4.2.4.2 Environmental Impacts

4.2.4.2.1 No Action

The continued operation of the River Water System would have no new impacts on the existing ambient air quality at the SRS. The water flow in the streams derived from pumping water from the Savannah River does not contribute additional air contaminants to the surrounding environment. Vegetative regrowth would mitigate potential exposure of dried sediment to winds due to natural fluctuations in stream flows.

4.2.4.2.2 Shut Down and Deactivate

The shutdown and deactivation of the River Water System would enable the receiving streams to return to a natural base flow; the small change in stream flows would not likely expose an appreciable amount of sediments. The potential for resuspension of contaminated sediment due to exposure to windborne currents would be minimal, and no impacts to ambient air quality would be likely.

DOE does not expect the vaporization of organics from dried sediment because an analysis of Steel Creek channel sediments indicates that no organic contaminants are present at levels close to EPA risk-based concentrations, which DOE used as screening levels at the SRS (DOE 1996c).

TE | As discussed in Section 4.1.5.2.2, the reduction in streamflow is not likely to result in exposed sediments. Vegetative cover would minimize the resuspension of contaminated soils.

4.2.4.2.3 Shut Down and Maintain

The shutdown and maintenance of the River Water System would have no impacts on the ambient air quality, as discussed in Section 4.2.4.2.2.

4.2.5 ECOLOGY

4.2.5.1 Affected Environment

4.2.5.1.1 Terrestrial Ecology

The *Environmental Assessment for the Natural Fluctuation of Water Level in Par Pond and Reduced Flow in Steel Creek Below L-Lake at the Savannah River Site* (DOE 1995a) evaluated the potential impacts to fish and wildlife of 10-cubic-foot-per-second (0.28-cubic-meter-per-second) flows in Steel Creek and Lower Three Runs. The environmental assessment concluded that impacts to downstream biotic resources would be small. Because the assessment evaluated potential impacts of 10-cubic-foot-per-second flows in these streams to terrestrial biota, this section does not discuss terrestrial wildlife.

Wike et al. (1994) summarizes existing ecological information on the major stream drainages of the SRS, including Fourmile Branch and Pen Branch/Indian Grave Branch. This includes limited information on the plant communities and terrestrial wildlife that occur along these streams. Because the Proposed Action would not affect terrestrial wildlife in the Fourmile Branch and Pen Branch areas, this section does not include detailed descriptions of terrestrial wildlife communities in these areas.

4.2.5.1.2 Aquatic Ecology

Fourmile Branch

The Fourmile Branch watershed includes a number of SRS facilities: C-Area (reactor), F- and H-Areas (separations), Defense Waste Processing Facility, and the Solid Waste Disposal Facility. Before C-Reactor was placed on standby in 1985, heated effluent was discharged into Fourmile Branch via Castor Creek. Flows in Fourmile Branch approached 400 cubic feet per second (11.3 cubic meters per second) when

C-Reactor was operating. Water temperatures exceeded 140°F (60°C) in Fourmile Branch downstream of its confluence with Castor Creek (Wike et al. 1994). In its lower reaches, Fourmile Branch broadens and flows through a delta created by the deposition of stream sediments.

Pen Branch and Indian Grave Branch

Pen Branch rises in the approximate center of the SRS and flows southwest to enter the Savannah River swamp. In its headwaters, Pen Branch is a small, largely undisturbed blackwater stream. Until K-Reactor was shut down in 1988, Indian Grave Branch received thermal effluent from K-Reactor. With K-Reactor operating, the natural flow of 10 cubic feet per second (0.28 cubic meter per second) increased to 400 cubic feet per second (11.3 cubic meters per second). Since 1988, the Pen Branch/Indian Grave system has received only nonthermal effluents (i.e., cooling water from auxiliary systems, ash basin runoff, sanitary waste water) from K-Area and sanitary effluent from the Central Shops Area (Wike et al. 1994).

The macroinvertebrate communities of Pen Branch were surveyed from 1983 to 1985 when K-Reactor was discharging heated effluent to Pen Branch, and in 1988 and 1989 after the K-Reactor shutdown (Wike et al. 1994). Prior to the shutdown of K-Reactor, portions of Pen Branch directly downstream from the reactor outfall contained few benthic macroinvertebrate taxa, while areas further removed from the outfall (such as the Savannah River swamp) had a more diverse benthic macroinvertebrate community. The macroinvertebrates in thermally-impacted areas were generally pollution-tolerant forms (e.g., chironomids, nematodes, and oligochaetes) capable of surviving high temperatures and low oxygen levels. After the shutdown of L-Reactor, macroinvertebrate communities began to recover, with densities and taxa richness generally higher (86 taxa collected in 1988-1989 versus 51 taxa in 1984-1985). The benthos continued to be dominated by pollution-tolerant groups (e.g., chironomids and black flies) after L-Reactor was shut down.

Aho et al. (1986) investigated the community structure of fishes in Pen Branch, Meyers Branch, and Steel Creek in 1984 and 1985 as part of the Comprehensive Cooling Water Study. Steel Creek had the highest species diversity, with slightly lower values for Pen Branch and Meyers Branch. Within each stream, diversity was highest at downstream sites.

