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AECU-3370

CHEMISTRY

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UNITED STATES ATOMIC ENERGY COMMISSION

PROCESS WASTE WATER TREATMENT PLANT
Preliminary Report

February 1957
[TISE Issuance Date]

Oak Ridge National Laboratory
Oak Ridge, Tennessee

and

Burns and McDonnell Engineering Company
Kansas City, Missouri

Technical Information Service Extension, Oak Ridge, Tenn.

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OAK RIDGE NATIONAL LABORATORY
Process Waste Water Treatment Plant
Preliminary Proposal No. 213

June 30, 1954

A presented
This proposal is for the construction, at a cost of \$180,000, of a plant to treat the low level radioactive liquid waste from the various Laboratory processes. The proposed plant will reduce the radiation activity of that waste to a level that will not exceed the accepted standards for discharges into White Oak Creek and the Clinch River. *(auth)*

A. Reference Data

1. Oak Ridge National Laboratory Permanent Project 6-24X-5039, FY-1955, Budget Submission KAD-163.
2. Request for Directive No. 213, "Process Waste Water Treatment Plant," dated June 30, 1954.

B. Justification of Basic Need

The Laboratory is faced with the problem of stopping the upward trend of radioactive contamination being discharged from the process waste water system into the natural drainage basin of the Laboratory area. This basin consists of White Oak Creek and White Oak Lake with an outlet to the Clinch River, approximately two miles southwest of the Laboratory site.

The disposal of all Laboratory radioactive liquid wastes is accomplished through two collection systems. One is the "hot" chemical waste system which handles materials relatively low in volume but very high in activity; the other is the process waste system which handles large volumes of normally low activity wastes such as operating area floor washings and cooling water from process tanks and condensers.

Several years ago, the Laboratory's main waste disposal problem was the discharge of large quantities of activity by the "hot" chemical waste system into White Oak Creek. This problem was solved in 1949 by the construction of a waste evaporator and the addition of monitoring tanks to the system which permitted hot wastes to be routed to a satisfactory disposal facility or stored if storage was the correct method. Waste lagoons, located approximately one mile from the Laboratory, recently incorporated into the system, have reduced the load on the evaporator and have proved to be a valuable addition to the Laboratory's waste disposal system. These lagoons, excavated in a soil formation in which the percolation rate is relatively low, receive the waste either by tank truck or pipe line; the liquid portion is reduced by evaporation and soil seepage leaving only a small amount of contaminated residue in the lagoon with much of the radioactivity being fixed in the soil a few feet below the bottom of the lagoon. In the four years (1950 through 1953) following the installation of the waste evaporator

and auxiliary equipment, the "hot" waste disposal system has been kept under good control; it has contributed less than 4.5% of the total activity discharged into White Oak Creek while handling over 99% of the total activity contained in the Laboratory's wastes.

With the expansion of the Laboratory's programs and the tremendous increase in the quantities of activity handled during the last several years, the activity discharged into White Oak Creek by the untreated wastes of the process waste system has frequently reached serious proportions. Such occurrences resulted mainly from accidents and equipment failures which were frequently difficult to locate.

With the care that has been exercised to prevent accidents and to control the release of activity into the process waste system, it has been possible to prevent the release of more than 40 curies of activity in any one day, however the possibility of discharging many times that amount exists. For example, a potential source that might have released about 400 curies of activity into the process waste system was recently discovered and eliminated before the activity was released into the process waste system.

With increasing emphasis on programs involving large quantities of highly radioactive materials, as for example in the Thorex processing operations, the 25 recovery in the Pilot Plant, Building 3019, high-radiation-level chemical operations in the Hot Laboratory in Building 4501, and in the radioisotope production operations, it is certain that both the volume and activity of process wastes will increase. Also the likelihood of accidental release of large quantities of radioactive materials will increase.

Although the process waste system handles less than 1% of the total activity discharged in the Laboratory wastes, it contributed 95.5% of the activity released to White Oak Creek during the last four years. The table below gives a breakdown of the discharge according to system during these years.

<u>Year</u>	<u>Beta Curies From Process Wastes</u>	<u>Beta Curies From "Hot" Waste System</u>	<u>Total</u>
1950	179.4	7.6	187
1951	164.8	7.2	172
1952	474.2*	23.8	498
1953	409.5*	19.5	429

*One underground waste line leak which could not be located for several months contributed approximately 200 curies during the latter part of 1952 and the early part of 1953.

Recent Health Physics surveys revealed that the level of the activity in the basin and in the Clinch River has increased considerably during the past three years and at times is in excess of the presently accepted limit of 10^{-7} microcuries per cc average concentration in the water of the Clinch River.

An upward trend of levels of activity in the Clinch River has been indicated by periodic surveys of the river and by the above data on release of activity. The present levels of activity in the Clinch River are already undesirably high and should not be permitted to go higher.

Efforts to segregate "hot" wastes and to eliminate at the source the activity that goes to process sewers in the area have been only partially successful, and this method does not offer much promise as a reliable means of controlling and reducing the high-level discharges from the settling basin. The total volume of effluent process waste being discharged into the settling ponds has been reduced in recent months by diverting, directly into White Oak Creek, the liquid drainage from activity-free processes.

In view of the limited available means for controlling the large discharges of activity, it now becomes necessary to provide other methods for removing the activity, if the Laboratory is to conform to present accepted safety standards.

It is proposed to divert the entire process waste stream through a waste treatment plant before it is discharged into White Oak Creek. In the treatment plant a coagulation-sedimentation process will be used to remove radioactive substances from the waste stream. This method has been demonstrated in laboratory tests to be applicable to the Laboratory's process waste solutions. An attractive feature is the nearly automatic operation of the plant, requiring very little attention. It is expected that operation of the plant on a 24-hour basis would require only one part-time operator. Thus the main element of plant operating costs would be chemical costs and amortization. While accurate estimates of processing costs must await the completion of pilot plant tests now under way, all evidence indicates that this would be the cheapest method of treating large volumes of low-activity waste solutions.

The installation of this treatment plant to decontaminate the process waste stream, according to preliminary laboratory tests, will reduce the average daily curie discharge by at least fifty (50) per cent. In case of emergency the removal of radioactivity can be increased by special processing. The proposed plant will be designed so that increased volumes can be treated at a minimum additional operating cost. The fifty (50) per cent reduction in the level of radioactivity released to White Oak Creek, which this plant will effect, will reduce the concentration of activity in the Clinch River from its present near-tolerance level to well below the accepted limit of 10^{-7} microcuries per cc average concentration. If still further reductions in the level of activity of discharged wastes are required, they can be accomplished, with a comparatively small increase in operating cost, by increasing the quantity or changing the types of chemicals used in treating the waste solutions. Due to the flexibility afforded by this type of system alterations to the treatment plant would not be required.

It is planned that under normal operating conditions, when activity concentrations in the waste solutions are low, minimum treatment would be used; but this could be increased at once when a rise in the level of activity

of waste solutions required more efficient removal of radioactive contaminants.

