Table 6-6

AGGREGATE DEMAND SCHEDULE FOR RUN 1 OF THE MOHAWK PERMIT SYSTEM SIMULATION

PRICE OF PERMIT	DEMAND, LBS/DAY	PRICE OF PERMIT	DEMAND, LBS/DAY
0.0	13624.00	880.07	5176.42
158.90	12912.00	957.83	4195.71
195.66	11741.36	983.68	3861.94
222.45	11612.88	992.19	3752.03
230.14	11545.30	996.06	3700.65
246.59	11414.00	1167.62	2640.16
253.06	11245.80	1222.27	2433.66
323.90	10391.33	1362.84	2216.13
359.16	10051.96	1409.44	2141.01
368.23	9987.02	1556.50	1903.90
392.70	9881.14	1616.14	1807.75
423.36	9734.00	1952.21	1265.94
485.45	9410.92	1997.57	1220.39
510.71	9188.34	2155.18	1058.79
537.87	8952.81	2214.97	1021.01
615.78	8127.80	2240.10	1005.13
740.76	6776.79	3067.10	847.02
749.31	6684.31	3245.83	838.33
799.73	6158.23	3964.91	733.00
800.67	5345.38	4683.98	712.00
		5403.06	691.00

Table 6-7

RESPONSES OF BIDDERS FOR RUN 1 OF THE MOHAWK PERMIT SYSTEM SIMULATION

NUMBER ISSUED= 4000. TERM= 5 YRS UNIT=LBS/DAY BOD

MARKET CLEARING PRICE=$ 972.99

POLLUTER	PERMITS BOUGHT LBS/DAY	COST $	TREATMENT LBS/DAY	COST $	TOTAL COST $
ILION	601.92	585657.19	4398.08	696975.63	1282632.00
FT PLAIN	277.22	269726.38	4902.78	546596.56	816322.94
CANAJOHARIE	655.36	637656.75	5344.64	795701.25	1433358.00
HERKIMER	295.35	287367.44	1914.65	54954.41	342321.81
LITTLE FALLS	514.69	500783.69	3815.31	1049460.00	1550243.00
ROME	696.19	677381.00	7093.81	1223471.00	1900852.00
ST JOHNSVILLE	508.04	494213.94	3771.96	587485.31	1081799.00
UTICA	451.25	439056.19	28378.75	2944344.00	3383400.00
TOTALS	4000.00	3891940.00	59619.98	7898987.00	11790927.00

	LBS/DAY	$/YR	LBS/DAY	$/YR	$/YR
ILION	601.92	154495.88	4398.08	183861.56	338357.44
FT PLAIN	277.22	71153.56	4902.78	144191.69	215345.25
CANAJOHARIE	655.36	168213.31	5344.64	209905.31	378118.63
HERKIMER	295.35	75807.25	1914.65	14496.93	90304.13
LITTLE FALLS	514.69	132106.31	3815.31	276846.69	408953.00
ROME	696.19	178692.56	7093.81	322750.63	501443.19
ST JOHNSVILLE	508.04	130399.63	3771.96	154978.13	285377.75
UTICA	451.25	115822.63	28378.75	776715.56	892538.19
TOTALS	4000.00	1026690.69	59619.98	2083746.00	3110436.00

TOTAL NATIONAL INCOME COST=$ 5144286.00/YR

Table 6-8

RESPONSES OF BIDDERS FOR RUN 1 OF THE MOHAWK PERMIT SYSTEM SIMULATION

NUMBER ISSUED= 2000. TERM= 5 YRS UNIT=LBS/DAY BOD

MARKET CLEARING PRICE=$1496.90

POLLUTER	PERMITS BOUGHT LBS/DAY	COST $	TREATMENT LBS/DAY	COST $	TOTAL COST $
ILION	377.56	565162.06	4622.44	975697.88	1540859.00
FT PLAIN	262.79	393366.31	4917.21	564415.25	957781.56
CANAJOHARIE	336.82	504192.00	5663.17	1189071.00	1693263.00
HERKIMER	245.89	368065.69	1964.11	117727.00	485792.69
LITTLE FALLS	47.00	70354.19	4283.00	1550027.00	1620381.00
ROME	140.00	209565.75	7650.00	1833961.00	2043526.00
ST JOHNSVILLE	301.95	451984.00	3978.05	841996.44	1293980.00
UTICA	288.00	431106.75	28542.00	3105067.00	3536173.00
TOTALS	2000.00	2993794.00	61619.99	10177962.00	13171755.00

	LBS/DAY	$/YR	LBS/DAY	$/YR	$/YR
ILION	377.56	149089.25	4622.44	257388.31	406477.56
FT PLAIN	262.79	103769.69	4917.21	148892.25	252661.94
CANAJOHARIE	336.82	133005.44	5663.17	313675.94	446681.38
HERKIMER	245.89	97095.38	1964.11	31056.29	128151.63
LITTLE FALLS	47.00	18559.38	4283.00	408895.88	427455.25
ROME	140.00	55283.28	7650.00	483797.44	539080.69
ST JOHNSVILLE	301.95	119233.00	3978.05	222117.94	341350.94
UTICA	288.00	113725.56	28542.00	819114.19	932839.75
TOTALS	2000.00	789760.44	61619.99	2684938.00	3474698.00

TOTAL NATIONAL INCOME COST=$ 6449094.00/YR

are BOD permits, and the market-clearing price of the permits (the price at which the total demand for permits is 2000) is $972.99. Thus each permit costs $972.99.

Column 1 of Table 6-7 lists the names of the eight municipalities twice. The top list refers to the data in the top half of the table. These data are the permit, discharge, and total cost amounts corresponding to run 1 of the model. For example, in simulation run 1 columns 2 and 3 indicate that Utica buys 451.25 effluent permits at a total cost of $439,056 (which, to four significant figures, equals $972.99 x 451.25). Column 4 shows the total effluent reduction of Utica is 28378.75 pounds of BOD per day. Total treatment costs for Utica are $2,944,344 and are given in column 5 of Table 6-7. The total costs that are borne by Utica are the treatment costs plus the cost of buying the permits. These are equal to $3,383,400 and are given in column 6.

The bottom half of Table 6-6 gives the same information as the top half with one important difference: the cost data are annualized figures rather than total amounts. Thus, the cost of permits for Utica is given in column 2 as $115,822.63 per year. This is the five-year annuity that $439,056 will purchase at an interest rate of 10 percent per year. Similarly, the lower half of Table 6-6 gives Utica's annualized treatment and annualized total costs as $776,715.56 per year and $892,538.19 per year respectively. These are given in column 5 and 6. (It should be noted that the data given in

Table 6-7 and in all such tables in the text and in the appendices are accurate to, at most, four significant figures.)

The final line of Table 6-7 gives the total national income cost for run 1. This is the sum for all municipalities of the annualized value (at a discount rate of 7 percent per year) of unsubsidized treatment costs.

In this section, the computer runs are discussed and comparisons made among them. However, except for Tables 6-5, 6-7 and 6-8, only summary data are presented in this section. Most of the data from the computer runs are relegated to Appendix A. Appendix A contains the aggregate demand numbers and the response data for each of the 27 computer runs. For 7 of those runs, there are also graphical demand curves given in Appendix A.

Table 6-9 provides a summary of the computer runs. That table contains the market-clearing price, annualized treatment and permit costs, annualized total costs, and annualized national income costs for each of the computer runs at both permit supply amounts. National income costs are defined as the present value of the total unsubsidized treatment costs associated with each permit program. The discount rate for national income costs is taken to be 7 percent per year: the cost of the permits and the reduction in costs due to

Table 6-9

Summary Information for the Mohawk Effluent Permit System Simulation

Run No.	Permit Supply (lbs.)	Market Price ($)	Total Subsidized Treatment Costs to Dischargers ($1000's/year)	Total Permit Costs to Dischargers ($1000's/year)	Total Costs to Dischargers ($1000's/year)	Total Unsubsidized National Income Costs ($1000's/year)
1	4,000 BOD	973	2,084	1,027	3,110	5,144
2	4,000 BOD	6,885	5,113	2,363	7,477	5,114
3	4,000 BOD	973	2,084	1,027	3,110	5,144
4	4,000 BOD	233	2,084	1,027	3,110	5,144
5	4,000 BOD	1,577	2,084	1,027	3,110	5,144
6	4,000 BOD	1,952	2,084	1,027	3,110	5,144
7	4,000 BOD	641	1,461	677	2,138	5,114
8	4,000 BOD	863	2,364	1,154	3,519	5,134
9	4,000 BOD	989	2,136	1,043	3,179	5,269
10	4,000 BOD	1,096	2,332	1,155	3,497	5,701
11	1,000 BOD	566	306	149	455	787
18	4,000 BOD	600	1,813	633	2,446	4,306
19	4,000 BOD	1,020	1,845	664	2,509	4,384
20	4,000 BOD	1,317	1,874	693	2,567	4,449
24	4,000 BOD	1,546	3,337	1,631	4,968	5,135
25	4,000 BOX	1,327	2,823	1,400	4,233	5,149

