CHAPTER I

INTRODUCTION

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A. PURPOSE

The purpose of this manual is to inform and to instruct the treatment system personnel in the proper understanding, techniques, references, and necessary procedures for operating and maintaining the Ernest Mine Drainage Treatment Plant.

By following the guidelines recommended by this manual, the owner will be assured of an efficient, effective, continuous operation in accordance with the rules and regulations of the local governments, the Commonwealth of Pennsylvania's Department of Environmental Resources and the Federal Environmental Protection Agency.

The ultimate goal of every wastewater treatment plant is to efficiently treat the incoming waste to the greatest degree possible prior to discharge. This manual will outline the recommendations and methods permissible by the available plant equipment; to enable the plant operating personnel to evaluate the incoming and outgoing waste and to treat the incoming waste at maximum plant efficiency in an attempt to achieve this goal.

This operation and maintenance manual has been prepared in such a way as to facilitate easy and quick reference. Plant operators should conscientiously study the manual's Table of Contents to become familiar with the order of information presented. The chapters are arranged in a logical order beginning with a general introduction, general plant operation, process descriptions, laboratory testing, records, maintenance, plant safety, utility and power systems, permits and regulations, and various important documents, drawings, and charts in the form of appendices.

It is recommended that all operating personnel read the entire manual so that they will become aware of the details contained in each chapter.

B. RESPONSIBILITY

The general public slowly is becoming aware of the fact that water pollution abatement costs money and that taxation is the only method of securing revenue to provide the clean waters they desire. Since monies for operation and maintenance of water pollution abatement facilities are obtained by taxation, the taxpayer will demand that he be able to see results in the form of clean streams and lakes and improved water recreation facilities. Realizing these demands, public officials will require top performance of personnel involved in the operation of water pollution abatement facilities.

1. Managerial Responsibility

The Owner of the Ernest Mine Drainage Treatment Plant is the Department of Environmental Resources. The Owner will have a person delegated to the managerial office; this person shall be a full-time employee of the D.E.R. He may hold a title such as Regional or District Engineer or Supervisor. His responsibility shall include:

i. The maintenance of efficient plant operation and maintenance.

ii. The maintenance of adequate treatment system operation and management records.

iii. Establishment of staff requirements, preparation of job descriptions, development of organizational charts, and assignment of personnel.

iv. Providing operational personnel with sufficient funds to properly operate and maintain the treatment facility.

v. The assurance that operational personnel are paid a salary commensurate with their level of responsibility.

vi. The provision of good working conditions, safety equipment, and proper tools for the operating personnel.

vii. The establishment of a harmonious relationship with the plant operator and, inasmuch as possible, among operating personnel.

viii. The provision of job security and career ladders for operational personnel.

ix. The establishment of an operator training program and seeing that the program is implemented.

x. The provision of incentives for employees.

xi. The motivation of operating personnel to achieve maximum efficiency of operation.

xii. Making personnel aware of the importance of proper plant performance.

xiii. Making periodic inspections of the treatment system, discussing mutual problems with operational personnel, and observing operational practices.

xiv. Creating an atmosphere that will make operational personnel feel that they can bring special problems to management's attention.

xv. Maintaining good public relations.

xvi. The preparation of budgets and reports.

xvii. Planning for future facility needs.

2. Operator Responsibility

The person in responsible charge; manager, superintendent, or chief operator, will occupy the most difficult and demanding position in his employer's organization chart.

It is obvious that having all of the knowledge required will not result in good operation unless this knowledge is effectively put to use. The competent operator in responsible charge uses his knowledge to obtain top efficiency of each unit in his plant. He:

i. Obtains background information about the characteristics of the wastewater to be treated.

ii. Changes the operation of plant units to meet changing flow and load conditions so that top efficiency of each unit and the entire plant process is maintained at all times.

iii. Keeps complete and accurate records of all phases of plant operation and maintenance.

iv. Supervises, instructs, and trains subordinate personnel in operating theory and practice, maintenance, safety, record keeping, and the art of getting along with each other.

v. Prepares reports based on his operating or maintenance records for his employer and/or regulatory agency as required.

vi. Should, as the need arises, be able to communicate in understandable language with his employer, employees, the news media, service organizations, etc., on any or all subjects relating to his water pollution abatement facilities.

vii. Should prepare operating budgets and keep such records as are necessary to justify budget requests.

viii. Should, voluntarily, keep his employer advised as to the status of his plant, in relation to design factors, physical condition, changes in wastewater being treated, changes in receiving water requirements, need for plant expansion or additional treatment, etc.

ix. Should be able to prepare or assist in the preparation of capital improvement programs.

x. Should be able to inform his employer as to the regulations or laws governing his operations. He should not attempt exact interpretations or give legal opinions of these laws.

xi. Should be aware of safety hazards connected with wastewater treatment.