Upper reaches of Pen Branch were characterized by low species richness (11 species collected) and diversity: six species [mud sunfish (*Acantharchus pomotis*), dollar sunfish (*Lepomis marginatus*), chubsucker (*Erimyzon* spp.), redfin pickerel (*Esox americanus*), brown bullhead (*Ameiurus nebulosus*), and pirate perch (*Aphredoderus sayanus*)] made up more than 91 percent of all fish collected (Aho et al. 1986). Lower reaches of Pen Branch contained more species (27), a higher percentage of which were small-bodied species [e.g., yellowfin shiner (*Notropis lutipinnis*), madtoms (*Noturus* spp.), and darters (*Percina* and *Etheostoma* spp.)] that are normally associated with blackwater streams of the Coastal Plain.

After K-Reactor was shutdown in April 1988, fish rapidly recolonized Pen Branch and Indian Grave Branch (Wike et al. 1994). Yellowfin shiners, bluehead chubs (*Nocomis leptocephalus*), and pirate perch were the most common species in the upper reaches of the stream. Largemouth bass (*Micropterus salmoides*), lake chubsucker (*Erimyzon sucetta*), redear sunfish (*Lepomis microlophus*, and redbreast sunfish (*L. auritus*) were most abundant in the middle reaches. Brook silversides (*Labidesthes sicculus*), coastal shiners (*Notropis petersoni*), spotted sunfish (*Lepomis punctatus*), and lake chubsuckers were most common in the delta. Indian Grave Branch collections were dominated by four species: spotted sucker (22.2 percent of total), coastal shiner (18.5 percent), lake chubsucker (14.8 percent), and redbreast sunfish (14.8 percent).

Steel Creek

Steel Creek originates near P-Reactor and flows southwest for about 2 miles (3 kilometers) before entering the headwaters of L-Lake. From the L-Lake Dam, Steel Creek flows south approximately 4 miles (6 kilometers) before entering the Savannah River swamp, and moves another 2 miles (3 kilometers) through the swamp before emptying into the Savannah River. Steel Creek began receiving thermal effluent from P- and L-Reactors in 1954. By 1961, the reactors were releasing a total of 850 cubic feet (24 cubic meters) per second of heated effluent into Steel Creek (Wike et al. 1994). In 1964, all P-Reactor effluent was diverted to Par Pond, and in 1968 L-Reactor was placed on standby. From 1968 to early 1985, Steel Creek recovered from the effects of SRS operations. The upper reaches of Steel Creek were impounded in 1985 to create L-Lake (see Section 4.1).

The abundance and distribution of benthic macroinvertebrates in the Steel Creek corridor, marsh/swamp, and lower channel region were evaluated from January 1986 through December 1991 (Wike et al. 1994). The macroinvertebrate communities in the Steel Creek corridor downstream of L-Lake were strongly influenced by seston inputs from L-Lake, and as a result contained high densities of filter feeding organisms (e.g., blackflies and net-spinning caddisflies). The macroinvertebrates of the lower reaches of the stream (delta and swamp) appeared to be less affected by releases from L-Lake. Amphipods, oligochaetes, caddisflies, isopods, gastropods, mayflies, and chironomids were all abundant in this portion of the stream.

Aho et al. (1986) investigated the community structure of fishes in Steel Creek, Pen Branch, and Meyers Branch in 1984 and 1985 as part of the Comprehensive Cooling Water Study. Steel Creek had the highest species diversity, with slightly lower values for Pen Branch and Meyers Branch. Within each stream, diversity was highest at downstream sites.

Upper reaches of Steel Creek were characterized by relatively-high species richness (29 species collected), while downstream portions of Steel Creek were characterized by high measures of species richness (43 species) and diversity (Aho et al. 1986). Upper reaches of Steel Creek were dominated by yellowfin shiners (54 percent of total), bluehead chubs (14 percent), northern hog sucker (*Hypentelium nigricans*) (11 percent), and redbreast sunfish (7 percent). Dusky shiners (*Notropis cummingsae*), spotted sunfish, pirate perch, yellowfin shiners, and tessellated darters (*Etheostoma olmstedi*) were collected most often in lower reaches of the stream. A number of species normally associated with river-swamp habitats contributed to the high diversity in lower Steel Creek.

Additional studies of Steel Creek fish were conducted after the restart of L-Reactor in 1985 (Wike et al. 1994). The fish community of the Steel Creek corridor was directly influenced by discharge of water from L-Lake to Steel Creek. Resulting increases in current velocity, stream width, and stream depth led to the displacement of small, minnow-like species typically found in headwater streams on the SRS (minnows and chubs) and the establishment of other species [e.g., bluegill (*Lepomis macrochirus*)] normally not found in high numbers in these small streams. After L-Reactor was shut down in 1988, fish were generally less abundant in Steel Creek as a result of a reduction in available habitat (Steel Creek became narrower and shallower). Sunfish and largemouth bass made up a larger proportion of the catch than in previous years.

