EPA TECHNOLOGY TRANSFER

CAPSULE REPORT

EFFICIENT TREATMENT OF SMALL MUNICIPAL FLOWS AT DAWSON, MINN.

PREPARED BY U.S. ENVIRONMENTAL PROTECTION AGENCY

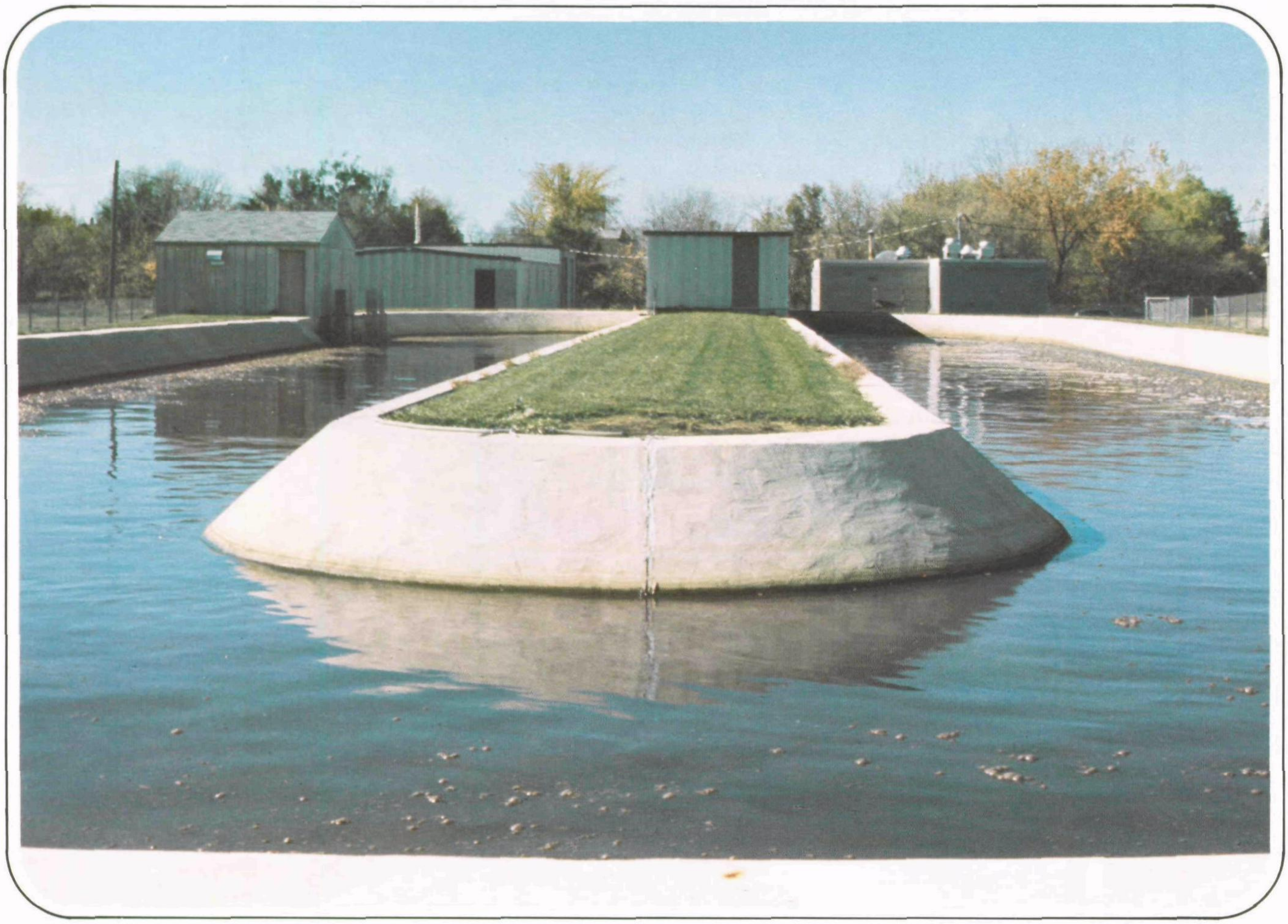
1. THE SIGNIFICANCE

Increasingly rigid water pollution control standards require, in many cases, higher degrees of sewage treatment than often provided by conventional processes. The performance of many small sewage treatment plants is frequently degraded by the discharge of large quantities of solids in the plant effluent. The solids discharges may be caused by improper plant operation, surges of raw sewage flow, or mechanical failures within the plant. These problems are particularly common to small plants which often receive limited operator attention and which are frequently subjected to severe flow variations. A survey in 1960 of extended aeration plants throughout the U.S. showed that they removed an average of 86 percent of the BOD but only 62 percent of the suspended solids found in the raw sewage. There are also an increasing number of cases where nitrification or nitrogen removal is required.

The Dawson, Minnesota, project was placed in operation in October, 1974 and has demonstrated the ability of a small plant (260,000 gpd capacity) to provide highly reliable and efficient removal of BOD suspended solids, and consistent nitrification. Under controlled conditions, nitrogen *removals* of up to 90% were also attained without the use of any chemicals. These desirable goals were achieved at reasonable costs and without any extraordinary operator attention. The Dawson project has demonstrated that small plants can meet very stringent effluent goals (BOD and suspended solids less than 5 mg/l, ammonia concentrations of 0.1 mg/l) without the use of expensive chemical treatment processes.