Table 6-9 (continued)

Run No.	Permit Supply (lbs.)	Market Price ($)	Total Subsidized Treatment Costs to Dischargers ($1000's/year)	Total Permit Costs to Dischargers ($1000's/year)	Total Costs to Dischargers ($1000's/year)	Total Unsubsidized National Income Costs ($1000's/year)
1	2,000 BOD	1,497	2,685	790	3,475	6,449
2	2,000 BOD	9,485	6,448	1,628	8,076	6,448
3	2,000 BOD	1,497	2,685	790	3,475	6,449
4	2,000 BOD	359	2,685	790	3,475	6,449
5	2,000 BOD	2,426	2,685	790	3,475	6,449
6	2,000 BOD	3,003	2,685	790	3,475	6,449
7	2,000 BOD	854	1,839	450	2,289	6,448
8	2,000 BOD	1,279	3,028	855	3,883	6,449
9	2,000 BOD	1,576	2,736	831	3,568	6,555
10	2,000 BOD	1,837	2,926	967	3,893	6,948
11	500 BOD	1,797	467	237	704	1,119
18	2,000 BOD	799	2,186	422	2,607	5,066
19	2,000 BOD	1,396	2,241	454	2,695	5,174
20	2,000 BOD	1,861	2,291	489	2,780	5,277
24	2,000	2,298	4,276	1,212	5,488	6,449
25	2,000 BOD	2,075	3,660	1,095	4,754	6,449

Table 6-9 (continued)

Run No.	Permit Supply (lbs.)	Market Price ($)	Total Subsidized Treatment Costs to Dischargers ($1000's/year)	Total Permit Costs to Dischargers ($1000's/year)	Total Costs to Dischargers ($1000's/year)	Total Unsubsidized National Income Costs ($1000's/year)
12	35,000 BP	105	2,171	970	3,141	5,040
13	35,000 BP	683	5,023	2,053	7,076	5,023
14	35,000 BP	105	2,171	970	3,141	5,040
15	35,000 BP	170	2,171	970	3,141	5,040
16	35,000 BP	211	2,171	970	3,141	5,040
17	5,500 BP	85	506	123	629	1,207
21	35,000 BP	74	1,635	681	2,316	3,808
22	35,000 BP	121	1,695	692	2,387	3,904
23	35,000 BP	156	1,751	716	2,466	4,005
26	35,000 BP	144	3,438	1,328	4,766	5,044
27	35,000 BP	129	2,966	1,196	4,162	5,074

Table 6-9 (continued)

Run No.	Permit Supply (lbs.)	Market Price ($)	Total Subsidized Treatment Costs to Dischargers ($1000's/year)	Total Permit Costs to Dischargers ($1000's/year)	Total Costs to Dischargers ($1000's/year)	Total Unsubsidized National Income Costs ($1000's/year)
12	70,000 BP	80	1,360	1,469	2,829	3,581
13	70,000 BP	510	3,331	3,062	6,393	3,331
14	70,000 BP	81	1,347	1,505	2,852	3,505
15	70,000 BP	129	1,360	1,469	2,829	3,581
16	70,000 BP	160	1,360	1,469	2,829	3,581
17	11,000 BP	77	389	225	614	974
21	70,000 BP	58	1,047	1,072	2,119	2,471
22	70,000 BP	97	1,077	1,108	2,185	2,523
23	70,000 BP	125	1,106	1,154	2,260	2,586
26	70,000 BP	113	2,248	2,087	4,336	3,462
27	70,000 BP	105	1,895	1,948	3,843	3,508

subsidies are not included in national income costs since they represent a transfer of funds rather than the expenditure of real resources. The annualized national income costs, A, are determined by the standard formula:

$$A = Tr/[1-(1+r)^{-n}]$$

where r is the discount rate (= .07 per year), T is the total present value of treatment costs, and n is the number of years of the permit term. It should be stressed that because of the assumptions regarding the responses of polluters (piecewise linear demand curves) and the costs incurred by them, the computer results provide only approximations to the responses that would actually be made by cost-minimizing dischargers. Additionally, the uncertainties of the quantities of future permit issues and of their prices are neglected.

In spite of these simplifying assumptions, the output of the simulation model is helpful in assessing the general characteristics of the effluent permit system. In order to facilitate the comparison among different runs of the simulation model, the cost data have been transformed into annual terms. Runs 1 and 2 provide standards of comparison for the remainder of the BOD simulations. Run 1 represents the conditions that hold in the Mohawk in terms of the present subsidy rates and the lower bound on treatment schemes. A 90% capital cost subsidy is provided--75% from the federal

government and 15% from New York State--and a 30% operating cost subsidy is provided by New York State. Run 1 is made for 5-year permits.

Run 2 is of interest because it provides an approximation to the least-cost (in terms of national income costs at a 7% discount rate) system of waste treatment. The cost figures for run 2 are considerably greater than those for run 1 because they are computed with a zero subsidy level and a 7% discount rate in accord with the definition of national income costs given above.

The important figure for comparison that run 2 provides is the least-cost figure for national income costs. This run equates the marginal national income costs of different polluters subject to the restriction on the total waste discharges. Thus the result is the least-cost treatment configuration and a permit price that represents the "shadow price" of the effluent discharge constraint. That is, in run 2 the price of the permit represents the increase in national income costs necessary to achieve the reduction of an additional pound of effluent when that effluent is reduced in the least-cost manner. The associated treatment configuration is of interest as a standard of efficiency. Run 2 can be compared with run 1 and runs 3 through 10. Since runs 11, 18, 19 and 20 involve different permit supply levels, they are not comparable to runs 1 and 2.

Runs 12 and 13 are the corresponding computer simulations for BP. Thus, they provide a standard for comparison with the other BP simulations. Run 12 represents the present Mohawk conditions in terms of subsidy rates and the lower bounds on treatment schemes. Run 13 is the least-cost solution in national income terms. Runs 12 and 13 can be compared with runs 14, 15 and 16.

The most striking thing to note about the computer results is the national income cost column. The permit systems, by and large, provide for waste treatment at a cost level that is less than one-half of 1% greater than the least-cost method. This attests to the relative efficiency of the permit system as a water pollution control tool. In fact, run 7 closely approximates the least-cost method.

There are other factors to note. First, permit costs are significant: they are often the same order of magnitude as treatment costs. That is, polluters must often pay almost as much for effluent permits as they do for treatment of wastes. The unit permit costs is also high; in almost all cases, it exceeds $100.

The primary differences among the unit cost of the permits for different computer runs are accounted for by the difference in the length of the permit term. A 5-year permit naturally costs less than a 10-year permit. Indeed, the only difference among computer runs 1 and 3 through 8 is the

permit price. Responses in terms of treatment and the number of permits purchased remain the same due to the assumptions regarding the cost functions.

In spite of the high permit costs, the system need not be excessively expensive for dischargers. Above, two methods for alleviating the cost burden are suggested. First, an initial allocation of permits can be made with a subsequent auction and market. Second, the costs of permits can be subsidized in the same manner as the costs of treatment. The latter course of action improves the efficiency properties of the system by assuring the desired equality of marginal treatment costs among polluters.

At present there is a discrepancy between subsidies for capital and operating costs. This leads to a distortion in the capital/operations expenditure mix and a consequent loss in efficiency. Run 7 was designed to test the magnitude of that distortion. In that run the capital and operating subsidies are both 75%. The results show that equalization of the two subsidy levels does lead to some efficiency gains--the resulting treatment configuration is a closer approximation to the least-cost system. The gains are not, however, significant: national income costs are reduced only 0.6 percent.

The approximation of run 7 to the treatment configuration of the least-cost method is better than that of run 1. In

run 1, even though the national income costs are close to the least-cost method, in some respects the distribution of treatment duties differs significantly from run 1. In fact, Utica buys less than half as many permits in run 1 as in run 2. This does not result in significantly higher national income costs, but it does affect the distribution of costs among polluters.

The striking uniformity of the national income costs is not surprising in view of (a) the nature of the pollution control costs used in these examples, and (b) the high minimum levels of waste reduction required of all polluters. The pollution control costs are all based on waste treatment only and on existing technology for waste treatment. In cases where other control methods such as process modification are admitted, a permit program will allow additional national efficiency savings to be achieved. Similarly a permits program would allow efficiency savings to be captured in the future through the use of advanced treatment technologies.

The constraint that all polluters must achieve a level of waste reduction equivalent to secondary waste treatment markedly limits the efficiency savings that can be achieved by a permit system (or any control mechanism) since it limits the degree to which differential treatment costs can be avoided. Beyond the secondary waste removal range (tertiary

treatment levels), the marginal treatment costs to the different polluters in the case examined do not differ markedly. This is a result of the relatively small economies of scale exhibited by tertiary treatment as opposed to primary and secondary treatment.*

Hence, at the high minimum level of waste reduction called for in this model, total costs are simply not significantly affected by the model's reallocations of waste treatment among dischargers. This fact mitigates the efficiency advantages of the effluent permit method, and must be considered in evaluating this pollution control method. Relaxing the constraint to require lower minimum treatment levels would, of course, allow additional efficiency gains under a permits method.

