Appendix B

FLOODPLAIN/WETLANDS ASSESSMENT--L-REACTOR OPERATIONS

B.1 INTRODUCTION

With the resumption of L-Reactor operation, thermal cooling water effluent will be discharged directly into Steel Creek in a manner identical to previous operations from 1954 to 1968 (base case). The thermal discharge will impact approximately 1000 acres of wetlands on the Savannah River Plant or approximately 3 percent of the wetlands on the SRP site. Chapter 3 described the affected wetlands environment, including the Steel Creek corridor and swamp adjacent to the Savannah River. Chapter 4 assessed, in part, the impacts on these wetlands.

In accordance with Executive Orders 11988 (Floodplain Management) and 11990 (Protection of Wetlands), and U.S. Department of Energy (DOE) regulation "Compliance with Floodplain/Wetlands Environmental Review Requirements (10 CFR 1022)," this appendix describes the effects on floodplain/wetlands by the direct discharge of cooling water to Steel Creek. It also examines the degree of mitigation that could be obtained from implementing alternative cooling systems. These effects will be caused by hot water and high flow rates. Because there will be no development in the floodplain, this appendix will address only wetlands impacts.

B.2 DESCRIPTION OF COOLING-WATER ALTERNATIVES

Several cooling water alternatives were evaluated with respect to schedule, cost, and wetlands impacts. Both once-through and recirculating cooling-water alternatives were considered. This section describes the physical layouts of these cooling-water alternatives to the base case, direct discharge to Steel Creek. Each alternative was sized so it would provide 96 to 100 percent operational efficiency during summer, a period of maximum ambient temperature. This places each alternative on a common base to facilitate their comparison.

B.2.1 Once-through systems

The alternative once-through cooling systems considered here would withdraw water from the Savannah River at about 11 cubic meters per second, pass it through the reactor to remove heat from the primary coolant, and return it to the Savannah River via either Steel Creek or Pen Branch. These alternatives to the base case include (1) spray canal and discharge to Steel Creek, (2) small impoundments on Steel Creek, and (3) diversions to Pen Branch. The base case (direct discharge to Steel Creek) is discussed in Section 2.2.3 of the Environmental Assessment.

B.2.1.1 Spray canal

The spray canal alternative features a gravity-powered spray cooling system installed in the L-Area outfall canal (Figure B-1). It would operate much in the same manner as a conventional pumped spray system but with the following exceptions:

- A reservoir (spray pond) is not required.
- Pumphouse, pit, and associated electrical services are not required.
- Capital costs and operational/maintenance costs associated with the pumped spray system are not incurred.

The spray system would be coupled to the present L-Area effluent pipe via a valve box. A steel penstock would be used to transport the water about 200 meters downstream, where the penstock would branch to divert the water into two parallel trunks running down the existing effluent canal. The trunk lines would be about 50 meters long; they would use ramp-bottom, hollow-cone spray nozzles, each having a flow of 5 liters per second at a pressure of 2.4×10^3 pascals.

The spray system would dissipate a portion of cooling-water heat into the atmosphere; under ideal conditions, its maximum performance would be about a 15°C drop in water temperature. However, an evaluation of this system, from both meteorological (Section 3.5) and design aspects, showed that for long periods during the summer the actual performance of the system would be less than its design conditions because of the canal location, topography, high humidity, and the light, variable winds in the SRP area. During the summer the proposed spray system is estimated to provide little additional cooling (about 5°C) before discharging to Steel Creek (du Pont, 1982). Additional cooling would occur as the effluent flows through Steel Creek and the Savannah River swamp to the river.

B.2.1.2 Small impoundments on Steel Creek

Two types of impoundment options could be used on Steel Creek to mitigate the thermal impacts of L-Area effluent on the lower reaches of the creek and the swamp. One system uses several small dams (rubble dams) to create small lakes; the other system uses one dam to create a single, larger lake.

A series of several rubble dams on Steel Creek would pool water to provide an increased surface area and decreased velocity to enhance cooling in the stream. The dams could be created by dumping large stone or broken concrete at accessible locations in Steel Creek. The dams would be 1.5 to 2.4 meters high; they could be solid or porous, but better results could be expected with solid dams. Sediment would collect upstream from a solid dam, and water spilling over would increase the effectiveness of the system by increasing the exposure of the hot water to air.

Locations of the dams would be selected to (1) minimize the relocation of existing roads and underground cables that parallel the 115 Kv transmission lines, and (2) maximize the potential for cooling in the upper reaches of the creek (Figure B-2). Small lakes would have a total surface area of about 120 acres which could reduce the stream temperature to about 38°C at Road A during summer.