Fish assemblages in the Steel Creek marsh and swamp were less obviously affected by the restart of L-Reactor in 1985 and subsequent shutdown of the reactor in 1988 (Wike et al. 1994). There was an apparent increase in the abundance of redbreast and bluegill after the restart of L-Reactor, and a reduction in abundance of brook silverside. Bluegill apparently emigrated from L-Lake to Steel Creek as larvae and juveniles. By 1988, a reproducing population of bluegill had become established in the Steel Creek marsh/swamp. Bluegill, which weren't collected in the Steel Creek marsh prior to 1986, made up 4.3 percent of fish collected in 1988. Spotted sunfish and largemouth bass were common in the marsh/swamp area of Steel Creek before (1983-1985), during (1986-1987), and after (1988) operation of L-Reactor.

Lower Three Runs

From the Par Pond Dam, Lower Three Runs flows about 24 miles (40 kilometers) before it enters the Savannah River. Before Par Pond was completed in 1958, heated effluent from R-Reactor [approximately 212 cubic feet per second (6 cubic meters per second)] was discharged to Lower Three Runs via Joyce Branch (Du Pont 1987b). In 1964 R-Reactor was shut down and heated discharge from P-Reactor was diverted from Steel Creek to Par Pond (Du Pont 1987b). P-Reactor was shut down in 1988. Historically, SRS operations caused large fluctuations in discharge immediately downstream of the Par Pond Dam, but groundwater and tributary inflows dampened these fluctuations several miles downstream (Wike et al. 1994).

4.2.5.1.3 Wetland Ecology

Steel Creek

Steel Creek and its main tributary, Meyers Branch, drain approximately 35 square miles (91 square kilometers) of the Aiken Plateau and flow to the Savannah River. The dam across Steel Creek creating L-Lake is approximately 3 miles (5 kilometers) upstream of the Steel Creek delta (Westbury 1993). | TC

Information characterizing the wetland vegetation of the Steel Creek corridor before the establishment of the SRS is not available, but Welbourne (1958) documents species present in and arour d the Steel Creek area during 1956 and 1957. Appendix D, Table D-8 lists these species. Upper Three Runs, a relatively undisturbed blackwater stream on the SRS, can illustrate the likely wetland vegetation of the Steel Creek corridor before the development of the SRS. Trees adjacent to the stream include tulip poplar, beech, sweetgum, willow oak, swamp chestnut oak, water oak, sycamore, and loblolly pine. Dogwood, red buckeye and American holly are also abundant. Tag alder is common along sandy stream margins. Macrophytes in wet sites with open canopies include eelgrass (*V. americana*), pondweed (*Potamogeton epihydrous*), and bulrush (*Scirpus subterminalis*). Golden club (*Orontium aquaticum*), wapato (*S. latifolia*), water primrose (*Ludwigia* spp.), and knotweed (*Polygonum* spp.) occur on small floodplains (Workman and McLeod 1990). | TC

The Savannah River Swamp System, of which Steel Creek and its delta are a part, consists of a variety of habitats that support several vegetation community types. The undisturbed wooded areas in the swamp contain four distinct communities: black oak-ironwood (*Quercus nigra-Carpinus caroliniana*), laurel oak-deciduous holly (*Quercus laurifolia-Ilex decidua*), water tupelo-ash (*Nyssa aquatica-Fraxinus pennsylvanica*), and bald cypress-blackgum (*Taxodium distichum-Nyssa aquatica*). Dominants are primarily determined by the depth and frequency of flooding (Smith, Sharitz, and Gladden 1981).

Steel Creek received reactor effluents from 1954 to 1968. Table 4-38 lists reactor-area discharges to Steel Creek by time period and source. Steel Creek received thermal effluents from both P- and L-Reactors between 1954 and 1963 and then from L-Reactor alone until 1968 (DOE 1984). Reactor effluent water released to SRS streams was commonly hotter than 158° F (70°C), and in Steel Creek reached a peak discharge of 850 cubic feet (24 cubic meters) per second in 1961 (Wike et al. 1994). | TE

Discharges before 1968 produced elevated water levels, increased water temperatures, substrate erosion, and deposition of scoured sediments throughout much of the Steel Creek system. The stream, floodplain, and associated wetlands were either destroyed or severely

TE | **Table 4-38.** Reactor-area discharges to Steel Creek.[a]

Years	Discharge (cubic meters per second)[b]		
	P-Reactor	L-Reactor	Total
1954 to 1958	5.6	5.7	11.3
1958 to early 1961	9.3	9.3	18.6
Mid-1961	11.3	11.3	22.6
Late 1961 to late 1963	9.3	11.3	20.6
November 1963 to February 1968	0.4[a]	11.3	11.7
February 1968 to 1980	0.4[a]	0.0	0.4
1981 to 1984	0.5[a]	0.002[c]	0.5

a. Source: DOE (1984).
b. To convert cubic meters to cubic feet, multiply by 35.31.
c. Flow from sanitary and domestic sources from L-Area at ambient temperature. During cold-water testing, the flow has approached 6.2 cubic meters per second.

altered by resultant above-normal water levels, silt deposition, and elevated water temperatures TE | (Westbury 1993). Table 4-39 compares stream characteristics before and after Steel Creek received heated discharges from L- and P-Reactors.

