#/3

BAXTER & WOODMAN, INC.
CIVIL AND SANITARY ENGINEERS
CRYSTAL LAKE, ILL. 60014

RICHARD M. BAXTER (1946-1963)
LORRIN E. WOODMAN

FRANK R. FABBRI, JR.
HJALMAR S. SUNDIN
OTTO L. LARSEN
GEORGE F. HECK
WALTER H. JOLLIE

RICHARD D. MILLS
HOWARD E. RIECK
ROBERT H. WOHNRADE
RICHARD M. WEIDNER
DENNIS P. SHINKS
JEROLD A. BUCKLES
DONALD R. SCHWEGEL

P. O. BOX 99
TELEPHONE 815 459-1260

January 24, 1974



President and Board of Trustees
Village of Barrington
206 South Hough Street
Barrington, Illinois 60010

Subject: Barrington - Infiltration/Inflow Study

Gentlemen:

Submitted herewith is the Infiltration/Inflow Analysis portion of the Sewer System Evaluation of the sewers tributary to the Village of Barrington's treatment facilities. This report is the first step in the complete Sewer System Evaluation as defined herein.

Our work on your behalf has been done in accordance with the letter of Authorization dated November 12, 1973.

The flows, rates and alternatives discussed in this Analysis are similar to the ones discussed in the 1973 Engineers' Report on the Sewage Treatment Plant Additions and Improvements. However, the 1973 Report was written to comply with the Water Pollution Regulations of Illinois, whereas this Analysis was written in accordance with the more recent Rules and Regulations of the United States Environmental Protection Agency.

Respectfully submitted,

BAXTER AND WOODMAN, INC.
CIVIL & SANITARY ENGINEERS

L. E. Woodman

L. E. Woodman

H. S. Sundin

H. S. Sundin

D. R. Gavle

D. R. Gavle

VILLAGE OF BARRINGTON

# INFILTRATION/INFLOW
# ANALYSIS

ENGINEERS' REPORT

JANUARY 1974



BAXTER AND WOODMAN, INC.
CIVIL & SANITARY ENGINEERS
Crystal Lake, Illinois

VILLAGE OF BARRINGTON, ILLINOIS

INFILTRATION/INFLOW

ANALYSIS

TABLE OF CONTENTS

## GENERAL CONSIDERATIONS

The Village of Barrington is located in northeastern Illinois near the Chicago Metropolitan area. The Village has a current estimated population of approximately 8,500 persons. The Village though primarily residential has several large industrial users.

The following statements are relevant to infiltration/inflow in the Village:

1. The Village owns approximately 39.1 miles of sanitary sewer ranging in size from 8-inch to 30-inch. Also there are approximately 80 miles of 6-inch service lines within the Village.
2. The oldest sewers were installed in the 1920's; however, approximately 50 percent of the sewers are less than ten years old.
3. None of the sewers are combined; however portions of the sewer system were originally combined sewers, but have been separated.
4. Most of the sanitary sewers are vitrified clay or concrete pipe. However, in recent years some ABS plastic sewer pipe has been installed.
5. Approximately 50 percent of the vitrified clay or concrete sanitary sewers have oakum-bituminous joints and the remainder have O-ring joints.

6. Sewer depths range from a minimum of 2 feet to approximately 26 feet deep with an average depth between 5 and 10 feet deep.
7. The soil in the Village is primarily clayey but some large areas of peat do exist.
8. Although overland drainage is used in the northwest section of the Village, most of the community is served with storm sewers. The majority of the storm sewers discharge into the North Branch of Flint Creek.
9. Grease and roots are the primary maintenance problems in the sanitary sewer system.
10. Sanitary sewer maintenance consists of rodding or bucketing.
11. The ground water level fluctuates with the amount and frequency of precipitation but some localized areas have high ground water throughout the year.
12. Most of the sewers surcharge during a heavy rain and cause some basement flooding.
13. Three lift stations are owned by the Village. Metering facilities at the stations indicate that they handle approximately 5 percent of the total flow.
14. The bypasses on the lift stations operate only when mechanical failure causes a prolonged interruption in service.