The topography along Steel Creek permits the construction of a single 500-acre lake (Figure B-3). Temperature profiles show that a three-stage lake would give acceptable cooling performance when joined to the L-Reactor effluent canal. The lake would be separated physically into three sections of about equal area with underflow baffles to enhance its cooling efficiency. The baffles would prevent short-circuiting of warm water and would maximize the use of the surface area. The final (underflow) baffle would discharge water from several feet below the pond surface. This arrangement would minimize diurnal temperature variations and provide additional cooling capacity during summer. An exit temperature of about 36°C can be expected from a 500-acre impoundment during summer. This would result in a temperature of about 34°C at Road A.

B.2.1.3 Diversion to Pen Branch

Two approaches for diverting thermal effluents to Pen Branch are: (1) diversion to Pen Branch by penstock and canal, and (2) diversion to Pen Branch by lake and canal. Either approach will avoid thermal discharges to Steel Creek.

Cooling-water effluent from L-Reactor could be diverted through a 2.1-meter underground penstock that would begin in L-Area. The pipe would convey the flow to the north side of SRP Road 7 where it would discharge into an excavated canal (Figure B-4). The water would flow through the canal about 1000 meters to Pen Branch. No pumping would be required in the pipe or canal. Structural improvements might be required at bridges crossing Pen Branch.

A second diversion concept would require an earthen dam in Steel Creek about 1500 meters below the L-Area effluent canal discharge (Figure B-5). The dam would form a small (60-acre) lake to provide additional cooling. A canal and a 3-meter-diameter pipe with a total length of about 1400 meters would divert the flow from the lake to Pen Branch. No pumping would be required. Structural improvements might be required at bridges crossing Pen Branch.

B.2.2 Recirculating systems

The alternative recirculating cooling systems considered here would utilize water from a pond, pool, or recirculation basin, and recycle it back to the reactor. Water will also be pumped from the Savannah River at a few cubic meters per second to provide blowdown and evaporative makeup. The recirculating cooling-water alternatives described below include (1) mechanical-draft cooling towers, (2) L-Pond, (3) Kal Pond, (4) a High-Level Pond, and (5) Par Pond.

B.2.2.1 Mechanical-draft cooling towers

Two cooling towers would be constructed adjacent to the reactor (Figure B-6). A reinforced concrete sump, approximately 9 meters square and 11 meters deep with six vertical pumps, would be built over the existing outfall pipe. Discharge pipes from the pumps would run above-ground to connections with an underground pipe that would convey the warm water to the top of the cooling towers. The flow would proceed by gravity to reinforced concrete basins beneath the towers and then to the reservoir.

The recirculation of L-Reactor cooling water in a cooling tower would require 1.6 cubic meters per second of make up water from the Savannah River. Blowdown would be discharged to Steel Creek at temperatures a few degrees centigrade above ambient and at flow rates of about 0.4 cubic meter per second.

B.2.2.2 L-Pond

An earthen dam would be constructed across Steel Creek approximately 750 meters above the Seaboard Coastline Railroad bridge. This dam would be about 32 meters high and about 1500 meters long, impounding about 1300 acres of land with a normal pool elevation of 61 meters (Figure B-7). Another earthen berm--1200 meters long and less than 5 meters high--would be required to prevent high water from overflowing natural saddles near the east end of the dam. A third berm--300 meters long and less than 5 meters high--would be required to close a saddle near the old Ashley Plantation.

The creation of L-Pond would require the relocation of two 115-kilovolt electric overhead transmission lines and buried control and relay cables that cross Steel Creek near Road A-14. A portion of Road A-14 would be inundated by the pond. Approximately 1400 meters of the South Carolina Electric and Gas Company's 115-kilovolt wood-pole transmission line would be replaced by three tall steel towers and new conductor cable to enable the line to span the widened waterway.

A new pumping station, similar to but smaller than the existing Par Pond station, would be constructed on the northwest shore of the pond near Road A-14. A new pipeline generally paralleling the northwest shore of the pond would carry cooled water back to L-Reactor.

Because the proposed water surface elevation would be higher than portions of Road B south of L-Reactor, approximately 1800 meters of this road would have to be raised as much as 6 meters.

This option would use about 3 cubic meters per second of make up water from the Savannah River; blowdown would be discharged to Steel Creek at a few degrees above ambient, and at a flow rate of about 0.6 cubic meter per second.

B.2.2.3 Kal Pond

This alternative would establish one large 2600-acre pond by constructing dams across both Steel Creek and Pen Branch (Figure B-8). This impoundment would furnish cooling water to both K- and L-Reactors. The Pen Branch dam would be approximately 750 meters above Road A and the Steel Creek dam would be about 300 meters above Road A-14. The Pen Branch dam would be approximately 800 meters long and the Steel Creek dam would extend about 1400 meters. The normal water-surface elevation would be 64 meters.

