10.3 DISCHARGE SYSTEM

The discharge system is the mechanism for release of all CRBRP effluent streams that are scheduled for final disposal in the Clinch River. (Storm water discharge is the single exception - see Section 10.4). Flows to the discharge system include cooling tower blowdown, process wastewater, radioactive waste system effluent and sanitary system effluent. It is the function of the discharge system to provide for the integration of the plant discharge into the main body of the Clinch River. Location of the discharge structure is shown in Figure 10.3-1. 13

Flow quantities and thermal and chemical composition of the CRBRP discharge are presented in Section 3.4, 3.6 and 3.7. Summarizing, the discharge may be characterized as similar to Clinch River water with major points of difference being elevated temperature (maximum temperature of 90°F in July and minimum temperature 60.5°F in December through February) and concentrated chemical composition (by a factor of 2.5). The discharge flow is an annual average of approximately 2432 gpm. During periods following intermittent loadings, the discharge will contain residual chlorine, the concentration of which will not exceed the limitations cited in the NPDES Permit, namely 0.14 mg/l. 13 13

In an environmental sense, the primary concern associated with the discharge system is the degree to which it promotes rapid and thorough mixing of the plant effluent with the river. The mixing zone, its extent and effect on river water quality and aquatic life, is predominately influenced by the discharge system. The ultimate effects of the thermal and chemical properties of the effluent are beyond the control of the discharge system and constitute the provinces of the specific plant systems responsible for those properties (thermal characteristics -- cooling system, chlorine residual -- biocide system, etc.). These effects are addressed, as appropriate in Section 10.1, 10.4, 10.5, and 10.6. Discharges from the CRBRP must comply with the applicable State guidelines relating

to the size of the mixing zone and the standards found in the NPDES Permit. Further, the selected discharge system should reflect the desired goal of reducing adverse environmental impact to that level consistent with the economic constraints of diminishing returns. 13

The discharge system selected for the CRBRP is a submerged single port discharge.

Alternatives considered for the discharge system are:

1. Surface discharge;
2. Submerged discharge; and
3. Variations of submerged discharge angle of nozzle inclination and orientation to river flow.

10.3.1 DESCRIPTION OF ALTERNATIVES

10.3.1.1 SURFACE DISCHARGE

Surface discharge is the simplest and most economically attractive discharge system. The plant effluent is transported via a canal or pipe to the shoreline where merger with the water body is accomplish by an open trough. An environmental disadvantage of surface discharge for power plant applications is the potential for the heated effluent to float out over the surface of the waterway its buoyant properties causing retardation of mixing action.

10.3.1.2 SUBMERGED DISCHARGE

An environmentally desirable alternative to the surface discharge that promotes more rapid and thorough mixing is the submerged discharge. The submerged discharge is designed to provide higher exit velocities than the surface discharge. The opportunity for the formation of an extensive floating layer of heated water is substantially reduced because significant mixing, fostered by a higher discharge velocity, is initiated below the river surface.

A submerged discharge may utilize either a single exit nozzle or any arrangement and number of individual nozzles in a multiport design.

10.3.1.3 VARIATIONS IN SUBMERGED NOZZLE INCLINATION AND ORIENTATION

Submerged discharge nozzles may be positioned in various configurations to respond to the particular characteristics of the receiving water body. Angle of inclination refers to the elevation of the discharge nozzle with respect to the horizontal plane of the water surface. While an angle of zero (horizontally directed jet) is most commonly used, a desire to prevent the expanding discharge plume from interfacing with the bottom of the water body may be satisfied by inclining the nozzle upwards.

Where the plant effluents are to be discharged to a flowing water body, nozzle orientation becomes an important determinant of mixing. Single port discharge nozzles may be oriented to achieve either cross-flow or coflow mixing. Multiports have an additional option in that individual nozzles may be staggered to produce both cross-flow and coflow mixing.

10.3.2 ELIMINATION OF IMPRACTICAL ALTERNATIVES

10.3.2.1 SURFACE DISCHARGE

The surface discharge alternative is eliminated from further consideration because it does not provide for enhanced environmental performance in comparison to the selected system (the submerged single port). As noted in 10.3.1.1, a potential disadvantage of the surface discharge is the flotation of the thermal plume across the water's surface. While this may be advantageous for certain applications on large, quiescent water

bodies (lakes, reservoirs, etc.) where it is desirable to have the plume extend over a sizeable surface area to promote radiant and evaporative heat transfer to the atmosphere, it would not be so for the CRBRP because of the potential for surface water temperatures of several F degrees above ambient developing across the full width of the river during periods of zero flow. Additionally, an area of the river in the vicinity of the discharge would be subjected to water temperature increases in excess of five F degrees due to the poor initial mixing of the heated effluent.

10.3.2.2 COFLOW NOZZLE ORIENTATION

Discharges located on unidirectional flowing waterways are often oriented in the downstream direction to reduce the potential for entrainment of the heated plume in the plant intake and/or to prevent the plume from extending across to the opposite shoreline. For the CRBRP, the intake is sufficiently far upstream from the discharge point to preclude recirculation. Additionally, since the Clinch River does not maintain unidirectional flow, there is a potential for the effluent plume to reach along the discharge point shoreline during periods of zero or reverse flow. Accordingly, orientation of the CRBRP discharge to produce coflow mixing is not considered a practical alternative. 13

10.3.2.3 INCLINED SINGLE PORT DISCHARGE

In the vicinity of the CRBRP discharge, the Clinch River varies from 6 to 12 feet in depth. A potential problem associated with submerged discharge systems in such shallow water is scouring of bottom material. As noted in 10.3.1.3, inclination of the discharge nozzle is an alternative design feature that may be utilized to prevent the developing plume from interfacing with

the river bottom. However, an adverse consequence of nozzle inclination is that the plume reaches the water surface faster and is less diluted by entrained ambient water. This would be particularly pronounced for a single port discharge where the jet momentum at the surface of the Clinch River would be great enough to cause noticeable turbulence. During periods of low pool elevation, a "boil" would be visible at the water surface which could potentially affect small river craft. It is not felt, therefore, that nozzle inclination is a viable design modification for the submerged single port discharge.

10.3.3 SPECIFICATIONS FOR REASONABLE ALTERNATIVES

10.3.3.1 SUBMERGED SINGLE PORT DISCHARGE

Design of the submerged single port discharge system is illustrated in Figure 10.3-2. The plant effluent flows through a 20- inch diameter buried pipe which terminates in an 8-inch diameter exit nozzle. (Note: Previous design was a 12-inch pipe based on pressure flow). Based on studies performed at the Site, a submerged discharge depth of four feet below the minimum water level of 735 feet MSL was selected. Deeper locations are not considered feasible due to the extensive piping into the river traffic channel that would be required. The exit nozzle is oriented for cross-flow mixing. 13

10.3.3.2 SUBMERGED MULTIPORT DISCHARGE

The submerged multiport discharge alternative employs four exit nozzles as shown in Figure 10.3-3. Piping from the plant and discharge depth are identical to that for the single port system. However, the supply pipe is oriented parallel to the river so that the perpendicularly mounted exit nozzles produce cross-flow mixing in the horizontal plane of the water surface. The nozzles are four-inch diameter extensions to the supply pipe and are equally spaced at three-foot intervals.

10.3.3.3 INCLINED MULTIPORT DISCHARGE

The inclined multiport is identical to the system described above (10.3.3.2) except that the nozzles are inclined at an angle of approximately 25 degrees from the horizontal.

10.3.4 ENVIRONMENTAL COSTS

The principal environmental concern relating to the CRBRP discharge system is the manner and effectiveness with which it promotes mixing of waste heat and chemical effluents in the river. Additional considerations include bottom scouring and effects on navigation.

As a discharge plume study has been conducted to evaluate the performance of the selected single port discharge, the results of this study will be described initially to provide a benchmark against which the operation of alternative discharge designs may be measured.

10.3.4.1 ENVIRONMENTAL PERFORMANCE OF THE SELECTED DISCHARGE SYSTEM

To predict thermal and chemical plume development in the Clinch River resulting from plant discharges, a thermal-hydraulic modeling study of the selected single port discharge system was performed by the University of Iowa, Institute of Hydraulic Research. The results of this investigation are presented in Appendices A and B to Section 10.3, and are utilized as the basis for the following discussions. Additionally, the environmental impacts due to thermal and chemical discharges are examined in Sections 5.1 and 5.4, respectively.

10.3.4.1.1 CLINCH RIVER HYDROLOGY

The Clinch River is a regulated stream controlled by TVA dams. As a result, pool elevation and river flow experience fluctuations uncommon to a free flowing stream. The most important consequence of this regulation is the occurrence of periods of no flow at the CRBRP Site due to shutdown of the Melton Hill Dam turbines. Accordingly, the standard parameter for analyzing worst case flow conditions, the 10 years 7 days consecutive low flow, is not applicable to the Clinch River.

INTENTIONALLY BLANK

While thermal and chemical plume development may be predicted on the basis of average values for the various influencing parameters (river flowrate, temperature, pool elevation; discharge velocity and temperature), the above noted variances of the Clinch River make it desirable to examine worst case mixing situations in order to determine upper bound limits on the extent of anticipated adverse environmental impact. Accordingly, extreme as well as typical conditions were modeled and are reported in the Appendices to Section 10.3. The mixing conditions examined include the following:

1. Winter and summer seasonal-average cases;
2. Winter and summer hypothetical worst case for thermal mixing; and
3. Short duration and extended no-flow events - worst case chemical mixing.

Values for the key parameters associated with each of these mixing conditions are presented in Table 10.3-1.

10.3.4.1.2 THERMAL PLUMES

Thermal plumes that may result in the Clinch River due to CRBRP waste heat discharges are illustrated in Figures 10.3-4 through 10.3-7. For all but the winter worst case, the river areas affected by excess temperatures above one F degree are small and confined to the section of the waterway in the immediate vicinity of the discharge point. The 0.9 F degree isotherm for the winter worst case will potentially extend across the river; however, this temperature rise is not considered biologically significant (see Section 5.1).

10.3.4.1.3 CHEMICAL PLUMES

Chemical isopheths (expressed as the percent difference between initial discharge and river ambient concentration) are indicated in Figures 10.3-4 through 10.3-7 for the corresponding isotherms. For all cases examined, the extent of chemical concentration increases which encompass measurable areas of the river is limited to six percent. As a basis for further assessment of worst case chemical mixing, an extended period of zero river flow is discussed in Appendix A to Section 10.3. During such events, chemical plumes may extend for several miles up and downstream of the discharge point. Even this extreme case of a lengthy period of quiescent water will not lead to a substantial concern (see Sec. 5.4), since the plant effluent is essentially river water concentrated by a factor of 2.5 with minor additions of the chemicals. 13 6 13

10.3.4.1.4 BOTTOM SCOURING

As the single port discharge nozzle is centered approximately one and one half feet above the river bottom, the expanding discharge jet will intercept the bottom within several feet from the nozzle. The jet will have retained sufficient momentum at this point to induce movement of bottom material. Based on measurements of the area of bottom scour in the flume used for the thermal-hydraulic modeling, the anticipated areas of the river bottom that would be subjected to sediment disturbance are depicted in Figure 10.3-8. For each of the various cases of river and discharge parameter values examined, the areas of predicted bottom scour are less than 0.01 acre (see Table 10.3A-9, Appendix A to Section 10.3). 6

10.3.4.1.5 EFFECTS ON NAVIGATION

As the proposed discharge structure is submerged to a minimum depth of four feet and does not extend into the navigation channel, no adverse effects on navigation are anticipated.

10.3.4.2 ALTERNATIVE DISCHARGE DESIGNS

10.3.4.2.1 SUBMERGED MULTIPORT

The submerged multiport discharge provides a greater degree of initial mixing than that of the single port as additional entrainment of ambient fluid is produced by a series of individual nozzles. Resulting plume temperatures and chemical concentrations are reduced. A consequence of the initial dilution advantage of the multiport design is more extensive plume growth. While the plumes for the multiport will be similar in shape to those produced by the single port discharge, they will encompass larger areas of the river (although at lower temperatures and chemical concentrations).

Scour holes associated with the multiport may be shallower than those for the single port discharge but will probably extend over a somewhat wider area of the river bottom. As for the single port design, no adverse effects on navigation would be expected.

10.3.4.2.2 INCLINED MULTIPORT

The purpose of nozzle inclination for the CRBRP multiport discharge is to prevent impingement of the developing plume with the river bottom prior to the establishment of sufficient dilution of jet momentum to negate the potential for scouring of sediment. However, plume interception with the river surface occurs sooner resulting in higher surface temperatures and chemical concentrations.

During the fall and winter months when the river pool elevation is at its lowest level, navigation (small river craft) could be potentially affected by plume turbulence caused by the higher jet velocities which reach the water surface for an inclined nozzle discharge. With the multiport design, this impact would not be expected to be substantial.

10.3.5 ECONOMIC COSTS

Economic costs for the discharge system alternatives are presented in Table 10.3-2. The single port discharge is the least expensive alternative while both multiport designs are approximately equal in cost.

10.3.6 COMPARISON OF ALTERNATIVES

10.3.6.1 DIRECT COMPARISON OF REASONABLE ALTERNATIVES

The discharge plume study presented in the Appendices to Section 10.3, environmental impact assessment for thermal and chemical releases in Sections 5.1 and 5.4, respectively, and environmental performance summary in Section 10.3.4.1 all indicate that the selected CRBRP discharge system will provide for rapid mixing of plant effluents and negligible adverse environmental effects. In comparison, the two alternative multiport designs offer environmental improvement in certain areas but, as a result, degrade environmental performance in other areas and incur additional economic cost. The submerged multiport discharge will lower plume temperatures and chemical concentrations; however, areas of the river encompassed by the plumes will be increased. Although elimination of bottom scouring can be achieved through use of an inclined multiport system, surface temperatures and chemical levels will rise. As the magnitude of the increases above river ambient values and extent of the plumes emanating from the single port discharge are very modest and bottom scouring is not a significant environmental impact, the alternative discharge systems do not appear to offer any important degree of overall environmental improvement.