15. A few manholes are known to overflow during a very heavy rainstorm.

16. The flow through the plant has been limited by the pumping capacity to approximately 9 MGD; however, this flow rate hydraulically overloads some of the treatment units.

17. The sewage treatment plant is designed for an average flow of 2.0 MGD.

18. An 18-inch bypass is operational at the sewage treatment plant; however, it functions only when very high flows to the plant must be mechanically reduced to protect the grinding equipment.

## FLOW DETERMINATION

A tabulation of the flow rates experienced in the sanitary sewer is as follows:

| | | |
|---|---|---|
| A. | Average dry weather flow rate | 1.14 MGD |
| B. | Peak dry weather flow rate | 2.28 MGD |
| C. | Infiltration flow rate | 1.22 MGD |
| D. | Inflow flow rate | 8.83 MGD |
| E. | Total flow rate | 12.33 MGD |

The following paragraphs explain how these figures were derived:

A. Average Dry Weather Flow Rate - The average dry weather flow rate is the quantity of sewage contributed by the inhabitants of the community plus the industrial wastes. A study of the records from the Water Department indicate that the water use in Barrington averages 120 gallons per capita per day. Therefore the domestic contribution from 8,500 persons is 1.02 MGD. The industrial waste is contributed by Jewel Tea Company and Quaker Oats Company, both of which are supplied by their own wells but discharge their waste to the sanitary sewer system. These two companies discharge an average of 0.12 MGD. Therefore, the average dry weather flow rate can be calculated as follows:

| | |
|---|---|
| Average domestic flow rate | 1.02 MGD |
| Average industrial flow rate | 0.12 MGD |
| Average dry weather flow rate | 1.14 MGD |

B. Peak Dry Weather Flow Rate - The peak dry weather flow rate was determined from an analysis of the sewage treatment plant's daily operating records for August 1973 which was a dry month with a minimum of infiltration. The analysis shows that on dry days the peak flow rate to the plant was approximately twice the average flow rate.

Therefore, the peak dry weather flow rate is two times the average dry weather flow of 1.14 MGD, or 2.28 MGD.

C. Infiltration Flow Rate - The ground water level is very dependent on the amount and frequency of precipitation. Generally the ground water level is the highest during the spring months. The flow to the sewage treatment plant during March and April 1973 averaged 3.36 and 3.68 MGD respectively. On dry days, after prolonged periods without precipitation. the flow averaged 2.36 MGD. Therefore, the infiltration flow rate is 2.36 MGD minus the average dry weather flow rate of 1.14 MGD, or 1.22 MGD.

D. Inflow Flow Rate - The inflow flow rate is difficult to accurately determine due to the limited raw sewage metering and pumping capacity at the sewage treatment plant. The raw sewage meter has a maximum limit of 6.0 MGD and the pumps when operated simultaneously have an estimated capacity of 9.0 MGD.

It has been reported that, during heavy rainstorms, the flow rate exceeds the capacity of the pumps and the sanitary sewers begin to surcharge. However, the sewers do not surcharge sufficiently to operate the 18-inch bypass at the plant.

The flow rates caused by the rainstorm of May 22, 1973 were analyzed to determine the inflow flow rate. The storm of May 22, 1973 was selected because a storm of this size (2.2 inches in 13 hours) occurs on an average of once yearly. The analysis indicates that the sanitary sewers became surcharged during the storm and that the system was not dewatered until the following day. During those two days a total of 12.08 million gallons of sewage was pumped. The quantity of water which can be attributed to this storm or the inflow is the total quantity pumped minus the average dry weather flow and the infiltration which occurred during the two day period. The inflow can therefore be calculated as follows:

| | |
|---|---|
| Total quantity pumped | 12.08 MG |
| Average dry weather flow, 1.14 x 2 (two days) | 2.28 MG |
| | 9.80 MG |
| Infiltration flow, 1.22 x 2 (two days) | 2.44 MG |
| Inflow | 7.36 MG |

The period of time when the 7.36 MG of inflow enter the system must be determined to arrive at the inflow flow rate. Experience has shown that inflow continues to enter the sanitary sewer system for several hours after the rain stops. Assuming that the inflow entered the system during a 20-hour period, the inflow flow rate is 8.83 MGD.