In addition to solving a major problem in the disposal of Laboratory wastes, this plant can reasonably be expected to provide valuable data and experience for other Atomic Energy installations wherever the problem of disposing of large volumes of low level radioactive wastes may occur.

Description

The proposed plant will consist of two coagulation-sedimentation raw waste treatment units, each having sufficient capacity to process 750,000 gallons per day, a 10,000-gallon sludge tank, a building for storing and feeding chemicals and the necessary pumps, piping and accessories.

The chemical feeder building will have concrete foundations and floors and will be a two-story concrete block structure approximately 17 feet by 31 feet, 20 feet high, with a one-story addition approximately 5 feet by 15 feet, 8 feet high. The first floor will house six dry and two liquid chemical feeders while the second floor will provide space for storing dry chemicals and for charging the dry chemical feeders. A one-ton monorail hoist will be provided on the second floor for handling chemicals. The one-story addition will be used for storing liquid chemicals and for charging the liquid chemical feeders. Metal doors and metal sash windows will be used. The roof will be a thin concrete slab, supported on metal decking and topped with built-up felt and asphalt roofing.

The building will be heated by steam unit heaters in all areas except the liquid chemical storage room which will be heated by fin type radiators. Ventilation for the building will be provided by power exhaust fans. Steam and process water will be extended from the nearby plant systems. Electrical power and light requirements which will be small will be supplied from the plant distribution system adjacent to the site.

Truck access to the building, will be provided by an asphalt paved driveway extending from an adjacent street. Only a small amount of excavation and grading will be required.

The present average volume of process waste from the Laboratory is approximately 500,000 gallons per day with peak days increasing to the range of 700,000 to 800,000 gallons per day. The proposed arrangement of two 750,000 gallons per day capacity coagulation sedimentation units will permit the flexibility required to meet the great fluxuations, both in volume and concentration of activity, resulting from the various Laboratory processes. During periods of normal operations, the units would be alternated in use, thus permitting routine maintenance and servicing. During periods of extremely high volume discharges, the units would share the discharge and operate in parallel, while during periods when the discharge contains a high concentration of activity the units would be operated in series, with each of the units removing a portion of the waste.

The waste which is treated will contain only a negligible amount of solid matter thus the sludge resulting from the treatment will be composed almost entirely of chemicals used in the treatment process. The sludge from one days' operation, in the consistency of slurry, will be stored in a 10,000-gallon storage tank from which it will be pumped through the waste pipe line to a waste lagoon beyond Haw Ridge.

C. Preliminary Schematic Plans

Drawing A - Plot Plan

Drawing B - Perspective View

Drawing C - First Floor Plan

Drawing D - Second Floor Plan

Drawing E - Section "A-A"

Drawing F - Flow Sheet

D. Outline Specifications

The building will be structural steel framing with concrete block walls.

The roof will be a thin concrete slab over metal decking topped with built-up felt and asphalt roofing.

Doors and window sash will be metal.

Power exhaust fans will provide ventilation.

Heating will be by means of unit heaters and fin type radiators.

The process equipment which will be commercially available units will consist of:

- (1) Two coagulation sedimentation raw waste treatment units, each with a nominal capacity of 750,000 gallons per day.
- (2) One 10,000 gallon sludge storage tank
- (3) Six dry chemical feed units
- (4) Two liquid chemical feed units
- (5) Monitoring instruments
- (6) Pumps, piping and accessories

Building services will conform to the latest edition of the applicable ASTM and National Underwriters Code.

E. Estimate of Cost

The total preliminary estimated cost of the proposed installation is (see accompanying estimate) ----- \$180,000.

SUMMARY COST ESTIMATE

<u>Cost Category</u>	<u>Contractor</u>	<u>ORNL</u>	<u>Total</u>
<u>Direct Construction Costs</u>			
Building Costs	\$ 19,000	\$ 500	\$ 19,500
Installed or Fixed Equipment	22,500	11,500	34,000
Building Costs plus Installed or Fixed Equipment	41,500	12,000	53,500
Installed Equipment (Outside Building)	72,800	8,200	81,000
Improvements to Land	1,200	-0-	1,200
Outside Utilities	-0-	6,100	6,100
<u>Engineering Design and Inspection</u>			
Design	-0-	3,700	3,700
Inspection	-0-	2,300	2,300
<u>Indirect Costs</u>	-0-	15,100	15,100
<u>Allowance for Contingencies</u>	<u>11,500</u>	<u>5,600</u>	<u>17,100</u>
<u>Total Gross Project Costs</u>	<u>\$127,000</u>	<u>\$53,000</u>	<u>\$180,000</u>

UNIT COSTS

Gross Floor Area 1168 Square Feet

Gross Cubage 24750 Cubic Feet

	(A) <u>Direct Cost</u> <u>to 5' Line</u>	(B) <u>Direct Cost</u> <u>Plus Con-</u> <u>tingencies</u>	(C) <u>Direct Cost Plus</u> <u>Contingencies &</u> <u>Indirect Costs</u>
Unit Cost w/out Equipment (Area)	\$16.70	\$18.36	\$18.56
Unit Cost w/out Equipment (Cubage)	0.79	0.87	0.88
Unit Cost - Installed Equipment (Area)	45.08	50.56	55.36
Unit Cost - Installed Equipment (Cubage)	2.16	2.39	2.61

F. *Proposed Starting and Completion Dates

<u>Engineering</u>	<u>Start</u>	<u>Complete</u>
Design	10-1-54	12-1-54
Inspection	1-1-55	5-15-55
<u>Construction</u>		
Contractor	1-1-55	5-15-55
ORNL	12-15-54	6-3-55

*These dates were established on the basis that directive approval will be received by September 30, 1954.

It is proposed that the Atomic Energy Commission award a prime contract for the construction of the building and services and the procurement and installation of certain equipment. Oak Ridge National Laboratory participation will consist in providing engineering services; miscellaneous work as required to assist the contractor; and the procurement and/or fabrication and installation of specialized equipment all which is described herein.