10.3.6.2 REASONS FOR SELECTION OF CHOSEN SYSTEM

The submerged single port discharge is the selected system for the CRBRP. It provides a high degree of mixing effectiveness under both typical

and extreme mixing conditions and ensures a rapid reduction in cooling tower blowdown excess temperature and adequate dilution of chemical effluents.

TABLE 10.3-1

INPUT PARAMETERS FOR MODELING OF THE CRBRP DISCHARGE PLUMES

Mixing Conditions	Plant Discharge				Ambient River Conditions				Initial Jet Parameters			
	Atmospheric Wet Bulb (^{o}F)	Blowdown Temp. (^{o}F)	Blowdown (gpm)	Flow[e] (cfs)	Water Temp. (^{o}F)	Flow Rate (cfs)	Velocity (fps)	Pool Elevation[(h)] (ft MSL)	T_o (^{o}F)	V_o (fps)	F_o	Z/D
Typical Cases												
Average Winter (Jan/Feb/Mar)	43.3[a]	74.9[c]	2,500	5.57	43.9[c]	5,338[g]	1.39	736	31.0	15.96	67.8	7.5
Average Summer (July/Aug/Sep)	73.2[a]	89.3[c]	3,240	7.22	65.7[c]	4,777[g]	0.63	741	23.6	20.68	77.1	15.0
Thermal Worst Cases												
Hypothetical Winter (Jan)	56.2[b]	79.8[d]	2,810	6.26	33[f]	0	0	735	46.8	17.93	68.2	6.0
Hypothetical Summer (June)	74.4[b]	89.6[d]	3,280	7.31	78[f]	0	0	739	11.6	20.94	84.3	12.0
Chemical Worst Cases												
Short Duration No Flow												
Winter (Jan)	56.2[b]	79.8[d]	2,810	6.26	33[f]	0	0	735	46.8	17.93	68.2	6.0
Summer (June)	74.4[b]	89.6[d]	3,280	7.31	78[f]	0	0	739	11.6	20.94	84.3	12.0

Table 3.4-3

Bull Run Steam Plant Data, 1/70-12/73

Table 10.3A-1

Figure 10.3A-2; account taken of cooling effect of makeup flow

Figure 10.3A-2

Clinch River (m 21.6) Data, 6/62-9/72

Table 2.5-3 (data base May 1963 - Dec. 1973)

Table 2.5-5 (data base Jan. 1964 - Dec. 1973)

TABLE 10.3-2

CAPITAL COSTS FOR DISCHARGE SYSTEM ALTERNATIVES

	Submerged Single Port	Submerged Multiport	Inclined Multiport
Material Cost	Base	$1,000	$1,000
Installation Cost	Base	$3,000	$3,000
Total Differential Capital Cost	Base	$4,000	$4,000
Operating Cost (Pumping Requirement)	Same	Same	Same

(Note: Economic comparison based on 12-inch pipe. Present design is 20-inch. Relative economics are not affected by this revision in design) 13*

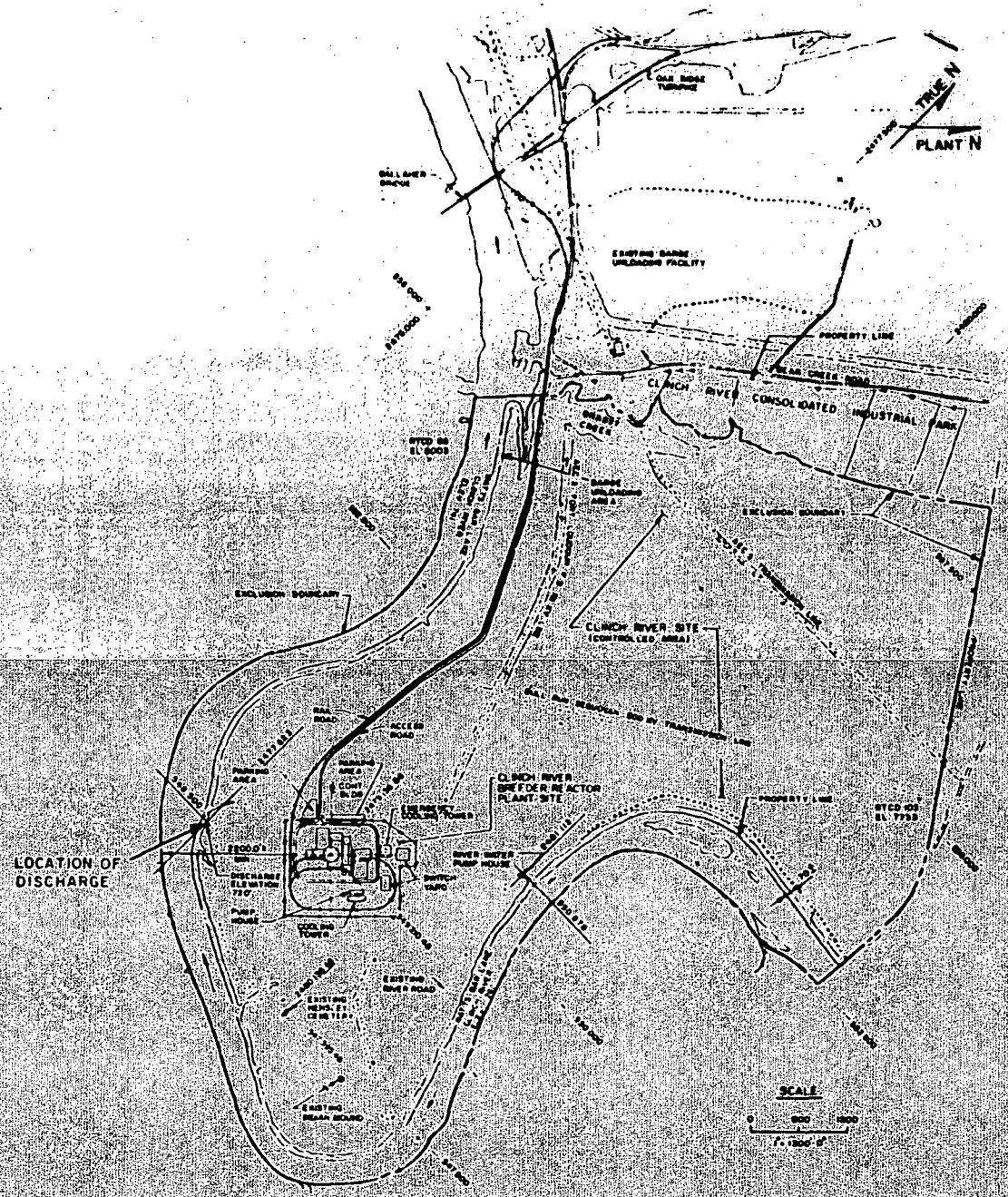


Figure 10.3-1 LOCATION OF CRBRP DISCHARGE

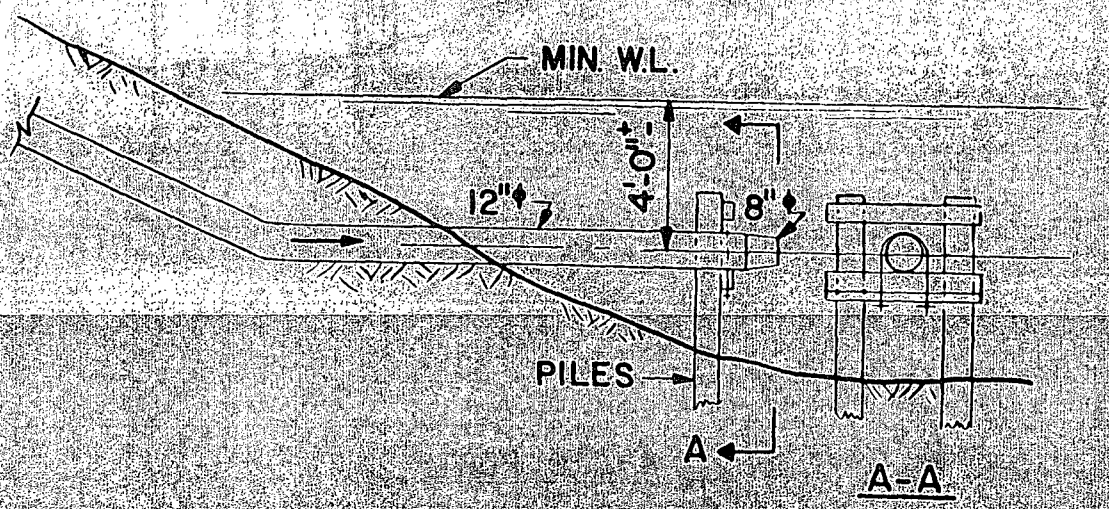
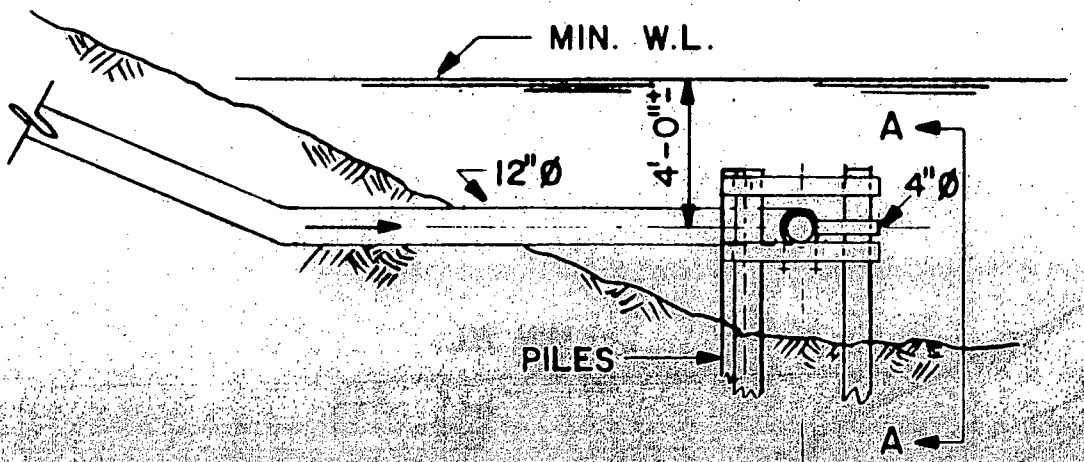
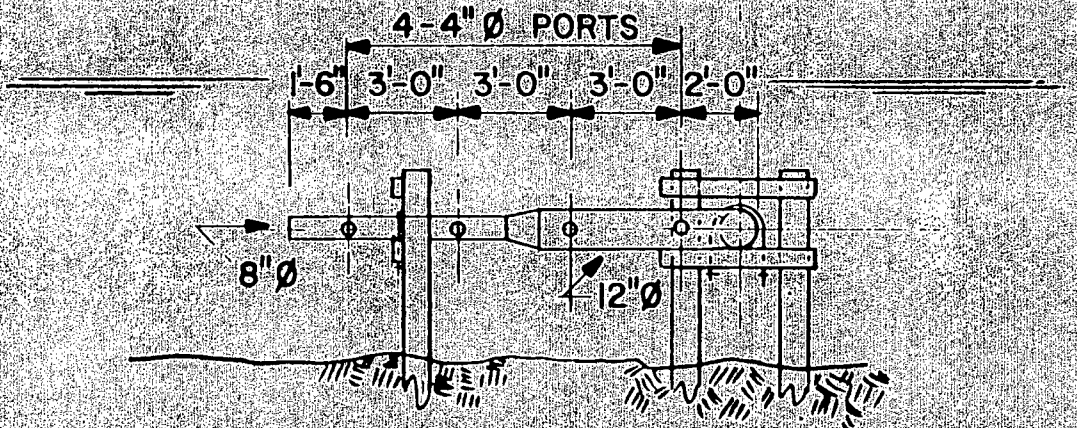


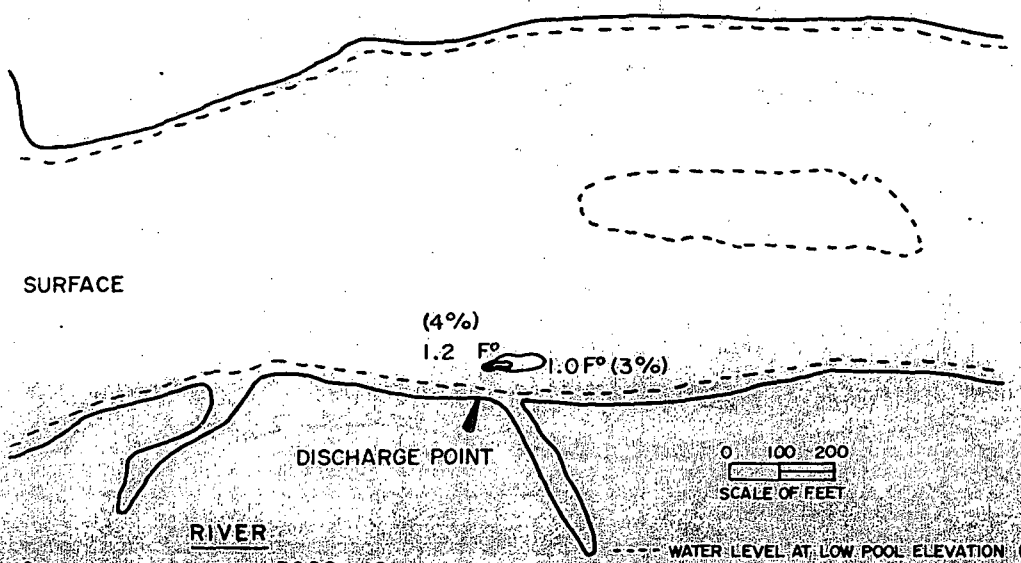
Figure 10.3-2 SUBMERGED SINGLE PORT DISCHARGE





A-A

Figure 10.3-3 SUBMERGED MULTIPORT DISCHARGE ALTERNATIVE



RIVER

flow = 5338 cfs
velocity = 1.39 fps (0.87 fps)*
pool elevation = 736 ft MSL

DISCHARGE JET

flow = 5.57 cfs
velocity = 15.96 fps
temp. diff. = 31.0F°

*Prototype velocity based on hydraulic model velocity. Reflects physical limitations of the flume.