The bidding for effluent permits need not be limited to dischargers. An environmental action group, for instance, might wish to purchase permits in order to keep them off the market and thereby improve water quality. This option is discussed in Section 2; runs 9 and 10 of the simulation model were made including such a market participant (the hypothetical "Society to Clean Up the Mohawk"). The assumption was made that the associated demand schedule is dictated by the

*These relative scale economies are presented in Appendix B.

sum of money available for the purchase of permits. Stated differently, the elasticity of demand for permits is assumed to equal 1 for this market participant. Thus, if $100,000 is available for buying permits, 1,000 are demanded if the price is $100 per permit, 500 are demanded if the price is $200, etc. Run 9 is made assuming that the environmental group has $200,000 available for the purchase of permits and $1,000,000 is assumed available in run 10. The effect of the added demand on the market can be seen by comparing runs 9 and 10 with run 1.

The increase in demand for permits resulting from the addition of the environmental group drives the price of permits up. The national income costs increase because the environmental group has withdrawn some permits from the market. Although the national income costs are higher, this situation is not necessarily inferior to the ones represented in the other computer runs. In runs 9 and 10 the costs are higher, but the water quality is also better. Total discharges are decreased from 5 to over 25%. There seems little reason to deny this group participation in the MEP market. Its rights should be equal to those of a polluter and market participation by such a group can help to mitigate the potential problems of market manipulation. Further, if the permits are of greater value to the polluter than to the environmentalist, the polluter can buy them back.

Simulations of Market Manipulating

The simulations thus far described are made assuming that each polluter is a price-taker who disregards (or is unaware of) the demand schedules of others and disregards its own effect on the price. In light of the fact that some of the anticipated problems of the MEP system are related to the possibility of manipulating the market, it is interesting to explore the consequences of assuming that one of the Mohawk dischargers is a price-maker, rather than a price-taker. The primary motivation of the price-maker is still assumed to be an interest in minimizing costs. However, unlike a price-taker the price-maker realizes that the amount that he demands affects the ultimate price of the permits in the market. For the market simulations the price-maker is assumed to know the aggregate demand curve of the other dischargers. Thus, the other dischargers act as price-takers and the price-maker knows their demand schedules. The price-maker takes advantage of this information by submitting bids for permits in a manner that results in the price/quantity combination that minimizes the price-maker's costs.

This approach is slightly different from the textbook duopoly solutions because of the fixed-supply character of the MEP system.[6] Since the supply of permits is fixed by the regulatory authority, the price-maker cannot manipulate the total market-clearing quantity. Instead he can affect only

the price and his share of the total quantity. At any given price the price-takers demand a certain quantity of permits depending on their treatment cost schedules; the price-maker assumes that he must purchase the remaining permits at that price. He thus strives to fix the price at the point most advantageous to him, the one that results in the best possible price/quantity combination under the given circumstances.

In the extreme case of the monopsonist--a single price-taker with no other market participants--an ongoing market is, of course, not a possibility. If the regulatory authority attempts to institute a competitive bidding process, the monopsonist will end up with all of the available permits at (almost) zero price. (As Rose points out, this will not be true if the supply schedule of permits has elasticity greater than zero, i.e., if the supply of permits is not fixed at a prespecified level.) Consequently the MEP system, like any market, makes little sense if there is only one participant.

Two price-making situations are examined using the Mohawk data. In the first, Utica is assumed to be the price-maker while all other cities are assumed to be price-takers. The situation for both BOD permits and BP permits is simulated. These simulations correspond (in terms of the basic input data) to computer runs 3 and 14. Price-making responses were computed with BOD and BP permit supplies at 2,000 and 35,000 pounds per day respectively.

The results of the simulations indicate that the effect of Utica's behavior is minimal. A comparison with the responses of computer run 3 with the price-making results reveals that in the case of the BOD permits, the outcome is the same whether Utica acts as a price-taker or as a price-maker. There is no measurable difference in the price of the response of dischargers; Utica's price-fixing power is effectively nil. This is due to the shape of the treatment cost functions and the fixed supply of permits. If Utica tries to lower the price of the permits, then that city's share of the permits drops so much that the savings realized from the lower permit price are washed out by the higher treatment costs. Similarly, an increase in the permit price does not provide Utica with enough extra permits to make that course of action profitable.

Utica does gain slightly in the BP permit situation. A comparison of the price-making responses with the responses of computer run 14 is given in Table 6-10. The values in that table represent the differences in responses between the price-taking and price-making situations. Thus, for example, the permit price is $5 lower and Utica's total costs (column 6) are $44,000 lower in the price-making situation than in the competitive situation. The numbers of Table 6-10 are small relative to the total figures and it appears that Utica does not carry much weight as a potential price-maker. The effect on the national income costs of pollution control is

Table 6-10

Difference Between the Results with Utica as Price-Maker and the Results of the Competitive Solution (Run 14)

Permit price difference = $5

Total Cost Differences

Polluter	Permits Bought (lbs. BP)	Cost ($1000's)	Treatment (lbs. BP)	Cost ($1000'S)	Total Cost ($1000's)
Fort Plain	17	-7	17	-2	-9
Ilion	12	-10	12	-1	-11
Canajoharie	14	-11	14	-1	-12
Herkimer	83	-3	83	-9	-11
Little Falls	274	-11	274	-28	-39
Rome	92	-24	92	-9	-33
St. Johnsville	9	-8	4	-1	-9
Utica	503	-104	-503	60	-44
TOTAL	0	-177	0	9	-168

Annualized Cost Differences ($100's/Year)

Polluter	Permit Cost	Treatment Cost	Total Cost	National Income Cost
Fort Plain	-19	-3	-22	-72
Ilion	-27	-1	-28	-60
Canajoharie	-28	-2	-30	-68
Herkimer	-7	-22	-29	-44
Little Falls	-28	-72	-100	-195
Rome	-62	-22	-84	-110
St. Johnsville	-20	-1	-21	16
Utica	-272	163	-109	532
TOTAL	-462	-388	-423	84

negligible. They are increased by $9,000--less than one-fifth of 1%--due to the price-making activity of Utica.

The second price-making simulation was made with only two polluters in the system: Fort Plain and Ilion. This was a test to determine whether the effects of price-making are greatly increased with fewer market participants. The results for the BOD permits are given in Table 6-11. The first part of the table gives the responses when Fort Plain is the price-maker and Ilion is the price-taker. The opposite situation is given in the second part of the table. Table 6-12 is taken from computer run 11 with both Fort Plain and Ilion as price-takers.

The effects of price-making are significant in this two-participant situation. The price of the permit varies from $749 to $1,797; consequently, the use of the price as a signal for resource allocation is severely distorted. The variances in treatment levels and treatment costs, although not as great as the variance in permit price, are significant. The variance in total costs is great, and provides a great incentive for price manipulation. The national income costs for the three situations depicted in Table 6-11 and Table 6-12 do not vary as much.

These results seem to confirm the earlier conclusions with regard to the problems of market size. The dangers of

Table 6-11

Ilion and Fort Plain as Price-Makers

500 BOD issued

Response with Ilion as Price-Maker

Price = $749.31

	Permits	Cost	Treatment	Cost	Total
Ilion	217	162,600	4,783	1,245,988	1,408,588
Fort Plain	283	212,055	4,897	541,295	753,350
	500	374,655	9,680	1,787,283	2,161,938

Annualized Costs	Permits	Treatment	Total	National Income
Ilion	42,789	327,891	370,680	763,616
Fort Plain	55,804	142,446	198,250	351,923
	98,593	470,337	568,930	1,115,539

Response with Fort Plain as Price-Maker

Price = $1,745.00

	Permits	Cost	Treatment	Cost	Total
Ilion	268	467,660	4,732	1,153,293	1,620,953
Fort Plain	232	404,840	4,948	625,438	1,030,278
	500	872,500	9,680	1,778,731	2,651,231

Annualized Costs	Permits	Treatment	Total	National Income
Ilion	123,068	303,498	426,566	718,669
Fort Plain	106,537	146,589	271.126	395,956
	229,605	468,087 n	697,692	1,114,625

Table 6-12

RESPONSES OF BIDDERS FOR RUN 11 OF THE MOHAWK PERMIT SYSTEM SIMULATION

NUMBER ISSUED= 500. TERM= 5 YRS UNIT=LBS/DAY BOD

MARKET CLEARING PRICE=$1796.60

POLLUTER	PERMITS BOUGHT LBS/DAY	COST $	TREATMENT LBS/DAY	COST $	TOTAL COST $
ILION	245.47	441004.00	4754.53	1193214.00	1634218.00
FT PLAIN	254.53	457296.81	4925.46	578006.69	1035303.50
TOTALS	500.00	898300.81	9680.00	1771220.00	2669521.00
	LBS/DAY	$/YR	LBS/DAY	$/YR	$/YR
ILION	245.47	116336.50	4754.53	314768.88	431105.38
FT PLAIN	254.53	120634.50	4925.46	152477.69	273112.19
TOTALS	500.00	236971.00	9680.00	467246.38	704217.38

TOTAL NATIONAL INCOME COST=$ 1118521.00/YR

market distortions and manipulations are greater with few numbers of market participants. It is encouraging to note, however, that with the eight cities of the Mohawk there appears to be little danger of price manipulation by a single polluter. This in spite of the fact that Utica's waste load (in pounds of BOD) comprises a significant percentage of the total river basin load.