PLOT PLAN

SCALE IN FEET

PLOT PLAN
PROCESS WASTE WATER TREATMENT PLANT
BUILDING 3518
OAK RIDGE NATIONAL LABORATORY
DRAWING A

PERSPECTIVE VIEW

PERSPECTIVE VIEW

PROCESS WASTE WATER TREATMENT PLANT

BUILDING 3518

OAK RIDGE NATIONAL LABORATORY

DRAWING B

C-11117

10

FIRST FLOOR PLAN

C-111118

10

FIRST FLOOR PLAN

PROCESS WASTE WATER TREATMENT PLANT

BUILDING 3518

OAK RIDGE NATIONAL LABORATORY

DRAWING C

SECOND FLOOR PLAN

SECOND FLOOR PLAN

PROCESS WASTE WATER TREATMENT PLANT

BUILDING 3518

OAK RIDGE NATIONAL LABORATORY

DRAWING D

11

C-111119

SECTION "A - A"

SECTION "A - A"
PROCESS WASTE WATER TREATMENT PLANT
BUILDING 3518
OAK RIDGE NATIONAL LABORATORY
DRAWING E

SCHEMATIC FLOW SHEET
PROCESS WASTE WATER TREATMENT PLANT

BUILDING-3518

OAK RIDGE NATIONAL LABORATORY

DRAWING F

OAK RIDGE NATIONAL LABORATORY
ENGINEERING DEPARTMENT

COST ESTIMATE

Preliminary Proposal
No. 213

"Process Waste Water Treatment Plant"

Date 5-25-54

ENTRY No.	QUANTITY	DESCRIPTION			
		<u>SUMMARY</u>	<u>CONTRACT</u>	<u>ORNL</u>	<u>TOTAL</u>
		<u>DIRECT CONSTRUCTION COSTS</u>			
		Building Costs	19,000	500	19,500
		Installed Equipment	27,500	11,500	34,000
		Building Costs Plus Installed or Fixed Equipment	41,500	12,000	53,500
		<u>EQUIPMENT-OUTSIDE BUILDING</u>	72,800	8,200	81,000
		<u>IMPROVEMENTS TO LAND</u>	1,200	-0-	1,200
		<u>OUTSIDE UTILITIES</u>	-0-	6,100	6,100
		<u>ENGINEERING</u>			
		Design		3,700	3,700
		Inspection		2,300	2,300
		<u>INDIRECT COSTS</u>		15,100	15,100
		<u>CONTINGENCY</u>	11,500	5,600	17,100
		<u>TOTAL GROSS PROJECT COST</u>	127,000	53,000	180,000

OAK RIDGE NATIONAL LABORATORY
ENGINEERING DEPARTMENT

COST ESTIMATE

Preliminary Proposal

No. 213

"Process Waste Water Treatment Plant"

Date 5-25-54

ENTRY No.	QUANTITY	DESCRIPTION			
		BUILDING STRUCTURE	CONTRACT	ORNL	TOTAL
		<u>Earthwork</u>			
		Trenching and rough grading for foundations and floor slab	380		380
		Remove contaminated earth and spread crushed stone on area		500	500
		SUB-TOTAL	380	500	880
		<u>Concrete</u>	3,400		3,400
		<u>Structural Steel</u>	3,800		3,800
		<u>Steel Decking</u>			
		Steel panels for second floor	600		600
		Steel panels for roof	700		700
		SUB-TOTAL	1,300		1,300
		<u>Masonry</u>			
		8" concrete block walls	1,420		1,420
		6" concrete block walls	230		230
		Coping - precast concrete	250		250
		SUB-TOTAL	1,900		1,900
		<u>Doors</u>			
		Exterior and interior doors - complete with hardware	1,430		1,430

OAK RIDGE NATIONAL LABORATORY
ENGINEERING DEPARTMENT

COST ESTIMATE

Preliminary Proposal
No. 213

"Process Waste Water Treatment Plant"

Date 5-25-54

ENTRY No.	QUANTITY	DESCRIPTION			
		<u>BUILDING STRUCTURE (CONTINUED)</u>	<u>CONTRACT</u>	<u>ORNL</u>	<u>TOTAL</u>
		Roofing			
		Tar and gravel roofing	200		200
		Wood cant and flashing	500		500
		SUB-TOTAL	700		700
		Painting			
		Seal exterior walls and paint two coats	320		320
		Paint interior three coats	570		570
		SUB-TOTAL	890		890
		NET MATERIAL AND LABOR, BUILDING STRUCTURE	13,800	500	14,300
		<u>BUILDING SERVICES</u>			
		Heating and Ventilating			
		Unit heaters	1,280		1,280
		Exhaust fans	640		640
		SUB-TOTAL	1,920		1,920
		Plumbing			
		Process water services	516		516
		Janitorial type sink	160		160
		Electrical hot water heater	192		192
		Process drains and vents	512		512
		SUB-TOTAL	1,380		1,380

OAK RIDGE NATIONAL LABORATORY
ENGINEERING DEPARTMENT

COST ESTIMATE

Preliminary Proposal

No. 213

"Process Waste Water Treatment Plant"

Date 5-25-54

ENTRY No.	QUANTITY	DESCRIPTION			
		<u>BUILDING SERVICES (CONTINUED)</u>	<u>CONTRACT</u>	<u>ORNL</u>	<u>TOTAL</u>
		<u>Electrical</u>			
		Main breaker and 440 V distribution panel	380		380
		115/230 V distribution panel	320		320
		Lighting and service outlets	500		500
		Power for hoist	260		260
		Conduit and conductors	440		440
		SUB-TOTAL	1,900		1,900
		NET MATERIAL AND LABOR - BUILDING SERVICES	5,200		5,200
		<u>EQUIPMENT</u>			
		Chemical Feeders *	20,200*		20,200
		Hoists *	2,300*		2,300
		Sludge Tank	4,300	200	4,500
		<u>Pumps</u>	3,000		3,000
		<u>Process Piping</u>	11,200	5,000	16,200
		<u>Coagulation Sedimentation Raw Waste Treatment Units</u>	54,300		54,300
		Accelerators		3,000	3,000

OAK RIDGE NATIONAL LABORATORY

ENGINEERING DEPARTMENT

COST ESTIMATE

Preliminary Proposal

No. 213

"Process Waste Water Treatment Plant"

Date 5-25-54

ENTRY No.	QUANTITY	DESCRIPTION			
		EQUIPMENT (CONTINUED)	CONTRACT	ORNL	TOTAL
		Monitoring Equipment *		11,500*	11,500
		NET MATERIAL AND LABOR - EQUIPMENT	95,300	19,700	115,000
		*Located inside the building			
		IMPROVEMENTS TO LAND			
		Paving			
		Install paved approach to building and necessary walks between structures	1,200		1,200
		UTILITIES			
		Process Water			
		Remove contaminated earth and install 2" galvanized pipe		1,600	1,600
		Steam			
		2" line - mounted on poles		2,500	2,500
		Electric Power		1,000	1,000
		Process Drain			
		Remove contaminated earth and install 4" cast iron line		1,000	1,000

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PROCESS WASTE WATER TREATMENT PLANT

INTRODUCTION

A Process Waste Water Treatment Plant is required for the treatment of process waste water containing low level radioactive waste from the various laboratory processes. It is required that this plant reduce the radiation activity to a level that will not exceed the accepted standards for discharge into White Oak Creek and the Clinch River. It has been found through laboratory experiments that by the addition of chemicals with accompanying coagulation and sedimentation that reduction of the radioactivity in the process water can be successfully accomplished. In case of emergency the removal of radioactivity can be increased by special processing such as recirculation with accompanying retreatment. One half million gallon equalization basin will always be kept empty as a reserve for storage of waste which must receive special treatment.