This water level would necessitate raising Road B almost 10 meters in some places between Road 7 and Road C; therefore, part of Road B must be abandoned. Traffic could use Road 7 and Road C as a bypass around the north and east sides of L-Reactor. New raised connections between Road B and Roads 7 and C would be constructed at each end with a new culvert for Steel Creek.

A new outlet structure would be needed for the L-Reactor effluent line because the present structure would be substantially below pond level. This structure would be constructed at the edge of the new pond north of the abandoned section of Road B. Few modifications would be required at the K-Reactor discharge because the present canal extends above the pond elevation of the proposed water level.

Road B would be about 15 meters below the water level where it crosses Pen Branch and about 9 meters below where it crosses Indian Grove Branch. Approximately 1100 and 750 meters of roadway, respectively, would have to be raised and new culverts constructed. Also, about 400 meters of Road C where it crosses Pen Branch would have to be raised as much as 3 meters. About 300 meters of Road 6.4 leading to K-Reactor would have to be raised about 3 meters.

Some modifications to the river water lines serving the K-, L-, and P-Reactors might have to be made because the areas where they cross both Indian Grove Branch and Pen Branch would be flooded by Kal Pond. Also, the proposed steam line from the K-Reactor power plant to L-Reactor would follow these water lines.

Two 115-kilovolt transmission lines and control cables would have to be relocated, one along Steel Creek and another paralleling Indian Grove Branch. In addition, a wooden-pole line of the South Carolina Electric and Gas Company would have to be replaced with tall steel towers at both Steel Creek and Pen Branch; five new towers and 2500 meters of new conductor would be needed. Steel towers and new conductor would also be needed where another 115-kilovolt transmission line and control cable line cross Pen Branch near Road C, where the Steel Creek lines cross the new pond south of Road B, and where the Indian Grove Branch lines cross the new pond near Road B.

Water from the Savannah River would be pumped to Kal Pond to supply makeup water for both K- and P-Reactors at about 4.7 cubic meters per second. The blowdown of 0.8 cubic meter per second would be divided equally between Pen Branch and Steel Creek.

B.2.2.4 High-Level Pond

Two sites on the Pen Branch drainage area north of L-Reactor were studied for creating a High-Level Pond dam; both would provide the same water elevation, 82 meters. The first site would provide a pond area of approximately 1225 acres; the dam would be about 1300 meters long with a maximum height of approximately 32 meters. This pond would have a lower cooling efficiency than the other alternative cooling ponds. Therefore, a second dam site (Figure B-9) was studied that would add 560 acres to the previous pond. This dam would be about 2750 meters long with a maximum height of 35 meters. Two sections of earthen berm would have to be constructed across a natural saddle west of this dam; they would total 460 meters long but not more than 3 meters high.

Both of these dams would be upstream from the existing river water lines and, therefore, would have no impact on them or on the proposed steam line from K-Reactor to L-Reactor. However, both would require the abandonment of Road C between Roads 6 and 7. In addition, approximately 1200 meters of Road 6 would have to be raised as much as 12 meters.

Thermal effluent from the reactor would flow through existing pipes to a new reinforced concrete sump, similar to that required by the cooling-tower alternative. The thermal effluent would be pumped through a new pipeline and discharged into the High-Level Pond. The water would flow through the pond to the intake structure near the dam and would flow by gravity back to the L-Reactor reservoir.

Makeup water would be pumped from the Savannah River at a rate of about 2 cubic meters per second. The blowdown would be discharged to Pen Branch a few degrees centigrade above ambient at a rate of about 0.4 cubic meter per second.

B.2.2.5 Par Pond

Under this alternative, Par Pond would be used to cool the effluent from both P- and L-Reactors. A pumping station similar to that required for the cooling-tower alternative, but with larger pumps (because of the longer pumping distance) would be built south of L-Reactor (Figure B-10). An underground discharge pipe from these pumps would extend north of L-Reactor to the ridgeline between the Pen Branch and Lower Three Runs Creek (Par Pond) watersheds. At this point, the pipe would discharge into an excavated canal. The new canal would follow the ground contours to the northeast of R-Reactor, and continue around the north side of R-Reactor to connect to Pond A near the R-Reactor effluent canal. From this point, the cooling-water for L-Reactor would follow the same path through Par Pond that the R-Reactor cooling water followed when that reactor was operating.

The Par Pond pumphouse served both P- and R-Reactors for some time. However, the Par Pond pumphouse and the existing water lines would require major upgrading to provide sufficient cooling water return from Par Pond to either L-Reactor or P-Reactor. A new underground pipeline would be required from the pumphouse on Par Pond paralleling the existing "P-to-R" river water line to a point near P-Reactor.