A Comparison with Effluent Charges

In the report, "Effluent Charges: Is the Price Right?", the Mohawk data were used to examine the characteristics of an effluent charge system. Some of the results of the model used in the effluent charge report are presented here in order to facilitate a comparison between the effluent charge and the MEP systems. Table 6-13 summarizes the results for both control systems when the pollutant is BP and the total allowable river basin load is 102,300 lbs/day. (This is the case reported on page 103 of "Effluent Charges: Is the Price Right?") In the effluent charge model the discount rate is 6 percent per year. The same rate was used to generate the effluent permit results given in Table 6-13.

From the examination of Table 6-13, it can be seen that the distribution of treatment duties among polluters is similar. In fact, the primary difference is the results arises due to the nature of response to the effluent charge. The

Table 6-13

The MEP Simulation vs. the Effluent Charge (EC) Model

	Fraction of BP Removed		BP Discharged to River	
	MEP	EC	MEP	EC
Ft. Plain	.571	.572	7,418	7,400
Ilion	.485	.488	9,813	9,753
Canajoharie	-508	.505	9,627	9,682
Herkimer	.586	.495	3,197	3,895
Little Falls	.476	.476	7,667	7,659
Rome	.416	.419	18,132	18,041
St. Johnsville	.496	.500	7,164	7,106
Utica	.627	.700	39,282	31,615
Total Discharges			102,300	95,150

Notes: Results of effluent charge model are for a single river basin charge of 3¢ per lb. Discount rate is 6 percent per year. Subsidy rates are 90 percent and 30 percent for capital and O&M costs respectively. Term of permits is 5 years.

response to the effluent charge is difficult to control precisely--thus the total discharge is 95,150 lbs/day even though the target amount is 102,300 lbs/day. Most of this difference comes at Utica.

The most important point of comparison between the MEP and the effluent charge systems is the total national income costs. The total cost for the MEP system is $4,270,000 per year while the total cost for the effluent charge system is $4,405,000 per year. In part, the lower costs of the MEP systems are due to the difference in total discharges that resulted in the two model runs.

The comparison between treatment levels and costs shows that the MEP and effluent charge results are similar. The efficiency gains of the MEP system are important, but perhaps not so important as the lack of uncertainty in the administration of the MEP system. If compliance to a MEP system is secured, then the total river basin discharges will not exceed the number of permits issued. In contrast, the response to the effluent charge is uncertain--a charge level may result in less than the anticipated waste treatment.

NOTES

[1] The choice was influenced by the availability of data. Meta Systems Inc used the Mohawk Valley for a case study on effluent charges for the Environmental Protection Agency. Appendices A and D to "Effluent Charges: Is the Price Right?" (Meta Systems Inc, Cambridge, 1973) detail many of the data used in this section of the permit study.

[2] See "Effluent Charges: Is the Price Right?", Tables B-1, B-2 and B-3.

[3] See "Effluent Charges: Is the Price Right?", Table B-8.

[4] See "Effluent Charges: Is the Price Right?", Appendix D, pp. D-41 through D-45, for derivations of the scaling factors.

[5] See Section 2 of this report.

$BP = 1.47\ BOD_5 + 4.57N_t + 30\ P_t$, where N_t = total fixed nitrogen concentration, P_t = total phosphorus concentration. See "Effluent Charges: Is the Price Right?", Appendix D, pp. D-45 through D-46 for justification.

[6] See Marshall Rose, "Market Problems in the Distribution of Emission Rights" in Water Resources Research, Vol. 9, No. 5, (October, 1973), pp. 1132-1144 for an examination of the possibilities of market manipulation in the distribution of emission rights. Unlike the case presented here, Rose deals primarily with regulatory authority that has a damage function and seeks to arrive at the optimal quantity and price of the permits.

Section 7

Legal and Administrative Issues

In this section the legal and administrative issues surrounding the use of a marketable effluent permit system are discussed. These issues include the constitutional and tax aspects of a MEP system, as well as the best course to pursue with regard to enabling legislation and administration. The relation of the National Pollutant Discharge Elimination System to the MEP system, and the probable administrative costs of the MEP system are discussed here.

The Constitutional Basis of the MEP System

Supplementary legislation would be necessary to authorize a MEP system, but it need not represent a departure from the basic approach of the 1972 Amendments nor from the set of expectations the Act has set in motion. Like other federal legislation in the field of water quality control, Congress could enact a MEP system in the exercise of its powers under the Commerce Clause to regulate the use of navigable waterways.[1] The validity of such regulation is too well established to warrant lengthy discussion here. Congress could, if it wished, go so far as to require the elimination of all discharges to public waters, and has in fact stated this as the national goal of the 1972 Amendments.

But suppose an existing discharger had to close shop because he could not afford a sufficient number of marketable

effluent permits sold at auction. Could he successfully sue to enjoin the MEP system on the ground that, as applied to him, it was in effect an unconstitutional "taking" of his property without compensation, in violation of due process rights guaranteed to him under the Fifth Amendment? Could he also claim that his right to equal protection of the laws, also embodied in the Fifth Amendment, had been abridged by a scheme that required him to yield his place on the stream to another who could better afford the price of discharge permits in an artificially created market? For reasons summarized below, both questions are answerable in the negative.

In general, the line between valid regulation of property uses for the protection of the public health or welfare (nuisance abatement, zoning, conservation), and compensable takings has been a difficult one to draw.[2] In the opinion of one expert, it remains "the conventional view that any governmental regulation that makes a private right essentially worthless is a taking of property for which compensation must be paid.[3] Thus, "[i]f the effect of prohibiting strip mining were to make the mining land utterly worthless to the holder, who might own only coal mining rights, most courts today would award compensation to him."[4] The opposing line of reasoning and precedent holds that any use of property in such a way as to impair legitimate competing uses or to injure the health, safety or welfare of others "may constitutionally be restrained,

however severe the economic loss on the property owner, without any compensation being required; for each of the competing interests that would be adversely affected by such uses has, a priori, an equal right to be free of such burdens."[5]

It is unnecessary, however, to puruse at length here the obscure boundaries between regulation of property and eminent domain. For the only activity a MEP system prohibits is the free discharge of wastes to public waterways, and the use of such waterways by private persons or public agencies for any purpose has always been recognized -- unlike other property interests -- as a mere privilege subject to the so-called "navigational servitude" in favor of the United States under the Commerce Clause.[6] Nobody can assert a property interest in navigable[7] waters as against the United States; "they are the public property of the nation."[8] In consequence, Congress may, for valid regulatory purposes, impair or even destory any person's access to navigable waters without having to compensate him for any resulting diminution in the value of his property.[9] "We deal here with federal domain, an area which Congress can completely pre-empt, leaving no vested private claims that constitute 'private property' within the meaning of the Fifth Amendment."[10]

The regulatory impact of a MEP system must be borne precisely in mind. It does not proscribe any private business

or public enterprise. It does not even prohibit discharges of industrial or municipal wastes. Rather, it is a scheme for allocating a scarce resource--the capacity of a waterway to assimilate wastes--in an efficient way among a number of competing uses, by means of a market mechanism. If a wasteproducer can recycle his wastes instead of discharging them, he is free to carry on his business without need of effluent permits. If he has no practicable choice but to use a waterway for waste disposal, he has no right to assume that the common property resource will forever be made available to him free of charge. He may fairly be compelled to pay a price for its use -- if indeed he is permitted to go on using it at all -- and to internalize this cost as a cost of doing business. He may have to go out of business because he cannot afford the cost, but his case is, in that event, essentially no different from any other failing enterprise. Analogously, if the federal government were to raise the price of scarce lumber from national forests to a point where some lumber users went out of business, they could hardly argue that they were entitled to compensation for a taking.