E. Total Flow Rate - It can be concluded that the total expected flow rate in the sewer system can be calculated as follows:

| | |
|---|---|
| Peak dry weather flow rate | 2.28 MGD |
| Infiltration flow rate | 1.22 MGD |
| Inflow flow rate | 8.83 MGD |
| Total flow rate | 12.33 MGD |

## SOURCES OF INFILTRATION/INFLOW

It can be stated that the sanitary sewer system receives infiltration at a rate of 1.22 MGD during periods of high ground water and inflow at a rate of 8.83 MGD during an annual rainstorm.

The Village has recently undertaken a comprehensive program to locate and eliminate the sources of infiltration/inflow. The program has included smoke testing, flow measuring and televising of the questionable sewers. These methods have enabled the Village to locate several direct connections between the sanitary sewers and the storm sewers, some leaky sewers which receive inflow and infiltration, and a number of downspouts which are connected to the sanitary sewers.

The Village has eliminated several of these sources by disconnecting direct connections between the storm and sanitary sewers, by replacing some very leaky sewers, by packing some leaky joints, and in some cases where packing is not feasible, by encasing the sewer in concrete. It is estimated that these measures have reduced infiltration/inflow approximately by 2.0 MGD.

Although the Village has been eliminating some of the sources of infiltration/inflow, many others are known to exist. A brief description of the various sources and the current estimated contribution from each follows:

1. Direct connections between the storm sewers and sanitary sewers account for an estimated 20 percent of the inflow.
2. Roof downspout connections to the sanitary sewer are scattered throughout the Village. These connections account for an estimated 5 percent of the inflow.
3. Footing drains which are connected to the sanitary sewer both by gravity and via sump pumps are prevalent in certain areas. These connections account for an estimated 15 percent of the inflow and 40 percent of the infiltration.
4. Leaky covers on manholes which are located in areas where rainwater ponds during storms accounts for an estimated 5 percent of the inflow.
5. Leaky joints and broken pipes exist throughout the system in the mains, laterals and service lines. Rainwater, leaked from storm sewers, will enter the sanitary sewer through a leaky joint or broken pipe particularly at pipe crossings between the storm and sanitary sewers. Storm water which enters the sanitary sewer in this manner accounts for an estimated 55 percent of the inflow. Ground water will also enter the sanitary sewer through leaky joints or broken pipes. This source accounts for an estimated 60 percent of the infiltration.

## PROPOSED IMPROVEMENTS AND ESTIMATES OF COST

The Village of Barrington sewage treatment plant consists of sewage grinders, raw sewage pumps, a grit tank, primary clarifiers, aeration tanks, final clarifiers, tertiary filters, anaerobic digesters, a flotation thickener, and a sludge filter. The sewage treatment plant is designed for an average flow of 2.0 MGD. However the peak capacity of the plant is limited by the primary and final clarifiers which have a maximum capacity of 2.9 MGD and 2.7 MGD respectively. These flows have been exceeded on almost 27 percent of the days during the past two years.

The treatment plant currently serves approximately 8,500 persons but the growth rate of the Village and the surrounding area indicates that the population may reach 20,000 persons by 1985.

