REPORT ON
PROPOSED ACID MINE DRAINAGE TREATMENT PLANT
HORSESHOE CURVE AREA
CITY OF ALTOONA WATERSHED
BLAIR COUNTY1968

I.INTRODUCTION

The Commonwealth of Pennsylvania Department of Mines and Mineral Industries engaged Gwin Engineers, Inc. to prepare a preliminary design report complete with recommendations and cost estimates for a Proposed Acid Mine Drainage Treatment Plant to treat mine drainage discharges in the City of Altoona watershed area

II. THE PROBLEM

General

The City of Altoona is situated in South Central Blair County and is bordered on the west by the Allegheny Mountains and on the east by one of the ridge and valley sections of the Allegheny Front. Until recent years, the major locomotive and car building and repair shops for the entire Pennsylvania Railroad System was in Altoona, the largest community in Blair County with a population in 1960 of 69,407.

The City of Altoona, like many other communities, has been faced with the problem of supplying an adequate quantity of potable water to meet the limiting factor is quantity, the City of Altoona has a problem of water quality. A review of the various watershed areas and conditions indicate that, due to the inability of the water to meet the minimum requirements for a public water supply, the City is able to use only about 50% of the runoff normally expected from watersheds of this size.

Water Quality Criteria and Problems

The minimum quality standards for a public water supply are set forth in the 1962 edition of "Public Health Service Drinking Water Standards" published by the United States Department of Health, Education and Welfare, Public Health Services and adopted by the Pennsylvania Department of Health in their Regulations issued in 1963.

These standards set the maximum limits of iron, manganese and sulphate as follows:

Iron	0.3 mg/l
Manganese	0.05 mg/l
Sulphates	250mg/l

The following analyses were obtained at City Hall from samples of the Altoona City Water:

Iron	0.6 mg/l
Manganese	2.5 mg/l
Sulphates	135mg/l

It is obvious from the above results that the amount of iron in the system runs about twice that allowed and the manganese as high as fifty times that allowed by the maximum standards set forth above.

As far as is known, humans suffer no harmful effects from waters containing iron and manganese. But such waters, when exposed to the air so that oxygen can enter, become turbid and highly unacceptable from the aesthetic viewpoint. Iron and manganese in waters also create several other problems:

1. Iron produces yellowish-brown to reddish-brown stains and manganese causes gray to black stains on white goods such as bathtubs, glassware, porcelain dishes and clothes. These stains are very difficult to remove and are the cause of numerous complaints.

2. Iron and manganese compounds deposit in pipelines, reducing their carrying capacity. Organic deposits containing iron and manganese also peel off the interior of pipes at inconvenient times causing "red" and "black" waters, However, iron and manganese are capable. of buildup in pipelines with no immediate deleterious aspects other than constriction of flow,

3. Iron and manganese tend to favor the growth of iron and manganese micro-organisms popularly lumped together under the designation "Crenothrex" or "iron bacteria". These growths clog pipelines, meter fixtures, nozzles, re-circulating systems, and other water handling equipment cutting down flow-rates and frequently breaking loose in large masses which, as they decompose, import objectionable tastes and odors to the water.

In addition to the iron and manganese problem, the supply contains free acid in amounts up to 50 ppm, Aside from the obvious fact that the acid is detrimental to the stream and reservoir life, acid conditions prevent the bio-oxidation of natural and man-made organic pollutions by most micro-organisms; thus placing even greater organic loads on the streams entering the reservoirs.

Cause of Quality Deterioration

It appears that the major cause for the deterioration of the water quality is the extent to which various mining operations have progressed on the City's watersheds. Research of existing records and plans indicate that mining has been carried out on the Horseshoe Curve Area watershed for about 70 to 80 years. In addition, coal stripping operations began on the Kittanning Run watershed prior to the second World War and are continuing at this date

The watershed areas available to the City of Altoona are shown on Exhibit No. 7; and are shown in Table 1, together with the amount of area on each drainage basin affected by mining programs.

Table 1.