The claim of unequal protection may be more rapidly disposed of. Auctioning off scarce resources to the highest bidders or creating a market for such resources is a rational, non-discriminatory way of allocating them. Moreover, priority of position on a stream does not entitle one to priority in

any redistribution of discharge permits, when the privilege of discharging any waste from a point source to a receiving waterway has already been made expressly and totally conditional upon having a license or permit to do so.[11] It is clear that, as licenses may be granted to engage in certain otherwise prohibited activities -- e.g., broadcasting or liquor licenses -- so they may be taken away.[12] They confer no vested rights. Especially is this true of discharge privileges which are subject to the navigational servitude.

The MEP System and Taxation

Absent a specific legislative direction to the contrary, marketable effluent permits purchased by an industrial or commercial discharger will probably be treated for tax purposes as intangible assets used in the trade or business of the discharger. Intangible assets such as patents, pipeline rights of way, copyrights, licenses, franchises and contracts are depreciable if it can be established that they have limited useful lives,[13] but only straight-line depreciation is allowed.[14] The same rules should apply to the MEP system permits. If each one expires at a fixed interval with no guarantee of reissuance to the current permitholder, then it has a useful life of fixed duration and its cost is accordingly deductible in equal yearly increments over that period of time.

If discharge permits are not actually used after purchase but are held in reserve, it will be a question of fact in each case whether they are "used in trade or business" of the discharger so as to be eligible for depreciation deductions. Arguably, they will be eligible if they have been purchased for such possible use and if there is any likelihood of their being so used, whether or not the need for them ever fully materializes or is fully sustained throughout the term for which the permits were issued. The opposite conclusion would be reached in the case of permits held for speculative purposes. If conservation groups acquire permits, no depreciation deductions would be allowed on account of the absence of any connected trade or business.

Gains or losses realized upon resale of permits would be calculated on the depreciated basis, or on the purchase price in the absence of depreciation, and would be classified as long-term or short-term capital gains to be netted with other comparable gains or losses for the year in accordance with familiar rules of tax accounting.[15]

Enabling Legislation for the MEP System

Since there is currently no authorization under federal law to establish a market for discharge permits, fresh legislation would be necessary for this purpose. As is mentioned above, the MEP system should be meshed with the ongoing NPDES permit program. For this reason, and because the purpose

of the MEP system is to implement the 1972 Amendments, it would make sense to introduce the system by means of further amendments to the Federal Water Pollution Control Act.

Partly for the same reason, administration of MEP should be vested by statute in the federal Environmental Protection Agency, which is responsible for regulating, directly or indirectly, virtually all aspects of the national program for water quality control. If any other federal agency were to be put in charge of the MEP system, conflicts with EPA over policies and strategies and unnecessary duplication of intelligence-gathering functions would be difficult to avoid.

The 1972 Amendments pose no obstacle to the pricing of residual discharge privileges through a marketable permit system. The Act does not guarantee waste producers that if they will only adopt controls to reduce their wastes to a certain degree, they will be permitted to dump the residue free of charge into public waterways. To the contrary, the goal of the Act is zero discharge and NPDES permits confer privileges of only temporary duration, which are likely to be renewed only on condition that the permittee takes successive steps toward eliminating his discharge. Therefore, to discourage discharges by a combination of prohibitions and prices would appear to be consistent with the policy of the FWPCA.

The Act will have to specify the relation between the MEP system and the NPDES permit system. The Act could make applicable to the MEP system the same requirements of effluent monitoring, reporting, recording and submission to inspection that so obtain in the NPDES. Further informational requirements for the MEP system, especially the recording of market transactions at a central registry, could be developed by administrative regulation. Discharges in excess of MEP permit allowances could entail the same civil and criminal penalties as the FWPCA specifies for violations of NPDES permits,[16] as long as these remain far in excess of the permit price.

The Act itself should determine whether permits are initially to be sold at auction or allocated in some non-market manner; whether municipalities must pay for the initial allocations they will need for their non-industrual wastes; for what terms permits shall be issued; what their status for tax purposes shall be; and what restrictions, if any, there shall be on reserve permit holdings to guard against anyone's cornering the market. If permits are initially sold, provision might be made in the Act for allowing dischargers to pay for them in installments over time.

In a preamble to the Act, the rationales for MEP should be carefully explained in terms intelligible to the layperson. MEP is an unfamiliar technique in this field, and the better it is explained, the better its chances of gaining acceptance

and withstanding constitutional challenge. As with the disposition of the NPDES permits, public notice and a full public hearing should be held on the proposed determination of the number of marketable effluent permits and the manner in which they are to be distributed and traded. These requirements should be written into the enabling act. They embody the view that the administrative process should be open to public participation, especially when sensitive issues of policy, such as the degree of pollution control and water quality, are being decided.

Other desirable features of the enabling legislation can be derived from the discussion in the remainder of this section and in Section 2.

The MEP System and the NPDES

Under the provisions of the 1972 Amendments, effluent restrictions will be administered through the National Pollutant Discharge Elimination System (NPDES).[17] Every discharger must have an NPDES permit,[18] which will be issued after public notice and opportunity for public hearing on the permit application has been given,[19] either by EPA or by a state whose permit program EPA has approved. The permit will specify effluent limitations or quotas for various waste parameters and deadline dates by which they must be achieved, together with strict requirements for influent and effluent monitoring, reporting, recording, and submission to official inspections.[20] The deadlines will in some cases be earlier than the overall 1977 and

1983 deadlines specified in the Act. All permits must be for fixed terms not exceeding five years.[21] Any permit may be "terminated or modified for cause including, but not limited to...change in any condition that requires...reduction or elimination of the permitted discharge."[22] As permits are renewed, it can be expected that effluent restrictions will be progressively tightened, working toward the Act's ultimate goal of zero discharge by 1985.[23] EPA hopes to have all initial permits issued by December 31, 1974, since that is the deadline contemplated by the Act for completion of this function,[24] and since the target dates for achieving effluent limitations could hardly be met otherwise.

If we assume that, as a matter of policy, a MEP system should be so fashioned and introduced as not to interfere unduly with the regulatory regime now unfolding under the new FWPCA, how might the desired accommodation of the MEP system to the NPDES best be achieved?

First of all, the MEP system would be used to supplement present control methods and would not supplant the 1977 effluent limitations being promulgated by the EPA. It is assumed, therefore, that all dischargers will operate under the 1977 waste treatment constraints that are given in the legislation; industrial dischargers are required to utilize best practicable treatment technology and municipal dischargers are required to utilize secondary treatment process. The permits issued under the NPDES will be tailored to fit those constraints.

The MEP system would allocate waste treatment within the limits proscribed by the 1977 treatment constraints. Suppose, for example, that the gross waste load of polluter i is X_i, the amount of waste reduction accomplished by the polluter is x_i, and the resulting discharges are equal to w_i, where, of course, $w_i = X_i - x_i$. The effect of the 1977 constraints is to restrict x_i to values greater than a specified level, $\bar{x}_i$. The effect of the MEP system is to require that the polluter hold at least $\bar{w}_i$ permits where $\bar{w}_i = X_i - \bar{x}_i$; in this example each polluter is given this number of permits at the outset.

If, in 1977,a polluter wishes to expand operations, more permits must be purchased on the open market from some other polluter willing to restrict waste discharges more than the required amount, $\bar{x}_i$.

Beyond 1977 when the regulatory authority wishes to work toward further waste reductions, the MEP system permits will be gradually withdrawn from the market through open market purchases or by replacing fewer permits than expire. It is at this time that the full effects of the MEP market begin to take effect, automatically allocating the discharge privileges and waste treatment among polluters.

It is, of course, not necessarily the case that w_i permits be given to each polluter. Some proportion of this amount,

say $.8w_i$, might be issued, the expectation being that the polluter will either buy more permits in the MEP market, or maintain a level of discharges below $\bar{x}_i$. In particular, there are some for which water quality standards will not be met unless discharges are reduced beyond the levels implied by the 1977 treatment constraints. In those cases, the MEP permits must be issued in lesser amounts.

An additional reason for issuing fewer than w_i permits is to preserve the efficiency properties of the MEP system. If, for each polluter, waste discharges are constrained to be less than $\bar{w}_{ik}$ and that number of permits is distributed to each polluter, then the only opportunity for market transactions arises when a polluter wants to grow or a new polluter tries to enter the river basin.

In the joint operation of the MEP system and the NPDES, each polluter would be required to apply for and receive the NPDES permit in order to establish the 1977 treatment requirement. This requirement would remain a constraint; as is presently contemplated, each polluter would be required to obtain an NPDES permit. In addition, however, the polluter must hold marketable effluent permits for those pollutants included in the MEP system. Under this approach, the polluters are allowed to discharge at rates not to exceed the lesser of the amounts indicated by the NPDES permits and the marketable effluent permits.

Administrative Costs of the MEP System

Existing data on the NPDES program element costs[25] do not allow determination of the level of administrative costs for a marketable permit system except in relation to existing programs. It is nevertheless possible to make a comparison between the administrative requirements of the MEP system, the effluent charge approach, and the NPDES. This comparison is outlined in Table 7-1 which gives the incremental requirements of the MEP system and the effluent charge system over those of the NPDES.

