RULS-AD-1981-240

7/1/81

Article: "Water Resource Issues in the Development of Proposed Bedminster Center:..."

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Pgs-26

Notes: pg. count includes title pages

PD-39 - ~~Rec~~
wd ~~recent~~ - 12/4/84
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WATER RESOURCE ISSUES IN THE DEVELOPMENT OF THE PROPOSED BEDMINSTER CENTER: INITIAL FINDINGS

BY

Michael Greenberg Robert Hordon

July 1, 1981

PREFACE

This report is labeled initial findings because the work began in June 1981. During the one month study period, we have begun to assess water resource issues relevant to the proposed Bedminster center. Solutions to one issue, water supply, seem to be in hand. Another, water quality, will require far more investigation before we can narrow the field of choices. A third, erosion during construction, has not been studied due to a lack of time.

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July 1, 1981

SUMMARY

The initial findings are that supplying water will not be a problem, and that in order to preserve water quality, a range of very different options, some conventional and some innovative, will have to be carefully considered. This report reviews the options, presents their advantages and disadvantages (not including economic), and where appropriate, offers recommendations.

WATER DEMAND AND SUPPLY

The shopping center would be a moderately sized water user and has three supply options: (1) local ground water; (2) purchase from outside sources as a retail customer; and (3) secure its own franchise area and purchase from an alternative supplier. Our initial research suggests that purchasing water as a retail customer from the Commonwealth Water Company will be the most easily implemented solution.

WATER DEMAND

In order to estimate supply requirements and sanitary waste needs, the average and peak daily demands must be estimated. The most comprehensive survey of commercial/institutional water use in the United States was made by researchers at Johns Hopkins University. They found a high correlation between water use and measures of activity such as employment, number of square feet, number of seats and others. Coefficients were developed for 28 of these commercial/institutional establishments (Hittman, 1969), including everything from barber shops to YMCA-YWCAs. The closest approximation to the activities of the proposed center is retail space, restaurant use, barber shops and beauty shops:

Expected Usage Coefficients (Gallons per day)

Store	Unit of Parameter	(1) Mean Annual	(2) Max Daily
Retail Space	Sale Sq. Ft.	0.106	0.154
Restaurant	Seat	24.2	83.4
Barber shop	Barber chair	54.6	80.3
Beauty shop	Station	269.0	328.0

There are also rule-of-thumb coefficients commonly used in New Jersey. These coefficients applied, for example, in the Hartz Mountain Berry's Creek application are 0.125 gallons per square foot per day and a daily peak of 1.5 times the average daily consumption.

Further research on water demand is being conducted for three reasons: (1) The dichotomy between black water (largely toilet) and gray water (restaurant and hand washing) is important for the sanitary sewage analysis; (2) the Johns Hopkins research is more than a decade old; (3) and rule-of-thumb coefficients may be erroneous. Ten regional shopping centers in New Jersey have been contacted. Some are supplying water use and other relevant data which will be used to test the accuracy of the Hittman and rule-of-thumb coefficients.

In order to obtain an initial estimate of gray water generation, water use by restaurants, other eating and drinking places, hairdressers and barber shops was sought for an existing shopping center. The Middlesex Water Company provided us with water use data for the year 1980 for Phase I of the Woodbridge Shopping Center which was opened before 1978 (1.1 million square

feet). Phase II of Woodbridge Shopping Center is served by one meter. Therefore, disaggregated data by store were not available. In addition, restaurant and other water uses could not be separated for the department stores. Estimates of square feet and seating capacity at Woodbridge were made through interview at the center.

The interviews disclosed that the Hittman coefficients are reasonable estimators. For example, restaurant water use per seat at Woodbridge Center was estimated to be 20 gallons per seat compared to 24.2 by the Hittman report. Water use per square foot of eating and drinking place at the Woodbridge Shopping Center was 0.8 gallons per day.

Assuming that the proposed Bedminster shopping center will have 1.2 million square feet, 55,000 square feet of eating and drinking places (including 15,000 feet in the department stores), two hairdressers, one barbershop, no supermarkets, no laundromats, and no other major water using activities leads to the following estimates:

Estimated Water Use at Proposed Center (million gallons per day)

Method		Daily Average (MGD)	Peak Daily (MGD)
1. Rule of thumb[a]: .125 gal/sq. ft.		0.150	0.225
2. Coefficient:	Retail[b]	0.121	0.175
	Restaurant[c]	0.044	0.152
	Barber shop and Beauty shops[d]	0.002	0.003
Total part 2.		0.167	0.330

Calculations:

[a].125 x 1.2 million = 0.150 MGD average; 0.150 x 1.5 = .225 peak daily MGD

[b].106 x 1.145 million = 0.121 MGD average; 0.121 x (1.45) = .175 peak daily MGD

1.45 is peak/average daily from the Hittman study

[c]0.8 x .055 million = 0.044 MGD average; 0.044 x (3.45) = .152 peak daily MGD

3.45 is the peak/average daily from the Hittman study

[d]Assume water use comparable to Woodbridge Center and peak/average daily coefficient from Hittman study (1.3).