Savannah River makeup water requirements under two-reactor operation would be similar to those for Kal Pond. Blowdown would be discharged to Lower Three Runs Creek a few degrees centigrade above ambient at a rate of less than 1 cubic meter per second.

B.3 SCHEDULE AND COSTS

The 10 alternative cooling systems described in the preceding sections are evaluated here on the basis of schedule and costs.

B.3.1 Schedule

A principal factor considered in this assessment is the time needed to implement the alternatives. The overall schedules took into consideration the time needed to design, permit and construct each alternative. Table B-1 gives the estimated amount of time that would be required to implement the alternative cooling systems.

Operation of L-Reactor is needed as soon as upgrading has been completed--currently scheduled for October 1983. Based on this criterion, some of the once-through cooling alternatives could be implemented in order to meet the schedule. The recirculating cooling alternatives require extensive periods of time to design, permit, and construct; therefore, they cannot be operational until at least 1.5 years after October 1983. The recirculating systems are not viable alternatives to the base case, and were not considered further in this assessment.

B.3.2 Capital costs

The preliminary capital costs for all of the alternative cooling systems are summarized in Table B-2; capital costs for the recirculating cooling systems equal or exceed 39 million dollars. Because of the protracted procurement process and high capital costs, the recirculating cooling alternatives are not viewed as practicable. Only the once-through cooling systems appear to be viable alternatives based on these preliminary capital cost estimates.

Table B-1. Alternative cooling systems: estimated schedule requirements (months) for design, permitting and construction

Alternative	Schedule requirements (months)
Direct discharge to Steel Creek	Standby
Spray canal/Steel Creek	18-24
Small impoundments on Steel Creek	
Rubble dams	18-24
500-acre lake	24-30
Diversion to Pen Branch	
Pen stock and canal	24-30
Small lake and canal	24-30
Cooling towers	36-42
L-Pond	48-54
Kal Pond	60-66
High-Level Pond[a]	42-48
Par Pond	36-42

a. Schedule based on comparison with other recirculation cooling systems.

Table B-2. Alternative Cooling systems: estimated capital costs[a]

Alternative	Capital costs (Millions of dollars)
Direct discharge to Steel Creek (base case)	Standby
Spray canal/Steel Creek[b]	5
Small impoundments on Steel Creek	
Rubble dam	3
500-acre lake	14
Diversion to Pen Branch	
Pen stock and canal	6
Small lake and canal	4
Cooling towers	39
L-Pond	72
Kal Pond	130-140
High-Level Pond[c]	100-120
Par Pond	47

a. Source: du Pont (1982).

b. Capital costs for a pumped spray cooling system are estimated to be similar in magnitude to those for cooling towers.

c. Cost based on comparisons with other recirculation cooling systems.

B.4 WETLANDS ASSESSMENT

This section describes the potential environmental effects to wetlands resulting from the implementation of the once-through cooling water systems. As stated previously, recirculation systems were eliminated from further consideration because of prolonged schedule requirements and high capital costs.

The Savannah River Plant contains approximately 39,000 acres of wetlands. Of this area, some 31,400 acres consist of bottomland hardwoods and about 7800 consists of swamp adjacent to the Savannah River. Although the wetlands are inhabited by certain endangered species and species of concern, these wetlands contain no critical habitats of endangered or threatened species, as recognized by the U.S. Fish and Wildlife Service (50 CFR 17.11-17.12).

Approximately 2800 acres of the 7800-acre Savannah River swamp have not been impacted by thermal discharges from operating reactors. Current SRP operation has impacted about 2000 acres of wetlands along Beaver Dam Creek, Four Mile Creek, and Pen Branch. Approximately 650 acres of Steel Creek wetlands were impacted prior to 1968 when both L- and P-Reactors discharged thermal effluent directly to Steel Creek. Sharitz et al. (1974) indicated that approximately 4700 acres of Savannah River swamp were impacted (about 1200 acres receiving moderate to intense impacts) by thermal effluent discharged from SRP operating reactors and coal-fired power plants. Discharges from L- and P-Reactors impacted about 380 acres in the vicinity of the Steel Creek delta.

Since L-Reactor was placed in standby status in early 1968, the wetland communities in the Steel Creek corridor and delta area have been undergoing natural sucession (i.e., recovering from thermal and flow induced impacts). These areas have progressed from floristic impoverishment to a condition of structural complexity (see Section 3.6 of the Environmental Assessment). Revegetation of the most intensely impacted swamp areas has increased by about 60 acres (Smith et al., 1981).

The discharge of thermal effluent from L-Reactor after restart could have the following effects on the environment:

- Erosion and sedimentation effects to streams and the progradation of their deltas in the swamp adjoining the Savannah River.
- Thermal flooding and fluctuating water level impacts on the vegetation in stream channels, floodplains, deltas, and the swamp.