It is essential for the operator to make his needs and accomplishments known to his superiors.

After the plant has been in operation for several months, procedures, methods, and results should become reasonably well stabilized.

The operator should acquire a thorough knowledge of his plant, the wastewater it treats, and the effects of the effluent on the receiving stream. He should keep informed about improved operating and maintenance practices. His records should accurately reflect the results of efficient and economical treatment and they should serve as a basis for decisions on replacement of parts and future enlargements or alterations.

The plant operator should always strive to anticipate needs for increased expenditures. He should advise the proper official of these needs to permit early planning and budgeting if possible. He should be prepared at all times to give a clear account of his needs and of the condition of the plant.

There are other responsibilities which are equally important, but none is more important than the maintenance of good public relations. The operator's pride or achievement and the knowledge of the importance of his operations form a sound starting point. High morale and sense of responsibility are essential. The next building block is a stable relationship with the official to whom he is immediately responsible, a relationship based on understanding and respect. But he will merit and receive the respect of his fellow workers and the general public only after he begins to carry out fully his responsibilities.

3. Operational Knowledge

The person in responsible charge is required to have varying degrees of knowledge in many subjects.

The operator in charge should:

i. Be thoroughly familiar with his plant. He should know the function of each unit in the plant; how each unit accomplished its function; how to evaluate the operation of each unit; and how each unit fits into the overall plant process.

ii. Be thoroughly familiar with the theory and practice of the operations of his plant and to some extent those of other types of plants.

iii. Be familiar with the characteristics of the raw wastewater to be treated including changes in flow patterns, in organic and solids loadings, etc.

iv. Be familiar with and continuously informed of the best maintenance procedures. It is impossible to have good operation without good maintenance.

v. Be familiar with personnel and public relations techniques.

vi. Be familiar with budgeting procedures, operations cost accounting and capital improvement program estimates.

vii. Be familiar with local, state and federal laws which may apply to the operation of the plant.

viii. Participate in short courses and schools when available.

ix. Subscribe to and regularly read several of the periodicals related to acid mine drainage treatment or chemical waste treatment.

xii. Make personnel aware of the importance of proper plant performance.

xiii. Make periodic inspections of the treatment system, discussing mutual problems with operational personnel, and observing operational practices.

xiv. Create an atmosphere that will make operational personnel feel that they can bring special problems to mangement's attention.

xv. Maintain good public relations.

xvi. Prepare budgets and reports.

x. Plan for future facility needs.

4. Operator Incentives

There are numerous reasons why a person might become interested in water pollution abatement operations. Among these reasons are:

i. There is a definite need for competent personnel.

ii. Persons in responsible charge of water pollution abatement facilities are recognized as community leaders.

iii. There is a feeling of satisfaction and pride in maintaining clean, useful streams.

iv. Many wastewater treatment plants are community show places.

v. Pay scales are attractive and, as public awareness increases, pay scales will rise.

vi. Operation of wastewater treatment facilities provides a continuing challenge. The job never becomes dull or monotonous.

vii. Many of the advances in wastewater treatment have been accomplished by plant operators.

viii. There are no seasonal lay-offs. Water pollution abatement is a seven-day-a-week, 52-week-a-year job.

ix. Although water pollution problems are almost as old as civilized man, water pollution abatement is a fairly new science. There is a continuing and growing demand for technically competent personnel.

C. TYPE OF TREATMENT

The Ernest Mine Drainage Treatment Plant is a wastewater treatment facility that is commonly known as a lime neutralization plant. The reason for this description is that basically lime is added to the raw wastewater, that is high in acidity (low pH), to lower the acidity to a point that is acceptable to the receiving waters. In this case, McKee Run which is tributary to Crooked Creek.

During the neutralization process the acidity is completely removed and sufficient lime is added to make the liquid alkaline (high pH). This is done to permit the iron in the raw wastewater to be removed in the wastewater treatment plant processing.