2. THE PROCESS

Figures 1 and 2 illustrate the process. Following screening, the raw wastewater from Dawson is pumped to an aeration channel or "oxidation ditch." The process is a modification of the activated sludge process. Aeration is provided by two floating aerators which also keep the liquid moving around the aeration channel at a velocity high enough to prevent deposition of the solids. The aeration channel at Dawson is designed so that the depth of mixed liquor can be varied from 3 feet to 4.1 feet, providing 83,000 gallons of surge storage capacity within the aeration channel. At design flows, the aeration time in the channel is 17.7 to 25.4 hours, depending upon the depth. Under the actual flows received, aeration times averaged 35 hours during a 300-day test period. The mixed liquor flows from the channel to a chamber which controls the flow to the downstream clarifiers. By use of the storage volume in the aeration channel, peak flows were reduced about 31%, stabilizing the operation of the secondary clarifiers. The mixed liquor flows to two downstream clarifiers in series. Design overflow rates are 580 and 400 gpd/sq ft for clarifiers 1 and 2 respectively. Provisions were made to feed chemicals and provide flocculation between the clarifiers to assure the stringent effluent suspended solids goal of 5 mg/l would be met. It has not proven necessary to feed chemicals. Chlorination is provided prior to discharge. Excess sludge is trucked to nearby farmland where it is spread.