TREATMENT REQUIREMENTS

It is believed that successful treatment can best be obtained through a straight line plant utilizing chemical feeders, mixing, coagulation and sedimentation. Treatment should be accomplished using standard equipment such as used in a water softening plant. It is essential that the calcium carbonate content be reduced as much as possible in order to effect satisfactory removal of radioactivity. A calcium carbonate content of 30-35 ppm is desired with a possible upper acceptable limit of 50 ppm. Provisions must be made for adding excess chemicals up to 200 ppm in order to accomplish this level.

Chemical feeders shall be provided to feed adequate dosages for lime, soda ash, calcium chloride and adaptable for feeding tri-sodium phosphate. These feeders shall be installed in a Control Building and so arranged for semi-automatic operation not requiring a full time operator. A means of storing and handling chemicals above the feeders shall be provided so that labor is held to a minimum consistent with initial costs.

The influent will always have a low PH value with a possible low of 2. Some means of protecting the plant must be provided. Very little solid matter is carried by the process water. Some debris such as paper and bottle corks will be present in the waste stream. It is believed these will settle out in the Equalization Basins.

Average flow of process water during the past two years have been from 330,000 to 730,000 gallons per day, with peak flows for very short period of 1,500,000 gallons per day. The treatment provided should include one treatment line of 500,000 gallons per day capacity consisting of rapid mixer, 2 or 3 flocculators as required and one sedimentation basin with sludge removal mechanism.

PLANT FEATURES

- A. Influent - All process waste will normally continue to flow through the Settling Basin shown on drawing D-23681. A monitoring device will be provided by Oak Ridge National Laboratory upstream from the new diversion box. See Sketch A-23632 attached showing a schematic diagram of the required arrangement. It will therefore be necessary to tie in all process lines except the existing 8" line flowing to the small retention pond, into a single main at a point upstream from the new diversion box. An automatic valve will be provided (see sketch A-23632) in the

new diversion box. This valve arrangement will normally allow process water to flow into the existing Settling Basin but upon accentuation by the upstream monitoring device will divert the waste water into the new Equalization Basins. Provision should be made, if practical, for a future installation of an automatic valve and monitoring device on the 8" line flowing to the small retention pond in order to divert this flow at some future date either to the Equalization Basins or White Oak Creek.

- B. Equalization Basins - Two earth basins in the order of 500,000 gallons each are required for storage of process water in order to provide sufficient hold up for proper plant treatment. It is proposed to make use of the existing East and West Ponds shown on drawing D-23681. By enlarging these ponds to the north and west and by increasing the height of the embankments it is believed sufficient capacity can be obtained. Select earth material must be used for embankments so that the possibility of seepage is held to a minimum. Influent must be divertable to either basin from the main diversion box by means of manual operated gates. Scheme No. 1 submitted by Burns & McDonnell is an acceptable arrangement for these basins. Free-board should be limited to 1'-6". The west pond should be modified in order to prevent fill from encroaching on 3rd Street. All work on these basins and immediately adjacent piping will be accomplished by forces other than a lump sum contractor.
- C. Pipe Lines - Terra cotta pipe is considered satisfactory for all gravity flow lines. Where pumping is necessary prior to treatment, some type of acid resistant material must be used or the influent must be neutralized. The waste coming from the existing 8" line now flowing into the existing Retention Pond shown on Drawing D-23681 (estimated to be 10,000 gallons per day) is an exception to the above and does not have a low PH.
- D. Sedimentation Basin - It is believed that a reinforced concrete sedimentation basin designed for use of standard straight line equipment is the most practical choice for this plant. Any area to the west of the existing earth Settling Basin and east of Third Street shown on drawing D-23681 may be utilized for the Plant.

The interior of the top of the concrete basin and the area one foot below water level must be painted to prevent porosity and to prevent corrosion from waste water. Below this level the water will provide shielding for any activity absorbed in the concrete. The top and first foot under water should be painted with some material such as Amercoat. The remainder of the concrete need have only standard waterproofing treatment.

- E. Equipment - Standard equipment should be used in all cases where possible in order to keep initial cost to a minimum. Consideration must also be given to maintenance problems. Where equipment is inaccessible, such as the sludge collector, it should be designed for easy removal. A collector suggested by Burns & McDonnell which operates on tracks above the water and having a retractable under-carriage appears to be the most feasible type providing the cost is reasonable. No skimming mechanism is to be provided; however, provisions shall be made for manual skimming. By inaccessible, it is by virtue of the fact that the basins will remain flooded with water in order to provide shielding from radioactivity in the sludge and plant slimes. Equipment such as pumps, valves, etc., which are likely to develop leaks should be so located that leakage will drain back into the Plant system.

Sludge storage on the order of 10,000 gallons must be provided. The storage sump must be readily accessible for transfer of the sludge to a tank truck. The truck to be used for ultimate disposal of the sludge has a capacity of 3,500 gallons. Sump should be located at least 25 feet away from the Control House in order to protect the operator from extended periods of radiation.

F. Control Building - A Control Building similar in arrangement to that shown in the preliminary proposal on drawings B, C, D and E is desired. This building should be located at least 25 feet from the sludge storage sump, sedimentation basin, or other plant features containing process waste water. Physical dimensions may vary to suit the equipment selected; however, space should be provided for future chemical feeders. Building should be heated with steam, have adequate ventilation, be provided with incandescent lights, a small number of 110 volt convenience outlets, floor drains with discharge into the plant process sewer system, process water hose connections, potable water supply, electric hot water heater with potable water, process sink, one-ton monorail at second floor level with cantilever to outside of building. No hoist is to be supplied with the contract. No fire protection or sanitary facilities are required. To meet laboratory standards Best Universal Lock Co. Cylinders 1-5/32" bore, 7 pin core No. 1E74 shall be specified for all doors. Two keys shall be furnished with each lock, cores shall be uncombined.

G. Utilities

1. Process Water - Laboratory policy requires the use of process water in all operations where there is direct line connection with process equipment. Process water may be obtained from a process water main as shown on drawing D-23681, or by providing a tank with air gap at the Plant and supplying this tank from a potable water main. The most economical method should be used.
2. Potable Water - Potable water is desirable for connection to a sink in the Control Building and for a drinking fountain. It is available at a 16" main shown on drawing D-23681. Should the cost be excessive this service could be eliminated by using bottled water for drinking and connecting the sink to the process supply.
3. Steam - Steam is available at 250 #/sq. in. saturated at a nearby main shown on drawing D-23681. An overhead supply line on steel pipe poles set in concrete is required. Line shall be insulated and have aluminum weather covering.
4. Electric Power - 440 volt, 3 phase and 115/230 volt single phase are available at a substation as shown on drawing D-23681.

H. Effluent - Effluent from the Sedimentation Basin must be arranged such that it can be returned to either of the 500,000 gallon Equalization Basins or be discharged to White Oak Creek. Discharge to White Oak Creek must be via the existing diversion box (weir box with automatic proportioning sampler) so that automatic recording of volume will be provided. Details of this diversion box are shown on drawing D-7676. Provision must be made for monitoring the effluent with automatic flow control similar to the arrangement described for the influent.