	Area Sq.Mi.	Used Sq.Mi.	Affected Stripping Sq. Mi.	No. of Mines Open	No. of Mines Draining	Coal Outcrop (miles) Total	Coal Outcrop (miles) Draining
Horseshoe Curve Area							
Glen White	8.05	8.05*	0.40	28	14	20.7	4.6+
Kittanning Run	4.00	0	0.66	19	8	10.0	5.0+
Scotch Run	1.34	0	0	0	0	0	0
Mill Run	4.26	4.26	0.21	3	0	4.7	2.5+
Allegheny Reservoir	2.09	2.09	0	0	0	0	0
Homers Gap	2.60	2.60	0	0	0	0	0
Sugar Run	4.19	0	0.53	22	9	17.2	4.0+
	26.53	17.00	1.80	72	31	52.6	16.1+

* Used except for mine drainage by-passed by special drains and during high flows when excessive turbidity occurs.

+ Estimated from contour, strike and dip of coal.

From the above it can be seen that, of the total watershed area presently available to the City, only seventy-six (76) per cent can be used for water purposes while the areas above the Horseshoe Curve only sixty (60) per cent can be used.

Although it is impossible to determine what the conditions of the streams and watersheds were prior to the beginning of mining operations, it seems safe to say that, because of the long coal outcrops which slope into the streams, they were acid and contained some iron and some sulphate However, there is no question that the various phases of the mining operation have caused serious degradation in the quality of these streams. Further, except for high turbidity during heavy runoff, there appears to be no appreciable difference between deep mining and strip mining other than the ease with which mine drainage might possibly be by-passed.

Need For Correction

As shown on Table No. 1 above, the City of Altoona has a total watershed area of 22.34 square miles, of which 13.39 square miles drain into the Horseshoe Curve Area. The three (3) reservoirs located below the Horseshoe Curve are capable of supplying approximately 4.5 million gallons per day or 70% of the daily average metered water usage of approximately 6.64 million gallons per day based upon the last twelve (12) months (July 1, 1967 to June 30, 1968). However, the present situation at the Horseshoe Curve is that these reservoirs are fed only from Glen White Run except during periods of high turbidity when this stream is by-passed. The flow in Kittanning Run is by-passed during normal flow and discharged into Burgoon Run below Lake Altoona. The major problem occurs during storm conditions when the flow from Glen White Run is also by-passed because of high turbidity. Table 2 following shows the average chemical analyses of these streams and the condition of the streams during periods of normal flow.

Table 2.

	Glen White Into Reservoir	Sugar Run	Kittanning Run	Mill Run Into Reservoir
pH	3.8	3.5	2.9	7.1
Alkalinity	0	0	0	16
Acidity	60	140	420	0
Iron	5.5	12	70	0.2
Manganese	3.3	2	11	0
Sulphates	195	300	---*	10
Hardness	126	168	---*	2
Total Solids	260	650	919	84
Suspended Solids	4	6	14	2

(Results are expressed in mg/l)

* Color Interference

The above results were determined by Gwin Engineers, Inc. from samples obtained for the research described in Appendix B. Data from the other streams supplying potable water to City's reservoirs were not included as they are not affected by mine drainage.

The above analyses show that the Kittanning Run water could not be used by the City without extensive treatment facilities. The City is presently using the Glen White Run water to feed its distribution system; however, the quality is continually deteriorating with time.

In addition to the sources of potable water presently available to the City of Altoona, the chemical analyses of Sugar Run has been included in the above table. Sugar Run is located south of the Horseshoe Curve Area and flows in an easterly direction into Burgoon Run where it combines with Kittanning Run flow and the discharge from the Horseshoe Curve Area Reservoirs. Mining operations on the Sugar Run watershed have greatly reduced the quality of water discharged to the stream In fact, the major tributary feeding Sugar Run has its origin in. strip mined areas,

The Sugar Run watershed is the last watershed of significant size which could be made available to the City of Altoona. With the construction of the necessary pipeline and. intake system approximately 400 square miles of watershed would be available to the City of Altoona. However, as the above table shows, Sugar Run water will also need extensive treatment prior to use by the City as a public water source.

Method of Correction

As stated above, the water now furnished the customers does not meet the minimum quality standards for a Public Water Supply. There are a number of different methods which might be adopted by the City of Altoona to improve the quality of the water now being used.