Aeration Channel

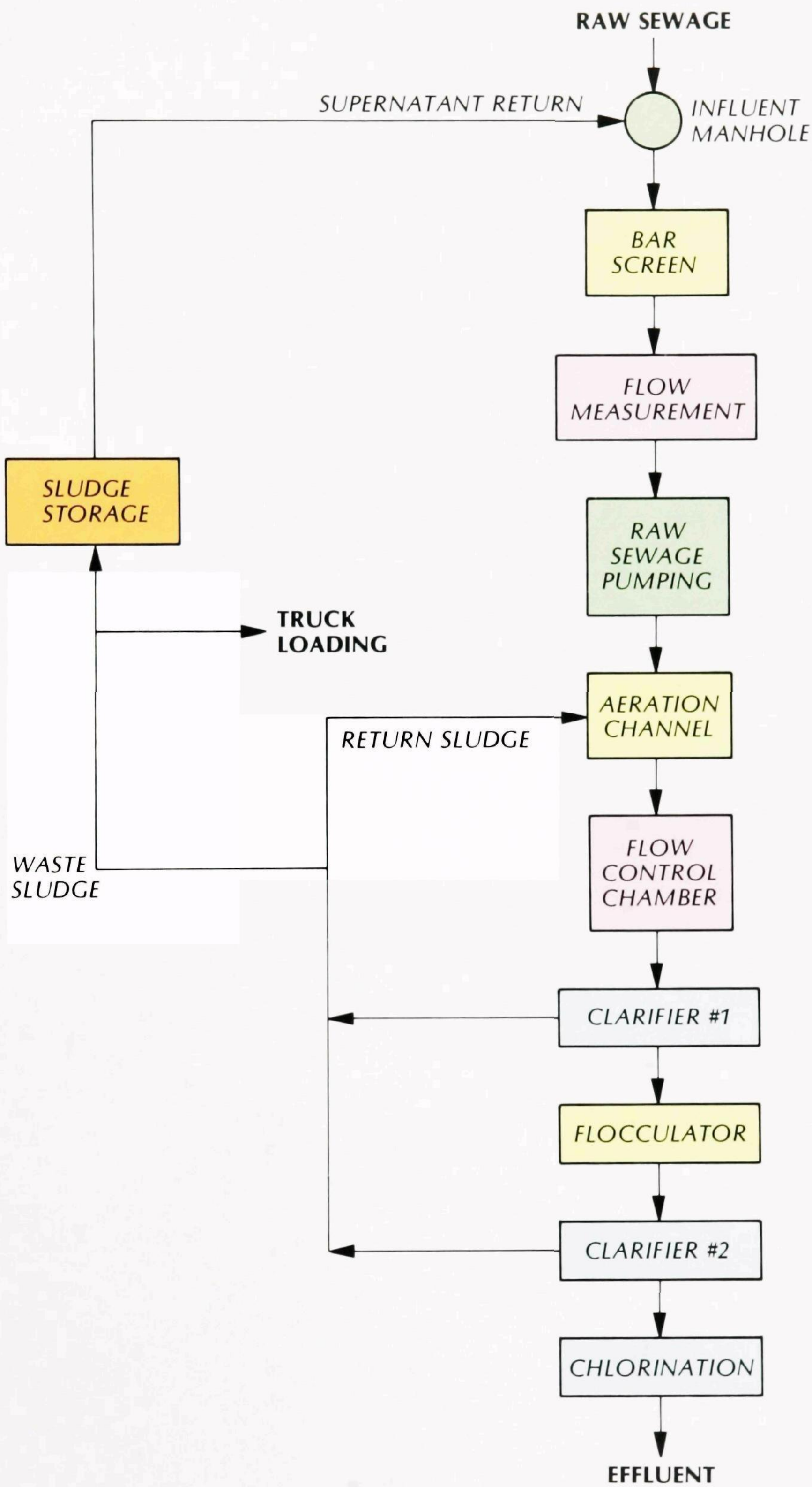


Figure 1. Process Flow Sheet

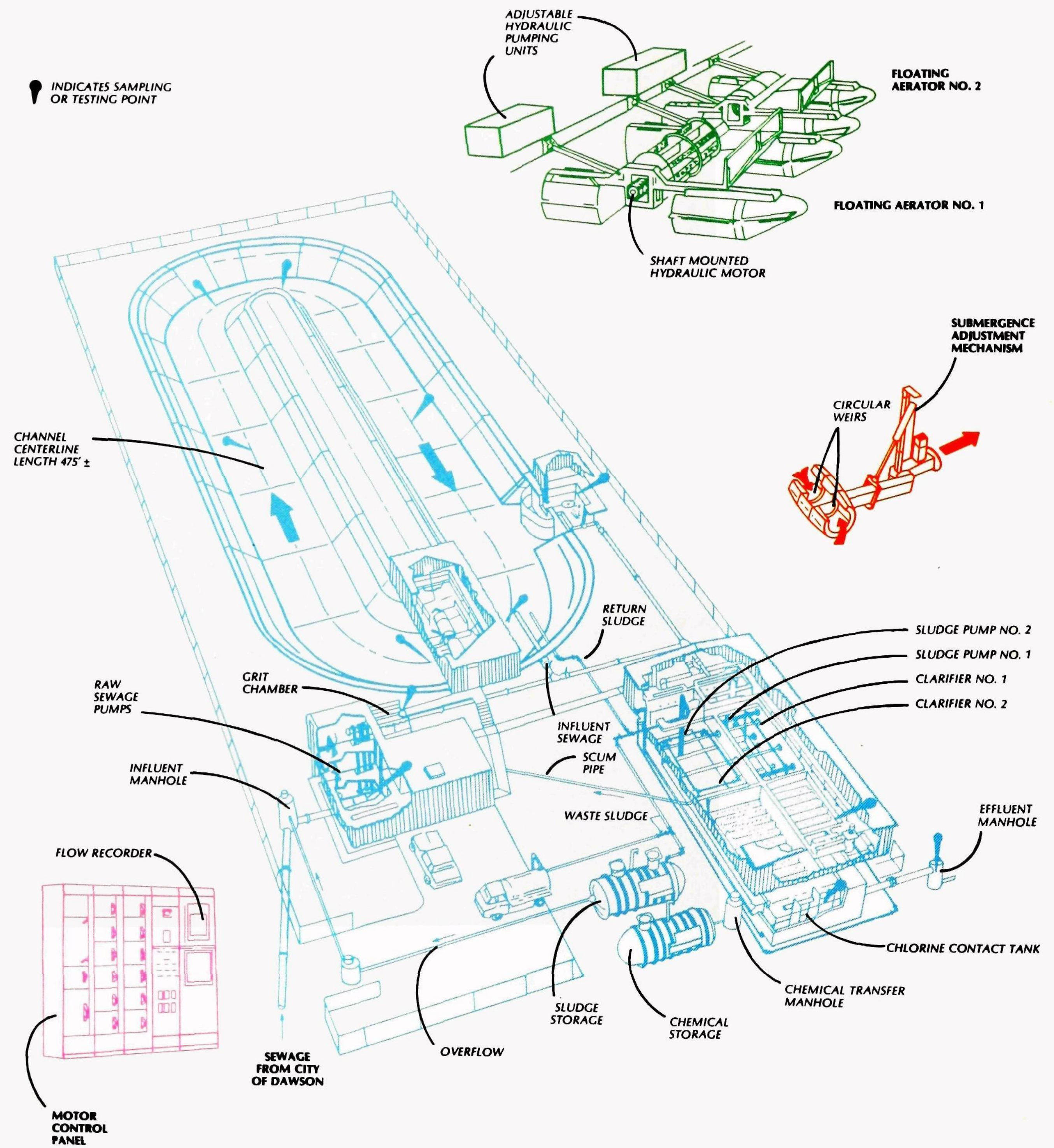


Figure 2. Dawson Treatment Plant

3. TREATMENT PERFORMANCE

The performance of the Dawson plant over the first 300 days of operation may be summarized as follows:

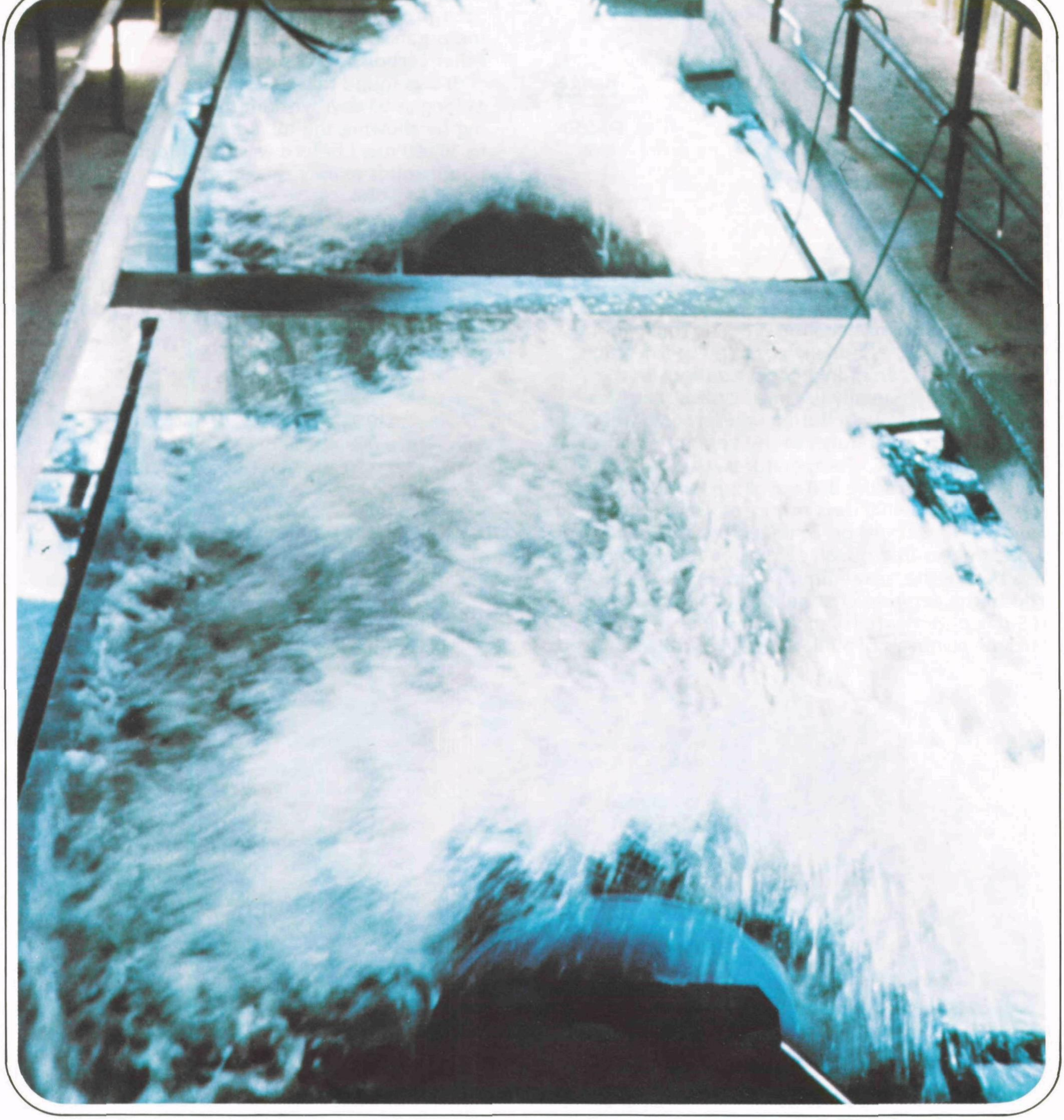
	Average	Range
BOD, mg/l		
Influent	155	60-250
Effluent	3	1-7
Suspended Solids, mg/l		
Influent	200	70-1621
Effluent	8	1-30

If only 2 days of the suspended solids data are eliminated, the average suspended solids content of the final effluent becomes 5 mg/l. Throughout the entire study, essentially complete nitrification was achieved as ammonia concentrations in the effluent were generally 0.1 mg/l or less. Nitrification was achieved even during severely cold weather when water temperatures in the aeration channel were very near 0°C. Temperatures were below 6°C for the first 100 of the 300-day study period. Sludge ages were always 20 days or more. It was found that denitrification could be achieved by careful control of aeration so that dissolved oxygen levels went to zero before the mixed liquor completed traveling around the aeration channel to the aerator. Over a 65-day period when such control was practiced, nitrogen removals of 60-80% were typically achieved with some values as high as 90%. The wastewater itself provided the carbon source for the denitrifying organisms so that no additions of methanol or other carbon sources were required.

It was found that the plant could be operated for as long as 90 days without the need for sludge wasting by allowing the mixed liquor solids to build up to 10,000 mg/l before wasting sludge. The mixed liquor solids readily settled to solids concentrations of 2.5 to 3.5%.