WATER SUPPLY

Local Groundwater

The local groundwater option may be the least expensive solution. The 211-acre site could meet some of the water requirements. Assuming a yield of 0.25 MGD per square mile from the Brunswick Shale (Greenberg and Hordon, 1976) leads to an estimated predevelopment yield of 0.082 MGD ((211 acres/640 acres) x 0.25 MGD = 0.082 MGD).

The local groundwater option has four major disadvantages which probably outweigh the advantages. One is that it will probably not meet all the daily demands, unless the most innovative sanitary waste methods (closed system) and new toilet designs (1 gallon per flush) are used and certainly will not suffice for fire fighting. The second disadvantage is the need to sink and operate wells. The third is that the predevelopment yield will probably be significantly reduced when recharge is reduced by covering a sizeable portion of the site with impervious surfaces. The fourth disadvantage is the likelihood of moderate to strong opposition from the Commonwealth and Elizabethtown Water Companies and the potential for opposition from other interests who would charge that the new local wells would draw

down on their existing supplies. In particular, the Elizabethtown Water Company would probably look askance at someone pumping directly or indirectly through wells out of the North Branch of the Raritan, thereby reducing the flow available to them at their downstream filter plant. Commonwealth stands to lose a paying customer and would probably join Elizabethtown in opposition. Both, we think, would offer regional water depletion arguments. The proposal would also require approval from the State Water Policy and Supply Council.

If further research is deemed appropriate, this option can be investigated by analyzing present ground water use in the area and legal/administrative issues.

Purchase Water

The proposed center could seek its own franchise area which would enable it to purchase water from the cheapest source. However, in this area, the only alternative to purchase from the Commonwealth Water Company is purchase from the Elizabethtown Water Company. Since Elizabethtown would probably bill at retail rates, similar to Commonwealth's, any savings that might have been realized by not contracting with Commonwealth would be eliminated. Overall, at this point, this option cannot be recommended because of the absence of an obvious economic advantage. Nevertheless, if deemed appropriate, it can be explored further. In particular, the legal process would have to be studied.

Direct purchase of water from the Commonwealth Water Company clearly seems to be the best option at this time. The American Water Works Company, of which Commonwealth is one component of the Eastern Division, sold more than 214 MGD in 1980 to about 5 million people in 20 states. It has a

financial incentive to sell water and maintain its systems as does the Elizabethtown Water Company which distributed an average of 138 MGD in 1980 in New Jersey. A 16 inch main with a capacity of 3.0 MGD was installed in 1975 along Route 206 which borders the site. Our conversations with senior officials of the Commonwealth and Elizabethtown Water Companies suggest that there will not be any engineering problem meeting the proposed center's average daily and peak daily needs, albeit Elizabethtown and Commonwealth will have to review their contractual relationships.

The water for the proposed development originates in the Raritan River basin. The safe yield of the Raritan River system based upon the design drought of the 1960's and the two State-built Spruce Run and Round Valley Reservoirs is 250 MGD. Of this amount, 90 MGD is allocated by law for low flow dilution purposes at Bound Brook, although this state-imposed release requirement can be relaxed during stress periods. This leaves 160 MGD of available water, of which 70 MGD has been allocated to Elizabethtown, Given increasing demands in the future, it is reasonable to presume that additional diversion rights will be granted to Elizabethtown. In short, Elizabethtown is in an excellent position to obtain additional water from the Raritan Basin for not only its own retail customers but also for its wholesale customers such as the Commonwealth Water Company.

Elizabethtown operates a filter plant with a design capacity of 150 MGD at the confluence of the Raritan and Millstone Rivers. The treated water is pumped from the filter plant to Bedminster via Bridgewater Township. A 16 inch main runs along Route 206 in Bedminster with sufficient booster stations to maintain adequate pressure.