Hydrodynamic effects, coupled with the thermal stresses induced by liquid effluent discharges, would eliminate trees and other vegetation in the streambed and portions of the swamp. Root systems would be exposed by erosion in some areas and buried by sediment in others. In addition to the impacts directly associated with the growth of the delta, some swamp vegetation would be eliminated by flooding, fluctuating water levels, and thermal stress. High rates of flow and fluctuating water levels (annual reactor use factor of about 65 percent) would adversely affect the wetlands vegetation. Macrophytes would be uprooted by the strong current, and woody flora would be eliminated due to prolonged inundation. Reproduction of wetlands vegetation in most areas would be reduced because of flooding and fluctuating water levels associated with production operation. In addition, the fluctuating water levels are expected to discourage spawning and inhibit the successful reproduction of fish.

B.4.1 Direct discharge to Steel Creek

The base case would discharge thermal effluent at about 11 cubic meters per second directly to Steel Creek as was done during pre-1968 operation of L-Reactor. Modeling of L-Reactor liquid discharges indicates that the thermal effluent will be discharged to Steel Creek at temperatures as high as 79°C during the summer. Cooling will occur as the effluent flows to the Savannah River. The thermal effluent will enter the swamp at temperatures between 40°C (spring) and 44°C (summer). When L-Reactor is operating, the segment of Steel Creek above the swamp will be subjected to temperatures greater than 40°C or at least 20°C above ambient creek temperatures.

The species which have been found in Steel Creek today are typical of similar nonthermal streams of the Savannah River Plant. The presence of stoneflies, mayflies, caddisflies and dragonflies indicate that Steel Creek is recovering from prior cooling water impacts. Collections of species of crustaceans (crayfish) have been similar in both Steel Creek and the nonthermal Upper Three Runs Creek. About 40 species of fish have been collected recently from Steel Creek. The present diversity of organisms in Steel Creek indicates that post-thermal recovery of the animal community has progressed in the past 13 years. Likewise, the water quality data of Steel Creek indicate that Steel Creek is recovering from previous thermal impacts.

When L-Reactor is restarted, its discharge is expected to have similar effects to those that occurred from 1954 to 1958 and from 1963 to 1968. Flooding and siltation associated with the thermal discharge are expected to modify aquatic habitat in the Steel Creek floodplain and delta. The delta is expected to expand into the swamp at a rate of about 3 acres per year. Some 250 acres of swamp are expected to be eliminated almost immediately and the remainder modified at a rate of about 7 to 10 acres per year. It is estimated that a total of about 1000 acres of wetlands will be impacted by direct discharge of thermal effluent to Steel Creek. This includes approximately 580 acres of the Steel Creek corridor and 420 acres of swamp. Aquatic macrophytes and woody plants will be lost in the Steel Creek corridor. Only thermophilic bacteria are expected to inhabit waters with temperatures greater than 40°C. Species that inhabit cooler backwater pools or other suitable substrates might experience a reduction in productivity.

Emergent wetland flora and submergent hydrophytes, which have revegetated the Steel Creek delta since 1968, will be eliminated and their substrates will revert to mudflats after resumption of operations. Some herbaceous flora will become established on exposed floodplain sediments and elevated stumps and logs of fallen trees. Almost all the shrubland communities also are anticipated to be eliminated. Because the water temperature at the confluence of Steel Creek and the Savannah River is estimated to be typical of southeastern warm-water streams (approximate summer ambient temperature of 27°C) no significant impact to riverine vegetation is expected.

During thermal discharge, Steel Creek will not be suitable for recreationally or commercially valuable fish. In addition, the warmer waters of Steel Creek might isolate the floodplain swamp from river fishes. Most, if not all, spawning activity could be eliminated; however, other similar spawning habitat is available in non-thermally affected areas on the Savannah River Plant and along the Savannah River. The most common fish remaining in the Steel Creek area probably will be the mosquitofish, although a few centrarchids might occur in backwater areas and tributary streams such as Meyers Branch (Cherry et al., 1976; McFarlane et al., 1978).

Except for backwater pools or other cool-water refuges, the high water temperatures from the outfall to the delta will make this section of Steel Creek uninhabitable for amphibian eggs and larvae. Adult life forms might survive along the stream margins, or relocate to adjacent habitats.

Reptiles are more dependent on aquatic habitat for food (i.e., insects, fish, amphibians) and shelter than for reproduction. The elevated water temperature and the elimination of prey organisms will eliminate the habitats of semiaquatic snakes and turtles upstream from the delta, and will cause a marked decrease in species richness. Portions of the delta might provide marginal habitat for water snakes and turtles following L-Reactor restart.