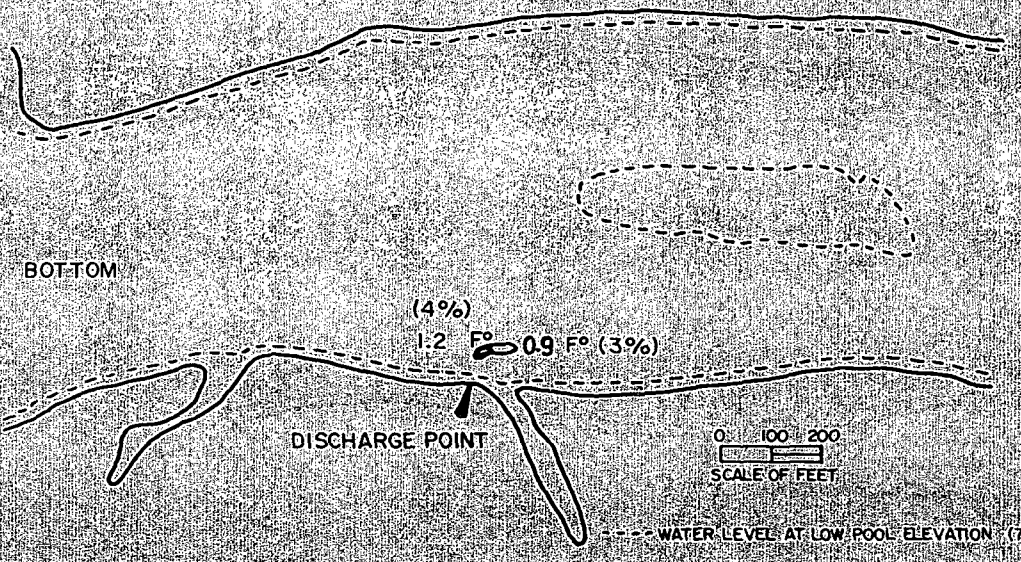
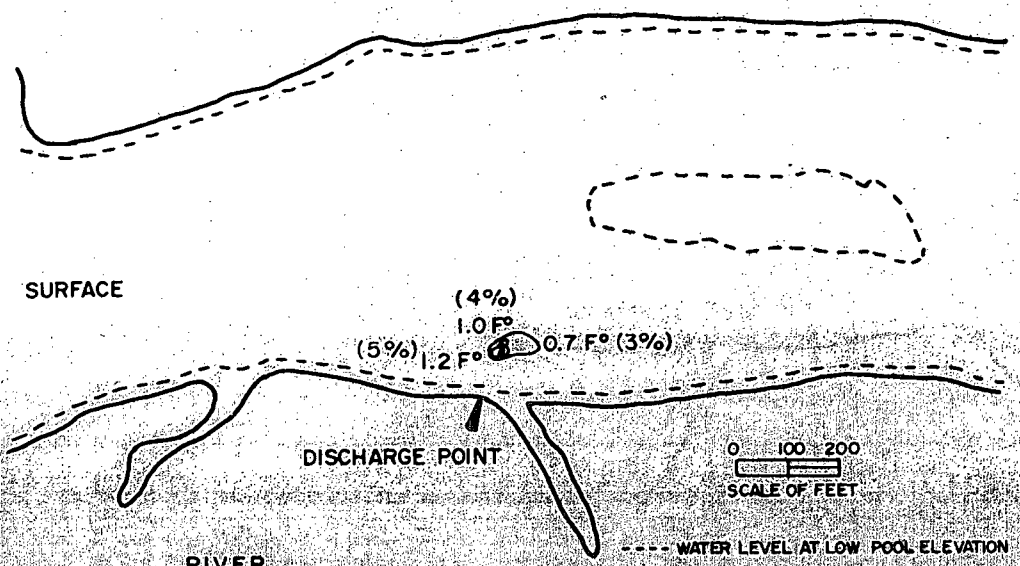


Figure 10.3-4 TYPICAL CASE-WINTER



RIVER

flow = 4777 cfs
velocity = 0.63 fps (0.50 fps)*
pool elevation = 741 ft MSL

DISCHARGE JET

flow = 7.22 cfs
velocity = 20.68 fps
temp. diff. = 23.6F°

*Prototype velocity based on hydraulic model velocity. Reflects physical limitations of the flume.

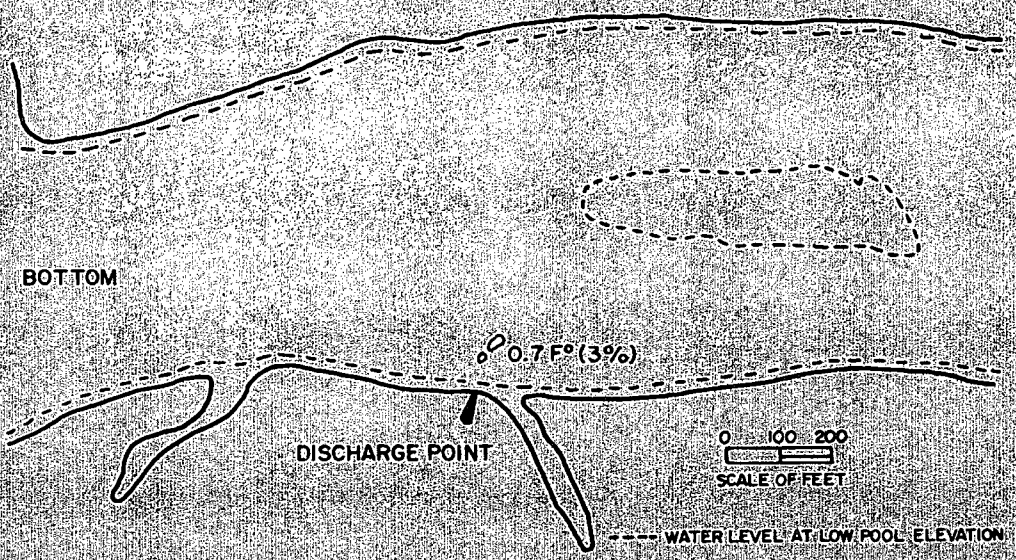
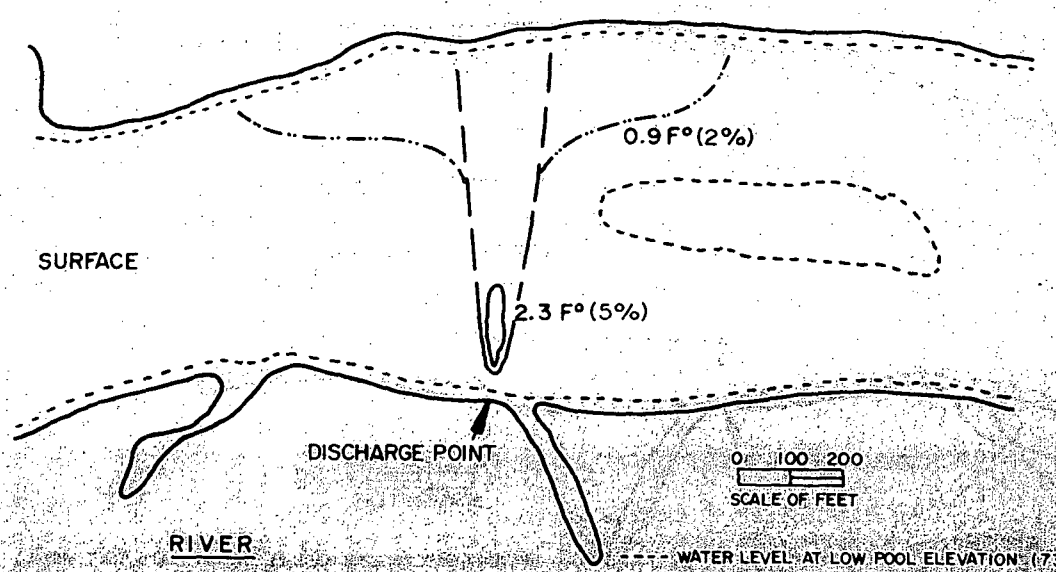


Figure 10.3-5 TYPICAL CASE-SUMMER



RIVER

flow = 0
velocity = 0 (0.17 fps)*
pool elevation = 735 ft MSL
temperature = 33°F

WATER LEVEL AT LOW POOL ELEVATION (735 FEET MSL).

EXTRAPOLATION OF PLUME WIDTH GROWTH BASED ON PHYSICAL MODEL DATA.

ESTIMATION OF PLUME DISTORATION DUE TO INTERACTION WITH OPPOSITE SHORE.

DISCHARGE JET

flow = 6.26 cfs
velocity = 17.93 fps
temp. diff. = 46.8F°

*Prototype velocity based on hydraulic model velocity. Reflects necessity of maintaining a flume crossflow to permit the attainment of steady-state conditions.

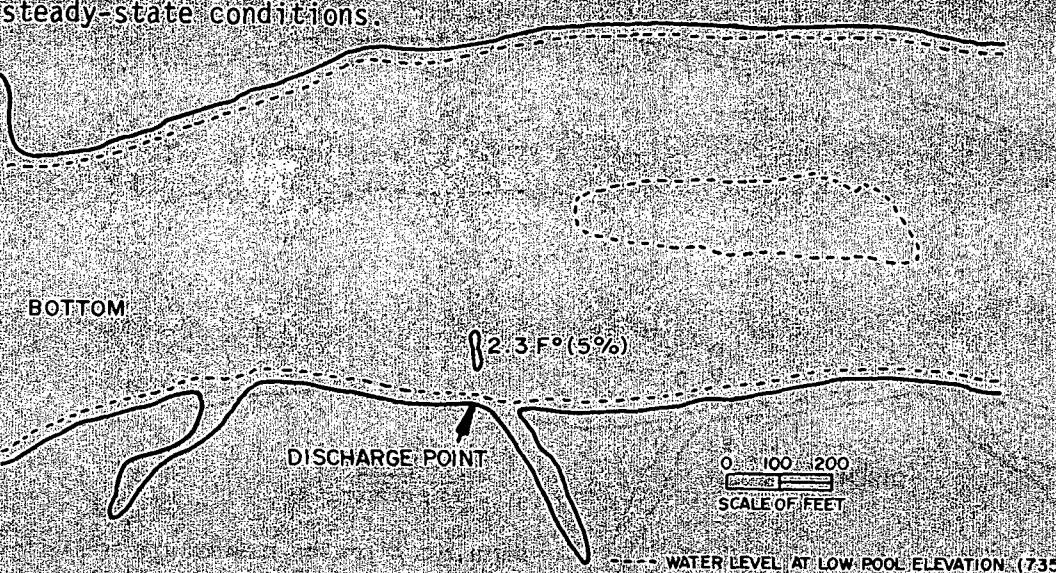
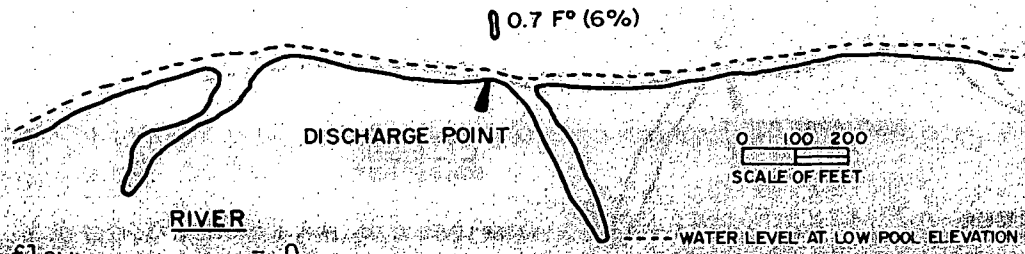


Figure 10.3-6 HYPOTHETICAL EXTREME CASE-WINTER (SHORT DURATION NO FLOW)

SURFACE



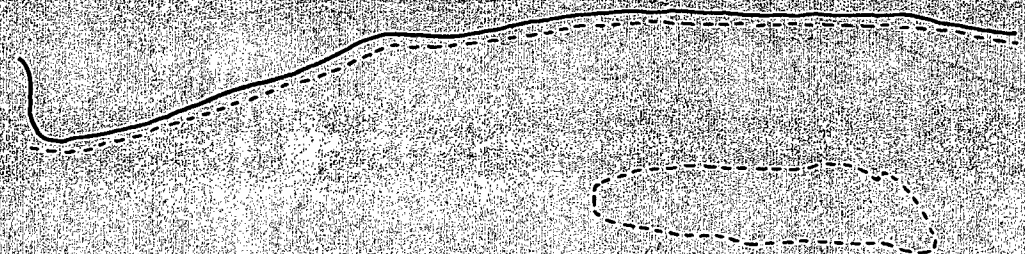
RIVER

flow = 0
velocity = 0 (0.17 fps)*
pool elevation = 739 ft MSL
temperature = 78°F

DISCHARGE JET

flow = 7.31 cfs
velocity = 20.94 fps
temp. diff. = 11.6F°

*Prototype velocity based on hydraulic model velocity. Reflects necessity of maintaining a flume crossflow to permit the attainment of steady-state conditions.