The institutional arrangements directing the flow are governed by

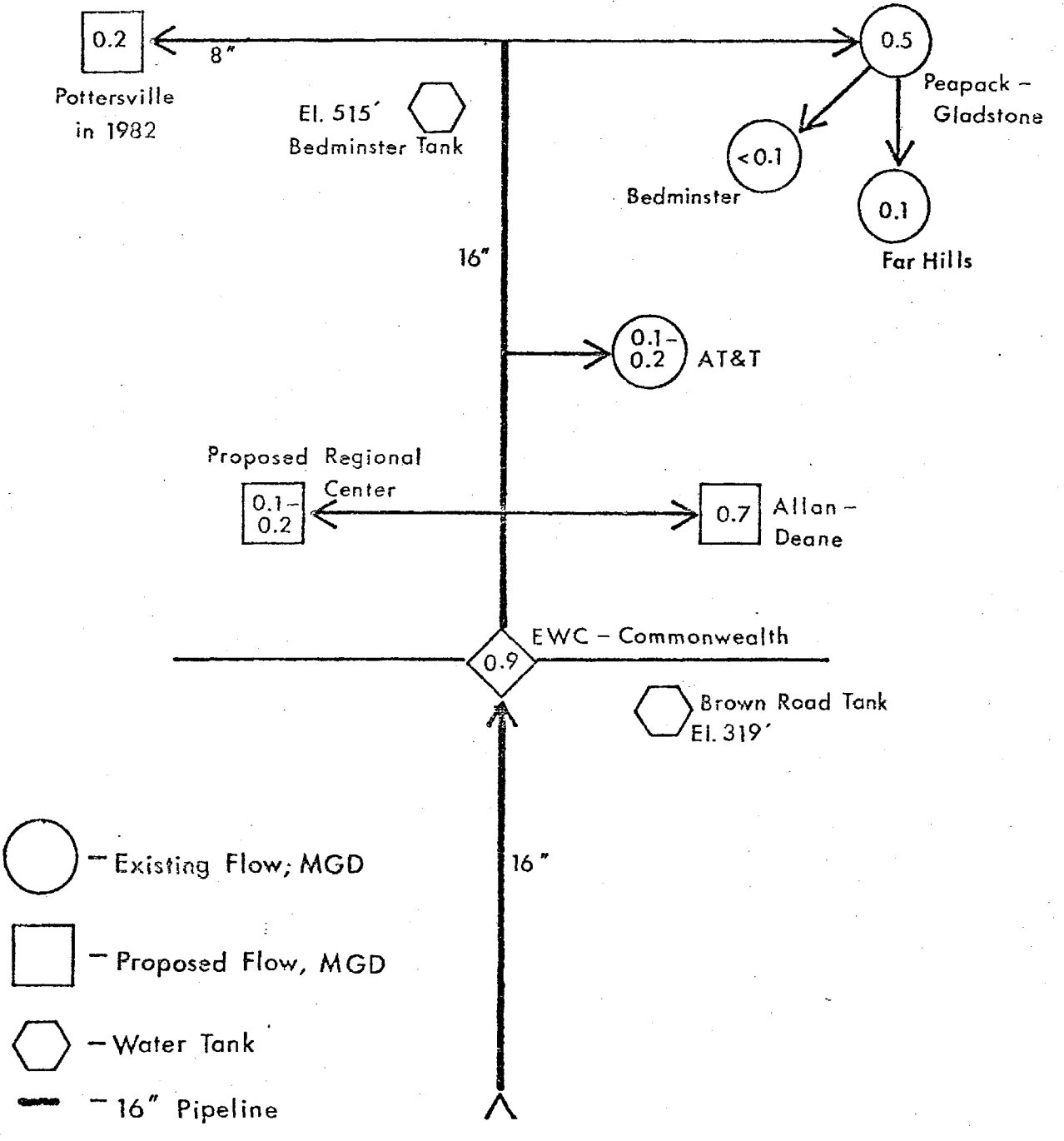
contracts between Elizabethtown and Commonwealth. Presently, 0.9 MGD enters the 16 inch main at the junction of the Elizabethtown-Commonwealth system near Routes 202/206 at the Bridgewater-Bedminster boundary. Within Bedminster, AT&T takes 0-1 to 0.2 mgd. The remaining 0.7 mgd is pumped north to be consumed by Peapack-Gladstone and Far Hills (See Figure 1). Commonwealth estimates that the existing demand plus the proposed Allan-Deane, Beneficial Finance, and proposed Bedminister shopping center would absorb 2.25 mgd of the 3.0 mgd that can pass through the pipe. In short, there appears to be sufficient pipe capacity.

Is Elizabethtown ready to supply the water to Commonwealth? The answer is yes. As already noted, water and piping should be no problem in the near future. The relationships between Commonwealth and Elizabethtown are not simple, but pose no threat to the proposed development nor other new developments in the area. The companies have a variety of contracts of which the one focusing on the Martinsville Road connection in Bernards Township and the 16 inch main that passes by the proposed site is relevant. The contract requires a 0.9 mgd minimum purchase and will increase each year by 0.1 mgd through the year 1999. Elizabethtown is willing to make design changes, if necessary, to accommodate growth along the 202/206 corridor, but they see nothing proposed including all of the above projects (i.e., Allan-Deane, Beneficial Finance, etc.) that would necessitate changes in their system. The two companies are presently negotiating regarding their contracts and engineering plans for the corridor.