EXPERIMENTAL DATA

The following experimental data was based on a Settling Basin Grab sample of May 27, 1955. The initial activity was 100 counts per minute per milliliter predominately Yttrium and Cerium but containing some other radioactive materials. The alkalinity was 26 ppm; total hardness 100 ppm; CA^{++} as $CaCO_3$ 70 ppm. Stoichiometric dosage for Lime Soda treatment on Sr^{90} - Y^{90} was ascertained from companion study on spiked sample.

I

SETTLING BASIN SERIAL TREATMENTCOLD LIME SODA

500 ml samples - Stoichiometric Dose

100 ppm Na_2CO_3 50 ppm $\text{Ca}(\text{OH})_2$

Step***	Dosage mg Added $\text{Ca}(\text{OH})_2$ Na_2CO_3		% Activity Spiked* Sample	Removal** Settling Basin Grab	Total Hardness in Supernatant		Ca ⁺⁺ ppm as CaCO_3 in Supernatant	
					Settling		Settling	
					Spiked* Sample	Basin Grab	Spiked* Sample	Basin Grab
1	25	50	36.1	18.1	78	82	50	60
2	25	50	56.1	28.9	52	78	34	55
3	25	50	65.5	39.8	47	66	30	47
4	25	50	78.8	54.7	45	58	30	35
5	25	50	86.9	61.3	36	42	26	21
6	25	50	92.2	68.0	34	45	20	20
7	25	50	95.4	69.4	28	40	10	20

* Inasmuch as the Settling Basin Grab activity was 100 C/M/ml, the spiked sample was also studied in this lime-soda treatment and contained about 15,000 C/M/ml Sr^{90} - Y^{90} added to the Settling Basin Grab.

** This sample contained a mixture of various radioactive materials. Per cent removal is per cent of total activity.

*** Steps 1, 2, 3 etc., indicate successive repetitive treatment, each consisting of dosage shown, mixing and one hour settling.

II

SETTLING BASIN SERIAL TREATMENTHOT LIME SODA

500 ml samples - Stoichiometric Dose

100 ppm Na_2CO_3 50 ppm $\text{Ca}(\text{OH})_2$

Step***	Dosage mg Added		% Activity Spiked* Sample	Removal** Settling Basin Grab	Total Hardness in Supernatant		Ca ⁺⁺ ppm as CaCO ₃ in Supernatant	
	Ca(OH) ₂	Na ₂ CO ₃			Settling		Settling	
					Spiked* Sample	Basin Grab	Spiked* Sample	Basin Grab
1	25	50	41.9	38.6	68	66	46	42
2	25	50	67.8	61.3	58	42	40	21
3	25	50	89.0	69.0	24	21	18	8
4	25	50	92.1	69.8	18	18	10	10
5	25	50	96.3	70.4	12	14	6	4
6	25	50	97.4	69.8	9	12	4	4
7	25	50	98.3	70.5	5	12	2	4

* Settling Basin Grab sample spiked with Sr^{90} - Y^{90} , to make final activity in sample about 15,000 C/M/ml.

** This sample contained a mixture of various radioactive materials. Per cent removal is per cent of total activity.

*** Steps 1, 2, 3 etc., indicate successive repetitive treatment, each consisting of dosage shown, mixing and one hour settling.

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OAK RIDGE NATIONAL LABORATORY
OPERATED BY
UNION CARBIDE NUCLEAR COMPANY
A DIVISION OF UNION CARBIDE AND CARBON CORPORATION

POST OFFICE BOX P
OAK RIDGE, TENNESSEE

November 9, 1955

U. S. Atomic Energy Commission
Post Office Box E
Oak Ridge, Tennessee

Attention: Mr. Herman M. Roth

Subject: Request for Directive No. CR-213 - Supplement No. 1
"Process Waste Water Treatment Plant"

Gentlemen:

Reference:

1. Oak Ridge National Laboratory Permanent Project 6-24X-5039, FY-1955, Budget Submission KAD-163.
2. Preliminary Proposal No. 213, "Process Waste Water Treatment Plant", dated June 30, 1954.
3. Request for Directive No. CR-213, "Process Waste Water Treatment Plant", dated June 30, 1954.
4. Letters, "ORNL Process Waste Water Treatment Plant" from Director, Oak Ridge National Laboratory to Director, Research and Medicine, dated December 1, 1954, and March 30, 1955.
5. Directive No. CL-174, "Process Waste Water Treatment Plant, Building No. 3518, ORNL", dated April 28, 1955.
6. Preliminary Report on "Process Waste Water Treatment Plant", by Burns & McDonnell Engineering Company, Kansas City, Missouri, dated October 3, 1955.

This supplement is submitted to describe a revised layout of the treatment plant with associated changes in cost estimate and redistribution of funds between ORNL and contractors. Authorization is requested for ORNL to

proceed with site preparation, for the Atomic Energy Commission to solicit bids for a construction contractor, and for the completion date of this project to be extended from April 30, 1956, to September 1, 1956.

Investigations and developmental research, by Oak Ridge National Laboratory and definitive design by Burns & McDonnell Engineering Company, Atomic Energy Commission prime architect-engineer contractor, subsequent to the issuance of the proposal have led to changes from that document as originally submitted. This has resulted in changes in the basic design of the plant. It is now planned for liquid waste to be collected in an Equalization Basin and fed to the treatment plant, which will consist of a control building, a single stage treatment unit (consisting of a flash mixer, coagulator and sedimentation basin), piping, and appurtenant yard structures. Rate of flow through the plant will be 500,000 gallons per day, and a pumping system will provide for recirculation where more than single-treatment is found to be necessary.

A detailed description of the plant as revised is contained in the "Preliminary Report on Process Waste Water Treatment Plant", dated October 3, 1955, by Burns & McDonnell Engineering Company (Reference No. 6).

The detailed description proposes that the existing East and West Ponds be utilized for an Equalization Basin. This would require that the highly contaminated silt, which has been deposited in the ponds during the several years they have been in use, be removed and disposed of in a safe manner, and the removal of the earth dike separating the ponds.

Removal of contaminated earth from the existing ponds and strengthening of their surrounding dikes will be accomplished by ORNL forces as an operating function and the cost of such work will not be a part of this project.

The investigations also proved the earth in the entire area of the site to be contaminated to some extent. This condition led to the decision that it would be advisable for ORNL to perform decontamination work, which involves excavation for the control building, treatment units and piping trenches and to dispose of all contaminated material. In order to take advantage of favorable weather and to define clearly the scope of work for a construction contractor, it is recommended that ORNL be authorized to proceed with the decontamination work during the bid advertisement period.

Thus, the preliminary proposal as amended in accordance with the above discussions now proposes that Oak Ridge National Laboratory provide engineering services for the preparation of design criteria; perform such decontamination as required for the removal and disposal of contaminated

November 8, 1955

material; make piping connections to the equalization basin; and make utility connections.

It further proposes that the Atomic Energy Commission award prime contracts for architect-engineer services and for the construction of the facility.

Delays occasioned by the investigations and decisions pertaining thereto now require that the completion date be extended from April 30, 1956, to September 1, 1956.