BOTTOM

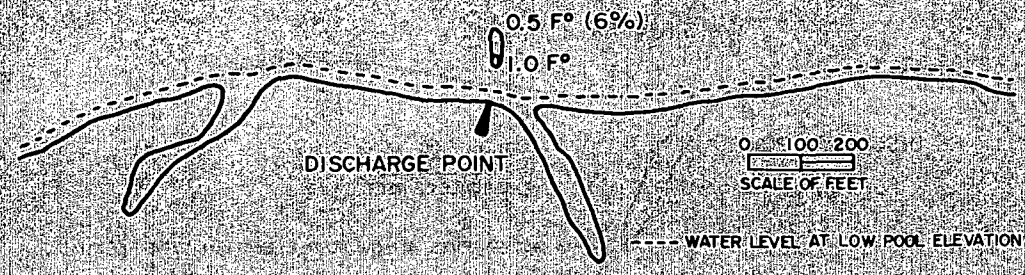
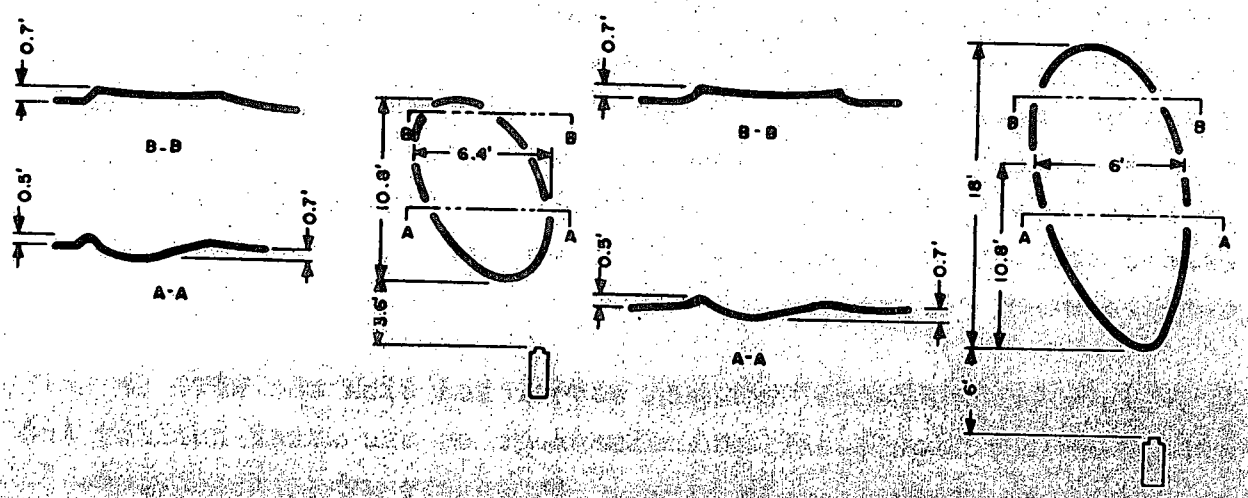
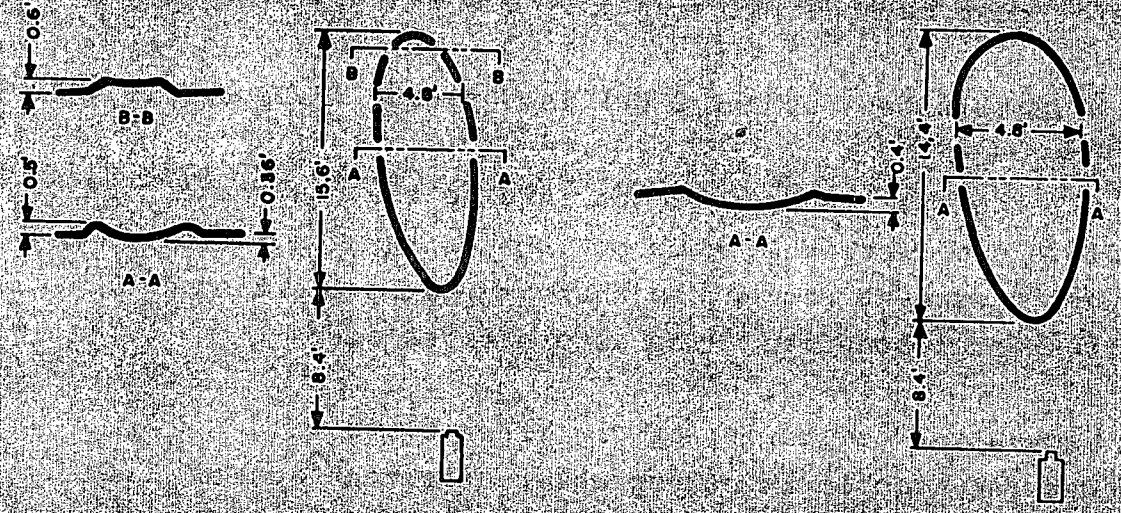


Figure 10.3-7 HYPOTHETICAL EXTREME CASE-SUMMER (SHORT DURATION NO FLOW)



WINTER - TYPICAL

SUMMER - TYPICAL



WINTER - WORST

SUMMER - WORST

Figure 10.3-8 AREAS OF BOTTOM SCOURING

10.4 WASTE WATER TREATMENT SYSTEM

The Waste Water Treatment System (WWTS) provides facilities for collection, treatment and disposal of all non-radioactive floor drainage, cooling tower blowdown, and process water treatment system wastes. Most of the wastes are discharged to the system on an intermittent basis, both scheduled and unscheduled. The wastes vary in chemical/physical characteristics and in temperatures. 13

A primary environmental concern associated with the WWTS is the effect of its liquid effluent discharge on the water quality and aquatic life of the Clinch River. Secondary concerns include disposal of sludges and environmental costs related to the operation of treatment processes. 13

The WWTS is designed to comply with applicable Federal and State requirements as indicated in Table 10.4-1 and is furthermore designed to minimize environmental impacts consistent with the benefit-cost balance. 13

The WWTS selected for the CRBRP is depicted in Figure 10.4-1. 13

The alternatives study does not involve the examination of completely different systems but rather the consideration of further treatment procedures that may yield additional environmental benefits. The alternatives are: 13

1. Mechanical dewatering of clarifier blowdown;
2. Reverse osmosis in makeup water treatment system; and
3. Zero discharge of effluent. 13

10.4.1 DESCRIPTION OF ALTERNATIVES

To facilitate the description of alternatives and to clarify their relation to the system as a whole, a description of the reference (selected) Waste Water Treatment System will precede the presentation of the alternatives. 13

10.4.1.1 REFERENCE SYSTEM DESIGN

10.4.1.1.1 WASTE STREAMS

As previously noted, the proposed WWTS handles waste streams that vary widely in volume, type and frequency. These may be divided into two major categories: neutral wastes, (non-rad floordrains, HVAC cooling coil condensate drains, non-sodium fire protection sprinkling, auxiliary boiler blowdown and oil storage area drains) and non-neutral wastes, (polisher regeneration waste water, chemical storage area drains, make-up demineralizer regeneration waste water, feedwater and steam sampling wastes). 13 Additional sources of discharge are cooling tower blowdown, stormwater drainage, sewage treatment effluent and low activity level liquid (LALL) radioactive wastes. Sewage treatment effluent and LALL discharges are discussed in Sections 10.6 and 10.7, respectively.

The source of all waste streams, the anticipated frequency and average and maximum quantities of these wastes are identified in Table 10.4-2.

Cooling Tower Blowdown

Cooling tower blowdown is the largest continuous waste stream produced during plant operation. The quantity of cooling

tower blowdown depends on reactor power level, ambient temperature and humidity, drift losses and the concentration of solids in the makeup water. Generally, the blowdown is continuous during normal operation and for full power operation varies from a summer time average of approximately 2,650 gpm to a winter average of 1,955 gpm. Blowdown temperature also varies from a maximum of 91 to a minimum of 61 degrees F. 13

During operation of the cooling tower, the combination of evaporation, drift, makeup and blowdown results in a buildup in the concentration of dissolved solids in the cooling system. Bicarbonate alkalinity in the cooling system also increases. The increase in alkalinity results in an increase in pH and carbonate concentrations. As pH and carbonate concentrations increase, the solubility of calcium carbonate decreases resulting in a calcium carbonate scale. Scaling of the condenser heat transfer surfaces results in a gradual decrease in plant operating efficiency and eventual loss of generating capacity. To preclude this loss, the blowdown rate is controlled to maintain the concentration of dissolved solids in the cooling system at approximately 2.5 times the river water dissolved solids concentration. The normal range of dissolved solids concentration in the blowdown will be approximately 220 to 360 mg/l. Calcium carbonate scaling conditions are not anticipated during normal operation of the CRBRP.

Use of corrosion inhibitors in the cooling water will not be required since the blowdown ranges from chemically balanced to only slightly scale forming. It should be noted that the cooling water system services not only the main condenser but other plant auxiliary cooling systems.

No wood will be used in the cooling tower construction. Therefore, chemical wood preservatives will not be extracted and discharged to the river.

The makeup water coming from the river will contain various types of microbiological organisms. Biological growth on heat transfer surfaces causes fouling which reduces heat transfer and creates a loss in efficiency. The service lifetime of the cooling system components will also be decreased, since algae, slimes and bacteria all increase the corrosion rate of metal surfaces. To prevent deposits from

forming, a biocide system will be employed. This system and alternatives are discussed in Section 10.5. 13

Storm Water

Storm water is comprised of rainwater collected by roof drains and yard drains. The quantity of runoff is a function of rainfall intensity, frequency, duration, site topography, vegetation, condition of soil and general layout of buildings, roads and other paved areas. 13

Outdoor oil and chemical storage tanks, unloading facilities and the transformer area are provided with dikes designed to retain leakage or spillage from this equipment. This will preclude their entry into the yard drain system.

Neutral Wastes

1. Filter Backwashes -- The Makeup Water Treatment System produces demineralized water for consensate makeup, laboratory use and other plant uses. The Makeup Water Treatment System includes gravity filters and activated carbon filters as part of the treatment process. All collect some suspended solids in their beds during operation. Filters are backwashed once a day for about 15 minutes. Backwash Water will be discharged to the sludge lagoons of the Waste Water Disposal System 13

2. Clarifier Blowdown--The Makeup Water Treatment System employs a clarifier which produces a sludge blowdown, consisting of river water, suspended solids and aluminum hydrate. Blowdown will be directed to the sludge lagoons. 13

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3. Non-Radioactive Floor Drainage--The building floor drains collect a wastewater that requires processing for oil removal. This water will be similar to river water and may contain a higher concentration of suspended solids.

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Non-Neutral Waste

1. Condensate Polishing System Wastes--The rinses, backwashes and regenerants from the condensate polishing system will consist of high dissolved solids wastewater. Concentration of dissolved solids in this stream is expected to be from 8,000 to 14,000 mg/l. About 85 percent of these solids will be sodium and sulfate and the remaining 15 percent will be primarily iron, calcium and magnesium with some traces of nickel and copper. 13

2. Makeup Water Treatment System Demineralizer Regenerant Waste--This waste stream will be similar to the Condensate Polishing System Wastes. 13

3. Auxiliary Steam Generator Blowdown--During startup, a small generator is used and approximately one gpm of blowdown will be produced. The blowdown will be alkaline, pH 9.0 to 9.5 and the temperature will be approximately 250 degrees F. It will contain approximately 200 mg/l dissolved solids and 0.5 mg/l ammonia. Hydrazine will be used as an oxygen scavenger in the generator water. Hydrazine decomposes to nitrogen and ammonia and does not produce suspended solids in the reaction.

4. Plant Laboratory and Feedwater and Steam Sampling Wastes--These wastes will be non-radioactive chemical wastes produced by laboratory analysis of the treated water systems and the various samples from in-plant monitoring. 13

5. Chemical Cleaning Wastes--Periodic chemical cleaning of large components such as the Auxiliary Steam Generator and Condenser will be required. This cleaning is done in several stages and the chemicals used depend on the metallurgy. A typical procedure involves alkaline and acid washings and rinsing and neutralizing and passivating rinses. The volume of these wastes is expected to be in the order of 500,000 gallons. Chemical cleaning wastes will be disposed of off-site by a state-approved, licensed contractor. 13

10.4.1.1.2 PROCESS DESCRIPTION

A schematic diagram of the reference Waste Water Treatment System is shown in Figure 10.4-1. The treatment processes for waste water treatment (neutral and non-neutral wastes), blowdown, and stormwater are described below.

Wastewater Treatment

Floor drain wastes that may contain oil undergo oil-water separation prior to discharge to the equalization basins. Oil from the separation process is discharged to a waste oil tank which will be periodically pumped out by a licensed contractor who will dispose of the waste oil off-site. Non-oily floor drains discharge to the equalization basins directly.

Chemical wastes, associated with process water treatment, consist of regeneration cycle wastes from the Condensate Polishing System, the Make-up Water Treatment System, Plant Laboratory and Feedwater and Steam Sampling and TGB (Turbine Generator Building) chemical storage area drains, and discharge to the chemical waste sump in the TGB. The wastes are then pumped to the batch chemical waste neutralization system located in the Waste Water Treatment area of the plant yard. Following neutralization, these wastes are discharged to the equalization basins.

The equalization basins consist of two equal capacity compartments, each compartment sized to provide one full day of storage capacity for normal plant waste volumes. Dual compartment design permits the basins to operate alternately: one in service, one in clean-up or standby. Since plant wastes are discharged at variable frequency and duration, and have variable characteristics, the basins provide equalization of flow and characteristics and hold-up capacity prior to processing in downstream treatment units. 13

Plant wastewater is pumped from the equalization basins to downstream treatment units by three submersible pumps which are located in a pre-cast concrete wetwell adjacent to the eualization basins. Each pump is designed to provide continuous discharge of wastewater based on average plant flows. Two pumps will handle unusual waste volumes resulting from intermittent discharges such as Fire Protection System discharge, high volume tank and basin cleanings and any unscheduled discharges. The third pump is a standby in case of pump failure. A flow meter on the discharge line monitors and records plant waste flows and provides a signal for pacing chemical feed in downstream treatment units.

The wastewater treatment units consist of the following major components: pH trim tank, solids contact clarifier and automatic gravity filters. These units are located in the Waste Water Treatment area of the plant yard. Appurtenant equipment consisting of bulk chemical storage tanks, mix tanks, chemical feed pumps, controls, instruments and associated panels is located within the Waste Disposal Building in the same area of the yard.