The first row entry, "information from operators" refers to the operator-submitted forms and data contained thereon that are mandatory under NPDES[26] and that would also be required with essentially the same information for a marketable permits system--to guide market regulation, monitoring, and enforcement--and for an effluent charge system--to facilitate monitoring and revenue collection.

Row two, "permit allocation" refers to the process whereby discharge permits are issued to specific dischargers. No such step occurs with an effluent charge system, except for toxics and those other materials not covered by charges; under NPDES, permits are issued subject to effluent limitations, water quality standards, new source performance standards, and toxic and pretreatment effluent standards established under authority

Table 7-1

Requirements of Marketable Permits System
Compared to Requirements of the
NPDES and of Effluent Permits

	NPDES	Effluent Charges	Marketable Permits
Information from Operators	same	same	same
Permit Allocation	same	less	same or less
Market Regulation	same	same	more
Public Participation	same	less	less
Determination of Construction Compliance	same	same	same
Monitoring	same	same	same
Enforcement	same	less	same
Planning	same	same	less
Revenue Collection	same	more	more

of the 1972 Amendments.[27] With the MEP system, there are two design alternatives with respect to permit allocation: either they are allocated as in NPDES (or by an essentially similar procedure) or they are allocated by auction. With the first case, administrative requirements are identical; with the second case, the MEP system requires determination of sum of discharge rights and organization of the auction, but beyond this the allocation is automatic.

Row three, "market regulation" concerns an administrative function required only by the MEP system. Market regulation is made necessary in part by problems of market size and collusion discussed elsewhere in this report. Even in the absence of market problems, the regulatory authority must know who has permits (and standard NPDES-type forms would probably be required from dischargers whenever permits changed hands) and must oversee all market transactions.

Row four, "public participation" refers to the series of "notice and public participation" regulations issued as part of the NPDES.[28] These regulations were promulgated by the Administrator of the EPA to provide public hearing opportunity as mandated by Section 402 of the 1972 Amendments. A MEP system would reduce opportunities for public participation in determining the allocation of permits insofar as permit allocation was accomplished by a market. Presumably public participation in hearings would occur only when total

discharge quantities are being determined for a stream. At other times public participation would be through the market only. Although public access to information, appeals provisions, and other safeguards as included in the regulations would be retained, some costs of hearings would be saved in either the effluent charge or marketable permit approach.

Row five, "determination of construction compliance" is of principal relevance with respect to old sources that are given a period of time during which to establish compliance with discharge permit conditions. Because the MEP system would not become operative until 1977, at the earliest, and because most sources will have achieved construction compliance by that date, administrative requirements under this heading can be expected to be small. In any event, these requirements would not differ among system alternatives.

Row six, "monitoring' refers to the entire series of measures necessary to ensure against cheating, including point source monitoring on a regular basis, acquisition of stream quality data, spot-checking of suspected violations, and organization of data into an accessible, meaningful form. It is difficult to imagine differences in monitoring requirements for an effective NPDES,[29] for an effective marketable permits system, and for an effective effluent charge system. Consequently monitoring requirements are considered equal for the three alternatives.

Row seven, "enforcement" highlights an important difference between the MEP and effluent charge systems. In the former, even more so than in NPDES, dischargers face an inelastic supply of discharge rights in the short run. That is, at any point in time the discharger must discharge no more than the amount specified on that discharger's permits. Consequently; it is more difficult to keep dischargers within the basic workings of the system; effluent charges offer an elastic system of discharge rights and shift the enforcement burden to the revenue collection function. Both the MEP system and NPDES must rely on penalties as enforcement weapons and must invest approximately like amounts in enforcement.

Row eight, "planning" highlights an important advantage of marketable permits: the planning requirements are less than in the other two systems because the administering agency only has to set the total waste quantities (although in some variants of the system these quantities must be reach-specific). Allocation of permits among dischargers takes place in the market, not by administrative fiat. Unlike with an effluent charge system, waste quantities are set and it is not necessary to predict discharger response to a price.

Row nine, "revenue collection" is an administrative task of primary relevance to an effluent charge system. In that system the regulatory authority must determine the fee

and extract it from the discharger. Revenue collection is also necessary in the MEP system, however the amount of the monetary transfer is determined by the market and connected with the transfer of permits.

To summarize, a marketable effluent permit system does not entail major new administrative requirements with the exception of a market regulation function. Requirements for market regulation can be expected to be offset by reduced requirements for public hearings and planning. By comparison, effluent charges require less enforcement and market regulation effort but greater revenue collection and planning efforts. We conclude, therefore, that the costs of administering such a system would be essentially the same as the costs of administering the existing NPDES in any state or river basin.

NOTES

[1] E.g., Gibbons v. Ogden, 22 U.S. (1 Wheat.) 1 (1824); U.S. v. Holt State Bank, 270 U.S. 49 (1926); U.S. v. Appalachian Electric Power Co., 311 U.S. 377 (1940). See Silas R. Lyman, The Constitutionality of Effluent Charges, (University of Wisconsin Water Resources Center; Madison, Wisconsin; May, 1969) 140-156.

[2] Cf. Mugler v. Kansas, 123 U.S. 623 (1887) and Goldblatt v. Hempstead, 369 U.S. 590 (1962) with Pennsylvania Coal Co., v. Mahon, 260 U.S. 393 (1922).

[3] Joseph L. Sax, "Takings, Private Property and Public Rights," 81 Yale L.J. 149, 152 (1971).

[4] Sax, p. 156.

[5] Sax, p. 162.

[6] E.g., Gibson v. U.S., 166 U.S. 269. (1897); Zabel v. Tabb, 430 F.2d 199, 206 (5th Cir. 1970); City of Eufala, Ala. v. U.S., 313 F.2d 745 (5th Cir. 1963).

[7] The Federal Water Pollution Control Act primarily regulates "discharge of pollutants" and defines this term as "any addition of any pollutant to navigable waters from any point source." Section 502(12) "Navigable waters" is further defined as "the waters of the United States, including the territorial seas." 502(7) The Conference Report on the Bill, S.2770, which became the Federal Water Pollution Control Act Amendments of 1972, states the conferees' intent "that the term 'navigable waters' be given the broadest possible constitutional interpretation..." Conference Report to Accompany S.2770 (September 28, 1972), p. 144. Judicial precedent indicates that virtually all public waterways can be characterized as navigable waters of the United States. E.g., U.S. v. Grand River Dam Authority, 363 U.S. 229, 232-33 (1960).

[8] Gilmann v. Philadelphia, 70 U.S. (3 Wall) 713, 725 (1965).

[9] U.S. v. Rands, 389 U.S. 121 (1967).

[10] U.S. v. Twin City Power Co., 350 U.S. 222 (1956).

[11] Federal Water Pollution Control Act Section 301(a).

12 FRC v. Nelson Bros. Bond & Mortgage Co., 289 U.S. 266 (1933) ; Seidenberg v. McSorley's Old Ale House, 308 F. Supp. 1253, 317 F. Supp. 593 (DCNY 1969).

13 IRS Reg. 1.167(a)-3.

14 IRS Reg. 1.167(c)-1.

15 IRC Sec. 1231.

16 Federal Water Pollution Control Act Section 309.

17 Sec. 402.

18 Sec. 301 (a).

19 Sec. 402 (b) (3)

20 Sec. 402 (b) (1) and (2).

21 Sec. 402 (b) (1) (B)

22 Sec. 402 (b) (1) (C)

23 Sec. 101 (a) (1)

24 Sec. 402 (k)

25 Data available from the EPA Region I office in Boston and personal communications with administrators in Connecticut, New York and Michigan. Connecticut, New York, Michigan and Washington are the only states having received EPA approval of their programs to participate in the NPDES.

26 40 CFR, Part 126.

27 See especially, Title III.

28 40 CFR Parts 124 or 125, Subpart D.

29 40 CFR Part 124, Subpart G, and Section 125.27 of Part 125.

Section 8

Evaluation and Comparison of the MEP System

From the analysis of the previous sections it is possible to draw conclusions about the MEP system. The most suitable variant of the MEP system and an evaluation of that system are presented here. This section also gives a comparison of the MEP system with alternative approaches to control. As is discussed in Section 1, the basic criterion of this evaluation and comparison is the ability of the control method to implement the goals of the 1972 Amendments, and to do so in an efficient and equitable manner. Legal and political feasibility and administrative ease are also important criteria.

Details of the MEP System

Many different variants of the MEP system are discussed in Section 2. In addition, aspects of this control system are analyzed in other sections of the report. Based on the analysis of those sections, suggestions can be made regarding the best form of the MEP system. These are as follows:

New legislation--probably in the form of amendments to the FWPCA--is required for the introduction of the MEP system.

The 1977 treatment requirements of the 1972 Amendments will be implemented as presently planned, and those requirements will remain as constraints on polluter behavior.

Quality standards will also continue to be in force with the total number of permits limited in accordance with those constraints.