Attached hereto are a revised cost estimate summary, a revised cost estimate, and a revised schedule for the project which reflect the proposed changes.

The present total estimate, \$192,780, exceeds by \$12,780 the budget ceiling for this project. However, a favorable bid for the construction work could lower the final cost sufficiently so that the project could be completed within the present budget ceiling. If at the time bids are received it develops that the present funds are not sufficient, additional funds will be necessary.

It is requested that Directive No. CL-174 be modified to authorize the preliminary proposal as thus amended.

Very truly yours,

OAK RIDGE NATIONAL LABORATORY

J. A. Swartout
Deputy Director

PROCESS WASTE WATER TREATMENT PLANT

REVISED SUMMARY COST ESTIMATE

<u>Cost Category</u>	<u>Contractor</u>	<u>ORNL</u>	<u>Total</u>
<u>Direct Construction Cost</u>			
Building Cost	\$ 27,350	\$ 1,500	\$ 28,850
Installed or Fixed Equipment	22,710	-0-	22,710
Building Costs plus Installed or Fixed Equipment	50,060	1,500	51,560
Installed Equipment (Outside Building Including Sedimentation, Basin)	87,800	4,700	92,500
Improvement to Land	1,200	-0-	1,200
Outside Utilities	11,650	800	12,450
<u>Engineering Design and Inspection</u>			
Design & Inspection (A-E)	13,500	-0-	13,500
Design Criteria (ORNL)	-0-	1,000	1,000
<u>Indirect Costs</u>	-0-	4,000	4,000
<u>Allowance for Contingencies</u>	<u>15,070</u>	<u>1,500</u>	<u>16,570</u>
<u>Total Gross Project Costs</u>	<u>\$179,280</u>	<u>\$13,500</u>	<u>\$192,780</u>

REVISED PROPOSED STARTING AND COMPLETION DATES

	<u>Start</u>	<u>Complete</u>
<u>Engineering</u>		
Design	6-1-55	10-31-55
Inspection	12-21-55	8-1-56
<u>Construction</u>		
Contractor	12-21-55	8-1-56
ORNL	11-15-55	9-1-56

OAK RIDGE NATIONAL LABORATORY

ENGINEERING DEPARTMENT

COST ESTIMATE

Preliminary Proposal

No. 213

"Process Waste Water Treatment Plant

Revised Estimate

Date 11-9-55

ENTRY NO.	QUANTITY	DESCRIPTION			
		<u>Building Structure</u>	<u>CONTRACT</u>	<u>ORNL</u>	<u>TOTAL</u>
		<u>Earthwork</u>			
		Excavate and remove contaminated earth		1,500	1,500
		<u>Building & Building Services Complete</u>	27,350		27,350
		Total Building Cost	27,350	1,500	28,850
		<u>Equipment</u>			
		<u>Inside Building</u>			
		Process waste pumps	4,370		4,370
		Chemical feed machines	18,340		18,340
		Total Equipment Inside Building	22,710		22,710
		<u>Outside Building</u>			
		Sedimentation basin (excavation)		3,000	3,000
		Treatment units	18,770		18,770
		Flash mixer agitator	1,510		1,510
		Coagulation agitator	6,380		6,380
		Sludge collector	7,800		7,800
		Sludge pumps	3,640		3,640
		Sump pumps	3,110		3,110
		Piping	46,590	500	47,090
		Excavation for equipment & piping and removal of contaminated earth		1,200	1,200
		Total Equipment Outside Building	87,800	4,700	92,500
		<u>Improvement to Land</u>			
		Paving	1,200		1,200

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OAK RIDGE NATIONAL LABORATORY

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UNION CARBIDE NUCLEAR COMPANY

POST OFFICE BOX P
OAK RIDGE, TENNESSEE

July 25, 1956

U. S. Atomic Energy Commission
Post Office Box E
Oak Ridge, Tennessee

Attention: Dr. H. M. Roth

Gentlemen:

Subject: Request for Directive No. CR-213, Supplement No. 2
"Process Waste Water Treatment Plant"

References:

1. Oak Ridge National Laboratory General Plant Project, 524-57nl-ORL5, Fiscal Year 1958 Budget Submission, KAD-253.
2. Preliminary Proposal No. 213, "Process Waste Water Treatment Plant", dated June 30, 1954.
3. Request for Directive No. CR-213, "Process Waste Water Treatment Plant", dated June 30, 1954, and Supplement No. 1, dated November 9, 1955.
4. Letters, "ORNL Process Waste Water Treatment Plant", from Director, Oak Ridge National Laboratory to Director, Research and Medicine, dated December 1, 1954, and March 30, 1955.
5. Directive No. CL-174, "Process Waste Water Treatment Plant, Building No. 3518, ORNL", dated April 28, 1955, and Modification No. 1, dated November 16, 1955.
6. Preliminary Report on "Process Waste Water Treatment Plant", by Burns & McDonnell Engineering Company, Kansas City, Missouri, dated October 3, 1955.

This supplement is submitted to request; (1) that funds for the project be increased from \$180,000 as authorized by Directive No. CL-174, Modification No. 1, to \$304,000 as submitted in KAD-253 under Project 524-57nl-ORL5,

July 25, 1956

General Plant Projects, Oak Ridge National Laboratory Budget Estimates for Fiscal Year 1958, (2) that a cost-plus-fixed-fee contractor be authorized to perform a portion of the work and (3) that the completion date be extended.

Bids received December 29, 1955, for the construction of the facility exceeded the funds available; therefore, no contract was awarded.

The architect-engineer's estimate was reviewed in light of the bids received and other pertinent information; on that basis a revised estimate was prepared and a request was submitted for the inclusion of that amount in the Oak Ridge National Laboratory budget for Fiscal Year 1957.

The scope and description of the work is as described in the Request for Directive No. CR-213, "Process Waste Water Treatment Plant", Supplement No. 1, dated November 9, 1955, and the Preliminary Report on "Process Waste Water Treatment Plant" by Burns & McDonnell Engineering Company, Kansas City, Missouri, dated October 3, 1955.

Due to a recent interpretation that the removal of contamination from a construction site be performed by a cost-plus-fixed-fee contractor, it is proposed that the H. K. Ferguson Company complete the excavation and disposal of contaminated earth from the control building, treatment units and pipe trenches.

A revised cost estimate summary reflecting the increased cost and a revised schedule for the project are attached.

It is requested that Directive No. CL-174 be further modified to authorize expenditures as shown on the revised cost estimate summary.