Wastewater pumped from the equalization basins is discharged to the pH trim tank which provides sufficient detention time for adjustment of wastewater pH to optimize the performance of the downstream solids contact clarifier. The pH trim tank is fitted with a mixer at the inlet end and a pH sensor at the outlet end. This sensor works in conjunction with a pH sensor located in the wastewater wetwell at the equalization basins to provide pH control. The pH controls pace a set of acid or caustic feed pumps, as required, to maintain a narrow preset pH range. The optimum pH range will be determined on a regular basis by plant operators. 13

From the pH trim tank, wastewater flows by gravity to the solids contact clarifier. The clarifier removes suspended solids and dissolved iron and copper from the wastewater stream. The clarifier provides flash mixing of chemicals and previously formed precipitates with inlet wastes, flocculation and clarification of wastewater. Solids produced in the clarifier are moved by a sludge scraper mechanism to a hopper in the clarifier bottom and are removed from the clarifier by an automatic system of backflush and blow-off valves. The sludge

removal cycle is adjustable and is paced by inlet flow. Cycle adjustments will be established and modified as required to maintain optimum clarifier performance based on waste characteristics. Chemical feed to the clarifier is paced by the flowmeter in the influent pump discharge line. Chemical dosage rates will be determined by plant operators on a periodic basis.

Following the solids contact clarifier, treated wastewater flows by gravity to two full design capacity automatic gravity filters. The filters remove traces of suspended solids, oil and grease and assure that the effluent meets the discharge limits stipulated in the CRBRP discharge permit. The backwashing of the filters is completely automatic and is based on loss of head through the filter media. The filter backwash system includes air scour of filter media to enhance the removal of sticky or gelatinous materials. Filter controls are interlocked so as to prevent simultaneous backwash of both filters. 13

Filter effluent is monitored for turbidity, oil and grease, and pH by automatic analyzers located in the Waste Disposal Building. An excursion in any of these parameters beyond discharge limits automatically diverts plant effluent back to the equalization basins so as not to contravene discharge limits.

Normally, plant effluent is combined with blowdown and discharged to the Clinch River. If chemistry permits, plant effluent can be discharged to the cooling tower basins for recycling.

The Waste Disposal building contains bulk storage tanks for acid and caustic; acid and caustic feed pumps; coagulant mix tanks and feed pumps; coagulant acid mix tanks and feed pumps; and instruments, controls and alarms associated with the waste water treatment and disposal process.

Solid Wastes

Plant wastes containing high suspended solids, including Make-up Water Treatment System clarifier blowdown, gravity filter backwash and activated carbon filter backwash; Waste Water Disposal System clarifier blowdown and gravity filter backwash; and other plant wastes such as cooling tower basin clean-up, are discharged to the sludge lagoons. The sludge lagoons are located adjacent to the equalization basins and are comprised of two equal capacity compartments. Dual compartment design permits the lagoons to operate alternately: one in service, one in clean-up or standby. Each compartment is sized to hold the solids production of approximately six months. Accumulated solids (sludge) will be removed and disposed of off-site by a licensed contractor. As sludge settles and thickens, clear supernatant is recycled to the equalization basins. 13

Cooling Tower Blowdown

The cooling tower blowdown discharge is designed to satisfy all effluent limitations imposed by the NPDES Permit. Monitoring of temperatures, pH and residual biocide is provided. No oil or grease is expected in the blowdown.

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10.4.1.2 ALTERNATIVES

Three areas within the Waste Water Treatment System were considered potentially applicable to further treatment: the clarifier blowdown; the volume of regenerant wastes produced; and the plant effluent. Each of the alternatives presented is designed to reduce the volume and/or improve the quality of its associated waste stream, thus enhancing the overall environmental performance of the waste treatment system. (Relative performance of several of the alternatives is included within Table 10.4-3). 13

10.4.1.2.1 MECHANICAL DEWATERING OF CLARIFIER BLOWDOWN

Gravity sludge drying beds and lagoons generally produce a sludge that is 10 to 40 weight-percent solids. The percentage achieved is a function of retention time and meteorological conditions. Mechanical dewatering is an alternative that often produces a more compact and a dryer sludge. The environmental advantages of this process include reduction in solid waste volume and a slight increase of recyclable water. 13

Two mechanical dewatering methods may be utilized: rotary vacuum filtration or centrifugation. Both require a thickener for pretreatment of the sludge.

10.4.1.2.2 REVERSE OSMOSIS IN MAKEUP WATER TREATMENT SYSTEM

The waste stream containing the highest level of impurities is the process water treatment wastewater. One method of further treating this stream is to reduce its volume at the source. Demineralizers are employed by the Makeup Water Treatment System to obtain the high quality water required for condensate makeup. Daily regeneration of the demineralizer beds is needed. This produces approximately 27,000 gpd input to the waste stream. 13

Frequency of regeneration and, consequently, the volume of wastewater can be reduced by providing pretreatment of the demineralizer influent through reverse osmosis.

Reverse osmosis reduces the dissolved solids content of water by reversing the process of natural osmosis through pressure-forced flow across a semipermeable membrane. The products of reverse osmosis are a low TDS effluent and a high TDS brine.

10.4.1.2.3 ZERO DISCHARGE OF WASTE WATER TREATMENT EFFLUENT | 13

A second alternative method of treating the waste streams is to provide a level of additional treatment to the effluent that will result in zero discharge to the Clinch River. Three processes that accomplish this are identified: off-site treatment at an existing facility, on-site percolation ponds, and evaporation. | 13

Off-Site Treatment

The processing of wastewater at an existing treatment facility is a potential means of achieving zero discharge at the site. A suitable facility capable of handling the increased load without suffering loss of efficiency and located close enough to keep pipeline construction and pumping costs reasonable is required. Pretreatment standards (EPA) would have to be met. | 13

Percolation Ponds

Percolation ponds would utilize the natural capacity of soil to absorb the wastewater treatment effluent prior to its entry into the groundwater supply. | 13

Successful application of ground discharge requires suitable soil composition and depth such that anticipated hydraulic loadings can be applied without clogging or back-up. 13

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Evaporation

An evaporation process can be employed to produce a high quality liquid effluent that is suitable for recycle. The evaporation procedure is a form of distillation in which the wastewater influent is vaporized and then condensed. Typical TDS levels for the condensate are in the order of 10 mg/l. By-products of the evaporation cycle are a concentrated brine and some release of chemicals to the atmosphere. The evaporation process would not only provide zero release of high TDS effluent to the river but also reduce makeup water requirements through recycle of the liquid effluent to the cooling tower basin.

10.4.2 ELIMINATION OF IMPRACTICAL ALTERNATIVES

10.4.2.1 MECHANICAL DEWATERING OF CLARIFIER BLOWDOWN

Sludge dewatering by either vacuum filtration or centrifugation are alternatives to the sludge lagoons. Use of these processes will require sludge holding tanks, mixing tanks, pumping equipment and process control equipment. Consequently, it is a process that requires continuous operator attention. Other disadvantages of thickening using sludge dewatering equipment include increased energy consumption, higher local noise levels, potential use of chemicals as sludge conditioning agents for rotary vacuum filtration or centrifugation. Unlike sludge lagoons, the rotary vacuum filters and centrifuges will be placed inside a building. 13

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Therefore, in view of its many drawbacks, mechanical sludge dewatering cannot be considered a reasonable alternative.

10.4.2.2 REVERSE OSMOSIS IN MAKEUP WATER TREATMENT SYSTEM

Addition of a reverse osmosis system to the Makeup Water Treatment System has the potential to reduce the frequency of the demineralizer regenerations and, therefore, the quantity of this waste stream. However, this application of reverse osmosis has several disadvantages. The reverse osmosis unit reduces the amount of regenerant waste, but its brine flow, while lower in solids, is higher in volume than the regenerant waste from the demineralizers. The unit will have to be operated on a start-stop basis or employ a surge tank since the flow rate is basically fixed by the minimum pressure requirement for proper salt rejection and the maximum pressure to avoid serious compaction of the membranes. The high alkalinity water will require pretreatment to avoid carbonate scaling in the unit. A decarbonator is required for the removal of carbon dioxide and to reduce the anion load in the demineralizer. Reliability of the reverse osmosis system is questionable. Therefore, the size of the demineralizers and the waste treatment facilities cannot be reduced, since there is a risk of loss of capacity in the reverse osmosis sytem.

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In view of the above enumerated difficulties and the fact that its use would only reduce (not eliminate) a regeneration waste stream that represents about one-third of the influent flow to the waste water treatment facility, reverse osmosis does not represent a reasonable alternative for the waste treatment system.

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10.4.2.3 OFF-SITE DISPOSAL OF WASTEWATER TREATMENT EFFLUENT |13

Off-site disposal of effluent was considered. Upon |13
investigation, it has been learned that, at this time, there are no treatment plants in the vicinity of the Site which can accept this quantity or type of effluent. This alternative is, therefore, not considered to be feasible.

10.4.2.4 PERCOLATION PONDS

Sending the effluent to percolation ponds for disposal was |13
considered. The use of ground discharge is predicated on the availability of suitable soil conditions. Soil in the area of the CRBRP has been determined to be clay to a depth of 20 to 30 feet. This alternative is, therefore, not considered to be feasible based on the poor absorption characteristics exhibited by clay soils.

10.4.3 SPECIFICATIONS FOR REASONABLE ALTERNATIVES

The only alternative to the reference waste treatment system |13
which warrants futher consideration is the additional treatment of effluent by an evaporation system. |13

Employment of an evaporator will result in concentration of the |13
wastewater into a brine and recovery of about 95 percent of the water as a high quality condensate (approximately 10 mg/l total solids).

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Evaporator design is based on a vapor-compression thermodynamic cycle. Other evaporation types would provide a similar service but would involve multiple units because of the high flow during startup operation. Also the metallurgical design of other less expensive evaporators was not considered to be operationally reliable for this application.

Vapor-compression evaporation concentrates the waste stream by raising the inlet water to the boiling point. Following pH correction and carbon dioxide removal with a scrubber, the feedwater is pumped to the heat transfer tubes where additional heat is added and the water vaporizes. Vapor is pumped to the opposite side of the tubes where condensation occurs. The condensate is then recycled to the cooling tower as makeup water and the brine sent for further processing. 13

Two processing methods for the brine are a small solar pond and mechanical spray dryers. While a solar pond is an inexpensive and reliable method for ultimate disposal, this alternative is limited to sites having higher net evaporation rates than are available at the Site. A mechanical spray dryer can be used to produce a dry powder that is collected in a dust-free manner in containers for disposal. 13

10.4.4 ENVIRONMENTAL COSTS

The principal environmental concern associated with the CRBRP waste treatment system is the effect of its liquid discharge on the water quality and aquatic life of the Clinch River. For the purpose of the alternatives study, it is sufficient to utilize a single parameter -- total dissolved solids -- for comparing the magnitude of the effects produced by the reference system and evaporator alternative. 13

By eliminating the discharge of a high solids content effluent and permitting recycle of the waste stream, the evaporator reduces by about 100 gpm the plant makeup water requirement and cooling tower blowdown flow rate, and produces less than a 1.5% decrease in the TDS concentration resulting from the CRBRP common plant discharge. The significance of these environmental improvements is a function of the magnitude of their ultimate benefit to the Clinch River. 13

The waste recycle afforded by the evaporation process yields a net decrease of 1.6 and 4.3 percent in makeup water requirement and blowdown flow rate, respectively. These quantities are quite small and constiture only a negligible water use savings. 13

Value of the improvement in discharge water chemistry realized by employment of the evaporator alternative must be measured against the severity of the potential adverse effects produced by the reference system discharge. Changes in river TDS concentration caused by the effluents of the reference waste treatment system alone and with the addition of the evaporator are presented in Table 10.4-4. Four cases representing the full range of possible river flow conditions, including extended no flow cases, are examined as discussed in the Appendices to Section 10.3. 13 6

Increases in river TDS concentrations for flowing water (typical) cases due to discharges from the reference system are approximately 8 mg/l and are limited to 0.07 acre of the river surface. Even for the extreme cases, these levels are considerably below the 500 mg/l maximum adopted by the Tennessee Water Quality Control Board as a general criterion for its most stringent water quality requirements.(2) Addition of the evaporator yields very small reductions in the concentrations associated with the reference system effluent. 13 6

An evaluation of the data presented in Table 10.4-4 indicates that the quality and quantity of the effluent from the reference waste treatment system are such that no significant water quality changes will occur under any probable river conditions. Consequently, no adverse impact on aquatic life is anticipated. The inclusion of an evaporator process yields only marginal environmental improvements in river water quality due, primarily, to the low volume of the waste stream. A greater reduction in TDS would be produced by evaporation 13 13

(or similar treatment) of the large volume cooling tower blowdown stream. However, two factors strongly argue against such action: (1) the actual amount of solids in the tower blowdown is the same as that removed from the river during makeup -- TDS concentration is raised only because the water volume is decreased (through cooling tower evaporation, drift, etc.); and (2) the reference Waste Water Treatment System has been shown to be environmentally acceptable and, thus, the high costs of blowdown TDS treatment would not be justified. |13

10.4.5 ECONOMIC COSTS

Monetary costs for the waste treatment system alternatives are presented in Table 10.4-5. The increases in the investment cost attributable to the evaporator is $592,850. |13 |13

10.4.6 COMPARISON OF ALTERNATIVES

10.4.6.1 DIRECT COMPARISON OF REASONABLE ALTERNATIVES

Employment of an evaporator process within the proposed waste treatment system has been identified as a viable alternative for the CRBRP. The foregoing environmental and economic analyses presented the benefits and the costs associated with evaporation of the waste stream. Summarization of these findings, presented in Table 10.4-6, indicates that the economic costs outweigh the environmental benefits. Reductions in discharge TDS attributable to the evaporator amount to about 1 1/2 percent and, in view of the environmental acceptability of the reference system, do not justify the expenditure of over one-half million dollars. |13 |13

10.4.6.2 REASON FOR SELECTION OF CHOSEN SYSTEM

The Waste Water Treatment System identified in Figure 10.4-1 has been selected for the CRBRP. Its levels of treatment comply with all applicable governmental standards. Further, its effluent discharge to the Clinch River will not produce adverse environmental effects for either normal or extreme case flow conditions in the river. | 13

TABLE 10.4-1

CLINCH RIVER BREEDER REACTOR PLANT
EFFLUENT LIMITATIONS AND WATER QUALITY*

Constituents	NPDES Permit Limitations	Proposed CRBRP Treatment Method
A. HEAT REJECTION SYSTEM BLOWDOWN: Thermal Discharge	The receiving water shall not exceed: (1) a maximum water temperature change of 3°C (5.4°F) relative to an upstream control point; (2) a maximum temperature of 30.5°C (86.9°F), and (3) a maximum rate of change of 2°C (3.6°F) per hour outside of a mixing zone which shall not exceed the dimensions of a circle with a maximum diameter of 30.5 meters (100 ft.)	Mechanical Draft Cooling Tower with cold leg blowdown and submerged discharge.
Hydrogen Ion Concentration (pH)	pH in the range of 6.0 to 9.0 at all times	pH control, as required.