D. FLOW PATTERNS

The flow patterns through the treatment plant are shown schematically in Chapter XI, Appendix A, of this manual. Sheet 8 of the Construction Drawings also give a partial schamatic of the plant operation. Some detailed schematics are also shown on sheet number 28 of the Construction Drawings. The graphic display on the Operating Console also has a schematic flow pattern. A brief description of each process flow pattern is provided here. A more detailed description is given in Chapter III of this manual.

1. Raw Water

Raw water is mine drainage from an abandoned mine. The mine drainage for this plant is also termed herein as wastewater. This water is pumped from an abandoned ungerground bituminous coal mining operation known as the Ernest Mine. There are six (6) raw water pumps each individually controlled via electrical equipment located in an

electrical control center; each pump is mounted in one of the coal mine headings via a vertical casing from the ground surface to the mine opening below; and each pump is fitted with its own discharge pipe to the plant influent flumes located on the second floor of the Control Building.

The raw water comes from a dual entry mine heading. The raw water discharge from the pumps is split into two directions at the raw water flumes in the Control Building. Pump numbers 1, 2 and 3 discharge into one flume while pump numbers 4, 5 and 6 discharge into the other flume. Fume number 1 (discharge of raw water pumps 1, 2 and 3) discharges to flash mixer number 1 and ultimately passes through one-half of the plant process becoming mixed with the processed raw water that goes through flume number 2 (discharge of raw water pumps 4,5, and 6) in the final tank just prior to discharge to the receiving stream.

2. Flash Mixing

All the raw water enters either flash mixer number 1 or Flash Mixer number 2. Generally one-half of the total raw water pumped will enter each Flash Mixer. Lime slurry is added to the treatment process at the Flash Mixer. The sump pump also discharges to the Flash Mixers.

In the Flash Mixers, the lime slurry is thoroughly mixed with the incoming liquor (raw water and sludge recirculation) by the use of a mechanical mixer. The mechanical mixer is center mounted with a submerged impeller which churns the mixing tank contents at such a rate of speed so that a high degree of mixing occurs.

Sludge from the Clarifier can also be recirculated in part or totally through the Flash Mixers. At the Flash Mixer the treatment process is already split and only the Clarifiers following the particular mixer can be recirculated to that mixer.

3. Aeration

Two (2) Aeration Tanks are available for use; one for each split process. The Aeration follows the Flash Mixing so that the wastewater has already been converted from an acidic to an alkaline condition (lime has been added and thoroughly mixed).

In the Aeration Tanks, sufficient air is added to the liquid to cause the subsequent settling of some suspended solids and practically all of the dissolved iron by converting ferrous iron (soluble state) to ferric iron (insoluble state). The tank contents are kept in agitation via a combination aerator-mixer so that precipitation will not occur in the Aeration Tank. Air is introduced both via the motorized aerator-mixer mounted on the tank and from the blowers located on the second floor of the Control Building.

Sludge from the Clarifiers can also be recirculated in part or totally through the Aeration Tanks.

Air is partially furnished by two (2) blowers located on the second floor of the Control Building. The remaining air is introduced by the mechanical aerators. Only one blower will operate at a time as the other unit is electrically locked out. Air is piped to the Aeration tanks and the amount of air to each tank is measured. Each tank is fitted with removable diffusers which are simply pipes with holes drilled into them to permit the release of air in a pattern around the tank perimeter near the tank bottom. Each tank is also fitted with a fixed air diffuser mechanism (pipe with holes) fastened to the tank floor immediately under the Aerator.

4. Settling

Four (4) Settling Tanks receive the wastewater from the Aeration Tanks; one Aeration Tank supplying two Settling Tanks. Settling tanks are sometimes called clarifiers and these terms are used interchangeably throughout this manual.

In the settling tanks the wastewater velocity of flow is reduced such that the previously prepared liquid will settle out all the material that will precipitate. This settled material is called sludge and is primarily a combination of iron and lime.

The settled material (sludge) is scraped to the tank center along the tank bottom, transferred to the waste sludge box, located at the tank perimeter, via a submerged pipeline and then either recirculated with a submersible pump or a portion drawn off to waste.

The Settling Tank effluent flows via the radial fiberglass launders (7 per tank) along the water surface to the trough at the center of the tank. From the center trough an outlet launder (8th radial launder) carries the tank effluent to the effluent box where it is then transferred via underground piping to the Final Tank, then to McKee Run, the receiving stream.

5. Lime Handling

Lime will be delivered to the plant via bulk type lime trucks. The lime will be in the form of pebble quicklime. Hydrated lime may be used in an emergency. The trucks must be equipped with unloading equipment to get the lime into the Chemical Storage Bins approximately 53 feet above the unloading area.