Commonwealth has a number of options for the future which could bring additional water to the area. These are dependent upon state policies for the western area of Region 1 of Northeastern New Jersey, which includes Morris,

EXISTING AND POTENTIAL POTABLE WATER FLOWS IN THE BEDMINSTER AREA

figure 1



the northern half of Somerset, and adjacent areas of Sussex and Hunterdon counties. One option is to escalate purchases from Elizabethtown. Our previous research with linear programing suggests a high potential for transfers from Elizabethtown to Commonwealth in the absence of the following two projects. A second option is to build a new filter plant at Canoe Brook if a 60 inch pipe from the North Branch Raritan River is constructed to run along I-78 and release water into the Dead River, a tributary of the Passaic River. A third option is to connect the Bernards and Gravity service areas of the Commonwealth Water Company. Commonwealth is awaiting state action at this time.

Both companies and the literature report that shopping center peak uses are not much of a problem. Indeed, shopping centers are viewed as stable customers. Peaking problems are due to sprinkling on residential properties. If the shopping center plans extensive planting which would require extensive sprinkling of potable waters, our characterization of the potential peaking problem as minor would have to be reevaluated.

Fire fighting flows can be met by proper planning. The 16 inch main can deliver 2000 gpm at 40 psi. Depending upon insurance and engineering studies, the fire flow requirements may be higher. Elizabethtown has two tanks in the area which might be used for these purposes. One holds 1.7 MG at elevation 319 feet. The second tank holds 1.0 MG at elevation 515 feet and is just being completed in Bedminster. Perhaps these two tanks can meet requirements above 2000 gpm at 40 psi. If they cannot, on-site storage will be necessary. A tank is likely to be unacceptable for aesthetic reasons. Stormwater detention basins are also unlikely to suffice because of winter freeze and drought conditions constraints on availability. The most likely

solution is ground storage which can be pumped.

In summary, there is sufficient water within the Raritan Basin to allow Elizabethtown to sell treated water to Commonwealth which in turn can supply water to the proposed shopping center.

WATER QUALITY

The initial findings are that meeting water quality goals at the site will require evaluation of a broad range of alternatives, selection of a combination of conventional and innovative technologies, and careful construction and maintenance practices.

WATER QUALITY GOALS AT THE SITE

The proposed site is situated along a sensitive segment of the North Branch of the Raritan River. It is presently classified as FW-2, non-trout, which means fresh surface water approved as a source of potable water, suitable for contact recreation and propagation of the natural and established biota, excluding trout. The primary use is potable water supply. The quantitative goals are the following:

Parameter	FW-2, non-trout
1. DO, 24 hr. avg. (mg/l)	5.0
DO, minimum at any time (mg/l)	4.0
2. Turbidity, 30 day avg. (JTU)	20
Turbidity, maximum (JTU)	110
3. pH (SU)	6.5 - 8.5
4. Fecal coliform (10g mean) MPN	200
5. Total phosphorus as P (mg/l)	.05
6. Total dissolved solids	not to exceed 500 mg/l or 133% of background

In addition, there are recommended USEPA and probably Bedminster Department of Health standards for many parameters including lead, oil and grease. Future federal and state goals for the site are governed by the nondegradation regulations of the USEPA and New Jersey:

USEPA: 40 CFR 130.17(e) (2):

> Existing high quality waters which exceed those levels necessary to support propagation of fish, shellfish and wildlife and recreation in and on the water shall be maintained and protected unless the state chooses, after full satisfaction of the intergovernmental coordination and public participation provisions of the State's continuing planning process, to allow lower water quality as a result of necessary and justifiable economic or social development.

NJAC:7:9-4.4(a) (7):

> Where existing water quality is better than the established criteria, the Department of Environmental Protection in the administration of these regulations shall maintain the quality of such waters unless it can be demonstrated that change is justifiable as a result of necessary economic or social developments.

If the site is sensitive, why was Allan-Deane given a permit? According to NJDEP staff, the Allan-Deane permit was granted largely as a result of the above economic and social development provisions. Furthermore, the Allan-Deane plant approval is contingent upon demonstration through monitoring that the plant meets expectations.

DEP staff indicated that existing and planned development virtually exhaust all nutrient (phosphates, nitrates) load allocations for the stream. There is some load available for organic wastes. However, even this potential allocation could be reduced or even eliminated if the state can be convinced that the stream should be upgraded from FW-2, non-trout to FW-2, trout maintenance. The latter classification is a stream that supports trout. The justification for such a reclassification is that the initial classification in 1968 missed trout because of construction in the area. The DEP has been receiving reports of trout in the stream.