We feel that any approach to this problem should take into consideration the status of the existing system with respect to quality and quantity. Consequently, we feel that a Water Treatment Plant should be constructed at the Horseshoe Curve Area and be sized to treat the supply from these reservoirs, from Kittanning Run, from Sugar Run and from Mill Run. Treatment facilities located here would add approximately 8.00 square miles of watershed to that presently available to the City for potable water and would improve the quality of the existing supply.

III. DESCRIPTION OF PROPOSED WATER TREATMENT PLANT

Purpose

The purpose of the proposed water treatment facilities is twofold: first, the treatment of acid mine waters (Sugar Run, Glen White Run and Kittanning Run) to stream quality standards; second, the treatment of stream quality water to public water supply standards. The primary or acid mine water neutralization phase will consist of flash mixing, coagulation and flocculation, aeration, and clarification. The secondary or potable water treatment phase will consist of lime-soda ash softening including mixing, coagulation and flocculation, and clarification followed by filtration with facilities for pH adjustment and disinfection.

Site Development

The proposed water treatment complex will be located on City of Altoona Watershed on approximately nine (9) acres of wooded land between the Impounding Dam and Lake Altoona in Logan Township, Blair County. The location will be at an elevation sufficient to permit gravity flow from the treatment plant to the City of Altoona's low service distribution system; however, it will be necessary to pump to the high service distribution areas. In addition, the proposed site was selected on the basis of the availability of the different water sources to be. treated and the existing water transmission mains which feed the City of Altoona's distribution system.

In order to develop this site, it will be necessary to relocate the existing Impounding Dam spillway overflow channel and to construct a new access roadway. The course of the present spillway channel, which conveys the overflow from the Impounding Dam into Lake Altoona, carries it through the center of the nine (9) acre tract. To make available a larger area for construction, it is proposed to construct a new, improved channel along the northern edge of the site. The channel will be lined with a concrete fabriform mattress to prevent erosion of the channel bottom and sides, In addition, reinforced concrete retaining walls will be constructed along the proposed spillway channel immediately below the spillway to prevent the water from leaping the channel sides and flooding the site due to a hydraulic jump which will occur at the junction of the spillway and channel.

Because of the lack of sufficient width and an adequate roadway surface, the existing access road to the plant site will not accommodate the bulk chemical supply trucks. The present roadway also enters the proposed plant site opposite to the normal direction of incoming and outgoing traffic, thus creating traffic hazards The proposed access roadway will be located as shown on Exhibit-Nom 2 and will consist of a 24-foot roadway surface and a structure to span the spillway channel.

<u>Treatment Plant Water Supply</u>

The sources of water supply to the primary phase of the proposed treatment plant will be Glen White Run, Sugar Run and Kittanning Run. The chemical characteristics of these sources are discussed in detail in Appendix B of this report. Under. present conditions the flow from Glen White Run discharges into Kittanning Point Reservoir, which overflows into the Impounding Dam. It is proposed to mix Sugar Run water in the Impounding Dam by construction of an intake structure in Sugar Run and a 30-inch transmission main to convey the Sugar Run stream supply across the mountain into the Impounding Dam. The intake structure will be located at an elevation to permit gravity flow. The combined waters from Sugar Run. and Glen White Run will then flow by gravity to the proposed treatment plant through the existing 24-inch transmission main presently supplying potable water from, the Impounding Dam to the City of Altoona's low service distribution system.

The other source of raw water for the primary treatment plant will be Kittanning Run. A catchment will be constructed in the Kittanning Run by-pass channel to provide an intake for the pipeline to the acid mine drainage neutralization facilities. The elevation of water behind the intake structure will be controlled to insure a full feed pipeline at all times. However, to prevent a flooding condition from occurring in the channel during periods of high rainfall on the Kittanning Run watershed, a by-pass will be installed.

Acid Mine Drainage Neutralization Facilities

The neutralization treatment facilities will be designed to treat 15 million gallons per day of acid mine waters. The design flow is based upon a study of the rainfall and stream flow records as discussed in Appendix A. The treatment units will be constructed in duplicate and operated in parallel with the necessary crossover connections provided for maintenance and mechanical equipment repair. Parallel operation of the primary treatment units will permit separation of the two feed sources throughout the entire neutralization process.