Sincerely yours,

J. A. Swartout
Deputy Director

REVISED SUMMARY COST ESTIMATE

<u>Cost Category</u>	<u>Contracts</u>		<u>ORNL</u>	<u>Total</u>
	<u>Lump-Sum</u>	<u>CPFF</u>		
<u>Direct Construction</u>				
<u>Costs</u>				
Building Costs	\$ 43,000	-0-	-0-	\$ 43,000
Installed or Fixed Equipment	35,700	-0-	-0-	35,700
Building Costs Plus Installed or Fixed Equipment	78,700	-0-	-0-	78,700
Installed Equipment (Outside Building)	138,100	\$4,000	\$ 4,600	146,700
Improvements to Land	1,800	-0-	-0-	1,800
Outside Utilities	18,300	1,400	800	20,500
<u>Engineering Design and Inspection</u>				
Design & Inspection	26,400	-0-	-0-	26,400
Design Criteria	-0-	-0-	1,400	1,400
<u>Indirect Costs</u>	-0-	-0-	3,200	3,200
<u>Allowance for Contingencies</u>	<u>23,700</u>	<u>600</u>	<u>1,000</u>	<u>25,300</u>
Total Gross Project Costs	\$287,000	\$6,000	\$11,000	\$304,000

REVISED STARTING AND COMPLETION DATES

	<u>Start</u>	<u>Complete</u>
<u>Engineering</u>		
Design	5-1-55	12-1-55
Inspection	8-15-56	3-15-57
<u>Construction</u>		
Contract	8-15-56	3-15-57
ORNL	11-15-55	4-15-57

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PRELIMINARY REPORT
ON
PROCESS WASTE WATER TREATMENT PLANT
FOR
UNITED STATES ATOMIC ENERGY COMMISSION
OAK RIDGE, TENNESSEE

o0o

BURNS & McDONNELL ENGINEERING COMPANY

KANSAS CITY, MISSOURI

1955

Job 55-15D

BURNS & McDONNELL
ENGINEERING COMPANY
CONSULTING ENGINEERS
95TH AND TROOST AVENUE
KANSAS CITY, MISSOURI
P. O. BOX 7088 DELMAR 4377

July 8, 1955

United States Atomic Energy Commission
Oak Ridge, Tennessee

Attention: Mr. R. B. Somers

Re: Preliminary Report on
Process Waste Water Treatment Plant

Gentlemen:

In accordance with Letter Contract No. AT-(40-1)-2008 dated June 27, 1955, we have made preliminary studies including a general layout and estimate of cost of all structures, equipment, and appurtenances for the Process Waste Water Treatment Plant.

We hereby submit our preliminary report setting forth our conclusions, recommendations, and estimates, together with a brief discussion of pertinent factors.

Respectfully submitted

BURNS & McDONNELL
Engineering Company

By *C. K. Mathews*

PURPOSE OF THE REPORT:

The purpose of this report is as follows:

1. To describe briefly the low level radioactive waste water treatment process.
2. To outline the operation and the function of the various component parts of the proposed plant.

SCOPE OF THE REPORT:

This report will be limited in scope to a discussion of the following items:

1. The nature and source of low level process waste waters,
2. The present method of process waste water treatment,
3. The proposed method of process waste water treatment,
4. The proposed method for collection and routing of the process waste water,
5. A description of the various component parts of the plant,
6. A cost estimate covering the proposed construction work.

INTRODUCTION:

During the past several years there has been a very pronounced increase in the use of radioactive substances by atomic energy establishments, industry, colleges and universities, hospitals, research laboratories, and for various other scientific investigations. In order to meet these increasing demands for radioactive substances, the Oak Ridge National Laboratory (ORNL) has placed increasing

emphasis on the expansion of its present programs and production facilities.

With the expansion of the ORNL programs and facilities there has been a continuing increase in the quantity of radioactive substances handled. This has, in turn, resulted in increased volumes and concentrations of untreated low level radioactive process waste waters being discharged by the process waste system into White Oak Creek. On several occasions during the past three years surveys have revealed that the level of activity in White Oak Creek and Clinch River has exceeded the accepted average concentration limit of 10^{-7} microcuries per cubic centimeter.

In the future there is every indication that both the volume and activity of low level process wastes being discharged by the process waste system will increase.

The increased volume and activity will also be accompanied by the likelihood of more frequent discharges of large quantities of radioactive substances resulting mainly from accidents and equipment failures.

The ORNL is, therefore, faced with the problem of halting the upward trend of low level radioactive contamination being discharged by the process waste system into White Oak Creek and Clinch River drainage basins if it is to conform to the present maximum permissible concentration standards for the disposal of fission products in water. As a result of considerable laboratory and research investigation, the ORNL has proposed employing the conventional lime-soda ash water softening process as a means of removing excessive radioactivity from waste waters discharged from the process waste system in order to meet the concentration standards fixed for White Oak Creek and Clinch River basins.

THE SOURCES, NATURE, AND QUANTITIES OF PROCESS WASTE WATER:

Low level process wastes result from various laboratory and process operations such as operating area floor washings, cooling water discharge from process tanks and condensers, accidental

spillages, and equipment failures. These process wastes are collected and conveyed by the process waste system to existing earthen retention basins from which they are discharged continually to White Oak Creek.

The process waste may contain any variety of radioactive substances but will generally be composed of those elements found in the center of the periodic table. The process wastes will probably be thoroughly commingled upon arrival at the treatment plant.

Untreated process wastes arriving at the treatment plant will almost always have a low pH value, with a possible low of approximately 2.0. The untreated wastes will contain very little solid matter. From time to time, however, some debris such as paper and bottle corks will be carried down by the process waste water. Small quantities of oils and greases containing radioactivity will be present in the process waste water.

The average flow of process wastes during the past few years has ranged from 0.33 mgd to 0.73 mgd, with peak flows, of very short duration, of 1.5 mgd.

PRESENT METHOD OF TREATMENT:

At the present time process wastes are treated by dilution with the waters of White Oak Creek and Clinch River. This is accomplished by collecting the incoming wastes in earthen retention basins and then slowly releasing them to White Oak Creek.

TREATMENT PROCESS:

The treatment process has been established, in general, by the design criteria, which are based largely on laboratory experiments. The conclusion reached is that adequate removal of radioactivity will be accomplished if a conventional lime-soda treatment plant is constructed. In order to provide flexibility, the plant will be built in duplicate, with piping arranged for either parallel or series flow through the two parts.

The laboratory experiments at Massachusetts Institute of Technology¹ indicate that "stage" treatment is necessary and effective in obtaining high removals of activity. The test results at Oak Ridge also show that "stage", or "repetitive" treatment is effective. However, it is stated that the experiments at Oak Ridge indicate that sufficient removal of activity will be accomplished in not more than two steps (series flow), if a very high pH is maintained and if considerable excess soda ash is applied (several hundred per cent of stoichiometric quantities).

All known experiments indicate that the reaction takes place faster and more completely in the presence of high concentrations of previously formed calcium carbonate crystals.

With the foregoing principles in mind, it is proposed to design the plant in conformance with the following criteria:

- (1) Provide two complete plants having a capacity of one-half million gallons per day (0.5 mgd) each, consisting of rapid mixer, flocculator, and sedimentation basin.
- (2) Arrange piping so that flow can be parallel or in series (two steps).
- (3) Provide pumps for returning the effluent from either or both of the sedimentation basins to the first rapid mixer. This operation will only be possible when inflow of raw waste from the holding tanks is stopped or greatly reduced.
- (4) Provide for pumping sludge from the sedimentation basin sludge hopper to the first rapid mixer, or to a waste sludge tank, as desired.
- (5) If return of sludge to the first rapid mixer, for the purpose of maintaining high concentrations of previously formed crystals, is not permissible or satisfactory (and for starting up) provide for continuous application of ground limestone through dry feeders to accomplish this purpose.