The high degree of treatment noted above has been consistently achieved without any extraordinary operator skills or attention. About 4 to 6 manhours per day are spent at the plant. A typical day in the life of a plant operator at Dawson includes the following duties:

1. Read influent flow meter.
2. Clean bar screen.
3. Skim settling tanks.
4. Make a visual check of all equipment to make sure it is operating.
5. Measure temperature of air, channel and settling tank contents.
6. Collect necessary samples for analysis (primarily raw sewage, MLSS and effluent).
7. Check DO of channel.
8. Check chlorine residual and set feed rate.
9. Wash down the walkways and building walls.
10. Sludge hauling (when required).
11. Cutting the grass or shoveling the snow as necessary.



Floating Aerators

4. THE ECONOMICS

Table 1 presents the construction costs of the Dawson plant both at the time of the actual bid (1971) and at an EPA sewage treatment plant index reflecting second quarter, 1976 cost levels.

Operation and maintenance costs are given in Table 2. Power costs, of course, are related primarily to the electric motors that drive the various items of process equipment. The total connected horsepower is 53 hp, not all of which is in service continuously. Heating costs relate to an oil fired furnace and hot air blower system within the control building and laboratory. This is the only structure on the plant site that is equipped with a permanent heating system. Due to freezing problems in the clarifier building, portable heater units are used at certain times during the winter months. This cost is included under miscellaneous supplies and replacement parts. Miscellaneous supplies and replacement parts included such items as a space heater for providing temporary heat in the clarifier building, three furnace repairs, replacement of a hydraulic hose on the aerators, grease and oil, cleaning supplies, lawn mower parts and similar items. There were no major repairs necessary to the process equipment items. The transportation item reflects the cost of disposing of sludge on nearby fields. The sludge is disposed of in liquid form as weather conditions permit.