The endangered American alligator inhabits all parts of Steel Creek from the L-Reactor outfall to the cypress-tupelo forest adjacent to the Steel Creek delta; it also uses areas lateral to Steel Creek, including Carolina bays, backwater lagoons, and beaver ponds. The number of animals inhabiting the Steel Creek ecosystem is not known precisely, but 25 individuals have been observed. The base case will eliminate alligator habitat in Steel Creek from the reactor outfall to the Savannah River, except for backwater pools or other cool-water refuges, by increasing the water temperature above physiologically tolerable limits, eliminating its principal food sources, and possibly inundating its nests and shallow-water wintering habitats (Smith et al., 1981, 1982). Adult alligators can avoid thermal waters and migrate considerable distances overland. Overwintering alligators could be killed by thermal effluent if they were in a torpid condition but operations are scheduled to begin in October 1983 which would avoid this situation. Juveniles would also be expected to avoid thermal effluents, but smaller alligators might have more difficulty migrating to suitable habitats and could be more subject to predation. Nesting sites and eggs could be flooded by cooling water flow and destroyed. Also, once thermal effluents become established in the Steel Creek area, higher levels of red-sore disease bacterium could contribute to possible reduction in alligators which migrate to the thermally peripheral areas of the Steel Creek delta and floodplain.

Waterfowl and wading birds will be affected by the thermal discharge more than the other avifauna of the Steel Creek ecosystem. The use of Steel Creek above the delta by waterfowl is uncommon, but the delta and other areas above the Savannah River support hundreds of overwintering ducks, including the mallard, wood duck, black duck, blue-winged and green-winged teal, and hooded merganser. Wading birds such as the heron, egret, and wood stork also will lose feeding and breeding habitat along Steel Creek (Smith et al., 1981, 1982).

Semiaquatic mammals that will be affected by the thermal effluent include the beaver, river otter, mink, and muskrat. Adults should not experience mortality due to increased flow and temperature, and, except for the muskrat, these species are common throughout the Savannah River Plant.

B.4.2 Spray Canal on Steel Creek

During the summer, effluent entering this spray canal at a rate of about 11 cubic meters per second would be cooled by about 5°C and discharged to Steel Creek at about 74°C. Based on thermal modeling, effluent temperatures at Road A and Steel Creek delta would be 54°C and 42°C, respectively. These temperatures are two degrees cooler than the temperature of the base case effluent at the same locations. Given this slight reduction in effluent temperature and identical flow rates, the impact of a spray canal on wetlands will not differ significantly from the implementation of the base case (Section B.4.1). Delta growth would be about 3 acres per year, and approximately 980 acres of wetlands would be impacted. Furthermore, this option offers no mitigation to the habitat of the endangered American alligator.

B.4.3 Small Impoundments on Steel Creek

B.4.3.1 Rubble Dams

A series of rubble dams constructed on Steel Creek could provide several small ponds with a combined area of about 120 acres; this would displace wetland and upland plant communities. The thermal effluent discharged through these ~~ponds at 11 cubic meters per second would be cooled to about 40°C on discharge~~ from the last pond and 36°C where Steel Creek enters the swamp. This cooling water alternative would provide limited use of Steel Creek below Road A by some thermally tolerant aquatic organisms. However, this system would not maintain alligator habitat below road A, because of the general loss of prey organisms. Although this alternative provides some mitigation of thermal impacts below Road A, impacts will occur. Delta growth would be about 2 acres per year, and 930 acres of wetlands would be adversely affected by flooding, siltation, and thermal impacts. Flooding, controlled by the reactor operation schedule, will be intermittent and cause fluctuating water levels. The cooler temperatures in the vicinity of the delta would result in a decreased rate of vegetative mortality. However, flooding, siltation, and fluctuating water levels when coupled with the thermal effects will interrupt the vegetative succession that has been occuring in the swamp since 1968. Fluctuating water levels are expected to discourage spawning and the successful reproduction of fish.

B.4.3.2 500 acre lake

The impacts to wetlands from a 500-acre impoundment on Steel Creek would be generally similar to the preceding alternatives. Although lower effluent temperatures are projected at Road A (34°C) and the delta (32°C), the high rate of flow and fluctuating water levels (annual reactor use factor of 65 percent) would adversely affect the wetland vegetation. Macrophytes would be uprooted by strong currents, and woody flora would be eliminated due to prolonged inundation. Reproduction of wetlands vegetation in most areas would be uncommon because of flooding and fluctuating water levels associated with production operation. In addition, the fluctuating water levels are expected to discourage spawning and inhibit the successful reproduction of fish. Even with lower effluent water temperatures below Road A, vegetation will be lost in the Steel Creek corridor and on the delta. Habitat quality for the American alligator will be reduced in Steel Creek below Road A because of the loss of prey organisms. Delta growth is projected to be 2 acres per year; approximately 890 acres of wetlands would be impacted by this action. Additional acreage of upland vegetation will be inundated by the impoundment. The principal difference between this option and direct discharge or spray canal options is not the magnitude of impact, but the rate. Cooler temperatures in peripheral areas of the delta should enable limited vegetative establishment. Flooding, siltation, and fluctuating water levels, when coupled with the thermal effects, will interrupt the vegetative succession that has been progressing in the swamp since 1968. Approximately five years after operation, no appreciable difference in impacts to wetlands from this action is anticipated as compared to the base case.