The initial distribution of permits can be determined on the basis of the desired distribution of costs. A combination direct allocation-Dutch auction system can be used to achieve the initial allocation of permits and to initiate the trading of permits. An example is the following: give municipalities 100% of the permits needed to cover their domestic waste discharges (as determined by the 1977 treatment requirements) and give industrial polluters 50% of the amount needed to cover their allowable discharges. Distribute some additional permits through a two-way Dutch auction in which polluters are allowed not only to buy additional permits, but are also allowed to sell. A system of this type retains the desired efficiency properties and has the flexibility to allow a great variety of cost distributions.

The marketable effluent permits should be depreciable on a straight-line basis for industrial dischargers, and their purchase by municipalities should be subsidized at the same rate as the costs of treatment are subsidized. If the capital and operating cost subsidies differ, a weighted average of those subsidies should be used to determine the permit subsidy level.

The pollutants included in the MEP system should include BOD_5 or BP, and any other pollutants that are discharged by several polluters and that cost significant amounts to control.

The system should not be geared to the differential effects on water quality of different dischargers. That is, the use of transfer coefficients should be minimized. The marketable effluent permits should therefore be effluent discharge licenses rather than ambient quality degradation licenses, and should trade among polluters on a one-to-one basis. The total number of permits issued should be small enough to assure that quality standards will be met.

The length of term of permits is, within reasonable limits, a variable that does not affect the workings of the system significantly. One possible approach is to issue permits for 2, 4, 6, 8, and 10 year terms--perhaps an equal number of each. Then at the expiration of the 2-year permits a decision can be made as to whether to sell additional permits to replace them, or, as is more likely given the mandate of the 1972 Amendments, those permits can be permanently retired as a step toward the goal of discharge elimination.

After the initiation of the MEP system, alterations in the number of permits should be effected only through open

market purchases and sales (or, as above, through natural attrition due to the expiration of permits).

The purchase of permits should be open to all.

All sources for which the measurement of discharges is possible should be required to hold permits. There is little reason to exclude a source from the permit system for any reason other than the inability to measure discharges with sufficient accuracy.

There should be no variations in the number of permits or in the privileges that they confer except as provided for above. This precludes the use of seasonal or hydrological changes designed to make use of changing assimilative capacity.

River basin areas covered by one market should be fashioned so as to provide the largest market possible, consistent with quality constraints. This implies that interconnected basins could be included in the same market if they are similar enough to ensure that there will be no large scale shift of discharges from one basin to the other.

The money collected through the sale of permits and through the enforcement of the MEP system can be used to support the administration of the system, including data acquisition, monitoring and enforcement functions, and the purchase of permits on the open market. Public works for

the improvement of water quality are also a potential use of the money, but only if such works would improve water quality more than the purchase of permits.

A monitoring and enforcement system must be maintained to assure that discharges by polluters are covered by the requisite permits. Fines and penalties for violations should be well in excess of the market price of permits.

The NPDES permits will be required in addition to the MEP permits. Any discharge of wastes must be covered by both types of permits.

All transactions involving MEP permits should take place in the regulated, central market. Bid and ask prices should be readily available through this market and all trades must take place on an arm's length basis. Transactions should be recorded and transmitted to the enforcement personnel. If necessary, additional rules should be established in order to assure the competitive functioning of the market.

This MEP system has the properties discussed in Section 2. It is efficient, it handles the growth and entry of polluters automatically and efficiently, it provides an indicator of the marginal cost of waste discharge reduction, it is flexible, and it is effective. These properties, of course, depend on the smooth operation of the market. Unless the market is a reasonably competitive one, the MEP system will not perform

its control function as well. The MEP system is flexible enough so that it can be fashioned to distribute costs equitably. The possibility of combining the direct allocation of permits with a Dutch auction provides much leeway in the construction of the control system and its effects on individual dischargers.

Administratively the MEP system is no more complicated than other systems of control. The organization and regulation of the market are not demanding enterprises. The MEP system is constitutional, but would probably require additional legislation.

Politically the MEP system suffers from extreme underexposure. The introduction and explanation of any new system of control will be difficult and potentially unsuccessful.

The efficiency of the MEP system, and its flexibility to provide for growth and the equitable distribution of costs, are its main virtues. The analysis of the previous sections indicates that the main threat to the system is the possibility of market manipulation. If the number of market participants is small or if the concentration of market power is extremely uneven, then the market cannot be expected to perform its allocative function efficiently.

The Mohawk simulation results suggest that the number of market participants required to avoid the problems of market manipulation may be as low as 8. In addition, those simulations indicated that, under stringent limitations on total river basin discharges the 1977 treatment constraints do not interfere with the efficient functioning of the market.

Market problems can be best avoided by the careful choice and definition of market regions. Additionally, there is the possibility of market rules such as limitations on the percentage of permits held by an individual. It may also be wise to require of each permit holder a demand and supply schedule--a statement of the number of permits that would be sold or purchased by the permit holder at each price (or for a reasonable set of prices). This could help to locate and avert monopolistic behavior, and would also assure that the equilibrium bid and ask prices were available for dissemination.

As a last resort, of course, the market can be phased out of those regions where it works poorly. Our evaluation, however, is that it will probably work efficiently in many places, and little will be lost in those cases where it works poorly and must be abandoned.

The MEP System Versus Effluent Charges and Effluent Standards

Here we compare the MEP system with the use of effluent

charges and effluent standards. In a system of effluent charges a price is charged polluters for each unit of wastes that is discharged. The price is established on the basis of the degree of waste control desired and can be changed to effect different total waste discharge reductions. In a control system based solely on effluent standards, allowable discharges are established administratively for each individual polluter. The discharge of wastes is authorized by the regulatory authority through a system such as the NPDES.

The efficiency properties of the three systems differ. In both the MEP and the effluent charge systems, continuing pressure is maintained on dischargers to reduce discharges and to seek better ways to deal with wastes. Effluent standards, if fashioned correctly, also have the property of inducing the use of least-cost methods of waste control. They do not, however, provide a continuing incentive for the reduction of waste discharges.

The most important difference among the three methods related to efficiency is related to total basin treatment costs. In both the MEP and the effluent charge systems, the incentive of the price is used to assure the equalization of marginal treatment costs among different polluters. This is a necessary condition for the minimization of total basin

treatment costs. In contrast, the effluent standards approach does not automatically allocate treatment activities in an efficient manner.

The MEP system has the additional advantage of providing for growth through a natural and automatic mechanism. In both the effluent charge and the effluent standard systems adjustments must be made in the system parameters in order to control the increases in discharges that occur naturally over time. For the effluent charge system, only one parameter, the effluent charge, must be adjusted while in the effluent standard system a decision must be made with regard to how each individual discharger or class of dischargers will be treated. In contrast to both of these systems, no administrative adjustments are necessary in the MEP system. Growth and entry are handled automatically through the market. As long as the regulatory authority issues no additional permits, the market maintains a policy of nondegradation.

Unlike the effluent standard approach, both the MEP and the effluent charge systems provide an indicator of the marginal costs of waste control. The price of the permits or the level of the effluent charge can be used as a guide to future public investments or to changes in the level of overall pollution control. For example, in run 1 of the simulation model with the permit supply equal to 4,000 pounds per day of BOD, the price of an effluent permit is

$973. This indicates that the out-of-pocket, subsidized marginal treatment costs for dischargers is $973 per pound per day of BOD. This level may be considered prohibitive and the number of permits consequently increased.

The administrative aspects of the systems are compared in Section 7. The conclusion there is that the costs are comparable. For the effluent charge system it is necessary to predict the response of polluters to the effluent charge. This is not necessary in the other two systems. However, enforcement is more automatic for the effluent charge system than for the other two systems. Other factors such as the need in the MEP system to operate a market, balance with the difficulties of specifying effluent standards and the need for an effluent charge collection system.

With regard to equity, each of the systems can be fashioned so as to produce many different cost distributions. Both the MEP and the effluent charge systems have the advantage of impersonally allocating costs. Once the market or effluent charge is established, the need to negotiate administratively with individual polluters is limited.

In terms of the legal and political feasibility of the systems, arguments can be made that favor any of the three systems. The effluent standard approach requires no additional legislation, while the other two control methods

probably do. The MEP system is probably easier to integrate with the NPDES than is the effluent charge system. Ultimately, however, the palatability of any system is going to depend on who calls the tune. We would argue that both the effluent charge and the MEP systems are more likely to prove effective in limiting waste discharges, and are therefore more acceptable to regulators and less acceptable to polluters.

In sum, it is the efficiency properties of the MEP system which set it apart from other methods of control. Under conditions conducive to the functioning of a good market, the MEP system offers performance superior to the effluent charge and effluent standard approaches. If those conditions are not met and the market does not function properly, then the effluent charge system is the best control alternative. Only experience with the actual use of a marketable effluent permit system will allow the more precise determination of those conditions.