The proposed Confluence Reservoir at the junction of the North and South Branch Raritan Rivers is yet another consideration to the state. While not immediately in the offing, the state will clearly take into account the proposed reservoir when evaluating the water quality impact of the proposed shopping center and any other developments along the Route 206 corridor.

The federal and state governments will certainly not be the only interested parties. The Elizabethtown Water Company and probably the Commonwealth Water Company could intervene in order to maintain the integrity of the water which is distributed to most of central New Jersey.

SANITARY WASTE

The first step is to estimate the amount and quality of effluent produced

at the site. It is particularly important to distinguish between organic and nutrient wastes at this site. A precise breakdown of water use into black and gray is not available. Conversations with the Thetford Corporation staff suggested a 70 percent black water, 30 percent gray water breakdown for retail space and a 30 percent gray, 70 percent black for restaurant and beauty shop space. Applying these admittedly very rough coefficients to the water demand estimates yields the following:

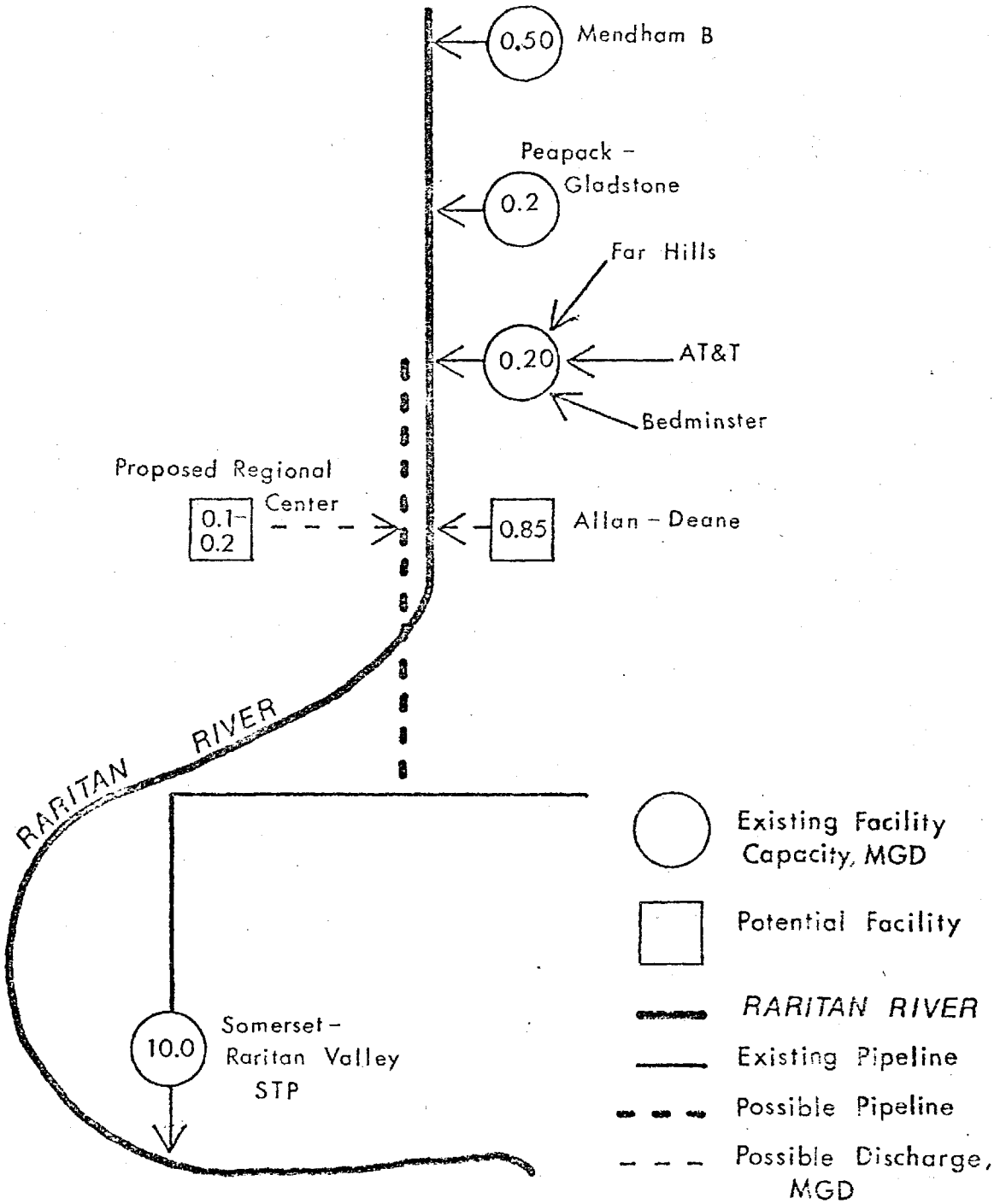
Estimated Black Water and Gray Water Effluent Quantity