Table 1

DAWSON CONSTRUCTION COSTS

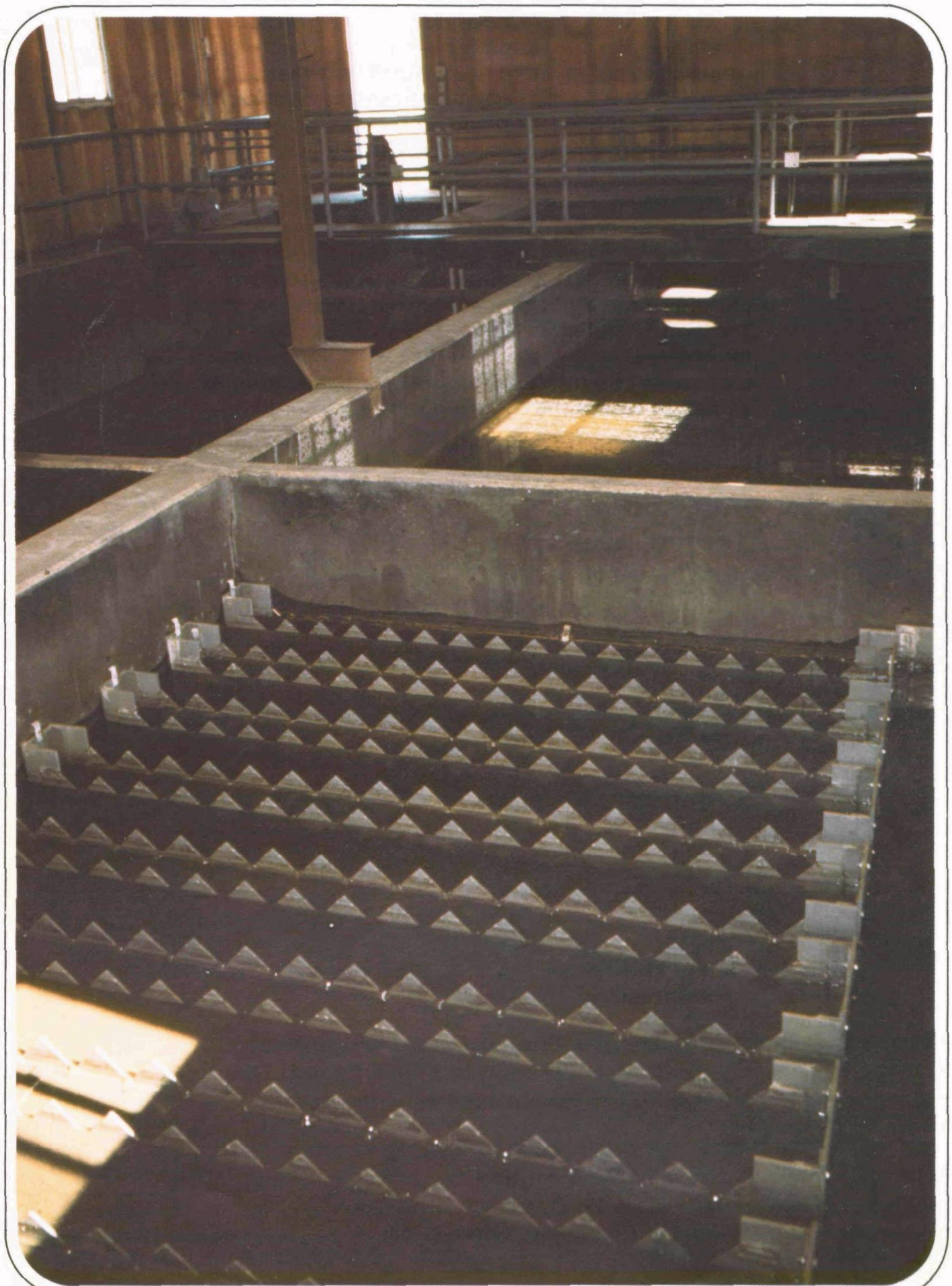
Approximate Unit Process or Item Costs	Bid Date November 30, 1971 @EPA STP Index = 166	Estimated Costs @EPA STP Index = 255
Raw Sewage Pumps and Related Items	$ 18,000	$ 28,000
Channel Aerators and Related Items	100,000	153,000
Clarifiers and Housing	65,000	100,000
Return Sludge Pumping System	12,000	18,000
Control Building and Laboratory	43,000	66,000
Other (Chlorination, Chemical Feed System)	12,000	18,000
	$250,000	**$383,000**

Table 2

DAWSON OPERATION AND MAINTENANCE COSTS [a]

Cost Item	Raw Sewage Pumping	Channel & Aerators	Clarifier No. 1	Clarifier No. 2	Return Sludge Pumping	Control Bldg. & Laboratory	Other	Totals
Power	0.5	3.6	0.1	0.1	1.2	0.5	0.2	6.2
Heating Costs						0.7		0.7
Chlorine							1.0	1.0
Misc. Supplies & Replacement Parts						2.0	0.6	2.6
Labor	0.5	1.5	1.0	1.0	1.2	6.0	2.3	13.5
Transportation							0.2	0.2
Subtotals	1.0	5.1	1.1	1.1	2.4	9.2	4.3	24.2

[a] *Average flow of 174,650 gallons per day*
Cents/1,000 gallons treated



5. AREAS OF APPLICATION

The technology demonstrated at Dawson provides a reliable, flexible, and highly efficient treatment approach applicable to many small treatment plants. This is particularly significant since about 70% of the municipal plants in the United States are less than 1 mgd in capacity. The high degrees of nitrification and of removal of suspended solids and BOD achieved without the need for chemical treatment techniques may make the approach cost-effective in many water quality limited areas. The simple, stable sludge handling aspects also contribute to the attractiveness of the process for small plants. The potential for nitrogen removal demonstrated at Dawson, although not yet fully defined, may make the process attractive for application to instances where nitrogen removal is required.

For Further Information:

Detailed information on this project is available in the form of a Final Report. This Report can be obtained by writing:

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