AN EVALUATION OF MARKETABLE EFFLUENT PERMIT SYSTEMS:

APPENDICES

prepared for the

Environmental Protection Agency

by

Meta Systems Inc
Cambridge, Massachusetts

August 1974

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APPENDIX A

THE MOHAWK RIVER PERMIT SYSTEM SIMULATION RESULTS

This appendix contains the computer output and accompanying figures for the Mohawk River permit system simulation model. The simulation model is discussed in Section 6 of this report. Each run of the computer model is described in that section. For convenience, Tables 6-3 and 6-4 have been reproduced in this appendix. They provide a key to the various computer runs.

The printed and graphical output of the model is described and illustrated in Section 6. The output is presented here following Tables 6-3 and 6-4. First the written market demand curve and the two market-clearing results are given for each of the 27 computer runs. They are arranged in order of computer run. Next the graphical demand curves for seven selected computer simulations are given. They are arranged in order of computer run with the individual demand curves for each run preceding the aggregate demand curve for that run. The pages of written output for each computer run are arranged as a removable entity to facilitate the comparison of results. Similarly, the graphical demand curves for each run are fastened together and can be removed for comparisons among computer runs.

Table 6-3

Inputs for the One-term Permit Simulations

Run Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Discount rate (% per year)	10	7	10	10	10	10	10	20	10	10	10	10	7	10	10	10	10
Capital cost subsidy (%)	90	0	90	90	90	90	75	90	90	90	90	90	0	90	90	90	90
Operating and maintenance cost subsidy (%)	30	0	30	30	30	30	75	30	30	30	30	30	0	30	30	30	30
Pollutant type (BOD or BP)	BOD	BOD	BOD	BOD	BOD	BOD	BOD	BOD	BOD	BOD	BOD	BP	BP	BP	BP	BP	BP
Permit term (years)	5	25	5	1	10	15	5	5	5	5	5	5	25	5	10	15	5
Lower bound on treatment (scheme)	2	0	0	2	2	2	2	2	2	2	0	2	0	0	2	2	0

Runs 11 and 17 were made with only two cities in the system: Ft. Plain and Ilion. Runs 9 and 10 have all eight Mohawk cities plus an additional market participant representing the demand by environmentalists. All other runs were made with the market comprised of the eight Mohawk cities.

Table 6-4

Inputs for the Staggered-term Permit Simulations

Run Number	18	19	20	21	22	23
Discount rate (% per year)	10	10	10	10	10	10
Capital cost subsidy (%)	90	90	90	90	90	90
Operating and maintenance cost subsidy (%)	30	30	30	30	30	30
Pollutant type (BOD or BP)	BOD	BOD	BOD	BP	BP	BP
Permit term (years)	5	10	15	5	10	15
Lower bound on treatment (scheme number)	2	2	2	2	2	2

For all runs the market consists of the eight Mohawk cities.

The following three pages contain Tables A-1, A-2, and A-3 of the Meta Systems Inc report, "Marketable Effluent Permit Systems." Table A-1 gives the aggregate demand schedule for permits from computer run 1. Tables A-2 and A-3 give the market-clearing results for computer run 1 when the supply of permits is set at 4,000 and 2,000 pounds per day of BOD respectively. The contents of all three tables are described in more detail in Section 6 of this report.

Table A-1

AGGREGATE DEMAND SCHEDULE FOR RUN 1 OF THE MOHAWK PERMIT SYSTEM SIMULATION

PRICE OF PERMIT	DEMAND,LBS/DAY	PRICE OF PERMIT	DEMAND,LBS/DAY
0.0	13624.00	880.07	5176.42
158.90	12912.00	957.83	4195.71
195.66	11741.36	983.68	3861.94
222.45	11612.88	992.19	3752.03
230.14	11545.30	996.06	3700.65
246.59	11414.00	1167.62	2640.16
253.06	11345.80	1222.27	2433.66
323.90	10391.33	1362.84	2216.13
359.16	10051.96	1409.44	2141.01
368.23	9987.02	1556.50	1903.90
392.70	9881.14	1616.14	1807.75
423.36	9734.00	1952.21	1265.94
435.45	9410.92	1997.57	1220.39
510.71	9188.34	2155.18	1058.79
537.87	8952.81	2214.97	1021.01
615.78	8127.80	2240.10	1005.13
740.76	6776.79	3067.10	847.02
749.31	6684.31	3245.83	838.33
799.73	6158.23	3964.91	733.00
866.67	5345.38	4683.98	712.00
		5403.06	691.00

Table A-2

RESPONSES OF BIDDERS FOR RUN 1 OF THE MOHAWK PERMIT SYSTEM SIMULATION

NUMBER ISSUED= 4000. TERM= 5 YRS UNIT=LBS/DAY BOD

MARKET CLEARING PRICE=$ 972.99

POLLUTER	PERMITS BOUGHT LBS/DAY	COST $	TREATMENT LBS/DAY	COST $	TOTAL COST $
ILION	601.92	585657.19	4398.08	696975.63	1282632.00
FT PLAIN	277.22	269726.38	4902.78	546596.56	816322.94
CANAJOHARIE	655.36	637656.75	5344.64	795701.25	1433358.00
HERKIMER	295.35	287367.44	1914.65	54954.41	342321.81
LITTLE FALLS	514.69	500783.69	3815.31	1049460.00	1550243.00
ROME	696.19	677381.00	7093.81	1223471.00	1900852.00
ST JOHNSVILLE	508.04	494313.94	3771.96	587485.31	1081799.00
UTICA	451.25	439056.19	28378.75	2944344.00	3383400.00
TOTALS	4000.00	3891940.00	59619.98	7898987.00	11790927.00

	LBS/DAY	$/YR	LBS/DAY	$/YR	$/YR
ILION	601.92	154495.88	4398.08	183861.56	338357.44
FT PLAIN	277.22	71153.56	4902.78	144191.69	215345.25
CANAJOHARIE	655.36	168213.31	5344.64	209905.31	378118.63
HERKIMER	295.35	75807.25	1914.65	14496.93	90304.13
LITTLE FALLS	514.69	132106.31	3815.31	276846.69	408953.00
ROME	696.19	178692.56	7093.81	322750.63	501443.19
ST JOHNSVILLE	508.04	130399.63	3771.96	154978.13	285377.75
UTICA	451.25	115822.63	28378.75	776715.56	892538.19
TOTALS	4000.00	1026690.69	59619.98	2083746.00	3110436.00

TOTAL NATIONAL INCOME COST=$ 5144286.00/YR

Table A-3

RESPONSES OF BIDDERS FOR RUN 1 OF THE MOHAWK PERMIT SYSTEM SIMULATION

NUMBER ISSUED= 2000. TERM= 5 YRS UNIT=LBS/DAY BOD

MARKET CLEARING PRICE=$1496.00

POLLUTER	PERMITS BOUGHT LBS/DAY	COST $	TREATMENT LBS/DAY	COST $	TOTAL COST $
ILION	377.56	565162.06	4622.44	975697.88	1540859.00
FT PLAIN	262.79	393366.31	4917.21	564415.25	957781.56
CANAJOHARIE	336.82	504192.00	5663.17	1189071.00	1693263.00
HERKIMER	245.89	368065.69	1964.11	117727.00	485792.69
LITTLE FALLS	47.00	70354.19	4283.00	1550027.00	1620381.00
ROME	140.00	209565.75	7650.00	1833961.00	2043526.00
ST JOHNSVILLE	301.95	451984.00	3978.05	841996.44	1293980.00
UTICA	298.00	431106.75	28542.00	3105067.00	3536173.00
TOTALS	2000.00	2993794.00	61619.99	10177962.00	13171755.00

	LBS/DAY	$/YR	LBS/DAY	$/YR	$/YR
ILION	377.56	149089.25	4622.44	257388.31	406477.56
FT PLAIN	262.79	103769.69	4917.21	148892.25	252661.94
CANAJOHARIE	336.82	133005.44	5663.17	313675.94	446681.38
HERKIMER	245.89	97095.38	1964.11	31056.29	128151.63
LITTLE FALLS	47.00	18559.38	4283.00	408895.88	427455.25
ROME	140.00	55283.28	7650.00	483797.44	539080.69
ST JOHNSVILLE	301.95	119233.00	3978.05	222117.94	341350.94
UTICA	298.00	117625.56	28542.00	819114.19	932839.75
TOTALS	2000.00	789760.44	61619.99	2684938.00	3474698.00

TOTAL NATIONAL INCOME COST=$ 6449094.00/YR

The following three pages contain Tables A-4, A-5, and A-6 of the Meta Systems Inc report, "Marketable Effluent Permit Systems." Table A-4 gives the aggregate demand schedule for permits from computer run 2. Tables A-5 and A-6 give the market-clearing results for computer run 2 when the supply of permits is set at 4,000 and 2,000 pounds per day of BOD respectively. The contents of all three tables are described in more detail in Section 6 of this report.