Between 1951 and 1972, the stream channel width increased more than three times due to effluent scour (DOE 1984). A pattern of upstream erosion and downstream delta formation resulted from the interaction of the stream corridor gradients and the increased stream discharges. A broad, flat delta formed where Steel Creek flowed into the Savannah River swamp.

The elevation of the delta area was higher than the adjacent natural swamp as a result of reactor-associated sediment buildup, organic matter accumulation, and greater entrapment of sediment afforded by the vegetation (Smith, Sharitz, and Gladden 1981).

Effects on the vegetation in the Steel Creek corridor and delta varied with species sensitivity to the stresses of the thermal effluent discharges. A high incidence of tree death occurred in areas of the Savannah River swamp where the thermally impacted streams entered the swamp. For example, the areal extent of the tree kill in the Steel Creek delta exceeded 247.1 acres (1.0 square kilometer) in 1966. However, vegetation in the swamp was not eliminated; areas such as sandbars, stumps, and logs elevated above the water continued to support diverse plant communities (Smith, Sharitz, and Gladden 1981).

TE | **Table 4-39.** Steel Creek stream characteristics.[a,b]

Date	Width (meters)[c]	Average depth (meter)	Flow rate (cubic meter per second)[d]	Temperature (°C)
May 1951	5.1	0.30	0.59[e]	16.1
June 1972	16.5	0.37	0.79	24.6

a. Source: DOE (1984).
b. Based on measurements taken at Road A.
c. To convert meters to feet, multiply by 3.281.
d. To convert cubic meters to cubic feet, multiply by 35.31.
e. July 1951 determination.

With the cessation of reactor discharges to Steel Creek in 1968, much of the previously impacted floodplain corridor underwent revegetation to scrub-shrub and young bottomland hardwood forested wetlands between 1968 and 1981 (Du Pont 1987c). More than 85 species of plants representing 50 families were identified in Steel Creek corridor (see Appendix D, Table D-9) during a study in the summer of 1981 (Smith, Sharitz, and Gladden 1981). Section 4.1.5 describes the characteristic vegetation of the northern portion of the Steel Creek corridor and the portion inundated by L-Lake. Below the site of the future L-Lake Dam, the corridor was similar to the portion inundated by the lake. Wax myrtle, willow, and blackberry dominated the floodplain community behind a band of alder bordering the stream. The lower portion of the stream was a broad flat floodplain with braided stream channels, with a low persistent herb community intermixed with shrub thickets. Table 4-40 lists the wetland community types occurring in the Steel Creek corridor below the dam site (before dam construction). The classification system used for mapping followed the Cowardin method with some modification to more accurately portray the features of this system (Smith, Sharitz, and Gladden 1981). Appendix D, Table D-4 describes the mapping units in the lower portion of the Steel Creek corridor.

Studies of the Steel Creek delta between 1968 and 1981 showed the plant communities undergoing early successional invasion by marsh and scrub-shrub wetland species. The initial flora of the emergent sandbars was dominated by the rush-like annual *Fimbristylis autumnalis*, water primrose (*Ludwigia leptocarpa*), primrose willow (*L. decurrens*), sedges (*Cyperus* spp.), and the annual *Echinochloa walteri* (Du Pont 1987c). There was limited recovery of the forest in areas adjacent to the delta. In the summer of 1981, the Steel Creek delta was characterized by heterogeneous vegetation with 124 species representing 66 families (see Appendix D, Table D-10) (Smith, Sharitz, and Gladden 1981). The deltaic fan rapidly colonized and supported successional willow forest, buttonbush shrub communities, and herbaceous wetlands dominated by cutgrass (*Leersia* sp.). A deeper-water zone peripheral to the delta was characterized by scattered trees that were remnants of the original swamp forest, as well as stumps bearing shrubs, and submerged and nonpersistent aquatic herbs. The surrounding swamp forest communities that were less affected by reactor operations were characterized by closed canopies. These areas are dominated by cypress and tupelo in deeper water and by oaks and other bottomland hardwoods on the ridges and higher elevations.

Table 4-40. Wetland community types occurring in the Steel Creek corridor below L-Lake dam.[a]

Wetland community type	Mapping unit
Emergent	Persistent - *Leersia* spp.
Emergent	Nonpersistent - *Polygonum lapathifolium*
Scrub-shrub - Broad-leaved deciduous	*Cephalanthus occidentalis-Salix nigra*
Scrub-shrub - Broad-leaved deciduous	*Alnus serrulata*
Forested - Broad-leaved deciduous	*Salix* sp.
Forested - Broad-leaved deciduous	*Alnus serrulata-Myrica cerifera*
Forested - Broad-leaved deciduous	*Liquidambar styraciflua-Acer rubrum-Salix* sp.
Forested - Mixed deciduous	*Taxodium distichum-Nyssa sylvatica* var. *biflora*

a. Source: Smith, Sharitz, and Gladden (1981).