When filling the Chemical Storage Bins, the operator must activate the bin vent filter on the bin. This is done with the switch near the loading dock doorway. The bin vent filters will require manual cleaning, and perhaps changing, periodically.

Lime is to be stored in the two (2) Chemical Storage Bins until ready to be used in the plant. Monitoring of this storage is essential to assure an adequate supply at all times.

The flow of lime will be down through the Chemical Storage Bin hopper (equipped with aeration equipment to prevent caking and/ or bridging) and out the bottom of the hopper. In the case of the third slaker (standby unit) lime may be drawn off from either bin via a conveyor system connected to the Chemical Storage Bin hoppers.

Each Chemical Storage Bin is fitted with a gate at the bottom to start and/or stop the flow of lime. A flexible coupling is also provided under the Bin to prevent the Bin weight from bearing on the equipment under the Bin.

Lime moves from the Bin to a Lime Feeder located directly under the Chemical Storage Bin. This feeder is adjustable and may require adjustment periodically.

Each Lime Feeder discharges to a Lime Slaker located directly under the Lime Feeder. The Lime Slaker mixes water with the lime to produce a liquid called Lime Slurry. The Lime Slaker also removes impurities that may be in the lime. These impurities are called Grit. The grit will be discharged into containers placed on the control room floor by the operator. Grit will be taken to a sanitary landfill for ultimate disposal. A trolley type hoist has been provided which may assist in the handling of the grit containers. The Lime Slaker is adjustable and may require adjustment periodically.

6. Lime Slurry Handling

Lime Slurry is made in the Lime Slaker. Each pound of lime will make about 1.25 pounds of 10% lime slurry. Three (3) slakers are provided. It is expected that two (2) Slakers will be operating together with the third Slaker as a standby unit. However, each slaker has the capacity of supplying a full compliment of Lime Slurry for the entire plant.

From each Slaker the Lime Slurry is discharged to one of three Lime Slurry Vats located on the first floor of the Control Building. From the Lime Slurry Vat the Lime Slurry is pumped (using progressing cavity type pumps) to two Lime Slurry Tanks located on the second floor of the Control Building. Excess Lime Slurry is returned to the Lime Slurry Vat and the Vat liquid level paces the Lime Slaker. The excess Lime Slurry provides recirculation and sufficient liquid velocity to reduce clogging. In an emergency, lime slurry will overflow the Lime Slurry Tanks into the Flash Mixer.

From the Lime Slurry Tank (there are two of these) the Lime Slurry flows by gravity to a Lime Slurry Feeder which then feeds the Lime Slurry to one of the Flash Mixers. There are three (3) Lime Slurry Feeders, two to be used together with the third one as a standby unit. Each Lime Slurry Feeder is adjustable so that different amounts of Lime Slurry may be introducted into the Flash Mixer. An overflow from the Lime Slurry Feeder returns excess Lime Slurry to the Lime Slurry Vat located near the Slaker on the Control Building first floor. The Lime Slurry Feeders are controlled by means of pH sensing units located in the effluent of the Flash Mixers.

7. Sludge Handling

Sludge is handled in two (2) ways: (1) recirculation and (2) disposal. The disposal flow pattern is described here, the recirculation pattern is described in paragraph 8, following this paragraph.

Sludge is the precipitated material in the Settling Tank. There are four (4) Settling Tanks. The sludge as it settles to the bottom of the tank is scraped to the center of the tank bottom where it then travels by gravity to the sludge waste box at the Settling Tank perimeter.

Draw-off from the sludge waste box is via a pipe fitted with an electrically operated plug valve. Flow is by gravity using the head of liquid in the Settling Tank to create a flow condition. The draw-off quantity is adjustable by opening and closing the electrically operated plug valve. The sludge drawn-off (waste sludge to be removed from the plant and disposed) flows through an open fiberglass trough through a parshall flume (where the quantity is measured) into the Sludge Well.

From the Sludge Well the waste sludge is pumped with a submersible type Sludge Pump through a six (6) inch fiberglass force main about 1300 feet to a point where the sludge discharges into the underground abandoned coal mine. The Sludge Pump is a variable speed unit and will automatically waste all the sludge that enters the Sludge Well regardless of volume. The pump should always be set in the "Automatic" position which will permit the pump to speed up as the sludge well liquid level rises and slow down as the sludge well liquid level lowers.