Use	Average Daily MGD	Peak Daily MGD	Breakdown	Black Avg.	Black Peak	Gray Avg.	Gray Peak
Retail	0.121	0.175	70% black, 30% gray	.085	.123	.036	.052
Restaurant	0.044	0.152	30% black, 70% gray	.013	.046	.031	.106
Barber & Beautyshop	0.002	0.003	30% black, 70% gray	<.001	.001	.002	.002
Total	0.167	0.330		.098	.170	.069	.160

The amount of sanitary sewage produced at the site is small in comparison to the 6.5 - 7.0 mgd treated at the Somerset-Raritan regional sewage plant in Bridgewater Township (see Figure 2). The proposed site, however, is not connected to this regional plant. It could be connected to the Middlebrook trunk sewer in Bridgewater Township and treated at the Somerset-Raritan Valley plant. The Allan-Deane Corporation investigated this possibility. It was found to be the cheapest solution on an annualized cost basis. However, the pipeline was opposed by municipalities through which it would have passed, and other persons were opposed because the water would have been discharged

EXISTING AND POTENTIAL SANITARY WASTE FLOWS IN THE BEDMINSTER AREA

figure 2



downstream of the Elizabethtown filter plant, thus preventing reuse of the water.

While we are personally not in favor of this approach, it should not be dismissed apriori if it is the only way of preserving the integrity of the North Branch. Specifically, should growth in the corridor escalate, and/or should the existing and planned treatment plants prove to be unreliable, water quality might be better served by an interceptor which would include the present and planned treatment facilities.

There is plenty of capacity in the Somerset-Raritan sewage system. The existing plant is designed for secondary treatment of 10 mgd. They have about 70 percent of that flow most of the time and as low as 5.6 mgd during very dry periods. During very wet periods their flow increases to 12 mgd. In order to meet peak period flows until their planned expansion to 15 - 18 mgd is completed in four to five years, they have negotiated an agreement to use 5 mgd of the advanced wastewater treatment system at American Cyanamid. In short, the sewerage authority has agreed to accept sanitary waste from Bedminster, if it can be tied into the system.

Could the proposed development tie into the Bedminster or Allan-Deane sewage plants? It is possible, though unlikely, that all of the flow could be sent to these plants as they presently exist or are planned. The Bedminster plant has a design capacity of 0.2 mgd and a present flow of 0.15 mgd. The Malcolm Pirnie 201 Facilities Report suggests expanding the plant which has a fluidized bed denitrification unit and an aqua-jet phosphate removal unit to 0.253 mgd. However, stream loading of pounds per day must not exceed the present NPDES permit. Since the phosphate and nitrogen removal processes at present do not function properly, the township will not be permitted to

allow additional connections until the units are operating properly and the NPDES limits are attained (Giallella, letter).

Could the plant be enlarged? Possibly, though not quickly, because Bedminster would have to go back to the NJDEP and go through the entire permit process.

The Allan-Deane plant has a design capacity of 0.85 mgd. Given the trend toward smaller families, the plant may not need that capacity. However, we doubt that they would risk losing their permit by allowing any additional hookups or by going back through the review process for a plant expansion.

The existing Peapack-Gladstone sewage plant is located about one mile north of the Bedminster plant on the North Branch Raritan. It has a design capacity of 0.2 MGD with an average flow now of about 0.08 MGD. The effluent from the corporate headquarters of Beneficial Finance is estimated to be 20,000-30,000 GPD and will go into the Peapack plant. Other planned developments in the Peapack area are expected to use up the remaining capacity. Therefore, the Peapack plant will not be available for the effluent from the proposed shopping center.

The Mendham Borough STP is too far north of the proposed site to be considered as an alternative for effluent disposal.

If connection to the aforementioned treatment plants are unlikely, what about a package plant for the proposed center? DEP staff did not dismiss this possibility, but they indicated that the sensitivity of the area would make the process a difficult one. For example, they indicated that a duplicate of the Allan-Deane plant would probably not be permitted on the same stream because the Allan-Deane plant has to be demonstrated to successfully work before another permit is granted.

Summarizing, the conventional options of connecting into another plant or even of building an advanced technology plant with a discharge will be difficult, though certainly not impossible, to plan and implement in this area.

Due to the sensitivity of the area, the unconventional must be carefully investigated. The preferred option would be a completely closed system. One type of closed system would divide the wastewater into black water (toilet) and gray water (hand & hair washing and restaurant) wastes. These wastes would then be handled by specialized technologies.

