conditions for efficient production by the relative over-utilization of materials and services priced below cost and a relative over-allocation of *all factors* devoted to the production of the end products for which these subsidized services are utilized.

We may consider an example. Assume that there exists an option between two alternative policies with respect to the incidence of costs for a water quality management program. On the one hand, the government may stand ready to supply at public expense releases of waste dilution flows from storage projects built for this purpose. Alternatively, a policy might be adopted which involved effluent charges on firms which discharge noxious substances into the stream, depending on the quality and quantity of the effluent,

18. A similar argument has been elaborated for a somewhat different circumstance by L. McKenzie, *Ideal Output and the Interdependence of Firms*, 41 The Economic Journal 785 (1951).

and its offsite costs. In the first instance no incentive exists for firms using the waste degradation capacity of the stream to restrict or modify the character of their discharge. On the other hand, if use of the waste degradation capacity of receiving waters is subject to an effluent charge, incentives exist for reviewing the least cost program by each firm whether through process adjustment which eliminates some portion of the noxious substances, internal treatment and waste recovery, or discharge into receiving waters unmodified subject to a charge. In many instances the economics internal to the firm when faced with effluent charges would commend adjusting to the circumstances with a reduced discharge of offending substances. Accordingly, if the cost of pursuing a water quality management program were assumed by the beneficiaries, a substantially different organization of productive factors would result. There is sufficient evidence to this effect as provided by the German experience in the Ruhr to warrant belief that reimbursement policies which do not require beneficiaries to assume costs of project services lead to substantial inefficiency throughout related sectors of the economy.[19]

Can we say something about the quantitative significance of these observations? It is not possible within the scope of this paper to attempt a precise measurements. But, quite short of such an effort, it may be possible to provide at least the roughest sort of notion as to what may be involved as an order of magnitude. The Deputy Chief for Civil Works of the Corps of Engineers, testifying before a congressional committee on water pollution and control had this to say:[20]

> The Corps of Engineers has recently estimated that the programs for which it has planning responsibility would be formulated to provide 320 million acre feet of reservoir storage capacity by 1980. Much of that capacity will be needed for water quality control.[21]

This amount of pollution abatement storage represents nearly double the total storage capacity developed to the present time in the United States for all purposes combined. If we consider the

19. A. V. Kneese, The Economics of Regional Water Quality Management (Johns Hopkins Press for Resources for the Future, Inc. 1964).

20. *Hearings Before a Subcommittee of the House Committee on Governmental Operations on Water Pollution Control and Abatement*, 88th Cong., 1st Sess. 1244 (1964).

21. The water quality control and pollution abatement storage requirements for the nation are put at 315 million acre-feet.

conditions which exist on the Ruhr in Germany, on the other hand, we have a vastly altered picture. Here, a region which supports about forty per cent of all West German industrial activity and a greater proportion of its heavy industry, is able to meet its urban and industrial water uses and demand for aesthetically pleasing recreation on an *annually* expected low flow of only 440 cubic feet per second, little more than half of the lowest flow of *record* on the Potomac River alone. If we were to assume the same water quality management organization and technology in operation in the United States as currently exists in the Ruhr, the industrial output *of the entire United States projected for 1980* could be adequately serviced by the stream flows of the Columbia River alone during its most adverse flow of record without benefit of any storage. This is not to claim that conditions in the United States are identical, nor that an exact replication of Ruhr technology would represent the most economical means of achieving the desired water quality in the United States. But between no additional storage for water quality management purposes and the estimated 315 million additional acres cited above there exists an enormous latitude for evolving a discriminating program of cost reducing technology for water quality management. Appropriate effluent charges would provide a powerful inducement to seek that program representing the most efficient way to deal with water quality problems.

There is one additional problem which arises as a consequence of the separation of project justification from reimbursement considerations. Typically, both theory and practice in water resource system design abstracts from the reimbursement question and seeks to address only the question whether or not the project is justified on the basis of efficiency criteria irrespective of pricing policy governing the output.[22] A project is to be included in the efficient program if its total benefits exceed its total cost. The project scale is determined by equating incremental benefits to incremental costs, *i.e.,* where the net benefit is maximized.[23] However, if the pricing policy governing output is not taken into consideration explicitly there is a dilemma which almost everyone involved in proposing investment criteria

22. An example of this is provided in Maass et al., The Design of Water Resource Systems 38-40 (Harvard Univ. Press 1962). While I am not certain that Hirshleifer, DeHaven and Milliman address this question explicitly, their implicit position would not be subject to the critique developed herein. See Hirshleifer et al., *op. cit. supra* note 11.

23. Green Book 12; O. Eckstein, Water Resources Development 65 *passim* (Harvard Univ. Press 1958).

for water resource development has failed to face up to directly.[24] This problem arises in connection with determining the scale of a facility when it is anticipated that no charge will be levied against beneficiaries. We have on the one hand the dicta that the scale of a facility be extended to the point at which the incremental benefit just equals the incremental cost. However, unless user charges are levied such as to cover the cost of providing the marginal unit of output, there will develop excess demand represented by those users who would not find incentive to use the services of the facility if charges appropriate to the design criteria were imposed, but who will make use of the facility because the service is provided at zero price. If such use by any beneficiary at capacity output adversely affects the utility received by any other, the design criteria result in a project which is inappropriately sized relative to realizing the benefits estimated for purposes of its design.[25] At any rate, it is clear that design criteria as presently advanced relate to the correct design for an irrelevant situation where reimbursement policies are at variance with design criteria. If the agencies over-design the capacity of their facilities to avoid the predictable congestion, it represents a pragmatic adjustment involving additional (uneconomic) capacity in a trade-off against congestion costs. Accordingly, in the absence of a pricing policy consistent with efficiency criteria, either an adulterated quality of service will be provided or a continuously existing over-capacity will prevail. In the case of some kinds of facilities, *e.g.*, recreational, the providing of uneconomic capacity for the inframarginal users may be dismissed perhaps with the "merit wants" rationale. This, however, would be obviously specious in connection with waterway traffic, occupance of the flood plain, use of the increased degradable capacity of streams, and other intermediate goods provided without cost to users.