TABLE 10.4-1 (Continued)

CLINCH RIVER BREEDER REACTOR PLANT
EFFLUENT LIMITATIONS AND WATER QUALITY*

Constituents	NPDES Permit Limitations	Proposed CRBRP Treatment Method
A. HEAT REJECTION SYSTEM BLOWDOWN (Continued)		
Chlorine (Cl)	Total residual chlorine shall not exceed a maximum instantaneous concentration of 0.14 mg/l	Controlled chlorination with blowdown stopped.
Other Debris	There shall be no discharge of floating solids or visible foam in other than trace amounts.	No dumping to river

TABLE 10.4-1 (Continued)

CLINCH RIVER BREEDER REACTOR PLANT
EFFLUENT LIMITATIONS AND WATER QUALITY*

Waste Stream	NPDES Permit Limitations	Proposed CRBRP Treatment Method
WASTE WATER DISPOSAL SYSTEM EFFLUENT		
Low volume waste sources**	Total suspended solids; 30 mg/l daily average 100 mg/l daily maximum Oil and grease; 15 mg/l daily average 20 mg/l daily maximum pH; Not less than 6.0 nor greater than 9.0	Neutralization/clarification/ filtration provided Oil separator provided where appropriate.
Polychlorinated Biphenyl Transformer Fluid	No Discharge	PCB containing equipment shall not be placed on the plant site, however, if such equipment is required, administrative procedures will be instituted to preclude release of PCB's to the environment.
Other Debris	There shall be no discharge of floating solids or visible foam in other than trace amounts.	No dumping to river

*Permits required to meet these criteria are listed in Section 12.
**Includes water treatment system backwashes and rinse water, ion exchange regeneration wastes, cooling tower basin cleaning wastes, etc.

TABLE 10.4-2 DISCHARGE FLOW RATES

WASTE STREAM SOURCE		DISCHARGE FREQUENCY	AVERAGE AND MAXIMUM QUANTITY
I. Cooling Tower Blowdown		Continuous	2,300 - 3,100 gpm
II. Storm Water Yard and Roof Drains		Unscheduled Intermittent	Design Basis; 10 years - 24 hours storm
III. Waste Water Treatment			ESTIMATED WASTE VOLUME, GPD
1. Condensate Polishers	Ion exchange regeneration wastes (sulfuric acid, sodium hydroxide), and rinses	once/week	40,000
2. Make-up Water Demineralizers (anionic and cationic)	"	daily	27,000
3. Make-up Water Demineralizers (mixed bed)	"	once/5 days	4,500
4. Make-up Water Treatment	Gravity Filter Backwash	daily	8,750
5. Make-up Water Treatment	Clarifier Blowdown	daily	2,140
6. Make-up Water Treatment	Activated Carbon Filter Backwash	daily	8,400

TABLE 10.4-2 (continued)

	WASTE STREAM SOURCE		DISCHARGE FREQUENCY	ESTIMATED WASTE VOLUME, GPD
7.	Waste Water Treatment	Clarifier Blowdown	daily	1,650
8.	Waste Water Treatment	Gravity Filter Backwash	daily	5,000
9.	Feedwater and Steam Sampling	Laboratory Analysis Wastes	daily	28,800
10.	Non-radioactive Floor Drains	Equipment drainage, floor washing, etc.	daily	20,000
11.	Cooling Coil Drainage	"	seasonal	0-74,000
12.	Hypochlorite Generating Plant	Water softener regeneration wastes (brine) and rinses	daily seasonal	800

TABLE 10.4-3

WASTE TREATMENT SYSTEM

Stream Description

Stream Description	Treatment Mode	Effluent Content	Range of Effluent Quantity	Remarks
Cooling Tower Blowdown	Provision for monitoring and control of pH, temperature, total residual chlorine	Clinch River Water concentrated 2-3 times. Total residual chlorine less than 0.14 mg/l	2,300 - 3,100 gpm	Base Case treatment
Plant Wastes				
Clarifier Blowdown, Filter Backwashes		Clinch River Water, Aluminum Hydrate & trace Iron & Manganese. Approx. 0.2% solids	Approx. 26,000 gpd	
Clarifier Blowdown Filter Backwashes	Sludge Lagoons	Sludge Approx. 10% solids	Approx. 500 gpd	Base Case Treatment Mode as shown in Figure 10.4-1
		Liquid Clinch River water with slight increase in sodium sulfate	Approx. 25,500 gpd	
Clarifier Blowdown Filter Backwashes	Thickener followed by Vacuum Filtration	Sludge Approx. 40% solids	Approx. 130 gpd	Alternative Treatment Mode for Clarifier Blowdown, Filter Backwashes
		Liquid Same as sludge lagoon	Approx. 25,870 gpd	

(Continued)

TABLE 10.4-3 (continued)

Stream Description	Treatment Mode	Effluent Content	Range of Effluent Quantity	Remarks
Clarifier Blowdown Filter Backwashes	Thickener followed by centrifugation	Sludge Approx. 25% solids	Approx. 210 gpd	Alternative Treatment Mode for Clarifier Blowdown, Filter Backwashes
		Liquid Same as sludge lagoon	Approx. 25,790 gpd	
Waste Water Treatment System Effluent	Neutralization, Flocculation, Clarification, Filtration	Clinch River Water with slightly high sodium sulfate content, pH 6.5-8.5, 1350 mg/l TDS TDS: 85% Sodium and Sulfate Remaining 15% consists primarily of Fe, Ca, Mg, PO_4, with trace quantities of Cu, Cr and Ni below detectable limits	Approx. 144,000 gpd	Base Case
	Evaporator	Evaporator Distillate is a high quality water (10 ppm TDS) and will be recycled	143,600 gpd	Alternative
		Sludge 50% solids content	400 gpd	

(Continu

TABLE 10.4-3 (Continued)

Stream Description	Treatment Mode	Effluent Content	Range of Effluent Quantity	Remarks
Non-Radioactive Floor Drains		Similar to Clinch River Water	Approx. 20,000 gpd	Water in Floor Drain System is assumed to be water used for washdown, pump seal leakage, etc.
Non-Radioactive Floor Drains	Oil Separator Effluent	Treated effluent will contain 15 ppm free oil	20,000 gpd	
III. Storm Water				
Roof and Yard Drain; Retention Ponds		Rain water that may have picked up a trace of oil+	Design basis: 10 yr. - 24 hr. storm	

(Continued)

TABLE 10.4-3 (Continued)

Stream Description	Treatment Mode	Effluent Content	Range of Effluent Quantity	Remarks	
Retention Pond Oil Waste	Oil Skimmer++	Oil & Misc. entrained solids	N.A.	Waste placed in container, sealed and disposed off-site	13

+Oil traces are interpreted to mean virtually undetectable.
++To be used only if visible oil slick is detected.

TABLE 10.4-4

EFFECT OF WASTE TREATMENT SYSTEM DISCHARGES OF TOTAL DISSOLVED SOLIDS ON CLINCH RIVER WATER QUALITY* 13

Mixing nditions**	Clinch River Concentration* (mg/l)	Reference System: Discharge Concentration (mg/l)	Reference System: Concentration in River (mg/l)	Reference System: Affected River Surface Area (acres)	Reference System with Evaporator: Discharge Concentration (mg/l)	Reference System with Evaporator: Concentration in River (mg/l)	Reference System with Evaporator: Affected River Surface Area (acres)
pical Cases							
Winter	142	396	150	0.05	355	148	0.05
Summer	142	396	150	0.07	355	148	0.07
treme Cases							
Short Duration No Flow (Winter)	174	473	180	3.92	435	179	3.92

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Values derived from Tables 10.3A-2 and 10.3A-7.
See Tables 10.3A-4 and 10.3A-10 for description of cases.
142 mg/l - average, 174 mg/l - maximum concentration.

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TABLE 10.4-5

INVESTMENT COSTS FOR
WASTE TREATMENT SYSTEM ALTERNATIVES

(All Costs in 1974 Dollars)

Evaluated Costs ($)	Reference Waste Treatment System	Reference System With Evaporator
A. INVESTMENT COSTS		
1. Civil-Structural	BASE	800
2. Electrical	BASE	4,100
3. Mechanical	BASE	570,000
4. Total Equipment Costs	BASE	574,900
B. EQUIVALENT INVESTMENT COSTS		
1. Chemical Costs	BASE	200
2. Storage and Handling of Chemicals	BASE	100
3. Storage and Handling of Wastes	BASE	100
4. Disposal of Wastes	BASE	400
5. Operation and Maintenance	BASE	8,300
6. Total Operating Costs	BASE	9,100
C. AUXILIARY POWER COSTS		
1. Total Power (kW)	BASE	150
2. Equivalent Investment Costs*	BASE	8,700
TOTAL EQUIVALENT INVESTMENT COST	BASE	592,850

*At $57.8/kW based on 3 hours per day operation

TABLE 10.4-6

SUMMARY OF ENVIRONMENTAL AND ECONOMIC FACTORS FOR EVAPORATOR ALTERNATIVE

Environmental Benefits	Evaporator
Reduction in River TDS Levels	
Typical Cases*	
Winter	1.3%
Summer	1.3%
Extreme Case*	
Short Duration No Flow	0.5%
Economic Costs	
Additional Investment Cost	$592,850

*See Tables 10.3A-4 and 10.3A-10 for description of cases. Winter cases used for Short Duration and Extended No flow events.

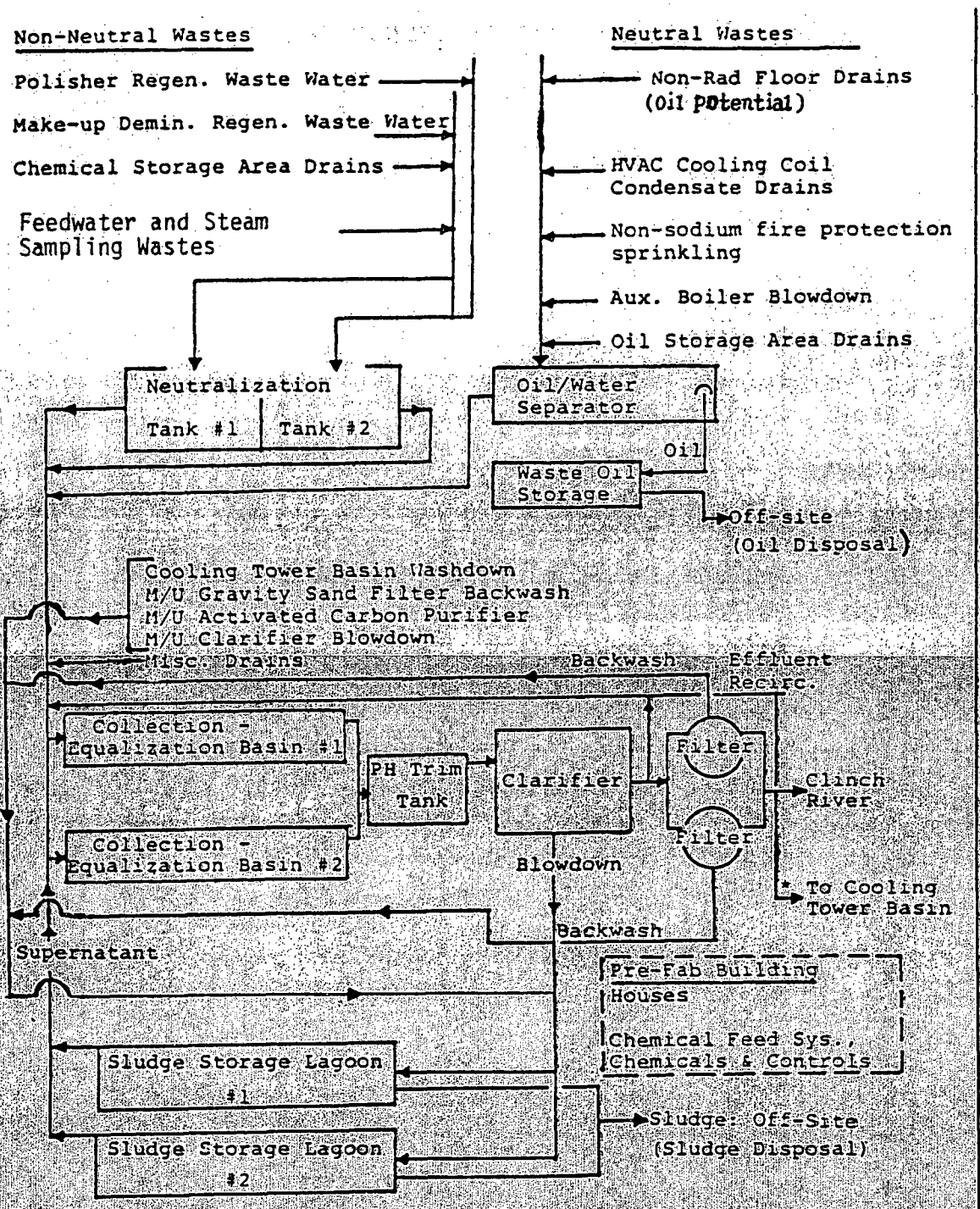

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Figure 10.4-1 WASTE WATER TREATMENT SYSTEM

* Whenever cooling tower chemistry permits, will discharge effluent to the cooling tower basin

10.5 BIOCIDE SYSTEM

The Biocide System is employed to maintain cooling system efficiency and longevity by eliminating biological interference. Algae, bacteria, fungi and occasionally crustacea and mollusks enter the cooling system via the plant intake and colonize condenser tubes, valves, pumps, cooling tower fill and auxiliary piping. Their presence causes a reduction in heat transfer rates and can lead to clogging with attendant flow rate losses. The Biocide System must control these growths and maintain relatively clean surfaces so that heat transfer and circulating water flow are not significantly impaired.