The Village therefore proposes to increase the treatment plant capacity to serve a population of 20,000 persons. The sewers built to serve the additional 11,500 persons will be built using modern materials and techniques and under close supervision. Therefore, infiltration and inflow in these sewers should be minimal. Assuming the current relationship among population, water consumption, and sanitary sewage quantities is maintained in the future, the theoretical contribution from 11,500 persons is approximately 1.38 MGD with a peak flow at the plant of 2.76 MGD. Therefore, the expected total peak flow rate to the treatment plant when the population reaches 20,000 persons is:

| | |
|---|---|
| Current peak dry weather flow rate (Item B, p. 5) | 2.28 MGD |
| Infiltration flow rate (Item C, p. 5) | 1.22 MGD |
| Inflow flow rate (Item D, p. 5) | 8.83 MGD |
| Peak dry weather flow rate from 11,500 additional persons | 2.76 MGD |
| Total flow rate | 15.09 MGD |

Two alternatives will be considered for providing adequate treatment capacity to serve 20,000 persons.

CASE I - Increase the sewage treatment pland and sanitary sewer capacities to 15.1 MGD.

CASE II - Eliminate a portion of the infiltration/inflow and provide treatment capacity to handle the remaining flow rates.

The alternatives will be economically compared using their present worth values to determine the most cost-effective method. The cost of CASE I - EXPANDED FACILITIES TO HANDLE TOTAL FLOW - is determined by calculating the cost of the required increase in treatment plant and sanitary sewer capacity and adding the present worth value of the operation and maintenance costs for treating the infiltration/inflow. The cost of CASE II - EXPANDED FACILITIES WITH SEWER SYSTEM REHABILITATION - is based on the estimated cost of identifying and eliminating some of the sources of infiltration/inflow and the cost of increasing the capacity of the treatment works to handle the remainder. Also included is the present worth value of the operation and maintenance costs for treating the remaining infiltration/inflow.

CASE I - EXPANDED FACILITIES TO HANDLE TOTAL FLOW

The cost of CASE I was determined under the assumption that all overflowing will cease and that the total flow will receive secondary treatment. Two alternatives were considered for Case I, namely:

Alternate IA - Detention ponds to hold excess flows until treatment is possible.

Alternate IB - Increased treatment and sanitary sewer capacities to handle the total flow rate.

Alternate IA - Detention Ponds

As previously stated the hydraulic capacity of the treatment plant is exceeded approximately 27 percent of the time. Therefore detention ponds to store excess flows until treatment is possible would have to be very large and the length of time before the ponds could be drained would be several weeks. The required size of the detention ponds and the detention time is considered undesirable; therefore, providing detention ponds for excess flow cannot be considered as a feasible alternative.

Alternate IB - Increased Treatment and Sewer Capacity.

The existing trunk sewers have an estimated capacity of 12 MGD. Therefore an additional 3.1 MGD capacity is required. The total estimated cost of the new trunk sewer is $288,000.

The treatment plant expansion is based on providing raw sewage pumping and primary clarification capacity for the total flow of 15.1 MGD. The secondary treatment units would have a capacity of 9.6 MGD and flows in excess of 9.6 MGD would be stored in an 8-million gallon detention pond prior to secondary treatment. The total estimated cost of a plant expansion of this size is $5,006,700 which includes $100,000 for land acquisition.

The present worth values of the operation and maintenance costs for treatment of the inflow and infiltration over a twenty year period are based on a yearly average inflow of 212 million gallons and a yearly average infiltration of 233.6 million gallons. These quantities were obtained from treatment plant operating records.

The total estimated cost for CASE I is as follows:

| | |
|---|---|
| Sewage treatment plant expansion | $5,006,700 |
| Trunk sewers | 288,000 |
| Present worth value of the operation and maintenance costs for treatment of the inflow over a twenty-year period | 680,500 |
| Present worth value of the operation and maintenance costs for treatment of the infiltration over a twenty-year period | 749,800 |
| Total estimated CASE I Cost . . . . . . | $6,725,000 |

CASE II - EXPANDED FACILITIES WITH SEWER SYSTEM REHABILITATION

A. Evaluation Survey Costs. - The evaluation survey costs are based on experience in infiltration/inflow identification. The cost of the various phases of the survey are based on following the procedures outlined under "SEWER SYSTEM EVALUATION SURVEY" (presented later in this report).