TE | Table 4-41 lists the wetland community types occurring in the Steel Creek delta. The classification system used for mapping followed the Cowardin method with some modification to portray more accurately the features of this system (Smith, Sharitz, and Gladden 1981). Appendix D, Table D-10 describes the mapping units in the Steel Creek delta (Smith, Sharitz, and Gladden 1981).

During the construction and filling of L-Lake from 1984 to 1985, the stream flow in Steel Creek at Road A ranged from 7 to 500 cubic feet (0.2 to 14.2 cubic meters) per second and averaged 261 cubic feet (7.4 cubic meters) per second. The restart of L-Reactor resulted in several changes in the Steel Creek floodplain. Water temperatures at the Steel Creek corridor sites were not greatly elevated when the reactor was in operation, so thermal impacts on floodplain vegetation were minimal. The changes were the result of an altered hydrologic regime and increased flows in the stream. Nearly 10 times the volume of water carried before reactor restart was discharged into the Steel Creek system during reactor operations. This increased flow altered the patterns of erosion and deposition in the channels and floodplain and caused extensive inundation of areas that had been relatively dry before the resumption of reactor operations (Westbury 1993). During this period, portions of the hardwood forest canopy opened and herbaceous vegetation invaded the areas where light penetrated to the forest floor (DOE 1990).

L-Reactor ceased operation in 1988; however, the L-Reactor Operations EIS (DOE 1984) had committed that, during reactor outages, DOE would maintain flow in Steel Creek at Road A at a rate of about 106 cubic feet (3.0 cubic meters) per second during the spring spawning season, and during the remainder of the year at a rate of about 53 cubic feet (1.5 cubic meter) per second during reactor outage (Wike et al. 1994). These flows were higher than normal Steel Creek flows to eliminate the potential for dewatering the stream through the fish spawning season during a reactor outage.

A recent mapping effort by the Savannah River Ecology Laboratory mapped aerial coverage of the Steel Creek corridor and delta (Wein 1996). Three vegetation classes were identified: TE | marsh, scrub-shrub, and hardwood. Table 4-42 lists the classes of vegetation and area of coverage for each. The dominant species in the marsh class were *Leersia* spp. and *S. latifolia.* Willow and buttonbush were the predominant scrub-shrub species. The hardwood class was predominated by a young developing stand of bald cypress, tupelo, and ash.

TE | **Table 4-41.** Wetland community types occurring in the Steel Creek delta.[a]

Wetland community type	Mapping unit
Aquatic Bed	Rooted Vascular - *Myriophyllum brasiliense*
Emergent	Persistent - *Leersia* spp.
Emergent	Nonpersistent - *Hydrolea quadrivalvis*
Scrub-shrub - Broad-leaved deciduous	*Cephalanthus occidentalis-Salix nigra*
Mixed Scrub-shrub - Nonpersistent emergent	*Cephalanthus occidentalis/Polygonum lapathifolium*
Forested - Broad-leaved deciduous	*Salix nigra*
Forested - Broad-leaved deciduous	*Quercus lyrata-Carya aquatica-Nyssa aquatica*
Forested - Broad-leaved deciduous	*Quercus laurifolia*
Forested - Mixed deciduous	*Taxodium distichum-Nyssa aquatica*
Forested - Mixed deciduous	*Taxodium distichum-Cephalanthus occidentalis*

a. Source Smith, Sharitz, and Gladden (1981).

Table 4-42. Aquatic macrophyte coverage of the Steel Creek corridor and delta, 1996.[a] TE

Class name	Area in acres (square kilometers)[b]
Water	106.3 (0.43)
Marsh	48.3 (0.20)
Shrub/Scrub	20.7 (0.08)
Hardwood	1,185.1 (4.80)
Totals	1,360.4 (5.51)

a. Source: Wein (1996).
b. To get square miles, multiply by 0.3861.

Lower Three Runs

Before 1958, heated effluent from R-Reactor discharged directly to Lower Three Runs through Joyce Branch. Lower Three Runs flows about 19 miles (31 kilometers) from the Par Pond Dam to the Savannah River. As a consequence of receiving cooling water effluent from R-Reactor (1953 to 1958) and the subsequent modification of stream flows after 1958 caused by the Par Pond Dam, the ecology of the stream has changed significantly since the early 1950s. In particular, the nature of the riparian habitats and associated floodplain wetlands along Lower Three Runs have changed.

For the most part, wetlands along Lower Three Runs downstream of Par Pond are bottomland-hardwood swamps associated with the floodplain (DOE 1990). Bottomland hardwoods on the SRS are typical of the mixed hardwood forests in low wet areas of the southeastern Coastal Plain (Workman and McLeod 1990). Common tree species in these areas are those that survive where flooding is of limited depth and normally restricted to the late winter and early spring when the plants are dormant (Whipple, Wellman, and Good 1981). Tree species of this type include several species of oaks (*Quercus* spp.), sweet-gum (*Liquidambar styraciflua*), cottonwood (*Populus heterophylla*), American elm (*Ulmus americana*), sycamore (*Platanus occidentalis*), and red maple (*Acer rubrum*). In addition, some scrub-shrub and other emergent wetlands are present in the main channel and tributaries of Lower Three Runs. Although most influenced by Par Pond releases, these bottomland areas have also been affected by beaver activity (DOE 1990). Some cypress-tupelo (*Taxodium* spp.-*Nyssa aquatica*) areas are located near the confluence of Lower Three Runs and the Savannah River.