But are there such technologies? The black water, which would constitute most of the waste might be handled by a system which we are presently investigating. The system, CYCLE-LET, was developed by the Thetford Corporation of Ann Arbor, Michigan. Briefly, wastewater from toilets, sinks, urinals and other fixtures is collected and sent by gravity or air pressure to a sump. It is then lifted via vacuum transfer into a treatment component where bacteria in an oxygen excess environment consume much of the organic waste. A screening device in the aerobic digestion chamber prevents passage of solids through to the next module of the process.

After leaving the aerobic chamber, the wastewater is pumped through tubes lined with filters. Water containing some solids is returned to the treatment system.

The filtered water goes to another component which removes color and odor with activated carbon. An ultra violet light/ozone process is used to disinfect the filtered water.

The recovered water is reused in toilets, thereby reducing water requirements. It is claimed to be clear, colorless, odorless and free of

harmful bacteria. (Their literature claims a recovered water BOD_5 and total suspended solids concentration of less than 5 mg/l and total coliform counts typically less than 1/100 ml).

Specialized modules are designed to detect and control problems. A remote monitor detects system malfunctions. The sumps are designed for 24 hour detention in the case of malfunctions. The aerobic processes digest organic materials. Therefore, only biologically inert and non-biodegradable solids are supposed to accumulate. When these become highly concentrated (40,000 - 80,000 ppm) the system is pumped out, usually every year or two.

The CYCLE-LET system is not presently operating at a shopping center at the scale of the proposed Bedminster site. However, it has been operating at Village Center, Great Falls, Virginia, for over 18 months. Village Center has 12 multi-tenant buildings occupying 60,000 square feet. A proposal for an office complex and a 60,000 square foot shopping center has already received conceptual approval in Hopewell Township, Mercer County, New Jersey.

Clearly, this system has potential. However, reliability, scale-up problems and cost must be investigated in more detail.

The smaller volume of gray water (estimated to be about 0.069 MGD) perhaps could be successfully handled by a septic system, spray irrigation, or even a transfer to the Bedminster plant. Septic system and spray irrigation may present problems at the site because a perched water table apparently exists at the site. Furthermore, a groundwater permit would be required for spray irrigation. However, neither should be dismissed a priori because the amount of gray water is relatively small and the concentration of wastes should be far less than from a comparable amount of black water.

STORMWATER

Like sanitary waste management, stormwater management will undoubtedly require innovative approaches.

Stormwater Loadings

A group of researchers at the University of Florida under contract to the USEPA have developed a set of pollutant loading factors for desktop assessment of stormwater runoff. The methods were discussed at the EPA Workshop on "Water Quality Assessment of Toxic and Conventional Pollutants in Lakes and Streams" that was held in Arlington, Virginia during June 23-25, 1981.

The following equation may be used to predict annual average loading rates as a function of land use, precipitation and population density:

$$M_s = A_{i,j} (P) (PD) (SS)$$

where M_s = pounds of pollutant j generated per acre of land use i per year for separately sewered areas;

A = pollutant loading factor,

i = land use,

j = pollutant type,

P = annual precipitation in inches/year,

PD = developed population density in persons/acre,

SS = street sweeping factor.

The SS factor is a function of street sweeping interval, N_s, (days), as follows. If the sweeping interval is 20 days or more, street sweeping is considered to be an ineffective mitigating factor. (SS = 1.0). The effectiveness of sweeping improves directly in proportion to street sweeping

if $0 \leq N_s \leq 20$ days, $SS = N_s/20$.

For commercial and industrial areas, the PD (population) function is 1.0 and therefore does not affect the results.

Application of the stormwater loading equation to the Bedminster site is shown below. Three projected land use scenarios are shown as illustrative:

SS = 1.0 for a sweeping interval of 20 days

SS = 0.5 for a sweeping interval of 10 days

SS = 0.1 for a sweeping interval of 2 days

Loadings for commercial land use are available for only five pollutants, not including lead, which is an important component of automobile pollution.

Estimated Pollutant Loadings from the Bedminster Site (pounds/year)

Land Use Scenarios	BOD	SS	VS	PO_4	N
1. Existing Open: 211 acres	152	3640	3506	13	82
2. Projected: SS = 1.0					
Open: 120 acres	87	2070	1994	8	46
Commercial: 91 acres	13104	90909	57330	310	1212
Total	13191	92979	59324	318	1258
3. Projected: SS = 0.5					
Open: 120 acres	87	2070	1994	8	46
Commercial: 91 acres	6552	45455	28665	155	606
Total	6639	47525	30659	163	652
4. Projected: SS = 0.1					
Open: 120 acres	87	2070	1994	8	46
Commercial: 91 acres	1310	9091	5733	31	121
Total	1397	11161	7727	39	167

BOD: Biochemical Oxygen Demand
SS: Suspended Solids
VS: Total Volatile Solids
N: Total Nitrogen
PO_4: Total Phosphate

As shown in the above Table, the loadings for all five pollutants are estimated to increase whenever a portion of the 211 acre site is developed for commercial purposes. However, frequent sweeping can substantially reduce the expected loadings. Note how BOD can decrease from 13191 pounds per year in scenario 2 (sweeping only once every 20 days) to 1397 pounds per year in scenario 4 (sweeping every 2 days). Similar conclusions can be drawn for the other four pollutants.