The estimated costs of cleaning and televising are included in the costs of Phase III and Phase IV, and are based on cleaning and televising 40 percent of the sanitary sewers in the Village.

The evaluation survey cost is as follows:

| | | |
|---|---|---|
| Phase I | PHYSICAL SURVEY | \$10,000 |
| Phase II | BASE FLOW DETERMINATION | \$15,000 |
| Phase III | INFLOW DETERMINATION | \$85,000 |
| Phase IV | INFILTRATION DETERMINATION | \$55,000 |
| Phase V | PREPARATION OF REPORT | \$10,000 |
| | | \$175,000 |

B. Rehabilitation Cost. The cost of rehabilitating the sanitary sewer system is based on removing 57 percent of the inflow and 37 percent of the infiltration. The estimated quantity, source, and costs of rehabilitation are as follows:

1. 17 percent of the inflow is removed by elimination of direct connections between the storm and sanitary sewers . . . . . . \$20,000

2. 4 percent of the inflow is removed by elimination of roof downspout connections to the sanitary sewer . . . . . . . \$25,000

3. 6 percent of the inflow and 7 percent of the infiltration is removed by elimination of footing drain connections to the sanitary sewer . . . . . . . $349,200

4. 4 percent of the inflow is removed by eliminating ponding of water over manhole covers. . . . . . . . . . . . . $9,600

5. 26 percent of the inflow and 30 percent of the infiltration are removed by repairing leaky joints and replacing or repairing broken pipe in the sanitary sewer system $234,200

Estimated Rehabilitation Cost . . . $638,000

C. Sewage Treatment Plant Expansion Cost. - After rehabilitation, it is expected that the infiltration flow rate will be reduced from 1.22 MGD to 0.77 MGD (a 37 percent reduction) and the inflow flow rate from 8.83 MGD to 3.80 MGD (a 57 percent reduction). When serving 8,500 persons, the expected maximum flow rate to the treatment plant during dry weather with high ground water is:

| | |
|---|---|
| Peak dry weather flow rate (Item B, p. 5) | 2.28 MGD |
| Infiltration flow rate | 0.77 MGD |
| Maximum dry weather flow rate | 3.05 MGD |

During wet weather the expected total flow rate is:

| | |
|---|---|
| Peak dry weather flow rate | 2.28 MGD |
| Infiltration flow rate | 0.77 MGD |
| Inflow flow rate | 3.80 MGD |
| Total flow rate | 6.85 MGD |

The maximum dry weather flow rate exceeds the capacity of the existing primary and final clarifiers and the total flow rate exceeds the maximum capacity of some of the other treatment units. Therefore, increased capacity in several of the treatment units is necessary to treat the reduced flow rates and an overall expansion is necessary to serve the additional 11,500 persons.

As previously determined, the average flow rate from an additional 11,500 persons is 1.38 MGD and the peak flow rate is 2.76 MGD. When serving 20,000 persons, the expected average flow rate to the plant during dry weather with high ground water is:

| | |
|---|---|
| Current average dry weather flow rate (Item A, p. 4) | 1.14 MGD |
| Infiltration flow rate | 0.77 MGD |
| Average dry weather flow rate from an additional 11,500 persons | 1.38 MGD |
| Average flow rate | 3.29 MGD |

The expected maximum dry weather flow rate with high ground water is:

| | |
|---|---|
| Current Peak dry weather flow rate | 2.28 MGD |
| Infiltration flow rate | 0.77 MGD |
| Peak flow rate from an additional 11,500 persons | 2.76 MGD |
| Maximum dry weather flow rate | 5.81 MGD |

The expected total flow rate during wet weather can be calculated as follows:

| | |
|---|---|
| Maximum dry weather flow rate | 5.81 MGD |
| Inflow flow rate | 3.80 MGD |
| Total flow rate | 9.61 MGD |

As in CASE I, the cost of the treatment plant expansion is determined under the assumption that all overflowing will cease and that the total flow will receive secondary treatment. Two alternatives to provide the required treatment capacity were considered, namely:

Alternate IIA - Detention ponds to hold excess flows until treatment is possible.