4.2.5.2 Environmental Impacts

4.2.5.2.1 No Action

Aquatic Ecology

Under the No-Action Alternative, DOE would maintain flows in Steel Creek and Lower Three Runs at approximately 10 cubic feet (0.28 cubic meter) per second, which would approximate historic (pre-1951) base flows in Steel Creek in the area below L-Lake and represent minimum flow rates protective of aquatic life in Lower Three Runs (del Carmen and Paller 1993b). River water would no longer be pumped to Indian Grave Branch through K-Area or to Fourmile Branch through C-Reactor (see Section 4.2.2.1).

Fourmile Branch

Under the No-Action Alternative, river water would no longer be pumped to C-Area. At present, a small amount of river water discharges to Fourmile Branch as a result of valve leakage. Because this discharge represents a small fraction of the normal stream flow, no impacts are likely from its discontinuation.

Steel Creek

DOE committed in the Final EIS on L-Reactor Operations (DOE 1984) to maintain year-round minimum flows of 53 cubic feet (1.5 cubic meters) per second in Steel Creek below the L-Lake Dam. Because this requirement was based on the full reactor cooling water flow of 388 cubic feet (11 cubic meters) per second and L-Reactor was permanently shut down in 1988, the 53 cubic feet (1.5 cubic meters) per second minimum flow requirement was eliminated in 1994 (DOE 1995a).

DOE evaluated the potential impacts of reducing flows from L-Lake to Steel Creek by almost 80 percent, from 53 cubic feet (1.5 cubic meters) per second to 10 cubic feet (0.28 cubic meter) per second (DOE 1995a). To determine minimal flows that would preserve the ecological integrity of Steel Creek, a hydrological and ecological study of the Steel Creek watershed and its fisheries resources concluded that a flow of 10 cubic feet per second (0.28 cubic meter per second) would approximate the historic (pre-SRS) Steel Creek flow, and would result in the reestablishment of an aquatic community similar to the one that existed in Steel Creek before the creation of L-Lake (del Carmen and Paller 1993a).

DOE predicted a 10-cubic-foot- (0.28-cubic-meter-) per-second flow would favor fish species native to first- and second-order streams on the SRS (DOE 1995a). These would include many small schooling species (e.g., shiners) that feed on insects and a few small bottom-feeding species (e.g., madtoms) (Paller 1994). Because DOE expected a balanced biological community to develop under these conditions, it concluded that there would be no significant impacts (DOE 1995b).

DOE did not discuss possible impacts to other stream organisms, such as macroinvertebrates, but implied that the proposed reduction in Steel Creek flows would in time result in the development of a benthic community typical of first- and second-order Coastal Plain streams with more normal temperature and flow regimes (DOE 1995a). The benthic communities that developed from 1954 to 1968, when Steel Creek received massive volumes of heated effluent, and from 1985 to 1988, when Steel Creek received large volumes of L-Reactor cooling water, were atypical.

After the restart of L-Reactor in 1985, there were pronounced changes in the community structure of Steel Creek benthic macroinvertebrates and fish (Mason and Bowen 1993; Mattson et al. 1993b). These alterations in community structure were attributed to increased flows and sediment loads rather than increased heat loading from reactor operation. After July 1988 when L-Reactor was shut down, stream flows were considerably lower as a result of greatly reduced reservoir releases to Steel Creek. Fish abundance and diversity declined in the Steel Creek corridor and marsh/delta after the flow reduction. Changes in community structure of benthic macroinvertebrates were more subtle, but there appeared to be reductions in the abundance and diversity of these organisms as well.

Because DOE has described impacts of 10-cubic-foot (0.28-cubic-meter)-per-second flows to Steel Creek aquatic biota (DOE 1995a), this EIS does not discuss them further.

Lower Three Runs

Del Carmen and Paller (1993b) conducted an instream flow study on Lower Three Runs to determine the minimum discharge rate that would support a balanced biological community downstream of the Par Pond Dam. They concluded that a base flow of approximately 10 cubic feet (0.28 cubic meter) per second would result in the establishment of a balanced biological community, with a fish community typical of first- and second-order Coastal Plain streams in South Carolina (del Carmen and Paller 1993b). As noted above, this would be a stream fish community containing more small-bodied insectivores (shiners, chubs, and madtoms) and fewer large-bodied carnivores and omnivores (suckers, sunfish, and largemouth bass) than before. Because DOE has described impacts of 10-cubic-foot-per-second flows to Lower Three Runs aquatic biota (DOE 1995a), this EIS does not discuss them further.