Flow segregation is indicated since from a treatment procedure and an economic standpoint Kittanning Run water does not lend itself to treatment to potable water standards unless blended with water containing lesser concentrations of iron, manganese, hardness and solids. Therefore, the normal operating procedure will be to treat the Kittanning Run water to meet stream quality standards for acid mine water discharge and use it as stream release, while the Glen White Run-Sugar Run mixture will receive secondary treatment to meet potable water quality standards. Provision will be made for blending the Kittanning Run flow with the Glen White - Sugar Run flow during periods when the Impounding Dam level is down.

The raw water will flow into two (2) square concrete flash mix basins 14'-0" x 14'-0" x 7'-6" side water depth. The mixer mechanism will be operated by a twenty (20) horsepower motor and will be capable of mixing re-circulated sludge from the sedimentation basins, coagulating chemicals and raw water. The flash mixer will disperse the coagulating agents and returned solids uniformly throughout the raw water, so that contact with suspended particles in the raw water is insured prior to the completion of the reactions. The mixing of coagulating chemicals and raw water in the presence of previously formed sludge or floc particles is incorporated in the design since research has shown that this practice promotes flow formation and growth.

The overflow from the flash mix tanks will flow into the slow mix or flocculation units. The grouping and compacting of the coagulated particles into larger assembles or floc particles will be accomplished in these basins by gentle stirring. A turbine-reactor driven by a five (5) horsepower motor will be installed in each of the eight (8) 15'-0" wide x 15'-0" long x 12'-0" side water depth to provide the required mixing rate. The cells have been sized large enough to prevent deposition of floc.

The water leaves the slow mixing chambers by overflowing a weir into a trough connecting the flocculation basins with the aeration tank. The aeration tank will consist of e 38˚-0" x 76'-0" x 14'-0" SWD retangular tank, divided in half end the halves operating in parallel. To oxidize the ferrous iron into the ferric state two (2) mechanical surface aerators will be installed for transferring oxygen from the atmosphere into the waste water. At the same time the aerators provide mixing to disperse the oxygen end keep the floc particles in suspension.

The aerated water will flaw into the sedimentation basins where it will have e retention time of 4 hours et average design flow. The cylindrical sedimentation tanks will be operated with the feed entering e center feedwell, settled solids being raked to center bottom cones end the overflow being collected in e peripheral launder. Sludge discharge pumps will be mounted on the centerwell superstructure for pumping the underflow up through the center column; thus, eliminating the underflow piping end tunnel beneath the sedimentation units. The sludge pump discharge pipe will be supported on top of the access walkway.

A controlled portion of the settled sludge, based upon actual plant operation, will be returned to the flesh mix basins end mixed with the coagulating chemicals end raw water. The remainder of the settled sludge will be pumped to the waste sludge thickener for additional concentration end subsequent disposal.

The effluent from the sedimentation basins will meet the minimum requirements of the Commonwealth of Pennsylvania Sanitary Water Board for stream release of acid mine waters (see Appendix B). These rules end regulations allow no more then 7.0 milligrams per liter of iron, limit the pH between 6.0 end 9.0 end require the alkalinity to exceed the acidity. To meet the requirements of the Commonwealth of Pennsylvania Department of Forests and Waters for stream release, the primary treated Kittanning Run water will be returned to Kittanning Run. During high flow conditions when the quality of Kittanning Run improves or when the level in Lake Altoona drops, the excess neutralized Kittanning Run water will be discharged to Lake Altoona. The primary treated Glen White Run - Sugar Run mixture will flow to the secondary or potable water treatment facilities.

Potable Water Treatment Facilities

The stream quality water from the sedimentation basins will be blended with Mill Run Reservoir water and the return flow from Lake Altoona and will flow into the lime-soda softening units. The Mill Run feed will be conveyed to the treatment facilities by means of a proposed transmission main with a design capacity of 5 MGD. A new pipeline will also be constructed to connect Lake Altoona to the treatment plant. The control of the quantities of feed from the different sources will by discussed in a later section of this report.