Alternate IIB - Increased treatment capacity to treat the entire flow.

Alternate IIA - Detention Ponds.

As previously stated the existing sewage treatment plant does not have adequate capacity to treat the expected average dry weather flow rate. Therefore, an increase in treatment capacity is necessary regardless of the size of the detention ponds.

The proposed treatment plant would be designed to handle an average flow of 3.3 MGD. The raw sewage pumps and primary clarifiers would have a peak capacity of 9.6 MGD and the secondary treatment units would have a peak capacity of 6.8 MGD. After primary treatment, flows in excess of 6.8 MGD would be stored in a 4.3 million gallon detention pond until secondary treatment was possible. An expansion of this size was proposed in the 1973 Sewage Treatment Report with the exception of the detention pond. The 1973 Report was written in compliance with the Water Pollution Regulations of Illinois which allow discharge of wet weather flows after primary treatment. However, recent Federal regulations require secondary treatment of all flows. The estimated total cost of an expansion of this size is $2,520,200 which includes $75,000 for land acquisition.

Alternate IIB - Increased Treatment Capacity

The treatment plant expansion is based on providing treatment of all of the flow without a detention pond. The plant would be designed to handle an average flow rate of 3.3 MGD and a peak flow rate of 9.6 MGD. The estimated total cost of a plant expansion of this size is $3,286,400 which includes $75,000 for land acquisition.

Since Alternate IIA - Detention Ponds is less expensive than Alternate IIB - Increased Treatment Capacity, Alternate IIA is recommended, and its cost will be used in the economic comparison between CASE I and CASE II.

The present worth values of the operation and maintenance costs are calculated as before, bearing in mind the 57 percent reduction in the inflow and a 37 percent reduction in the infiltration.

The total estimated cost of CASE II is as follows:

| | |
|---|---|
| Evaluation Survey | $175,000 |
| Sewer System Rehabilitation | $638,000 |
| Treatment Plant Expansion | $2,520,200 |
| Present worth value of the operation and maintenance cost for treatment of the inflow over a 20-year period | $292,600 |

| | |
|---|---|
| Present worth value of the operation and maintenance cost for treatment of the infiltration over a 20-year period | $472,400 |
| Total Estimated CASE II Cost | $4,098,200 |

## COST EFFECTIVE ANALYSIS

The cost effective analysis is based on a comparison between CASE I - EXPANDED FACILITIES TO HANDLE TOTAL FLOW and CASE II - EXPANDED FACILITIES WITH SEWER SYSTEM REHABILITATION. The total cost of CASE I is $6,725,000 and the total cost of CASE II is $4,098,200. Since the cost of eliminating a portion of the infiltration/inflow is less than the cost of providing facilities to transport and treat the entire flow, possible excessive infiltration/inflow exists in the sanitary sewer system. It is therefore recommended that the Village conduct a sewer system evaluation survey.

## SEWER SYSTEM EVALUATION SURVEY

The Sewer System Evaluation Survey would consist of the following phases:

| | |
|---|---|
| Phase I | PHYSICAL SURVEY |
| Phase II | BASE FLOW DETERMINATION |
| Phase III | INFLOW DETERMINATION |
| Phase IV | INFILTRATION DETERMINATION |
| Phase V | PREPARATION OF REPORT |

A brief description of the various phases follows:

Phase I - PHYSICAL SURVEY

The physical survey phase consists of an investigation of the sanitary sewer system. Interviews will be conducted to determine areas with obvious problems. Past engineering reports prepared for the Village and all television reports will be studied to provide additional information. Also, the condition of the sanitary sewers and manholes in certain areas will be physically inspected.