IV

THE VULNERABILITY OF VENERABILITY

This brings us finally to a consideration not related to public intervention per se, but rather to the efficiency with which the mechanism

24. The personnel of Electricité de France represent a notable exception in this regard. See J. R. Nelson, Marginal Cost Pricing (Prentice-Hall 1964).

25. Congestion costs, whether they be at lockage facilities on waterways or, say, recreational facilities provided by the development, would have an effect equivalent to shifting downward the marginal willingness to pay or benefit function for all *supra marginal* beneficiaries. Whether or not the benefits aggregated over all *infra marginal* beneficiaries are sufficient to compensate is not *a priori* determinate.

of public intervention operates. Typically, a governmental agency is established initially to carry out specific functions deemed desirable in the public interest. In the course of its activities the agency defines its role consistent with the functions it was established to discharge, develops the means or capabilities appropriate to these particular responsibilities, and in the process evolves a pattern of analysis and action unique to its role as it is perceived. The more venerable the agency the more traditional the perception of its role and the means for performing its functions become, not only internally but also as a reflection of its public image. But with the passage of time, growth of the community, and changes in peripheral institutions with which it deals, the functions which the agency has been created to perform may recede in importance in the face of emerging new circumstances outside the competence of its original character. The legacy of traditional policy governing its behavior not only internal to the agency, but also imposed from without to a certain extent, restricts its capabilities to deal with the problems coming into dominance. The means of dealing with new situations is often restricted to the reservoir of expertise developed over the years in its traditional role. An example is provided.

In the Eastern United States, emergence of water quality management as a matter of dominant concern is increasingly recognized. Yet, despite the qualitatively different character of the problem, the first major planning effort undertaken in this context, the Potomac River Plan, bears a remarkable resemblance to the conventianal Corps of Engineers plans. In this case we discover the traditional emphasis on physical structures, but in this case for purposes of augmenting low flows (of relatively rare occurrence but considerable severity) to dilute pollution concentrations. A very large part of the problem to be dealt with is concentrated in the Potomac estuary associated with the Washington metropolitan area's metropolitan area's sewage treatment plant outfalls. Assuring specified flows for an increasingly higher proportion of the time requires disproportional amounts of storage capacity which come at steeply rising costs because of conflicting uses for the technically superior reservoir sites. In this range of costs careful evaluation of the plan's latter increments is required by reference to alternative technical means or combinations of measures to achieve specified goals. Nevertheless, no detailed consideration was given alternatives such as the more uniform distribution of the treatment plant's effluent throughout the estuary to mitigate the concentration of biochemical

oxygen demand, nor was consideration given to effluent oxygenation or other means of artificial reaeration or chemical treatment, some of which are relatively low in capital costs and suitable for dealing with occurrence of the rare event.

We may speculate as to the reasons for this. Typically, challenges are met with the aid of expertise within the responsible agency, and it is not surprising that such expertise has been developed in response to meeting qualitatively different problems. Secondly, the Congress has not been very suggestible with respect to providing the Corps of Engineers with resources to mount a program of research and investigation relevant to the new range of problems which would support addition of staff with competence qualitatively consistent with the new circumstances. There is periodic static observed on Capitol Hill directed at suspected "duplication and waste" in the area of water resources research in the federal establishment. It does not require on overly perceptive agency head to conclude that prospects remain slim for obtaining the support to staff expanded facilities which are deemed by the Congress to be esoteric to the agency's traditional functions. Finally, irrespective of the problem posed by the foregoing considerations, there is little disposition by any agency to consider seriously non-conventional alternatives falling outside the scope of its own capabilities when the institutional mechanism for introducing such measures is either ill-defined or non-existent. There is a wholly understandable tendency for the responsible agency to feel constrained to rely only on the measures subject to its control. Given the permanence of reservoir structures, and agencies with a highly developed capability for their construction, the effect is to diminish seriously the prospects for introduction of known alternative technology which at certain times and under specified conditions will be superior to the measures relied on.

CONCLUSION

These observations on the institutional machinery of public intervention at the present time merit serious consideration when the question is posed with respect to the sufficiency of public intervention for the improvement of efficiency in the water resource development field. Perhaps the time has arrived when the greatest dividend to study and experimentation would come in response to a concerted effort to review the character and capabilities of exist-

ing agencies, to identify the barriers to improved performance, and to address the problem of organizing a capability consonant with the requirements of the present and future. In such an evaluation and assessment of alternative institutional arrangements, the centrality of reimbursement policy for improvement in efficiency would need to be faced squarely with a recognition of the powerful influence which cost bearing by beneficiaries would have on the discriminating use of the entire range of cost reducing technological alternatives. Not a little could be learned from the pioneering work in water quality management by the cooperative water quality management associations in the Ruhr, or the integration of investment planning, design criteria and pricing policy of Electricité de France. Doubtless a similar spirit of innovation in the water resources field in the United States would add a considerable measure of assurance that public intervention would be sufficient as well as necessary to improvement of efficiency in water resource development programs.