Indian Grave/Pen Branch

Under the No-Action Alternative, DOE would continue to pump 4,800 gallons per minute (0.30 cubic meter per second) of river water to L-Lake to maintain the normal operating level of 190 feet (58.0 meters) and would continue to pump up to 200 gallons per minute (0.013 cubic meter per second) to K-Area for fire protection. An additional 200 gallons per minute of well water would be supplied to K-Area for compressor cooling. As a result, Pen Branch would continue to receive as much as 400 gallons per minute (0.025 cubic meter per second) of river water and well water from K-Area.

Flow in Pen Branch upstream of the confluence with Indian Grave averaged 7.7 cubic feet (0.22 cubic meter) per second over the 1983-1991 period (Wike et al. 1994). Under the No-Action Alternative, DOE would continue to discharge approximately 400 gallons per minute (0.89 cubic feet; 0.025 cubic meter) per second of river and well water to Pen Branch, augmenting the base flow of approximately 7.7 cubic feet per second.

Under the No-Action Alternative, Indian Grave Branch would probably support small numbers of shiners, chubs, pirate perch and darters; these minnow-like species are often found in first-order SRS streams (Aho et al. 1986; Wike et al. 1994). Flows in Pen Branch downstream of its confluence with Indian Grave Branch would probably be sufficient to support a more diverse fish community, with shiners, chubs, pirate perch, chubsuckers, small sunfish, and catfish (madtoms and bullheads). Projected flows in both Indian Grave Branch and Pen Branch would approximate natural flows, and aquatic communities would, over time, become more like the communities that existed prior to the operation of SRS production reactors.

Wetland Ecology

Steel Creek

Under the No-Action Alternative, DOE would ensure that Steel Creek received a minimum flow of 10 cubic feet (0.28 meter) per second. This flow was evaluated in the *Environmental Assessment for the Natural Fluctuation of Water Level in Par Pond and Reduced Water Flow in Steel Creek Below L-Lake at the Savannah River Site* (DOE 1995a). DOE concluded that no significant impacts to wetlands in Steel Creek were likely as a result of a return to the historic flow rate (DOE 1995b).

A stream flow of 10 cubic feet (0.28 cubic meter) per second could result in fewer extreme flooding events and fewer years with high annual floods. As a consequence, a narrowing of the riparian wetlands could occur downstream of the dam. Frequency, depth, and duration of flooding affect forest composition and vegetation patterns in bottomlands such as those found along the Steel Creek corridor (Workman and McLeod 1990). Plant species generally occur along a moisture gradient in these areas. Since flooding would be less frequent and less extreme under the 10-cubic-foot-per-second discharge scenario than in previous years, a denser understory could develop along with greater diversity in the herbaceous layer (Wike et al. 1994).

At present, most of the aquatic macrophyte coverage in the stream corridor and delta is in open water and marsh (Wein 1996). A return to the lower historic flow probably would result in shallower water and, therefore, a decrease in open water and marsh habitat. Tree species likely to invade the area include willow (*Salix spp.*), loblolly pine, sweetgum, cottonwood, cypress, and tupelo. An increase in scrub-shrub vegetation along the narrower stream corridor could occur. L11-18 This trend was observed in surveys conducted in the stream corridor between the cessation of cooler water discharges in Steel Creek in the late 1960s and the construction of L-Lake and the restart of L-Reactor in the mid-

1980s (Wike et al. 1994). For the most part, grasses and similar emergent species dominated in 1982 after 15 years of successional revegetation. Woody vegetation could reinvade after a return to the historic flow and could be dominated by willow (*Salix* spp.), as observed in the early 1980s.

As mentioned above, sediment accumulations raised part of the delta, resulting in lower water depths and favoring scrub-shrub invasion and establishment. If hardwood species became reestablished in the deltaic fan, it probably would eventually resemble deciduous bottomland forest rather than the original swamp forest (Wike et al. 1994). The lower water level and less severe flooding events could lead to the invasion of such woody species as sweetgum (*Liquidambar styraciflua*), laurel oak (*Quercus laurifolia*), water oak (*Quercus nigra*), ironwood (*Carprinus caroliniana*), winged elm (*Ulmus alata*), and water elm (*Planera aquatica*), which thrive in that environment. In addition, willows (*Salix* spp.) and buttonbush (*Cephalanthus occidentalis*) tend to dominate higher, drier areas of deltas on SRS, as do herbaceous plants such as sedges (*Carex* spp.), rushes (*Juncus* spp.), and water primrose (*Ludwigia* spp.) (Workman and McLeod 1990).

Lower Three Runs

Under the No-Action Alternative, DOE would ensure that Lower Three Runs received a minimum discharge of 10 cubic feet (0.28 cubic meter) per second. An in-steam flow study in Lower Three Runs Creek to determine the discharge rate from Par Pond that would both protect downstream natural resources and allow for the reduction of river water pumping to Par Pond concluded that a minimum flow of about 10 cubic feet (0.28 cubic meter) per second in the reach of Lower Three Runs below the Par Pond Dam would be sufficient to support a balanced fish community typical of a first/second order Coastal Plain stream (del Carmen and Paller 1993b). The *Environmental Assessment for the Natural Fluctuation of Water Level in Par Pond and Reduced Water Flow in Steel Creek Below L-Lake at the Savannah River Site* (DOE 1995a) evaluated the flow rate of 10 cubic feet (0.28 cubic meter) per second.