The information obtained from the above procedures will be used to determine areas with infiltration/inflow problems. However, areas without apparent problems will not be eliminated from the study since sewers in apparently good condition can still be subject to infiltration/inflow. This situation exists in the newer sections of the Village where several of the houses have their footing drains connected to the sanitary sewer..

Phase II - BASE FLOW DETERMINATION

In order to quantify inflow and infiltration it will be necessary to determine base flows throughout the system. Manholes at key locations will be selected for flow measurement. After a series of dry weather flow measurements are made at these locations, a value will be assigned to the manhole denoting normal dry weather flow. House counts will also be made at this time to determine the predicted flow at each of these key manholes. Should the predicted flows vary considerably from the measured flows, the portion of the system in question will be investigated further for ground water infiltration or leaks in the lines causing exfiltration. Ground water level gauges will also be installed at this time in areas suspected of having high ground water.

Phase III - INFLOW DETERMINATION

Flow measurements to determine the quantity of inflow will be made at the manholes mentioned above during period of rainfall. When it is found that the wet weather flow is considerably greater than the dry weather flow at a key manhole, flow measurements will be made at manholes along the line in question in order to isolate the source of inflow to a particular run of sewer. Further investigations at this time will be conducted as follows:

A. Make a visual check of the manhole frames and covers on the sanitary sewer in question during rainfall and estimate the quantity of contribution of inflow.

B. Smoke test the sanitary sewer to determine if there are direct roof drain and/or storm sewer cross connections.

C. When smoke is detected in the storm sewer, simulate a rainfall condition by flooding or running dyed water into the storm sewer while measuring flows in the sanitary sewer.

D. When it is determined that considerable flow is the result of a cross connection with the storm sewer, televise the sanitary sewer during simulated rainfall conditions to determine the actual source of inflow.

E. Make a house-to-house investigation along the sanitary sewer in question to determine if sump pumps with footing drains are connected to the sanitary sewer. Calculate the capacity of these pumps and install running time meters on the pumps to determine the quantity of their contribution to inflow.

Phase IV - INFILTRATION DETERMINATION

Flow measurements to determine the quantity of infiltration will be made at the key flow measuring manholes during dry weather periods when the ground water level is high. When higher than normal flows are found, the same methods as mentioned previously will be used to isolate the source of infiltraiton to a particular run of sewer. Further investigations will then be conducted as follows:

A. Make a house-to-house investigation and install running time meters on sump pumps tributary to the sanitary sewer system as in Paragraph III D above.

B. Televise the sanitary sewer in question during high ground water conditions to determine actual location of leaks.

Phase V - PREPARATION OF REPORT

A report will be prepared which will summarize the findings of our study. This report will include the following:

A. A map showing the location of lines exhibiting an excess flow problem.

B. The actual locations and quantity of flow contributed for each source of excess flow.

C. Recommendations on a line by line basis as to remedial action which should be undertaken along with an estimate of cost. The recommendations will be based on cost comparisons using present worth values between the cost of additional treatment capacity and the cost of the rehabilitation of the sewer. Rehabilitation will be proposed only where the cost of treatment exceeds the cost of elimination.

## CONCLUSIONS

Based on the results of this analysis it is recommended that the Village proceed in the following manner:

1. That upon approval of this analysis by the United States Environmental Protection Agency's Regional Administrator, a Sewer System Evaluation Survey be conducted as outlined in this Analysis.
2. That upon completion, the Sewer System Evaluation Survey be submitted to the USEPA Regional Administrator for approval.
3. That upon approval of the Sewer System Evaluation Survey by the USEPA Regional Administrator, the recommended improvements be completed.