The loadings in the Table include only one mitigative measure for storm water management: street (or parking lot) sweeping. The loadings did not include other measures, such as detention basins, grassed swales, and overland flow over other vegetated surfaces. Although not documented at this point, it is reasonable to assume that these and similar types of storm water management techniques would reduce the amount of pollutant loadings. It is apparent that reduced pollutant loadings from storm water runoff can occur when appropriate mitigative measures are employed.

In short, the impact of the stormwater could be serious in the absence of mitigating measures. After discussion with DEP staff, we have concluded that the problem can be handled. For example, since many contaminants are usually associated with sediments, frequent sweeping of the parking areas with a vacuum sweeper is advised. Grassed strips heading to the basins and catchment basins for pre-settling were also suggested as worthy of exploration. A parking deck which would reduce impervious surfaces should also be weighed.

Next, a set of detention ponds that would allow 90 - 95% settling out would be needed. This could be accomplished by pumping the stormwater back and forth between the basins or by artificially creating a cascade with berms. Location and design of the outlet and depth of the basins are also particularly

important. DEP staff suggested the lagoons in the Hackensack Meadowlands as a model.

Heat from runoff is yet another potential problem. Specifically, the aquatic environment of the river is cold. Flow of heated water from parking lots should be avoided and probably would not be permitted. Accordingly, the detention system should be shaded. The detention system may also have to be expanded due to potential flooding at the site.

Summarizing, stormwater management at the site will be a challenging task, but one that can be accomplished with careful planning, proper engineering, and a good program of maintenance. A state discharge permit for the stormwater system is likely to be required.

DOCUMENTS

American Water Works Company, Inc., 1980 Annual Report, the Company, 1980.

Commonwealth Water Company, Plant Description Book, mimeo, May 1981.

Giallella, S. T., Chief, Bureau of Municipal Waste Management to Richard Jeske, Engineer, Springfield, April 10, 1981, DEP files, letter.

Greenberg, Michael and Robert Hordon, Water Supply Planning: A Case Study and Systems Analysis, New Brunswick, New Jersey; Center for Urban Policy research, 1976.

Hittman Associates, Inc., Forecasting Municipal Water Requirements, 2 vols. HIT-43, Columbia, Maryland, Hittman, 1969.

Resource Analysis, Evaluation of the Water Quality Impacts of the Proposed Wastewater Discharge from the Allan-Deane Development, Waltham, Mass: Camp, Dresser & McKee, 1979.

State of New Jersey, Department of Environmental Protection, The Draft Phase I Water Quality Management Basic Plan - Raritan River Basin, Trenton: The Agency, 1976.

State of New Jersey, Department of Environmental Protection, Surface Water Quality Standards, Trenton: The Agency, 1974.

State of New Jersey, Department of Environmental Protection, Division of Water Resources, Summary of Consultants' Findings for the New Jersey Statewide Water Supply Plan, Trenton, 1980.

Thetford Corporation, various documents.

Wood, Charles D., Director of Environmental Engineering, Louis Berger and Associates to Jack Devlin, Hackensack Water Company, September 22, 1978 included in Supplement to Berry's Creek Center, General Plan Application, Part I, March 1979.

INTERVIEWS

Thomas Cawley, Vice President, Elizabethtown Water Company, Plainfield, New Jersey, June 13, 1981.

Jeane Decker, Executive Director, Somerset-Raritan Valley Sewerage Authority, June 17, 1981.

Tom Jenq, Division of Water Resource, NJDEP, June 11, 1981.

George Horzepa, Office of Planning and Standards, NJDEP, June 11, 1981.

Shing-Fu Hsueh, Division of Water Resources, NJDEP, June 11, 1981.

Mr. LaPointe, Peapack-Gladstone, Sewage Treatment Plant Operator, June 29, 1981.

Dennis Palmer, Section Chief, Technical Review for Municipal Waste Management, NJDEP, June 11, 1981.

Navin Patel, Contract Grants Approval, 201 Section, NJDEP, June 11, 1981.

William H. Pearce, P.E., Easton Division Engineer, American Water Works, Service Co., Inc., Haddon Heights, New Jersey, June 10, 1981.