Based upon the water demand data compiled from City of Altoona Records, the potable water treatment facilities will be designed to treat an average flow of 7 million gallons per day.

The lime-soda softening units proposed are commonly referred to as "solids contact units" and consist of chemical addition, mixing, flocculation in the presence of a previously formed flow, separation of the clarified water from the sludge in vertical flow tanks, sludge concentration, sludge thickening and sludge removal in a single unit. The softening and clarification units will be constructed in duplicate and operated in parallel. Each unit will be cylindrical and provide a detention period of 110 minutes.

The influent will enter the reaction zone in the middle of the primary reaction well. A turbine will mix the raw water with previously formed floc and treatment chemicals (see Appendix B for chemicals and dosages), which will be added in the influent pipe at the point of entry into the tank. Research has shown that it will be necessary to use a coagulant aid to increase floc size and strength. Further re-circulation will occur in the secondary reaction. zone beneath the turbine, where flocculation will be carried to completion in the presence of large quantities of re-circulated floc and solids. This treatment will insure thorough chemical mixing and complete floc development.

The flocculated water will leave the bottom reaction well and will enter the encircling settling area. The mixture will then rise and final "upflow" clarification will take place as the mixture passes through the sludge blanket while the sludge will settle to the bottom of the tank where it will again be swept into the reaction zone. The nominal rise rate in the separation area will approach l.25 gpm/sq. ft. based upon an influent of 3.5 million gallons per day per unit. All excess sludge will be wasted to the sludge thickener.

Because of the fact that lime-soda softening reactions have a tendency to keep on working after the water leaves the clarifier and the high pH of the clarifier effluent, there will be a tendency for deposits of residue to occur on the sand filter media and in the pipelines. The addition of carbon dioxide gas ($C0_2$) to/or recarbonation of the softened water will be required to stop the softening action by combining with any excess chemicals and any unsettled, residual calcium carbonate and magnesium hydroxide with the resultant formation of soluble calcium and magnesium carbonates. The recarbonation process will also provide for pH adjustment of the softened water.

The recarbonation of the lime-soda softened water will be accomplished by means of a package recarbonation unit equipped with a submersible type burner. The burner will be equipped with a compressed gas and combustion 'air from generator units located with the recarbonator control panel in the filter and control building. Submersible combustion units using compressed gases will provide complete and clean combustion and will eliminate the use of a coolerscrubber and drier. The gas and compressed air will be blended in the airgas flow' mixer and diffused into the softened water in the rectangular recarbonation basin by a corrosion resistant distribution grid.

The softened and stabilized effluent from the recarbonation basin will contain in suspension a certain amount of calcium carbonate and magnesium hydroxide which will carry over from the reactor-clarifier. As a result, filters are proposed to remove the suspended matter. The filters will be of the dual media type, consisting of a deep layer of coarse grain coal overlying a thinner layer of finer grain sand. The size of the coal or anthrafil will be uniform, generally lying between I.0 and 1.4 mm. The absence of the fines permits the flow to penetrate into the bed., rather than being retained near the surface of the filter. Such a filter has a large sludge capacity per unit area and permits high filtration rates with reasonably long filter runs between backwashes. The filters will be sized for a surface loading rate of 2 gpm/sq. ft for an average flow rate of 7 million gallons per day.

The filters will be enclosed in the filter control building. Six (6) filters, arranged in two rows of three on each side of the pipe galley, are proposed. Each filter will be controlled by an individual filter control console containing controllers for influent, effluent, backwash, and rewash rates and indicators for filtering rate and head loss through the filter.

All recorders for the filters will be located in the central control panel in the administrative and plant services section of the building.

Filter backwash water will be obtained from the Kittanning Point Reservoir. This source of backwash water will take advantage of the elevation and storage of this high service reservoir to eliminate the necessity of pumps and elevated storage on the site. In addition, the source permits the use of the existing transmission main from Kittanning Point Reservoir to supply the backwash water to the filters.

Since the backwash water will be untreated water, the Pennsylvania Department of Health requires the filters be rewashed to waste prior to returning the filters to normal service. The filter to waste operation will serve the purpose of wasting the raw water held in the filter after backwashing.