B.4.4 Diversions to Pen Branch

The lower segment of Pen Branch presently receives thermal effluent from K-Reactor. Depending on the diversion method, approximately 2 to 5 kilometers of Pen Branch above Indian Grove Branch which have never received thermal discharge would receive heated effluent from L-Reactor. Flows in this reach of the stream would be about 10 times the natural flow rate at the point of L-Reactor discharge, resulting in appreciable stream erosion. Portions of Pen Branch are expected to be severely eroded by the downcutting, widening, and straightening of its channel. A mixture of sand and mud would be deposited in its delta region, resulting in the growth of the delta by 18 acres per year or more during the first 7-10 years of combined K- and L-Area discharges to Pen Branch and eventually modifying the heat dissipation characteristics of the swamp. Below the confluence of Pen Branch and Indian Grove Branch the combined K- and L-Reactor discharge would double the flow in the lower reaches of Pen Branch. The effluent temperature is estimated to be 58°C when the effluent enters the swamp. Approximately 715 to 875 acres of wetlands are expected to be adversely impacted. No mitigation of swamp habitat for the endangered American alligator will be achieved by this alternative.

B.5 SUMMARY

Five once-through and five recirculation cooling water alternatives to the proposed action were evaluated. The intent of this approach was to identify a cooling system that would be the most practicable under existing programmatic constraints. The schedule for design, permitting and construction for recirculation systems would range from 36-66 months. Thus, none of the recirculating systems can become operational by the restart date presently scheduled for October 1983. In addition, their capital costs exceed those of the once-through systems by 39 to 140 million dollars. The recirculation systems, therefore, were judged to be nonviable alternatives, and only the once-through systems received further consideration. Summarized below are the schedule, cost, and environmental effects on wetland from the base case and the four once-through cooling systems. Table B-3 presents an overall comparison of these options.

Direct discharge

The base case is to discharge thermal effluent to Steel Creek at a rate of about 11 cubic meters per second, as was done during previous operations of L-Reactor. The thermal effluent would gradually cool as it flowed through the Steel Creek corridor and swamp enroute to the Savannah River (Table B-3). The thermal effluent would again affect approximately 1000 acres of previously impacted wetlands of Steel Creek and the swamp adjacent to the Savannah River. As the L-Reactor cooling system for the base case is on standby, there are no schedule or capital cost constraints with this alternative.

Spray Canal on Steel Creek

A gravity-powered spray canal system would be installed in the L-Reactor outfall and operate in much the same manner as a conventional pumped spray cooling system. During the summer, effluent entering this spray canal at a rate of about 11 cubic meters per second would be cooled by about 5°C in the summer and discharged to Steel Creek at about 74°C. Additional cooling would occur as the effluent flows through Steel Creek and the swamp to the Savannah River (Table B-3). Impacts to the wetlands of the Steel Creek corridor and the swamp (about 980 acres) would be nearly identical to those of the direct discharge alternative. Captial costs for the spray system would be about 5 million dollars and would require about 18 to 24 months to implement. Spray cooling provides very little mitigation when compared to the direct discharge to Steel Creek (Table B-1).

Rubble dams

A series of rubble dams constructed on Steel Creek would provide several small ponds with a combined area of about 120 acres. The thermal effluent discharged through these ponds at 11 cubic meters per second would be cooled to about 36°C where Steel Creek enters the swamp (Table B-3). This cooling water alternative would provide limited use of Steel Creek below Road A by some aquatic organisms. However, this sytem would not maintain alligator habitat below Road A because of the general loss of prey organisms. Although this alternative provides some mitigation of thermal impacts below Road A, impacts will occur. Delta growth would be about 2 acres per year, and 930 acres of wetlands would be adversely affected by flooding, siltation, and thermal impacts. The vegetative succession that has been occuring in the swamp since 1968 will be interrupted. Fluctuating water levels are expected to discourage spawning and the reproduction of fish. Captial costs are estimated to be about 3 million dollars with an