A major environmental concern associated with the Biocide System is the effect on aquatic life of any residual biocide (chemical) activity that may be present in the plant discharge. An additional concern is the effect of the biocide on the survival of organisms entrained in the cooling system water supply. This, however, becomes a valid issue only for once through cooling systems where some survival is expected; in a closed cycle system such as that of the CRBRP no survival is anticipated, irrespective of the biocide system utilized.

Chlorination is the selected biocide system for the CRBRP.

Alternatives considered for the biocide system are as follows:

1. Chlorination;
2. Organic chemicals;
3. Ozone; and
4. Mechanical cleaning.

10.5.1 DESCRIPTION OF ALTERNATIVES

10.5.1.1 CHLORINATION

Chlorine is the most widely employed water disinfectant and biocide in this country. It is economical, fast acting and well proven with a substantial body of technical information available concerning effectiveness and application.

One of the principal advantages of chlorination becomes a potential liability when it is used as a biocide. The chlorine residual, if not dissipated prior to cooling system blowdown, can adversely affect aquatic life in the receiving water body. This potential is increased if tars or ammonia are available to form chlorinated hydrocarbons or chloramines, both of which are highly toxic to fish.[1,2]

Since chlorine is an oxidizing biocide, its costs are escalated when a high chlorine demand cooling water (from a polluted stream) is utilized. Additionally, the use of chlorination is less favored when sufficient iron and manganese are present and their reactions with chlorine lead to fouling problems.[3] Wooden cooling towers are subject to delignification at excessive chlorine concentrations.[1]

Chlorination for a closed cycle cooling system is usually applied at the intake system circulating water pumps. Chlorine is available as a gas, in liquid form or as sodium hypochlorite. The method of application is continuous low level addition (approximately 1 ppm) to control biological fouling supplemented by slug feeding intermittently (3 ppm for 15 minutes every eight hours) to remove accumulated slime deposits.

10.5.1.2 ORGANIC CHEMICALS

Organic chemicals represent a relatively new class of biocides. These are generally complex hydrocarbons whose mode of action is non-oxidizing resulting in a potential competitive advantage over chlorination under certain conditions; see Section 10.5.1.1. The cost of organic biocide treatment, however, is usually much higher than chlorination and the amount of technical information available concerning its application is not as extensive.

Environmentally, organic biocides present the same problem as chlorination -- residual activity. Although there is wide variation among them, all of the organic biocides are toxic to fish in the concentration range typical of slug feeding applications.(1)

Two of the more common types of organic biocides are the quaternary ammonium compounds and the unsaturated aldehydes (acroleins). The latter are the more highly toxic and volatile group.

10.5.1.3 OZONE

Ozone (O_3) is a highly reactive form of oxygen with very strong oxidizing capabilities. As a disinfectant and particularly as a virucide, ozone is superior to chlorine. Contact time is greatly reduced as ozone disinfection is nearly instantaneous. Additionally, ozone reduces taste, odor, color and BOD, and increases dissolved oxygen levels.

The half-life for ozone in water is in the order of minutes; consequently, there is no residual activity. This gives ozone a strong environmental advantage in applications where the treated effluent is discharged into a natural water body. Further, it mandates that ozone be generated on-site thus alleviating the potential transportation hazards that are associated with the shipment of chlorine.

Ozone is generated by passing clean, cold air (or pure oxygen) over electrically charged plates. Various types of injectors are then utilized to introduce the O_3 gas into the water for treatment.

The use of ozone in this country has been quite limited. For many years the economics of its production were prohibitive. Today, however, technical advancements in ozonation have greatly improved its economic position.[4,5]

10.5.1.4 MECHANICAL CLEANING

Mechanical cleaning is a direct way of attacking biological fouling that produces a more positive cleaning of condenser tubes and, therefore, is advantageous from the viewpoint of plant performance. It is environmentally attractive because it does not produce a discharge of residual chemical activity.

There are two major types of mechanical cleaning systems. One utilizes sponge rubber balls of slightly larger diameter than the condenser tubing. These are continually recirculated and produce a scouring effect on the inside tube surfaces. The other system employs plastic brushes which periodically travel from end to end of the condenser tubes actuated by flow direction changes.

Mechanical cleaning is limited in usage to fairly straight sections of tubing such as the main condenser and certain auxiliary cooling systems. Valves, pumps and cooling towers cannot be serviced; thus, a chemical biocide such as chlorine must be used in conjunction with mechanical cleaning. The quantity and frequency of biocide application, however, is reduced in a mechanical cleaning system.

10.5.2 ELIMINATION OF IMPRACTICAL ALTERNATIVES

10.5.2.1 ORGANIC CHEMICALS

Organic biocides are beset by the same environmental disadvantage as chlorination -- residual activity. Further, the fate of complex hydrocarbons released in a water body is less well understood. Organic biocides would be preferable only for those cases where high chlorine demand, fouling caused by iron/manganese-chlorine reactions, or deterioration of wooden cooling towers is anticipated. The organic loading of the Clinch River at the Site is low and no unusually high chlorine demand is expected. Concentrations of iron and manganese are also low and the cooling towers will be of concrete. Consequently, no economic, performance, or environmental advantage exists that would favor the use of an organic biocide for the CRBRP.

10.5.2.2 OZONE

Although its use in water and wastewater disinfection has been rising, ozonation has not achieved sufficient operational exposure as a biocide to recommend its employment at this time. Experience in selecting proper dose levels and application frequencies is lacking, a point that is particularly important in reference to the Asiatic clam infestation of the Ohio and Tennessee River Valleys.[6] These clams are prevalent in the Clinch River at the Site and are known to create clogging problems in plant waterlines. Considerable experience has been gained in controlling such organisms through chlorination. The use of ozonation would require the development of new control procedures.

The main environmental advantage of ozonation is its lack of residual activity. However, as ozone is rapidly reduced, oxygen levels increase and supersaturation may occur. This likelihood is particularly enhanced for a power plant where the ozonated water is also heated prior to

discharge. Supersaturated conditions in the thermal plume would be detrimental to fish. If the ozonator receives air rather than pure oxygen, the more serious case of nitrogen supersaturation is a distinct possibility.

10.5.3 SPECIFICATIONS FOR REASONABLE ALTERNATIVES

The chlorination biocide system for the CRBRP will primarily utilize intermittent application several times daily to control biological fouling. Residual chlorine levels in the cooling tower basin will be continuously monitored. System design will provide the capability for automatically stopping the blowdown flow in case of excursion beyond total residual chlorine (TRC) effluent limits, and for maintaining zero release of total residual chlorine until the residual concentration has fallen to an acceptable preset level that assures compliance with state and Federal requirements. 13

A feasible addition to the chlorination system is mechanical cleaning. As noted in Section 10.5.1.4, mechanical cleaning has limited applications and cannot supersede chlorination. It does permit reductions in the quantity of chlorine applied and would be advantageous in situations where discharged residual chlorine presents a significant environmental concern.

10.5.4 ENVIRONMENTAL COSTS

The effect of the chlorine residual on aquatic life in the Clinch River is the principal environmental concern associated with the CRBRP Biocide System.

Free available chlorine does not present a significant environmental concern as oxidation and dissipation will occur rapidly at the point of discharge to the river. Chlorine demand in the river (in terms of BOD and COD concentrations, from preliminary aquatic baseline survey data) is sufficient to consume the low level chlorine addition well within the near field mixing zone. The 5.2 cfs annual average cooling tower blowdown represents only 0.1 percent of the 5066 cfs summer river flow and will be significantly diluted within the near field mixing zone.

The most potentially severe effect on aquatic life would result from complexation of the free available chlorine with ammonia that may be present in the plant discharge. Chloramine compounds formed by such a reaction are relatively stable compared to chlorine and are highly toxic to aquatic life. Sufficient ammonia is available from the sanitary waste treatment (0.5 mg/l ammonia-N in 7,000 gpd) and auxiliary steam generator (hydrazine decomposition: 0.5 mg/l NH_3-N in 480 gpd when operating) influents to the plant discharge to complex a portion of the available chlorine. An extreme case can be postulated by assuming the remaining chlorine is complexed by the ammonia available in the river before any oxidation or dissipation can occur. Given this conservative assumption, the resulting chloramine concentrations in the Clinch River for various flow regimes are presented in Table 10.5-1. As EPA has limited the permissible duration of discharges of free available and total residual chlorine to two hours per day, (7) the values given in Table 10.5-1 represent maximum possible concentrations. Chloramine in the river will approach these levels during the period of chlorine discharge and then recede from them after

chlorine release is terminated. Due to its intermittent presence in the CRBRP effluent, chloramine will not be subject to the same concentration increases during an extended no-flow occurrence as are plant chemicals whose discharge is continuous. 6

A review of the toxicity literature indicates that the maximum chloramine concentrations given in Table 10.5-1 are below levels associated with acute toxicity to aquatic life.(1) Although sublethal effects (reductions in number of young produced in the amphipod and egg production in the minnow) have been observed at concentrations greater than 0.0034 mg/l

and 0.0165 mg/l for an amphipod and minnow species, respectively,[8] aquatic life will not receive constant exposure to chloramine levels in these ranges, as noted above.

The control of residual chlorine in the cooling tower blowdown will ensure that the CRBRP Biocide System will comply with applicable standards. Further, the foregoing analyses indicate that residual chlorine activity will not adversely affect aquatic life in the Clinch River.

10.5.5 ECONOMIC COSTS

The addition of mechanical cleaning to the CRBRP Biocide System would result in increased capital and operating costs that would not be offset by the reductions in chlorine requirements provided.

10.5.6 COMPARISON OF ALTERNATIVES

As indicated in Section 10.5.4, the environmental costs associated with a "worst" case of discharge of complexed residual chlorine during no-flow river conditions are not significant. Consequently, the intermittent chlorine application method to be utilized by the CRBRP Biocide System will not adversely affect aquatic life in the Clinch River.

Although mechanical cleaning does not offer a measurable environmental advantage over the proposed chlorination system, it would be desirable from a plant performance viewpoint.

Chlorination, with or without supplemental mechanical cleaning, is an environmentally acceptable Biocide System for the CRBRP.

TABLE 10.5-1

MAXIMUM CHLORAMINE CONCENTRATIONS IN CLINCH RIVER RESULTING FROM BIOCIDE SYSTEM RESIDUAL CHLORINE DISCHARGES*

Mixing Conditions**	Chloramine Concentration+ (mg/l)	River Surface Affected (acre)
Typical Cases		
Winter	0.009-0.015	0.05
Summer	0.009-0.015	0.07
Extreme Case++		
Short Duration No Flow	0.006-0.015	3.92
Extended No Flow▽	0.079	71

6

*Values presented based on Table 10.3A-7. 6

**See Tables 10.3A-4 and 10.3A-10 for description of cases.

+Chloramine concentration is computed as follows:

$$NH_2Cl = (\text{isopleth } \%) \times (0.2 \text{ mg/l } Cl_2) \times (1.47)$$

(1.47 is a stoichiometric factor -- 0.68 moles of Cl_2 are required to produce one mole of NH_2Cl.)

++Winter cases

▽Based on revised Section 5.4.1.2.3. The system selection decision is not affected. 6

10.6 SANITARY WASTE SYSTEM

A sanitary waste system will be required to provide sewage treatment during normal operation of the CRBRP. It will be a permanent facility designed to process a waste stream that is similar to domestic sewage, except that kitchen and laundry wastes are not anticipated. Radioactive wastes are not handled by the sanitary waste system. 13

The average daily sanitary wastewater flow during normal operation will be 7,000 gallons. This is based upon 200 plant personnel and 35 gal/person/day for normal plant operation. Present projected number of plant personnel is 179 persons with a peak manning of 300 men anticipated for annual shutdown. The permanent plant design flow of 13,000 gal/day will be adequate during normal operation and annual shutdown. 13

Plant sanitary wastes will be processed in a manner that is consistent with applicable State regulations(1) and reflects the goal of reducing environmental impact. Alternatives considered represent a variety of approaches offering different levels of environmental and economic cost.

The selected sanitary waste system for the CRBRP is on-site treatment via an extended aeration variation of the activated sludge process with chlorination of the effluent prior to discharge into the Clinch River. This system has a design capacity of 13,000 gpd. 13

Alternative systems considered for processing plant sanitary wastes are:

1. Tap-in to existing treatment facility;
2. Ground discharge;
3. Incineration;
4. Extended aeration/filtration/chlorination;
5. Activated sludge/membrane filtration;

6. Clarification/filtration/carbon adsorption; and
7. Extended aeration/chlorination. 13

10.6.1 DESCRIPTION OF ALTERNATIVES

10.6.1.1 TAP-IN TO EXISTING TREATMENT FACILITY

An environmentally attractive alternative for plant sanitary waste treatment is to tap-in to an already existing sewage treatment facility. In this manner, use is made of available capability and the potentially adverse environmental effects of construction and operation of an on-site facility are avoided. This alternative is dependent upon the existence of a nearby sewage treatment plant that can accept the additional load without suffering reduced treatment efficiency.

The tap-in scheme would require construction of a pipeline to the treatment plant and sufficient pumping power at the CRBRP. 13

10.6.1.2 GROUND DISCHARGE

Ground discharge of sanitary wastes possesses several environmental advantages. It utilizes the natural assimilative capacity of soil, eliminating the need for extensive treatment facilities. Energy requirements are low and no effluent is discharged directly into the river.