1. "A Study of the Lime-Soda Softening Process as a Method for Decontaminating Radioactive Waters", by Robert F. McCauley et al, September 1, 1953, Massachusetts Institute of Technology, AEC Report NYO-4439. Also see Jour. AWWA 47-487, 494, May, 1955.

- (6) In order to maintain heavy concentration of solids in the flocculator, design flocculators for higher than normal peripheral speeds (five to six feet per second). Design so sprockets can be easily changed to provide optimum speed determined by trial.
- (7) Design flocculators with shafts at right angles to direction of flow to accomplish three things:
 - (a) Short shafts for torque strength,
 - (b) Shaft bearings in dry pits,
 - (c) By reversal of rotation to "sweep" any settled solids along bottom of flocculator tank.
- (8) Provide baffles between flocculator units, thus making possible application of chemicals (CaCl_2) and a degree of mixing at each unit, thus providing a means of repetitive treatment if necessary, or desired.
- (9) Provide chemical feeders in number and of ample capacity to apply:
 - (a) Ground limestone
 - (b) Soda ash
 - (c) Lime (CaO or $\text{Ca}(\text{OH})_2$)
 - (d) Calcium chloride
 - (e) Coagulant (alum or iron sulfate)
- (10) Sedimentation basins to be rectangular and equipped with "straight-line" sludge removal equipment and a separately operated skimmer.
- (11) Sedimentation basins decanted by effluent launders across tank.

DESCRIPTION OF PROCESS WASTE WATER TREATMENT PLANT:

Figure No. 1 shows a general layout of the existing retention basins, pipe lines, and facilities together with the location of the proposed waste treatment plant and appurtenant structures.

Untreated process wastes are conveyed to the site, at various elevations, by six process sewers varying in size from 2-inch to 30-inch. The existing process sewers are constructed mainly of vitrified clay tile pipe except for a small amount of chemical ware pipe.

The new waste flow routing to the waste treatment plant would be as follows:

- (1) Flow from the existing 30-inch process sewer would be intercepted and conveyed by gravity to a new diversion box located north of White Oak Avenue,
- (2) Gravity flow from the 3-inch, and 15-inch process sewers would be intercepted by the new diversion box, as shown on Figure No. 1,
- (3) Flows in the existing (low elevation) 6 and 8-inch process sewers would be routed to an automatic in-line pumping station which would discharge the intercepted wastes into the adjacent diversion box.

The foregoing scheme of waste flow routing would congregate all the process wastes into a single diversion box.

All process waste entering the new diversion box would be monitored to determine the concentration of radioactivity in the waste water. If the monitored activity is below the permissible level for disposal by dilution only, the untreated wastes will be discharged directly through a new 30-inch process bypass sewer to White Oak Creek. If process waste activity is excessively high the monitoring device will activate automatic valves, located in the diversion box, which will shunt the flow through a 30-inch process sewer to either of two new holding tanks.

The holding tanks would be constructed of reinforced concrete in order to keep radioactive waste leakage to a minimum. The capacity of each holding tank would be 500,000 gallons. Earthen basins, of 500,000 gallon capacity, may be used in lieu of the concrete tanks. The use of earthen basins would, however, present the problem of bank maintenance and the more serious problem of preventing radioactive waste seepage into the surrounding ground. Another point to consider is the fact that construction of adequate earthen basins will require utilizing a large area of the present plant site.

The holding tanks would be operated on a "fill and treat" basis, i.e. one tank would be filling while the contents of the other were being treated. Diverted process wastes would be withdrawn from a full holding tank and treated, through a controller, at a uniform treatment plant flow rate of 0.5 mgd.

The flow through the treatment plant would be as follows:

- (1) The process wastes would be pumped to the flash mixer. The flash mixer would be provided with a high speed mechanical agitator mounted for easy removal. Lime, soda ash, and ground limestone would be introduced to the wastes at the flash mixer.
- (2) The waste water would then flow by gravity to the flocculator unit. The flocculator units would be provided with five paddles set at right angles to the direction of flow and have a retention period of 60 minutes. The equipment would provide for reversal of rotational sweep, varying peripheral speeds by easy sprocket changes, and specially coated steel paddle. All motor drives and bearings would be located in dry wells or adjacent to the units for ease of maintenance. Flocculator units would be suitably baffled and outfitted for the addition of calcium chloride if repetitive precipitation is desired.
- (3) Waste water effluent from the flocculator unit would flow by gravity to the settling tank. The settling tank would provide for a retention period of four hours. The settling tanks would be of rectangular design and equipped with "straight-line" sludge removal equipment with the head shaft above the water surface for easy inspection and repair of specially treated steel flights and chains. A separately driven skimmer device for oil and grease removal would be provided for each settling tank. Effluent from the tanks would be withdrawn by means of multiple effluent weirs and discharged either to the "head-end" of the plant or directly to White Oak Creek.
- (4) Settled sludge and skimmings would be withdrawn to separate storage hoppers which would, in turn, be piped for disposal to the sludge storage tank or the sludge returned to the treatment process. Sludge and skimmings would be handled with reciprocating type plunger pumps.

- (5) Waste sludge and skimmings would be stored in a 10,000 gallon elevated steel tank which would provide for easy gravity transfer to a disposal tank truck.
- (6) The control building would contain the necessary pumps (three waste pumps, two sludge pumps, and one sump pump), chemical feeders (two CaCl_2 solution feeders, three lime and ground limestone feeders, and one soda ash feeder, all of the gravimetric dry feed type) connecting piping, valves, and other appurtenances required for the proper operation of the treatment plant. Space would also be provided for storing approximately two weeks supply of chemicals.

COST ESTIMATE:

The following is a summary of the estimated cost of the process waste water treatment plant:

1. Earthwork and Roads	\$ 6,900
2. Concrete Holding Tanks (including protective coating)	83,750
3. Control and Pump Building	22,530
4. Concrete Mixer, Flocculator, and Settling Basins (including protective coating)	60,600
5. Equipment:	
a. Flash mixers	5,000
b. Flocculators	43,000
c. Sludge removal & skimming mechanisms	21,000
d. Process waste pumps	6,000
e. Sludge pumps	3,500
f. Sump pumps	500
g. Chemical Feed Machines	37,000
h. Installation and Miscellaneous Items	29,000
6. Building and Yard Piping	32,220
7. Elevated Sludge Storage Tank	<u>4,000</u>

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Subtotal	\$355,000
Contingencies	<u>53,000</u>
Total Estimated Construction Cost*	\$408,000

* The above estimate does not include the fees of the architect engineer or the cost of any work performed by the ORNL.