Table B-3. Comparison of once-through cooling water alternatives

Evaluation Criteria	Direct discharge to Steel Creek—base case	Spray Canal on Steel Creek	Small impoundments on Steel Creek		Diversions to Pen Branch	
			Rubble dams	500-acre lake	Penstock and Canal	Small lake and canal
Schedule (months)	Standby	18–24	18–24	24–30	24–30	24–30
Capital costs (millions of dollars)	Standby	5	3	14	6	4
Thermal effects (summer water temp. °C)						
Outfall at Steel Creek	79	74	79	79	79	79
Discharge from Pond	NA	NA	40	36	NA	77
Road A	56	54	38	34	77	77
Entry to swamp	44	42	36	32	58	58
Entry to Savannah River	32	31	30	29	30	30
Habitat effects						
Habitat modification (acres affected)	1010	980	930	890	875	715
American alligator (endangered)	yes	yes	yes	yes	possible	possible
Delta growth (acres/year)	3	3	2	2	18	18

NA = not applicable.

overall schedule of about 18-24 months to implement (Table B-3). Because the mitigation is small in relation to the capital costs, this alternative is considered to be less desirable than the base case.

500-acre lake

A 500-acre lake on Steel Creek could be created by placing a dam with a elevation of about 55 meters north of the intersection of Road A and the Seaboard Coast Line Railroad. Underflow baffles would be used to maximize cooling effeciency. The thermal effluent discharged from the lake at 11 cubic meters per second would have a exit temperature of about 36°C and about 32°C on entry to the swamp (Table B-3). Thus, mitigation offered by this alternative is expected to be similar to that afforded by rubble dams. However, this system would not maintain alligator habitat below Road A because of the general loss of prey organisms. Delta growth would be about 2 acres per year, and 890 acres of wetlands would be adversely affected by flooding, siltation, and thermal impacts. Flooding, controlled by the reactor operation schedule, will be intermittent, but will, on an annual basis, occur about 65 percent of the time. The cooler temperatures in peripheral areas of the delta would support limited vegetative growth. However, flooding, siltation, and fluctuating water levels when coupled with the thermal effects will interrupt the vegetative succession that has been occurring in the swamp since 1968. Fluctuating water levels are expected to discourage spawning and the reproduction of fish. Capital costs are estimated to be about 14 million dollars with an overall schedule of about 24-30 months to implement (Table B-3). Because mitigation is small, restart is delayed, and capital costs are markedly higher than direct discharge, this option is not considered to be a viable alternative to the base case.

Diversions to Pen Branch

L-Reactor thermal effluent could be diverted to Pen Branch to mitigate the impacts on the wetlands of Steel Creek. Pen Branch presently receives thermal effluent from K-Reactor. Depending on the diversion method (Table B-3), approximately 2 to 5 kilometers of Pen Branch above Indian Grove Branch which have never received thermal discharge would receive heated effluent from L-Reactor. Flows in this reach of the stream at the point of L-Reactor discharge would result in appreciable stream erosion and thermal impacts. Below the confluence of Pen Branch and Indian Grove Branch the combined K- and L-Reactor discharge would double the flow in the lower reaches of Pen Branch. The effluent temperature is estimated to be 58°C when the effluent enters the swamp. Approximately 715 to 875 acres of wetlands and Pen Branch floodplain are expected to be adversely impacted. Capital costs are estimated to be 4 to 6 million dollars, with an overall schedule of 24 to 30 months to implement. This cooling-water alternative is considered to be impracticable because (1) it will adversely impact appreciable acreage of wetlands in the stream and swamp that have not been previously impacted; (2) stream erosion and associated growth of the Pen Branch delta would decrease the heat dissipation properties of the swamp; and (3) design, permitting and construction phases cannot be completed until a year or more beyond the October 1983 time frame established by programmatic requirements.

Conclusions

The magnitude of impacts to wetlands from the once-through cooling systems is predicted to be relatively similar in terms of affected acreage; approximately 700 to 1000 acres of wetlands would be adversely impacted. The effects of implementing a spray canal system would be nearly identical to the base case.

The implementation of small impoundments on Steel Creek were also found to offer no appreciable advantage as compared to the other once-through options. Although a series of small ponds or a single 500-acre impoundment would provide limited thermal mitigation below Road A, the rate of flow and fluctuating water level would still eliminate the wetland communities above the delta; in addition, vegetative mortality within the swamp would approach levels predicted for the other discharge options into Steel Creek.

The diversions to Pen Branch were judged as environmentally unacceptable because: (1) previously unimpacted wetlands would be affected, (2) thermal impacts to the Savannah River swamp would increase in magnitude, (3) stream erosion and associated growth of the Pen Branch delta would decrease the heat dissipation properties of the swamp, and (4) schedule and costs were prohibitive.

It is concluded, therefore, that the base case is the most reasonable option based on schedule, costs, and impacts to wetlands. The markedly higher costs and schedule delays associated with the other once-through cooling water alternatives do not justify their minimal mitigating effects predicted with their implementation.

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