After chlorination the filtered water will flow into the clearwell located in the second sublevel under the filtration and the plant services and administrative sections of the building. The clearwell will have a total storage capacity of approximately 700,000 gallons and will be divided into two (2) independent sections to provide for maintenance. Gates or valves will be provided for connection of the clearwell segments to the high service pump well, from which the finished water will be pumped into the existing 16" high service feed main presently feeding the high service areas of the City from Kittanning Point Reservoir. A gravity pipeline will also connect the clearwell with the existing 24" low service feed main currently carrying the flow from the Impounding Dam.

Each of the three (3) high service pumps to be installed will be capable of delivering 1200 gallons per minute against a total head of 130 feet. The pumps will be vertical turbines mounted on the first sublevel of the building. During normal operation two of the pumps will be pumping while the third pump will act as a standby unit to be used during maintenance or breakdown of an operating pump. An overhead crane will be installed from pump room to the maintenance shop to permit ease of pump removal when repair or periodic maintenance is required.

Control and Filter Building

The building will consist of three interconnected sections; chemical feed equipment, filtration equipment and plant services and administration. The plant services and administration section will contain (I) an office for the plant operator; (2) a central control panel from which the treatment operations of the plant will be directed; (3) laboratory facilities for water quality analysis and chemical dosage controls as well as some research; (4) main motor control center; (5) maintenance shop, standby generator and storage for maintenance equipment and (6) high service pumping equipment discussed above.

The chemical feed equipment section of the building will be described later in this report.

The filtration section will consist of the dual media filters, filter control consoles and pipe galley which were discussed in a earlier section of this preliminary report.

The construction materials proposed for the control and filter building will be reinforced concrete for basement and foundation walls and structure, pre-stressed and reinforced concrete structural members above grade for the filtration and administration and plant services sections and steel structural members and metal siding above grade for the chemical feed equipment section and also the maintenances shop area. Clay brick masonry units 4" x 16" face dimensions will be used for the exterior walls of the filtration and administration and plant services sections of the building. Aluminum windows are proposed for ease of maintenance and a coal tar built-up roof incorporating a vapor barrier is indicated because of the moisture conditions which will exist, Steel structural members, metal roof decks, and metal siding were considered for all above grade construction but because of the water contained within the building and the resulting deterioration of such materials, masonry and concrete construction is proposed,

The proposed building layout for each of the three floors is shown on Exhibit No. 6 of this report The total ground level floor area shown, including the sand filters, will be approximate 10,500 square feet.

The central control panel will be situated off the main entrance lobby. As shown on the proposed plant site plan, all major piping systems entering or leaving the plant site will pass through the building under the control panel so that the indicating and control valves and equipment required to operate the treatment facilities can be located within the control building. Chemical feed rates will be displayed and will be adjusted at the feeders in the chemical feed equipment section of the building.

The motor control center will be located to the rear of the central control panel; thus, allowing for a minimum length of electrical conduits between the two panels. A standby generator will be provided to permit operation of the control facilities, mechanical equipment and disinfection equipment should a power failure occur This standby generator will also insure the delivery of a safe water to the distrubution system at all times.

Chemical Feed Equipment

Facilities will be provided in the chemical feed equipment section of the building for storing, handling and dispensing of lime, soda ash, coagulant aid and phosphates. The chlorination facilities will be located as shown on the building floor plan (Exhibit 6-A) adjacent to the sand filters.

All chemicals will be delivered to the site by trucks. Multiple unloading points will be provided to prevent delays during times of heavy chemical demands. Pneumatic unloading and self-unloading trucks will be accommodated and all powder handling systems will be equipped with dust collectors.

Due to the lack of an elevated site for chemical storage, it will be necessary to elevate the dry chemicals artificially for gravity flow into the chemical feeders, To provide the required elevation duplicate storage silos will be provided for lime and soda ash. Each lime storage bin will be equipped with level indicators, a loss-of-weight feeder, a lime slaker, a dissolving chamber, and two (2) chemical feed pumps located on the sublevel floor of the chemical feed equipment section of the building. Dust collectors will be provided on all of the storage bins.

The soda ash storage silos will be equipped with the same feed equipment as the lime storage bins except for the slakers.