The 10-cubic-foot (0.28-cubic-meter)-per-second minimum flow would be roughly one-third of the mean historic flow (for 1974 to 1982 and 1987 to 1991) downstream of the Par Pond Dam of 36.5 cubic feet (1.0 cubic meter) per second (Wike et al. 1994). Although a stream flow of 10 cubic feet per second would support a balanced aquatic community, impacts to riparian wetlands could occur because this flow was below historic levels. The 10-cubic-foot-per-second flow probably would result in a narrowing of the Lower Three Runs stream corridor and floodplain compared to recent conditions. This flow below the Par Pond Dam would have less of an additive effect with runoff and groundwater discharge into Lower Three Runs (i.e., less total surface water) and would result in fewer extreme flooding events and fewer years with annual floods. As a consequence, a narrowing of the riparian wetlands would occur (McLeod 1996). This would be most noticeable in areas just downstream of the dam, where the flow rate is heavily influenced by releases from Par Pond.

Frequency, depth, and duration of flooding affect forest composition and vegetation patterns in bottomlands such as those along Lower Three Runs (Workman and McLeod 1990). Plant species generally occur along a moisture gradient in these areas. Because flows would be lower under the 10-cubic-foot (0.28-cubic-meter)-per-second discharge scenario and flooding would be less frequent than under historic conditions, a denser understory could develop along with greater diversity in the herbaceous layer. Over time, tree species such as white oak (*Quercus alba*), black oak (*Quercus velutina*), and mockernut hickory (*Carya tomentosa*) that are characteristic of drier, less frequently flooded areas could predominate (Whipple, Wellman, and Good 1981). Decades could pass before these changes in dominant tree species occurred (McLeod 1996).

An SRS Set-Aside Area, the Boiling Springs Natural Area, is approximately 7 miles (11 kilometers) downstream of the Par Pond Dam. Set-asides are undisturbed natural areas on the SRS that are protected to promote biological diversity and provide control data to evaluate the impacts of development (McFarlane 1988). The Boiling Springs Natural Area is an excellent example of an SRS bottomland hardwood community. Impacts to this area from the 10-cubic-foot (0.28-cubic-meter)-per-second flow and less frequent flooding probably would be minimal because this stretch of Lower Three Runs receives significant inputs from groundwater and runoff and is less dependent on Par Pond discharge. The cypress-tupelo wetlands near the confluence with the Savannah River would probably be unaffected by the 10-cubic-foot-per-second release from Par Pond because they are more than 17 miles (27 kilometers) from the reservoir and are much more strongly influenced by Savannah River flows and flooding.

4.2.5.2.2 Shutdown and Deactivate

Terrestrial, wetland, and aquatic impacts under this alternative would be identical to those described for the No-Action Alternative.

4.2.5.2.3 Shutdown and Maintain

Terrestrial, wetland, and aquatic impacts under this alternative would be identical to those described for the No-Action Alternative.

4.2.6 LAND USE

4.2.6.1 Affected Environment

Fourmile Branch, Pen Branch/Indian Grave Branch, Steel Creek, and Lower Three Runs flow through the SRS in a generally southerly direction and empty into the Savannah River. The streams are narrow at their headwaters, broadening into wide swampy deltas where they empty into the Savannah River. Section 4.2 provides a more detailed description of the flora and fauna along their paths.

DOE monitors the waters of these streams regularly for chemical, metal, physical, and biological properties and radioactive effluents; the monitoring frequency varies with the location and sample type. Sampling stations are upstream and downstream, including offsite portions of the streams. Hunting and fishing along onsite streams are prohibited; the number and frequency of people participating in offsite fishing and hunting are unknown.

As described in Section 4.1.6.1, DOE has a system in place to assist in making a decision about the future of SRS land and facilities. That section also contains information on the Future Use Project Team and its recommendations for SRS future use, the land and surroundings on the Site, and the current status of the National Environmental Research Park.

DOE has not identified any future mission or use, other than research and monitoring, for the SRS streams (Hill 1996).

4.2.6.2 Land Use Impacts

4.2.6.2.1 No Action

Under the No-Action Alternative, current uses of the streams would not change; their status would be the same as that described in Section 4.2.6.1. DOE would make decisions on future uses in accordance with Future Use Project recommendations and other avenues.

4.2.6.2.2 Shut Down and Deactivate

Activities associated with this alternative would not affect current or future uses of the streams. In relation to water quantity and quality, this alternative should not affect offsite downstream users of the streams; and DOE would maintain flow through natural recharge at 10 cubic feet (0.28 cubic meter) per second.

4.2.6.2.3 Shut Down and Maintain

As described above, activities associated with this alternative would not affect current or fu-