8. Sludge Recirculating

There are four (4) Sludge Recirculating Pumps; one at each Settling Tank. Each pump is controlled by a variable frequency electrical drive controller with speed selection by the plant operator.

The plant operator has a choice of recirculating sludge to various points along the flow pattern of the liquid being treated. The options are (1) No Recirculation, (2) recirculate to the Flash Mixer, (3) recirculate to the Aeration Tank (4) Recirculate to the inlet of the settling tank and (5) various combinations of the above. The recirculation quantity to the Flash Mixer is measured with the electrically operated instrumentation provided. Measurement of sludge recirculation at all other points is done by measuring the sludge flow depth with a ruler and picking the flow from a chart fitting the primary measuring device (rectangular channel, flat crested weir, parshall flume, etc.).

Recirculation to any of the various points mentioned above must be done manually with the rate measured and calculated by the operator. Recirculation is used to affect the treatment process. The quantity and location of recirculation has to be programmed for each individual plant at the different rates and points which best suit the process. This is due to the variables found in mine drainage.

9. Utility Water

Utility Water is water taken from the plant effluent. This water originated in the mine and went through the treatment plant process. The source of this water is the Final Tank.

The Utility Water (wastewater treatment plant effluent) may at times not be suitable for its intended use; therefore, provisions have been made to use city water for Utility Water. The determination on the use of Utility Water will be made by utilizing a chemical analysis of the water. High sulfate content in the wastewater effluent may render it unusable for slurry purposes.

Utility Water is furnished via two (2) vertical turbine pumps located in the Final Tank. The water is pumped to a hydropneumatic tank which will balance the utility water system. The hydropneumatic tank has an automatic air-water mechanism that maintains a preset pressure range and air-water ratio in the tank.

Utility Water is used for the following purposes:

a. Hydrants - Yard hydrants to be connected with a hose and nozzle and hose down the structures for cleaning.

b. Sludge Wells - For dilution of waste sludge which will clean out the force mains to the disposal pit.

c. Hose Bibbs - For cleaning floors and spills in the Control Building.

d. Slakers - Water for making lime slurry (this only if water quality is suitable).

e. Lime Slurry Pumps - To periodically clean out the Lime Slurry Pumps and pipelines to the Lime Slurry Tanks.

f. Lime Slurry Feeders - To periodically clean out the Lime Slurry Feeders and their related pipelines (requires manual hook-up).

10. Potable Water

Potable Water at the plant comes from the public water supply system serving the Borough of Creekside. The Borough's water supply is adequate but not overabundant so the operator should use this water conservatively. During the dry season restrictions may be placed on the use of this supply.

Potable Water is used in the laboratory, toilet, water cooler, and the service sinks. As mentioned earlier this water may be used in place of utility water by making a temporary connection with backflow preventer between the two piping systems. The operator may desire to utilize this source for slaking water (making lime slurry).

11. pH Meters

pH sensors are provided at each Flash Mixer effluent to monitor the pH of this liquid. The pH at this point must be between 6.5 and 8.5 with a pH of 8.0 desirable. The pH instrumentation is connected to pace the Lime Slurry Feeders to assure maintenance of proper pH. Recording and indicating of the pH is done in the operating console.

12. Instrumentation

Measuring devices, with their receivers located in the operating console are provided as follows:

i. Two (2) flow meters for measuring the raw water pumped

ii. Two (2) flow meters for measuring sludge recirculation to the Flash Mixers or Aeration Tanks when the Flash Mixers are bypassed.

iii. Four (4) flow meters for measuring the sludge wasted

iv. Two (2) pH meters for monitoring the Flash Mixer effluent.

v. Two (2) flow meters for measuring the air from the blowers to the Aeration Tanks.

vi. One (1) indicator for showing mine water level

Indicating devices located in the operating console for various items of equipment operation consist of:

i. Elapsed time meters which give total running time of equipment

ii. Ammeters which give amperage draw of equipment

iii. Lights which provide one color for running and another color for malfunction

iv. Tachometers which give revolutions per minute of revolving equipment

Some areas have been provided with a primary measuring device with no instrumentation. For these areas the plant operator will have to take a manual measurement (generally with a ruler) and compute the flow via mathematical formula or read from a chart or nomograph. These areas are as follows:

i. Rectangular channels for sludge recirculation

ii. Flat crested weirs on several processes

iii. "V" notch weirs on settling tank outlet launders