Provision will also be made for installation of eight((8) volumetric feeders, located with the lime and soda ash feed equipment, for feeding coagulant aid, alum, permanganate and phosphates when required (See Appendix B). Coagulant aid storage space will be provided in the chemical feed equipment section of the building.
Chlorine will be added to the filtered water in a common header connecting the rapid sand filters and the clearwell area. Two (2) commercially available

solution feed chlorinators will be installed. Ton cylinders of chlorine will be unloaded from trucks by means of hoists.

Disposal of Water By-Products

The waste products from the treatment facilities will include backwash and rewaste water from the sand filters and excess sludge from the sedimentation basins and the lime-soda ash softening units. The backwash and rewash water will flow by gravity into holding lagoons with sufficient available capacity to retain the backwash and rewash water from two filters if simultaneous backwashing should occur. The lagoons will provide the necessary quiescent settling required to drop out the fine solids present in the back-wash water. The overflow from the lagoons will flow into the channel proposed to carry that portion of the discharge from the sedimentation basin which will flow into Lake Altoona (see control section of this report).

The excess sludge (that sludge not being recirculated) will be pumped to the sludge thickener unit. In the thickener the sludge will be stirred for a prolonged period for the purpose of forming larger, more rapid settling sludge flocs with smaller water content. The proposed thickener will increase the solids concentration from less than 1 per cent to as much as 15 per cent. The concentrated sludge from the thickener will be pumped from the plant site to mines as is discussed in Appendix C. The supernatent from the thickener will flow by gravity to the backwash lagoons

Controls

The operation and control of the proposed water treatment complex will be based upon the quality of the raw water sources. As discussed previously the two feed sources to the neutralization facilities will be separated throughout the treatment process under normal operating procedure. The level of water behind the proposed Kittanning Run intake catchment will be used to regulate the flow control valve on the influent pipeline. As the water level rises, the flow to the plant will increase to the design flow; as the water level drops, the flow to the plant will decrease until the water level stabilized. A crossover, controlled by a manual setpoint, will be provided to permit blending of Kittanning Run with the Glen White Run - Sugar Run mixture during periods when the quality improves. A connection between the Kittanning Run bypass channel and the Kittanning Point Reservoir is proposed for use during periods of high flow when the quality of Kittanning Run water improves.

The quantity of feed from the Impounding Dam will be controlled with a manual or automatic setpoint to be adjusted according to the level of water in the Impounding Dam.

The quantity of lime and soda ash fed to the flash mix units will be controlled by pH probes located between the flash mix and slow mix basins. The recirculated sludge flow will be regulated based upon actual plant operational data.

The raw water to the potable water treatment facilities will be from three sources; (l) neutralizated water from the Impounding Dam; (2) return flow from Lake Altoona; and (3) Mill Run water, The ratio of each of the three sources being fed will vary in accordance with the fluctuation in the respective reservoir levels and will be controlled by manual setpoints. The actual operation of the secondary treatment facilities will be based upon clearwell level, functioning as follows. Upon a lowering clearwell level, rate of inflow will increase up to a predetermined rate of 2.7/GPM/ft. over the filters; upon an increasing clearwell level, the rate of inflow will gradually decrease until a balanced condition is obtained. Provision will be made to override controls and operate at any predetermined rate which might be desired.

The chemical feed to the softening-clarification units will be controlled by a pH probe between the softening-clarification units and the rapid sand filters. The coagulant aid feed rate will be regulated based upon actual plant operational data.

The entire operation of the recarbonator will be monitored at the central control panel. The controls will permit varying the gas and air flow to satisfy the demand for carbon dioxide, The quantity of carbon dioxide introduced into the reactor-clarifier effluent in the recarbonation chamber will be controlled so to provide a pH of 8.0. At this pH, a finished water with a desirable alkalinity, hardness and taste will be produced. Also by carbonating to this point there should be little or no incrustation of the media in the filters.

The high service pumping equipment will be operated according to the water levels in the City of Altoona's high service reservoirs. Two (2) pumps will be operated in parallel and third pump will be the standby unit.

See Exhibit No. 4 for a schematic of the control system described above.