Successful application of ground discharge requires suitable soil composition and depth such that anticipated waste loadings can be applied without clogging or back-up. Soils subject to short-circuiting with attendant introduction of inadequately treated wastes into ground water supplies must be avoided.(2) Several application techniques can be utilized in a ground discharge treatment system. Notable among these are percolation ponds and spraying.

10.6.1.3 INCINERATION

Incineration of sewage sludge provides the least quantity of sludge achievable. The small quantities of dry ash produced considerably lessen the environmental costs associated with the disposal of moisture-laden sludge from conventional sludge treatment processes. 13 13

Incineration of sewage sludge is preceded by comminution and dewatering to reduce the water content of the sludge feed so that combustion can occur. In the incinerator, fuel (commonly No. 2 oil) is utilized to initiate and sustain burning when the heat content of the sludge is insufficient. Combustion gases are cycled through a stack scrubber prior to atmospheric release to reduce particulate emissions.(3) 13

10.6.1.4 EXTENDED AERATION/FILTRATION/CHLORINATION

A fourth alternative to off-site treatment, ground discharge, or sludge incineration of sanitary wastes is on-site treatment that produces a liquid effluent environmentally acceptable for discharge to the Clinch River and a sludge for land disposal. In comparison to off-site processing, an on-site treatment facility offers the environmental advantages of more direct control over effluent quality and greater flexibility to changing loads. It does not release airborne particulates or consume water as occurs with incineration and the odor problems that may accompany ground discharge are eliminated. 13

The extended aeration/filtration/chlorination alternative system provides tertiary level treatment for the CRBRP sanitary wastes. Liquid effluent quality will comply with the EPA guidelines for secondary treatment, Table 10.6-1, and the NPDES Permit standards for CRBRP sanitary waste discharges, shown in Table 10.6-2. 13

Extended aeration provides secondary level treatment. It uses a modification of the diffused air-aerobic digestion process for sewage decomposition and treatment. It functions by maintaining sufficient oxygen, mixing and detention time to allow microorganisms to decompose the treatable wastes. Detention times are much longer than conventional activated sludge (on the order of 24 hours) eliminating the need for primary settling and reducing sludge production.(4) Extended aeration treatment will reduce suspended solids and biochemical oxygen demand by approximately 85 percent.(3) Filtration of the above effluent will provide tertiary level treatment and ensure that effluent suspended solids content is within permissible levels. The filtration unit utilizes two 100 percent capacity slow sand filters and will be capable of removing 85 percent of the suspended solids from the normal effluent of extended aeration and producing an overall BOD reduction of 95 to 98 percent.

Chlorination of the tertiary treatment effluent provides disinfection for the elimination of water-borne pathogens as required by the State.

10.6.1.5 ACTIVATED SLUDGE/MEMBRANE FILTRATION

The activated sludge/membrane filtration sewage treatment system produces a higher quality effluent than that possible via extended aeration/filtration/chlorination.

Activated sludge is a basic secondary treatment process utilizing biological decomposition of sanitary wastes in an aerobic environment.

The higher effluent quality of the activated sludge/membrane/filtration system is accomplished at the tertiary treatment level. Membrane filtration produces an effluent with virtually no suspended solids, BOD of 0-20 mg/l and a "very low" coliform count.(3)

10.6.1.6 CLARIFICATION/FILTRATION/CARBON ADSORBTION

The clarification/filtration/carbon adsorption sewage treatment system also produces a final effluent of higher quality than extended aeration/filtration/chlorination.

Clarification is a secondary level treatment process that utilizes coagulation, flocculation and sedimentation to achieve suspended solids reductions greater than that of conventional biological decomposition systems. Chemical coagulants are added to the wastewater to form small flocs which will settle and are removed in a sedimentation tank. Filtration similar to that employed with the extended aeration system is utilized to polish the clarification effluent.

Activated carbon possesses a very high sorptive capacity for soluble organic matter. The carbon adsorption unit is a tertiary level treatment process that utilizes this capacity to produce a final effluent lower in BOD than that of the activated sludge/membrane/filtration system.

10.6.1.7 EXTENDED AERATION/CHLORINATION

The extended aeration/chlorination process is identical to that described in Section 10.6.1.4, except that the filtration of sewage effluent is omitted. The deletion of the tertiary treatment level is justified on the basis that the extended aeration process alone is sufficient to produce effluent meeting the NPDES Permit limits of 30 mg/l BOD and 30 mg/l suspended solids. Flow equalization and post aeration are provided to insure good plant operation. 13

10.6.2 ELIMINATION OF IMPRACTICAL ALTERNATIVES

10.6.2.1 TAP-IN TO EXISTING TREATMENT FACILITY

The employment of this alternative system requires the presence of an existing treatment plant located close enough to the CRBRP that pipeline construction and pumping costs do not become excessive. Additionally, the existing facility must be capable of handling the plant waste load without detriment to its efficiency or effluent quality.

Three sewage treatment facilities in the general vicinity of the CRBRP Site were considered. The DOE Gaseous Diffusion Plant facility located four miles to the north does not have sufficient reserve capacity at this time. Although it is scheduled for expansion in the near future, dependence on this cannot be advised and the distance is too far to merit further consideration of the diffusion plant facility. The Oak Ridge municipal sewage treatment plant is located 15 miles away and on this basis it is considered too remote to be included as a viable alternative. There is a small treatment plant planned for servicing the Clinch River Industrial Park (at CRM 14.6); however, this facility is not yet constructed. Consequently, an off-site treatment alternative cannot be considered adaptable for use with the CRBRP. 13 13 13

10.6.2.2 GROUND DISCHARGE

Utilization of ground discharge is predicated on the availability of suitable soil conditions. As the soil in the area of the CRBRP has been determined to be clay to a depth of 20 to 30 feet, this alternative is not considered to be feasible based on the poor absorption characteristics exhibited by clay soils.

10.6.2.3 INCINERATION

Sewage sludge incineration is not considerd feasible because of a lack of demonstrative applications of this technology and the prohibitively high capital and energy costs involved in a small volume unit. Additionally, conventional treatment units are required for processing the liquid fraction. 13

10.6.3 SPECIFICATIONS FOR REASONABLE ALTERNATIVES

10.6.3.1 EXTENDED AERATION/FILTRATION/CHLORINATION

A schematic diagram of the extended aeration/filtration/chlorination sanitary waste treatment system for the CRBRP appears in Figure 10.6-1. System capacity is 13,000 gpd, a size that provides a reserve margin for handling peak loads. Packaged extended aeration units are offered by a variety of manufacturers and have been widely employed nationwide for handling small waste volumes.(3,5) 13

Three units comprise the treatment facility. The extended aeration unit includes the aeration, settling and sludge holding tanks. Sludges will be disposed of off-site by a licensed contractor. Sand filtration utilizes two 100 percent capacity slow sand filters and does not require filter backwashing. Chlorination is by hypochlorite; a 1.0 mg/l residual level will be maintained in the treatment system effluent.

The final effluent from the treatment facility will contain less than 10 mg/l BOD and 5 mg/l suspended solids and will be released to the river through the common plant discharge system. 13

10.6.3.2 ACTIVATED SLUDGE/MEMBRANE FILTRATION

Activated sludge/membrane/filtration sanitary waste treatment system for the CRBRP is designed for a flow of 13,000 gpd. It is estimated to produce a final effluent with 10 mg/l BOD and 1 mg/l suspended solids. 13

10.6.3.3 CLARIFICATION/FILTRATION/CARBON ADSORPTION

The clarification/filtration/carbon adsorption sanitary waste treatment system for the CRBRP is designed for a flow of 13,000 gpd and is estimated to produce a final effluent with BOD and suspended solids of less than 5 mg/l. 13

10.6.3.4 EXTENDED AERATION/CHLORINATION

The extended aeration/chlorination process for the CRBRP is designed for a flow of 13,000 gpd and is estimated to produce a final effluent having BOD and suspended solids concentrations of less than 30 mg/l. 13

10.6.4 ENVIRONMENTAL COSTS

The principal environmental concern associated with the four sanitary waste systems identified in 10.6.3 is the effect of the liquid effluent discharge on the Clinch River. Effluent quality of the sanitary treatment system alternatives as compared to the NPDES Permit standards is shown in Table 10.6-3. 13

Compared to the discharge of chemicals resulting from cooling tower blowdown (~2400 gpm), the sanitary system effluent stream (~5 gpm) is a minor contributor to the total plant discharge. The sanitary system contribution is approximately 0.2 percent, and the differences in treatment level among the four alternatives are inconsequential when compared to the overall plant discharge. 13

Concentrations of BOD and TSS occurring in the Clinch River as a result of plant chemical discharges are presented in Table 10.6-5 for the selected sanitary system. These levels represent very modest increases above ambient river values and do not constitute a significant environmental concern. The values in Table 10.6-5 would be essentially the same regardless of which sanitary system alternative is employed. 13

Each of the alternative sanitary waste treatment systems produces an effluent too small in volume and high in quality to be capable of any significant adverse environmental impact on the Clinch River. Each alternative's effluent complies with applicable standards for the chemical constituents examined as shown in Table 10.6-3. Relatively small sludge quantities are produced by each alternative sanitary waste system. 13

10.6.5 ECONOMIC COSTS

Total monetary cost for the extended aeration/chlorination system is estimated at $1.50 per 1,000 gallons treated.(3) This treatment facility is a packaged unit that affords easy installation. Reliability is good and the required level of operator attention is low. Monetary costs for the extended aeration/filtration/chlorination system are about the same as for 13 13

extended aeration/chlorination, however, the level of operator attention is higher. Specific monetary costs were not available for the activated sludge/membrane/filtration and clarification/filtration/carbon adsorption systems. However, general cost differences among the three alternatives can be estimated. 13

The activated sludge/membrane filtration system is more expensive than the packaged extended aeration unit due principally to the higher capital and operating costs of membrane filtration as opposed to sand filtration and chlorination.(3) The reliability of the activated sludge system is lower, also, as a result of the membrane filtration process. The membrane is subject to physical deterioration and requires continuous monitoring.

Due to the relatively high cost of clarification as a secondary treatment process and the additional expense of carbon reactivation in the tertiary level treatment, the clarification/filtration/carbon adsorption system is the most expensive of the four alternatives.(3,6) 13

10.6.6 COMPARISON OF ALTERNATIVES

10.6.6.1 DIRECT COMPARISON OF REASONABLE ALTERNATIVES

The environmental costs for the four sanitary waste system alternatives are substantially identical because of the negligible effect of the sanitary discharge on the Clinch River. There is little environmental preference, therefore, for the alternatives producing marginally higher quality effluents. 13 13

The packaged extended aeration facility is economically preferable in terms of monetary costs, ease of installation, reliability and operational experience.

10.6.6.2 REASONS FOR SELECTION OF CHOSEN SYSTEM

The extended aeration variation of the activated sludge process with chlorination prior to discharge is the selected system for the treatment of sanitary wastes from the CRBRP. It produces a liquid effluent for discharge to the Clinch River that fully complies with the applicable governmental regulations, Section 3.7, and has no adverse effects on river water quality. Furthermore, the extended aeration facility utilizes a well proven technology, provides reserve capability for peak loads and is economically advantageous. 13

TABLE 10.6-1

EPA GUIDELINES FOR SECONDARY TREATMENT EFFLUENT QUALITY(7)

	Monthly Average
Biochemical Oxygen Demand (BOD)	30 mg/l
Suspended Solids (SS)	30 mg/l
pH	6.0-9.0

13

TABLE 10.6-2

NPDES PERMIT STANDARDS FOR THE CRBRP SANITARY WASTES DISCHARGE

	Daily Average	Daily Maximum
Biochemical Oxygen Demand (BOD)	30 mg/l	45*
Suspended Solids (SS)	30 mg/l	45*
Residual Chlorine	---	2.0*
pH	6.0 - 9.0	--
Settleable Solids (ml/l)	1.0	1.0
Fecal Coliform (organisms/100 ml)	---	200*

* Conditions of Section 401 Certification, Attachment D of NPDES Permit

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TABLE 10.6-3

EFFLUENT QUALITY OF SANITARY SYSTEM ALTERNATIVES*

	NPDES Permit	Extended Aeration/ Filtration/ Chlorination	Activated Sludge/ Membrane Filtration	Clarification/ Filtration/ Carbon Absorption	Extended Aeration/ Chlorination
BOD	30 mg/l	10 mg/l	10 mg/l	5 mg/l	<30 mg/l
Suspended Solids	30 mg/l	5 mg/l	1 mg/l	5 mg/l	<30 mg/l
Residual Chlorine	2.0+	1.0 mg/l	0	NA**	1 mg/l
Ammonia Nitrogen	++	0.5 mg/l	NA**	NA**	<5 mg/l
pH	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0

* Daily averages
**Not available
\+ Section 401 Certification Condition, Attachment D of the NPDES Permit.
++Not applicable

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16
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TABLE 10.6-4 DELETED

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TABLE 10.6-5

CHANGES IN RIVER QUALITY RESULTING FROM PLANT DISCHARGES OF BOD AND TSS*

Mixing Conditions**	Ambient River Concentration+ (mg/l)		Extended Aeration/Chlorination Concentration in River (mg/l)		Affected River Surface Area (acres)
	BOD	TSS	BOD	TSS	
Typical Cases					
Winter	<1.0	7.0	1.0	7.7	0.05
Summer	<1.0	7.0	1.0	7.7	0.07
Extreme Case++					
Short Duration No Flow	<1.0	7.0	1.0	7.5	3.92

*Values presented derived from Table 10.3A-7.
**See Tables 10.3A-4 and 10.3A-10 for description of cases.
+From Table 2.5-14a; CRM 17.9
++Winter Case

Figure 10.6-1 EXTENDED AERATION/CHLORINATION SANITARY WASTE TREATMENT SYSTEM (Selected Treatment Process)

10.6-16

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